

Case Study 6: Unlocking Viable Investment Pipelines for Resilience



Structure	Technical assistance, including city scans, rapid capital assessments and dedicated financial advisory services to identify and structure deals
Size	\$13.8 million
Region or country	Global
Stage	Active
Barriers addressed	Commercial barriers and bankability of city resilience projects

The City Resilience Program (CRP) - a partnership between the World Bank and the Global Facility for Disaster Reduction and Recovery (GFDRR) - is a multi-donor initiative aimed at increasing investment for urban resilience and helping cities identify a pipeline of viable, well-informed city resilience projects that mobilize multiple types of financing, including private capital. The program aims to achieve this through three thematic areas: planning for resilience; financing for resilience; and partnerships for resilience.

Under the finance for resilience area, CRP helps cities look both at a) financing - how to mobilize the private sector to deliver resilience-related infrastructure projects (i.e. concessions or PPPs) and b) funding - how cities can capture portions of the economic value generated by investments through land value capture mechanisms. To this end, CRP provides tailored operational and technical support through:

1. Upstream diagnostics such as the Rapid Capital Assessment tool (RCA) to help understand the general context for partnering with the private sector in resilience related infrastructure investments. This upstream

work includes review of national and local track records and economic conditions for both PPP type contracts and land value capture mechanisms. Outputs include both strategic recommendations and identification of specific transaction opportunities.

2. Midstream financial and regulatory analysis related to a specific project (or program) concept to identify opportunities for a sustainable engagement with the private sector, and associated World Bank Group financing support to enable private capital mobilization. It includes identification of the underlying project economics (customer demand, revenue streams and costs); the technical solution (cost benefit analysis, financial or fiscal analysis, risks analysis) and regulatory factors (environmental, social and governance (ESG) analysis) as well as market sounding in many cases. Examples of where this support has been deployed include Accra, Barranquilla, Medellin, Porto Alegre, Casablanca, Irbid, Abidjan, Buenos Aires, Quilmes and Dakar.

3. Downstream transaction advisory services to support governments in their implementation of identified transactions that appear viable in terms of private capital mobilization through concessions or PPPs, and/or their ability to generate privately funded cash flows to city authorities (i.e. land value capture). Support at this stage is generally focused on providing advice to World Bank teams, in parallel to transaction advisory mandates executed by cities themselves. Where necessary, support may include partial funding of the city-led transaction advisory mandates themselves. The outcome of this stage is generally a procurement process leading to signing of contracts with the private sector.

For example, in Abidjan, Cote D'Ivoire, CRP is providing financing support to identify ways to bring private sector expertise and investment into the solid waste sector. In cities like Dar es Salaam (Tanzania), Quilmes (Argentina), Porto Alegre (Brazil) and Medellin (Colombia) CRP has provided support to develop land-based financing, combining land value capture funding with actual mobilization of private capital. For example, in Porto Alegre, CRP identified opportunities for catalytic urban regeneration in the city's 4th District whereby the private sector could partially cover area-wide streetscaping and drainage improvements. In Dar-es-Salaam, CRP examined the market potential for developing a 57-hectare regularly flooded area near the city center and identified the private sector's capacity to include affordable housing and drainage improvements in mixed-use real estate investment programs.

On the funding side, an example of CRP's work is in Buenos Aires where local authorities and the Ministry of Transport are aiming to redevelop a publicly owned 2.5-hectare site near Saenz Peña Metro Station, on the outskirts of the city. The station will benefit from infrastructure upgrades that will increase access and ridership. Supported by Cushman & Wakefield, CRP support helped identify the best, highest use of the targeted site in a way that meets the city's objectives

and captures the future increase in land values. After market sounding, it was recommended that the site be put on the market on a parcel-by-parcel basis after some infrastructure upgrades were made. The CRP-funded study showed that the final sale price could be maximized to approximately \$16.5 million (more than 50 percent more than in the original plan). This engagement exemplifies an approach to generating additional financial resources for public infrastructure upgrades through monetization of underused public assets. It may be replicated on a wider scale, especially where productive land uses are constrained because of infrastructure deficiencies, including exposure to flooding and lack of transit infrastructure.

