

ISSUE 25 • JAN 2025

# URBAN SOLUTIONS

---

INTERVIEW

**Rohit T. Aggarwala**  
**H.E. Almansoori**  
**David Craig & Esther An**

---

OPINION

**Mark Watts**

---

ESSAY

**Hugh Lim & Geraldine How**  
**Jerome Frost**  
**Jacques Beltran**  
**Mike Hayes & Deven Chhaya**  
**Lauren Sorkin & Valerie Brown**

---

CASE STUDY

**Sydney**  
**Shanghai**

---



## Resilience and Regeneration

A biannual magazine  
published by

CENTRE for  
**LiveableCities**  
SINGAPORE





# World Cities Summit



## Liveable and Sustainable Cities: Local Solutions, Global Impact

2 – 4 July 2025, Vienna

2020 Lee Kuan Yew World City Prize Laureate

By invite only



worldcityssummit.com.sg

info@worldcities.com.sg

@worldcityssummit

@World Cities Summit

@world.cities.summit

@WorldCitiesSummit

# URBAN SOLUTIONS

ISSUE 25 • JAN 2025

CENTRE for  
**LiveableCities**  
SINGAPORE

CLC IS A DIVISION OF



**URBAN SOLUTIONS** is a bi-annual magazine published by the Centre for Liveable Cities. It aims to equip and inspire city leaders and allied professionals to make cities more liveable and sustainable.

Set up in 2008 by the Ministry of National Development and the then-Ministry of the Environment and Water Resources, the Centre for Liveable Cities (CLC)'s mission is to distil, create and share knowledge on liveable and sustainable cities. CLC's work spans four main areas—Research, Capability Development, Knowledge Platforms, and Advisory. Through these activities, CLC hopes to provide urban leaders and practitioners with the knowledge and support needed to make our cities better. For more information, visit [www.clc.gov.sg](http://www.clc.gov.sg).

### Editorial Team

Elaine Tan  
Stewart Tan  
Sze Xuan Ng  
Jonas Hong

### Editorial Consultant

Hedgehog  
Communications LLP

### Design Consultant

Green House  
Design + Communications

### Image Credits

- 6: Ed Reed / Mayoral Photography Office
- 8 / 10 (1) / 10 (2) / 11 (1) / 11 (2) / 12: New York City Department of Environmental Protection
- 14 / Ministry of Energy and Infrastructure, United Arab Emirates
- 16: CNBC
- 17 (1) / 17 (2): NASA Earth Observatory
- 17 (3): Emirates News Agency WAM
- 18: Stantec
- 19: Government of Dubai
- 20: Sharjah Sustainable City
- 21: Expo City Dubai
- 22: City Developments Limited
- 24 / 25 / 26 / 27 (1) / 27 (2): TFND
- 28 (1): City Developments Limited
- 28 (2): Hiking the Green Isle
- 33 / 35: C40
- 34 (1): Mumbai Climate Budget FY 24-25
- 34 (2): Foster and Partners
- 36: Florian Wehde / Unsplash
- 37 / 41 / 42: Centre for Liveable Cities
- 38: Bob Tan, Wikimedia Commons
- 40 (1): Nguyen Thu Hoai / Unsplash
- 40 (2): NParks
- 44 / 46 / 47 (1) / 47 (2) / 48: Arup
- 50 / 52 / 53 (1) / 53 (2) / 54: Dassault Systèmes
- 56: Emel Green Power
- 58 (1): Jose A. Bernat Bacete / Getty Images
- 58 (2): Daqo New Energy
- 60: Reuters / Arton Pookasook
- 61: Port of Antwerp-Bruges
- 62 (1): Engie Group
- 62 (2): Breakthrough Energy
- 64: Urban Sustainability Exchange
- 66 (1) / 67 (1) / 67 (2): Barcelona City Council
- 69 (1) / 69 (2): ALPH
- 70: Groundwork UK
- 73 / 75 / 76 (1) / 76 (2) / 77 / 78 / 79: 3XN
- 74 (1) / 74 (2): City of Sydney
- 81 (1) / 81 (2) / 82 / 83 / 84 (1) / 84 (2) / 85 (1) / 85 (2): Shanghai AMJ Architecture and Urban Planning Co., Ltd.

© 2025 Centre for Liveable Cities, Singapore

Opinions expressed in Urban Solutions do not necessarily represent the views of CLC. While the publisher has taken reasonable care in compiling the magazine, it shall not be liable for any omission, error or inaccuracy.

### Contact

**Centre for Liveable Cities**  
T +65 6645 9560  
E [mnd\\_clc\\_publications@mnd.gov.sg](mailto:mnd_clc_publications@mnd.gov.sg)  
W [www.clc.gov.sg](http://www.clc.gov.sg)

45 Maxwell Road #07-01, The URA Centre  
Singapore 069118

ISSN 2301-3540 (print)  
ISSN 2301-3532 (e-version)

**E-version:** [www.clc.gov.sg/research-publications/publications/urban-solutions](http://www.clc.gov.sg/research-publications/publications/urban-solutions)

Printed on Enviro Wove, a paper made from 100% recycled content.



CC BY 2.0 - <http://creativecommons.org/licenses/by/2.0/legalcode>  
CC BY-NC 2.0 - <https://creativecommons.org/licenses/by-nc/2.0/legalcode>  
CC BY-SA 2.0 - <https://creativecommons.org/licenses/by-sa/2.0/legalcode>  
CC BY-SA 4.0 - <https://creativecommons.org/licenses/by-sa/4.0/legalcode>

Some original images have been edited for page layout purposes. Every effort has been made to trace the copyright holders. The publisher will correct any omission of due acknowledgement in the online version, and in any subsequent printing.

**Cover Image:** A view of Little Island Public Park in New York City.  
Image: Boogich / iStock



# Resilience and Regeneration

“What we should be doing is looking at green and grey solutions as an integrated set of tools.”

06

ROHIT T. AGGARWALA



“UAE’s 2024 flooding was a critical learning experience for us, underscoring the need for enhanced resilience across our urban environments.”

14

H.E. ALMANSOORI



30

“Many city governments may be tempted to concede that the set targets are not realistic or possible, and proceed to set a lower target. With the climate budget, however, failure is not acceptable.”

MARK WATTS



“Shanghai’s 228 Neighbourhood has adapted to the increase in standard of living, growing urban population, and evolving cultural shifts.”

80

MINGHUA XUE & WANG LIN

“In response to the unpredictability of today’s interconnected world, resilience is very much embedded in Singapore’s urban planning and development.”

36

HUGH LIM & GERALDYNE HOW



“It is impossible to create an infallible city with perfect infrastructure; recovery comes down to the ability of the city to regain full operation, and its people to adapt and bounce back.”

JEROME FROST

44





# Contents

## i INTERVIEW

**Integration and Collaboration in Stormwater Resilience** 06  
ROHIT T. AGGARWALA

**A Flood Resilient Nation Built on Technology and Infrastructure** 14  
H.E. ALMANSOORI

**Financing Climate-Resilient Nature-Based Solutions** 22  
DAVID CRAIG & ESTHER AN

## e ESSAY

**Building a Regenerative and Resilient Singapore: Perspectives from the Liveability Framework** 36  
HUGH LIM & GERALDYNE HOW

**City Resilience in a New Investment Climate** 44  
JEROME FROST

## o OPINION

**Climate Budgeting for Rapid Action in Cities** 30  
MARK WATTS

**Powering Urban Energy Transition Through Innovation and Industry Expertise** 56  
MIKE HAYES & DEVEN CHHAYA

## c CASE STUDY

**Carbon-Sensitive and Socially-Driven Transformation: Quay Quarter Tower** 72  
SYDNEY | ADAPTIVE REUSE

**A Community for People: Regeneration of Shanghai's 228 Neighbourhood** 80  
SHANGHAI | URBAN REJUVENATION

**Heat Resilience: A Gateway to Solving Urban Challenges** 64  
LAUREN SORKIN & VALERIE BROWN



## From the Executive Director

# Creating Flourishing Ecosystems and Resilient Communities

As I write this foreword, COP29 has just concluded, and while opinions on the climate finance deal remain divided, the imperative to prepare our cities for climate change remains clear. It is timely for us to understand and act upon the opportunities that regeneration potentially offers, to reconcile the tension between liveability and a climate-changed, resource-constrained world. I distil three key insights that can serve as a springboard for cities' regenerative journey.

**Foremost, building regenerative cities is about instilling resilience in urban systems.**

Rohit T. Aggarwala, Chief Climate Officer of New York City, outlines plans to strengthen the city's climate resilience, sharing the value of co-creating solutions with the community as cities undertake environmental transformation.

Underscoring the need for community-driven regeneration, Jerome Frost reminds us that resilient cities require continuous efforts in strengthening both the hardware and software of cities, equipping its people to recover from disruptions and emergencies. Likewise, I share more about the Centre for Liveable Cities' refreshed Liveability Framework, reflecting on the integration of resilience into city planning to enhance liveability.

**An integrated and systems-driven approach is core to achieving regeneration in cities.**

David Craig, co-chair of the Taskforce for Nature-related Financial Disclosures, posits that nature must be understood holistically, examining both upstream and downstream impacts in our pursuit of regenerative development. Wang Lin showcases Shanghai's Changbai Neighbourhood 228 as a case study, prompting us to consider deeply how

rejuvenation of a single neighbourhood can benefit its wider district.

And in so doing, the value of regeneration can go beyond environmental benefits, enabling all ecosystems and communities to thrive collectively. Lauren Sorkin and Valerie Brown guides us to think of the interconnections in urban systems, demonstrating that tackling heat resilience can bring about a slew of co-benefits.

**Finally, regeneration places the environment at the heart of everyday life.**

Regenerative cities begin with embedding nature-centric principles into developmental strategies. Mark Watts emphasises the need to mainstream climate action in city governance, incorporating climate budgeting into cities' fiscal strategies.

