# CITIES 100

→ 100 solutions for climate action in cities

2017

SUSTAINIA

C40 CITIES
CLIMATE LEADERSHIP GROUP

Realdania

5

*SECTORS*

73

*CITIES*

100

*SOLUTIONS*

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# → 100 **solutions** for climate action in cities

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### ENERGY



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## ADAPTATION



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Foreword

# → Nothing Can Halt Our Green Ambitions

## How action on climate change is becoming the new normal in the world's great cities

On June 5, 2017, in response to President Trump's decision to withdraw the United States from the Paris Agreement, I signed an Executive Order reaffirming Washington, D.C.'s commitment to the historic deal. **The effects of climate change are already here,** and in Washington, D.C. – our nation's capital – we value building a more sustainable society and a greener future. At a moment in history when our federal government should be leading the way to protect our planet, the responsibility is instead falling to America's cities, with the support of states, businesses, and citizens, to provide global leadership.

More than 360 U.S. cities have now pledged to intensify their efforts to meet ambitious climate goals and work together to create a 21st century clean energy economy. In Washington, D.C. we have launched Climate Ready D.C., entered into one of the largest municipal onsite solar projects in the U.S., completed the largest wind power purchase agreement deal of its kind ever entered into by an American city, and committed to expanding access to solar to at least 100,000 low-income households.

Fortunately, mayors across the U.S. know that we are not alone in this work. This year's Cities100 exhibits extraordinary actions undertaken by cities of all sizes from around the globe. The 100 solutions presented here are not only proof that cities are leading the fight against climate change, but that green policies, projects, and investments are becoming central for functioning cities. **Climate action is becoming the new normal.**

Cutting greenhouse gas emissions and adapting our cities to withstand the effects of climate change is good for the environment and it is also making our cities healthier, happier, and more equitable. The cities that are acting fastest in creating more green spaces, incentivizing citizens to travel on foot, by bike, or on low-emission public transport, and creating jobs by investing in renewable energy will make our planet healthier and, in the years ahead, these cities will become the most desirable places to live.

In the days and weeks following the announcement that the U.S. would pull out of the Paris Agreement, cities around the world, including Washington D.C., lit up their city halls, buildings, and monuments green as a symbol of our collective commitment to fighting climate change. This simple act of global solidarity reveals just how interconnected our world has become. **As mayors and city officials, we recognize our responsibility and obligation to work together to share ideas that will accelerate climate action in cities everywhere.** Through powerful networks such as C40 and vital publications like Cities100 we are inspiring change like never before.

This year's Cities100 reveals the scale of our collective ambition to solve the climate crisis. Here you will find 100 steps in the right direction, 100 rebukes to those who would reject the Paris Agreement, and 100 arguments for turning the climate threat into new opportunities to build a better future.

"THIS YEAR'S CITIES100 REVEALS THE SCALE OF OUR COLLECTIVE AMBITION TO SOLVE THE CLIMATE CRISIS."

Muriel Bowser
Mayor of Washington, D.C.

## Introduction

# → 100 City Solutions for Advancing Climate Action

More than ever before, there is an acute need for action to solve the challenges posed by climate change. The Cities100, now in its third year, cements the fact that cities stand at the forefront when it comes to global climate action. From ditching fossil fuels to dedicating roads to cyclists, creating urban gardens on rooftops to launching city-wide adaptation plans, the 100 city solutions presented here demonstrate the innovative ways in which local governments all over the world are adapting cities and making them resilient to climate change, while at the same time creating valuable co-benefits for their economies, communities, and citizens' health.

These 100 solutions were selected from 175 submissions from 91 cities spread across the globe. By identifying 100 readily available city solutions, the partners behind Cities100 – C40, Realdania, and Sustainia – wish to highlight the potential for a sustainable urban future and inspire other change makers throughout the world.

### Uncovering the 100 projects

Cities100 is a mission shared by Sustainia, C40, and Realdania to find the 100 leading city solutions to climate change. To identify groundbreaking projects from around the world, C40 and Sustainia launched a public campaign for applications, which yielded 175 eligible project submissions. In order to find the projects with the largest potential to create low-carbon and resilient cities, the applications were vetted and assessed by city and climate change experts at C40 and Sustainia, who used a detailed scoring system based on five criteria:

**1 CLIMATE ACTION**

The expected or achieved $CO_2$ reduction and/or climate risk mitigation of the project.

**2 CO-BENEFITS**

The extent to which the project has positive co-benefits for other aspects of society, in addition to its climate change mitigation and $CO_2$ reductions.

**3 INNOVATION**

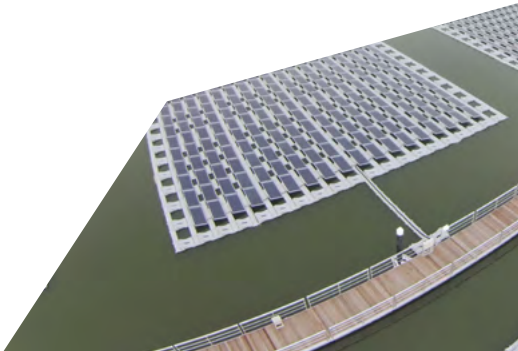
The extent to which the project takes an entirely new or groundbreaking approach to address major environmental issues.

**4 GOVERNANCE**

How well the project is incorporated into larger city plans, collaborates with other entities in the city, and engages citizens in the project's development and implementation.

**5 SHARING AND SCALING**

The extent to which the project experience is shared with other cities and regions, and the future potential to scale the project within the city.



## WHAT IS SUSTAINIA?

Sustainia is an international sustainability think tank and advisory group working to turn global risks into new opportunities and business ventures. We build stories, digital publications, and platforms based on our vast knowledge on sustainability for what we call 'the committed'; businesses, cities, and organizations that believe in innovating the world of tomorrow. We help them by translating knowledge into branding and strategic insights via owned and earned media, using innovative digital tools, trends, communication, and design. We are experts in mapping solutions and opportunities for a more fair, prosperous, and sustainable world. We apply this knowledge to our products ranging from event concepts and digital platforms to written "handheld" publications.

## WHAT IS C40?

The C40 Cities Climate Leadership Group connects more than 90 of the world's greatest cities, representing 650+ million people and one quarter of the global economy. Created and led by cities, C40 is focused on tackling climate change and driving urban action that reduces greenhouse gas emissions and climate risks, while increasing the health, wellbeing and economic opportunities of urban citizens. The current chair of the C40 is Mayor of Paris, Anne Hidalgo; and three-term Mayor of New York City Michael R. Bloomberg serves as President of the Board. C40's work is made possible by three strategic funders: Bloomberg Philanthropies, Children's Investment Fund Foundation (CIFF), and Realdania.

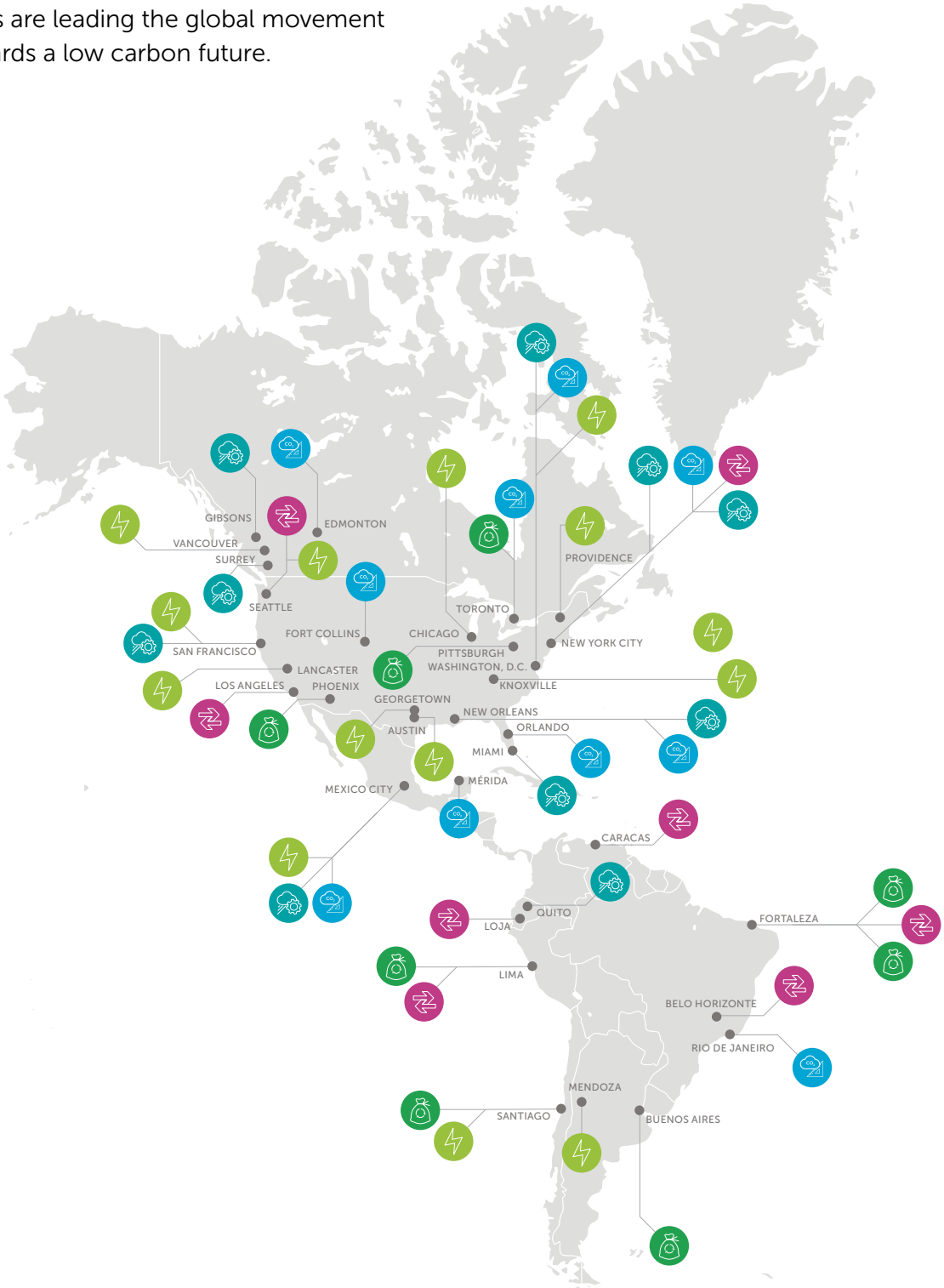
## WHAT IS REALDANIA?

Realdania is a Danish, modern philanthropic association that works to create quality of life and benefit the common good by improving the built environment: cities, buildings, and the built heritage. Realdania is both a Strategic Funder of C40 and a Founding Partner of Sustainia.

World Map

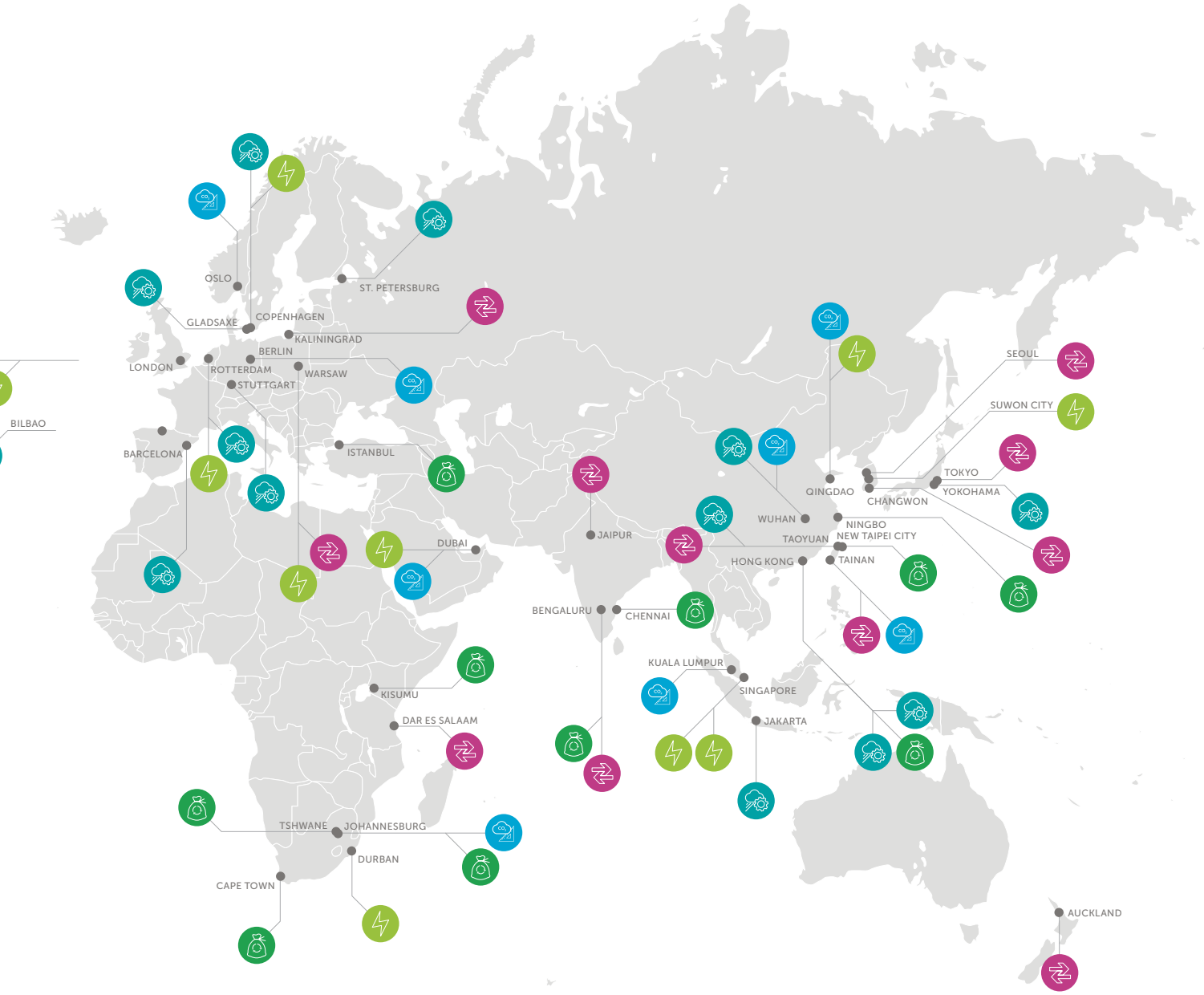
# → Putting City Solutions on the Map

Cities100 is a testament to the fact that cities are leading the global movement towards a low carbon future.



THIS PUBLICATION PRESENTS SOLUTIONS WITHIN 5 CITY SECTORS:

ENERGY WASTE ADAPTATION MITIGATION TRANSPORTATION



# ENERGY

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→ The solutions in the Energy sector demonstrate how clean energy is becoming the new norm in cities across the world, disrupting traditional power and heat markets, showing the impact of energy efficiency policy in new and old buildings, and displaying the growing role of data to deliver clean energy rollouts.

CITY: **AUSTIN**

# Commitment to Low-Cost Solar, Net-Zero Emissions

→ The people of Austin are blessed with abundant sunshine, and together with the municipal utility, they are committed to powering their lives using this incredible resource.

↓354K

TONS OF $CO_2$ SAVED YEARLY FROM SOLAR INVESTMENTS

## THE CHALLENGE

Texas was the leading crude oil- and natural gas-producing state in 2015[1], and shifting to clean energy runs up against this fossil fuel legacy. However, the state is now also the top producer of wind power in the USA[2] and solar is surging.

## CO-BENEFITS

### Economic

Austin's local solar industry employs more than 900 people and has created an estimated $370 million worth of local economic activity through direct investments in solar installations to date. Customers already save a total of around $7 million per year from currently installed solar.

### Health

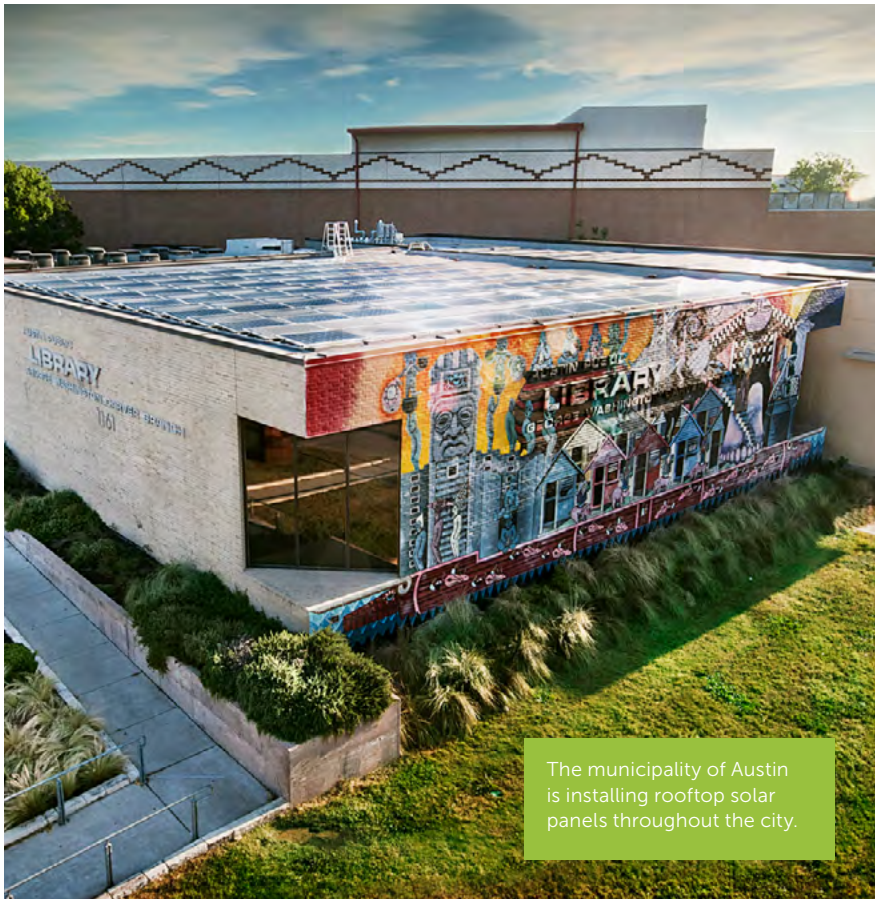
Shifting from coal- and natural gas-fired power plants to solar power reduces particulate emissions and improves local air quality for Austin's residents.

### Social

A proportional metering solution is under development that will enable the cost of solar installations in multi-family affordable housing properties to be split fairly amongst tenants. This will bring solar to properties and families that have traditionally been shut out of the solar energy market.

In the heart of Texas, a solar revolution is unfolding. Austin, the state capital, has set a goal of reaching net-zero greenhouse gas emissions by 2050, and plans to reach the target via solar commitments, innovative tariff structures, and electric storage integration. Austin's municipally-owned electric utility, in coordination with community stakeholders, aims to deploy **950 MW of solar by 2025, including 200 MW of rooftop solar, throughout the city.**

To meet these ambitious goals, Austin Energy is implementing a multi-prong solar strategy. Long-term procurement contracts with utility-scale solar plants will comprise the majority of the target, but to change attitudes and achieve community buy-in, Austin Energy is also developing clever tariffs to fairly spread the cost of solar and make solar accessible for all. **Their first community solar project was launched in early 2017,** with an 180-kW array at the Palmer Events Center. The utility also launched its own solar mapping tool, allowing residents to calculate the solar potential of their property.




The municipality of Austin is installing rooftop solar panels throughout the city.

[1,2] Energy Information Administration. Texas Energy Production Estimates. (2017.)

CITY: **CHICAGO**

# Energy-Saving Retrofits for Aging Housing Stock

→ Chicago is pursuing energy efficiency retrofits for the city's aging housing stock. In partnership with private, public, and nonprofit stakeholders, Chicago aims to cut energy consumption by 20% over five years.

**↓504K**

TONS OF $CO_2$ REDUCTIONS HAVE RESULTED FROM RETROFIT CHICAGO ACTIONS

## THE CHALLENGE

Buildings are responsible for an estimated 70% of Chicago's total emissions. Driving this down is key to unlocking easy carbon savings for the city.

## CO-BENEFITS

### Economic

More than $200 million has been invested as part of the scheme, boosting the local economy and creating jobs in construction and project management. Additionally, utility savings from the projects generated an estimated $45 million for residents, businesses, and city government.

### Health

Retrofitting homes with improved insulation not only improves energy efficiency but also means that residents can afford to heat their homes during cold winter nights, preventing temperature-related illness.

### Social

Several Retrofit Chicago projects have targeted Chicago's low-income, working-class neighborhoods. Investments in these properties improve the overall building stock for Chicago's low- and middle-income earners and provide utility savings for homes.

Around two-thirds of Chicago citizens live in a building 50 years of age or older – a third higher than the USA average – resulting in many power-hungry and leaky buildings. In the residential sphere, the city offers free energy assessments and expert recommendations as well as free installation of energy-saving products such as LED lights and certified water-saving showerheads.

The city has also embarked on "one of the largest municipal lighting modernization programs in the country," replacing 85% of the inefficient high-pressure sodium public street lights with power-saving LEDs. So far, **changes via this simple scheme have resulted in 173,000 tons of $CO_2$ reductions.**

Chicago is the USA's third-largest city. Outfitting street lights with LED bulbs has the potential to reduce around 25,000 tons of $CO_2$ annually.

CITY: **COPENHAGEN**

# Mapping Real-Time Consumption to Plan Efficiency Updates

→ Copenhagen is digitizing energy and water consumption data from municipal buildings to bring about significant savings and plan strategic efficiency upgrades.

**↑90%**

OF MUNICIPAL BUILDINGS SEND HOURLY DATA UPDATES ON ENERGY AND WATER USE

## THE CHALLENGE

Seventy-six percent of the water pipelines in Copenhagen are more than 60 years old, and 11% are more than 100 years old. With aging infrastructure comes a higher risk of leakage, so having a smart surveillance network can yield energy, water, and utility bill savings for residents.

## CO-BENEFITS

### Economic

Once fully implemented, the scheme is forecast to save approximately $6 million annually with a payback time of six years.

### Environmental

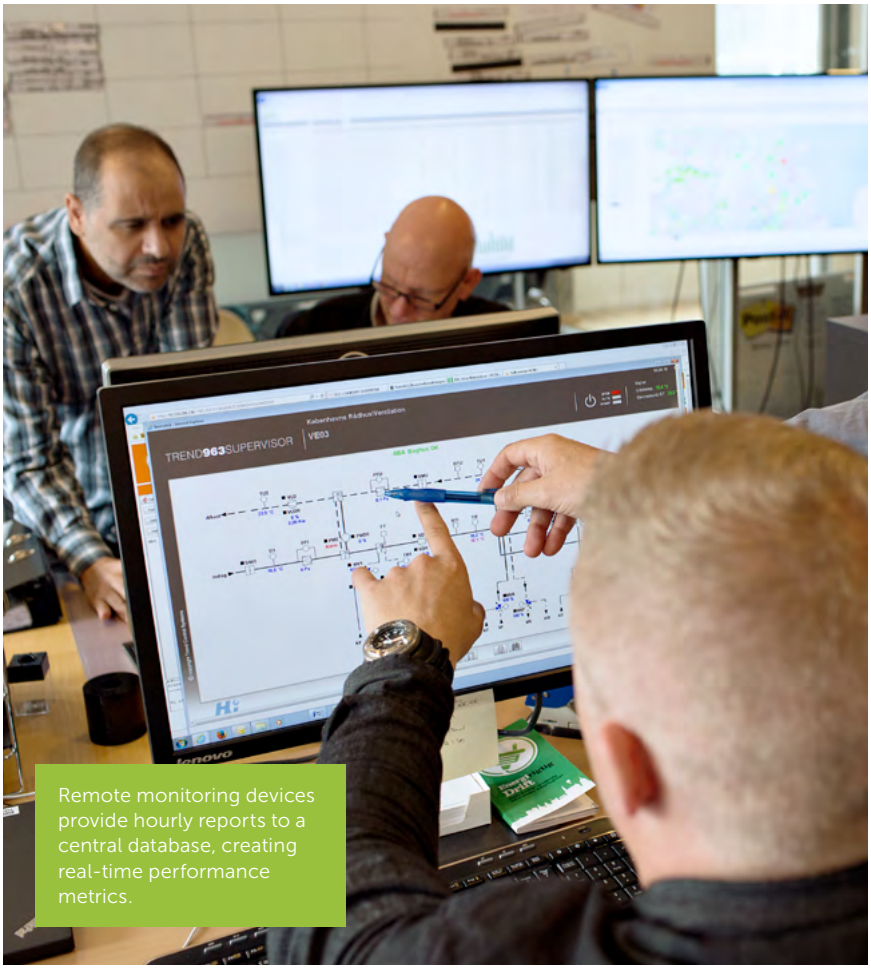
In addition to the energy savings the surveillance system is accruing, it is estimated that in 2016 the project saved 30 million liters of groundwater.

### Social

The city is working with schools to develop a program that uses the energy data for educational purposes to engage children in energy efficiency thinking from an early age.

The Municipality of Copenhagen is working with utility companies to establish extensive energy and water surveillance systems in all municipal buildings, providing data that can be studied and analyzed on one central platform. Using high-resolution data from smart electricity, heat, and water meters, the **city can identify leaks in real time** and plan strategic upgrades to inefficient buildings.

The scheme, which has a payback time of just six years, is unique in that it combines information from many building management systems on one platform. In 2016, the surveillance system helped to save **6,500 MWh of heat and 1,345 MWh of electricity.** The city plans to extend the scheme to some of the largest privately owned buildings in the capital, helping to further bring down energy consumption. This is part of the city-wide climate strategy that has put Copenhagen on the road to $CO_2$ neutrality by 2025.




Remote monitoring devices provide hourly reports to a central database, creating real-time performance metrics.

CITY: **DUBAI**

# Record-Breaking Solar Plant Aids Clean Energy Strategy

→ The people of Dubai are beginning to realize the enormous potential of their solar endowment, and are also targeting demand-side reductions in energy consumption to reduce their dependence on fossil fuels.

↑75%

CLEAN ENERGY GENERATION TARGET FOR 2050

## THE CHALLENGE

The United Arab Emirates' gross domestic electricity consumption has more than doubled over the past ten years and is forecast to surge over the next five years as population and GDP grow. Ensuring that growth begins to decouple from emissions is crucial to ensuring a sustainable future.

## CO-BENEFITS

### Economic

The demand-side strategy has yielded an estimated $1.5 billion from 2011-2015 in energy and water savings.

### Environmental

Five million tons of $CO_2$ are estimated to have been saved through energy and water saving activities since the start of the demand-side strategy in 2011.

### Social

The R&D center and innovation hub situated in the Mohammed bin Rashid Al Maktoum Solar Park will create economic and academic opportunities in the field of clean energy for the city and Gulf region.

Dubai's Integrated Energy Strategy (DIES) aims to reduce energy and water consumption as well as significantly increase the city's renewable energy generation. It is the first strategy of its kind in the Gulf region. On the demand side, Dubai wants to see a **30% reduction in water and electricity consumption by 2030,** and has developed a number of incentives and regulations designed to encourage flexible consumption activity and energy efficiency improvements.

On the supply side, **the city aims to have more than 1,000 MW of solar power installed by 2019,** which will include an 800 MW solar farm: the Mohammed bin Rashid Al Maktoum Solar Park. When the 25-year contracts were awarded in 2015, this solar plant broke global records for the lowest cost per unit of energy[1]. Once completed, it will cover 77 km² – an area roughly the size of Copenhagen – making it the world's largest solar plant on a single plot[2]. It will also contain state-of-the-art R&D and energy innovation centers.

The 800MW Mohammed bin Rashid Al Maktoum Solar Park is part of Dubai's Integrated Energy Strategy.

[1,2] Pothecary, S. Groundbreaking to commence on 800 MW solar plant in Dubai. PV Magazine. (2017, January 17.)

CITY: **DURBAN**

# Solar Framework Calls Citizens to Action

→ With an emphasis on educating and inspiring residents, Durban has created a framework enabling solar technology to flourish amongst its citizens.

**↑5,710**

MW IS THE ESTIMATED SOLAR ROOFTOP CAPACITY OF DURBAN[1]

## THE CHALLENGE

Eighty-seven percent of South Africa's primary energy consumption came from coal and oil in 2014. Establishing renewables in the energy mix will require an intelligent combination of national strategies as well as educational campaigns such as Durban's calling individuals to action.

## CO-BENEFITS

### Economic

Estimated annual savings from the pilot PV installations are more than $5,000. If the project was scaled to cover all municipal buildings, the city would save around $10 million annually.

### Environmental

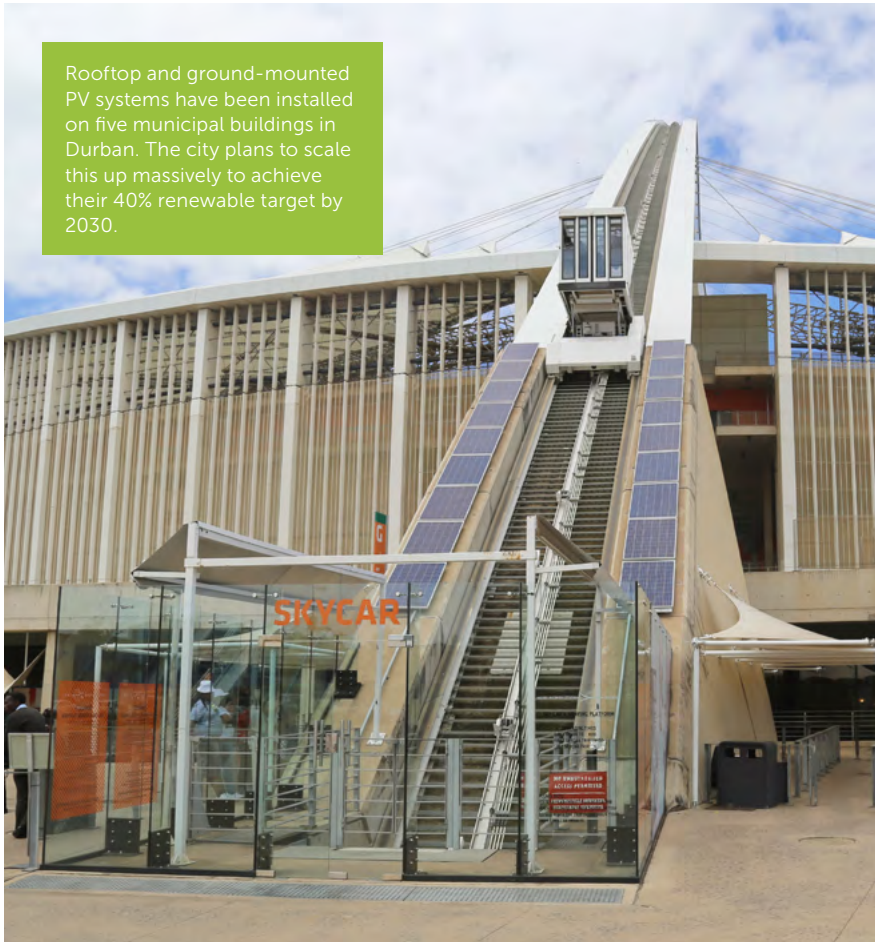
The rooftop PV pilot project delivered an estimated 82 metric tons of $CO_2$ reductions in February and March of 2017 alone.

### Social

Online educational tools, including the digital PV mapping tool, the renewable energy short course, and the educational website, are all ways the municipality spreads the word about the power of renewables.

Durban has created an evidence-based solar framework to promote the uptake of solar technologies in residential and commercial properties, stimulate local industry, and promote information sharing among municipalities to encourage further solar development. In a learning-by-doing approach, **the city has installed 300 kW of PV on five municipal buildings.** The lessons learned from these initial projects will feed into future policy developments and installations as the city adds to its solar portfolio on the 2,000 available municipal buildings.

In order to encourage solar uptake more widely, the city created the first **African PV mapping tool**, enabling residents and businesses to calculate the PV potential of their roof, estimate savings, payback time, and find a local installer. Additionally, they are developing an online short course about renewable energy as well as an educational website for people to learn more about the potential of solar technology.




Rooftop and ground-mounted PV systems have been installed on five municipal buildings in Durban. The city plans to scale this up massively to achieve their 40% renewable target by 2030.

[1] Fisher, N. & Downes, G. The Role of Coal for Energy Security in World Regions: South Africa. IEA Coal Industry Advisory Board. (Undated.)

CITY: **GEORGETOWN**

# 100% Renewable Electricity Supply Commitment

→ In the heart of Texas, Georgetown's utility is providing 100% renewable electricity to 60,000 citizens, proof that the economic and health benefits of renewables are difficult to oppose.

↓384K

TONS OF $CO_2$ PER YEAR SAVED BY TRANSITIONING TO 100% RENEWABLES[1]

## THE CHALLENGE

The population of Texas is expected to double in the next 50 years, putting pressure on already limited resources, including water. Wind and solar energy require essentially no water to operate and do not pollute water resources or stress supply by competing with agriculture or drinking water.

## CO-BENEFITS

### Economic

Customers can expect an almost-static electricity rate between $0.09 and $0.095 per kWh now and into the future. Comparatively, the coal and gas markets are notoriously unpredictable.

### Environmental

Transitioning to renewables can alleviate environmental concerns from fracking, used to extract natural gas from previously inaccessible fossil fuel reserves. These concerns include water pollution and unintended tectonic activity.

### Health

The flat landscapes seen across Texas are conducive to consistent winds, making it ideal for wind farm development, and particularly bad for coal plants, which produce particulate pollution damaging to health.

Georgetown Utility Systems (GUS) serves 60,000 people and has developed a new power plan focused on long-term, fixed-priced generation of renewable energy. The utility has entered into contracts with large wind (144 MW) and solar (150 MW) generators, using Renewable Energy Certificates (RECs) to guarantee renewable origins of electricity. As of April 2017, **the utility provides 100% renewable electricity to the people of Georgetown.**

With another large solar plant expected to come online in 2018, the utility will have more than enough power to guarantee renewable electricity supply, and is developing more decentralized solar options as well as storage solutions to meet future peak demand. By transitioning to 100% renewable electricity, GUS is providing customers with a **stable, long-term electricity price that mitigates any price volatility** associated with fossil fuels and potential future carbon legislation.

Wind turbines benefit from consistent winds that blow across the large swathes of flat land in the second-largest state in the USA.

[1]Ura, A. Report: Texas Population to Double by 2050. The Texas Tribune. (2015, March 5).

CITY: **KNOXVILLE**

# Energy Efficiency Retrofits Benefit City's Most Vulnerable

→ By using utility data to target the least efficient properties and most vulnerable residents in the city, and offering free energy efficiency upgrades, Knoxville targets social inequality while improving climate resilience and reducing emissions.

Knoxville Extreme Energy Makeover (KEEM) is a multi-partner program that is transforming Knoxville's oldest buildings by providing energy efficiency retrofits to some of the most vulnerable community members. In less than two years, KEEM has provided **whole-home energy efficiency upgrades to more than 1,200 low-income families** and educated more than 1,700 residents on how to take control of their utility bills via energy-saving habits.

Using data from the Knoxville Utilities Board to identify the least efficient properties, KEEM provides **comprehensive energy upgrades at no cost for families** who are struggling with utility bills and who live in older homes. Each home is audited to determine exactly what types of efficiency upgrades are most needed, and local contractors make the improvements. Community workshops educate and empower residents to further increase energy savings in their homes.

↓31%

ELECTRICITY USE REDUCTION ON AVERAGE PER HOUSEHOLD FOLLOWING A KEEM RETROFIT

## THE CHALLENGE

Knoxville charities spend around $5 million every year helping low-income families pay their bills. KEEM aims to address this problem at the source by improving the efficiency of aging buildings and reducing energy bill.

## CO-BENEFITS

### Economic

The average KEEM retrofit improves energy efficiency, saving families around $500 each year while improving home comfort.