In Dar es Salaam, CRP supported a study of the potential effect of urban flooding on firms and supply chains that highlighted the importance of resilient infrastructure systems and the need to consider infrastructure disruptions in spatial planning activities. Specific objectives of the study were to understand the spatial distribution of infrastructure disruptions within cities, the role of urban flooding in these infrastructure disruptions, and what share of the urban economy flooding affects directly and indirectly. Using data from the World Bank Enterprise Survey and two sets of flood maps, the analysis showed that firms in flood zones tend to experience more infrastructure disruptions but that those outside of flood zones experience almost as many disruptions, illustrating that, although flooding may occur locally, the effects spread quickly across infrastructure networks. The analysis also showed that floods directly threaten areas with high employment densities and thus a large portion of all economic activity.

Going forward, CRP will be complimented by the Resilient City Development Program (RECIDE), a partnership with AECID managed by CRP, to access resources from the EU External Investment Plan of up to EUR 100 million in guarantees and EUR 14 million in technical assistance to source, originate, and execute transactions for empowering cities in Sub-Saharan Africa to strengthen resilience, and to access a broader range of financing options.

Case Study 7: Reducing Transaction Costs through Green Bulk Procurement of Electric Buses in Santiago Chile



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Structure	Green bulk procurement for electric buses
Size	455 electric buses, estimated at \$ 136.5 million
Region or country	Santiago, Chile
Stage	Implementation
Barriers addressed	Transaction costs

More cities are testing electric bus (e-bus) technology to address urban air pollution while providing flexibility at lower costs than building light rail or metro systems. Globally, sales of e-buses increased 80-fold between 2011 and 2017 (WRI 2019).

City-level bulk procurement and PPPs can reduce transaction costs and catalyze private investment and manufacturing. For example, in the past few years, Santiago, Chile, has procured an impressive 455 e-bus and now has the largest city fleet outside of China (CleanTechnica 2020). It was achieved through a bulk procurement process, expanded over several years, combined with an innovative financial model under which electricity suppliers Enel and Engie acquired the buses from Chinese

manufacturers BYD and Zhengzhou Yutong, leased them to the local operators, installed charging stations, and supply electricity (Azzopardi 2020). The first e-bus was piloted in 2016, providing free transit for locals and visitors in the city center until the end of 2017. In 2017, Enel X acquired an additional 100 e-buses from BYD. A combination of a grid capacity analysis (utility company), pilot test (operator), route selection analysis (consulting institute), and determination of business and service models (with the manufacturer) were conducted jointly (Orbea 2018), giving local stakeholders confidence and enabling them to prepare, which led to ambitious adoption targets (WRI 2019). In 2018 and 2019, an additional 300 e-buses were added to the fleet.

E-buses are helping the city reduce operating and maintenance costs significantly (70 percent lower than for diesel-powered units). At approximately \$300,000 each, electric buses cost almost twice as much as conventional buses, but the savings in operating and maintenance costs are huge, potentially allowing fare reductions. At current power prices in Santiago, they cost just \$0.10 per kilometer, against more than \$0.35 per kilometer for diesel buses.²⁸ Furthermore, the fleet generates no tailpipe emissions, which is helping the city reduce air pollution, which is costly to the economy in terms of productivity and human health. E-buses are also increasing the attractiveness of ridership thanks to air conditioning; better design; and a smoother, quieter rider experience than with the old buses. With happier customers, operators report less bus fare avoidance, and none of the e-buses were torched during the recent riots.