Jannie Krall Johnsen illustrates this through the rejuvenation of Sydney's Quay Quarter Tower, which combines carbon-sensitive transformation with spaces for sociality. In tandem, Mike Hayes and Deven Chhaya demonstrates the need to gear innovation towards decarbonisation to deliver clean energy to cities.

As we draw inspiration from the insights shared in this issue, let us take decisive steps to embed regeneration into our urban fabric, ensuring that cities become more resilient in the face of climate change.

I wish you an enlightening and enjoyable read.

**Hugh Lim**

Executive Director  
Centre for Liveable Cities





IN CONVERSATION WITH  
**ROHIT T. AGGARWALA**

**Rohit T. "Rit" Aggarwala, Chief Climate Officer of New York City and the Commissioner of the Department of Environmental Protection, talks about what the city is doing to build up stormwater and coastal resilience.**

# Integration and Collaboration in Stormwater Resilience



Image: Ed Reed / Mayoral Photography Office



**As a city with 520 miles of coastline, building coastal resilience in NYC is a significant challenge. Hurricane Sandy flooded large parts of NYC, including lower Manhattan back in 2012, emphasising the need for physical defences along our waterfront.**



**The Department of Environmental Protection (DEP) is the water and wastewater utility for New York City, providing 1 billion gallons (3.8 billion litres) of water and treating 1.3 billion gallons (4.9 billion litres) of wastewater for nearly 10 million New Yorkers every day. Can you share with us how DEP's mission and operations have evolved as New York City has begun to experience the effects of climate change?**

DEP's mandate has evolved over its 180-year history. At first, we only provided drinking water. Then we took on wastewater treatment. After that, we took on consolidated management of the sewer system. A decade ago, we branched out into green infrastructure. With climate change dramatically affecting New York City (NYC), we now need to embrace the role of protecting New Yorkers from flooding.

As a city with 520 miles (837 km) of coastline, building coastal resilience in NYC is a significant challenge. Hurricane Sandy flooded large parts of NYC, including lower Manhattan back in 2012, emphasising the need for physical defences along our waterfront. While NYC has been thinking about climate adaptation since 2006, many New Yorkers did not take it seriously until Hurricane Sandy.

After Hurricane Sandy, the city was given a substantial amount of federal money to do repair and protection work for the parts of the city that had been flooded. A lot of that work is underway, and by 2027, areas such as Staten Island, Lower Manhattan, and parts of Brooklyn will have coastal defences. However, as the policy for federal disaster relief in America is backward-looking, money is only available for formerly devastated places. Thus, the challenge is in figuring out how we can fund coastal defences for our other at-risk neighbourhoods.





Construction of elevated East River Park as part of the ESCR project along the East River in lower Manhattan.  
Image: NYC Department of Environmental Protection

### How did DEP arrive at its current path of environmental transformation and climate adaptation?

There were two major turning points. The first is what we learned from the East Side Coastal Resiliency (ESCR) project—a nearly US\$2 billion project to protect Manhattan’s Lower East Side. This project underwent two phases: the first was an architect- and design-led phase that produced some very exciting concepts, and the second was a more pragmatic phase where plans were scaled back by the agencies that had to maintain and operate it. A key lesson from ESCR was that we have to think both ambitiously and pragmatically from the outset to avoid creating false expectations. It also demonstrated what were the creative solutions that the community would value and endorse. This helped to shape the final design, which included seawalls with an elevated park on top.

The other turning point was realizing that for the decade since Hurricane Sandy, until a year or so ago, all of our coastal resilience planning had been conducted out of the Mayor’s Office, with agencies being pulled in to deliver specific initiatives. Coastal resilience, however, is a multibillion dollar and decades-long effort, and so we had to rehouse it in an agency with the mandate, technical expertise, and capability to do things over a much longer time frame than any given mayoral administration.

## Finding a balance between nature-based solutions and man-made solutions will be critical.

We ultimately concluded that DEP was the right place for two reasons. Firstly, the DEP deals with massive drainage and impacts behind coastal defence, and secondly, as a major capital agency it has all the requisite functionalities.

### What are some challenges that DEP faces in enhancing the city’s climate resiliency?

There are three main challenges. Foremost, it is building up a team for climate resilience. As we are still in the process of getting funding and hiring people, there is a need to balance between near-term operating mandates and long-term planning.

The second challenge is funding. Relying on the city’s general fund is insufficient because it is a limited pot that funds the rest of local government services. So we need to find a dedicated revenue source.

Finally, coordination with other levels of government is challenging. National coastal infrastructure is the domain of the US Army Corps of Engineers. Figuring out exactly what the Army Corps, NYC, and the State of New York should do and how we all work together is essential. Moreover, finding a balance between nature-based solutions and man-made solutions will be critical. There are some New Yorkers who have an unrealistic expectation for how much of our coastal protection can come from nature-based solutions, so navigating that is going to be an important step for us to maintain both efficacy and public support.

### What are some of the specific strategies used to tackle the challenges of staffing, fiscal constraints, and inter-agency coordination required to build resilience against other types of flooding in NYC?

A big challenge that we have had to tackle recently is the stormwater flooding issue in NYC. Since 2021, we have experienced rainfall patterns that are much more tropical in nature. These flooding events really put the issue of stormwater resilience into the public consciousness.





Green roof on Steiner Studios, Brooklyn Navy Yard. Green roofs help infiltrate rainwater, reducing peak flows from the sewer system.  
Image: NYC DEP



New Creek Bluebelt Olympia Boulevard portion, taken in July 2024.  
Image: NYC DEP

||  
**What we should be doing is looking at solutions as an integrated set of tools. Over the past few years, our grey and green planning and engineering teams have started planning together, leveraging the combination of their stormwater management solutions.**

||

A key strategy for us is teamwork and integrated design. Up until a couple of years ago, we would look at a stormwater challenge and decide whether it should have a grey or green solution. What we should be doing, however, is looking at solutions as an integrated set of tools. Over the past few years, our grey and green planning and engineering teams have started planning together, leveraging the combination of their stormwater management solutions. In the process, they have systematically identified more than 80 high flood-risk locations that we will identify solutions for as part of a multi-year plan.

The second strategy is expanding our network of bluebelts, which are a series of engineered wetlands, streams, and ponds that are connected to storm sewers, allowing them to convey and store very large volumes of rainfall. In addition to their stormwater benefits, bluebelts beautify neighbourhoods, support biodiversity, and enhance property values. However, finding space for new bluebelts in a densely populated city is challenging. Furthermore, if we are to expand them citywide, it may require integration into parklands or be part of potential buyout programmes for homes in frequently flooded zones.

The third strategy involves our FloodNet system. These are optical sensors mounted on lamp posts to measure surface flooding. Our plan is to install 500 of them. To date, we have already installed more than 250 sensors. FloodNet provides real-time understanding of where the city is experiencing flooding. This is useful not only for city officials, but also in helping the public make informed travel decisions.



FloodNet sensors.  
Image: NYC DEP





**Can you share how DEP is working with the community to plan infrastructure and manage climate risks?**

We are beginning to train residents to protect their properties from flooding. Because building climate resilience is going to be a 10- to 25-year project, we have started to say that while the DEP works on infrastructure, residents too need to get involved. This includes installing flood alarms in basements and placing inflatable barriers in front of basement doors as interim protection measures. We have started holding community preparedness events where we make educational presentations and give away flood protection products to raise awareness.

Two years ago, the Mayor's office also started an initiative called Climate Strong Communities, which involves going into neighbourhoods to workshop ideas about resilience against multiple climate hazards. Through this process, we have collated a set of project ideas that we are confident the community will support. Such projects are particularly valuable when it comes to federal funding opportunities because climate-related grants often require community endorsement.



In June 2024, DEP staff connected with community members in Kissena, Queens to discuss the Kissena Cloudburst Hub project. Participants provided feedback for more open spaces, shared their insights on localised flooding, and learned about stormwater management and climate change in NYC.  
Image: NYC DEP

**What does DEP plan to do over the next five to ten years to prepare its infrastructure and operations for the future?**

A significant portion of our water supply infrastructure is over 100 years old, necessitating extensive reconstruction. We will soon begin crucial dam rehabilitation work as well as complete a third water tunnel to ensure redundancy in our water supply system.

We are also focused on making better use of data and automation to improve our operations.

Two years ago, we started a collaboration with the Partnership for New York City, which is a group of large private sector employers in New York who collaborate with and serve as a resource to NYC's government. They are now in their second year of hosting an Environmental Tech Lab that poses challenges to entrepreneurs to help solve challenges facing DEP. This has helped us systematically identify areas where we can introduce technology, as well as suitable partners and suppliers to support the endeavour.

As an example, we have found partners that use satellite imagery to better understand water quality in our reservoirs. Others use sensors to provide real-time data on wastewater flows, or enhance our capacity to quickly analyse engineering designs. Working with these types of partners could potentially help us to understand our operations through a much more data-driven approach and make our operations more efficient. It can also contribute towards making NYC's built environment more climate-ready and climate-resilient. 📍

||  
**We are also focused on making better use of data and automation to improve our operations.**  
||





IN CONVERSATION WITH  
**H.E. MOHD ALMANSOORI**

His Excellency Eng. Mohd. Almansoori, Director General of Sheikh Zayed Housing Programme, shares about building flood resilience amid the wider threat of climate change.

# A Flood Resilient Nation Built on Technology and Infrastructure



Image: MoEI, Ministry of Energy and Infrastructure

||  
**In the aftermath of the 2024 flooding, all federal, local, private entities, and individuals came together to address a well-coordinated crisis management.**  
||

**What is the Ministry of Energy and Infrastructure's (MoEI) mission and vision for environmental sustainability in United Arab Emirates' (UAE) built environment?**

The UAE firmly acknowledges that sustainability, in all its facets, is the bedrock of urban development. MoEI and Sheikh Zayed Housing Programme's (SZHP) mission is to drive sustainable development through the integration of innovative technologies, the enhancement of energy efficiency, and the promotion of renewable energy sources.