### Environmental

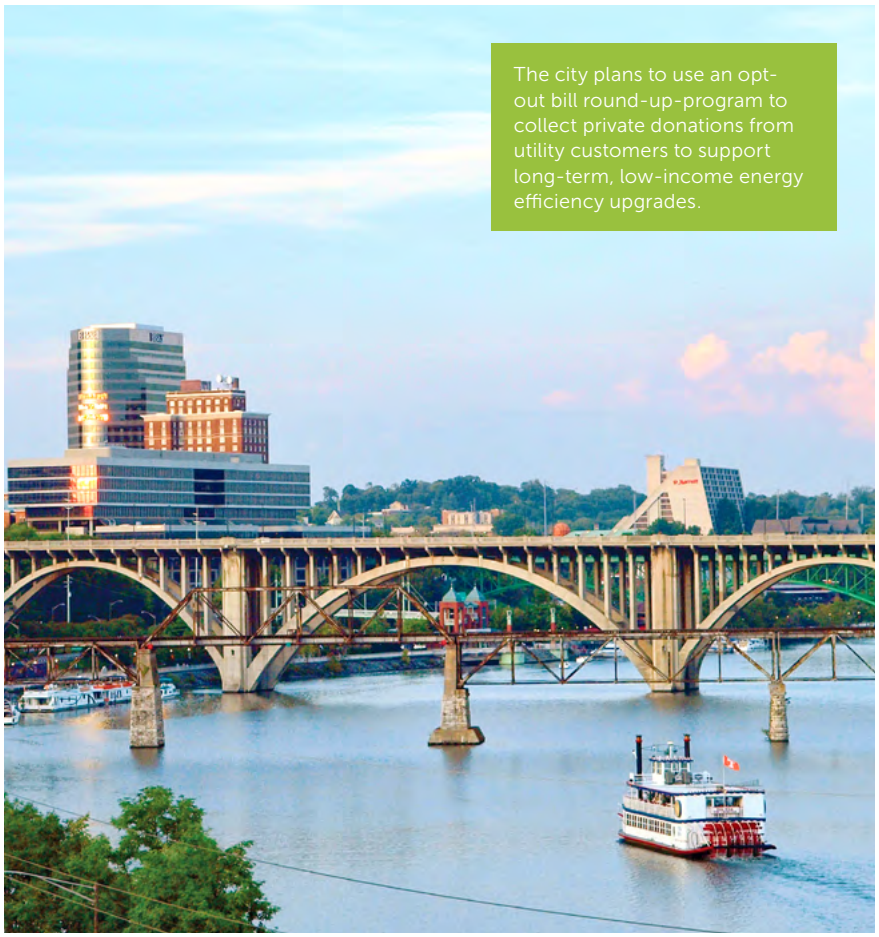
Collectively, the homes upgraded so far in the KEEM program save more than 6,055 MWh annually, the equivalent of taking 900 cars off the road.

### Health

By reducing energy bills, residents are able to afford heating and cooling when they need it most, reducing the risk of temperature-related health-problems.

### Social

KEEM hosted 150 free workshops to educate participants on energy efficiency, empowering citizens to take control of their energy bill and reduce energy consumption.



The city plans to use an opt-out bill round-up-program to collect private donations from utility customers to support long-term, low-income energy efficiency upgrades.

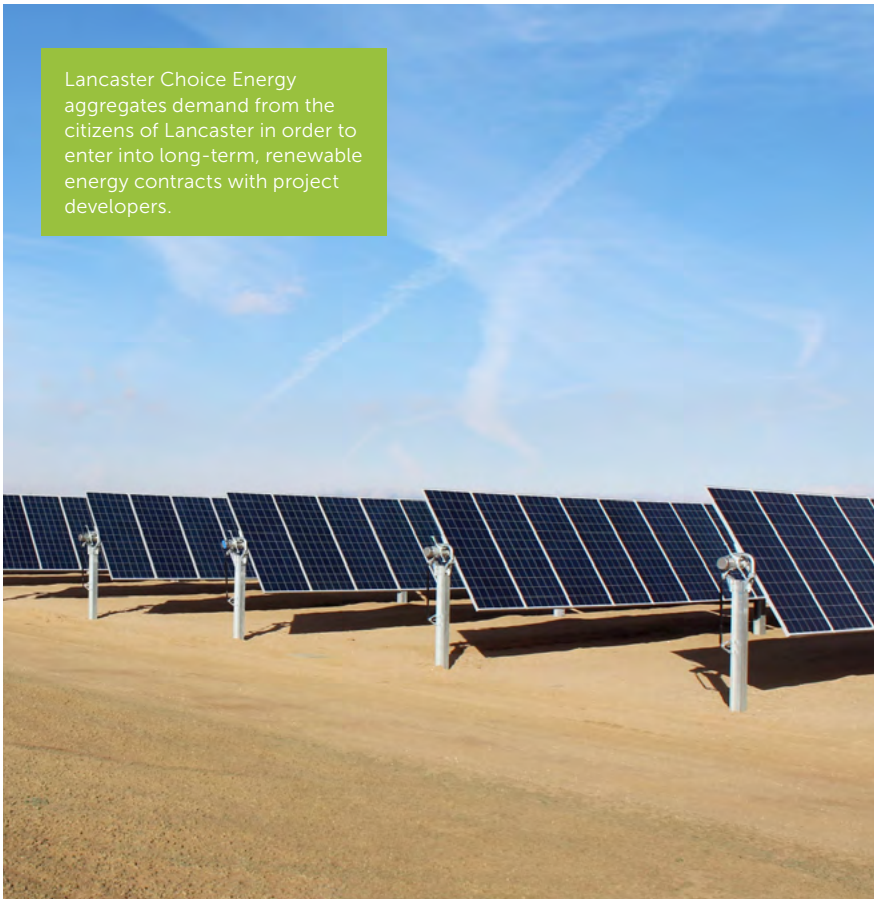
CITY: **LANCASTER**

# Strength in Numbers Enables Cheap, Clean Energy

→ The City of Lancaster aggregated energy demand from its citizens to secure long-term, fixed contracts with renewable energy producers and created its own electric service provider, which offers competitively priced, clean energy.

Lancaster Choice Energy (LCE) is the City of Lancaster's municipal energy supplier, which offers customers two tiers of renewable energy service. The first tier, Clear Choice, provides a 35% renewable plan and is the most cost-effective, with lower rates than the incumbent energy supplier. The second tier provides 100% renewable energy content for an extra $10 per month. In addition to a tiered tariff structure, **LCE also pays customers $.06 per kWh for solar electricity fed back into the grid.**

The City of Lancaster created LCE after becoming a Community Choice Aggregator, which is a **non-profit organization capable of aggregating community energy demand** in order to secure renewable energy contracts. The model, available to all communities across California, allows customers to act cooperatively, while utilizing cleaner energy options at affordable rates. Utility bill savings and positive customer experiences contribute to LCE's 94% customer retention rate.



Lancaster Choice Energy aggregates demand from the citizens of Lancaster in order to enter into long-term, renewable energy contracts with project developers.

## ↓60K

TONS OF $CO_2$ EXPECTED TO BE SAVED ANNUALLY FROM THE SHIFT TO RENEWABLES

## THE CHALLENGE

Developing socially inclusive, clean energy tariffs with strong customer support was a serious challenge for the region's first Community Choice Aggregator, but by focusing on schools, malls, and large businesses first, LCE could soon let the bill savings speak for themselves.

## CO-BENEFITS

### Economic

Lancaster's local school districts, auto mall, and several large businesses were among its first customers. In the first year of operation, customers together saved more than $1 million in energy costs.

### Environmental

LCE's efforts led to a more than threefold increase in the city's solar power capacity in just two years, from 118 MW to 430 MW. Located in a part of California that receives 300 days of sunshine annually, Lancaster expects to reach zero-net energy status in 2017.

### Social

By offering renewable energy resources to citizens at affordable rates, LCE provides all of the city's energy customers the ability to participate in climate change mitigation.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CITY: **LONDON**

# Replacing Boilers Cuts Bills and Emissions

→ The mayor of London has delivered two city-wide schemes to replace and repair some of the most inefficient gas boilers in the city's homes, supporting climate action, improving energy efficiency, and delivering numerous positive socioeconomic outcomes.

The majority of Londoners rely on individual gas boilers for hot water and warm homes. However, as with many aging cities, much of the existing housing stock and heating systems are inefficient and expensive. The London Boiler Cashback Scheme and Better Boilers are two schemes designed to **replace aging boilers, reduce fuel poverty, and improve air quality in London.**

The Cashback Scheme provided around 4,000 homeowners and private landlords with $500 cashback to replace boilers operating at less than 70% efficiency with new boilers operating at more than 90% efficiency and outfitted with better controls. The scheme used mayoral funds at the outset to leverage a further **$13 million from the private sector** to create deeper $CO_2$ reductions and help achieve the mayor's target of becoming a zero-carbon city by 2050. The Better Boilers scheme specifically targets the most vulnerable communities in London and is in response to rising numbers of fuel-poor citizens in the capital.

Installing modern boilers with 90% efficiency ratings has cut utility bills and $CO_2$ emissions for thousands of households in London.

## 6,500

METRIC TONS OF $CO_2$ ARE SAVED EACH YEAR FROM THE BOILER SCHEMES

## THE CHALLENGE

Residential buildings are estimated to be responsible for a 36% of London's total emissions, with two-thirds coming from heating and hot water. Targeting the most vulnerable is one of several ways to realize $CO_2$ reductions in an inclusive and economic manner.

## CO-BENEFITS

### Economic

The schemes are expected to drive investment of $13 million or more in new efficient boilers, helping to sustain work for the construction and heating sectors across the capital.

### Environmental

The London Boiler Cashback Scheme is reducing NOx emissions by around six metric tons per year, improving air quality in the capital.

### Health

Installing more efficient and safer boilers is expected to reduce the risk of carbon monoxide poisoning from old boiler heating systems, reduce cold-related health conditions, and improve local air quality.

### Social

The Better Boilers scheme supports up to 500 fuel-poor households. The scheme aims to support the most vulnerable and tackle growing fuel poverty in London.

CITY: **MENDOZA**

# Small Municipality with Big Renewable Energy Plans

→ A municipality in Argentina is ramping up its ambitions by installing renewable energy systems on municipal buildings and freeing up finance to encourage citizens to power their futures sustainably.

**↓15K**

KG OF $CO_2$ HAVE BEEN SAVED AS A RESULT OF THE FIRST MUNICIPAL RENEWABLE ENERGY SYSTEMS

## THE CHALLENGE

Renewables accounted for less than 2% of Argentina's energy mix in 2016[1], despite an abundance of wind and sun throughout the country. Achieving the country's ambitious target of 20% renewables by 2020 will require more strategies such as those underway in Godoy Cruz.

## CO-BENEFITS

### Economic

As well as savings on energy bills and short payback times, renewable energy manufacturing and installations in Godoy Cruz will stimulate the local green economy.

### Social

The newly built wind turbine manufacturing plant will employ more people from Godoy Cruz as wind power is deployed throughout Argentina.

### Health

Reduced particulate pollution from fossil fuel-fired power plants in dense urban areas improves air quality and reduces respiratory diseases.

The municipality of Godoy Cruz, situated in Mendoza, may have a population of just 200,000, but it has big ambitions for renewable energy. Their Local Climate Action Plan **unlocks access to finance for renewable energy systems for citizens and businesses** who were previously priced out of the market. The municipal bank will provide citizens low-interest loans, and the municipality will facilitate approvals and installations, making it as affordable and hassle-free as possible for citizens to invest in solar. The program is the first of its kind in Argentina.

To lead by example and promote the benefits of renewable energy, the municipality has so far installed 10 kW of solar PV and thermal systems across its buildings. The city aims to scale this program to reach **50% of the municipality's** buildings. In addition, the city promotes information campaigns, which are broadcast by local media.

Godoy Cruz is also **home to Argentina's first wind turbine manufacturing plant,** which is expected to double its annual capacity in 2017, after just one year of operation.


The municipality of Godoy Cruz is leading by example with renewable energy systems and informative signs to transfer knowledge to the public.

[1] St. James, Carlos. Argentina's upcoming renewable energy tenders: Wind projects. The Latin American Energy Review. (2016, March 14.)

CITY: **MEXICO CITY**

# Hospitals Lead the Way in Energy Transition

→ Hospitals and other public buildings in Mexico City are being outfitted with energy efficiency upgrades and renewable energy systems to cut bills and carbon emissions.

↓2.8

YEARS IS THE TIME REQUIRED FOR SOLAR THERMAL PANELS TO PAY FOR THEMSELVES IN ENERGY SAVINGS

## THE CHALLENGE

Transitioning to a sustainable city will be a challenge for the most populous city in the Americas, when more than 80% of the energy consumption comes from fossil fuels. Implementing energy efficiency and installing renewable energy systems are two strategies the city is pursuing, starting in the public sector.

## CO-BENEFITS

### Economic

Each hospital under the project's scope could save around $8,500 annually after efficiency upgrades and installation of renewable energy systems.

### Environmental

With the installation of solar water heating systems and energy retrofits in 12 hospitals, Mexico City expects to save around 750 tons of $CO_2$ equivalent.

### Social

Promoting sustainability actions in public buildings increases the visibility of the sustainability agenda to citizens and demonstrates the government is willing to take the first step in the clean energy transition.

Mexico City is pursuing a dual-action strategy as part of their low-carbon energy transition, using **energy efficiency improvements in combination with investment in renewable energy systems** for public buildings. Building on the UN's Energy Efficiency Accelerator Platform, the city is performing energy diagnostics on public buildings in order to plan strategic upgrades and reduce energy consumption. As well as these "invisible" actions, the city is also investing in solar thermal heating systems to provide hot water in all public hospitals.

Mexico City already has an ambitious Climate Action Program calling for a 30% reduction in $CO_2$ by 2020, but reducing emissions from existing, inefficient buildings is notoriously difficult. When done right, however, efficiency upgrades can be one of the cheapest ways to reduce emissions, as the pilot project at La Villa Pediatric Hospital demonstrates. After the installation of 32 rooftop solar thermal collectors, **the hospital now saves around $8,800 per year in heating costs and 52 tons of $CO_2$** equivalent.

The capabilities of solar thermal collectors are demonstrated to healthcare professionals on the roof of the La Villa Pediatric Hospital in Mexico City.

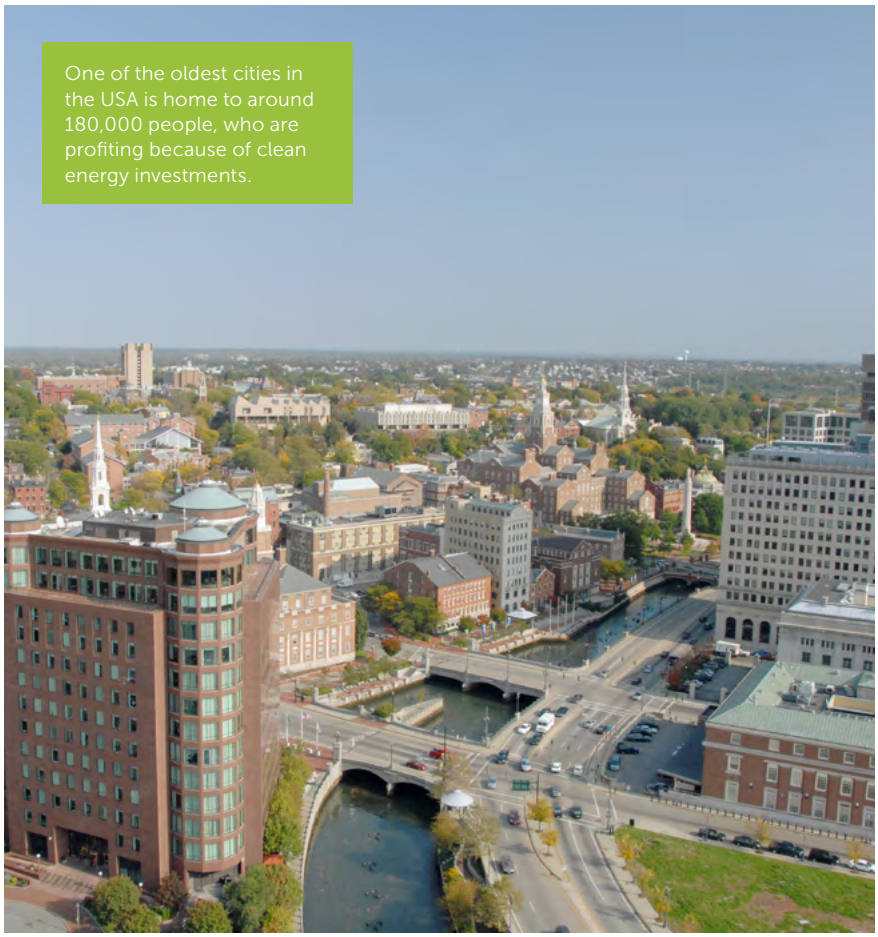
CITY: **PROVIDENCE**

# Clean Energy Pays for Itself

→ The City of Providence completed energy efficiency retrofits for municipal buildings, installed enough solar PV to power half the city, and has outfitted streetlights with LEDs throughout the city, all without a dedicated municipal budget for the work.

Rhode Island's largest city is profiting because of clean energy investments, putting the city on course to **reduce energy consumption by 30% by 2030**. By leveraging private capital and utility energy efficiency programs, the city is on target to meet its ambitious goals and is showing you don't need deep pockets to make the green transition.

The Rhode Island Infrastructure Bank has financed energy retrofits for five of the city's municipal buildings and expects to see savings after year one. This is the first step for the city, which next aims to target energy consumption in private buildings. The city is also replacing 17,000 energy-sapping high-pressure sodium streetlights with LEDs to cut carbon emissions and save an estimated $3 million annually. Finally, a long-term contract was signed to build a 20-MW solar plant that will **supply half of the city's power needs, with no upfront cost for the city.**



One of the oldest cities in the USA is home to around 180,000 people, who are profiting because of clean energy investments.

↓10K

METRIC TONS OF $CO_2$ HAVE BEEN SAVED VIA THE CLEAN ENERGY INVESTMENTS

## THE CHALLENGE

Providence's building stock accounts for more than two-thirds of their carbon emissions. Leading by example and installing energy efficiency upgrades in municipal buildings will pave the way for broader policy change and help achieve the goal of becoming a carbon neutral city by 2050.

## CO-BENEFITS

### Economic

The projects, when fully implemented, will save the city more than $4 million per year. Furthermore, completion of the projects supports the growing energy efficiency and renewable energy job sectors.

### Environmental

Taken together, the projects conserve energy and reduce Providence's dependency on fossil fuels, which improves air and water quality and reduces carbon emissions. Between 2010 and 2016, methane emissions were reduced by 1.2 metric tons and nitrous oxide emissions reduced by 0.17 metric tons.

### Social

More than 1,100 people in the Providence area are employed in solar energy jobs, and across the whole state of Rhode Island, clean energy jobs employ nearly 14,000 people.

CITY: **QINGDAO**

# Mining Waste Heat to Cut Smog Levels

→ Qingdao is utilizing waste heat sources to reduce reliance on coal and cut air pollution. Together with ambitious energy efficiency programs and large renewable investments, the city is making strides towards meeting its low-carbon and low-air pollution goals.

Around 12 million people live in the coastal Chinese city of Qingdao, which has suffered from high pollution levels, like many other coal-powered cities in China. To combat this and drive investment in green growth, the city is pursuing **energy efficiency and clean energy innovations on an enormous scale.**

Regulations covering energy efficiency standards in buildings, heating energy consumption limits, and financial incentives have all been put in place to help the city on its low-carbon transition. More than **$550 million has been invested in renewable energy systems and building retrofits** since 2012, more than half of which came from public funds.

Combining energy efficiency with renewable investment is not a groundbreaking strategy for reducing emissions, but when it comes to heating, the city is pursuing a truly innovative approach. Qingdao is **investing $3.5 billion in a clean district heating network** covering 180 km² that will make use of air, ground, and waste-source heat pumps. Waste heat from industry and the sewage system is being mined in order to reduce the requirement for polluting coal power plants.

A sewage heat pump installed as part of Qingdao's new clean heating network, which will eventually cover 180 km².

## ↓20M

TONS OF $CO_2$ EMISSIONS SAVED SINCE 2012 VIA CLEAN ENERGY DEVELOPMENTS

## THE CHALLENGE

Qingdao's challenge of moving from a coal-based energy strategy to a more sustainable one mirrors the challenge many other Chinese cities face. Making use of waste heat from existing sources and investing in energy efficiency will help to reduce reliance on coal and bring down dangerous air pollution levels.

## CO-BENEFITS

### Economic

Implementing retrofits to old, inefficient buildings alone is estimated to save the city around $6 million a year.

### Environmental

By implementing a clean heating network for the city, Qingdao aims to cut coal consumption by more than three million tons annually and reduce carbon dioxide emissions by around eight million tons per year.

### Health

The use of clean energy is reducing winter smog levels, creating a more livable city for its 12 million inhabitants. In 2016, the number of "good quality air" days rose to 299, up 17 from 2015.

### Social

Qingdao is pursuing green growth, and with the large public investment in clean energy has come new business investment and an estimated 10 million jobs to the region.

CITY: **ROTTERDAM**

# Strategic Transition to a Clean Heating Network

→ Rotterdam is undergoing an unprecedented modern transition from individually heated houses to city-wide district heating with increased efficiencies and emissions reductions.

**↓900K**

TONS OF $CO_2$ REDUCTIONS PER YEAR WILL BE GENERATED ONCE THE TRANSITION IS COMPLETE

## THE CHALLENGE

Installing a district heating system to serve the needs of more than 900,000 people is an enormous logistical challenge for the city, but by focusing on the potential improvements in other areas, the city is turning a risk into an opportunity.

## CO-BENEFITS

### Economic

The long-term transition is expected to generate around 500 jobs a year in the clean technology sector and will likely stimulate new innovation and market niches that will enable new companies to emerge.

### Environmental

Rotterdam expects to see a 10% reduction in NOx as a result of the transition from individual gas boilers to district heating.

### Health

The city is using the heat transition as an opportunity to address social issues and improve local problems such as waste water management and sustainable mobility solutions.

### Social

The reduction in NOx from reduced gas boiler use will improve the air quality of Rotterdam and reduce the frequency of respiratory-related illnesses.

In order to reduce energy consumption and replace fossil-based energy use, Rotterdam launched its Heat Transition Programme, which will optimize the balance between targeting individual building performance and city-wide clean energy policy. The city is rolling out the changes in stages, and is using **the opportunity to identify other city-wide upgrades that can be achieved simultaneously,** such as sewage and building maintenance. The pilot stage of the project will connect the first 1% of houses to the district heating system, and the lessons learned will be used to produce a blueprint for city-wide scale up.

The goal of the heat transition is to **achieve virtually zero-emission heating.** The districts in transition will also be scanned for improvement opportunities such as parking problems or social cohesion. This will not only result in lower emissions, cleaner air, more jobs, and a call for innovations, but will also have a valuable and positive social and physical impact.

Rotterdam's heat transition will deliver essentially emission-free heating by 2050.


SUSHI
TEMAKI
sumo

CITY: **SAN FRANCISCO**

# Reporting and Incentives Cut Emissions and Bills

→ San Francisco has gone above and beyond California's already rigorous buildings standards to encourage large commercial building owners to invest in energy-saving upgrades.

↓36%

REDUCTION IN COMMERCIAL BUILDING EMISSIONS IN 2015, COMPARED WITH 1990 LEVELS

## THE CHALLENGE

Buildings are responsible for almost half of San Francisco's greenhouse gas emissions. Benchmarking energy use in existing large commercial and municipal buildings, and encouraging energy efficiency retrofits, is one way to target emissions reductions in existing building stock.

## CO-BENEFITS

### Economic

Energy audits for more than 800 private commercial buildings identified $60.6 million in opportunities for cost-effective energy efficiency investments, which will save building owners millions of dollars for years to come.

### Environmental

The average energy use intensity for buildings included in the scheme is 27% below the national average, and is the lowest of all American cities that have published benchmarking results.

### Social

The various energy use reporting requirements have created more than 200 jobs so far, which is likely to expand as energy efficiency becomes big business in the city.

San Francisco aims for **100% renewable electricity by 2030 and an 80% emissions reduction by 2050.** In order to achieve the latter objective, the city is targeting large municipal and privately owned buildings that consume the most energy. Expanding upon existing legislation requiring large commercial buildings to report their energy usage every year, San Francisco now requires audits that identify energy- and cost-saving opportunities. A full retrocommissioning audit provides a thorough examination of the building's operations and identifies where the easiest and most effective upgrades can be made, with a helping hand from the city's cash incentives.

Over four years, 468 buildings of 4.55 million m² in the municipal portfolio cut energy use intensity by 18% and carbon emissions by more than 30%. In the private sector, **audits identified energy savings worth $25 million and led to a 10% reduction in electricity usage** in upgraded buildings.

Buildings are responsible for almost half of San Francisco's energy usage. Improving efficiency in existing buildings is one of the most cost-effective ways of reducing greenhouse emissions.

CITY: **SANTIAGO**

# Slashing Smog with Public Building Enhancements

→ Chile's capital is investing millions in energy efficiency upgrades and renewable energy projects for public buildings to reduce emissions and toxic smog levels.

↓3,419

TONS OF $CO_2$ SAVED ANNUALLY FROM THE CLEAN ENERGY INVESTMENTS AND EFFICIENCY UPGRADES

## THE CHALLENGE

Santiago generates only 43% of the electricity the city consumes, with more than half of electricity generated from imported diesel and gas. Increasing the local generation of clean energy and ramping up energy efficiency will contribute to reduced emissions, healthier air for citizens, and reduced dependency on fuel imports.

## CO-BENEFITS

### Economic

The solar energy systems installed on 15 public roofs generated savings of $140,000 annually, and the efficiency upgrades installed in the first 14 buildings generated $1.2 million in savings per year.

### Environmental

The savings from the energy efficiency program in hospitals saved an estimated 258 liters of diesel, 1,000 $m^3$ of natural gas, and 1.3 GWh of electricity in the first year.

### Health

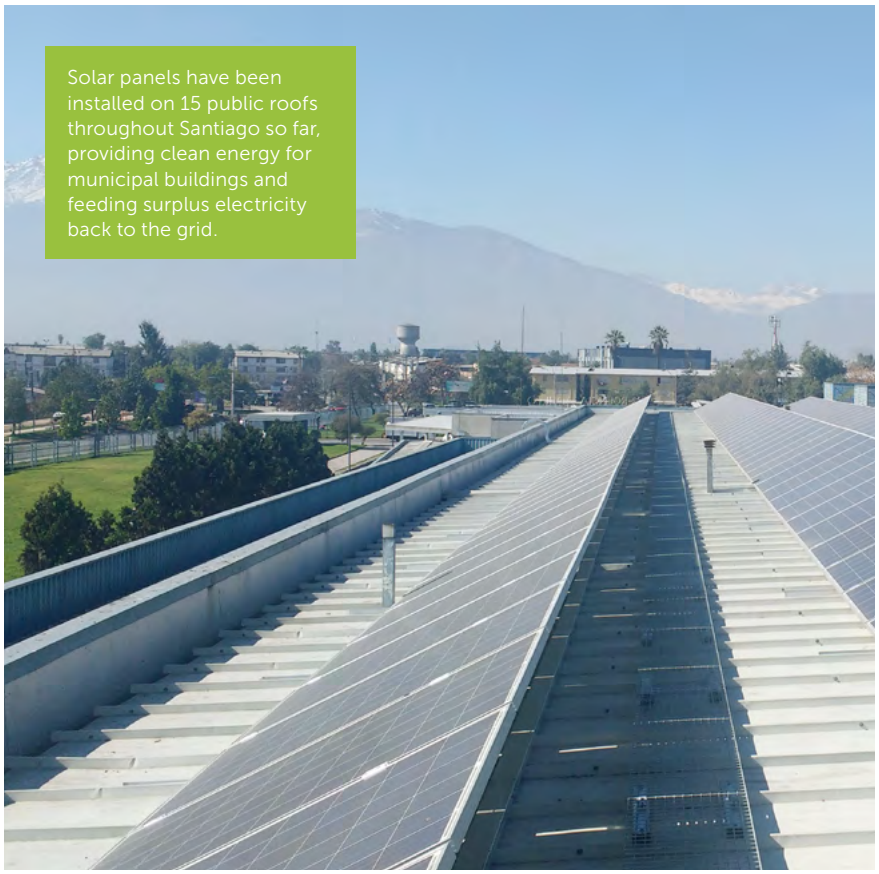
Reducing fossil fuel use via efficiency upgrades improves temperature regulation, noise levels, humidity, and air quality for patients, employees, and visitors in hospitals.

[1] Chile's largest city temporarily shut down due to smog 'emergency'. The Guardian. (2015, June 23.)

[2] Renewable Energy in Latin America. Norton Rose Fulbright. (2017, February.)

Santiago is aggressively investing in renewable energy projects and efficiency upgrades for their schools, hospitals, and other public buildings. Between 2015 and 2018, the city will **invest almost $5 million in rooftop solar projects and efficiency retrofits** expected to deliver significant reductions in utility bills and emissions for the municipally owned buildings. By aggregating demand across all of the projects, the municipality was able to drive down the cost of solar from $5.40 to $0.96 per installed watt.

As the city is surrounded by mountains, heat and toxic gases can be trapped in the city bowl, leading to dangerous levels of air pollution. On several occasions the city has been forced to temporarily "shut down"[1] due to high levels of toxic air pollutants. This project is one part of the Regional Strategy of Resilience aiming to **cut energy consumption levels and derive more energy from local renewable sources.** This drive towards cleaner energy is mirrored on the national scale, which has seen Chile double its renewable energy capacity[2] between 2013 and 2016.



Solar panels have been installed on 15 public roofs throughout Santiago so far, providing clean energy for municipal buildings and feeding surplus electricity back to the grid.

ST
ND
200
AVE

CITY: **SEATTLE**

# Public Disclosure of Energy Performance in Buildings

→ Seattle is implementing a series of regulations, benchmarks, and codes targeting greenhouse gas emissions from the buildings sector, including an open-source platform for energy performance.

**↓81K**

METRIC TONS OF $CO_2$ EQUIVALENT SAVED FROM BUILDINGS VIA NEXT-GEN PROGRAM

## THE CHALLENGE

Buildings are the second-largest source of carbon emissions in Seattle, primarily due to the use of natural gas for heating and cooling. Reducing building emissions is critical to meeting the city's ambitious climate goals.

## CO-BENEFITS

### Economic

Energy savings from the programs are expected to save approximately $44 million per year on utility bills.

### Environmental

The building tune-up program reduces energy consumption and reliance on fossil fuels, which lowers associated life-cycle impacts on ecosystems and health. It also reduces water consumption, which is important for a water-scarce city like Seattle.

### Social

In order to avoid unfair regulatory and economic burdens on small buildings and businesses, Seattle's Building Tune-Up Accelerator offers free technical assistance and financial incentives to help smaller buildings take early action to improve efficiency.

Seattle's recently adopted package of four NextGen efficiency programs will reduce energy use and greenhouse gas emissions in new and existing buildings via a coordinated suite of strategies, including **regulations, technical and financial assistance, and building performance data.**

For new buildings, the Seattle Energy Code builds upon national policy guidelines and sets the bar higher for energy efficiency standards. For existing buildings, owners are required to publicly publish energy performance figures annually, creating awareness and a competitive environment for energy efficiency in the private sector. On top of this, **every five years, buildings are required to tune up energy and water operations to make further efficiency improvements.** These policy tools are expected to ratchet up emissions savings in a sector notoriously difficult to impact, in order to achieve climate neutrality by 2050.

In April 2017, the city published energy performance data from 3,300 of Seattle's buildings in order to promote energy-efficient operation and maintenance.

CITY: **SINGAPORE**

# Solar Power on Land and Sea

↓900K

TONS OF $CO_2$ WILL BE SAVED IF SINGAPORE ACHIEVES THE SOLAR NOVA AND FLOATING PV TARGETS

→ Space-constrained Singapore is looking to water as well as rooftops for solar energy as the city's population continues to grow and demand more energy.

Singapore is one of the most densely populated cities in the world and lacks land for large-scale solar plants compared with the likes of China or Dubai. Therefore, they are now implementing Solar Nova, an **accelerator program designed to aggregate demand and facilitate installation,** as well as use reservoirs to host large-scale solar power projects.

The city is developing floating solar panels that can be deployed on 17 available freshwater reservoirs. The first project under development will sit on the Tengeh reservoir and act as a test bed for future installations. Eight companies will have the chance to deploy panels, and after six months of performance monitoring, the two most efficient systems will be selected for additional deployments. In addition to this project, Singapore is also implementing Solar Nova, which aims to facilitate installation of **350 MW of solar across the city by 2020.** In order to achieve this, there is a leasing arrangement in place where solar companies install and own the equipment and the customer pays lower utility fees each month.

## THE CHALLENGE

Almost all of Singapore's energy – primarily natural gas – is imported. By investing in solar PV, Singapore can reduce both its dependence on fuel imports and $CO_2$ emissions.

## CO-BENEFITS

### Economic

The Solar Nova and floating PV programs will position Singapore as a regional innovation hub for solar and green tech. The floating solar market alone is estimated to be worth $2.7 billion by 2025[1].

### Environmental

The floating PV test project will determine how panels affect water quality and biodiversity in aquatic ecosystems.

### Social

Schools and universities are using the floating solar systems as an educational tool to demonstrate renewable energy in action as well as consider how these systems may affect the natural world.

The floating solar test bed on the Tengeh reservoir is monitoring performance of the solar panels as well as aquatic conditions.

[1] Floating Solar Panels Market Size & Trend Analysis, By Product, Region, And Segment Forecasts, 2014 - 2025. Grand View Research. (2017, January.)

CITY: **SUWON**

# Social Cooperative Creates Energy Sharing Projects

→ The people of Suwon created a cooperative to invest in solar installations and reinvest profits in additional projects, aiming to create exponential and equitable renewable growth.

↓20%

REDUCTION IN GREENHOUSE GAS EMISSIONS BY 2020

## THE CHALLENGE

Between 1990 and 2012, South Korea's greenhouse gas emissions more than doubled. To combat this and improve air quality in urban areas, the country launched several initiatives as part of their green growth strategy, including an emissions cap-and-trade scheme. Grassroots projects such as the Sharing Solar Power Project could contribute significantly to changing perceptions and ramping up renewables over short timescales.

## CO-BENEFITS

### Economic

Fifty percent of the returns from solar investments will either be put into a social welfare fund or reinvested into additional solar projects. As of February 2017, the city had accumulated $200,000 in profits.

### Health

Welfare projects using installation profits will target the energy poor to reduce the impact of heat and cold temperature stresses.

### Social

The social cooperative that builds and operates the solar projects is also responsible for reinvestment in additional community projects. The profits generated by projects installed in 2016 were used to finance a 10-kW PV system at a children's welfare facility.

Started by citizens, the "Sharing Solar Power Project" in Suwon is a **cooperative that invests in solar energy and uses the returns to invest in social welfare** and additional solar projects. Fifty percent of the profits generated by the solar photovoltaic (PV) projects are directed to a social welfare fund; the remaining half is reinvested in new PV installations, decided by the 271 cooperative members.

The city, which aims to become one of the world's top three eco-cities, has a goal of reducing greenhouse gas emissions 20% by 2020. The Sharing Solar Power Project, one of the city's seven key strategies, is bringing renewable energy to more citizens every day. The cooperative aims to install **2 MW of PV by 2020, which will provide 2,410 MWh,** and reduce carbon emissions by 1,000 metric tons of $CO_2$ equivalent, annually. Suwon is on track to reach their target early, and there are plans to build an additional 3 MW by 2030.


The solar cooperative was first proposed by ordinary citizens and is promoted by citizens, too.