With this positive model, Chile's transport minister, Gloria Hutt, has launched a tender to replace more than 2,000 buses in Santiago, with electric vehicles being prioritized. Although the tender is open to

conventional diesel buses and natural gas and hybrid alternatives, the government is encouraging operators to prioritize e-buses by offering them 14-year contracts rather than the 10-year deals offered for other technologies. The conversion to e-buses in Chile may have started in Santiago, but similar plans are in place across the country in major cities such as Antofagasta, Valparaiso, Concepcion, and Temuco. Not surprisingly, President Sebastian Piñera has set ambitious targets of having 10 times as many electric vehicles (of all kinds) on Chile's roads by 2022 and replacing all the country's buses with e-buses by 2040.

Bus procurement models should consider total cost of ownership over the lifetime of the investment, rather than just upfront cost, and include a mechanism to manage the risks and uncertainties of e-buses as a new technology, such as financial leasing and operational leasing mechanisms in the case of Santiago. Financial leasing mechanisms can reduce costs for bus operators, which do not need to pay the up-front cost and have the flexibility to procure the asset at the end of the leasing period. Operators make regular payments to lessors, and lessors might receive a tax benefit if the buses are recorded as an asset on their balance sheets (instead of on those of the operators) (WRI 2019).

The case of Santiago e-buses shows the power of green bulk procurement. Globally, public procurement accounts for 10 percent to 15 percent of global GDP, much of which is from cities. This represents a huge degree of purchasing power. Procurement modeling and decisions can significantly affect the market and encourage provision of sustainable, resilient goods and services. Cities are driving new technologies and solutions by providing an invaluable launch market and helping suppliers achieve economies of scale (IFC 2017).

28 See <https://www.enelx.com/cl/en/electric-mobility/products/public-administration/bus-electrico>

Case Study 8: Trailblazing Investment in Urban Vertical Farming Technology



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Structure	Accelerator Programme
Size	\$100 million
Region or country	Abu Dhabi
Stage	Active
Barriers addressed	Financing and Green Technology Risk

Recent investments in vertical farming companies include \$90 million in Bowery Farming by GV with the funds coming from investors such as Singapore’s Temasek, \$200 million invested in Plenty by Softbank’s Vision Fund, and an anticipated \$55 million being invested by AeroFarms in its 138,000 square foot Cane Creek Industrial Park building. The global vertical farming market, which includes operations in the United States, Canada, Germany, the United Kingdom, Japan, India, China, South Korea, South Africa, Brazil, Mexico, Argentina, Netherlands, and Belgium, was estimated to have reached between \$2.23 billion and \$3.16 billion in 2018 and is projected to reach \$12.77 billion to \$22.07 billion by 2026. In the United States these transactions are supported upstream by the US

2018 Farm Bill that provides additional support for urban, indoor, and other emerging agricultural production and established the Office of Urban Agriculture and Innovative Production within the US Department of Agriculture.

AeroFarms, which previously received \$590,000 in grants to construct its Cane Creek Industrial Park in Virginia, recently announced it will be one of four companies to receive funding from the Abu Dhabi Investment Office under the \$272 million AgTech Incentive Programme. The initial \$100 million funding round for the Programme will be allocated to four companies to build facilities in Abu Dhabi. AeroFarms will utilize these funds to build a 90,000 square foot indoor vertical farm dedicated to R&D and commercialization of crops using vertical farming techniques. The AgTech investment includes cash and non-cash incentives, including a rebate of up to 75 percent for R&D expenditures that later lead to commercialization.²⁹

Indoor and vertical farming may be part of the solution to rising demands for food and limited resources, and provides significant climate mitigation and resilience benefits, especially in urban environments. Vertical farming uses hydroponics, aquaponics, and aeroponics to raise crops in vertically stacked layers housed in climate- and environmentally controlled buildings that protect against weather and pests. It would provide fresh, local produce with significant benefits including

greater crop yields of 10 times or more per hectare, the potential to reduce water usage by up to 95 percent, and organic produce without the use of pesticides and chemical fertilizers. Furthermore, as these facilities are enclosed, they are resilient from a climate perspective and can be built in any environment to raise a variety of crops. The proximity of vertical farms to urban markets has the potential to reduce significant amounts of emissions from shipping and freight. Agriculture was estimated to account for as much as 31 percent of all freight in the United States, for example. Produce harvested at a local urban farm, only a few hours before its sale or consumption, would also save on the energy needed for the agricultural cold chain or refrigeration and could also help reduce food loss and associated GHGs.