In our pursuit of sustainability excellence, the UAE has developed not only a strong technical infrastructure but also a comprehensive regulatory framework. This includes the implementation of building codes and standards that mandate sustainability through energy efficiency requirements and sustainable design practices, as well as regulations like the Green Building Regulations, which encourage developers to embrace environmentally responsible practices, such as waste reduction, water conservation, and the use of sustainable materials.

The UAE also remains steadfast in supporting research and development in sustainable construction materials and technologies and partnering with universities and research institutions to drive sustainable construction.

**How did MoEI respond to and recover from the recent 2024 UAE flooding, especially with regards to its environmental, social, and economic impacts?**

In the aftermath of the 2024 flooding, federal, local, private entities, and individuals came together in a remarkable display of unity to address the crisis. MoEI and SZHP were an integral part of this collaborative effort.

The response to the flood by our housing teams across UAE was a highly coordinated one. As housing was one of our most immediate concerns, MoEI and SZHP worked closely with local Governments and developers



to carry out emergency repairs and safety checks on homes. As part of our strategic planning efforts, we also ensured that families were granted temporary residence at hotels and hotel apartments, and that infrastructure assessments were conducted swiftly.

One of our key actions was deploying rapid-response teams to assess the structural integrity of housing in flooded areas. The use of previously developed digital platforms for monitoring building safety allowed us to remotely assess damage, prioritise repairs, and ensure that residents were able to return to their homes safely in the shortest time possible.

The UAE has always placed great emphasis on resilience and sustainability in its urban planning. Over the last decade, we have embedded climate adaptation into the design and construction of new housing and infrastructure developments, such as by adopting advanced sustainable drainage systems and urban green spaces that can absorb excess water.

We have also been emphasising decentralised, mixed-use urban areas that integrate residential, commercial, and recreational spaces. This urban planning approach improves the capacity for emergency response by allowing easier access to essential services and creating resilient communities where people can live and work even in challenging circumstances. These strategies were affirmed during the flood, as we were able to mobilise support and resources quickly in areas where infrastructure had been strengthened.

As a final point, our country's response to the 2024 flooding was significantly bolstered by advanced digital and technological tools, such as real-time data monitoring systems, which provided critical information on water levels, weather patterns, and drainage system performance.



Cars partially submerged during the severe 2024 UAE flooding.  
Image: CNBC



Satellite imagery of Dubai taken before (on 3rd April) and after (on 19th April) the 2024 flooding show subsequent inundation of inland, urban areas.  
Image: NASA Earth Observatory

By leveraging predictive analytics, we were able to anticipate the severity of rainfall and identify areas most at risk of flooding. This proactive approach allowed us to deploy emergency response teams and flood mitigation resources to the most vulnerable regions, minimising damage to critical infrastructure and residential areas. GIS-based flood mapping systems also allowed us to map out flood zones in real time, track the progression of floodwaters, and reroute emergency services to areas most in need. They were useful in generating real-time insights for making informed decisions about resource allocation, such as whether to redirect emergency teams or strategically place flood barriers.

### **In light of the lessons gleaned from the recent flood, what are MoEI's plans to mitigate and adapt to the increase in frequency and intensity of future flooding events, brought about by climate change?**

The 2024 flood was a critical learning experience for us. The growing frequency and intensity of extreme weather events, driven by climate change, underscore the need for enhanced resilience across our urban environments. Accordingly, MoEI and SZHP are advancing a range of strategic plans and technological innovations to mitigate and adapt to the growing risk of future flooding.



A total of 2,300 personnel were deployed to respond to emergencies and mitigate the impact of heavy rains.  
Image: Emirates News Agency-WAM





The Dubai Deep Tunnel Storm Water System can drain 40% of the entire urban area of the city.  
Image: Stantec

18

By creating a network of underground reservoirs and smart retention basins, we can divert and store excess water, and prevent it from overwhelming urban areas. These systems are scalable to accommodate future increases in precipitation.

One of these is robust stormwater management systems. Even though our previous strategies already emphasised sustainable urban drainage systems (SUDS) as a cornerstone of urban planning, the intensity of the recent flooding event revealed the need for even more sophisticated solutions. Moving forward, we will be accelerating the integration of cutting-edge stormwater management technologies.

We are currently in the midst of implementing advanced technologies that allow us to predict stormwater behaviour and manage water flow more effectively during heavy rainfall. By creating a network of underground reservoirs and smart retention basins, we can divert and store excess water, and prevent it from overwhelming urban areas. These systems are not only suited to handle current conditions but are also scalable to accommodate future increases in precipitation.

Additionally, we are also integrating permeable surfaces and green infrastructure, such as rain gardens, bioswales, and green roofs into our urban planning. These natural systems enhance water absorption and reduce surface runoff, allowing stormwater to be managed at the source. This approach not only mitigates flooding risks but also improves the urban environment by promoting biodiversity and reducing the urban heat island effect. Already in the works are retrofitting and upgrading of our existing drainage networks to cope with higher volumes of water, as well as redesigning urban layouts to allow for better water flow. We are also incorporating in our new developments elevated foundations, flood-resistant materials, and redesigned roads and pavements that can channel water more efficiently.

Low-lying coastal and densely populated urban areas, in particular, presented significant challenges during the recent flooding, due to their vulnerability to rising sea levels and flash flooding. An essential step forward will be to incorporate flood barriers, levees, and more extensive drainage infrastructure. In these areas, we are exploring nature-based solutions, such as coastal wetlands and mangrove restoration, which provide natural defence against storm surges while enhancing the ecological health of the coastline.

### How is MoEI ensuring that UAE's built environment can balance the needs of climate resilience, environmental regeneration, and liveability?

UAE's approach is comprehensive and multifaceted—drawing on existing strategies while also embracing new policies and innovations designed to ensure a climate resilient and environmentally regenerative future for all residents.

At MoEI and SZHP, we recognise that addressing climate resilience is not just about fortifying our infrastructure against extreme weather events, it is also about regenerating our environment and enhancing quality of life for citizens. To achieve this balance, we have developed a strategic framework that encompasses innovative policies, research initiatives, and infrastructural plans.



The tunnel is a groundwater and stormwater collection network, running 45 m deep.  
Image: Government of Dubai





The Sharjah Sustainable City was designed to reduce carbon footprint in Sharjah through the use of renewable energy and recycling of water and waste.  
Image: Sharjah Sustainable City

One such plan is the UAE Climate Change Adaptation Strategy, which emphasises sustainable urban planning principles that integrate climate adaptation measures directly into land-use planning and building codes. This ensures that new developments not only withstand climate-related challenges but also contribute positively to their surroundings.

Liveability is at the heart of our urban planning efforts. We strive to create communities that are not only resilient but also enjoyable to live in. This involves designing mixed-use developments that integrate residential, commercial, and recreational spaces. By creating vibrant neighbourhoods where people can live, work, and play, we foster social cohesion and enhance the overall quality of life. We view preparation for the challenges of climate change as an opportunity to enhance the quality of life for our residents.

#### **How has MoEI leveraged digital participation and consultation with the public to foster greater preparedness and involvement in the area of climate resilience?**

Building climate resilience is not solely a matter of infrastructure and policy—it requires active participation by the public. Over the years, we have established various channels to ensure that residents and stakeholders are part of the planning and decision-making process for urban development. As we work towards broadening the reach of our engagement efforts, our focus has been on utilising digital tools to streamline communication, gather input, and foster a collaborative spirit between government entities, the private sector, and the public.



Expo City Dubai aims to be a model for a sustainable and smart built environment through passive design strategies and technology-based solutions.  
Image: Expo City Dubai

## By leveraging digital participation and consultation, MoEI has empowered citizens to become active participants in our climate resilience journey, fostering a culture of collaboration and shared responsibility.

One of the key tools that we have implemented is the “MoEI Digital Participation Platform”, which serves as an interactive space where citizens can provide feedback on housing developments, urban planning projects, and environmental initiatives. This platform allows us to gather input directly from the people who are most affected by these projects, ensuring that their needs and concerns are reflected in our climate resilience strategies.

In the lead-up to the 2024 flooding event, we used social media platforms to share vital preparedness tips, safety measures, and real-time updates on emergency response efforts. Social media proved to be a key tool for encouraging public awareness and preparedness in the face of the disaster. Following the event, we continued to use these channels to gather feedback from affected communities, ensuring that their experiences inform future planning and response strategies. By leveraging digital participation and consultation, MoEI has empowered citizens to become active participants in our climate resilience journey, fostering a culture of collaboration and shared responsibility.

In conclusion, while the 2024 flood presented significant challenges, it also reinforced our resolve to build more resilient, adaptive urban environments. Our goal is not just to protect ourselves from the next flood but to create a sustainable urban framework that can thrive in the face of a changing climate. 🌱





IN CONVERSATION WITH  
**DAVID CRAIG & ESTHER AN**

# Financing Climate-Resilient Nature-Based Solutions

**David Craig, Co-Chair of the Taskforce on Nature-related Financial Disclosures (TNFD), and Esther An, Chief Sustainability Officer at City Developments Limited (CDL) and a TNFD Taskforce Member, share their perspectives on the importance of recognising the dialectical relationship between nature and finance.**



Image: City Developments Limited

The Taskforce on Nature-related Financial Disclosures (TNFD) equips companies and financial institutions with a set of recommendations and guidance on how to assess, report, and act on their nature-related dependencies, impacts, risks, and opportunities.