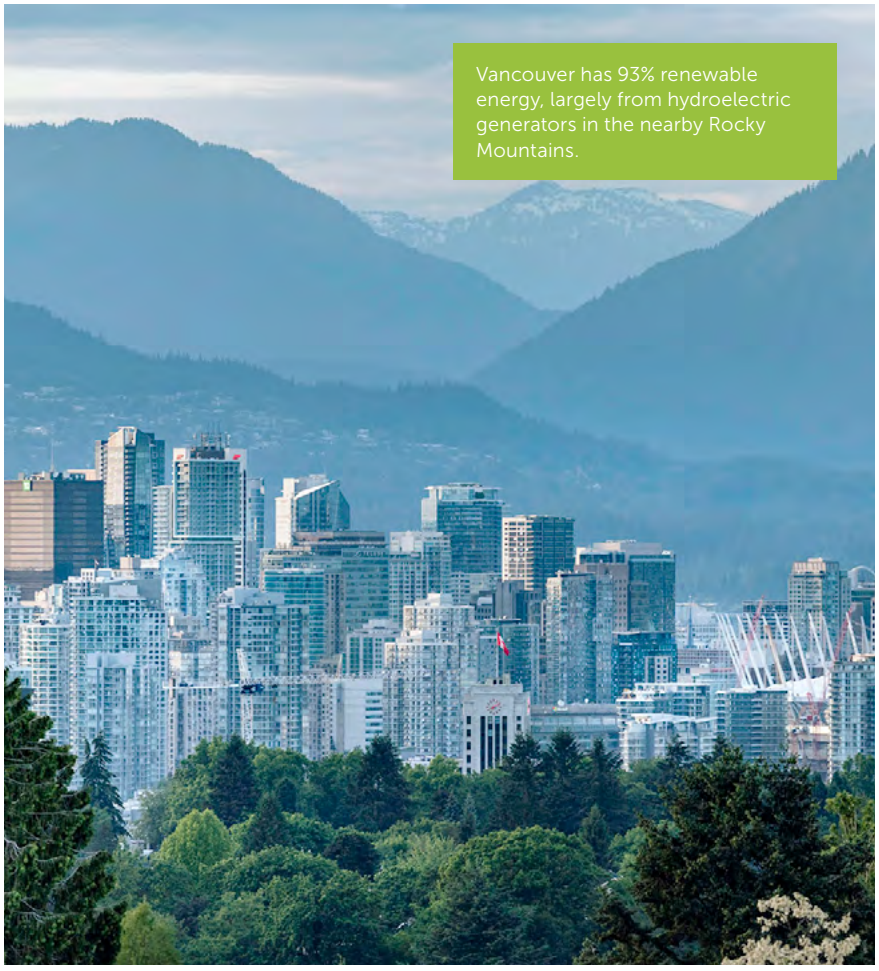
CITY: **VANCOUVER**

# Zero Emissions From New Buildings

→ Vancouver is on the road to ensuring all new buildings contribute zero greenhouse gas emissions. A string of progressive policy actions are being put in place to require future generations of buildings to be the greenest yet.

Vancouver has developed the most stringent building codes in North America for a cold climate city, in an effort to cut emissions in half from newly constructed buildings under seven stories high. Energy efficiency standards were set higher than LEED Gold standards by focusing on greenhouse gas emissions rather than energy consumption. These ambitious codes and regulations are part of Vancouver's Green Buildings program, which set the city on the path to **eliminate emissions in new buildings by 2030.**

Buildings are an important area of focus for the Canadian city if it is to achieve its goal of **80% carbon emission reductions by 2050.** Thanks to a large-scale hydroelectric plant, the city's electricity supply is 93% renewable, so by focusing on building highly efficient new buildings, Vancouver can make big strides towards a zero-carbon future.



Vancouver has 93% renewable energy, largely from hydroelectric generators in the nearby Rocky Mountains.

**↓8KG**

OF $CO_2$ SAVED PER $M^2$ OF ALL NEW CONSTRUCTION COMPARED TO 2007

## THE CHALLENGE

Roughly 55% of city-wide emissions are from buildings, so making improvements to building design is a top priority. Ensuring new buildings go above and beyond internationally recognized standards demonstrates global climate leadership.

## CO-BENEFITS

### Economic

Vancouver's Green Buildings program has evolved in step with the building industry, and ambitious new targets will continue to ensure the city is a center of expertise in building science, design, and manufacturing to drive innovation across the continent.

### Environmental

Vancouver's Green Buildings program seeks to reduce emissions from buildings by 20% by 2020 and further reduce emissions by at least 80% before 2050.

### Social

Green building design and construction jobs increased by 50% between 2010 and 2013, and the city aims to reach a 100% increase in the near future.


Bell
SEYMOUR BUILDING

CITY: **WARSAW**

# District Heating Upgrades Cut Air Pollution

→ Warsaw is upgrading its Soviet-era district heating system, improving liveability for residents and reducing greenhouse gas emissions.

↓20K

METRIC TONS OF $CO_2$ PER YEAR ARE SAVED FROM SUBSTATION UPGRADES

## THE CHALLENGE

Air pollution is a real problem in Poland, which is largely dependent on coal for its electricity. Warsaw's district heating system ensures that air quality is much better than in other cities such as Krakow where many people heat their homes by burning coal.

## CO-BENEFITS

### Environmental

District heating is a more efficient and environmentally friendly way of heating homes compared to individual boilers, especially if the energy source for the district heating is renewable.

### Health

As well as $CO_2$ savings, the project will also reduce particulate emissions by two metric tons per year, $SO_2$ by 76 metric tons per year, and NOx by 38 metric tons per year. This will improve air quality and reduce respiratory health problems for citizens.

### Social

Customers who receive heat from group substations have limited influence on heat management in the building, as well as poorer capabilities to use and control heat. The upgrades help to reduce social and economic inequalities between Warsaw residents.

Following Warsaw's devastation during the Second World War, a centrally planned heating system was put in place to heat the homes of the 2.6 million inhabitants. It is the largest district heating system in Europe, and in need of upgrading. Substations are used throughout the network to control the quality of heat distributed to end-users, and the Polish capital has **invested more than $30** million to replace 111 group substations with 810 individual substations. These individual substations allow end-users much more control over heat levels in homes, so making the changes will improve liveability for residents as well as heat transfer efficiency and will reduce emissions.

In order to complete construction during the summer before the cold weather began and minimize disruption to residents, the city distributed 30,000 information leaflets and held meetings with residents and building managers. **The system covers 56% of the city**, but with new substations allowing more connections, it could be expanded significantly.

Eight hundred and ten new individual substations were installed throughout Warsaw's district heating system, making heating more efficient and controllable for residents.

CITY: **WASHINGTON, D.C.**

# Legal Obligations for Renewables

↑50%

OF ELECTRICITY FROM SUPPLIERS MUST BE DERIVED FROM RENEWABLE SOURCES BY 2032

→ Washington, D.C. created a legal requirement for energy suppliers to derive half of their electricity from renewable sources by 2032.

The USA's capital city passed a law requiring all energy suppliers to **source 50% of their electricity from renewable energy sources by 2032,** 5% of which must come from locally generated solar energy. In order to meet this target, the city must increase local solar capacity from 60 MW to 400 MW, which is expected to generate an additional 3,500 jobs in the clean energy sector.

"Solar for All" is an extension of the new act that obliges non-conforming suppliers to pay a fee, which is then used to provide the benefits of solar energy to low- and moderate-income residents of the city. These benefits must be equivalent to reducing the household's electricity bill by 50%, and can either be distributed in direct payments or by way of investment in energy storage, rooftop repair, or electrical upgrades related to development of solar projects. The Solar for All program also works with private partners to provide further benefits to low-income residents. They plan to award **$13 million in grants for organizations that help low-income residents access solar technology.**

## THE CHALLENGE

Washington, D.C. is almost entirely reliant upon imported electricity. By targeting 5% of electricity generation from local solar, and providing financial assistance for low- and middle-income earners to access solar power, the city hopes to reduce its reliance on imports.

## CO-BENEFITS

### Environmental

Reducing the amount of electricity consumed from coal and nuclear power plants will improve water quality and water habitats. A coal-fired power plant can consume between one and four billion liters of water per year, and a nuclear powered plant consumes even more.

### Health

Reducing the amount of electricity produced from fossil fuels will reduce NOx, SOx, and particulate matter released by fossil fuel combustion and improve air quality in the city.

### Social

The Solar for All program redistributes the benefits from the new legal framework, ensuring that low- and middle-income residents feel the benefits of renewable electricity generation.

5% of energy consumed in Washington, D.C. must come from locally generated, renewable sources.

# WASTE


## TORONTO

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## SANTIAGO

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→ The solutions in the Waste sector help cities to transform waste resources into clean energy and raw materials, effectively manage waste collection and separation, limit food waste, and promote and incentivize behavioral change among residents. These solutions prove the potential to reduce greenhouse gas emissions from city waste while providing co-benefits such as reduced air and soil pollution and fossil fuel consumption.

CITY: **BENGALURU**

# Valuable Waste Segregated at Source

→ Bengaluru is beginning to clean up its streets with a domestic waste segregation program driven by community volunteers and providing valuable resources for farmers and recycling facilities.

**↓10%**

OF ALL COLLECTED WASTE GOES TO LANDFILL

## THE CHALLENGE

Changing public perceptions and behaviors involving waste processing was challenging in a city used to dumping waste on street corners, but more than 2,000 dedicated volunteers, called "Suchi Mitras," have been responsible for monitoring their local community and ensuring waste is properly disposed of.

## CO-BENEFITS

### Environmental

Reducing the amount of rubbish either sent to landfill or burned on the street has many environmental benefits: reduced methane emissions, improved soil fertility from compost, and reduced contamination of groundwater.

### Health

Reducing street-level waste dumping decreases vermin-spread disease and improves living conditions in the city via improved air quality and fewer odors.

### Social

The waste segregation scheme employs informal waste-pickers, providing some security for low earners and encouraging volunteers to take responsibility for their local area.

India's third most populous and second-fastest growing city is leading the way on waste separation and collection. Bengaluru, formerly Bangalore, has transitioned from a system reliant on street corner dumping to a well-organized segregation system in which the municipality collects wet, dry, and sanitary waste on a door-to-door basis across the entire city. Bengaluru is the first city in India to segregate as much as 50% of its waste, and is also the **first Indian city to collect sanitary waste** separately from households.

The collected wet waste is **converted into manure compost, which is then given to local farmers** in collaboration with the Agriculture and Urban Development ministries. Anyone generating more than 10 kg of waste per day is classified as a bulk waste generator and must either deploy their own waste processing units or use private companies.

The large network of 'Suchi Mitras' are an indispensible part of Bengaluru's new waste management strategy.

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CITY: **BUENOS AIRES**

# Changing Food Waste Attitudes and Behavior

→ Buenos Aires is tackling the growing challenges of food waste and food shortages with a source-based strategy targeting households, schools, and restaurants.

**150K**

CITIZENS WERE REACHED IN THE FIRST YEAR OF AWARENESS RAISING

## THE CHALLENGE

It is estimated that 16 million tonnes of food are thrown away annually in Argentina; meanwhile, 32% of the population lives below the poverty line[1]. This is the first municipal strategy that aims to tackle both problems simultaneously.

## CO-BENEFITS

### Economic

Reducing waste volumes benefits consumers, who save money on food shops, as well as the municipality, which saves money via reduced waste processing.

### Environmental

Combatting waste sent to landfill will reduce emissions of carbon dioxide and methane produced via fermentation in landfills.

### Social

Creating a mechanism to collect surplus food to feed those below the poverty line will create a fairer city with lower inequality levels.

The sustainable urban food strategy in Argentina's capital is reducing food waste sent to landfill. In recent years, the city has been praised for recognizing the importance and rights of informal waste-pickers, as well as processing municipal waste sustainably. But the newest strategy aims to tackle a more culturally ingrained attitude to food waste. Starting in primary schools and working with the UN's Food and Agriculture Organization, **the city aims to disseminate information about best practices for minimizing and dealing with food waste.** The information campaign also focuses on restaurants and communities, where workshops will be held to engage citizens.

In addition, the University of Bologna recently launched a survey on food waste in the city, which is the first research of its kind in Latin America. The city hopes to **use the results as a starting point to cut food waste further and determine how to reallocate surplus food to the hungry.**


Buenos Aires launched a city-wide awareness-raising campaign to tackle the growing levels of food waste in the city.

[1]CIA World Factbook. (2016.)

CITY: **CAPE TOWN**

# Industrial Resource Exchanges Reduce $CO_2$

→ An industrial symbiosis program in Cape Town is facilitating waste and $CO_2$ reduction via resource exchanges between companies, and is also encouraging small business development and job creation.

**↓46.7K**

METRIC TONS OF $CO_2$ EQUIVALENT SAVED OVER FOUR YEARS SINCE THE PROGRAM LAUNCH

## THE CHALLENGE

South Africa faces numerous challenges with respect to resource use, including its reliance on fossil fuels for energy, water scarcity, and high landfill rates. Industrial symbiosis aims to address this by promoting the reuse and recycling of industrial waste.

## CO-BENEFITS

### Economic

In just three years, WISP is expected to generate $2.27 million in economic benefits and promises a three to one rate of return on investment.

### Environmental

WISP has diverted a total 4,950 metric tons of waste from landfill. Saving $CO_2$ equating to 15,500 trees growing over 30 years.

### Social

WISP promotes local employment and so far, 20 permanent jobs and 25 temporary jobs have been added at member companies.

The Western Cape Industrial Symbiosis Programme (WISP) is a free business facilitation service based in Cape Town, and is the first industrial symbiosis program in Africa. It connects companies so they can realize the benefits of exchanging underutilized or wasted resources. **WISP targets the diversion of all industrial waste from landfill, complementing the city's zero waste to landfill activities.** The program also focuses on reducing greenhouse gas emissions, generating financial benefits for companies and creating jobs.

WISP has an enterprise development program, which creates new businesses via an incubation program linking entrepreneurs to raw material supply agreements. Workshops have identified more than 4,000 potential synergies between the 486 companies that are part of the WISP network. WISP has also developed an international standard carbon calculator to measure emissions savings from materials saved from landfilling and emissions avoided in producing and transporting new raw materials. Over the next three years, **WISP synergies are expected to generate 64,500 metric tons in $CO_2$ equivalent savings.**

SMEs, such as those supported by WISP, employ 28% of South Africa's population.

CITY: **CHENNAI**

# Citizen, Public, and Private Engagement in Waste Management

→ By targeting public, private, and residential actors, Chennai is experimenting to find the most effective methods for reducing waste, as well as making the most of any waste produced.

**17.5M**

PEOPLE HAVE BENEFITED FROM THE CITY'S NEW WASTE MANAGEMENT SCHEME

## THE CHALLENGE

In 2016, Chennai saw some of the worst floods in its history, and clearing 145,000 tons of waste from the streets after the waters subsided highlighted the extent of the city's rubbish problem. Chennai's new waste management strategy aims to reduce the buildup of waste and realize some of the potential value.

## CO-BENEFITS

### Environmental

The city's scheme aims to reduce the quantities of waste littered in streets and rivers, improving the urban environment for millions of citizens.

### Health

Cleaning up Chennai's streets reduces the spread of diseases such as jaundice, malaria, and dengue fever, which are linked with waste-dumping practices.

### Social

Fifteen thousand sanitary workers are employed by the Solid Waste Management Department, many of whom have little employment alternatives.

Chennai has embarked on a journey to uproot deeply ingrained attitudes towards waste. More than two-thirds of all waste in the city is from residential sources, and of that, 60% is organic, showing that segregation at the source could be a simple and powerful tool for cleaning up the streets. **Households throughout the city are now required to segregate their waste,** which is then collected and taken to recycling, incineration, or landfill sites. Community meetings, youth club conventions, and social media campaigns were all part of the city's strategy to spread awareness amongst the community, and since the start of the program in 2016, the city has recorded a 2.5% reduction in total waste production.

Chennai is no stranger to innovative waste management strategies – in 2002, the infamous **Jambulingam Street was laid with shredded-plastic infused tarmac[1],** which has passed the test of time, constant rickshaw turbulence, and monsoon flooding. Now, the government continues to look for innovation from the private sector and is pursuing public-private partnerships for better processing of previously segregated waste.

Waste management work offers employment opportunities for thousands of Chennai's citizens and is helping to clean up the Indian city's streets.

[1] Plastic roads: India's radical plan to bury its garbage beneath the streets. The Guardian. (2016, June.)

CITY: **FORTALEZA**

# Utilizing Digital Tools to Transform Waste

→ Fortaleza has implemented an online system to devolve municipal responsibilities, enabling innovative waste management strategies to be developed that recognize the rights of informal waste-pickers.

**125K**

TONS OF $CO_2$ EQUIVALENT WILL BE SAVED BY 2030 BY ACHIEVING RECYCLING AND COMPOSTING GOALS

## THE CHALLENGE

Around 1% of the world's population sustains themselves with informal waste-picking and recycling. Recognizing their rights while changing perceptions around waste is the aim of Fortaleza's waste program.

## CO-BENEFITS

### Economic

More than 200 waste-pickers directly benefited from temporary contracting at community events supported by Fortaleza.

### Environmental

Sports communities, such as canoeing or paddle boarding groups, engage in regular beach-cleaning campaigns involving between 50 and 300 people

### Social

Recycling Attitudes has trained 1,000 teachers and 10,000 students in environmental topics and benefited 200 waste pickers.

Fortaleza has set about reshaping residents' connection to waste. As part of the Recycling Attitudes Program, the city is engaging civil society with awareness campaigns, institutional partnerships, and active campaigns to change the way people produce and think about their waste. Teachers are trained in best recycling practices in order to educate students and arrange community litter-clearing activities. **The program has already benefited more than 50% of municipal schools.**

Fortaleza is also formalizing the role of waste-pickers in society by offering short-term contracts to waste-pickers at municipally organized events and activities, keeping the city clean and offering an income stream for waste collection. Both strategies have been facilitated by the Fortaleza online system – a paperless, more efficient method of developing and approving all kinds of municipal strategies. **Fortaleza aims to achieve 40% recycling and 20% composting rates by 2030** with the help of the new programs.

Fortaleza's online system has helped to formalize the role of waste-pickers and improve recycling rates.

CITY: **FORTALEZA**

# Valuing Waste Segregation and Recycling Habits

→ Fortaleza is implementing a recycling system that incentivizes the proper separation of materials at waste collection points throughout the city and reduces waste to landfill.

↑40%

INCREASE IN RECYCLING IS TARGETED BY 2030

## THE CHALLENGE

Brazil has an overall recycling rate of around 1%[1]. Improving this rate is crucial for reducing carbon emissions associated with landfill waste, as well as protecting Brazil's natural environment from human-generated waste. Financial incentives for recycling can be a powerful tool for changing habits.

## CO-BENEFITS

### Economic

Recycling Fortaleza distributes around $6,500 per month, mainly among the poorer communities of Fortaleza.

### Environmental

Fortaleza aims to increase composting of organic waste by 20% by 2020.

### Social

Participants sorted their waste into 33 types of household waste, demonstrating that behavioral change is possible in waste management.

[1] Arce, M. et al. Regional Evaluation on Urban Solid Waste Management in Latin America and the Caribbean: (2010 Report.)

Having struggled with expensive and inefficient door-to-door recycling systems, the Brazilian coastal city of Fortaleza is piloting a value-based community recycling strategy. Currently rolled out in 24 neighborhoods throughout the city, **Fortaleza offers transport and energy credits for citizens who correctly sort and recycle their waste** at collection points. This approach was designed to create real behavioral changes and avoid waste to landfill.

Since the start of the project in 2016, Recycling Fortaleza has led to **9,000 people practicing waste separation and disposal** and more than 830 tons of waste being recycled rather than taken to landfill. Based on the success of the program thus far, the city intends to roll out collection points to a further 100 neighborhoods.


One of Fortaleza's 24 currently operational collection points provide transport and energy credits for citizens who recycle their waste.

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CITY: **HONG KONG**

# Energy-Positive Wastewater Sludge Treatment

→ T.PARK is the world's largest wastewater sludge incineration plant, self-sufficient and designed to convert all of Hong Kong's sludge into space-saving ash and renewable energy.

↓237K

TONS OF $CO_2$ EMISSIONS WILL BE REDUCED EVERY YEAR WHEN THE PLANT REACHES FULL CAPACITY

As the first large-scale waste-to-energy facility in Hong Kong, T.PARK is a key environmental infrastructure project in the city's "Climate Action Plan 2030+." The plant uses fluidized bed incineration to process wastewater sludge from the large sewage treatment works in the city. **With a total capacity of 2,000 tons of sludge per day, it will meet the needs of the city beyond 2030.** Previously, the wet and energy-rich sludge was dumped in landfills. With incineration at T.PARK, the residual ash uses 90% less landfill volume, and $CO_2$ emissions from landfilling are significantly reduced. The process also generates renewable energy to power the plant and export to the city's grid.

The entire facility has been built as a model for sustainability. Drinking water is provided by a desalination plant and rainwater is collected for non-potable uses. **All wastewater generated within the facility is treated on site for reuse, resulting in zero effluent discharge to the sea.** There is also an Environmental Education Centre equipped with leisure, educational, and landscaped facilities, including a spa, exhibition halls, upcycling showrooms, wetland garden, and bird sanctuary.

## THE CHALLENGE

Hong Kong's sewage production is expected to grow significantly due to a growing population. A further challenge is that the city's buildings account for 90% of electricity consumption and 60% of the carbon emissions.

## CO-BENEFITS

### Economic

The plant will generate 80 million kWh of electricity annually to power the plant and for export to the grid, generating cost savings and powering 4,000 households.

### Environmental

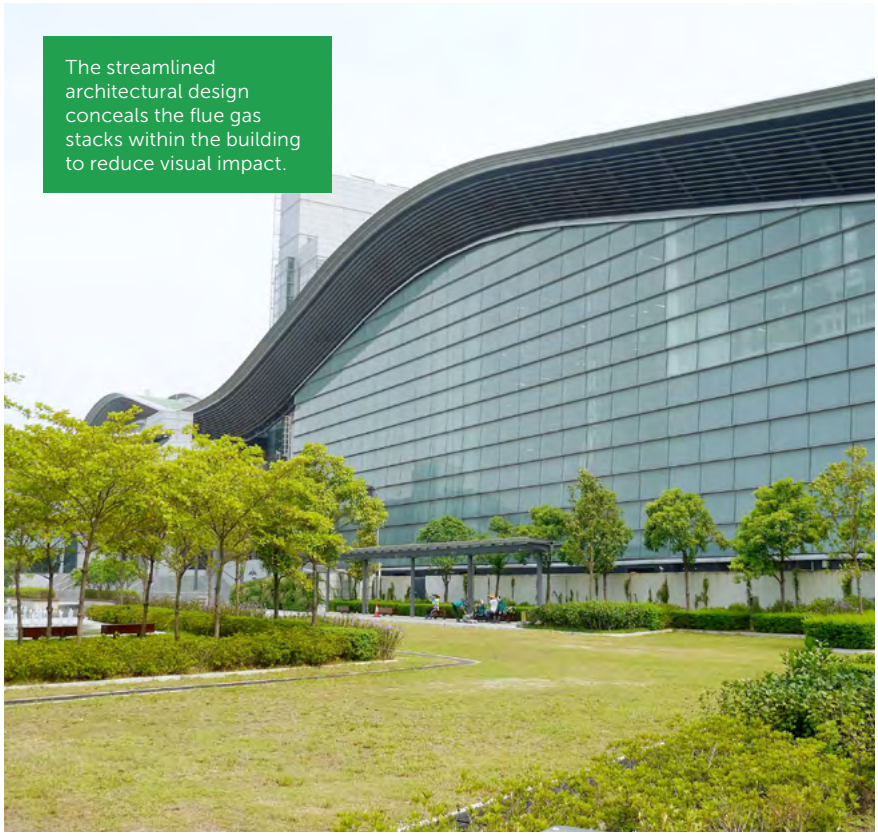
The facility has been designed to the highest green building standards as a model for other buildings in the city.

### Health

At the facility, double-door design and negative air pressure inside the sludge delivery bays help to prevent bad odors and dust pollution.

### Social

The Environmental Education Centre at T.PARK aims to encourage sustainable living via educational and recreational initiatives. There is also an eco-cafe that employs socially disadvantaged members of the Tuen Mun District.



The streamlined architectural design conceals the flue gas stacks within the building to reduce visual impact.

CITY: **ISTANBUL**

# Circular Design Approach for Processing Waste

→ Istanbul's circular design approach to waste management allows the city to produce electricity and compost from different waste streams, as well as divert excess heat to greenhouses for greater productivity.

↓800K

TONS OF $CO_2$ MITIGATED PER YEAR AS A RESULT OF NOT BURNING NATURAL GAS FOR HEAT

## THE CHALLENGE

Istanbul faces a serious air pollution challenge, with particulate levels consistently above the WHO recommended level. Smart designs for heating and cooling that do not create extra pollution such as the greenhouse project are needed to reduce health risks for citizens.

## CO-BENEFITS

### Economic

By using waste heat from the waste processing site instead of burning natural gas, the greenhouse saves an estimated $130,000 per year.

### Environmental

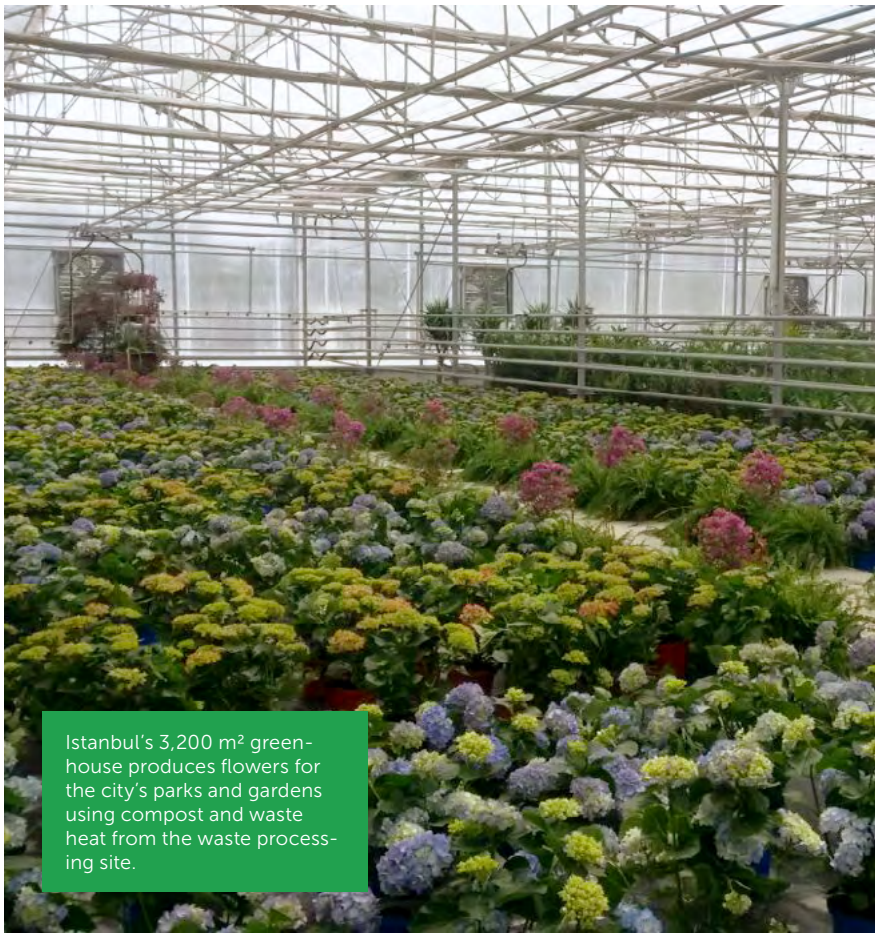
Seasonal flowers in Turkey are usually grown in Mediterranean climates. Using excess heat to grow the flowers locally results in logistical and cost savings.

### Social

The greenhouse attracts around 300 people a month to see the flowers and learn about the circular design approach Odayeri employs to generate resources from waste.

Istanbul's Odayeri waste management site is not only large, varied, and capable of processing 12,000 tons of waste per day, but also has a strong focus on environmental protection and tapping the potential resources for new growth. **The 266-hectare site is dedicated to many different waste streams** including municipal, medical, and organic waste. Landfill sites are isolated from groundwater using natural and geotechnical membranes, and drainage lines exist to collect methane gas produced over time.

**There is also a waste-to-energy plant with a capacity of 35 MW** – enough to power 130,000 families for a year – which also produces heat as a by-product. Rather than let this go to waste, the heat is captured and sent to a nearby 3,200 m² greenhouse for increased productivity. The organic waste processing area also produces compost for the greenhouse, which grows 600,000 flowers per month for the city's parks and gardens.



Istanbul's 3,200 m² greenhouse produces flowers for the city's parks and gardens using compost and waste heat from the waste processing site.

CITY: **JOHANNESBURG**

# Trash for Cash

↓20%

WASTE REDUCTION IS THE AIM OF THE CITY'S WASTE MANAGEMENT PLAN

→ Johannesburg seeks to divert waste from landfill by encouraging communities to run waste co-operatives and pay waste collectors to gather the waste.

To cope with a massive waste problem, the City of Johannesburg has initiated a waste strategy. **Entrepreneurship is stimulated in the communities by establishing waste buy-back centers,** which are operated by communities. The centers buy recyclable waste such as paper, plastic, cans, and glass from people and then sell it to recyclers. Waste collectors receive a direct cash payment according to the volume of cleaned waste they bring in. An important aspect of the initiative is the incorporation of the informal waste collectors. Without the buy-back centers matching supply and demand, waste collectors would have to travel long distances by foot to sell waste.

The aim is to **empower impoverished communities via business entity ownership and increased recycling rates.** There are seven buy-back centers spread across the city, each of which employs 10 to 15 full-time staff as well as 30 more people who indirectly benefit from the centers.

## THE CHALLENGE

Johannesburg generates about 1.6 million tons of waste annually, a majority of which goes to landfill. Three out of four landfill sites are approaching their full capacity, with less than 10 years disposal time left. To avoid adding more landfill sites, Johannesburg must move away from a waste-to-landfill model.

## CO-BENEFITS

### Economic

Each of the buy-back centers generates up to 45 jobs and increases the earnings of the waste collectors, who reduce their travel time for processing and selling waste.

### Environmental

Waste is diverted from landfills and enters the recycling chain, contributing to a cleaner environment in Johannesburg.

### Social

Johannesburg has long had an informal community of waste-pickers, collecting recyclables from piles of abandoned rubbish. The city now aims to formalize these workers and provide benefits of job security and predictable demand for goods.

Seven buy-back centres are spread across Johannesburg, to improve waste processing and formalize the role of waste-pickers.

CITY: **KISUMU**

# Academia Focuses on Cleaning Up Marketplace

→ An international university collaboration is working with local stakeholders in the Kenyan town of Kisumu to reduce waste levels, improve livelihoods, and protect the environment.

**65%**

OF THE WASTE PRODUCED IN KISUMU WILL BE AVOIDED UNDER THE RESEARCH-BASED PROGRAM

## THE CHALLENGE

Waste processing in many semi-urban areas of Kenya is extremely limited, and there have been grave concerns raised for years about the state of Lake Victoria's polluted waters. Schemes like this can diminish the amount of waste produced and minimize environmental degradation.

## CO-BENEFITS

### Economic

Waste-pickers and entrepreneurs making the most of the waste are recognized and encouraged, in order to reduce waste quantities and recover valuable materials for sale. Fuel savings are also leveraged by producing briquettes from waste.

### Environmental

Transforming waste into energy briquettes preserves local forests, and composting helps to preserve natural soil quality. Reduced quantities of organic waste in dump sites also decreases the quantities of methane released.

### Health

Reduction of decomposing organic matter on the streets improves aesthetics and reduces survival of disease-causing parasites.

### Social

Informal litter-pickers are recognized and provided with a source of income from waste sites.

The Kisumu Local Interaction Platform has facilitated a collaboration between two Kenyan universities and Chalmers University of Technology, in Sweden, who are working with local community leaders to clean up the streets of Kisumu. The **evidence-based approach has identified a number of methods** aiming to reduce waste produced by market traders in Kisumu. Without a waste processing site or even a landfill, the primarily organic waste stream ends up in scrap piles that encourage disease-spreading pests.

**Some successful, win-win practices** identified by the partnership include: transforming organic waste into compost; developing fuel briquettes from market waste; preparation of animal feed from vegetable waste; and promotion of recovery and recycling of waste through waste-pickers and entrepreneurs.

By providing a formal platform for sharing ideas with city officials, **research findings can be translated quickly into policy actions**, which can then be monitored and results fed back to researchers.

In collaboration with international academic institutions, the people of Kisumu are making fuel briquettes from municipal waste.

CITY: **LIMA**

# City's Informal Recyclers Recognized

→ By recycling solid waste from households in the city, Lima is mitigating emissions and creating a better environment for its citizens, especially its recyclers whose work is now recognized.

**↓824**

TONS OF $CO_2$ EMISSIONS HAVE BEEN AVOIDED BY INCORPORATING WASTE INTO THE RECYCLING INDUSTRY

## THE CHALLENGE

Much of Lima's solid waste is burned, discharging large volumes of greenhouse gases. Raising awareness among citizens and formalizing recyclers are both efforts seeking to reverse this.

## CO-BENEFITS

### Economic

By formalizing recyclers, their income has increased and the cost of final disposal of solid waste has been reduced.

### Environmental

Reducing the amount of waste that goes into landfills decreases water and land pollution and results in less natural resources being used when solid waste is recycled into new products.

### Health

The formalized recyclers are provided with personal protection equipment and vaccine protections against diseases.

To better manage and dispose of solid waste from its citizens, Lima initiated a range of activities that promote a formal recycling chain, while simultaneously increasing environmental awareness. Commercialization of solid waste is underway, which will ensure more waste is absorbed by the recycling industry, **resulting in less extraction of natural resources and energy savings** from avoided manufacturing of new materials.

**The project currently covers 42% of all the downtown district's housing, and the city aims to scale up to 100%** of the population in the district and expand to include other sectors that generate solid waste as well. The project has also formalized the work of recyclers, increasing their income and improving their working conditions.


Formalization of recyclers benefits the environment and improves living conditions.

CITY: **NEW TAIPEI CITY**

# Recycling Rewards Pave the Way Towards a Circular City

→ New Taipei City's Low Carbon Circular City initiative is reducing waste and increasing the collection of reusable resources.

↓6.4%

REDUCTION IN $CO_2$ EQUIVALENT EMISSIONS HAS BEEN ACHIEVED SINCE 2008

## THE CHALLENGE

Despite progress, New Taipei City still has challenges with the management of solid waste, and lack of green areas which could help to cope with increasing temperatures that threaten the livelihoods of citizens.

## CO-BENEFITS

### Economic

Each year, recycling generates around $10 million of revenue, which benefits the citizens and the city.

### Environmental

The specially designed garbage bags are expected to replace more than 2.69 million plastic bags.

### Health

By 2017, green areas of the city will have increased to 4,000 m², increasing the carbon sequestration potential, cooling the city, and improving air quality.

### Social

The township residents who own rooftop farms regularly organize communal meals to share the fruits and vegetables they grow, also contributing to improved eating habits.

New Taipei City has reduced the volume of incinerated waste by 9% from 2012 to 2016 by implementing a range of initiatives to tackle waste. The Recycling Rewards Service System allows the public to **bring reusable resources to 310 Recycling Rewards Service Stations to exchange them for designated garbage bags and green products**. Since implementation, the resource recycling rate has gone up by more than 8%. Additionally, at "Happiness Stations," still functioning home goods and materials can be donated and reused by low-income communities.

Kitchen waste is another focus area. **Organic waste is collected and composted before being used on organic rooftop farms or in schools' vegetable gardens.** The 46 rooftop gardens and 1,200 m² of organic vegetable cultivation area also have a cooling effect, resulting in reduced energy consumption by the 678,000 air-conditioning units in the city.

Rooftop garden using composted waste providing the citizens with a cooler climate and fresh local food.

CITY: **NINGBO**

# Separating Waste at Source and Maximizing Recycling

→ Ningbo is undertaking an ambitious, long-term recycling and waste recovery program to reduce waste to landfill in line with national circular economy principles.

↓173K

TONS OF $CO_2$ EQUIVALENT PER YEAR WILL BE SAVED BY THE KITCHEN WASTE TREATMENT FACILITY BY 2019

## THE CHALLENGE

China produces around 300 million tons of waste per year, the majority of which ends up in landfill or at incineration plants. Ningbo's new strategies aim to reverse this and create an environment that encourages recycling.

## CO-BENEFITS

### Economic

Increasing recycling rates provides access to cheaper resources, and separating organic waste allows for harvesting of natural gas for energy and heat.

### Environmental

The project will improve solid waste collection and separation at the household level in six urban districts in Ningbo, reducing the amount of waste sent to the existing landfill and incineration facilities.

### Social

Community workshops are designed to educate citizens and improve waste segregation at the source. Over the past four years, more than 1,750 training sessions have been organized, engaging 108,000 citizens.