Vertical farming requires significantly less land to provide the same crop yield, with growing year-round rather than seasonal. This efficient and year-round vertical production can free up horizontal land for potential use in renewable power generation, for new buildings, or for reforestation and afforestation and has the potential to reverse the trend in deforestation. Energy needs are significant for vertical farms because they use constant lighting, with electricity representing one of vertical farming's greatest costs, which is one of the industry's greatest challenges. Models that enable vertical farms to source renewable electricity at utility-scale prices would reduce costs and reduce carbon emissions for agriculture.

29 See <https://www.usda.gov/media/blog/2018/08/14/vertical-farming-future> and <https://aerofarms.com/our-project-partners/> and <https://businessfacilities.com/2015/03/worlds-largest-indoor-vertical-farm-to-be-developed-in-newark-nj/>

Case Study 9: Developing Natural Capital Insurance Products for Urban Coastal Resilience

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Structure	Insurance policy with revolving loan facility
Size	Policies ranging from \$2 million to \$5 million and revolving loan structures planned for \$10 million by region
Region or country	Currently Mexico, expanding to Southeast Asia and Caribbean
Stage	In pilot in Mexico; in development in Southeast Asia and Caribbean
Barriers addressed	Monetizing resilience and adaptation

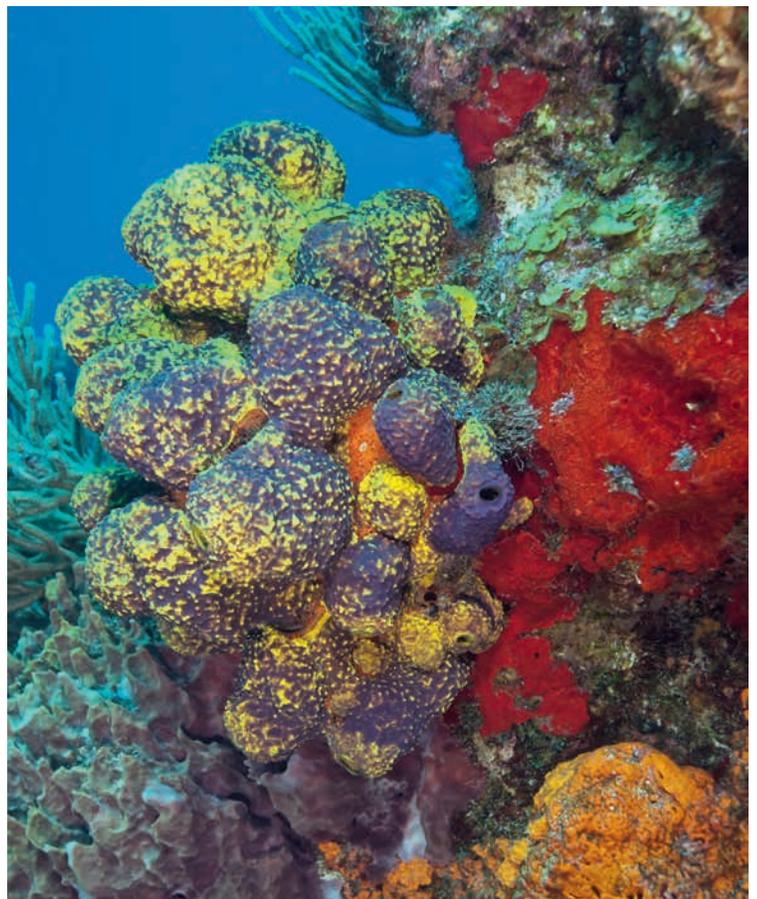
Natural capital-driven solutions offer substantial opportunity to enhance urban climate resilience, including protecting coastal infrastructure, improving water conservation, and reducing urban heat island effects. Nature contributes more than \$125 trillion annually to the global economy, and integrating conservation- and nature-based solutions such as green roofs, mangrove restoration, coral reef rejuvenation, and watershed protection into sustainable infrastructure design can lower operational costs, unlock new revenue streams, and increase climate resilience (Blended Finance Task Force 2019). Integrating natural solutions into infrastructure could generate economic cost savings of \$100 billion based on natural disasters, with \$50 billion in savings from insurance losses alone (Blended Finance Task Force 2019).