**Could you share more about the strategic work that TNFD does, as well as elaborate on the transformative impact that the Taskforce hopes to achieve?**

**David:** TNFD is a market-led, science-based, and government-backed initiative that seeks to support a shift in global financial flows away from nature-negative outcomes and towards nature-positive outcomes, aligned with the Global Biodiversity Framework. We do that by creating recommendations and guidance that enable business and finance to assess their interface with nature, allowing them to understand their dependencies and impacts on nature and the related risks and opportunities. The framework uses a scientifically-robust definition of the natural system to reveal how each actor in the supply chain is both dependent on the flow of nature's inputs (ecosystem services) or impacting them.

**Esther, as a member of this ecosystem, could you share more about the strategic value that TNFD has brought for you and your organisation, CDL?**

**Esther:** CDL has been in the green building development industry for a long time. We started looking at environmental conservation as part of our construction work in 1995, almost 30 years ago—even at a time when there was little pressure from regulators and investors. We also introduced sustainability reporting 17 years ago in 2008 as we saw the importance of setting targets, measuring, and tracking performance.

Hence, when TNFD was launched in 2021, we were keen to jump on board given that it aligned with the work that CDL already does. It was especially useful that TNFD leverages the four pillars of the Task Force on Climate-related Financial Disclosures (TCFD)—namely, governance, strategy, risk management, and metrics and targets—which CDL has adopted since 2017.

For the built environment sector, which accounts for almost 40% of global greenhouse gas emissions and a huge part of cities, the transition to a low-carbon future goes beyond infrastructure technology or energy solutions. Echoing TNFD's mission, we must learn to harness the benefits of nature, creating nature-based solutions that help lower our carbon footprint.

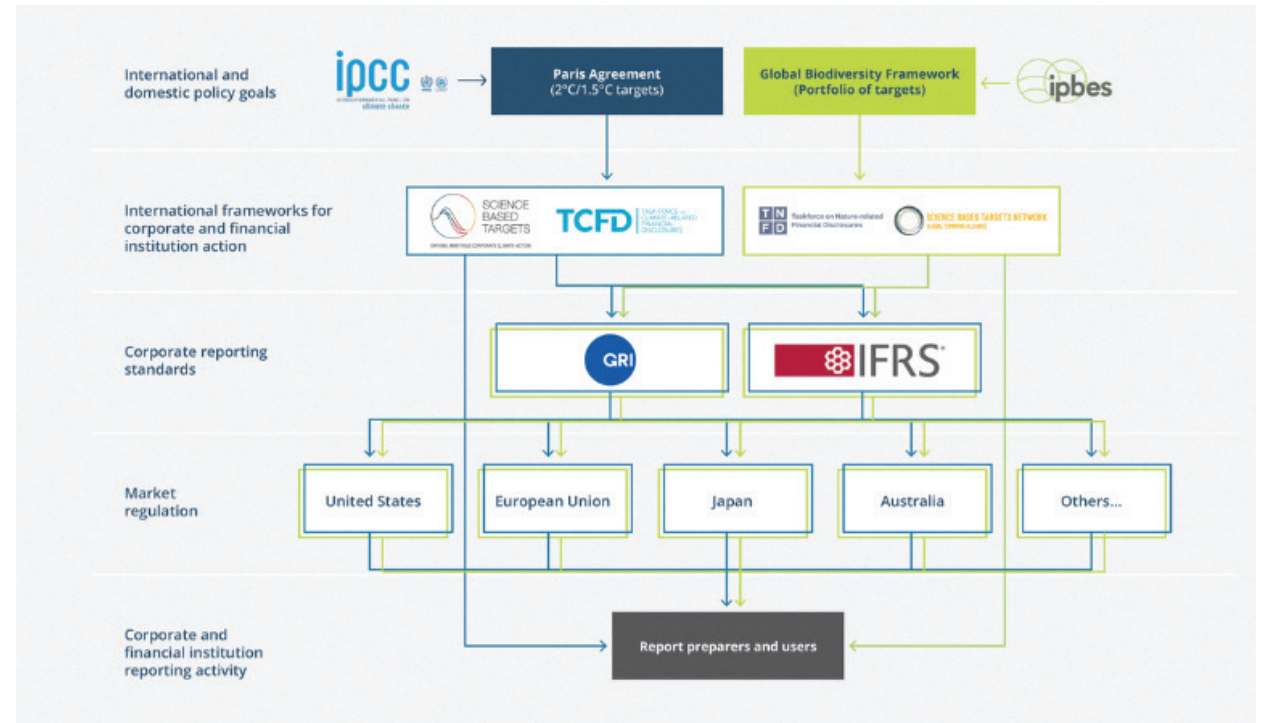


||  
**To break the cycle of consuming, producing, and living at the pace that we cannot sustain, we have to use all levers of change—the markets, government, and people.**  
 ||

**What kind of impact does TNFD envision its work to have in informing the ways business and finance operate?**

**David:** Our goal is to encourage companies and financial institutions to integrate nature into their decision making. To attain this goal, TNFD encourages voluntary adoption among investors, given their influence on expenditure and funding. As of October 2024, over 500 organisations including 129 financial institutions have registered as TNFD Adopters, representing \$17.7 trillion in assets under management—approximately 10% of managed assets in global equities. When investors start to care about businesses’ interface with nature, their choice of investment will follow suit, naturally moving businesses to incorporate nature in their operational decisions. Investors—which includes asset managers and owners—are currently our biggest adopter group by type.

TNFD also has a large group of business adopters that are making changes because they recognise the risks and opportunities of interfacing with nature and climate. While regulation and consumers play a pivotal role, our goal is to lead the way by having science-based recommendations that are practical and pragmatic for the market to implement. To break the cycle of consuming, producing, and living at the pace that we cannot sustain, we have to use all levers of change—the markets, government, and people. Only then can we get it right and reap enormous benefits.



The present reporting architecture.  
 Image: TNFD

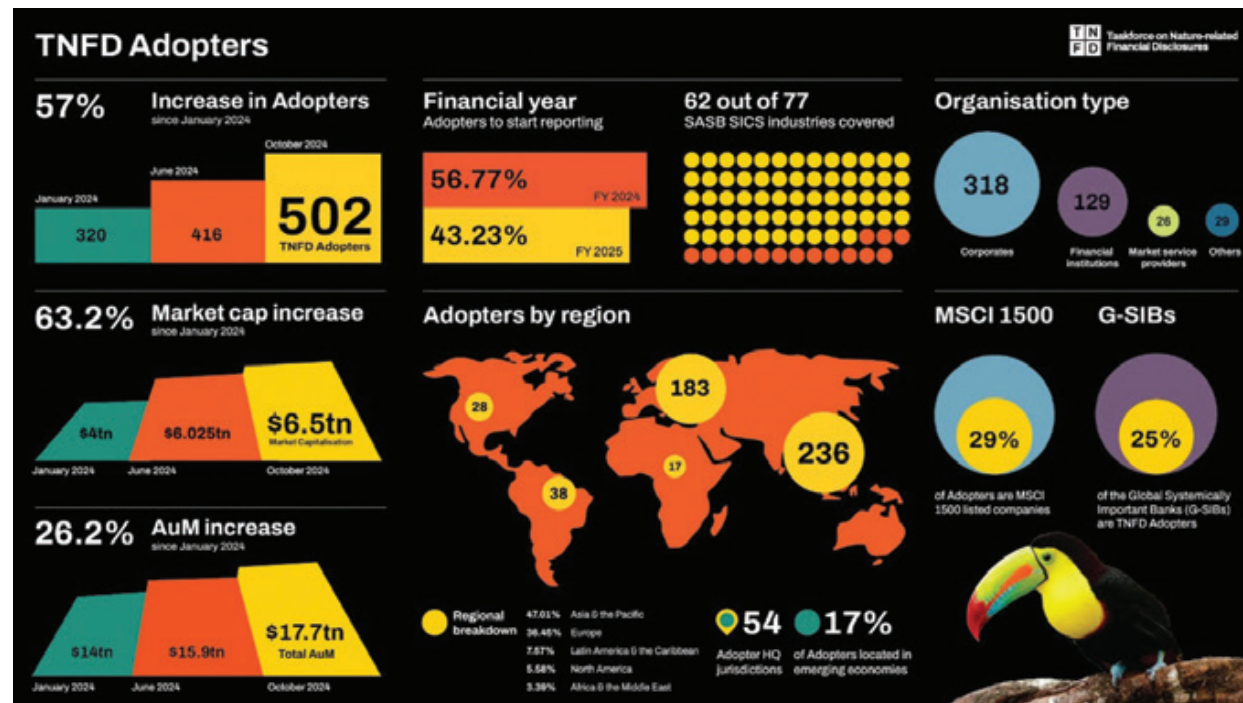
**Esther:** TNFD urges adopters to consider the multi-layered dependencies between the environment, people, and economic prosperity.

From the perspective of the building industry, nature is an integral part of CDL’s operations. This is because buildings extract a lot of raw materials from nature, making it crucial for developers to not only avoid destroying nature but ensure regeneration through nature-based and circular solutions.

In this light, CDL began adopting Biodiversity impact assessment for sites that are sensitive or near nature since 2010 and the Global Reporting Initiative (GRI) standards, which cover water and waste management, circularity, and biodiversity conservation. In relation to these existing frameworks, TNFD plays a complementary role in guiding CDL to rethink our reciprocal relationship with finance, i.e., how finance can drive positive change, and in turn how positive impact the planet can be created through finance.