Home to around 3.5 million people on China's east coast, Ningbo is a medium-sized city that is implementing an advanced waste separation, collection, and treatment strategy, with World Bank backing. The city is incentivizing separation of municipal waste at the source, before it is collected and either recycled or converted to energy. An anaerobic digestion facility for kitchen waste, the product of a public-private partnership, will be completed in 2018, with **capacity for 30,000 m³ of organic waste per day.** This will harvest natural gas produced from the decomposition process, which can be used for power or heat.

The project links with the national agenda and current Chinese Five-Year Plan, which explicitly requires a "sound collection and recycling system" for separated waste, as well as "promoting resource utilization and hazard free treatment of foods and other waste." Citizens will benefit from **better solid waste management, a cleaner environment and living conditions, and improved public health.**

Information campaigns have been held at schools throughout Ningbo to educate pupils about the benefits of waste separation and recycling.


垃圾分类
校园更美
环保小天使

CITY: **PHOENIX**

# Waste Reduction by Innovative Resource Recovery

→ The Reimagine Phoenix Initiative is tackling waste by promoting circular economy entrepreneurship and resource recovery initiatives.

**↑25%**

INCREASE IN WASTE DIVERSION FROM LANDFILL SINCE LAUNCHING REIMAGINE PHOENIX

## THE CHALLENGE

Achieving zero waste in Phoenix will require finding value in all waste streams not currently recycled. Greenhouse gas emissions from organics sent to landfills are a problem. Addressing this will require city-wide scaling of curbside organics collection and the pilot food waste program.

## CO-BENEFITS

### Economic

The RIC will create jobs and economic activity via remanufacturing waste. The projects have created 27 jobs and generated $10 million.

### Environmental

The composting program will avoid 3,660 metric tons of $CO_2$ emissions per 100,000 tons of organic waste diverted.

### Health

Reduced NOx and particulate emissions from waste hauling will improve air quality in Phoenix.

### Social

The city is partnering with Recyclebank, which offers an app-based recycling education and incentive program enjoyed by more than 35,000 residents.

In 2013, Phoenix's Mayor and City Council set a goal to divert 40% of the city's waste from landfill by 2020. In **2016, this goal was expanded to achieve zero waste by 2050.** The Reimagine Phoenix Initiative is key to reaching that goal, and it includes the development of a Resource Innovation Campus (RIC), establishing waste recovery programs and increasing community education. The RIC is a flagship project and will become a circular economy hub attracting entrepreneurs to create economic growth from materials recovered in the city's waste streams. The facility will include a technology solutions business incubator operated by Arizona State University, along with $2.75 million in funding over five years for research, technology development, and venture incubation of resource management solutions.

One of the resource recovery programs is the rollout of curbside organics collection. The city's state-of-the-art composting facility **can currently process 55,000 tons per year, with the potential to expand to 220,000 tons per year,** and is highly water-efficient. Phoenix is also looking to fuel its vehicle fleet with gas captured at the city's landfills.


Phoenix is the first city in the USA to be included in the Ellen MacArthur Foundation's Circular Economy 100 Group.

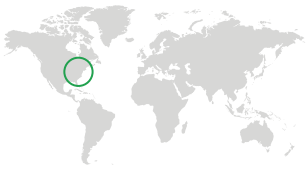
CITY: **PITTSBURGH**

# Recycling Pilot Informs City for Scale-Up

→ Pittsburgh conducted an experiment to test a new recycling scheme and is using the findings to roll out a city-wide scheme to improve recycling and move towards zero waste.

**↑25%**

INCREASE IN RECYCLING RATES DURING THE PROJECT



## THE CHALLENGE

Waste production and collection in Pittsburgh is responsible for more than 40,000 tons of $CO_2$ equivalent annually. Increasing diversion rates and reducing landfill waste can reduce emissions from both the waste and transportation sectors.

## CO-BENEFITS

### Economic

Every ton of materials recycled instead of sent to landfill saves Pittsburgh $19. When the bins are rolled out citywide, a 15% increase in recycling is estimated to save the city $74,000 annually.

### Health

Reducing trips to landfill will lower particulate levels and improve air quality for Pittsburgh, which is ranked in the top 10 most polluted cities in the USA[1].

### Social

Pittsburgh employed door-to-door resident outreach and education to increase recycling participation. The use of recycling bins also improved the cleanliness of the routes.

[1] State of the Air 2017. American Lung Association. 2017.

The Northside Bin Initiative is a pilot project that **distributed approximately 1,100 recycling containers to residents served by one recycling route** in the Northside area of Pittsburgh. It was designed to test the impacts of converting the collection system from bagged set-outs to provisioned bins.

During the course of the project, **data was gathered to analyze the impacts of the city's proposed new approach for recycling collection.** The information included: impacts to fleet, staff time, routing, finances, changes to recycling participation rates, material quality and contamination levels, and resident feedback. The main goal of the program was to reduce waste going to landfill, but the city also wanted to determine the baseline recycling participation percentage in the population and educate as many residents as possible about the benefits of recycling and waste reduction.

Pittsburgh's Northside Bin Initiative used distinctive blue bins for collection, and saw an 25% increase in recycling rates during the pilot project.

CITY: **SANTIAGO**

# Local Recycling Centers Boost the Recycling Rate

→ Santiago is increasing the rate of recycling by building local centers that benefit the environment and increase entrepreneurship.

**136K**

TONS OF WASTE DIVERTED FROM LANDFILLS IS THE GOAL OF THE PROJECT

## THE CHALLENGE

A lack of adequate infrastructure and cultural norms have limited Santiago to a 10% recycling rate, according to a local survey. The majority of waste ends up in landfills, negatively impacting the lives of mainly low-income communities.

## CO-BENEFITS

### Economic

Reimagining waste as a resource instead of "garbage" makes possible revenue generation from the sale of recovered and/or recycled waste.

### Environmental

Local recovery of waste reduces emissions by avoiding longer collection and transportation trips, as well as reduced methane emissions from organic decomposition in landfills.

### Social

Collaboration between the "Base Recyclers" and the municipality will improve social entrepreneurship, enabling continued socio-economic improvement for the working class and creation of new business opportunities.

The City of Santiago is making it easier for citizens to recycle by implementing so-called "clean points" where waste can be sorted in order to be reused. **A network of points will be built to increase the recycling rate.** New equipment and training of personnel will also be used to classify, transport, and eliminate illegal waste disposal in public spaces. An important aspect of the project is the inclusion of "Base Recyclers" (one-man recycling companies) in the waste network, as their income will increase with more efficient waste collection.

The project will create 20 new clean points in 16 municipalities that integrate the pre-treatment processing of waste, facilitating the transport and trade onto processing companies. **Existing local recycling initiatives will be strengthened by the local centers,** and the project aims to improve economic, social, and environmental measures related to solid waste management. Local governments are free to adapt the approach, so it responds to local market demands, making it an adaptive, flexible waste management system.


Clean points are being implemented to boost the recycling rate and benefit local recyclers.

CITY: **TORONTO**

# On the Road to Zero Waste

→ With a new waste management strategy in place, Toronto will divert the majority of its waste from landfills and eventually become a zero-waste city.

↑70%

WASTE DIVERSION FROM LANDFILL BY 2026

## THE CHALLENGE

By sending 50% of its residential waste to the city's landfill, Toronto is looking at a full landfill by 2029. The new waste management strategy will extend the landfill's life and help Toronto take its first steps towards a zero-waste future.

## CO-BENEFITS

### Economic

Zero-waste goals support a local, circular economy. It is estimated that implementing the five Rs supports 10 times as many jobs as a simple disposal model.

### Environmental

The strategy seeks an overall reduction in consumption of resources, leading to less landfill and associated pollution, and reduced carbon emissions via improved recycling rates and decreased methane releases.

### Social

Toronto aims to increase collaboration amongst community members, social organizations, and the local government to improve knowledge about waste reduction and recycling.

Two years after its launch, Toronto's Long Term Waste Management Strategy's overall focus is to divert as much waste as possible from landfill. To do so, the strategy recommends waste reduction, reuse, recycling, recovery, and residual disposal policies and programs – also known as the "5Rs" – that are environmentally sustainable, socially acceptable, and cost-effective. **The strategy will assist Canada's most populous city in achieving a 70% residential diversion rate.** By working with community partners and leveraging existing social infrastructure, Toronto aims to divert an additional 200,000 metric tons of waste from landfill by 2026.

Toronto is also developing a pilot program to capture natural gas generated at the city's anaerobic digestion facility, which would reduce 100,000 metric tons of $CO_2$ emissions annually. The strategy is included in Toronto's Climate Change Action Plan, and will **assist the city in reaching its goal to reduce greenhouse gas emissions by 80% in 2050.**


Toronto-based artist Sean Martindale showcases the amount of garbage Toronto throws out every day in an art installation called, "There Is No Away."

CITY: **TSHWANE**

# Private Funding Creates Recycling Park and Green Jobs

→ The Atteridgeville Recycling Park is the first multi-waste stream recycling facility developed via a public-private partnership in South Africa.

↑75%

OF WASTE IN TSHWANE WILL BE DIVERTED FROM LANDFILL ONCE A SECOND RECYCLING PARK IS COMPLETED NEXT YEAR

## THE CHALLENGE

More than 10 million tons of $CO_2$ equivalent emissions come from Tshwane's current landfilling practices annually. The city is rapidly running out of landfill space, and it does not have the required capital to develop recycling infrastructure. Private sector funding has offered a solution to develop advanced recycling centers.

## CO-BENEFITS

### Economic

For the city, the economic benefit of the public-private financing model is that the waste management facility has been constructed without significant outlay of public funds, whilst the private operator is providing much-needed employment.

### Environmental

The recycling park will divert a significant portion of garden and recyclable waste in Tshwane from landfills, with consequent savings in greenhouse gas emissions. Since being launched in November 2016, more than 10 tons of garden waste has been composted.

### Social

A key social benefit is the provision of more than 70 jobs to residents of Atteridgeville who live in close proximity to the facility, so they are gainfully employed and can avoid expensive work-related transport costs.

The Atteridgeville Recycling Park (ARP) is being developed on public land in Tshwane with private financing through a novel "build, operate, and transfer" agreement. The concessionaire – New GX Enviro – will operate the facility for 15 years, before ownership of the waste management facility reverts to the city at no cost. Two phases of the ARP have been completed so far, the material recovery facility, and the garden waste composting facility. These represent $5.2 million of a planned $16.4 million investment. The next phases are **a municipal waste screening facility, which will separate organic and inorganic waste,** and a construction and demolition waste disposal facility.

**The facility will serve 300,000 households in the surrounding regions and divert waste from landfill.** It is also creating permanent jobs for the people of Atteridgeville, a historically disadvantaged area.

Once in operation, the Atteridgeville Recycling Park will serve 300,000 households and divert waste from landfill.

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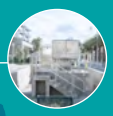

## MIAMI BEACH

*Raising Roads to Combat Sea-Level Rise*

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→ The Adaptation sector showcases solutions that make cities more resilient and adaptable for future climate changes, by integrating climate adaptation and ecosystem services in municipal planning, prioritizing green infrastructure, and redesigning streetscapes, while simultaneously increasing recreational opportunities and providing significant social benefits to residents.

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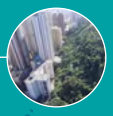

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CITY: **BARCELONA**

# Managing Trees for a Healthier City

→ The trees of Barcelona take center stage in the city's efforts towards improving habitability and health for its growing population.

**113K**

METRIC TONS OF CARBON STORED ANNUALLY IN BARCELONA'S TREES

## THE CHALLENGE

With periods of drought, heat waves, and higher levels of solar radiation, Barcelona faces challenges in ensuring the health of its citizens. By managing its green infrastructure, the city is adapting to climate change while increasing livability for its citizens.

## CO-BENEFITS

### Economic

The shade and microclimate generated by trees reduce the energy consumed for air conditioning in adjacent buildings, slashing utility bills by $10 million annually.

### Environmental

Trees make attractive habitats for fauna. Increasing the number of trees increases animal biodiversity in the city.

### Health

Trees improve air quality by eliminating atmospheric pollutants, caused by vehicles and industry. In one year, the city's trees and bushes eliminate more than 305 metric tons of polluting compounds.

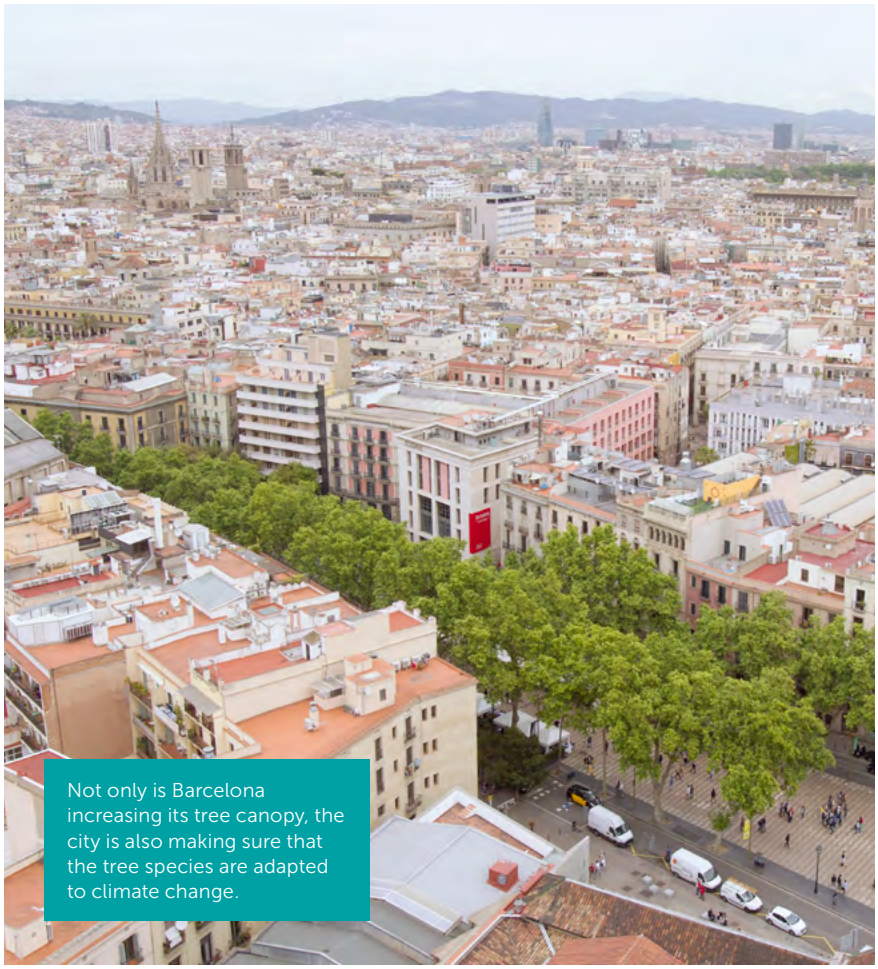
### Social

Green infrastructure has a positive effect on life expectancy and reduces health inequality due to the psychological and physical benefits from being in contact with nature[1].

[1] Forest Research. Report: Benefits of green infrastructure. (2010, October)

Barcelona's green infrastructure – specifically its trees – will play a significant role in improving quality of life in the Mediterranean city. With the Master Plan for Barcelona's Trees 2017-2037, the city placed trees at the heart of local policies ensuring the appropriate management of Barcelona's tree heritage. Part of the planning focuses on **guaranteeing that 40% of the tree species are adapted to climate change,** such as being able to withstand droughts and heat.

The plan aims to minimize the urban heat island effect by **increasing the tree canopy from today's 5% to 30%**, as shade and humidity from vegetation help cool the atmosphere and lower the temperature during the hotter months. Tree pits will be enlarged to better retain rainwater, enabling its use as groundwater resource and compensating for potential flooding issues with impermeable surfaces in the city's urban areas.



Not only is Barcelona increasing its tree canopy, the city is also making sure that the tree species are adapted to climate change.

CITY: **BILBAO**

# From Degraded Peninsula to Carbon-Neutral Island

→ Bilbao's major urban regeneration project will turn a formerly industrial and contaminated peninsula into a carbon-neutral island, safe from flooding.

839K

M² OF LAND RECOVERED FOR THE CITY, CREATING A NEW DISTRICT

## THE CHALLENGE

Having experienced both social and industrial decline since the 1970s, Bilbao's former industrial port, Zorrotzaurre, has become a depleted area abandoned by industry, with contaminated soil, and scarcely 500 residents left. Due to the area's low-lying topography surrounded by the Bilbao River and the Deusto Canal, Zorrotzaurre is at risk from rising sea levels.

## CO-BENEFITS

### Economic

Construction of the island will create approximately 5,000 jobs, and the planned Urban Technology Park will create up to 6,000 jobs.

### Environmental

As a result of the industrial activity, some of the peninsula's soils are contaminated. To avoid any risk to residents' health and to prevent landscape degradation, 300,000 m² of polluted land will be cleaned.

### Social

The island will have major walkways on both sides of the bank and a 40,000 m² central park for the island's residents.

Zorrotzaurre is an artificial peninsula in the city of Bilbao that sits between the Nervión river and a man-made canal. By extending the canal to rejoin the river, **the city will create an island complete with affordable housing, environmentally friendly industry, and carbon-neutral transportation.** Regional climate models forecast a 10% increase in precipitation for Bilbao, so developers had to consider flood prevention for the new island. This will be achieved by elevating the ground by 1.5 meters, creating flood protection barriers, and providing stormwater tanks. The act of opening the Deusto Canal to create the island will also form a natural flood defense by allowing more space for the river during heavy precipitation events. The planned flood-protection measures for the future 15,000 residents are thought to be able to withstand a 1-in-500 year flood event.

Plans call for **Zorrotzaurre to become a carbon-neutral island** with 100% electric public transportation, infrastructure prioritizing pedestrians and bicycles, zero building emissions enabled by geothermal heating and cooling, and a goal to obtain all electricity from renewable resources. Any emissions stemming from transportation to and from the island and from water management will be neutralized with afforestation elsewhere.

Designed by architect Zaha Hadid, the new city district with its plethora of cultural and social facilities will improve quality of life for the island's residents.

CITY: **GIBSONS**

# Utilizing Services Provided by Nature

**↑73%**

OF GIBSONS' INHABITANTS RELY ON WATER FROM THE CITY'S AQUIFER

→ Gibsons has pioneered municipal asset management by making natural assets a fundamental component of the city's infrastructure system.

Gibsons has become the first North American city to pass a municipal asset management policy that explicitly recognizes natural assets, or "eco-assets," as an asset class, acknowledging that eco-assets are often superior to engineered ones. The Canadian coastal city's new Eco-Asset Strategy will **help the city save money, reduce risks, and maintain healthy ecosystems.** The Gibsons Aquifer is a great example. At a cost of just $28,000 annually, the aquifer provides clean drinking water in perpetuity and reduces the risk of liabilities for new water purification and storage infrastructure. By comparison, an engineered treatment plant would cost hundreds of thousands of dollars.

The city's foreshore is another eco-asset, which – if properly managed – will protect the waterfront from storm surges and sea level rise at a significantly lower cost than the construction and operating costs of an engineered alternative. Other natural assets include soil and forest areas providing valuable stormwater management. By granting Gibsons' eco-assets a financial value, **a flow of ecosystem services supporting human health is enabled** along with vital climate change adaptation.

## THE CHALLENGE

With one-meter sea level rise projected by 2100, coupled with storm surges, the coastal city of Gibsons will require measures to protect its assets and livelihoods in the foreshore area. The city has therefore innovated municipal asset management, ensuring its resilience to future change in weather conditions.

## CO-BENEFITS

### Economic

Natural assets have a financial advantage over engineered assets in that they have lower operational costs, lower risks, no upfront or replacement costs, and no depreciation.

### Environmental

The increased habitat from preserved forests and foreshore increases biodiversity in Gibsons.

### Health

Abundant research demonstrates the positive mental and physical health impacts resulting from the presence of nature in urban areas.

A collaboration between artists and local schools was developed to highlight the value of local ecosystems.

CITY: **GLADSAXE**

# Recreation and Adaptation Go Hand-in-Hand

→ Aiming to make its citizens more active and to connect the city, Gladsaxe has managed to include recreational uses in all aspects of one of the largest Danish climate adaptation projects yet.

↓99

TONS $CO_2$ REDUCED ANNUALLY FROM AN INCREASE IN BICYCLE TRAFFIC ON THE CITY'S NEW BICYCLE PATH

## THE CHALLENGE

Growing massively in the '50s and '60s, Gladsaxe built a combined sewer system. Yet, with increased rainfall in recent years, the city struggled with combined sewer overflow and, in 2011, one extreme weather event led to damages of more than $900 million. Avoiding similar losses in the future, the city is implementing blue-green solutions targeting sewer issues and providing climate benefits.

## CO-BENEFITS

### Environmental

The city has developed trench wells with a special valve construction for winter changeover, so that during winter, when temperatures fall below 0°C and roads need salting, any road runoff water is led to the wastewater sewer, preventing the road salt from causing damage to nearby ecosystems.

### Health

With a great focus on physical activity as a dual function of the rainwater solutions, the city improves public health. The city's bicycle path alone has seen a 30% increase in use.

### Social

Dubbed "the girls' room," an area with swings, hammocks, and nets for climbing, has become a popular meeting point for the city's teenage girls, a group who previously rarely used the area.

With an area equivalent to 200 soccer fields, the Gladsaxe Heights Nature Park is one of the largest climate adaptation projects in Denmark. **The 142-hectare water catchment area handles rainwater from roads, 2,700 households**, and a sports center. While reducing the risk of combined sewer overflow, the area consists of blue and green surface solutions serving as both climate adaptive and recreational spaces.

The project comprises a number of interconnected sub-projects, including an outdoor sports center with nine rainwater basins designed for different activities. 'Paddle tennis' courts, skateboarding areas, and climbing frames all act as rainwater reservoirs during intense rain but for the majority of the time provide fun recreational spaces for children. The project also includes a **non-profit social housing association that has developed a rainwater distribution system independent of traditional wastewater infrastructure,** reducing total volumes for the system to process during cloudburst events.

The Gladsaxe Heights Nature Park is an extensive protected natural area that receives rainwater from the other subprojects.

CITY: **HONG KONG**

# Abandoned Quarry Converted to Resilient Neighborhood

→ Hong Kong is transforming an old industrial site into a sustainable residential development, providing much-needed housing while ensuring climate resiliency and low environmental impact.

**↓4.6K**

METRIC TONS OF $CO_2$ REMOVED ANNUALLY BY ALLOCATING 230,000 $M^2$ TO GREEN AREAS

## THE CHALLENGE

In recent years, Hong Kong has experienced a housing shortage with a rapidly growing population, as well as issues with increased rainfall intensity and increased temperatures. The project aims to address the housing and climate change challenges in an integrated, multi-sectoral, and sustainable manner to develop a prosperous, livable, and attractive city.

## CO-BENEFITS

### Environmental

With at least 23 hectares of green areas, and plans to plant 200,000 trees, $CO_2$ will be sequestered and air quality significantly improved.

### Health

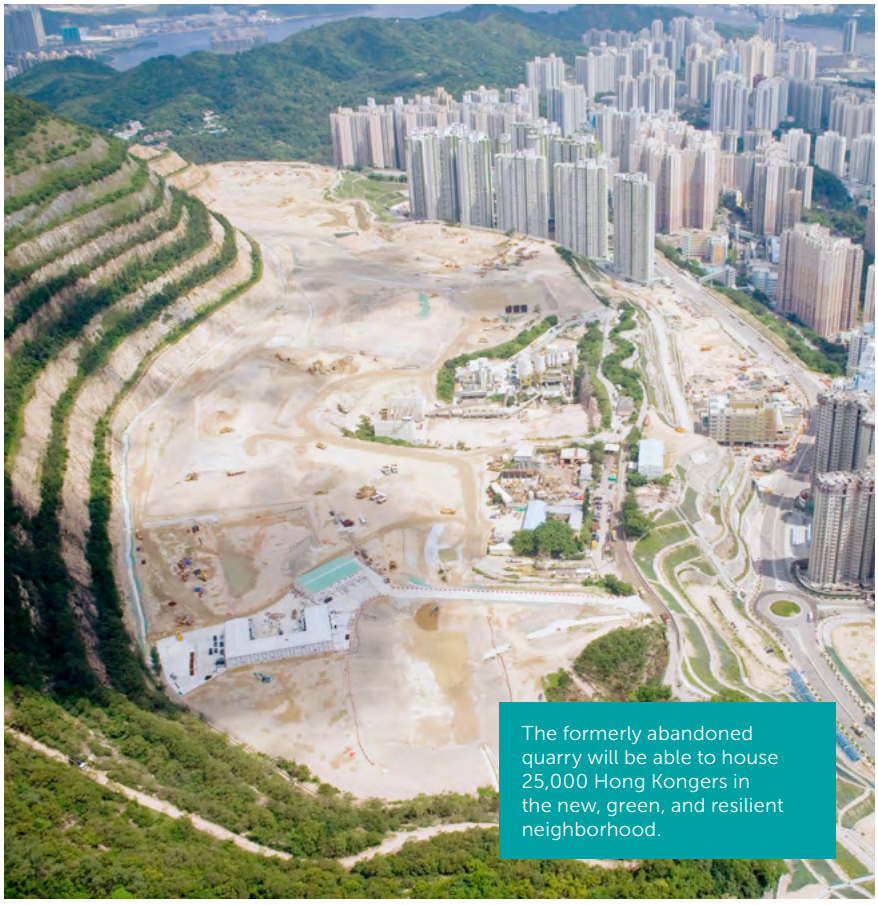
The project provides 2.6 km of cycling path integrated with 5.3 km of walking paths within the community parks. A bike-sharing program and interactive bus stops integrated with a smartphone app will encourage residents to use more active, sustainable means of transportation.

### Social

The project provides 155,000 $m^2$ of parkland for residents of the Anderson Road Quarry and nearby neighborhoods, increasing the social cohesion between different Hong Kong communities.

The Anderson Road Quarry in Hong Kong was once a facility supplying asphalt and concrete, but **the now vacant 40-hectare site will supply housing for 25,000 people.** In order to prepare the urban development for the impacts of climate change, the city is employing a wide array of adaptive and resilient approaches. One focus for the large redevelopment is sustainable water management, which will be attained by implementing a first-of-its-kind 7,200 $m^3$ artificial stormwater attenuation lake park, a rainwater harvesting system, and a gray water reuse system. These measures avoid expensive upgrades to existing drainage systems and **will save around 3,000 metric tons of $CO_2$ annually,** helping the city live up to its 65% to 75% carbon reduction goal by 2030 set in the Hong Kong Climate Action Plan.

In further efforts to save energy and $CO_2$, all streets will be lit with LEDs, saving up to 70% more energy than conventional light fittings, and buildings will have 3,700 $m^2$ green roofs and 35 $m^2$ solar panels.



The formerly abandoned quarry will be able to house 25,000 Hong Kongers in the new, green, and resilient neighborhood.

CITY: **HONG KONG**

# Landslide Protection with Low-Impact Design

→ Hong Kong is protecting residents from deadly, rain-induced landslides by strategically installing barriers and drainage tunnels.

**↓50K**

PROJECTED LANDSLIDES COULD BE AVOIDED THROUGH LOW-IMPACT DESIGN

## THE CHALLENGE

Hong Kong is a mountainous city with dense urban development built on steep man-made and natural terrain. Many of the man-made slopes were constructed 50 years ago without proper engineering, and with the city's high rainfall, landslides are common and cause extensive socio-economic damage and fatalities.

## CO-BENEFITS

### Economic

The project lowered the landslide risk to "as low as reasonably practicable," reducing direct and indirect economic losses associated with landslides. The project also created 550 jobs during construction.

### Environmental

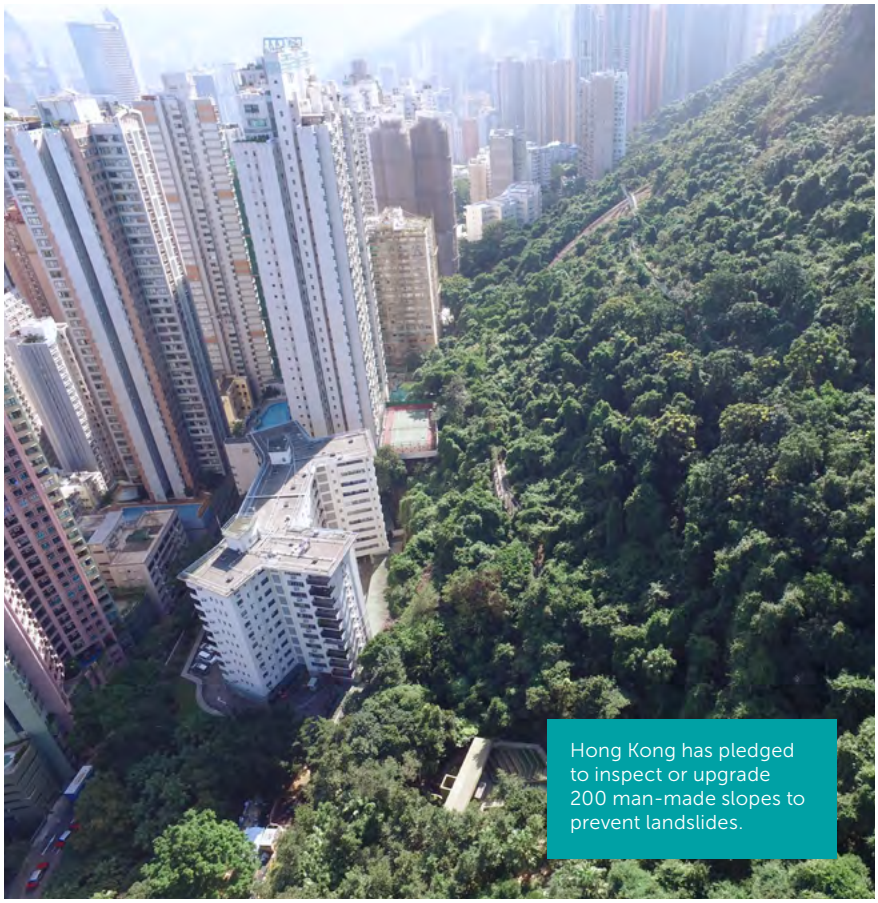
Any trees felled and undergrowth cleared during the engineering works is compensated by planting additional trees and shrubs.

### Health

Reduced landslide risk has improved public safety and created a more livable environment for Hong Kong citizens.

The topography across Hong Kong's land area is dramatic: more than 60% of the land is steeper than 15 degrees and 30% is steeper than 30 degrees. Very high rainfall on this hilly natural and man-made terrain has resulted in frequent and disastrous landslides across the densely developed city. **Quantitative risk assessments had predicted up to 2,500 landslides per year and identified high-risk zones.** To mitigate these risks, the city is implementing low-impact and effective landslide protection solutions.

Using remote sensing tools and GIS-based landslide modeling, **the city has designed and strategically placed both flexible and rigid barriers to resist the impacts of landslides.** This approach was chosen in favor of slope stabilization, which is not only costly but also requires extensive earthworks and tree felling. In addition, drainage tunnels and smart monitoring technology enable better control of groundwater in the city's slopes – one of the primary drivers of landslides.



Hong Kong has pledged to inspect or upgrade 200 man-made slopes to prevent landslides.

CITY: **JAKARTA**

# Alleviating Floods with Parks for Children

↑200

KM² COVERED IN GREEN AREAS BY 2030

→ Jakarta is constructing parks all over the city to reduce flood duration and to ensure better quality of life for the city's children.

Indonesia's capital has committed to increase green open spaces from 10% to 30% of the city's 662 km² by 2030 as part of the city's Climate Action Plan. Seeing public green spaces reduced almost 78% in the past 40 years in the city, while also experiencing steady population growth and regular flooding events, Jakarta needed a solution. To reach the 30% target, Jakarta has begun building parks through the Green Open Space and Child-Friendly Integrated Public Spaces program. **By 2016, the city had completed 200 parks, and is set to complete 306 by the end of 2017.** Increasing green infrastructure has improved the city's resilience and reduced flood duration from the former three days to just three hours per flooding event.

Kalidojo, Jakarta's oldest and largest red-light district, was demolished and turned into one of the city's green, child-friendly parks, including jogging tracks and bicycle lanes, a skate park, an amphitheater, and outdoor fitness facilities. **The city plans to have around 3,000 parks** built, covering all high-density and vulnerable areas by 2022.

## THE CHALLENGE

With more than 10 million inhabitants, the densely populated Jakarta struggles to keep the city safe when torrential rains hit. In an attempt to reduce flood duration and enhance quality of life – especially for children – Jakarta is constructing hundreds of parks across the capital.

## CO-BENEFITS

### Economic

The construction of the parks has created jobs for local Jakartans, who will see many more opportunities for work, as the city plans to construct 3,000 parks by 2022.

### Environmental

The parks have generated a more attractive and greener environment, reducing $CO_2$ and improving air quality, while enabling the city to recover from flooding in a matter of hours.

### Social

Some parks have libraries, creative studios for children, hydroponic gardens, and free WiFi.

With 3,000 parks to be constructed, Jakarta is making great strides to become a safe city and increase quality of life for children.

[1] Atkins. Study: Flood Loss Avoidance Benefits of Green Infrastructure for Stormwater Management. (December, 2015)

CITY: **MEXICO CITY**

# Harvesting Rain to Reduce Water Scarcity

→ By installing rainwater harvesting systems, Mexico City is reducing its drinkable water scarcity problem by making use of something it has in abundance: rain.

**↑75M**

LITERS OF WATER SAVED SINCE IMPLEMENTATION OF THE "AGUA A TU CASA" PROGRAM

## THE CHALLENGE

Factors such as inaccessibility and high population density, along with water and soil pollution, result in a lack of adequate supply of drinking water for more than a million people in Mexico City. The city is solving this problem by making better use of the abundant rainwater in an equitable, sustainable, and innovative manner.

## CO-BENEFITS

### Economic

Each rainwater harvesting system guarantees the supply of up to 40,000 liters of drinking water per year, which means an annual saving of around $200 per family.

### Environmental

Each rainwater harvesting system has the capacity to store around 670 liters per square meter, preventing aquifers, groundwater and drainage systems from being over exploited.

### Health

The water purification systems and drinking devices ensure the quality of water for human consumption, mitigating 99% of pathogenic bacteria, which helps to prevent diseases such as diarrhea and typhoid.

In 2016, Mexico City launched the "Aqua a tu Casa" program with the purpose of solving the drinking water scarcity problem in marginalized areas. By installing rainwater harvesting systems and water purification technologies in houses, apartments, and public buildings, **75 million liters of water have been saved since the implementation of the program.** One of the main goals is to consolidate the reuse of rainwater in the city, thus avoiding overexploitation of aquifers and groundwater systems, the latter of which is already sinking up to 40 cm per year. Since its implementation, **nearly 500 rainwater harvesting systems, water purification technologies, and drinking devices have been installed,** benefitting 56,320 people.

The program's focus goes beyond water conservation, and it has become a core part of the city's social policy, with its efforts towards gender equality. To promote empowerment of women who have suffered domestic violence, the city offers these women training in the installation and maintenance of rainwater harvesting systems.


Almost 500 rainwater harvesting systems have been installed under "Agua a tu Casa," benefitting 56,320 people in Mexico City.

CITY: **MIAMI BEACH**

# Raising Roads to Combat Sea-Level Rise

→ Miami Beach is embarking on a comprehensive plan to combat flooding from rising sea levels by raising its roads and seawalls.

**↑366M**

LITERS OF WATER CAN BE PUMPED AWAY FROM STREETS IN 24 HOURS

## THE CHALLENGE

The coastal city of Miami Beach has low-lying topography and 100 km of shoreline, making it vulnerable to storm and tidal flooding. These events are exacerbated by climate change and sea-level rise, and the city is adapting by modifying its public infrastructure to better manage flood waters and protect the community.

## CO-BENEFITS

### Economic

The program has reduced flood insurance premiums for private properties by reducing the number of flood events. Flood damage and disruption to local businesses have also been reduced.

### Environmental

Miami Beach installed water treatment plants that capture pollutants that were previously washed directly into the city's waterways. The plants remove approximately 70 tons of debris per month.

### Social

The city created funding sources to minimize the financial burden of flood events on the low-income families in Miami Beach.