When considering tourism in urban coastal environments, natural capital, such as coral reefs, is an integral part of the protection of onshore assets and the local economy. Reefs are critical natural barriers that protect communities from volatile weather hazards such as ocean surges and flooding and are a source of economic opportunities including tourism and fishing. The global economic value derived from reefs is estimated to be \$375 billion annually, but they are maintained and restored on a small scale, with limited and unpredictable funding. There is an urgent need to care for this natural protective barrier because 20 percent of the world's reefs have been lost, and a further 15 percent are severely threatened (Rockefeller Foundation n.d.).

Reef2Resilience is an innovative, natural capital-driven insurance instrument that addresses climate resilience before and after a severe weather event. Developed by UNDP, the Nature Conservancy, and insurance industry partners, Reef2Resilience will monetize the resilience benefits of the global reef system and is being piloted in Mexico on the Meso-American reef—the second largest in the world. Benefits include absorbing waves and storm surges, protecting against inland flooding, and avoiding beach erosion. A healthy coral reef can absorb 97 percent of a wave's energy before it hits shore, placing the reef's protective ecosystem services on par with more expensive, less-durable man-made protections such as breakwaters and seawalls. In Mexico alone, it is estimated that a one-meter loss of reef height would translate into 1,300 km² of inland flooding and \$20 billion in lost infrastructure, imperiling the lives and livelihoods of vulnerable people. Coral reefs also provide other important ecosystem services to coastal communities; the value of services they provide globally has been estimated at as much as \$9.9 trillion (Costanza et al. 2014). Before a severe weather event, Reef2Resilience structures and distributes a parametric insurance product linked to natural assets to insure the local reef and

reduce the effect of disasters, reducing financial risk and damage to coastal communities and their livelihoods and speeding socioeconomic recovery. After a severe weather event, Reef2Resilience identifies opportunities for resilient infrastructure investments and packages them into a resilience bond or marketing them as direct investments to the private sector to increase protection for local communities in the event of natural disasters.

The Reef2Resilience model operates like a trust fund, with local businesses such as hotel associations paying into a coastal zone management trust. The fund then invests in the restoration and maintenance of the reef and purchases insurance to pay for recovery in the event