**Financial institutions, corporates, and market services, while all operating in the private sector, have differing priorities and goals. How does TNFD balance and synergise these different demands to formulate a disclosure standard?**

**David:** TNFD has created an integrated assessment approach, LEAP, designed for use by organisations of all sizes and across all sectors and geographies. It helps organisations conduct the due diligence necessary to inform disclosure statements aligned with the TNFD recommendations. The LEAP approach guides organisations through four phases: “Locate interface with nature”, “Evaluate dependencies and impacts on nature”,



TNFD Adopters, as of October 2024, announced at COP16 in Cali, Colombia.  
 Image: TNFD





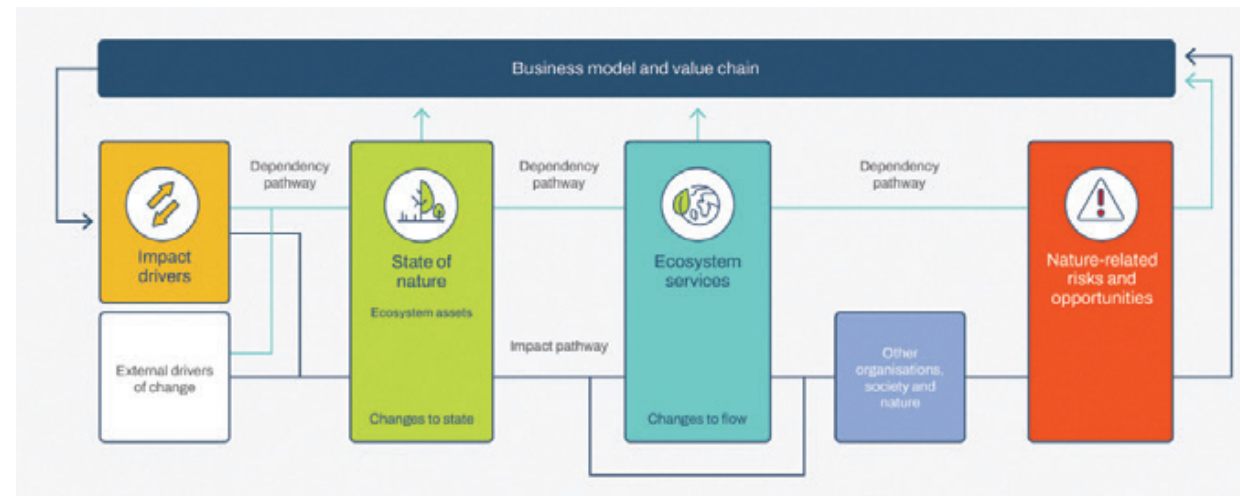
The LEAP approach.  
Image: TNFD

“Assess nature-related risks and opportunities”, and “Prepare to respond to and report on material nature-related issues”, providing organisations with a more granular understanding of their supply chains.

Through the process of establishing our LEAP approach, we found that many organisations looking to report in line with the TNFD recommendations were unaware of the exact location of their supply chain. This can weaken the resilience of businesses, which requires an in-depth understanding of supply chains, whether it is in the knowledge of products used, raw materials sourced, or the communities relied upon and impacted.

**What are the challenges that TNFD faces in getting buy-in from financial institutions, corporates, and market services?**

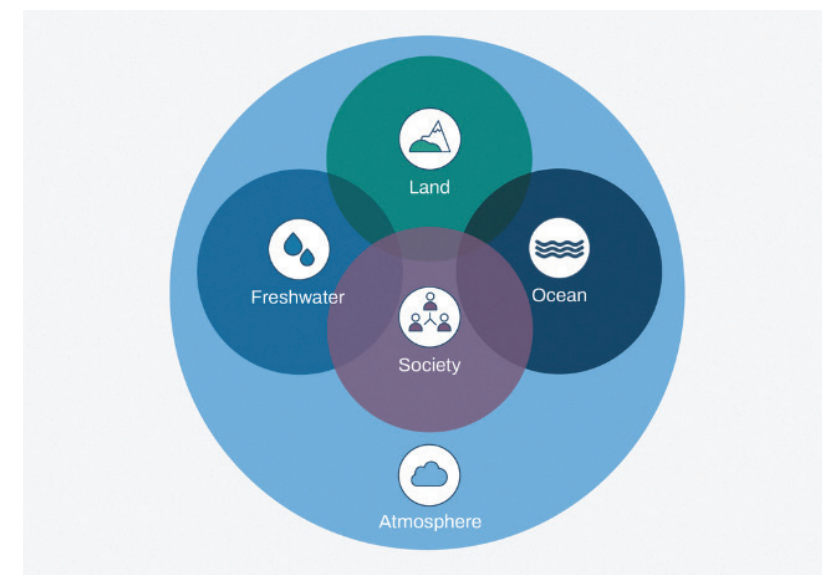
**David:** One of the key challenges lies in the prioritisation of nature over climate. This is underpinned by the fact that the climate is a part of the natural system, and both climate and nature are integrated and interconnected. In this vein, we encourage people to take a holistic view of the natural environment.



Nature-related dependencies of the business model and value chain.  
Image: TNFD

Nature is comprised of four realms—fresh water, oceans, land, and atmosphere—and we rely on not just one of the realms, but the intactness of all four realms. This calls for nature and climate to be embedded into everyday business operations, models, and supply chains; viewed as core to business and a strategic risk management issue, rather than a corporate social responsibility issue.

The answer to this lies in education. We have focused a lot of our work on training and capacity building among market participants. As part of the TNFD’s open innovation approach to developing the recommendations, over 200 pilot tests were carried out on the LEAP approach by companies and financial institutions across geographies, sectors, and biomes. Recognising the complexity of assessment and reporting across value chains, the Taskforce has also produced guidance on how organisations can approach the analysis of their upstream and downstream value chains.



Nature’s four realms: land, ocean, freshwater, and atmosphere.  
Image: TNFD



Data is another challenge, particularly in finding the right datasets and filling the gaps. At the end of 2024, TNFD launched a roadmap for enhancing market access to high quality nature-related data to improve decision-making informed by nature and biodiversity loss and its concomitant risks.

### How would you propose for nature to be valued in a way that encapsulates its range of benefits, opportunities, risks, and dependencies?

**David:** I believe that government policy plays an important role in regulations, policies, and initiating green financing to ensure that nature is not shortchanged. Having worked in the financial markets for 30 years, it is surprising how good we can be at pricing risk and items, yet attach so little value to what is probably the most valuable asset class we have, nature.

Simultaneously, with the growing recognition that the resilience of business depends on the resilience of nature, the conversation needs to focus on the opportunities presented to businesses; it is in the strong self-interest of businesses to incorporate nature into decision-making processes. Analysis by the BloombergNEF team shows that when nature risk is not managed and resilience is not in place, companies are exposed. The Bloomberg (2023) research highlights 10 companies that have experienced an accumulated loss of value of around US\$80 billion.

**Esther:** Putting a value on greening the built environment and conserving nature requires a long-term view. When we first started green building in the early 2000s and even up till the point where Singapore's Green Mark scheme was introduced (in 2005) and became mandatory (in 2008), it was challenging to quantify the value and even harder to get consumers to share the cost of investments in green building design and features. This is because just as nature takes time to regenerate, people too take time to grow their appreciation for nature. And despite initial resistance, buildings with green ratings are reporting higher capital value for sale or rental in key cities. For instance, Prime Central London office buildings with



CDL Tree House Condominium, completed in 2014, embodies extensive adoption of nature-based solutions.  
Image: City Developments Limited



Straw headed Bulbul at Chestnut Nature Park, which is adjacent to the Tree House.  
Image: Hiking the Green Isle

|| We must begin to acknowledge our everyday dependence on nature's value in safeguarding people's lives and our cities. When we allow nature to flourish, we create more resilient and liveable cities against the climate crisis.



a BREEAM Excellent rating enjoy a 10.5% premium on sales price compared to equivalent unrated buildings, while those with a BREEAM Very Good rating enjoy a 10.1% premium (Knight Frank, 2021).

Valuing nature also requires us to recognise its intricacies and in turn create conditions for nature to thrive. For CDL's Tree House condominium, completed in 2014, almost 77% of the site area was dedicated to landscape and nature features. We conducted a biodiversity impact assessment and identified 99 native animals and more than 32 native plants, which we sought to embrace through landscaping. Its iconic 24-storey high green wall was included in the Guinness World Records from April 2014 to June 2015 for the Largest Vertical Garden.

A one-year survey by the then School of Design and Environment, National University Singapore concluded that the green wall was able to cool the indoor space by up to 3°C. The development's other green features were able to achieve both energy and water savings. Its favourable brand and innovative green features are believed to have contributed to a higher investment value for residents.

**David:** To add, we must begin to acknowledge our everyday dependence on nature's value in safeguarding people's lives and our cities. This is especially evident in the many cities around the world dealing with extreme weather. A big part of the solution lies in choosing greenery over concrete. When we allow nature to flourish, we create more resilient and liveable cities against the climate crisis.

### As we advance cities' regenerative agenda, what visions do you have for the role of TNFD and the larger finance and investment industry?

**Esther:** As a practitioner, I am excited about the fast traction that TNFD has gained and look forward to further work in simplifying and streamlining the presentation of TNFD-aligned recommended disclosures in existing voluntary or mandatory corporate reporting. There has been close collaboration with standards bodies such as the European Financial Reporting Advisory Group (EFRAG) and International Sustainability Standards Board (ISSB), to deliver further harmonisation of sustainability reporting framework with TNFD. Given that over half of the world's GDP depends highly or moderately on nature and its services, I believe TNFD is set to become mainstream in global reporting standards.