Miami Beach is experiencing the physical, economic, and social consequences of rising seas. Taking matters into its own hands, the city has begun implementing a sea-level rise adaptation program. It includes converting the city's stormwater system from a gravity-based system to a pump-based system, raising seawalls and roads up by one meter, and restoring natural systems such as the shorelines to reduce flood risk. The city is already reaping the benefits of the program, which began in 2014, with upgraded **neighborhoods experiencing substantial reductions in flood events.** Roads previously impassable during high tides no longer experience tidal flooding.

Restoring shorelines with endemic plants to reduce storm surges is regarded as a non-conventional sea-level rise adaptation strategy, and currently requires extensive permitting processes. Miami Beach has pushed regulatory agencies to **encourage these more natural adaptations to climate change.**

Miami Beach is installing 80 stormwater pumping stations across the city.

CITY: **NEW ORLEANS**

# Comprehensive Strategy for Equality and Resilience

→ New Orleans is determined to make the city resilient to future climate change in a socially equitable way via a range of environmental, social, and structural projects.

↓50%

$CO_2$ REDUCTION GOAL BY 2030 WITH RESILIENT NEW ORLEANS

## THE CHALLENGE

More than a decade after Hurricane Katrina flooded 80% of the city and the homes and businesses of one million people, New Orleans is moving forward with its comprehensive strategy to reduce inequality and climate change vulnerability.

## CO-BENEFITS

### Economic

Improved flood protection is expected to result in lower insurance premiums for low-income communities.

### Environmental

By reintegrating green and blue infrastructure back into the city's urban landscape, biodiversity will increase and natural filtration capacity will improve water quality.

### Health

Equitable public health is a key goal and improved air and water quality and improved housing conditions will all contribute to better health for the city's residents.

### Social

With more than 52% of black men unemployed or underemployed, Resilient New Orleans is focused on advancing social cohesion and mobility. A workforce development program is in progress to accompany environmental projects.

[1]Goldenberg, Suzanne. The Guardian. Climate change: the poor will suffer most. (March, 2014)

"Resilient New Orleans" is a portfolio of policies combining environmental, social, and infrastructure systems to reduce climate risk and socio-economic inequality. Climate change is expected to disproportionately affect poor communities[1], so to increase resiliency, New Orleans is investing in the most vulnerable neighborhoods. One initiative is an **emergency account program, which matches financial savings for low- and moderate-income earners** to create emergency funds dedicated to natural disaster response. Another initiative incentivizes property owners to invest in risk reduction via a tested financial tool that removes high upfront cost barriers for homeowners.

The city is also investing in green infrastructure to improve resilience. Built on a river delta and low-lying marshy land, water is at the heart of New Orleans. **After decades of trying to work against the water, the city now embraces it via a network of parks and green spaces**. The green infrastructure absorbs water slowly, filtering and cleaning it in the process, allowing the city's drainage system to cope with storm downpours more effectively. New Orleans will also establish a pioneering Resilience Center to serve as a hub for resilience innovation and leadership.

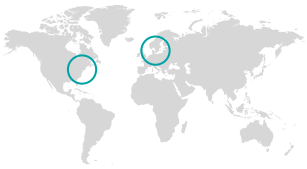
Integrating green and blue infrastructure throughout the city provides recreational spaces as well as natural flood protection for New Orleans.

CITY: **NEW YORK CITY & COPENHAGEN**

# Cities Collaborating on Climate Resilience

**↑603M**

DOLLARS IS THE ESTIMATED TOTAL BENEFITS FROM THE COPENHAGEN-BASED CLOUDBURST STRATEGY IN NYC



→ New York City and Copenhagen have joined forces in an international, innovative collaboration to build upon the successes of their respective resiliency projects.

Instead of waiting for more extreme weather to hit, **New York City and Copenhagen have decided to leverage experiences from each other and share their successful climate solutions.** While New York City is learning from Copenhagen's experience with cloudburst management, Copenhagen is drawing on New York City's experience with coastal flooding. For example, New York City's Cloudburst Resilience Planning Study is based on Copenhagen's approach, and seeks to use a combination of blue-green and traditional infrastructure to manage extreme rain events. This approach brings added benefits of $CO_2$ sequestration, aesthetic improvements, and increased biodiversity.

Not only does the collaboration demonstrate how to share and develop innovative adaptation projects, but **it also paves the way for future climate action partnerships.** The extensive engagement involved between the cities' governments, as well as their public and and private sectors, proves intercontinental collaboration can result in climate-adapted, resilient cities.


This green infrastructure playground in Brooklyn serves as flood protection while increasing quality of life for the community's children.

## THE CHALLENGE

New York City and Copenhagen both experienced extreme weather events in 2011 and 2012 respectively. New York City experienced severe coastal flooding, and Copenhagen battled downpours. As both coastal cities face rising sea levels and more frequent cloudbursts, they have teamed up to develop projects based on past experiences.

## CO-BENEFITS

### Economic

With full implementation of the Copenhagen cloudburst project, the avoided social and environmental costs are estimated at $290 million.

### Environmental

The proposed green infrastructure in New York City will reduce runoff and flooding, and also have a natural filtration capacity that treats stormwater before being discharged into Jamaica Bay.

### Health

Flooding in both cities resulted in loss of life and displaced populations, which will be avoided through these climate resilience projects.

### Social

Green infrastructure encourages community engagement via activities such as gardening and farming.

CITY: **NEW YORK CITY**

# Integrating Climate Projections in City Planning

→ In New York City, climate change risks are now integrated into the city's existing planning and construction operations, ensuring city projects' resilience.

**↑20B**

DOLLARS IS INVESTED IN NEW YORK CITY´S RESILIENCE PROGRAM

## THE CHALLENGE

New York City faces sea level rise, storm surges, heat waves, extreme hot days, and intense rain events. In order to increase resilience, the city has mainstreamed adaptation into the planning process, ensuring that climate projections inform building and infrastructure design.

## CO-BENEFITS

### Economic

The economic benefits of the guidelines will be seen in losses avoided, ensuring that New York City bounces back quickly from extreme weather events. Hurricane Sandy cost $19 billion in damages and lost economic activity.

### Environmental

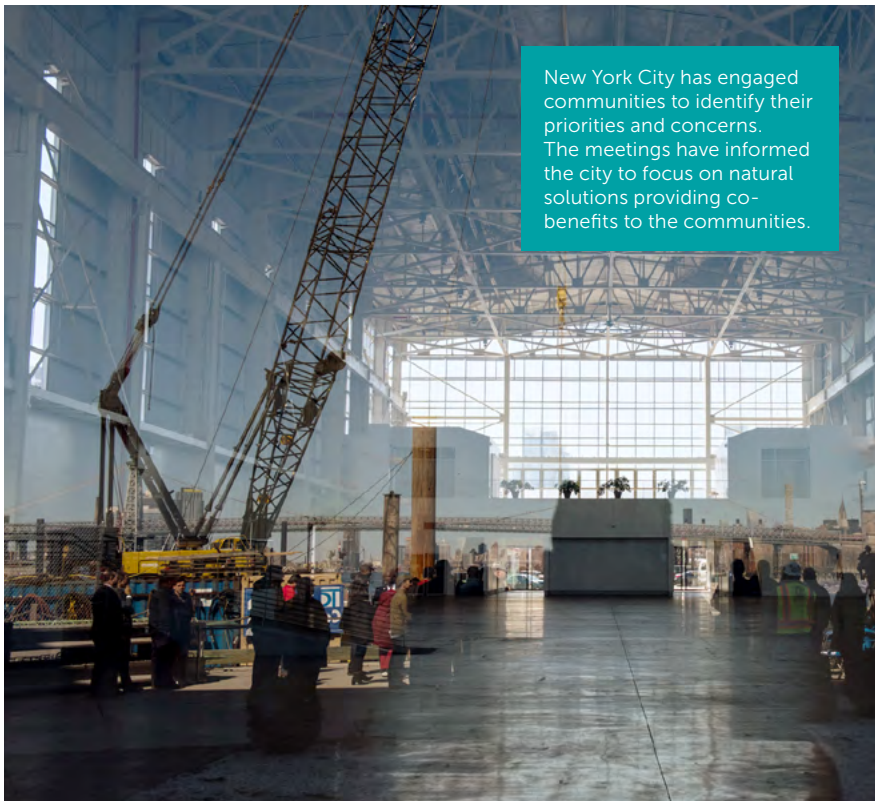
The guidelines require an increase in the capacity of stormwater management systems, which reduces urban flooding and reduces combined sewer overflows, an existing challenge that will be aggravated as the intensity of rain events increases with climate change.

### Health

Minimizing the city's urban heat island effect will result in a cooler city, better able to keep vulnerable New Yorkers safe during heat waves. Critical city services such as hospitals will be well-protected and quickly restored following major weather events.

New York City is the first American city to institutionalize climate resiliency by establishing city-wide Climate Resiliency Design Guidelines for using forward-looking climate projections in city project designs. New York City's government departments all have previously developed their own development guidance but lacked a consistent approach for how to use climate projections. The guidelines provide a consistent methodology for engineers, architects, and planners to **design facilities that are resilient to continued changes in climate** across the entire lifespan of the facilities.

The Climate Resiliency Design Guidelines are multi-hazard, addressing all major climate change risks identified by the New York City Panel on Climate Change. **The guidelines address some of New York's most acute issues,** such as how to limit the urban heat island effect, while also protecting facilities against extreme heat. By recommending flexible adaptation pathways, a way of designing facilities with coastal storm protections that are upgradable, the city will limit urban flooding from extreme precipitation. In doing so, the city is not only becoming increasingly resilient but also a more enjoyable place to live for millions of New Yorkers.



New York City has engaged communities to identify their priorities and concerns. The meetings have informed the city to focus on natural solutions providing co-benefits to the communities.

CITY: **QUITO**

# Prioritizing Nature for a Climate-Adapted, Low-Carbon City

→ By recognizing the value of the city's ecosystems and protecting them in municipal planning, Quito is setting the standard for low-carbon, climate-adapted urban and rural development.

**↓11.2M**

TONS OF $CO_2$ EQUIVALENT SAVED BY SUSTAINABLY MANAGING AND CONSERVING LAND

## THE CHALLENGE

More than 56% of Quito's natural vegetation is deemed vulnerable to climatic changes, including temperature and precipitation changes. With a population of 2.5 million, which is expected to double by 2025[1], the subtropical highland ecosystems are under growing pressure.

## CO-BENEFITS

### Economic

By enabling access to job opportunities in sustainable agriculture and tourism, rural communities close to natural areas can benefit from urban economic developments.

### Environmental

Situated at an altitude of almost 3,000 m, Quito has a unique city climate and associated biodiversity. The city is protecting the three Important Bird and Biodiversity Areas, as well as a habitat for the highly vulnerable Andean Spectacled Bear populations native to the area.

### Social

By conserving natural areas and diversifying economic activities in the city, quality of life will improve for the part of the population that is vulnerable to socio-economic and climate-related impacts.

More than 60% of Quito's high-altitude territory is covered by vegetation. Yet, as changes in climate come into contact with economic and agricultural developments, ecosystems are being put under increasing pressure. The Ecuadorian mountain capital has therefore **initiated efforts to guarantee sustainable city development focused on the city's fragile ecosystems.** Quito manages the city's natural surroundings and forests as an integral part of its municipal planning and development, pursuing collaborative environmental governance between multiple city actors to enable sustainable land management from all sectors. The city has used geographic information systems (GIS) to map the baseline ecosystem data, estimate future deforestation rates, and prioritize adaptation measures in the most vulnerable ecosystems to ensure continued ecosystem services and natural resilience.

Quito has recognized the importance of forest conservation for preservation of water services, including flood protection and freshwater supply, and has ring-fenced 175,000 hectares of land for protection under its "Municipal Protected Areas" scheme. **The city is also reclaiming 60,000 hectares of previously degraded land, which is expected to sequester around six million tons of carbon dioxide.** This ultimately contributes to reducing the city's carbon footprint by 5% every year.

A pilot project adapted three farms to climate change by implementing sustainable agriculture, improving irrigation systems, and restoring native plant species.

[1] CDKN. Feature: Adapting to flood and fire in Quito, Ecuador. (January 26, 2015)

CITY: **ROTTERDAM**

# Mitigation Meets Adaptation on Rotterdam's Rooftops

→ Turning the city's rooftops into a second ground level, Rotterdam is mitigating tons of $CO_2$, while adapting the city to become a resilient and attractive place to live for Rotterdammers.

**↑1M**

M² OF MULTIFUNCTIONAL ROOFS BY 2030

## THE CHALLENGE

WWII bombardment destroyed the center of Rotterdam in 1940, and flat roofs now dominate the reconstructed areas. Today, facing climate hazards and high urban population density, Rotterdam is using its rooftops to address its climate challenges and add value to the city.

## CO-BENEFITS

### Economic

Green roofs already reduce water treatment costs by $75,000 annually.

### Environmental

75,000 m² of PV panels have been installed so far, preventing roughly 10,000 tons of $CO_2$ emissions. The 250,000 m² green roofs can retain 5,000 m³ of water, alleviating flooding.

### Health

The Erasmus Medical Centre in Rotterdam has installed 5,000 m² of green roofs and turned 3,000 m² into gardens, improving the environment for patients.

### Social

A so-called "lunch room" on a green rooftop has 2,000 weekly guests and uses only fresh produce cultivated on the roof.

In Rotterdam, **colored roofs have officially become part of the city's climate adaptation strategy.** Challenges with flooding, air quality, and a lack of green space are all addressed via a multifunctional approach to the development of the roofs. And with 14.5 km² of unused roof space above the city, the possibilities seem almost endless.

Four colors represent four functions: blue roofs retain water, green roofs add biodiversity, yellow roofs produce renewable energy, and red roofs add social value. This holistic approach offers valuable cross-sector co-benefits. **The city aims to create 10,000 m² of yellow roofs, generating 1.25 MW of renewable energy**, and construct another 80,000 m² of blue roofs, which can retain 2,000 m³ of water.

Built on top of a shopping center, the DakPark Rotterdam is the biggest rooftop garden in Europe, covering 100,000m².

CITY: **SAN FRANCISCO**

# Connecting Climate Action with Public Health

→ San Francisco explicitly linked climate change with adverse public health effects and created an adaptation framework to better prepare citizens for the consequences of a changing climate.

**↑70+**

INTERVENTIONS ARE INTRODUCED BY THE FRAMEWORK TO SAFEGUARD PUBLIC HEALTH IN SAN FRANCISCO

## THE CHALLENGE

Global climate change has local impacts. For San Francisco, these include extreme heat days, sea-level rise and storms, and severe droughts, all of which can cause fatalities. San Francisco's Climate and Health Adaptation Framework explicitly addresses these risks.

## CO-BENEFITS

### Environmental

Strategies in the framework include working with city partners to develop green urban spaces and increase tree canopy to reduce the urban heat island effect, as well as develop natural stormwater management practices to soften the impact of extreme storms.

### Health

The framework will alleviate health consequences of climate change such as extreme heat, flood inundation increasing exposure to molds, and worsening air quality that exacerbates respiratory illnesses and triggers asthma symptoms.

### Social

One of the objectives of the framework is to develop an outreach plan that builds capacity between the SFDPH and the people they serve. Improving social cohesion will support resilience and help protect vulnerable communities.

The San Francisco Department of Public Health (SFDPH) has released a framework describing the connection between climate change and local health impacts. **It represents a comprehensive approach to engage stakeholders in designing solutions that reduce health disparities and climate health impacts.** The SFDPH's framework assesses climate trends, defines disease burden, develops specific intervention methods, and evaluates the effects of change for communities at greatest risk.

Some of the suggested city-led strategies include the **deployment of a sensor network to provide real-time monitoring of air quality and weather-related warnings for vulnerable populations.** To continuously address the projected health impacts of climate change, the city will develop emergency plans, create educational material for adaptation and resilience efforts, strengthen cross-collaboration between government agencies, and support vulnerable communities in capacity building.


Increasing green urban spaces is one of the strategies employed by the city to reduce the urban heat island effect and improve air quality.

CITY: **ST. PETERSBURG**

# Grassroots Low-Cost, Low-Impact Flood Defense

→ To manage urban stormwater and protect biodiversity, Novoe Devyatkino adopted an environmentally friendly approach that is among the first to be developed in Russia in response to climate change.

↓35%

REDUCTION IN COST COMPARED TO TRADITIONAL DRAINAGE SYSTEMS

## THE CHALLENGE

In a country that has not ratified the Paris Agreement, grassroots adaptation schemes such as this could prove to be crucial for coping with rainfall events predicted to increase in frequency and intensity[2] over the coming decades. The city is already sharing its experiences, and is co-developing plans for more rain gardens, with other Russian cities.

## CO-BENEFITS

### Economic

Natural LID flood defenses require little maintenance compared with aging stormwater drainage systems requiring regular cleaning and filter replacements.

### Environmental

The rain gardens contain local and non-invasive species, which bolsters biodiversity and protects natural fauna and flora, whilst also naturally filtering surface runoff water.

### Social

Residents were heavily involved in the development and design of the rain gardens, and wanted to maximize the potential for recreational space.

Located on the outskirts of St. Petersburg, Novoye Devyatkino faces many of the challenges other Northern European cities face under climate change scenarios. In response to increasingly frequent and severe cloudburst events, Novoye Devyatkino opted for **a Low-Impact Development (LID) flood-protection system that mimics natural processes to protect water quality and aquatic habitats**[1] as well as reduce flood water volumes. Instead of adding to the traditional storm management systems, the city designed a "net" of rain gardens to capture surface runoff and filter it slowly back into the groundwater.

Implementing LID method of design allowed Novoye Devyatkino to work with nature, only planting local and non-invasive plants, and helping to restore local ecosystems in surrounding neighborhoods. **The result is a pleasant, recreational space for the majority of the year** and a natural flood-defense system when rainfall intensifies – all at a small cost covered by the local budget.

Novoye Devyatkino has large areas of paving, which creates intense surface runoff following heavy rain events. LID approaches help to absorb the excess water.

[1] EPA. Urban Runoff: Low Impact Development. (June, 2017)

[2] Davydova, Angelina. Article: Russia's top cities wake up to need for climate change adaptation. (July, 2014)

CITY: **STUTTGART**

# Evidence-Based Approach to Adaptation

→ Using quantitative studies from the field of human biometeorology, Stuttgart is building long-term adaptation methods into planning procedures to reduce the threats from extreme heat events.

**↓8.4**

DEGREES CELSIUS OF AIR TEMPERATURE CAN BE REDUCED BY KLIPPS DESIGN STRATEGIES

## THE CHALLENGE

Southern European cities such as Stuttgart are more likely to face heat waves and more days with extreme temperatures resulting from climate change. Understanding the relationship between urban planning and temperature regulation is of crucial importance for long-term climate adaptation.

## CO-BENEFITS

### Environmental

The urban green designs of the KlippS project show potential $CO_2$ reduction of more than 2,000 kg per year within a 25,000 m² green area.

### Health

The KlippS project provides cooling effects from green infrastructure via shading and increased evapotranspiration, and recorded a mean temperature reduction of 1.5 degrees Celsius during the daytime period of a heat wave, under the suggested local green design.

### Social

Green infrastructure has multiple social co-benefits. Urban aesthetic improvements, options for increased recreational activities, and opportunities for cultural performances all lead to greater social cohesion.

Stuttgart has used results from the field of human biometeorology – the study of interactions between humans and the atmosphere – to model how urban designs can cope with increased frequencies of extreme heat events. The Climate Planning Passport Stuttgart, or "KlippS," is a two-stage strategy that first evaluates the state of urban climate in areas throughout the city and then focuses on optimizing urban planning measures in vulnerable districts.

After screening 59 areas, KlippS identified 24 in urgent need of action to address high levels of potential urban heat stress. The city then used a 3D model to study the impacts of various urban forms on temperature gradients and heat effects on citizens. A number of urban design strategies have since been proposed, developed, and applied as long-term strategies that focus around maximizing green infrastructure to improve air quality and reduce temperatures.

Green roofs help to keep buildings cool and delay surface runoff in times of intense rainfall.

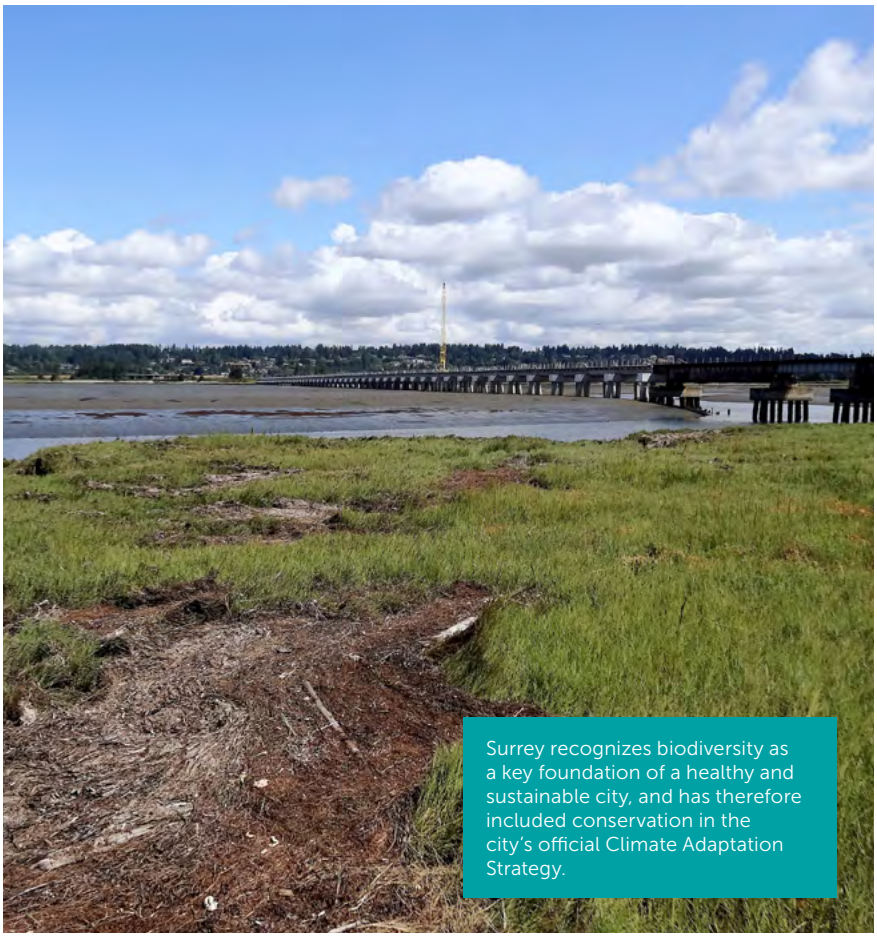
CITY: **SURREY**

# Adapting City for Resilience and Biodiversity

→ In Surrey, the Climate Adaptation Strategy not only seeks to adapt the coastal city to climate change, it also protects the city's ecosystems and biodiversity against future impacts.

Taking action against climate change is more than just preparing for uncertainty and extreme weather. Recognizing this, the Canadian coastal city of Surrey implemented the Climate Adaptation Strategy which identifies actions and prioritizes those that tackle the highest-risk impacts. One particular project that is part of the adaptation strategy aims to protect the coastal floodplain, comprising 20% of Surrey's total land area. **The project will protect more than 1,500 residents and more than 30 km² of agricultural land.**

Unlike most climate adaptation plans, **Surrey's also incorporates biodiversity conservation in its overall strategy,** improving the quality of the city's natural habitat to enable species migration and resilience. In 2016, 117,600 m² of degraded parklands were added to the Green Infrastructure Network: an interconnected system of natural areas and open spaces that conserve ecosystems and improve livability for the people of Surrey.



Surrey recognizes biodiversity as a key foundation of a healthy and sustainable city, and has therefore included conservation in the city's official Climate Adaptation Strategy.

**↓20M**

M² LAND PROTECTED VIA THE GREEN INFRASTRUCTURE NETWORK

## THE CHALLENGE

Increased flooding, loss of ecosystem services, and heat stress are all high-risk climate change impacts identified by Surrey's risk assessment. The extensive adaptation strategy seeks to tackle all of these.

## CO-BENEFITS

### Economic

The economic benefits of the adaptation strategy include securing $100 million of annual farm gate revenue and almost $25 billion in annual truck and rail freight traffic.

### Environmental

Surrey also adopted a plan to manage forestry practices on public property, protecting trees in new development projects, and planting approximately 5,000 trees yearly to lower the heat urban island effect and improve air quality.

### Social

The adaptation strategy aims to reduce the vulnerability of communities to extreme weather events, which are predicted to increase in intensity and frequency with climate change.

CITY: **TAOYUAN**

# Water Monitoring System to Warn and Protect

→ Taoyuan developed a water monitoring system and app enabling early warning and disaster preparation for authorities and citizens in the coastal city.

**↑24M**

SENT MESSAGES TO RESIDENTS WITH THE "WATER INFORMATION IN TAOYUAN" APP

## THE CHALLENGE

In the recent years, flooding has caused levee breaches and drainage system failures in Taoyuan, costing the city almost $120 million. Developing a water information system has ensured access to groundwater and increased ability to prevent disasters in both wet and dry seasons.

## CO-BENEFITS

### Economic

Taoyuan avoids millions in damages by reducing vulnerability to natural disasters, via direct costs such as damage to property, and indirectly through insurance premiums and health-related costs.

### Health

The system helps improve the resilience of the city against disasters at every level, minimizing lost lives and creating a safer city.

### Social

The app shares the locations of nearby evacuation shelters to help people get to safety faster in the event of a disaster.

In 2015, in response to the consequences of increased flooding, **Taoyuan launched a water information system to better forecast disasters, dispatch rescue efforts, allocate municipal resources, and broadcast warnings**. The system is based on a geographic information system database, combined with street surveillance and road condition information. All information used in the system is provided by city departments, who collaborate to ensure the system is continuously operating with updated data, which it shares in real time. Furthermore, the Taiwanese city has built systems that provide water information, such as a remote flood gate monitor, a storm drain water level monitor, and a water information monitoring mechanism. Since implementation, the system has become indispensable for the city's disaster prevention work and emergency responses.

The city also developed the "Water information in Taoyuan" app **to give citizens access to disaster prevention and response information in real time.** Citizens can also report floods with the app. So far, 20,000 people have downloaded the app and more than 1,200 disaster prevention messages have been sent to app users.

The water monitoring systems in Taoyuan's rivers provide real-time information to the city, enabling citizens and response teams to stay alert and avoid danger.

CITY: **WASHINGTON, D.C.**

# Addressing Risks to Become Climate Ready

→ Washington, D.C. is taking a holistic approach to climate adaptation, addressing all potential future risks and committing to a comprehensive set of adaptive solutions.

↑260K

M² GREEN ROOFS INSTALLED THROUGHOUT THE CITY

## THE CHALLENGE

Record-breaking heat waves, flooding and heavy rains, and the Derecho storm in 2012 were some of the reminders that without action, Washington, D.C. would see disruptions to its power grid and face increasing economic challenges and worsening health issues. In efforts to adapt to the changing climate, the Climate Ready DC strategy was developed to ensure resilience, and a greener, healthier, and more livable city.

## CO-BENEFITS

### Economic

The city will leverage existing incentive programs for solar power, energy efficiency, and green infrastructure to help residents improve the resilience of their homes and save money on water and energy bills.

### Environmental

The strategy uses natural solutions, including tree planting, living shorelines, and other green infrastructure, to maximize co-benefits of habitat creation and water quality improvements. Last year, 14,137 trees were planted and around 18,000 m² of green roofs were installed.

### Social

Outlined in the strategy are several actions aiming to strengthen community cohesion, encourage active participation in community-based organizations, and expand opportunities for civic engagement and volunteerism.

Climate Ready DC is Washington, D.C.'s new climate adaptation plan. As part of a holistic planning process, the city worked with technical experts to develop local climate change projections; conduct a vulnerability and risk assessment of infrastructure, community resources, and residents; and identify adaptation actions. In total, **77 actions will address the identified risks across four sectors:** utilities and transportation infrastructure; buildings and development; neighborhoods and communities; and governance. In addition to increasing resilience via the actions, the city also remains committed to cutting greenhouse gas emissions 50% by 2032 and 80% by 2050.

Four goals set by Climate Ready DC include improving transportation and infrastructure to maintain viability during periods of extreme weather; upgrading existing and designing new buildings to withstand climate change impacts; making neighborhoods safer and more prepared; and, finally, establishing the policies and evaluation procedures to ensure successful implementation of adaptation. In one of the initial steps, **the city increased tree canopy cover to 38% to reduce the urban heat island effect.**

Climate Action DC encompasses 77 actions to increase resiliency in the city and slash greenhouse gas emissions by 80% in 2050.

CITY: **WUHAN**

# Rehabilitated River Embankment Becomes Beach Park

→ Wuhan has re-embraced nature to make its city safe from flooding, while also providing the world's largest beach park for the city's nine million citizens to enjoy.

**↓724**

TONS OF CARBON ARE SEQUESTERED ANNUALLY BY VEGETATION IN THE YANGTZE RIVER BEACH PARK

## THE CHALLENGE

In 2016, Wuhan experienced its worst rain in 18 years, reaching up to 1,087.2 mm in some districts, affecting 1.7 million people and causing almost $4 billion in damages[1]. The rainfall exceeded 100-year standards of 344 mm, and the flood level reached 1 m higher than the average warning level.

## CO-BENEFITS

### Economic

Since the completion of the first phase of construction, the value of land in areas surrounding the park has risen from $631 to $1,471 per m².

### Environmental

In addition to thousands of trees, 325,000 m² of shrubs and 387,000 m² of grass have been planted, improving the regional microclimate and lowering the urban heat island effect, with a drop in temperature of three degrees.

### Social

Turning the embankment into a beach with non-polluted water and a park for recreational activities is enhancing public health and quality of life for city residents.

The Chinese megacity Wuhan is rehabilitating the embankment of the Yangtze River, as El Niño and monsoon rains have broken all records in recent years and exposed the city's inadequate flood defences. Historically, giant dikes lined the river banks, protecting riverside neighborhoods, but during extreme summer rainfall these systems failed. **The city is now dismantling old defenses and instead embracing the natural protection qualities of vegetation.** By modifying the embankment with a gentle slope, the area has now become the Yangtze River Beach Park.

The newly established Beach Park is more than 7 km long and contains a vegetation buffer strip, 700,000 m² of green park area, including 45,000 trees and rain gardens, which naturally filter polluted runoff water and defend Wuhan from intense storm events. Social perks add further value to the development. Fifteen kilometers of non-motorized roads, seven swimming pools, and 15 football courts cater to the 3.2 million people who have visited the park so far. **A part of China's 13th Five Year Plan, the park is to become the largest urban riverfront park in the world at 10 million m².**

Millions of people have visited the park, which provides ample recreational activities, improving residents' health and living conditions.

[1] Hao, F. South China overwhelmed by heavy rain, flooding. Climate Change News. (2016, July 13.)

CITY: **YOKOHAMA**

# Recognizing Ecosystem Services for Climate Adaptation

→ By mainstreaming adaptation measures and investing in green infrastructure, Yokohama is continuing on its path to becoming a climate adapted and safe city.

**433M**

DOLLARS INVESTED IN INCREASING GREEN AREAS IN THE CITY

## THE CHALLENGE

Torrential downpours and heat waves have become more common in Yokohama in recent years. As the impacts become increasingly serious, the city has implemented adaptation measures to minimize damage and to create a safe, secure, and sustainable city.

## CO-BENEFITS

### Economic

Yokohama plans to invest in infrastructure projects for disaster mitigation, including $1.9 billion in sewage management to limit torrential rain consequences and $185 million in hazard mapping.

### Health

The city issues caution alerts for heat stroke and infectious disease prevention via media channels and with the help from the public.

### Social

Part of the policy is the Yokohama Green-up Plan, in which elementary school students participate in greening around the city and help promote environmental efforts.

Yokohama is introducing a new climate adaptation strategy aiming to improve urban resilience and mainstream adaptation into all city policies. Within the strategy, concrete actions are proposed in response to climatic changes such as increased downpours and extreme heat events. One such action is **to install more than 1,000 infiltration inlet systems by 2018,** to separate stormwater and wastewater flows, improving flood response. Other actions include hazard mapping and disaster mitigation, improving infrastructure around the city's rivers and sewerage system, and issuing public reminders about heat stroke prevention.

Under the policy – in efforts to conserve the city's green environment – is **the Yokohama Green Tax, which collects $116 million yearly, enabling protection of rivers, waterways, forests, parks, and farmlands.** Including the taxation income, the city plans to invest $433 million over the next five years to increase conserved forest areas by an extra five million m², increase rice paddies by 1.2 million m², and establish a public agriculture farm which will all add to the natural climate resiliency of the city.

By mainstreaming adaptation perspectives in all city policies, Yokohama is increasing green areas in the city and reducing flood risks.

# MITIGATION

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→ The solutions in the Mitigation sector present comprehensive plans and actions taken by cities to lower their carbon footprints and pursue long-term social, economic, and environmental agendas. These solutions demonstrate the strategic role that emission reduction targets can have in cities' overall green development plans.

CITY: **BERLIN**

# Emissions Reductions Ratchet to Climate Neutrality

→ Berlin has identified 95 separate actions across six different sectors to bring the city to climate neutrality by 2050.

**↓25.7M**

METRIC TONS LESS $CO_2$ WILL BE EMITTED ANNUALLY BY 2050 COMPARED TO 1990

## THE CHALLENGE

Although Berlin has been able to reduce its $CO_2$ emissions by a third since 1990, emissions have started to rise again since the mid-2000s. BEK aims to involve all citizens in reversing this trend.

## CO-BENEFITS

### Economic

According to one study, energy-efficient building renovations and investment in renewables could yield benefits worth more than $106 million by 2030.

### Environmental

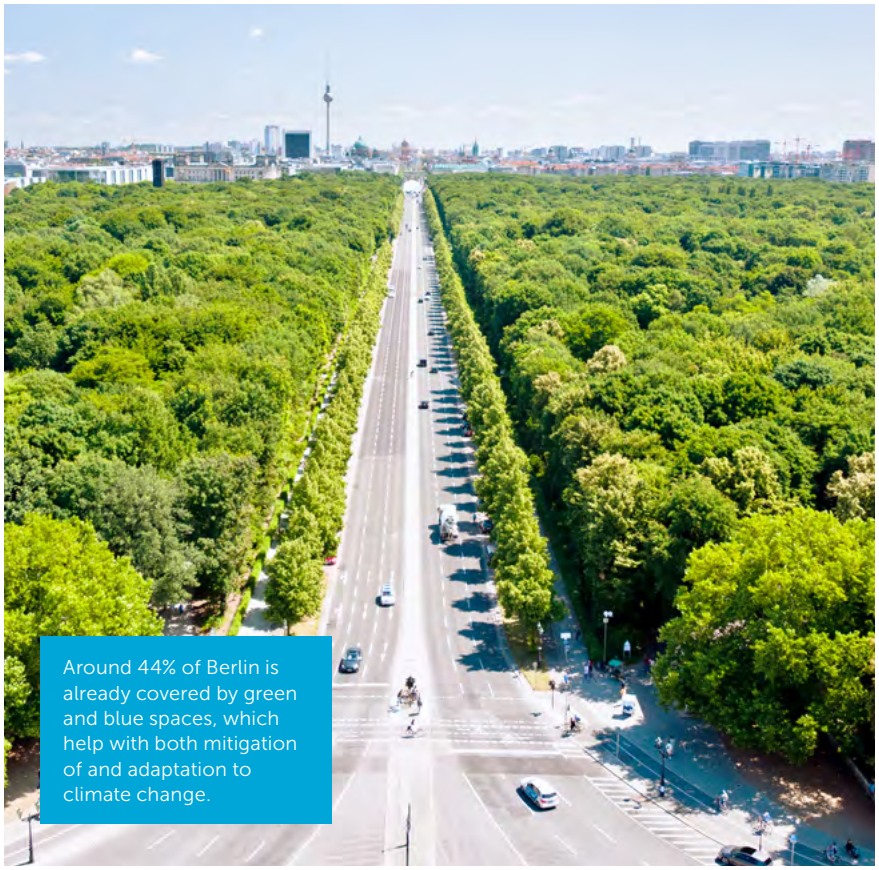
Encouraging green infrastructure contributes to $CO_2$ mitigation as well as improved air quality and greater urban biodiversity.

### Social

A broad and lengthy citizen engagement program ensured that the benefits of the BEK will be felt by all residents.