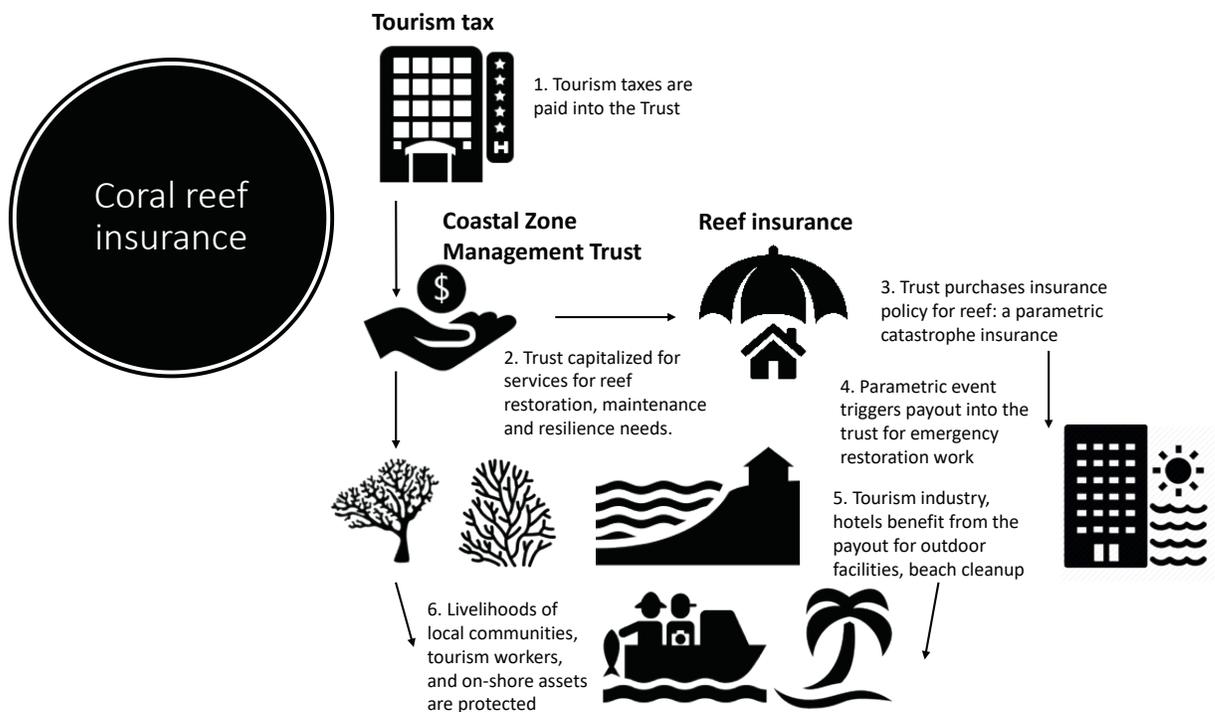
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of a disaster. The insurance product is a parametric catastrophe insurance policy³⁰ for the reef because recovery work needs to be done quickly. The policy will cover beach erosion for hotels as an incentive to participate in the initiative. If a parametric event occurs (e.g., high winds or waves), a payout is triggered that goes into the trust to support emergency restoration work on the reef. The tourism industry, ranging from luxury hotels to local fisherman, benefits from coastal protection

from the payout, including outdoor facilities and beach cleanup.

The model is being piloted in the province of Quintana Roo and the city of Cancun, Mexico. Discussion is ongoing about expanding the model to coral reefs in Southeast Asia and the Caribbean, especially for Small Island Developing States (SIDS) (Spaulding et al. 2016). A summary of the Reef2Resilience structure is in figure 5.

Figure 5 Reef2Resilience Structure Diagram



30 The term parametric insurance describes a type of insurance contract that insures a policyholder against the occurrence of a specific event by paying a set amount based on the magnitude of the event, as opposed to the magnitude of the losses in a traditional indemnity policy. See: https://content.naic.org/cipr_topics/topic_parametric_disaster_insurance.htm

Case Study 10: Building Software Planning Tools for Cities



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The IFC is piloting a new software called the Environment Positive Innovations for Cities (EPIC) to help cities prioritize and transition to a low-carbon and resource efficient urban growth pathway.³¹

The online software is an early-stage prefeasibility climate investment tool that helps cities identify and evaluate green investments, policies, and planning opportunities.

EPIC starts with a baseline-case, projected business-as-usual scenario to 2030. Users can quickly see the effect of different measures on the city’s business-as-usual performance into the future, including on future energy consumption, water requirements, waste production, private vehicle travel, carbon