**David:** To mainstream TNFD, there are a few key values I wish to emphasise for the wider finance and investment landscape. We should start thinking about the natural ecosystem in its entirety rather than in silos. It is also important to appreciate the different roles that government, finance and investment, and business sectors play individually and collectively in the ecosystem; all players need to come together and recognise their roles in this shared interest. I look forward to a world where humanity is built on sustainability and resilience. 🌱



VIEWPOINT  
MARK WATTS

# Climate Budgeting for Rapid Action in Cities



Mark Watts is the Executive Director of C40 Cities, a global network of nearly 100 mayors from the world's leading cities driving science based action and political leadership for climate justice.

||  
Achieving economy-wide transformational change necessitates first the determination of a mission, followed by a redesigning of government mechanisms to achieve that common purpose together.

||

We have a very short time in which to prevent global heating from accelerating beyond human capacity to constrain it. Progress has been made, but the scale of the task will continue to increase as long as our economy remains dependent on fossil fuels. We now need to halve global emissions and make an irreversible shift beyond oil, gas, and coal in the next five years. While many actors need to contribute, such a rapid, economy-wide shift will not happen without decisive, innovative, and mission-driven leadership by governments. One example of what is needed is climate budgeting—a whole-of-government approach to climate action which is rapidly gaining traction at the city level.

## Intensified Impact of Today's Changed Climate

The impacts of our changed climate have intensified rapidly in the last few years, with cities on the front lines confronted almost daily with increasing heat, flooding, storms, toxic air, climate-related disease, and shortages of power and water. Almost all C40 cities report that they have faced severe climate threats that jeopardise their economic and social prosperity.

City governments—responsible for more than half of the world's population and 75% of the world's

energy consumption—are becoming increasingly central to the global response to the crisis. While frighteningly few countries have published climate action plans aligned with the goals of the Paris Agreement, it is a condition of membership of C40. Among C40 cities, most have been implementing plans for some years now, and 82% are cutting emissions faster than their respective national governments.

Nevertheless, even among this group of highly committed cities, they are still not turning goals into action at the requisite speed and scale. Despite the number of “high-impact climate actions” implemented by C40's own member cities tripling over the past 10 years, there is still a further need to double the rate of implementation and triple the number of actions to achieve our 2030 goal of halving emissions across the network.

Halving emissions within five years requires large-scale systemic transformation that traditional models of governance are not designed for. Government departments tend to work in silos, focused on incremental changes in specific sectors. Achieving economy-wide transformational change necessitates first the determination of a mission, followed by a redesigning of government mechanisms to achieve that common purpose together.



### Employing Existing Governance Mechanisms to Achieve Climate Goals

Climate budgeting is a powerful, comprehensive mechanism that makes use of the existing financial budget to mainstream climate action. By integrating climate considerations into ordinary budget instructions and guidance, it allows for bottom-up proposals for new actions that can lead the city closer to its targets. At the same time, climate budgeting can also serve as a climate lens to all financial decision-making, ensuring that harmful activities are identified and mitigated against.

In the integrated climate and financial budget model, the city states its climate targets for the year and outlines actions for achieving them across all departments, complete with costs and impacts. Departments will become responsible for monitoring, assessing, and reporting progress and impact of climate actions.

At a political level, climate budgeting ensures transparency in what actions are required and what actions are being taken, as well as accountability in delivering them.

Historically, responsibility for climate policy has sat with the sustainability or climate department. With climate budgeting, however, each department will identify and propose climate actions relevant to their responsibilities, collect and report climate data, and implement climate measures. This will, in turn, make the responsibility for cutting emissions, building up a city’s resiliency, and making reducing consumption a shared goal across all government departments.

In many cases, it may not be clear at the outset how a city’s science-based emission reduction target can be achieved. Many city governments may be tempted to concede that the set targets are not realistic or possible, and proceed to set a lower target. With the climate budget, however, failure is not acceptable. It is mission-driven government in practice—akin to the example of

President Kennedy pledging to put a man [sic] on the moon, before the technology to achieve such a feat had been invented, thereby forcing NASA to find a new way of working.

### Climate Budget in Action

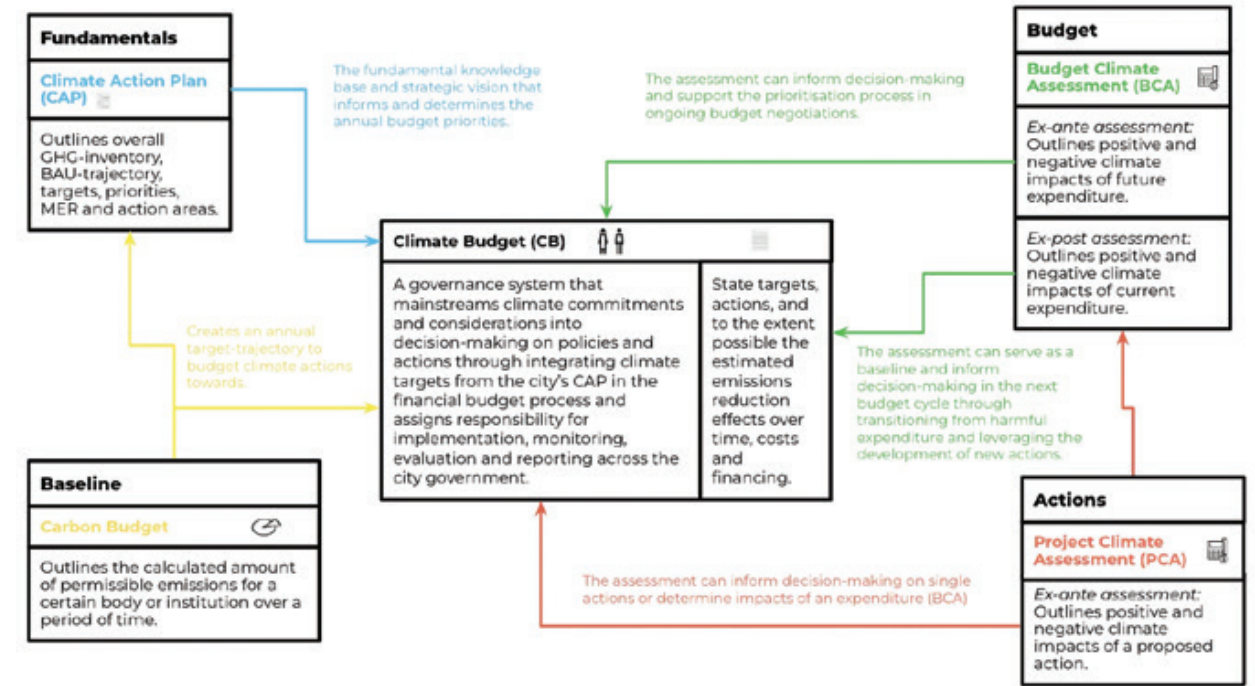
One of the benefits of a climate budget is that it can ensure various agencies take responsibility for climate action within their sector. This is done by incorporating all aspects of city governance, from procurement and contracts to training and job descriptions, into the budget.

In Oslo, the city which first pioneered the climate budget system, the Agency for Urban Environment, Agency for Improvement and Development, and Agency for Climate work together to establish loading bays, freight consolidation centres, charging infrastructure, city procurement of freight services, and financial incentives.

Every year, the city calculates the emissions reductions then zeroes in on the highest emitting sectors. Departments overseeing the offending sectors are then instructed to identify and propose new actions. These are negotiated and adopted as part of the ordinary budget process. For each measure, lines of responsibility are established, costs are estimated, and sources of financing are identified. This system helps to identify and address gaps quickly and ensure delivery plans are reviewed and improved.

#### The Difference Between Climate Budgets and Carbon Budgets

A carbon budget is a physical measure of the amount of carbon dioxide emissions permitted over a period of time to keep within a certain temperature threshold, while a climate budget is a governance system in which science-based climate goals are incorporated into a financial budget.



The graphic showcases the components of climate budgeting, and how they can connect and inform one other. Image: C40

Measures brought about by the climate budget have also improved liveability for the residents of Oslo. Expanding the city’s network of cycling lanes by 100 km has resulted in a 51% increase in cycling, and improved safety for cyclists and pedestrians. Since 2019, there have been zero pedestrian and cyclist deaths. At the same time, Oslo also boasts the highest levels of electric car use outside of China. This is due in part to the city government’s efforts in making sure that electric charging stations are widely available. Beyond road users, innovative government regulations have also led to the rise of electrified construction equipment, making construction sites cleaner and quieter.

To share its experience, Oslo conducted a two-year climate budgeting pilot programme with 12 cities under the C40 programme—Barcelona, Berlin, London, Los Angeles, Milan, Montréal, Mumbai, New York, Stockholm, Paris, Rio de Janeiro, and Tshwane. At the time of writing, London, Mumbai, and New York have already published their climate budgets, with more to follow.

### Ensuring the Success of Climate Budgeting

A number of key considerations can ensure the success of climate budgeting in a city:

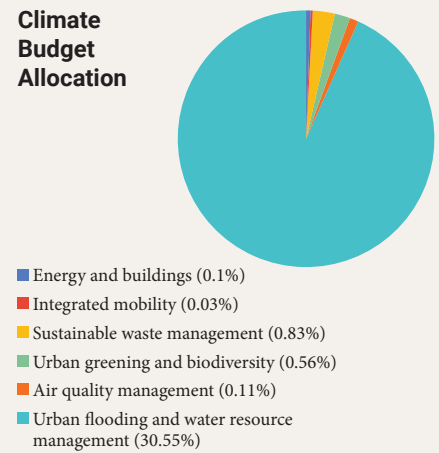
- **Political leadership** is the single most important factor in establishing and sustaining a climate budgeting system. Top-down direction and continuous support provides the space, resources, and legitimacy for leading departments to take ownership and helps to facilitate necessary conversations between departments. Climate budgeting works best when leaders remain actively engaged in the process. Providing progress reports to leaders throughout the administration allows informed decision-making across different governance levels.
- **Leveraging of existing mechanisms** to reach and engage other departments, especially those for whom climate policy is new. Integrating climate in the financial budget process sends a powerful signal that these considerations should be included in all



### Mumbai

Mumbai launched its climate budget in June 2024, using it as a governance system to deliver the city's Climate Action Plan. It was developed in collaboration with more than 20 departments, creating an opportunity to link every decision towards their climate goals. The budget covers both mitigation and adaptation, and has assessed co-benefits for all actions.