The City of Berlin has set a **legally binding target of carbon neutrality by 2050.** In order to achieve this ambitious target, the city developed Climate-Neutral Berlin 2050, with the Berlin Energy and Climate Protection Programme (BEK) at its center. It is the city's roadmap towards climate neutrality, in which 95 specific strategies from six different sectors are defined. The BEK is based on results of an interdisciplinary research project, as well as a broad public participation process, involving stakeholders from industry, civil society, and political organizations.

The project combines actions from six different sectors: energy supply, buildings and urban development, economy, traffic, private households and consumption, and adaptation to the consequences of climate change. **The specific strategies will ratchet up Berlin's emissions cuts,** from 40% by 2020, 60% by 2030, and at least 85% by 2050 compared with 1990 levels. If monitoring and evaluation finds emissions trends not to be in line with these targets, adjustments are required by law.



Around 44% of Berlin is already covered by green and blue spaces, which help with both mitigation of and adaptation to climate change.

CITY: **DUBAI**

# Demand- and Supply-Side $CO_2$ Reduction

→ Dubai has targeted both the demand and supply sides of the energy equation in a region-leading carbon abatement strategy.

↓16%

REDUCTION IN $CO_2$ EMISSIONS BY 2021 COMPARED WITH BUSINESS-AS-USUAL ESTIMATES

## THE CHALLENGE

Dubai is situated in one of the world's leading oil-producing countries and faces challenges regarding deeply rooted, vested carbon interests. The carbon abatement strategy is a big step towards reframing the city as a sustainability pioneer.

## CO-BENEFITS

### Economic

Dubai's CAS aims to enhance green trade and investment and accelerate adoption of green technologies via initiatives like the Green Economy Partnership.

### Environmental

Dubai aims to increase domestic solid waste recycling rates from 10% to 70% by 2030, significantly reducing waste to landfill.

### Social

The strategy aims to reduce exposure to harmful air pollutants caused by fossil fuel-burning activities such as conventional transport and energy production.

The Dubai Carbon Abatement Strategy (CAS) is a performance-based program for reducing carbon emissions up to 2021 that **integrates demand reductions with increased supply of renewable energy.** This strategy, costing around $4 billion in total, allows Dubai to manage its energy demand, increase energy efficiency, and develop sector-based greenhouse gas emissions reduction targets.

The high-impact sectors identified for emissions reductions in a preliminary study are power, water, manufacturing, road transportation, and waste processing. In 2015, Dubai reduced emissions equivalent to 5.7 million metric tons of $CO_2$ and has achieved a 7.29% sectoral reduction target, of which 11% is from the power and water, 3% is from manufacturing, 6% is from road transport, and 6% is from waste. On the supply side, a planned **800-MW solar photovoltaic power plant will contribute more than 260,000 tons of $CO_2$ equivalent emissions savings.**

As Dubai continues to grow rapidly, the Carbon Abatement Strategy will be crucial for keeping carbon emissions in check.

© Alex Block

CITY: **EDMONTON**

# Community-Backed Energy Transition Strategy

→ Edmonton's holistic, long-term, low-carbon transition strategy includes 150 specific actions across seven different sectors.

↓35%

DECREASE IN GREENHOUSE GAS EMISSIONS TARGETED FOR 2035

## THE CHALLENGE

95% of Edmonton's energy comes from fossil fuels, and 60% of greenhouse gas emissions in the city come from buildings. The strategy was designed to: help Edmonton become a carbon-neutral city; promote sustainable energy sources and uses; and make energy supply and distribution resilient.

## CO-BENEFITS

### Economic

Edmonton's strategy is expected to deliver a net present value of approximately $2 billion more than the investment by the year 2035, which increases if the cost of carbon is taken into account.

### Health

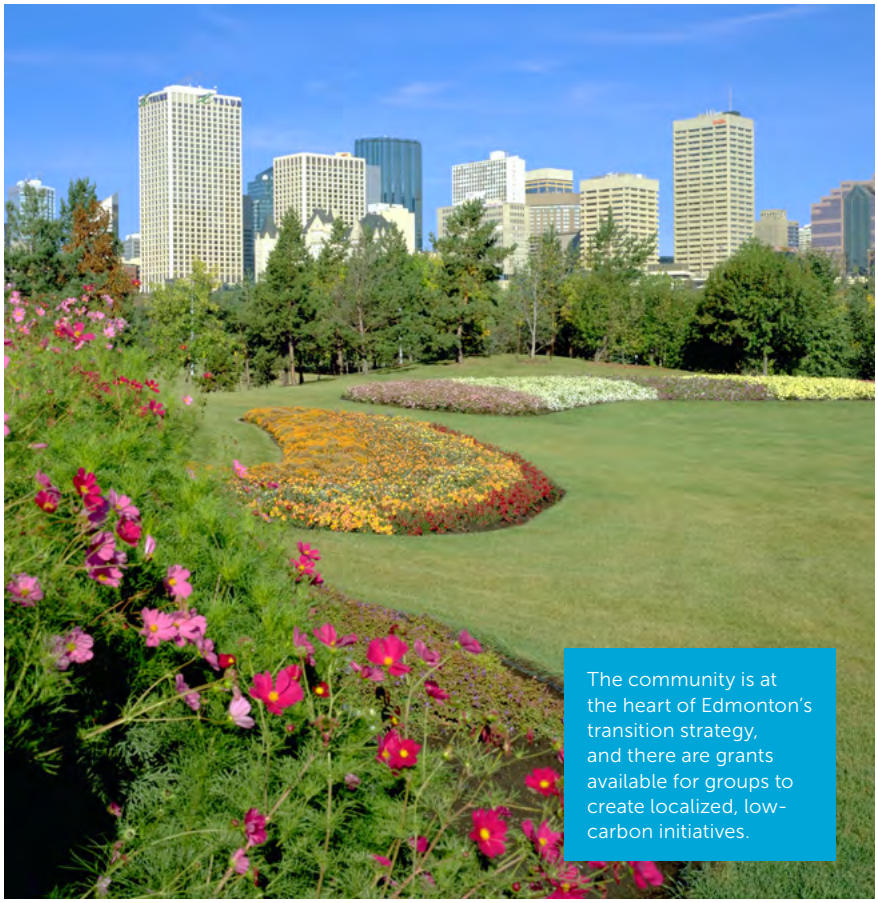
Edmonton launched a Downtown Bike Network to promote a healthier transport alternative to private car usage. Increased physical activity and improved air quality are direct benefits from increased cycling.

### Social

The strategy was created with significant public engagement and includes tactics at the community level to increase awareness and education and encourage energy savings.

Edmonton's Community Energy Transition Strategy is an eight-year climate change mitigation and risk management strategy designed to shift the city from fossil fuels towards carbon neutrality. The strategy includes 150 specific actions across seven different opportunity areas to reduce carbon emissions via electricity use reductions as well as adoption of a cleaner electricity supply. **Edmonton aims for a 35% reduction in greenhouse gas emissions by 2035,** with a 35% decrease in building energy use, a 25% decrease in personal energy consumption, and a goal that at least 10% of energy is produced by renewable technology by the same year.

In developing the strategy, Edmonton **surveyed more than 1,000 community members** and used a demographically representative panel to approve the low-carbon transition strategy. Implementation is now underway, with an energy disclosure program for residential and large buildings and planning amendments to streamline solar PV installations.



The community is at the heart of Edmonton's transition strategy, and there are grants available for groups to create localized, low-carbon initiatives.

CITY: **FORT COLLINS**

# Small City Demonstrates Climate Leadership with Big Goals

→ Using modeling and mainstreaming, Fort Collins established its strategy to reach carbon neutrality by 2050, showing you don't need to be a big city to achieve big climate results.

**↓220K**

METRIC TONS OF $CO_2$ EQUIVALENT REDUCED SINCE THE START OF THE ACTION PLAN

## THE CHALLENGE

Major forest fires and flooding in 2012 and 2013 emphasized the vulnerability of Fort Collins to changing climatic conditions and extreme weather events. The city recognized this danger and has been an early advocate of action plans – their first was released in 1999.

## CO-BENEFITS

### Economic

Fort Collins businesses are saving an estimated $9.5 million annually from improved efficiencies created by the climate action plan.

### Environmental

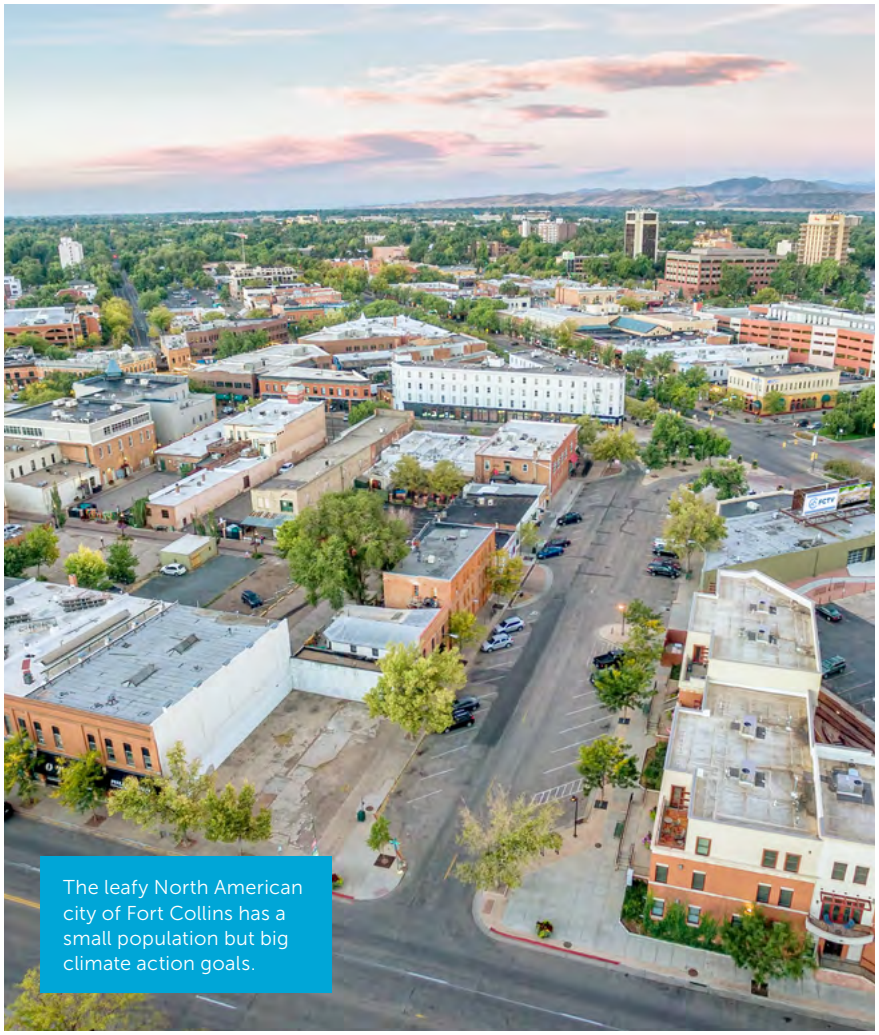
Around 60% of solid waste is being diverted from the landfill, and public transit usage has doubled in the past 10 years, contributing to Fort Collins achieving more than half of its $CO_2$ reduction goals by 2020.

### Social

In 2016, Fort Collins partnered with Grid Alternatives to develop a low-income community solar garden that will reduce the energy bills of 20 families.

Fort Collins is punching above its weight. For a city with just 164,000 residents, **it has one of the most ambitious climate action plans in the USA,** with goals to reduce greenhouse gas emissions by 20% by 2020, 80% by 2030, and to be carbon neutral by 2050. The city council unanimously adopted the goals in 2015 and created the framework, budget, staff capacity, and metrics to implement the plan.

To plan investments and calculate greenhouse gas emissions reductions measures over time, **the city built an in-house model and has invested more than $12 million to date.** The city is also aligning the decarbonization commitment with its zero-waste and sustainable mobility goals to maximize the efficiency of municipal services.



The leafy North American city of Fort Collins has a small population but big climate action goals.

CITY: **JOHANNESBURG**

# Mainstreaming Climate Action to Lower $CO_2$

→ By introducing a new strategic framework that includes all actors in society, Johannesburg is mainstreaming climate change mitigation and setting big goals for the future.

**↓65%**

REDUCED $CO_2$ EMISSIONS BY 2050 WITH THE CLIMATE CHANGE STRATEGIC FRAMEWORK

## THE CHALLENGE

Eighty-seven percent of South Africa's energy came from fossil fuel in 2014. Instead of producing an energy-centric, short-term policy to cut emissions, South Africa has instead mainstreamed mitigation into all aspects of society, creating a more holistic approach.

## CO-BENEFITS

### Economic

Johannesburg issued $143 million worth of green bonds in 2014 for climate mitigation investments, which will feed into the holistic climate action strategy.

### Environmental

Working towards significantly reducing its $CO_2$ emissions, Johannesburg will undertake projects that will benefit the overall environment of the city.

### Social

Johannesburg aims to mobilize society to work together in realizing the city's ambitious climate change goals.

In 2006, Johannesburg developed its first strategy for long-term growth and development, envisioning a resilient and sustainable city. To deliver on this vision, the city has introduced the Climate Change Strategic Framework (CCSF). **The purpose of the CCSF is to strengthen the city's organization in its delivery on climate change action across sectors** internally in the municipality and between communities, businesses, and citizens in the city.

As part of the CCSF, **Johannesburg aims to mainstream climate action in the city.** Measuring greenhouse gas emissions will take a bottom-up approach, with a joint effort between the municipality's departments as well as from business and communities. The city will make use of C40's modeling tool "CURB," which helps cities and local climate planners better understand the energy and emission implications of different low-carbon interventions in order to implement those most appropriate for Johannesburg. In doing so, Johannesburg hopes to see a unified city working towards a greener and more resilient future together.

Johannesburg's strategic framework aims to include all actors in society to mainstream climate change mitigation and deliver on goals for a more resilient future.

CITY: **KUALA LUMPUR**

# Carbon Inventory Leads to Action Plan

↓134K

METRIC TONS OF $CO_2$ EQUIVALENT WILL BE AVOIDED BY 2022

→ Kuala Lumpur is committed to reducing its carbon emissions by 20% by 2022, demonstrating strong climate leadership for the region.

Malaysia's largest and most populous city performed a carbon accounting exercise to measure quantities emitted in 2015, and is using that baseline to make further cuts through to 2022. Working with the Carbon Trust and the UK Foreign and Commonwealth Office, the city set up **five-year carbon management strategies focusing on low-cost, high-impact policies.**

**The greenhouse gas inventory was performed in line with the World Resources Institute's globally recognized accounting methodology** and calculated that emissions in 2015 totaled 120,906 metric tons of $CO_2$ equivalent. The inventory also identified buildings, transport, and outdoor lighting as the most emitting sectors. With an LED streetlight replacement program, as well as upgrading energy systems in inefficient municipal buildings, the city is showing the way for others in the region.

## THE CHALLENGE

According to the greenhouse gas inventory, buildings account for 55% of total emissions. Public housing makes up 64% of that figure. Leveraging emissions cuts in private buildings is a considerable challenge for cities like Kuala Lumpur.

## CO-BENEFITS

### Economic

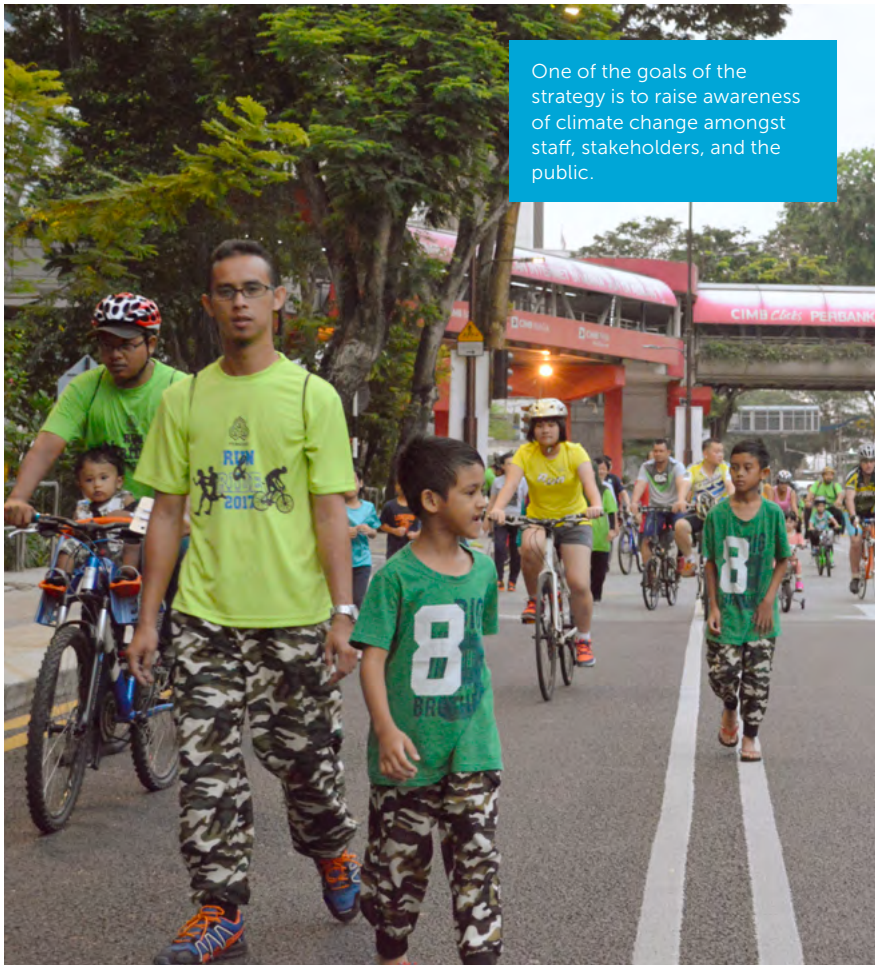
If successful, the carbon management plan will produce financial savings of $18 million compared to business as usual.

### Environmental

Kuala Lumpur has a consistent problem with air pollution due to illegal forest burning, industrial activity, and traffic emissions. Cutting energy consumption in the city can help to clear the haze.

### Social

Outreach programs conducted via social media and city workshops will raise awareness of climate change amongst staff, stakeholders, and the public.



One of the goals of the strategy is to raise awareness of climate change amongst staff, stakeholders, and the public.

CITY: **MÉRIDA**

# Blocking Urban Sprawl

→ Mérida makes use of existing infrastructure, converts informal housing to sustainable buildings, and tackles increasing congestion via its new Urban Development Program to ensure sustainable growth.

The Mexican city of Mérida has formed an Urban Development Program to ensure sustainable growth. **The program aims to halt Mérida's urban sprawl by encouraging growth within the inner city,** where public services already exist and 1,700 hectares lay unoccupied. Informal rural settlements will be transformed into orderly settlements provided with infrastructure, public services, resilience procedures, and climate change mitigation measures.

The long-term urban vision will ensure the city's further growth stays on the green path. To make this happen, **the plan will incentivize sustainable housing investments, energy efficiency, and the development of low-emission public transport.** This will also involve densification of the city to ensure a more effective use of public services and energy use. In making the development plan, the city involved more than 21,000 participants in workshops and actions on environmental awareness as well as more than 7,000 experts and citizens in the formulation of the program.


Expanding green areas for recreational use is one of the initiatives in the development program.

**19m²**

OF GREEN SPACE PER PERSON WHEN THE PLAN IS FULLY IMPLEMENTED, AS RECOMMENDED BY THE WORLD HEALTH ORGANIZATION

## THE CHALLENGE

With a fourfold increase in cars since 2003, and number of homes rising from 120,000 to 323,000 in the last few decades, Mérida needed a plan to tackle intense traffic and urban sprawl.

## CO-BENEFITS

### Economic

The conversion of housing to sustainable buildings and improved efficiency of public expenditure will save money.

### Environmental

Zoning in the development plan will secure the preservation of forest land, and changing consumption habits will reduce waste generation.

### Health

Increased space for urban recreational activities, reduction of heat islands, and an increase in non-motorized mobility will all contribute to healthier lifestyles in the city.

### Social

Inhabitants will be living in compact, accessible, permeable, and connected urban areas with a high level of urban functionality.

CITY: **MEXICO CITY**

# Green Bonds for Climate Action

→ Mexico City has financed a program that will reduce $CO_2$ emissions and strengthen the city's capacity to withstand climate change, whilst ensuring gender equality.

**↓10 M**

TONS OF $CO_2$ EQUIVALENT AIM TO BE SAVED BY 2020 UNDER THE CLIMATE ACTION PROGRAM

## THE CHALLENGE

Mexico City's population is expected to grow to 23.5 million people by 2030. Decoupling emissions from population and GDP growth will be a significant challenge for the megacity.

## CO-BENEFITS

### Economic

The green bonds issued by Mexico City were oversubscribed two-and-a-half times, showing how novel financing models can be used to catalyze climate action projects in cities around the world.

### Environmental

The Climate Action Program has also resulted in the maintenance of more than 200,000 m² of green areas, collection of 376 tons of used batteries, and the protection of 925,000 m² hectares of conservation land.

### Health

The bikeability and walkability actions of the program have generated large health benefits. More than 230,000 people use the bike-sharing program and 82% report improvements in quality of life.

### Social

Including a gender perspective in the program ensures greater equality as climate change impacts affect women and men differently.

Mexico City's Climate Action Program is designed to maximize emissions reductions and increase resilience against future climatic shocks. **The city issued $50 million worth of green bonds to finance much of the project, including investments in a new bus rapid transit lines and an LED street lighting project.** This was the first example of such a financing scheme for a Latin American city, and proved popular – the bonds were oversubscribed by a factor of 2.5. The city also has an online monitoring system designed to track compliance of the program and the progress of each of its 102 climate actions. Finally, **the program includes a gender perspective, which seeks to reduce inequality gaps between men and women** caused by climate change effects.

The city has set itself seven strategies as part of its climate action program, which include a rural and urban energy transition, containing urban sprawl, and building resilience. Each of the 16 boroughs involved has the responsibility to develop their own Borough Climate Action Program with both mitigation and adaptation actions.

To develop new climate actions in Mexico City, the local government will engage citizens to expand projects at a community level.

CITY: **NEW ORLEANS**

# Turning Hurricane Risk into Mitigation Opportunity

→ New Orleans is ready to tackle climate change head on to help reduce the frequency and intensity of climate-related extreme weather events.

**↓1.8M**

METRIC TONS OF $CO_2$ REDUCED BY 2030

## THE CHALLENGE

While many cities in the USA began implementing climate mitigation strategies 10 years ago, New Orleans was recovering from hurricane devastation. Ready to turn hurricane risk into mitigation opportunity, the city is rolling out its first community-wide strategy designed to mitigate the effects of climate change.

## CO-BENEFITS

### Economic

Rebuilding the region's ability to generate value from waste will stimulate economic development and jobs in this area as part of the Climate Action for a Resilient New Orleans.

### Environmental

In addition to actions designed to reduce emissions, the strategy includes a plethora of adaptation initiatives that also have mitigation benefit such as planting 40,000 trees.

### Social

The strategy addresses the energy burden on low-income New Orleanians and improves access to affordable public transportation.

Attack is the best form of defense for coastal cities like New Orleans that face rising sea levels and climate change-related extreme weather events. Climate Action for a Resilient New Orleans outlines 27 actions to reduce greenhouse gas emissions 50% by 2030. The strategy considers best practices in greenhouse gas mitigation such as **planning to scale local solar from 40 MW to 255 MW and moving to 100% low-carbon power by 2030,** a remarkable feat for a city in a state largely dependent on fossil fuels.

To further reduce its contribution to climate change, New Orleans seeks to **electrify the city's public transportation and ensure 50% of all trips are made using non-fossil-fuel-powered vehicles by 2030.** Finally, the city currently diverts only 5% of waste from landfills, as recycling infrastructure was dismantled during Hurricane Katrina. But, with its new strategy, New Orleans plans to divert 50% of waste from landfills by 2030.

New Orleans' action plan outlines 27 actions to reduce greenhouse gas emissions by 50% by 2030 and make the city more resilient.

CITY: **NEW YORK CITY**

# Modeling Aids Emissions Reductions Roadmap

↓39.8M

TONS OF $CO_2$ EQUIVALENT REDUCTIONS FROM KEY INITIATIVES LAID OUT IN THE ROADMAP

→ New York City has prepared a detailed road map to steer the city towards an 80% reduction in greenhouse gas emissions by 2050.

Having goals is one thing, but working out how to achieve them is another. **New York City has developed a greenhouse gas emissions calculator** that can tally the emissions associated with all fuel sources, waste streams, and avoided emissions throughout the city. Using this detailed and quantitative assessment, the city has calculated the necessary pace and extent of the transition to a renewable-based electric grid, renewable or high-efficiency heating and hot water in buildings, energy-efficient buildings, electric and clean fuel vehicles, and zero waste to landfills.

With the emissions-cutting plans, **New York City has a clear roadmap to 80 x 50 – 80% reductions by 2050** – and is demonstrating climate leadership via an evidence-based, comprehensive approach. To date, the city has reduced its annual greenhouse gas emissions by 14% from 2005 levels. Additionally, New York City and C40 are working to identify new measures to achieve a 9% decrease in greenhouse gas emissions by 2020, followed by steeper emissions reductions of 70% by 2030 and 100% by 2050, as part of C40's Action Plan 2020 pilot.

The energy sector is one of four key areas identified by the roadmap on the path to decarbonize New York City.

## THE CHALLENGE

The effects of climate change are already evident in New York City: rising sea levels; increased frequency in heavy precipitation and coastal storms; hotter days on average; and more extended heat waves. The roadmap is designed to reduce emissions from the four highest-emitting sectors.

## CO-BENEFITS

### Economic

New York City sees 80 x 50 as an opportunity to encourage green jobs for the local workforce and to spur new industries. They hope to become a global hub for energy efficiency and clean energy technology via initiatives such as UrbanTech NYC and Applied Sciences NY.

### Environmental

Sector-based initiatives in the roadmap have several environmental co-benefits for the city. For example, the NYC Clean Fleet and other related on-road vehicle initiatives will improve air quality for citizens.

### Social

The roadmap is geared towards reaching diverse communities of New Yorkers and reducing disparities. For example, the Zero Waste program targeted outreach in neighborhoods with historically low diversion rates.

CITY: **ORLANDO**

# Sunshine State's Carbon Transition

→ Orlando aims to reach 90% emissions reductions by 2040 via a series of sector-specific strategies, led by public investment in energy efficiency and renewable energy.

**↓41K**

METRIC TONS OF $CO_2$ EQUIVALENT REDUCED PER YEAR FROM 2015, COMPARED WITH A 2010 BASELINE

## THE CHALLENGE

Orlando and Florida more generally have been heavily reliant on coal and natural gas for energy, and renewables provided just 2% of the state's electricity in 2015. However, as prices plummet for solar and wind power, renewable energy becomes much more attractive for cities in the Sunshine State.

## CO-BENEFITS

### Economic

The energy efficiency improvements save around $2.5 million annually and add value to municipal buildings.

### Environmental

Orlando aims to grow an urban forest, with trees on 95% of streets with tree-growing potential, which entails planting an additional 250,000 trees by 2040.

### Health

By committing to 100% electricity from renewable sources by 2030 in municipal operations, and promoting clean mobility solutions, Orlando is improving air quality and reducing respiratory problems for citizens.

Orlando's "Green Works" program is the city's main policy tool for **driving a 90% carbon emissions reduction by 2040** and is divided into seven focus areas: energy and green buildings, local food systems, solid waste, livability, transportation, water, and the green economy. Each focus area and the initiatives therein have important impacts on the community and are driven by specific strategic goals for 2040, as described in the Community Action Plan.

The city leads by example and aims to achieve carbon neutrality in municipal operations by 2030 via energy efficiency upgrades to buildings and by **transitioning to 100% renewable energy.** The buildings will also be connected to a city-wide building automation system, which tracks the success of new installations via an online building analytics dashboard. Improvements have been financed under a savings-as-payment finance model.

**Orlando has decreased its electricity consumption in municipal buildings by half,** surpassing the 2030 goal, and has reduced city-wide carbon emissions by more than 30% to date.

Engineers install energy-saving LED lights in a city-owned building in Orlando.

CITY: **OSLO**

# Smart Initiatives to Cut $CO_2$ Emissions

→ The City of Oslo strives to be a leading force in the green transformation, and will cut emissions in half by 2020. A smart climate and energy strategy encompassing mobility, governance, and energy will make Oslo a green and livable city.

↓95%

REDUCTION IN GREENHOUSE GASES BY 2030

## THE CHALLENGE

Greenhouse gas emissions have increased by 25% since 1990 in Oslo. However, Oslo is in a unique position, with ready access to renewable energy and financial and human resources to develop and test new solutions, contributing to a better, greener, and more livable city.

## CO-BENEFITS

### Economic

New business opportunities have arisen in sectors like EV charging equipment and services, EV manufacturing, renewable fuels, e-bikes, green buildings, smart grid, and the circular economy.

### Environmental

The project will have a positive impact on reducing air and noise pollution increasing biodiversity, and increasing the focus on reducing waste, waste recovery, and recycling,

### Health

Reduced air pollution and more green spaces, as well as an increase in active transportation will improve citizens' health.

### Social

As public transport increases its market share, Oslo will have more room for its residents, creating a more liveable city.

One of the most novel initiatives is integrating climate budgets as a part of the city's financial budget and, as such, count carbon dioxide the same way the city counts money. It was launched in 2016, and is **one of the first city carbon budgets in the world.** All city departments have been given responsibility for goal attainment and annual expected progress on the targets in the climate budget. The quarterly and annual reports on the progress are managed within the existing formal financial and governance system of the city.


Smart mobility is one of three key strategies to cut emissions in Oslo, benefitting both the environment and public health.


VISMA
DNB
VISNINGSSENTER
ORIGIN

CITY: **QINGDAO**

# Decoupling Carbon Emissions from Economic Growth

→ Specific reduction targets for each energy-intensive sector will guide the City of Qingdao in achieving its emissions targets, despite experiencing rapid economic growth.

**↓40M**

TONS OF $CO_2$ EMISSIONS WILL BE REDUCED BY 2020, SLASHING CARBON INTENSITY PER UNIT OF GDP BY 50% FROM 2005 LEVELS

## THE CHALLENGE

Qingdao is a fast-growing city with a high proportion of manufacturing, and is seeking to pursue further economic growth. The city's new low-carbon plan ensures that Qingdao will not be plagued by air pollution like many neighboring cities.

## CO-BENEFITS

### Economic

The city has experienced rapid economic growth, yet at the same time cut its carbon intensity, signaling healthy growth and preparing the city to decouple carbon emissions from economic growth in the future.

### Environmental

The annual average PM2.5 concentration has decreased from 66 μg/m³ in 2013 to 45 μg/m³. Likewise, the quality of water and soil has improved.

### Health

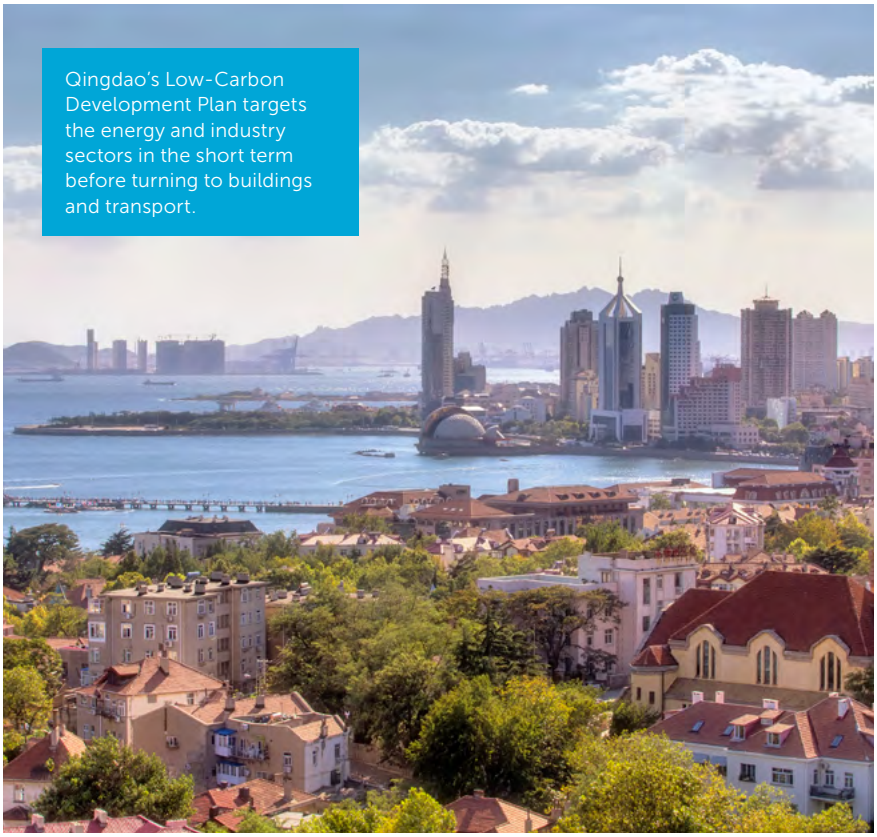
Morbidity and mortality connected to climate change-related local epidemics have been on the decline. Curbing the growth of carbon emissions can further improve air quality and the well-being of urban residents.

### Social

Employment opportunities have been created in the service industry as a result of pushing low-carbon development.

The Qingdao Low-Carbon Development Plan, part of the second batch of Chinese low-carbon pilots, has put forward specific, systematic, and comprehensive actions and policies. The plan, running from 2014 to 2020, includes systems for spatial layout, industry, energy supply, and transportation. **The plan has issued guidance for every department in the city, encouraging the local government to become low-carbon in all operations.** Other Chinese cities are expected follow in Qingdao's footsteps to make low-carbon development plans.

Qingdao has established a close connection between its economic development target and mitigation target over the short, medium, and long term. Before 2020, Qingdao will focus on improving energy efficiency and rationalization of industrial structure. After 2020, transport and buildings will be the key areas of carbon emissions control. Low-carbon standards in the buildings and transport sectors will be perfected in order to avoid lock-in effects that could hinder the mitigation efforts. **The city seeks to cut the carbon intensity level per unit of GDP by 50% in 2020 from 2005 levels.**



Qingdao's Low-Carbon Development Plan targets the energy and industry sectors in the short term before turning to buildings and transport.

CITY: **RIO DE JANEIRO**

# Pioneering Sustainability in Schools

→ In Rio de Janeiro, an increasing number of schools are becoming greener and adding climate change to the curriculum, disseminating important knowledge to students and communities.

↑40

SUSTAINABLE SCHOOLS BY THE END OF 2020

## THE CHALLENGE

In Rio de Janeiro's low-income areas, there is a need for educating residents about the importance of recycling waste, water conservation, and general low-emission habits, which the Sustainable Schools Project addresses.

## CO-BENEFITS

### Environmental

More than 800 liters of oil were collected by students from three schools in 2016 in order to avoid improper disposal and water pollution.

### Health

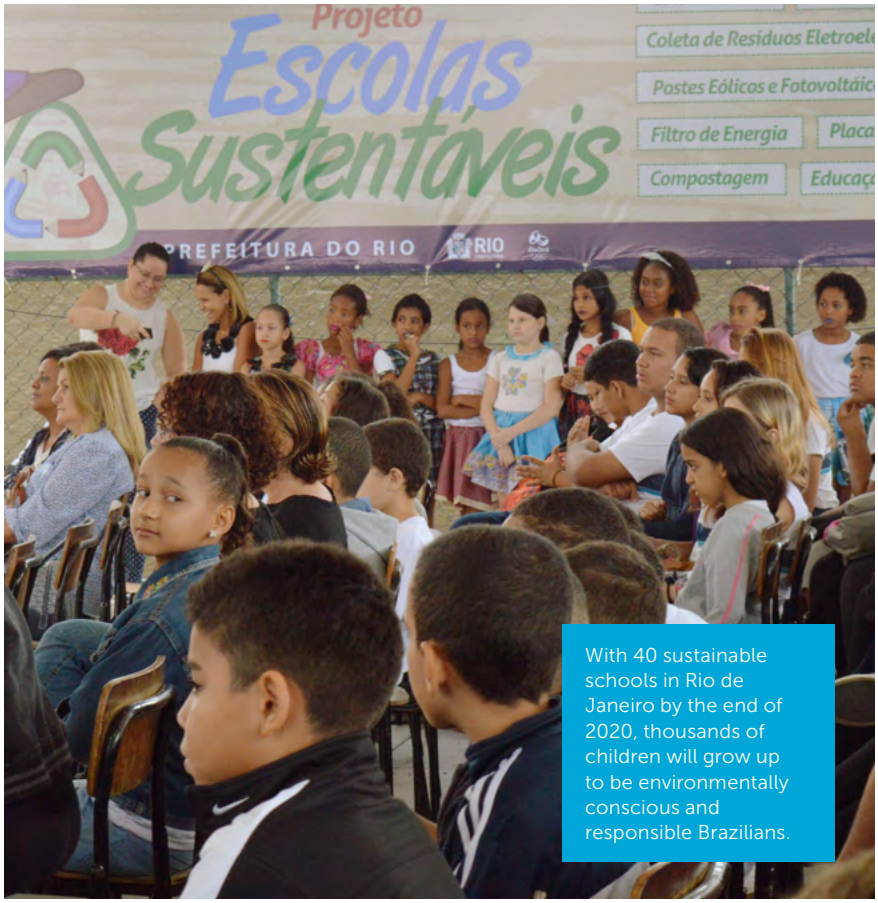
The project promotes healthy eating, and communities surrounding the schools benefit from the organic vegetables grown at the schools.