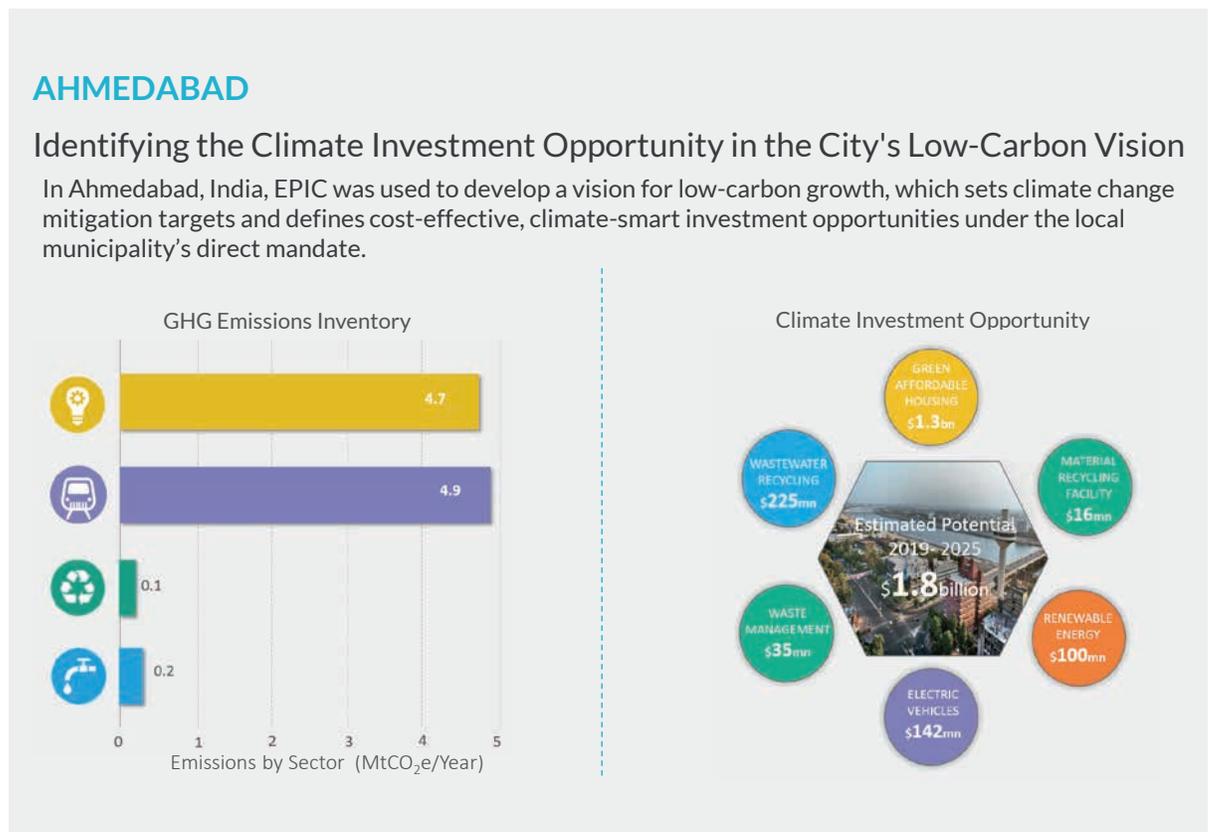
Structure	Planning software
Size	N/A
Region or country	Global
Stage	Being piloted
Barriers addressed	Long-term planning barriers

³¹ Please note the EPIC tool has been built on and evolved from a previous version developed by the World Bank in collaboration with C40, Bloomberg Philanthropies, and the Global Covenant of Mayors, known as CURB (Climate Action for Urban Sustainability) and applies the same GHG methodologies and approaches.

emissions, and air quality. It then aggregates emissions, showing the baseline case and the target trajectory with the savings from selected measures. EPIC will be used to identify a list of low-carbon investments and track the effect of investments based on costs, payback, GHG emissions, and feasibility, leading to a pipeline for climate financing, (e.g., green bonds, green loans).

In Ho Chi Minh City, Vietnam, EPIC helped identify essential policy and planning actions needed to ensure the efficacy of public transport investments. In Ahmedabad, India, EPIC was used to assess actions in the city's "carbon neutrality vision" presenting a climate investment opportunity of \$1.8 billion. IFC is in the process of investing in Ahmedabad Municipal Corporation.³²

Figure 6 Identifying the Climate Investment Opportunity in Ahmedabad



32 See <https://www.proptiger.com/guide/post/ahmedabad-municipal-corporation-to-raise-through-dollar-bonds>