Climate Budget Allocation



Mumbai's Climate Budget Allocation.  
Image: Mumbai Climate Budget FY 24-25

### London

London uses a phased approach to implement its climate budget:

- Year 1 – review of the city's own operations.
- Year 2 – incorporate emissions for the whole of London, including areas the city government is not directly responsible for.
- Year 3 – include embodied emissions from supply chains.

London is also considering adaptation measures in their climate budget. This involves reviewing their experiences and doing an annual review to improve and expand upon their approach.



London City Hall.  
Image: Foster and Partners

decisions. It also opens the way for cities to deliver, monitor, and report on climate action in the same budget reporting process as other strategic priorities.

- **Solutions-driven approach** Building on existing skills and capacity to promote emissions reduction and boost resilience. Every city has a unique set of stakeholders, resources, and processes. Fostering inter-departmental collaboration through cross-disciplinary teams can accelerate action.
- **Phased implementation approach** Identify where the city is and where it wants to go. Consider a phased implementation approach, beginning with emissions and measures within

the administration's control, then target the biggest emissions sectors and sources in the city context. The city may begin by tackling key hazards or work within important sectors for adaptation resilience.

- **Customisation** of the climate budget to local context and priorities. Embed it in the existing systems and solve challenges where the impacts of the climate crisis are experienced locally. Track progress and adjust course if needed.
- **Shared ownership** Ensure co-ownership and early involvement of key stakeholders. Climate budgeting connects a city's climate and finance departments and involves effective



Mark Watts and Erik Lae Solberg, Governing Mayor of Oslo. C40 mayors are at the forefront of climate leadership, driving the issue of climate action at the front and centre of local policies.  
Image: C40

coordination with others. The Chief Financial Officer should take a leading role, and the city could consider establishing cross-departmental working groups to help maintain clear roles and responsibilities within the process.

- **Knowledge exchange** Embrace external stakeholders and participate in knowledge sharing activities. Cities can benefit from strong relationships with allies outside the administration. A key enabler is to convene all the relevant actors, including the private sector and civil society.

Climate budgeting is not a technical or a box-ticking exercise. It requires political courage to be transparent in what is done and what is needed. Climate budgeting should be the backbone of the organisation helping to steer decisions in the needed direction. As climate budgeting is universally applicable, it can be taken up by regional and national governments to support large-scale, rapid climate action. Cities have demonstrated how the system utilises a government's strengths to deliver results for both climate and people. Most of all, climate budgeting holds leaders accountable for delivering on climate goals in current and future administrations. 📍





URBAN GOVERNANCE

**HUGH LIM & GERALDYNE HOW**

Hugh Lim is the Executive Director of the Centre for Liveable Cities (CLC), a Singapore-based global knowledge centre with a future oriented focus on the liveability and sustainability of cities. Geraldyne is an Assistant Director at CLC. She researches on urban liveability, specialising in the development of CLC's liveability framework and indices.

# Building a Regenerative and Resilient Singapore: Perspectives from the Liveability Framework



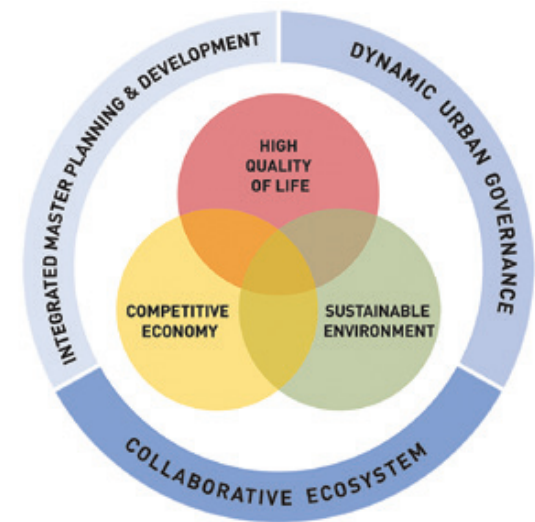
Accessible green spaces, as pictured, within Gardens by the Bay not only bring about ecosystem benefits but also serve as spaces of respite and recreation in the downtown of Singapore.  
Image: Florian Wehde / Unsplash

Singapore, an island city-state of 735 km<sup>2</sup>, is home to approximately six million people. Since independence, its land area has grown by about 26% through reclamation, while its resident population has tripled. Despite its high population density, Singapore is considered among the world's most liveable cities. This stems from a long-term, integrated approach to urban development, encapsulated in the Liveability Framework (LF) first proposed by the Centre for Liveable Cities in 2010. The LF serves as a guide for urban planning and policy development, describing the need to aim for a balance of three key outcomes: high quality of life, sustainable environment, and competitive economy.

|| A city ... must also have the capacity to absorb, adapt to, and emerge stronger from environmental, economic, and social shocks over the long-term.

Liveability and the balance among these three desired outcomes are not static goals; as Singapore evolves, so too must its vision of liveability. Singapore faces new urban development challenges, such as ageing infrastructure, changing demographics, and the need to transform to a low carbon economy, amidst geo-political tensions and uncertainties.

In this period of polycrisis, greater focus has also been called on resilience as a critical component of liveability. It is not enough for a city to thrive under benign conditions; it must also have the capacity to absorb, adapt to, and emerge stronger from environmental, economic, and social shocks over the long-term. These factors necessitate an



The Liveability Framework for planning future liveable and sustainable cities, with resilience as an implicit yet fundamental element underpinning the dynamic interplay of systems and outcomes.  
Image: Centre for Liveable Cities



evolution of the LF to reflect not only current realities but also future aspirations for Singapore.

The updated framework reflects this across several aspects: securing access to essential supplies and services that underpin a high quality of life; enhancing resource, climate, and social resilience for a sustainable environment; building economic resilience to withstand global economic fluctuations and disruptions for a competitive economy; and adopting innovative planning and governance approaches that enhance resilience in urban systems. The refreshed

framework also emphasises the need for a collaborative ecosystem and enablers that are not only instrumental in achieving liveability outcomes but are vital for fostering resilience for the future.

### Building Resilience in the Urban Landscape

In response to the unpredictability of crises in today's interconnected world, resilience is very much embedded in Singapore's urban planning and development. By addressing potential vulnerabilities and leveraging its sustainable development strengths, Singapore is building resilience to sudden shocks and changing conditions across resource, climate, economic, and social domains.

Singapore's climate resilience strategy is illustrated through projects like the Marina Barrage, and the Active, Beautiful, Clean Waters programme, which



The Marina Barrage serves as a source of water for Singapore, provides flood control for low-lying urban areas, and is a venue for lifestyle attractions.  
Image: Bob Tan / Wikimedia Commons

## Singapore's growth as a city reflects a compact approach which balances quality of life with environmental and economic considerations.

demonstrate how infrastructure can be multifunctional. In the former example, flood control functions are integrated with recreational facilities. Resource resilience is also reflected in initiatives such as the Four National Taps water strategy—comprising local catchment, imported water, NEWater (recycled water), and desalinated water—as well as the '30 by 30' food security goal, aimed at enhancing domestic production to guard against the risk of large scale or prolonged supply disruptions.

In terms of economic resilience, Singapore is committed to strengthening its key sectors and enhancing workforce adaptability. For instance, its knowledge-based economy has been bolstered by the development of mixed-use innovation districts such as the upcoming Punggol Digital District, which integrate business, learning, and living spaces. The tourism industry has also been reinforced with new world-class attractions like Gardens by the Bay, which feature lush, accessible green spaces that enhance urban liveability in the city.

In recent years, Singapore's urban planning approach has been made even more robust. The latest Long-Term Plan (LTP, 2021), a strategic land use and transportation plan guiding development for the

next 40 to 50 years, reflects this evolution by adopting a scenario based approach. This allows urban planners to consider multiple pathways, thereby enhancing future optionality and the city's ability to adapt and address evolving demographic needs and unforeseen challenges.

Building upon the strategies outlined in the LTP, Singapore is currently developing the Draft Master Plan 2025. The Master Plan, a statutory land use plan that guides development over 10 to 15 years, provides detailed zoning and development guidelines, and actively incorporate extensive public feedback from Singaporeans through a series of workshops, consultations, and exhibition to gather diverse views and inputs as part of the Draft Master Plan 2025 review. With its shorter five-year review cycle, it enables consistent and regular opportunities for public to contribute and to share their views on their needs and aspirations, in support of the LTP's implementation, for a more responsive and flexible urban planning process.

Additionally, adaptive land use also allows for the inclusion of buffer spaces and reserve sites within towns to accommodate future developments as well as to meet unexpected needs.

### Pioneering Regenerative City Approaches

Singapore's urban development has historically been, and will continue to be, influenced by its land constraints. Accordingly, Singapore's growth as a city reflects a compact approach which balances quality of life with environmental and economic considerations. This has sometimes required trade-offs. For instance, strict pollution controls posed challenges for investors in the past but have proven instrumental in ensuring a high quality of life for its residents.

As Singapore matures, its resilience journey will require innovation beyond traditional sustainability measures. The challenge is two-fold: rejuvenating an ageing cityscape and creating spaces that actively nurture nature. This requires a reimagining of urban development, and embracing a regenerative design approach that can actively restore and enhance environmental outcomes.

#### Designing with Nature

Recognising the intrinsically interconnected nature between human habitats and natural ecosystems, Singapore has started to embrace a paradigm shift towards symbiotic urban development. This shift centres on regenerative design, which reimagines urban spaces as dynamic, adaptive entities that can foster a mutually beneficial relationship between human activity and ecological health.