### Social

Providing students with a hands-on environmental education enables them to learn the importance of cooperation and the effects of doing good in their communities at an early age.

Initiated in 2016, six schools in the Brazilian coastal city joined the pilot of the Sustainable Schools Project. Now at eight schools, **the project is a pioneering initiative in Brazil, developed to empower students, teachers, and their surrounding communities with knowledge on sustainability and climate change.** By teaching new concepts and practices, students learn how to use natural resources in a sustainable fashion, the importance of recycling, and how to shrink their carbon footprint.

The schools are not merely talking about climate change, they are walking the walk, too. Participating schools have developed vegetable gardens, composting facilities, vegetable oil collection to avoid disposal in the sewers, and electronics and batteries waste collection. **The schools have also installed PV solar panels, LED lamps, and hybrid lampposts with integrated wind and solar power devices to power them off-grid.** The city plans to have 40 sustainable schools by the end of 2020.




With 40 sustainable schools in Rio de Janeiro by the end of 2020, thousands of children will grow up to be environmentally conscious and responsible Brazilians.

CITY: **TAINAN**

# Happiness Incorporated in Climate Action

→ Tainan has incorporated the ambitions of the Paris Agreement into its low-carbon city projects, translating global goals into local action and prioritizing the happiness of citizens

↓2.7M

METRIC TONS OF $CO_2$ EQUIVALENT HAS BEEN REDUCED IN THE LAST FIVE YEARS

## THE CHALLENGE

Taiwan is a small, highly populated island, which relies on fossil fuel imports for more than 90% of its energy. Targeting green energy as part of the low-carbon strategy will help the small island nation become more energy secure as well as cut carbon emissions.

## CO-BENEFITS

### Environmental

Tainan recognizes the importance of ecosystems for climate change mitigation, adaptation and citizen well-being, and has developed an ecological framework to preserve urban wetlands and promote conservation tourism.

### Health

Low-carbon transportation investments in bicycle infrastructure and a bus rapid transport network will improve air quality, and there are specific targets for particulate concentrations for future years.

### Social

The city is creating low-carbon communities, with at least 60% green coverage, reusage of waste, and energy conservation programs.

The City of Tainan announced ambitions in 2012 to become Taiwan's first low-carbon city. This strategy continues today, and following the Paris Agreement in 2015, Tainan set ambitions to **reduce greenhouse gas emissions from the city 12% by 2020, 20% by 2030, and 50% by 2050.** This accelerating rate of change will be spurred by 10 strategies across sectors from green energy to low-carbon education and eco-tourism.

Over the last five years, **Tainan has invested $160 million in carbon reduction projects,** with non-industrial emissions accounting for 300,000 metric tons of the reduction. Tainan also has a strong focus on the happiness of citizens and includes this in planning low-carbon projects to build a vibrant and sustainable city.


Tainan's bike-sharing scheme is just one of the strategies the city is employing to cut emissions 50% by 2050.

CITY:**TORONTO**

# Accelerating Climate Action to Reduce Emissions


## ↓9.5M

TONS OF $CO_2$ REDUCED BY 2030 THROUGH TRANSFORMTO

→ Toronto is fast-tracking climate action with its new plan, which sets the city on a sure path to 80% emissions reduction by 2050.

Toronto is picking up the pace when it comes to saving the planet. Building on the success of the city's first climate action plan and aiming to accelerate action, the city's council initiated TransformTO in 2015. The action plan recommends cross-sector targets, including **75% of energy to be renewable and 100% of transportation to use zero-carbon energy by 2050; 100% of new buildings to be near-zero emissions by 2030; and 100% of existing buildings retrofitted by 2050.** Toronto seeks to not only address climate change mitigation with these goals, but equally to focus on adapting the city, making it resilient against future impacts. When implemented, these accelerated actions are projected to reduce greenhouse gas emissions by up to 857,000 metric tons by 2020.

To reach the ambitious targets, Toronto has developed acceleration campaigns to mobilize low-carbon neighborhoods, prepare the city for electric mobility, and educate the workforce to construct high-performance buildings. Achieving these targets will **ensure that Toronto exceeds its short-term target of 30% greenhouse gas emissions reduction by 2020** and successfully set the city on a path to reach a city-wide emissions reduction target of 80% by 2050.

Public consultations, roundtable conversation events, online surveys, and creative low-carbon Toronto games were all part of the planning process for TransformTO.

### THE CHALLENGE

TransformTO recognizes the acute danger of climate change and accelerates the current climate action plan to ensure carbon emissions reductions of 80% by 2050.

### CO-BENEFITS

**Economic**

Meeting Toronto's emissions targets is estimated to save the city approximately $11 billion between 2016 and 2050 via lower heating, cooling, and power costs.

**Environmental**

In order to reduce carbon emissions and waste to landfill, TransfromTO also aims to achieve a 95% waste diversion goal by 2050.

**Health**

TransformTO encourages the use of active transportation for 75% of trips under five km by 2050, reducing illness and mortality associated with inactivity.

**Social**

The transformative plan aims to advance social equity, improve affordability, and reduce poverty to increase quality of life for all Torontonians.

CITY: **WASHINGTON, D.C.**

# Retrofitted Municipal Roofs Mitigate and Adapt

→ The capital of the USA is making the most of its municipal buildings by installing solar PV panels, vegetation, and cooling measures on rooftops, making the city climate resilient and reducing $CO_2$ emissions.

The DC SmartRoof Program maximizes the potential of the roofs on all public buildings to minimize and battle the effects of climate change. **The city is utilizing roofs of office buildings, schools, and hospitals, totaling more than 2.6 million m².** So far, nine megawatts of solar PV have been deployed, more than 204,000 m² of white-colored, "cool roofs" have been constructed, and more than 37,000 m² of vegetative roofs have been installed. The latter will be able to retain more than 360,000 liters of stormwater runoff annually, which earlier contributed to flooding caused by climate change-related extreme weather events.

The program also **seeks to reduce the urban heat island effect with its adapted roofs,** as studies show that increasing the albedo of just under 100 m² roof by 0.25 can offset 0.5 tons of $CO_2$ equivalent per year, through reduced cooling demand. The nine megawatts of PV installed has further reduced $CO_2$ emissions by approximately 5,000 metric tons in just over a year.

With almost 290,000 m² of rooftops remaining eligible for retrofits, the city plans to install an additional seven megawatts of solar PV in the coming years.

**↓350K**

METRIC TONS OF $CO_2$ EMISSIONS AVOIDED WITH THE DC SMARTROOF PROGRAM OVER 20 YEARS

## THE CHALLENGE

Washington, D.C.'s overarching adaptation strategy identified four local climate change-related challenges: extreme heat events, extreme precipitation, sea-level rise, and storm surge. The DC SmartRoof Program is designed to mitigate emissions and adapt to these challenges.

## CO-BENEFITS

### Economic

The DC SmartRoof Program is expected to save $40.2 million, with $25 million from solar PV installations and $15.2 million from cool roofs. The program has also created more than 300 jobs and employed dozens of local companies.

### Environmental

Introducing solar into the power generation mix pushes out unhealthy fossil fuels responsible for other pollutants including particulate matter, nitrogen oxides, and mercury.

### Health

Installing cool and green roofs will help to reduce the urban heat island effect and the exposure of citizens to extreme heat conditions, whilst PV will contribute to improved air quality and lower rates of respiratory health issues.

CITY: **WUHAN**

# Climate Action Plan Educates Next Generation

→ Wuhan has set a goal to peak emissions ahead of Chinese targets, and has placed a strong emphasis on education and management of schools to create a generational shift in carbon emissions.

↓8

YEARS AHEAD OF NATIONAL PEAK EMISSIONS TARGETS WITH WUHAN'S ACTION PLAN.

## 'THE CHALLENGE

Wuhan, the largest city in central China, is growing rapidly. Building sustainability into future economic growth plans is a challenge for many Chinese cities, and Wuhan is demonstrating how more ambitious strategies can be put into place.

## CO-BENEFITS

### Economic

Based on the current carbon price, Wuhan will save around $370 million by 2022 with carbon emissions reductions.

### Health

Reducing emissions associated with polluting transport and coal burning will also improve air quality and save an estimated 50,000 lives by 2022.

### Social

Including schools as a main pillar of the low-carbon strategy recognizes the intergenerational nature of climate change, as it is the next generation who need to live radically different lifestyles to achieve carbon emissions reduction goals.

The Chinese megacity Wuhan **has committed to reach its carbon emissions peak around 2022.** The model-based action plan established yearly carbon emission goals by district and industry across the city, and received input from businesses and citizens during the drafting process.

Schools are seen to be a key focus area for Wuhan, which has established a set of **low-carbon management and education principles suited for middle and primary schools**. This strategy is the first of its kind in China, and will foster awareness of a low-carbon life and society and help students understand what steps are being taken in response to climate change in their city and why. The city hopes that with teachers and students as knowledge brokers, awareness amongst the general public will increase too.

Wuhan is home to more than 10 million people and faces a huge challenge to decouple growth from carbon emissions.

# TRANSPORTATION

## SEATTLE

*Finished with Fossil Fuels, City Electrifies Vehicles*

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## NEW YORK CITY

*Retrofitting Trucks for Cleaner Air*

P. 134

## LOS ANGELES

*Demand Aggregation for EV Proliferation Plan*

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## CARACAS

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## LOJA

*Bicycles and Electric Taxis for Clean Mobility*

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## FORTALEZA

*Mobility for the Unbanked*

P. 125

## LIMA

*Car-Free Day Clears Streets*

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## BELO HORIZONTE

*Pedestrian-Centric Mobility Design*

P. 119

→ The Transportation sector highlights how cities are encouraging more active means of transport, optimizing the urban freight transport, improving public transport systems to reach last-mile connectivity, and promoting the use of clean fuelled-vehicles to become healthy, low-carbon, and more livable cities.

CITY: **AUCKLAND**

# Bike Network Given Priority in City Center

→ Auckland has recognized cycling as a key component of the low-carbon approach to transforming the way we travel and is working to integrate cycling as a "one network" solution alongside public transport.

**↑62%**

IS THE INCREASE IN CYCLE TRIPS AUCKLAND HAS SEEN BETWEEN 2013 AND 2015

## THE CHALLENGE

Auckland has identified transport as the first of key transformation areas, as it accounts for 39% of the city's greenhouse gas emissions. Lowering these emissions will help Auckland reach its goal of reducing $CO_2$ emissions by 10% to 20% by 2020 and 40% by 2040.

## CO-BENEFITS

### Economic

Auckland-based research has shown that people who cycle are also more likely to buy local goods compared to people using other transport modes, meaning the project helps strengthen the local economy while simultaneously saving travel costs.

### Environmental

Noise, air, and water pollution are significant problems in Auckland – all of which the cycling network will alleviate.

### Health

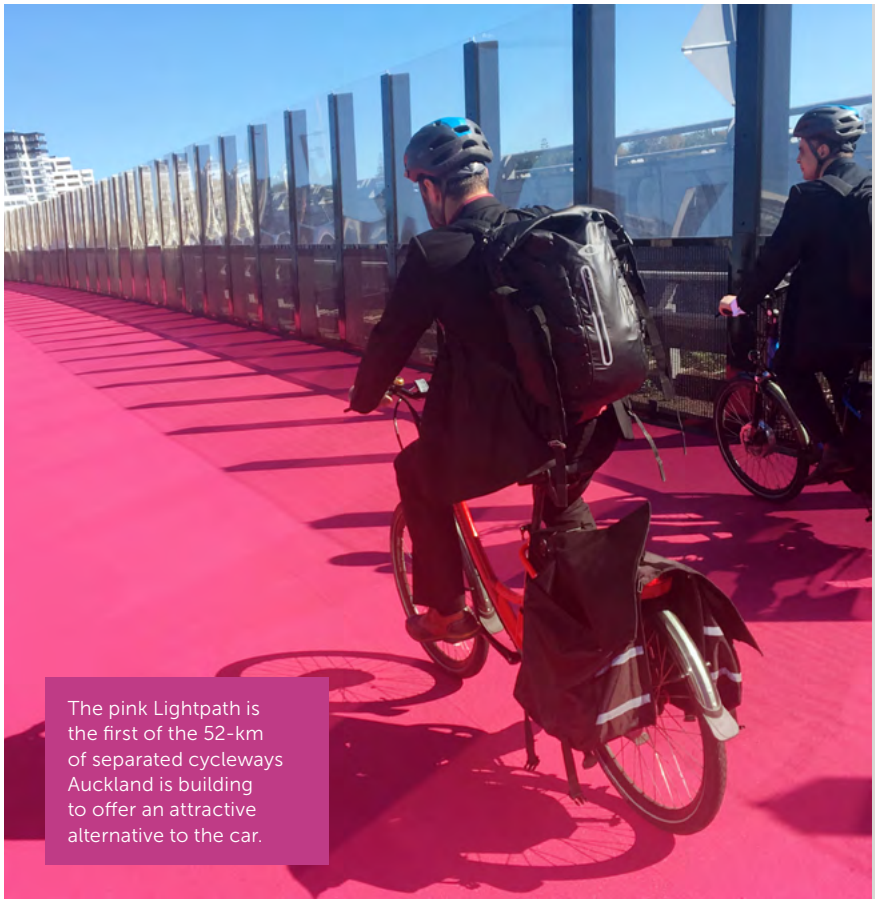
The project will target the direct and indirect costs of physical inactivity, which are valued at $292 million and contribute to 73 deaths per year in Auckland.

### Social

By designing streets for people, and not cars, the city enables greater social connection, ultimately making it a more desirable place to live.

To tackle greenhouse gas emissions from transport, Auckland launched a City Centre Cycle Network program that provides a high-quality cycling experience for all Aucklanders. The city center is the most densely populated in the region and has the largest concentration of jobs: more than 230,000 people live within a 30-minute bike ride of the center, where more than 156,000 jobs are located. The city plans to build 52 km of separated cycleways by 2018. Already, **after building the first seven km of cycleways, the city has experienced a steep increase of people cycling.**

Auckland has turned an old motorway off-ramp into a colorful new walking and cycleway. The path reached 100,000 bicycle trips just 118 days after it opened. Retrofitting the ramp signals, **the city is seeing a paradigm shift from one of polluting travel to restorative travel;** a clear statement of changed values. By 2020, Auckland aims for a 5% cycling mode share and by 2030, to be the "mode of choice" alongside walking and public transport.



The pink Lightpath is the first of the 52-km of separated cycleways Auckland is building to offer an attractive alternative to the car.

CITY: **BELO HORIZONTE**

# Pedestrian-Centric Mobility Design

→ The City of Belo Horizonte has made a shift to prioritize pedestrians and public transport over private vehicles, benefiting citizens and improving the performance of the already constructed bus rapid transit (BRT) system.

Through simple, low-cost measures in the Mobicentro project, the City of Belo Horizonte has increased the efficiency and mobility of the citizens in the downtown area. This has been achieved through a pedestrian-centric design focus and prioritization of the public transport system. Increasing the time for pedestrian road crossing and implementing diagonal crossings are two ways that **the city has shifted the focus back to people and away from vehicles.** Finally, a paradigm shift in the development of road projects in Belo Horizonte was implemented, prioritizing pedestrians over motorized vehicles.

The Mobicentro project was influenced by citizens in its creation, and included an educational outreach program after completion. **Changing traffic circulation patterns, creating areas of restricted use, and new parking rules were all suggested by the people of Belo Horizonte.** The project, "Pedestre, Eu Respeito" ("Pedestrians, I respect them"), has helped to guide pedestrians and created a safer environment for all.


A safer and healthier urban mobility environment has been achieved via low-cost measures in Belo Horizonte.

## ↓41%

REDUCTION IN $CO_2$ EMISSIONS IN THE REGION AFTER THE IMPLEMENTATION OF THE PROJECT

## THE CHALLENGE

From 1999 to 2013, Belo Horizonte saw an alarming drop in public transportation usage and more than a doubling in the use of motorized vehicles. The BRT system and the Mobicentro project seek to reverse the trend.

## CO-BENEFITS

### Economic

The operational speed of Belo Horizonte's BRT system has increased from 9 km/h to 17 km/h and the buses from 11 km/h to 21 km/h, saving the citizens time in their daily commuting.

### Environmental

As a result of the city's interventions, the reduction of emission has been 41% for $CO_2$, 39% for NOx, 68% for volatile organic compounds, and 32% for inhalable particulates.

### Health

A decrease in pedestrian-car accidents of 18% has been achieved and a 32% decrease in particulate emissions.

### Social

Prioritizing public transport has benefited those unable to afford private vehicles, and installing traffic lights with sound aids helps those with visual impairments.

CITY: **BENGALURU**

# Using Intelligence to Create Better Public Transport

→ By using big data and an electronic tracking system, the City of Bengaluru can optimize the operation of public transport in one of India's fastest-growing cities, with more than eight million citizens.

↓51.4K

METRIC TONS OF $CO_2$ PER YEAR IS WHAT BMTC AIMS TO REDUCE

## THE CHALLENGE

Getting an overview of the BMTC, which operates a fleet of 6,000 buses and serves five million passengers every day is a difficult task. An ITS was designed to improve the efficiency and operations of the buses, incentivizing even greater ridership numbers from the citizens of Bengaluru.

## CO-BENEFITS

### Economic

The system enabled BMTC to establish and maintain tight control over operations, resulting in an increase in total effective kilometers covered daily, making a positive impact on the system's financial performance.

### Environmental

Improved information has led to increased loyalty from commuters and modal shift of passengers from private cars to public transport, reducing pollution.

### Social

BMTC's app provides commuters with information on the ETA (estimated time of arrival) of buses in real time. The app also provides a platform for commuters to submit concerns or complaints, for BMTC to act upon.

Nicknamed "the Silicon Valley of India," **Bengaluru saw the introduction of an intelligent transport system (ITS) as a natural next step in support of the city's bus rapid transit system.** In order to provide real-time information about the buses, the Bengaluru Metropolitan Transport Corporation (BMTC) deployed an ITS featuring a GPS-enabled vehicle tracking system, electronic ticketing machines, a passenger information system (PIS), control room, and data center.

The system will improve user mobility by providing reliable real-time information on bus arrivals and route information to commuters via PIS, website, and an app. The operators can monitor and track buses and their performance – improving efficiency by route optimization, decreasing operational costs, and optimizing resource utilization. The $10.9 million project launched in 2016 and is expected to be fully implemented in 2021. **The project will also include installation of 10,000+ handheld electronic ticket machines and vehicle tracking systems in 6,400 buses.**

The BMTC will introduce more than 10,000 handheld electronic ticket machines making it easier for citizens to purchase tickets on the go.

CITY: **CARACAS**

# Holistically Improving Urban Life

→ With a comprehensive and holistic plan, Caracas is combating congestion and natural damages to upgrade the quality of life for citizens in one of the most dense areas the city.

↓30%

REDUCTION IN CARBON EMISSIONS BY BUILDING A PUBLIC TRANSPORT SYSTEM

## THE CHALLENGE

Explosive urban development southeast of Caracas has generated a problematic and unsustainable situation in terms of mobility and its repercussions on the habitat, environment, and quality of life for residents.

## CO-BENEFITS

### Economic

New premises for commercial activities are created to support entrepreneurship in the area.

### Environmental

By building 5.35 km of sewage collectors, surface water pollution is reduced and the public green space of the area is increased by 24,534 m².

### Health

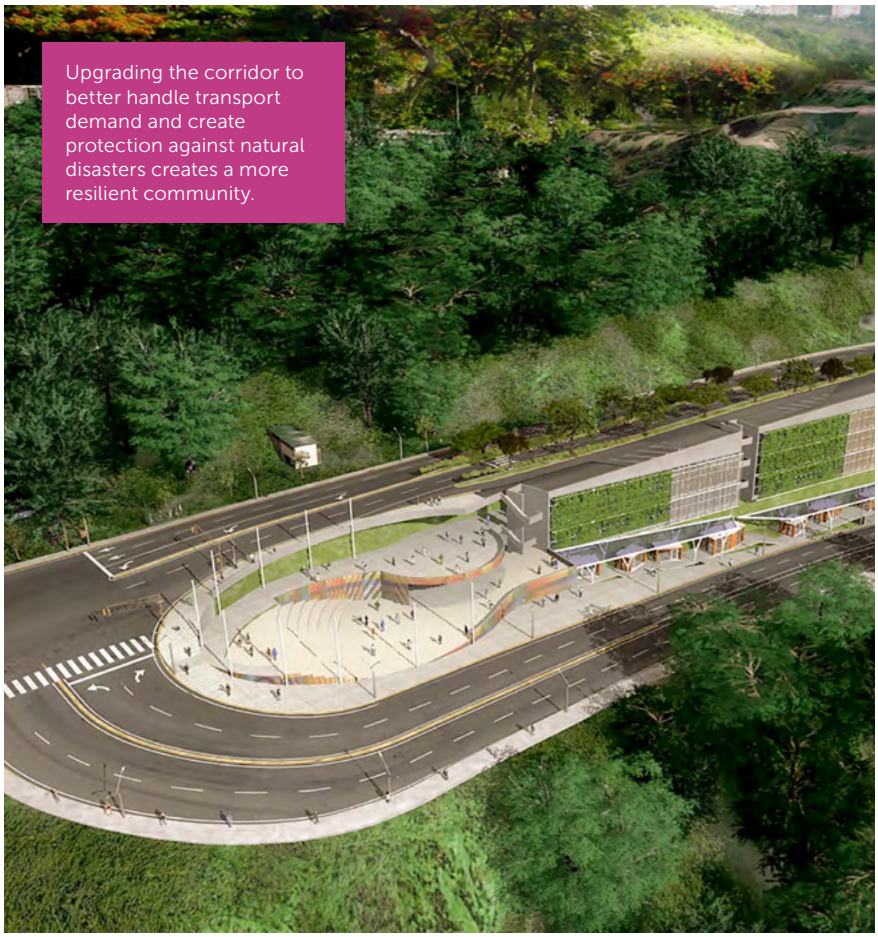
Living conditions of people located in the margins of the ravine have been improved by generating new and hygienic homes, schools, parks, and green areas.

### Social

A new urban center was built, benefitting cultural activities and consolidating local social organizations.

In response to accelerated expansion and resulting congestion south of Caracas, in Venezuela, the city is implementing a plan for the corridor going through three different municipalities. **The main focus is to connect a fractured and disconnected area in a sustainable manner.** The holistic urban plan is developed in partnership with civic organizations, local authorities, and private developers, aiming to integrate mobility efforts and recreation opportunities and prevent natural disasters like flooding and erosion.

**The plan includes the construction of a new and exclusive 17-km-long public transport system with 29 stops.** In addition, six km of bikeways and a system of green public spaces will be built, the latter including activities such as playgrounds, exercise stations, and special areas for elderly people. New commercial zones will be added to support the popular entrepreneurship of the informal merchants in the area.



Upgrading the corridor to better handle transport demand and create protection against natural disasters creates a more resilient community.

CITY: **CHANGWON**

# Incentives for a Shift to Electric Vehicles

→ Changwon is taking the next step towards sustainable transport by promoting the uptake of electric vehicles to combat local air pollution and carbon emissions.

**↓389**

TONS OF $CO_2$ EMISSIONS HAVE BEEN AVOIDED SINCE THE INTRODUCTION OF THE EVS

## THE CHALLENGE

Changwon is situated in a basin that exacerbates the negative effects of air pollution, and has experienced twice the global average temperature increase. After implementing South Korea's first bike-sharing system, the city now turns towards making cars more sustainable.

## CO-BENEFITS

### Economic

The policy will boost the regional economy as increasing numbers of locally manufactured EVs are sold.

### Environmental

Shifting to EVs will help to prevent further warming of the city, and will also reduce air and noise pollution associated with traditional vehicles.

### Health

The deployment of EVs will help to reduce levels of local air pollutants.

Through public-private partnerships, various incentives, and new regulations, the city of Changwon aims to restore clean air and reduce $CO_2$ emissions by replacing existing vehicles with environmentally friendly electric vehicles (EVs). The city has installed 31 quick-charge stations, and, from January 2017, new regulation requires all new buildings to install EV charging facilities. The city plans to **supply 3,000 mobile chargers to multi-unit houses and public facilities** by the end of 2017, and add 50 additional public charging stations by 2018.

The EV fleet rollout is part of the city's plan to become an "Environmental Capital" by 2020. After first installing EVs for public use, the city now offers briefing sessions and trial rides for interested companies and individuals to promote and further disperse the technology. **The goal is 5,500 EVs on the road, 1% of all registered vehicles, by 2020.**


In order to push the shift to EVs, and lead by example, the municipality has added EVs to its fleet.

CITY: **DAR ES SALAAM**

# First Bus Rapid Transit System in Eastern Africa

→ Dar es Salaam is making a shift towards faster, cleaner, and more reliable urban transportation with a new BRT system.

**↓90**

MINUTE REDUCTION IN TRAVEL TIME FOR A RETURN TRIP ON THE CORRIDOR

## THE CHALLENGE

Dar es Salaam is one of the fastest-growing urban centers in the region, with a population growth of 6.5% annually. The population is expected to reach 10 million by 2027. The large and ambitious BRT aims to provide sustainable transport solutions for this growing population and will help to avoid urban congestion and air pollution.

## CO-BENEFITS

### Economic

The BRT corridor has increased productivity, as people are cutting journey times at affordable costs. Additionally, new jobs have been created alongside the corridor, with park and ride services like car-parking and car-washing.

### Environmental

The dedicated bus lanes are helping to make the city more attractive for residents, with lower congestion levels and sidewalks with space for trees and other plants.

### Health

Non-motorized-transport facilities have been provided along the BRT corridor to attract and encourage road users to change to more environmentally friendly transportation.

Dar es Salaam is the first Eastern African city to implement a public bus rapid transit (BRT) project. The ambitious project, which will eventually cover 130 km and serve 90% of the population, is being phased in incrementally. Phase one has 39 trunk buses of 18 m, which can carry 160 passengers each, and 101 feeder buses of 12 m, with a capacity of 80 passengers each. When fully implemented, **the BRT system will provide better, more environmentally friendly, and more efficient mobility to the city's residents.** Until now, public transport, which accounts for up to 60% of all trips made daily, has been provided by more than 5,200 privately owned so-called daladala buses.

The BRT line already in operation has 100% exclusive lanes and elevated terminals, and **is transporting about 200,000 passengers daily.** Stations and terminals bring safety and comfort not only for those who use the system, but for the entire local population, with sidewalks, cycle tracks, and a better organized public space. Funding for phase two, which will expand the network further, will commence shortly.

The Dar es Salaam BRT is transporting more than 200,000 people every day and reducing the time spent on traveling.

CITY: **FORTALEZA**

# Mobility for the Unbanked

↓270

TONS $CO_2$ REDUCED ANNUALLY WHEN THE SYSTEM IS FULLY IMPLEMENTED BY THE END OF 2017

## THE CHALLENGE

In Fortaleza, although there are more than 1,000,000 trips by public transportation per day, there's an increasing amount of motorization. Bringing sustainable alternatives to the population is essential to attract more people to transit and active modes of transportation.

## CO-BENEFITS

### Economic

With Bicicleta Integrada, the user does not need to have a credit card or prove income to register. Any penalty is assessed through usage and never through payment.

### Health

The project helps attack a sedentary way of life and by mitigating air pollution, it can reduce diseases such as respiratory ailments.

### Social

The system offers low-income workers without credit cards an opportunity to complement their daily mobility.

→ Fortaleza introduced a new bike-sharing system, Bicicleta Integrada, that is free to use and guarantees sustainable transport for all.

Fortaleza has rolled out a new, innovative bike-sharing system that differs from the many others around the world. The system offers low-income workers an opportunity to add bike-sharing trips to their customary transport, as the system does not require a credit card to register and is free of charge. With an installed app or a single ticket, **the user can unlock and borrow a bike for a maximum of 14 hours.** If the user does not return the bike in time, the user is blocked from using the system for a period of time. The system is integrated with the existing public transport, and thereby offers a sustainable means of last-mile transport. Today, **there are five bus terminals with Bicicleta Integrada stations and 250 bikes in total.**

Bicicleta Integrada does not have direct costs to the city of Fortaleza. The system was launched as part of a public bidding, inviting companies to operate the system, providing publicity by applying company logos on stations and bicycles.


With the use of either a ticket or the mobile app, bikes are unlocked and free to use up to 14 hours.


D.A.V.
SENIOR SECONDARY SCHOOL
SCIENCE
COMMERCE
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CITY: **JAIPUR**

# Cutting-Edge Technology for Safer, Smarter Streets

→ Through innovative and inclusive solutions, Jaipur seeks to improve pedestrian mobility and increase public transport ridership while leveraging historic heritage and enhancing quality of life.

↓770

TONS OF $CO_2$ EMISSIONS REDUCED ANNUALLY BY DECREASING THE USE OF PRIVATE VEHICLES IN THE CITY

## THE CHALLENGE

Jaipur is one of the country's fastest-growing and most chaotic urban centers, and the historic inner city's infrastructure is not able to cope with the increase in population and traffic. The promotion of smart low-carbon modes of transportation seeks to improve mobility in the area.

## CO-BENEFITS

### Economic

A better walking and biking environment is expected to both increase visitors to the Pink City and support local enterprises.

### Environmental

The goal is to improve the air quality by reducing the air pollution from the current 155 µg/m³ to 60 µg/m³ PM10.

### Health

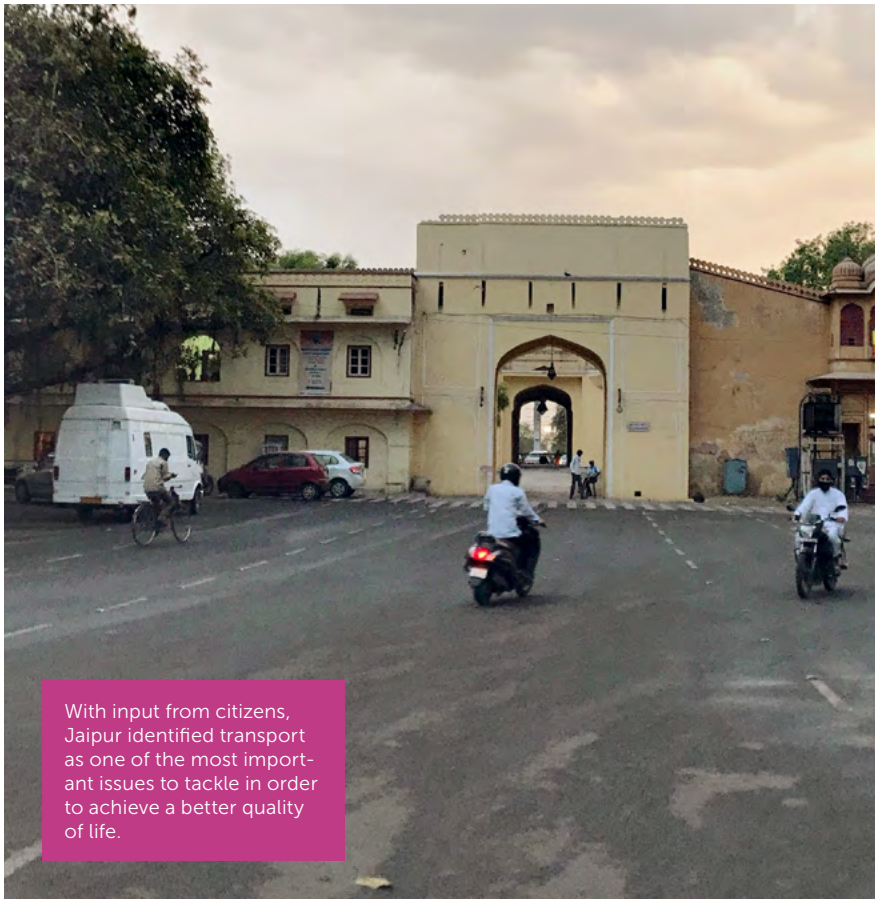
With streets designed to calm traffic and protect vulnerable NMT users, streets become safer and the risk of accidents is reduced. Fatalities from accidents are to be reduced from 35 annually to near zero.

### Social

Protecting the livelihoods of 2,500 street vendors will benefit not just them but their families and the entire community, too.

The city center of Jaipur, known as the Pink Walled City and home to more than 20% of the city's population in just 1.5% of the city area, is getting more friendly for non-motorized transportation (NMT). **By using smart technology, the city is calming traffic and providing more space for NMT.**

The Smart Mobility project, part of the Indian government's Smart Cities Mission, consists of several initiatives. Implementing smart roads will create safer conditions for pedestrians, enable smart mobility, and improve the overall physical environment. **Using smart sensors, the city is collecting actionable data to use to optimize its services.** As an example, the city deployed parking sensors for better management of parking spaces, smart lightning that turns on or off depending on nearby activity, synchronized traffic lights to provide "green waves," and a mobility card to use with various modes of public transport. This plethora of smart initiatives aim to reduce $CO^2$ emissions and improve the quality of life for citizens and visitors.



With input from citizens, Jaipur identified transport as one of the most important issues to tackle in order to achieve a better quality of life.

CITY: **KALININGRAD**

# Public Transport Upgrades Unclog Congested Roads

→ Kaliningrad is transforming its car-centric mobility infrastructure into a more efficient, less polluting multi-modal system.

**↓240K**

TONS OF $CO_2$ EQUIVALENT WILL BE SAVED BY 2020 VIA CLEAN MOBILITY PROJECTS

## THE CHALLENGE

The level of motor vehicle ownership in Kaliningrad is one of the highest in Russia. The old urban transport system was designed for 60 to 100 cars per 1,000 citizens, but today there are 436 cars per 1,000 people. The move to improve public transport should help reduce the strain on the city's congested road network.

## CO-BENEFITS

### Economic

Economic benefits from a more efficient and well-organized transport network include time savings for commuters and higher sales for businesses. Reduced road congestion also leads to fuel savings for drivers.

### Health

Kaliningrad expects to see increased physical activity with a shift to more walking and cycling. Improved air quality is also expected to reduce rates of respiratory diseases.

### Social

The projects help promote healthy lifestyles in all communities via increased cycling, walking, and the development of multi-functional recreational areas.

The Russian city of Kaliningrad has created a long-term plan for urban mobility, shifting the focus from cars and private vehicles to public transport and pedestrian areas in the city center. The city plans to improve planning and management of public transport based on efficient monitoring systems to encourage increased usage, as well as introduce new modes and routes for urban mobility. With the development of a combination of policies, the city created a **first-of-its-kind mobility model in Russia.**

The city has used federal and regional funds to leverage investment from the private sector, too. So far, Kaliningrad has procured 145 efficient EURO-5 buses with lower particulate emissions, which replaced 200 old buses with smaller passenger capacity. The city has also constructed 15 km of bike lanes and constructed more strategic parking spaces throughout the city. The old tram network is also being upgraded, with **larger electric trolley buses replacing the small and clunky trams.**


Kaliningrad's tram network is the oldest in Russia and is being upgraded to make use of electric "trolley buses," which have greater capacity and more effective hill climbing ability than trams.

CITY: **LIMA**

# Car-Free Day Clears Streets

→ Lima introduced one day a month where all motorized transport is banned from the historic city center of Lima, opening and cleaning up the streets for pedestrians.

133

µG/M³ OF PARTICULATE EMISSIONS HAVE BEEN REDUCED DURING A SUNDAY WITHOUT CARS

## THE CHALLENGE

Lima had the most polluted air in Latin America in 2014[1], with motor vehicles cited as the main cause. By freeing the streets from dangerous smog once a month, the city hopes to raise awareness of the problem and change transportation habits.

## CO-BENEFITS

### Environmental

Preventing cars from entering the city center not only reduces air and noise pollution, but also cuts greenhouse gas emissions from cars.

### Health

Lima is taking its first small step in reducing air pollution, showing what sort of environment is possible when cars are absent and more people cycle.

### Social

Taking cars off the road allows more space for socially inclusive activities. The city estimates that the free cycling workshops and entertainment have benefited more than 7,000 people.

For 12 hours on the last Sunday of every month, the Peruvian capital city has created **a ban for vehicles in the old and central district.** This road closure promotes more sustainable transport alternatives and is also used as a chance to create artistic, educational, and gastronomic activities for the city's citizens and tourists. It also serves as respite for the air pollution caused by traffic during the remainder of the month.

To further encourage walking and cycling in the city, Lima offers free cycling workshops and has created additional cycle routes. And to determine the difference created by the scheme, the city regularly measures air particulates as well as noise levels. **Particulate levels more than halved** during one of the car-free days and noise levels fell from 78 to 59 decibels, creating a cleaner, calmer, and healthier environment for all to enjoy.

The citizens of Lima can enjoy a day without cars once a month in the historic city center.

[1] WHO Global Urban Ambient Air Pollution Database. World Health Organization. 2016.

CITY: **LOJA**

# Bicycles and Electric Taxis for Clean Mobility

→ The city of Loja, in Ecuador, is cutting air pollution, improving public health, and reducing its carbon emissions by replacing fossil fuel taxis with EVs and promoting cycling amongst the population.

↓5,000

TONS OF $CO_2$ HAVE BEEN REDUCED SINCE 2016 FROM THE MOBILITY PROJECTS

## THE CHALLENGE

Governments are often wary of creating legislation that threatens fossil fuel-based industries, but when communities demand more sustainable forms of transport, as in Loja, it gives local governments the green light to push more environmentally progressive policies.

## CO-BENEFITS

### Economic

Owners of the electric taxis save an estimated 40% on fuel and operational costs compared to traditional fossil fuel-based vehicles.

### Environmental

Creating ecological trails has led to the creation of additional green spaces throughout the city, improving urban biodiversity.

### Health

Loja's ecological trail network offers pleasant and healthy alternatives to traditional, polluting vehicles.

### Social

The electric taxi project was co-designed by Ecuadorian migrants living abroad who wanted to return to their home country. The scheme offers a stable source of income for them and their families.

A fleet of 30 electric taxis has been introduced to the Andean city of Loja, in Ecuador, as part of a city-wide strategy to improve sustainable transportation. The city is also building cycle paths, and has constructed **72 km of ecological trails** in and outside the city to promote healthy mobility and maintain Loja's reputation as Ecuador's "ecological city."

The people of Loja are environmentally proud and unafraid of new technology, demonstrated by previous pioneering recycling and wind energy projects, which both came from grassroots beginnings. The citizens were once more at the forefront of another sustainable project, and presented the business case for the electric taxis to City Hall. In addition to financing the project, Loja has gone one step further and **required all future taxis to be electric,** which will benefit from the high share of renewable energy in the country's energy mix.

The fleet of 30 fully electric taxis operating throughout the city of Loja receives tax incentives and provides job opportunities for returning Ecuadorian migrants.

CITY: **LONDON**

# Iconic Buses Provide Real-Time Air Quality Alerts

→ Low-emission bus zones and real-time air quality updates are two ways London is cleaning up the capital's dangerous air quality.

↓30%

REDUCTION IN $CO_2$ TAILPIPE EMISSIONS IN CENTRAL LONDON BY 2020

## THE CHALLENGE

London faces dangerous air pollution levels, despite being one of the first cities to introduce maximum air pollution levels following The Great Smog of 1952.

## CO-BENEFITS

### Economic

The total economic burden associated with London's poor air quality is valued at around $4.8 billion. Improving air quality is expected to benefit high-street businesses as well as increase property values.

### Environmental

London aims to achieve a 70% reduction in bus NOx emissions via low-emission bus zones and changing transport habits with the air quality alerts, which will also help to tackle carbon emissions.

### Health

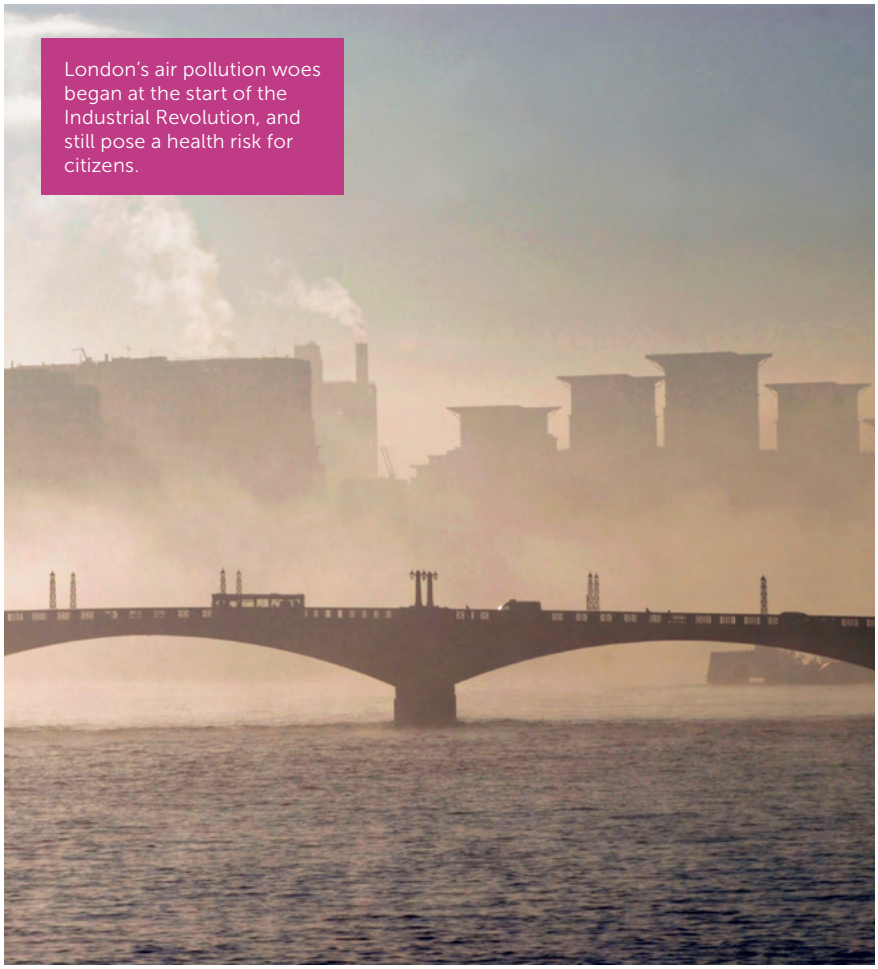
Long-term exposure to air pollution is estimated to cause more than 9,000 premature deaths every year in London. Low-emission bus zones and information updates are two ways in which the capital is trying to slash this figure.

### Social

The low-emission bus zones have taken into account the proximity of schools to reduce children's exposure to pollution.

Information and awareness campaigns can go a long way towards changing people's behaviors. London is rolling out real-time updates at bus stops and via road-side messages and digital alerts to inform citizens about poor air quality. When high and very high air pollution is forecast, **2,500 bus stops will display warnings about air quality,** and alerts will be sent to app users as well as to the 700,000 followers of Mayor Sadiq Khan's Twitter account.

London also created low-emission bus zones to **prioritize the use of the cleanest, greenest buses where they are needed most.** Measurements were carried out to identify the areas of highest exposure to dangerous nitrogen dioxide, and only top-of-the-range Euro 6 buses or hybrid-electric buses can use the lanes. The first of these zones was completed in January 2017 and 11 more will be completed before 2020.



London's air pollution woes began at the start of the Industrial Revolution, and still pose a health risk for citizens.

CITY: **LOS ANGELES**

# Demand Aggregation for EV Proliferation Plan

→ Los Angeles is serious about the future of electric vehicles and is installing infrastructure to create a city that facilitates the transition to EVs.

↓64%

REDUCTION IN $CO_2$ EMISSIONS WILL RESULT FROM A QUARTER OF ALL VEHICLES TRANSITIONING TO EVS

## THE CHALLENGE

Los Angeles experiences unhealthy levels of particulate pollution for the equivalent of nearly a month each year. Targeting the transportation sector provides immediate relief for LA's most vulnerable residents on both a climate and public health level.

## CO-BENEFITS

### Economic

The city is spending 35% less on maintenance for its EVs fleet compared to the fossil fuel counterparts.

### Environmental

Los Angeles has avoided more than 1,300 tons of $CO_2$ equivalent from city procurement of EVs alone, and the car-sharing pilot is expected to save a further 2,150 tons of $CO_2$ equivalent per year.

### Social

The power utility company offers up to $4,000 in rebates for EV charging infrastructure at commercial and multifamily locations, encouraging inclusive infrastructure investment.

The American West Coast city of Los Angeles is pursuing sustainability via electrification of the transportation sector as part of their Sustainable City pLAn, which aims to cut 80% of greenhouse gas emissions by 2050. So far, the city has **installed 1,000 publicly available chargers** and is one of the most EV-friendly cities in the USA. More than half of the municipality's light-duty fleet is electric, and the city has piloted an EV car-sharing scheme to create equitable access to EVs and increase low-carbon mobility in low- and middle-income areas. This public sector investment is designed to spur private engagement and lead to a quarter of all vehicles being electric by 2035.

Los Angeles has also spearheaded an unprecedented aggregation of municipal demand across the USA with its recently released Electric Vehicle Request for Information. This initiative bundled demand for EVs from several cities in order to prove the demand for EVs and drive down prices. As of March 2017, the order stood at **114,000 vehicles with a total value of $10 billion[1].**

Los Angeles is part of a multi-city, mayor-led campaign to aggregate demand of EVs to spur investment and drive down manufacturing costs.

[1] Ryan, J. Cities Shop for $10 Billion of Electric Cars to Defy Trump. Bloomberg. (2017, March 14.)

CITY: **NEW YORK CITY**

# Retrofitting Trucks for Cleaner Air

→ New York City is targeting air pollution by offering rebates to retrofit or replace older trucks with alternatively fuelled models.

**↓5.7K**

METRIC TONS $CO_2$ REDUCED YEARLY UNDER THE PROGRAM

## THE CHALLENGE

Thousands of trucks drive through the South Bronx every day, with high levels of particulate matter contributing to a community asthma rate three times the national average. Advanced vehicle technologies with low-carbon fuels are a breath of fresh air for New Yorkers.

## CO-BENEFITS

### Economic

Many of the program's applicants are immigrant-owned, small businesses. The program helps these businesses stay competitive and provide jobs for New Yorkers.

### Environmental

Transport refrigeration unit replacements alone have cut emissions by 900 metric tons $CO_2$ per year.

### Health

Health benefits are expected to be seen over the years as more trucks are replaced or retrofitted, emissions are reduced, and air quality improves.

In 2012, New York City introduced the Hunts Point Clean Truck Program (HPCTP), **working to address the poor air quality** experienced by the Hunts Point and Port Morris communities in the South Bronx, where 15,000 truck trips begin or end every day. The program provides financial incentives to truck owners who are based, or who regularly operate, in the South Bronx, to retrofit diesel exhaust systems with scrubber technologies, or to replace older trucks with newer, cleaner models such as hybrid-electric, compressed natural gas, or fully electric.

Three years into the program, the HPCTP celebrated **the replacement of 500 old, highly-polluting diesel trucks.** In total, truck replacements, retrofits, scrappage schemes, and transport refrigeration unit replacements have resulted in annual reductions of NOx by 90%, PM2.5 by more than 95%, hydrocarbons by 80%, and carbon monoxide by almost 85% for HTCTP vehicles


More than 500 polluting diesel trucks have been replaced, lowering $CO_2$ emissions and improving air quality in the South Bronx.

CITY: **SEATTLE**

# Finished with Fossil Fuels, City Electrifies Vehicles

→ By transitioning the city's transportation sector from oil to electricity, Seattle is one step closer to becoming carbon neutral.

**1.6M**

KM DRIVEN BY ELECTRIC VEHICLES DUE TO DRIVE CLEAN SEATTLE

## THE CHALLENGE

In Seattle, the transportation sector accounts for 60% of greenhouse gas emissions, which is why the city is jump-starting its transition from oil to electricity, with the ultimate goal of eliminating emissions from transportation in 2050.

## CO-BENEFITS

### Economic

In Seattle's municipal fleet, each hybrid vehicle replaced with an EV saves $6,929 in total cost of ownership. With 150 EVs in the fleet, and at least 100 purchases planned for 2017, the city saves $1.7 million.

### Environmental

With one electric vehicle saving approximately 19 tons of carbon dioxide over its life-cycle, the city's fleet will save 4,750 tons of $CO_2$ emissions. The 40% increase in EVs throughout Seattle since 2016 represents an even greater $CO_2$ reduction.

### Health

Air quality improves with the shift to electric vehicles as pollutants from gasoline and diesel combustion are reduced.

Drive Clean Seattle is the city's strategy to reduce greenhouse gas emissions and localized air pollution in the highly emitting transport sector. Leading by example, **Seattle wants at least 30% of light-duty vehicles in the municipal fleet to be electric by 2030** and to halve emissions from the fleet by 2050. To accelerate progress in the privately owned vehicle sector, the city is installing 20 fast-charging stations, and is establishing rules to allow curbside EV charging. Seattle is also part of a $10-billion, multi-city demand aggregation agreement designed to spur increased EV manufacturing.

Regionally, Seattle is also expanding electric transit via a $50-billion light-rail expansion. And **by partnering with the private sector, the city hopes to facilitate a record-breaking purchase of all-electric transit buses.** By driving the transition from oil to electricity in transportation, Seattle moves closer to its goal of becoming carbon neutral by 2050.

By transitioning from oil to electricity, Seattle hopes to eliminate emissions from transportation by 2050.

CITY: **SEOUL**

# Leaving the Car Behind Pays Off

→ The City of Seoul seeks to reduce carbon emissions and localized air pollution under a voluntary civic engagement program whereby citizens are rewarded for reduced driving.

**A voluntary program in the city of Seoul, South Korea, rewards citizens who reduce their driving** compared to kilometers driven the year before. Incentives are given in the form of points, which can be used to pay for local taxes, purchase mobile gift cards, or donate to a local fund that fights energy poverty by installing energy-saving units like LED lights and mini solar panels. The city expects to pay out $1.36 million annually in program incentives.

A two-year trial period resulted in doubling the carbon emission reductions compared to Seoul's Voluntary No-driving Days program. The Eco-driving mileage program, launched in April 2017, aims to enlist 50,000 members each year and maintain 250,000 members after 2022. This program directly engages citizens in the city's efforts to tackle climate change. **Members of the program are expected to build better driving habits and acquire better understanding of climate change.**


The 250,000 members expected to join the program will cut $CO_2$ by 10,000 tons yearly; equivalent to the carbon absorption by 1.3 million 30-year-old pine trees.

## ↓10K

TONS OF $CO_2$ IS ESTIMATED TO BE CUT BY THE PROGRAM ANNUALLY

## THE CHALLENGE

The City of Seoul boasts a highly effective public transport system. Even so, the city still struggles with very high levels of localized air pollution and $CO_2$ emissions caused in part by the increasing number of private vehicles.

## CO-BENEFITS

### Environmental

By inducing less driving, the program will improve Seoul's air quality by reducing both fine particle pollution and greenhouse gas emissions.

### Health

The program is designed to cut vehicle driving, which will improve public health, as transportation is responsible for 37% of air pollution in Seoul.

### Social

The program was designed with the knowledge that in order for it to be successful, a meaningful number of people would have to willingly accept daily inconveniences, which is why participating citizens are rewarded as environmental problem-solvers.

CITY: **TAINAN**

# Redesigned Bus System Reduces Pollution and Emissions

→ Tainan's recipe to become a low-carbon city includes an attractive and sustainable public transport system that accommodates citizens' needs while cutting localized air pollution and $CO_2$ emissions.

↓7,075

TONS OF $CO_2$ REDUCED ANNUALLY SINCE 2012

## THE CHALLENGE

The scale and structure of Tainan is unique, including both dense urban and countryside areas, making it difficult to serve all citizens with the previous mobility strategy in a satisfying and environmentally effective manner.

## CO-BENEFITS

### Economic

As a result of the increase in passenger volumes, bus companies now operate routes at a profit and thereby without government subsidies.

### Environmental

Shifting people from personal cars to public transport has lowered congestion, and travel times have decreased by 30%, resulting in lower emissions.

### Health

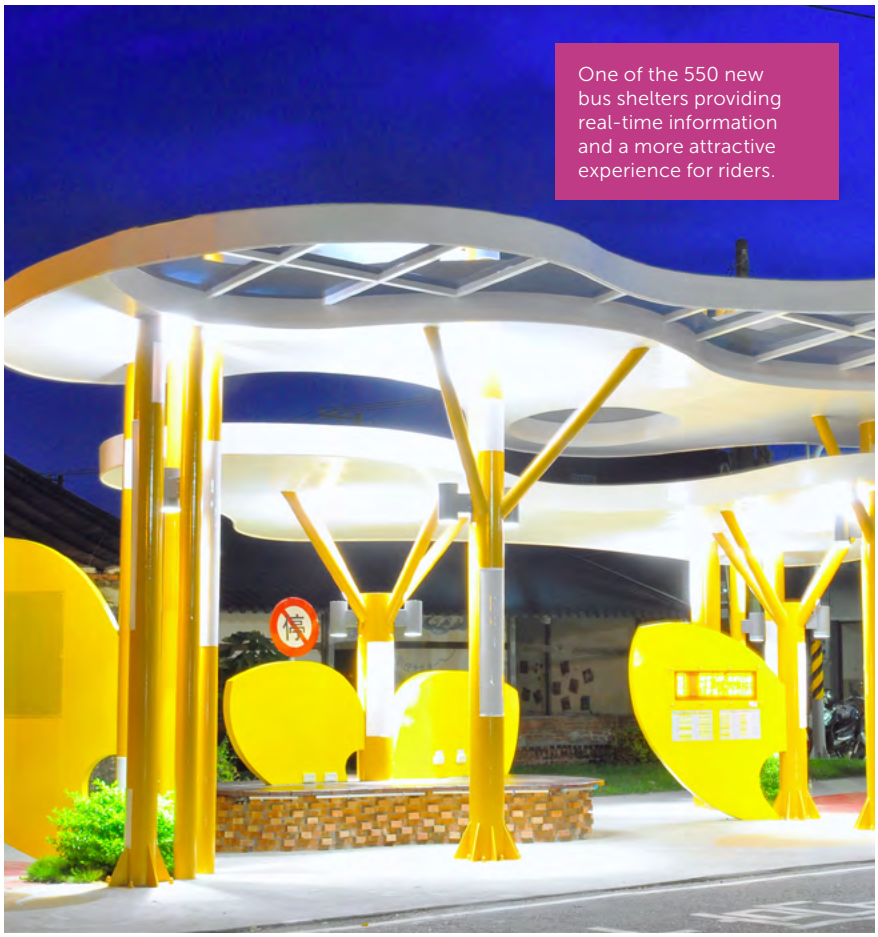
As a result of the higher usage of the buses, death caused by accidents in private vehicles has decreased by 7.3% and injuries have been reduced with 6.1%.

### Social

The bus system has improved the mobility of the citizens, and the usage of free tickets for the elderly has increased by 150%, indicating an increase in use by the city's seniors.

Tainan, Taiwan's oldest city, is shifting people from private cars to public transport by remodeling the bus system to be more effective and user friendly, and introducing the "Metro Bus" as a new bus brand with easily recognizable colors for each of the seven main lines. So far, the change has been a success, as **the annual passenger volume has increased from 9.8 million in 2012 to 20 million in 2016.**

The $120-million Metro Bus project, part of Tainan's vision for becoming a low-carbon city, has **replaced 130 old, polluting vehicles with new accessible buses and established more than 3,000 bus stops, 550 shelters, and nine intermodal stations** equipped with real-time information. The system, not yet fully expanded, will replace 30 vehicles with low-carbon ones and build 50 intelligent bus stops every year. The number of passengers is also expected to increase by 10% annually.



One of the 550 new bus shelters providing real-time information and a more attractive experience for riders.


youbike
youbike

CITY: **TAOYUAN**

# Bike-Rental System for "Last-Mile" Transportation

→ The City of Taoyuan provided its citizens with a low-carbon transportation option by introducing a new bike-rental system and upgrading cycling facilities.

↓2.5K

TONS OF $CO_2$ EMISSIONS TO BE REDUCED ANNUALLY WITH THE SHIFT TO BICYCLES

## THE CHALLENGE

Taoyuan has been focused on improving mass transit in order to achieve a 50% reduction in greenhouse gas emissions by 2050. The city's new rapid transit system has been introduced, but commuters still lack good "last-mile" solutions. To combat this, a new public bike-rental system with affordable prices is getting people out of cars and cutting emissions.

## CO-BENEFITS

### Economic

The city plans to provide 586 new jobs during the seven years of the program, as there is a need for people in operation maintenance, management, and bicycle dispatching.

### Environmental

The amount of fuel saved during the seven-year program is estimated at more than eight million liters, which will reduce emissions and improve air quality in the city.

### Health

According to a survey, at least 18.7% of people are willing to use public transportation instead of motorcycles and cars. When regularly using a bicycle for transportation, residents' health will improve, which benefits residents and the government.

To achieve a seamless transport system and provide transportation service for the "last mile," the Taiwanese city of Taoyuan launched a bike-rental system. The program started in 2015, and 130 bike-rental stations are up and running, with a total of 2,800 bikes in service. Several of the stations are located at Metro Rail Transit stations, making multimodal travel easier. The idea is to **create a low-carbon, green, and convenient urban environment by reducing the use of private motorized vehicles.** The system also promotes healthier lifestyles for residents, and is one of Taoyuan's "Low-Carbon Green City Flagship Projects."

**Conditions for cyclists have been improved to incentivize citizens to choose a bike** over private motorized vehicles. Upgrades include: adjustment of traffic lanes, optimization of signals for bicycles, improvement of bike-friendly facilities, and enhancement of bike route guidance. Furthermore, the goal for 2017 is to establish an additional 15 km of bike lanes.


A bike-rental station near one of the rail stations, providing citizens an environmentally friendly transportation option for the"last mile."

CITY: **TOKYO**

# Big Data to Promote Eco-Friendly Freight Transport

→ State-of-the-art indicators will be used by the City of Tokyo to measure fuel efficiency of freight trucks, enabling the shipping industry to choose the most environmentally friendly freight companies.

↓20%

REDUCTION OF $CO_2$ EMISSIONS HAS BEEN ACHIEVED FOR TRUCKS PARTICIPATING IN THE PROGRAM

## THE CHALLENGE

Tokyo plans to reduce $CO_2$ emissions by 30% below 2000 levels by 2030, and the transport sector is set to reduce $CO_2$ emissions by 60%. Targeting the freight transport industry will be important to reach these goals, as trucks account for approximately 40% of $CO_2$ emissions from vehicles.

## CO-BENEFITS

### Economic

By driving more efficiently, a 20% reduction in fuel consumption has been achieved, saving the companies on operating costs each month.

### Environmental

Air quality in the city will improve, as eco-driving reduces NOx and $CO_2$ emissions.

### Health

According to a survey, eco-driving has contributed to a 49% reduction in traffic accidents.

The City of Tokyo seeks to reduce $CO_2$ emissions by making freight trucks' efficiency completely transparent. **Tokyo Metropolitan Government (TMG) launched the world's first fuel efficiency indicator for freight transport by collecting data from 960,000 trucks each month,** analyzing more than seven million samples, and categorizing them in 60 different segments based on parameters such as type of trucks, fuel, and total weight of the vehicles. Based on the indicators, TMG evaluates $CO_2$ reduction efforts by freight companies in a quantitative manner and encourages freight companies to make further efforts. Freight companies that can show progress will be prioritized by shippers, and their efforts will be visible on the trucks with a one- to three-star rating system.

In total, 264 freight companies are participating in the program, and the number of participating vehicles exceeds 10,000 trucks. As freight trucks are expensive to replace with more environmentally friendly ones, promoting a more efficient driving style is a more viable approach for many companies. **If all trucks in Tokyo implemented eco-driving, an 8% reduction of $CO_2$ emissions could be expected in the transport sector.**


Tokyo, home to more than 13 million inhabitants, has implemented the world's first fuel efficiency indicator system to promote eco-friendly driving for freight transport.

CITY: **WARSAW**

# Electrification of the Bus Fleet

↓135K

TONS OF $CO_2$ REDUCED OVER A 10-YEAR PERIOD BY REPLACING EXISTING DIESEL BUSES WITH E-BUSES

→ To fight increasing $CO_2$ emissions from transport, the city of Warsaw aims to have one of the cleanest bus fleets in Europe and innovative charging facilities.

By 2020, **Warsaw Municipal Bus Company (MZA) will place 130 electric buses into operation together with cutting-edge charging infrastructure.** Nineteen aerial chargers will be installed at selected ends of the bus lines, making it possible to reduce battery weight and thereby improve the environmental performance of the vehicles. Plans call for one-third of Warsaw's buses to be powered by clean technology, either electric, hybrid, or gas models, in 2020. The goal is for 25% of all buses to run on electricity by 2030.

In the long run, the project shall assist the Poland-wide trend towards electric mobility, limiting risks related to $CO_2$ emissions generated by fossil fuels consumed in the transportation sector. **The project will also reduce local air pollutants such as NOx and $SO_2$,** which are generated by diesel buses, and reduce noise produced by standard vehicles.


The shift of Warsaw transportation from fossil fuels to e-mobility is a key step in addressing local environmental and climate challenges.

## THE CHALLENGE

In Warsaw, $CO_2$ emissions from transport increased by 34% from 2007 to 2012, while other sectors reduced their emissions. Shifting to e-mobility will be important in addressing environmental and climate challenges facing Warsaw.

## CO-BENEFITS

### Economic

While the purchase price for e-buses is higher, the fuel costs are just one-quarter of that for diesel buses, resulting in an overall lifecycle saving of $3.5 million for 130 buses.

### Environmental

The shift to e-buses will improve air quality significantly by reducing NOx, $SO_2$, and PM2.5 emissions.

### Health

An upgrade of the public transport system will improve the mobility of all citizens in Warsaw – independently of income.

### Social

After full implementation, the first 10 years of the project is expected to save environmental costs worth $42.9 million.

## Methodology

# → Arriving at the Top 100

Creating Cities100 was a long, multi-step process. The transparency of our application and evaluation procedures is of the utmost importance to the integrity of Cities100. By presenting our methodology, we enable readers to understand how we selected these 100 city solutions.

**Finding the solutions**
Throughout May of 2017, Sustainia and C40 conducted a public campaign to encourage as many cities as possible to submit applications for exciting climate change projects to be featured in Cities100. This campaign included direct contact with city officials, desk research, and social media outreach and communication. In all, these efforts yielded 175 applications from 91 cities across every region of the world.

**Who was eligible?**
In order to ensure that applications came from the most viable, innovative, and replicable solutions, all submissions had to meet the following eligibility requirements:

- Applications had to be submitted by a municipality, or by a third-party organization with the support of the cooperating municipality
- Solutions must be operating, and had to be initiated in 2012 or later
- Solutions must have all or a substantial amount of the project funds secured

In order to feature new solutions each year, projects featured in the 2015 or 2016 editions of Cities100 were not eligible for consideration in this year's edition.

CITIES SUBMITTED PROJECTS WITHIN 5 SECTORS:

ENERGY

WASTE

ADAPTATION


MITIGATION

TRANSPORTATION

**How did we score them?**
Scoring and ranking such a wide range of innovative projects was no easy task. In order to be as rigorous and objective as possible, we created a detailed, multi-step scoring system.

→ **STEP 1:** First, the Sustainia team of experts analyzed all 175 applications and scored them on the following five criteria:

## 1

### CLIMATE ACTION

→ $CO_2$ reductions or climate change risk mitigation goals and results. Preference was given to results or goals that are measured and assessed quantitatively and to documented results over goals.

## 2

### CO-BENEFITS

→ Co-benefits (economic, environmental, health, and social) goals and results. Preference was given to results or goals that are measured and assessed quantitatively and to documented results over goals.

## 3

### INNOVATION

→ The geographic scale of innovation – this comprises innovation at an international level (e.g. the first in the world to apply this technology, approach, scale, etc.), and innovation at a city or regional level (either across the continent or within that country).

→ The evidence provided to support the claim of the project's level of innovation.

→ Description of the innovative elements of the project.

## 4

### GOVERNANCE

→ Whether the project is referenced within the city's overall strategy or climate plans.

→ How the project collaborates with other entities in the city (i.e. other city departments, government agencies, NGOs, private companies, etc.).

→ How the project has undertaken citizen engagement activities and whether those activities have been quantified.

→ How citizen engagement has influenced the development and implementation of the project.

## 5

### SHARING & SCALING

→ The extent to which the application demonstrates that the project experience has been shared openly or is planned to be shared openly with other cities.

→ Demonstration of plans to scale the project within the city, or a suitable explanation as to why scaling is not possible.

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*Within each of the five evaluation criteria, solutions were scored on sub-criteria (bullet points listed below each of the aforementioned evaluation criterion). For each sub-criterion, a solution could score 1 (low), 2 (medium), or 3 (high). A solution's overall score is the sum of their five evaluation criteria scores.*

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→ **STEP 2:** Once solutions received their initial overall score, a team of C40 sector-specific experts analyzed all projects within their given sector and provided detailed input for all evaluation criteria of every solution based on years of hands-on knowledge and experience. Solutions' initial scores were adjusted according to this input, yielding a final score for every solution. The highest scoring solutions in each sector were selected to be featured in Cities100.

**Writing Notes**
Monetary amounts provided by cities have been converted to United States dollars. Distance and volume measurements have been converted to metric system units. In regards to mass, we have used the unit provided by the city in their applications (either tons or metric tons). "Tonnes" have been written as "metric tons."

## Explore Sustainia

# → We Are a Team Driven by our Passion for a Better Tomorrow

We build stories, digital publications, and platforms based on our vast knowledge on sustainability for what we call 'the committed'; Businesses, cities, and organizations that believe in innovating the world of tomorrow. We help them by translating knowledge into branding and strategic insights via owned and earned media, using innovative digital tools, trends, communication, and design.

We are experts in mapping solutions and opportunities for a more fair, prosperous, and sustainable world. We apply this knowledge to our products ranging from event concepts and digital platforms to written "handheld" publications.

Since our formation, we have delivered value for clients and partners that include UN Global Compact, Asian Development Bank, C40, Grundfos, Novo Nordisk, Carlsberg, Nordic Council of Ministers, DNV GL, and Realdania.

→ How we deliver sustainable **innovation:**


## 1) Insight

**MAPPING & ANALYZING**

The world is changing fast and all organizations are struggling to stay ahead. Our research gives insights into emerging sustainable market trends, new business models, and innovative partnerships on the Sustainable Development Goals. We can help you:

→ Identify sustainable solutions from all regions and sectors
→ Get inspiration on how to work with the Sustainable Development Goals
→ Prepare for the future with trend analysis on cities, business, and consumers

Over the past seven years, we have tracked more than 5,000 business solutions and city projects from all over the world through our Sustainia100 and Cities100 publications and the Global Opportunity Explorer.


# 2) Involvement

## NAVIGATING & COLLABORATING

Beyond every risk sits a new opportunity. We apply this mindset to explore new markets through our networks with hundreds of experts, thought leaders, and business pioneers. We work with you to develop a new approach – your navigation tool – to tackle your most pressing challenges and find your way in an increasingly complex landscape. We can help you:

→ Turn your risks into business opportunities
→ Establish new relations and business opportunities through our global network
→ Innovate and co-create by being a partner on the Global Opportunity Explorer


# 3) Impact

## COMMUNICATING & INFLUENCING

Powerful storytelling and captivating visuals drive influence and impact. Together with our global media partners and digital community of 60,000+ people, we're shifting the narrative on sustainability by making it inclusive, positive, and compelling. We can help you:

→ Bring your sustainability agenda to life
→ Create events with impact
→ Inspire your audiences through multi-channel campaigns

Based on the latest research and knowledge, combined with specific examples from available technologies, solutions, and products, Sustainia specializes in creating sector-specific studies and analyses, trend reports, visual conceptualization, and strategic communication.

Explore C40

# → Local Action, Global Impact

The C40 Cities Climate Leadership Group (C40) connects 91 of the world's greatest cities, representing more than 650 million people and one quarter of the global economy. Created and led by cities, C40 is focused on tackling climate change and driving action that reduces greenhouse gas emissions and climate risks, while increasing the health, wellbeing and economic opportunities of urban citizens.

## Connecting & Learning

C40 networks connect hundreds of city officials around the world, helping them to implement climate action, forge partnerships, access resources and overcome technical and financial barriers. C40 delivers over 100 workshops and webinars each year, alongside a dynamic online knowledge exchange platform. Sharing is working. The power of the C40 network is that when one city demonstrates the success of a great idea, other cities can quickly implement it.

- Nearly 75% of C40 cities have been able to take new, better, or faster climate actions as a result of participating in C40 networks; for example, investment in bus rapid transit (BRT) grew from 21 to 42 cities in 2 years.
- C40 cities focus on what works: 50% of all reported actions have gone from pilots to city-wide, up from 15% in 2011.
- Cities' ambition is still growing, with nearly 80% of all actions planned for future expansion.

## Empowering Cities with Data

C40 leverages an unprecedented database of climate actions taken by cities, an extensive network of partnerships, and unique organizational insight to demonstrate the power of cities to address climate change. Our research analyzes key trends, identifies opportunities for further action across the global C40 network, and helps to prioritize initiative areas with the greatest potential impact. C40's research agenda is committed to creating actionable data, supporting decision-making and driving investments.

C40's Deadline 2020 research identified the scale of the climate crisis facing the world's great cities and defined precisely what needs to be done by C40 cities to deliver on the ambition of the Paris Agreement. The world's megacities must act to peak emissions by 2020 and then nearly halve carbon emissions for every citizen in a decade.

**100%**

of cities reporting data to C40.

**98%**

of cities report that climate change poses a significant risk to their city.

## The Voice of Megacities on the Global Stage

As leaders of the world's great cities, C40 mayors have provided unique global leadership, over more than a decade, in the fight against climate change. Playing a vital role in driving nation states to secure the Paris Agreement on Climate Change, C40 mayors are doing their part to deliver on its ambition by curbing greenhouse gas emissions, adapting to the realities of a changing climate, and ensuring their cities are equitable and inclusive places to live and work.

C40 supports mayors to share their achievements and collectively speak out on climate issues on a world stage. The 2016 C40 Mayors Summit in Mexico City brought together more than 40 mayors and secured headlines around the world for the scale of their climate commitments.

The Women4Climate conference brought together C40's powerful women mayors, alongside female business leaders, in New York City, demonstrating the key role of women leaders in the global fight against climate change. Through agenda setting initiatives such as the C40 Clean Bus Declaration, commitments to tackle air pollution and efforts to finance sustainable infrastructure, C40 supports mayors to achieve global impact.

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Cutting greenhouse gas emissions and adapting our cities to withstand the effects of climate change is not only essential for the planet, but is also making citizens healthier, happier, and more prosperous. This year's Cities100 exhibits extraordinary levels of climate action undertaken by cities of all sizes from around the world. The 100 solutions presented here add to the gathering evidence that cities are leading the fight against climate change, and that green policies, projects, and investments are becoming central to how cities function – climate action is becoming the new normal.

These 100 solutions were selected from 175 submissions from 91 cities spread across the globe. By showcasing the 100 most ambitious, innovative, and exciting projects being implemented in cities around the world, Sustainia, C40, and Realdania hope to show what is possible and inspire further action.

## → 100 solutions for climate action in cities

www.sustainia.me

www.cities100.com #Cities100

www.c40.org

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C40 CITIES CLIMATE LEADERSHIP GROUP

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