Singapore's pioneering efforts to integrate nature into the urban fabric, such as through vertical gardens, and urban forests, are not mere aesthetic additions but functional ecosystems that enhance



## More than just designing with nature in mind, it is also about maximising utility of our limited green spaces.



People adopting active mobility options like cycling.  
Image: Nguyen Thu Hoai / Unsplash

air quality, regulate temperature against the effects of Urban Heat Island, and provide habitats for diverse species.

More than just designing with nature in mind, it is also about maximising utility of our limited green spaces. Rooftop gardens doubling up as community spaces and urban farms, is one example. Alkaff Lake in Bidadari Park, which serves as both a recreational area as well as a flood management system, is another.

To enhance nature integration, Singapore is leveraging on data and science. This can be seen in the National Parks Board (NParks) island-wide Ecological Profiling Exercise, which utilises data and modelling to identify ecological corridors, to guide conservation strategies and urban planning. This data-driven approach ensures that urban development not only minimises disruption to natural habitats but actively creates corridors and spaces that support biodiversity.

### Circularity and Resource Regeneration

Regeneration involves developing a circular economy through closed loops and upcycling, to optimise resource use. Singapore has already started to embrace circular economy principles through the development of Semakau Landfill, which integrates waste management and ecosystem conservation. This offshore facility uses incinerated ash and non-incinerable waste to create new

land, enabling a new ecosystem that supports diverse flora and fauna, such as mangroves and marine life.

Similarly, the Tuas Nexus Integrated Waste Management Facility, set for phased completion from 2026, combines water reclamation, solid waste treatment, and energy recovery, to create a closed-loop system that can potentially reduce annual carbon emissions by over 200,000 tonnes.



Alkaff Lake in Bidadari Park retains stormwater to prevent flooding. The accumulated stormwater is slowly discharged to Marina Reservoir.  
Image: NParks

### The Human Element in Resilience

Singapore recognises that a truly resilient city is not just about clever infrastructure, but also about the adaptability, cohesion, and resourcefulness of its people. This was evident during the COVID-19 pandemic, when Singapore was able to activate a robust community response for initiatives such as mask-making and social support groups for the hardest hit, such as migrant workers.

This strong sense of community is fostered through public engagement and stewardship. Acknowledging that community support is essential for environmental resilience and addressing climate change, Singapore leverages policy, education, and community involvement to involve its citizens in adopting greener lifestyles, and to promote environmental consciousness from the ground up.

Public participation is another invaluable part of the planning processes, as demonstrated by the latest Long-Term Plan Review. This extensive engagement, involving over 15,000 residents, helped ensure that long term plans could take in the needs and aspirations of the wider community.

Additionally, Singapore is also cognisant of the need to focus on long-term changes, such as demographic shifts. A key concern is its rapidly ageing population, brought about by greater longevity and falling birth rates. By 2030, one in four Singaporeans will be aged 65 and above, up from one in ten in 2010. Such a demographic transition can present significant challenges, if the city is not prepared.

Singapore's future resilience can, however, seek to tap on its ageing population as an asset. By harnessing this 'longevity dividend', Singapore can transform demographic change into opportunity. To achieve this, urban planning should allow for future development that strengthens the social fabric, complements new social norms, and bonds a more age-diverse community.

The Age Well SG programme, launched in 2023, is one such example of an overarching initiative that aims to raise seniors' quality of life by improving their physical living environment, encouraging active ageing and strengthening support mechanisms. Part of this initiative also involves increasing the supply of Community Care Apartments that offer innovative ageing-in-place solutions such as senior-friendly features and integrated care services.



Residents of Cambridge Road neighbourhood participating in a green corridor planting activity. Beyond providing an opportunity for community bonding, this activity also contributes to improving walkability and thermal comfort for pedestrians.  
Image: Centre for Liveable Cities



A growing number of Active Ageing Centres further strengthens social networks, promotes cohesion, and combats isolation among seniors. These robust community support networks develop social capital that can be called upon during crises.

With an ageing population, the Agency for Integrated Care (AIC) is also supporting persons with dementia through the Dementia Friendly Communities initiative, which aims to raise awareness, reduce stigma, and create a more inclusive society. In this initiative, CLC worked with AIC to lead Singapore's first evidence-based study on Dementia-Friendly

Neighbourhoods. This subsequently prompted the implementation of infrastructure like sensorial gardens and wayfinding installations to help persons living with dementia to navigate their neighbourhoods safely and interact with their communities.

These initiatives create age-friendly urban spaces and foster intergenerational connections, contributing to a society that thrives amidst an ageing population. As Singapore adapts to changing demographics, such efforts will be crucial in maintaining resilience and social cohesion.

### Harnessing Collaborative Ecosystems

Developing a robust collaborative ecosystem that supports public, private, and people partnerships is vital to Singapore's resilience-building efforts. In recent years, Singapore has actively engaged the community in protecting shared resources and participating in policy formation. Public-people collaborations such as "reimagining the Rail Corridor and co-create plans for its future" has led to tangible improvements, such as enhanced safety and connectivity of bridges near Bukit Timah Railway Station and the formation of Friends of the Rail Corridor to foster community stewardship. Similarly, partnerships between the Public



Wayfinding installations to support residents with dementia have been implemented in selected areas of Yio Chu Kang.  
Image: Centre for Liveable Cities

Liveability is a continuing process of adaptation and growth that requires the embracing of new paradigms such as regenerative design and development to help build urban resilience.

### Conclusion

Utilities Board (PUB) and the private sector have helped to build up Singapore's water resilience through technological innovations.

Being renewable energy challenged, Singapore recognises that domestic efforts alone are insufficient, and international cooperation and knowledge sharing are needed to help build resilience. This can be seen in how Singapore has sought regional power connectivity for energy security, and also identified cross-border partnerships as a potential way to achieve effective circularity in resource management and waste reduction.

Singapore's journey, as reflected in the refreshed Liveability Framework, demonstrates an ongoing commitment to both liveability and urban resilience. This effort, underpinned by data-driven decision-making and cross-sector collaboration, recognises that liveability is a continuing process of adaptation and growth that requires the embracing of new paradigms such as regenerative design and development to help build urban resilience.

Just as every city has unique approaches to building resilience that can be learnt from, Singapore too can offer valuable insights to accelerate collective learning and adaptation, and also learn from others to improve our readiness for whatever the future may bring to all of us. 🌐

To access the Liveability Framework e-publication, *Building Liveable and Sustainable Cities: A Framework for the Future*, please scan the QR code on the right:







CLIMATE FINANCING  
**JEROME FROST**

Jerome Frost has been the Chair of Arup Group since 2024. He was previously the chair of United Kingdom, India, Middle East, and Africa (UKIMEA) region and has been a member of the Arup Group Board since 2017.

# City Resilience in a New Investment Climate



The City Resilience Framework enables cities to measure and monitor the multiple factors that contribute to resilience, identifying vulnerabilities and points of action. Pictured: Semarang, Indonesia, is one of the cities where Arup's international development team delivered an assessment.  
Image: Arup

||  
Unlocking innovative financing for resilient infrastructure is, in my view, both our greatest challenge and our most potent enabler of positive action.

||

**As I write this, it is New York Climate Week 2024 and Storm Boris—supposedly a ‘once-in-a-hundred-years’ phenomenon—has just blown through Europe, leaving devastation in its wake...**

A decade ago, with support from the Rockefeller Foundation, Arup developed the City Resilience Framework (CRF). Since then, much has changed and we have endured global events more intense than what we could have previously imagined. Yet, the definition that our work is based on still holds true:

*City resilience reflects the overall “capacity of a city (individuals, communities, institutions, businesses and systems) to survive, adapt and thrive no matter what kinds of chronic stresses or acute shocks they experience” (Rockefeller Foundation: 2013).*

As urbanisation continues across the world, with 70% of the global population predicted to be living in a city by 2050 and with many established cities already straining at their seams, it is critical that we move from measurement and planning of resilience to more direct action.

From Rockefeller Foundation's 100 Resilient Cities Challenge in 2013, which catalysed a global movement, the Resilient Cities Network was born, and hundreds of cities now have resilience strategies and even Chief Resilience Officers.

While CRF and similar frameworks remain invaluable in helping cities assess their resilience, the impacts of climate change, pandemics, and economic and political volatility are decisively shifting the focus from strategy-setting towards implementation.

Today, the most pressing task is not merely to understand what makes a city resilient but to take concrete steps to enhance that resilience. The era of cheap money and low interest rates is over, and the need for cities to invest in a climate-safe future is growing. Unlocking innovative financing for resilient infrastructure is, in my view, both our greatest challenge and our most potent enabler of positive action.



## Making Resilient Cities Investable

One of the most significant barriers to implementing resilience measures is funding. We are seeing an abundance of green finance, but often there is a mismatch between available funds and investable green projects. To bridge this gap, we need to engage financiers and insurers in the shaping stages of project development to ensure that such projects are truly attractive to investors.

Capacity building in cities is critical to delivering projects that are bankable and capable of being financed at scale. Stable and aligned policy, regulation, and standards are also essential if we are to attract city investment and innovative financing mechanisms such as green bonds, public private partnerships, and blended financing.

A prime example of innovative financing comes from Miami, whose citizens voted in 2017 to approve a US\$400 million "Miami Forever Bond" to finance climate resilience projects with both short- and longer-term impacts. This approach not only enhanced the city's resilience

but also safeguarded its long-term economic viability; in 2023, Miami increased its S&P rating from 'AA-' to 'AA'.

Of course, there comes a point where it becomes too costly to design for every provision against emergencies. It is impossible to create a perfect, infallible city with perfect infrastructure, and this is where the juxtaposition between physical and human resilience comes into focus. Following any disaster, recovery comes down to two things: the ability of a city to regain full operation, and the ability of its people to adapt and bounce back. Societies that are better able to respond to natural events are seen as more resilient and as such, more attractive to investors in an increasingly competitive global landscape.

## Technology Underpins Investor Confidence

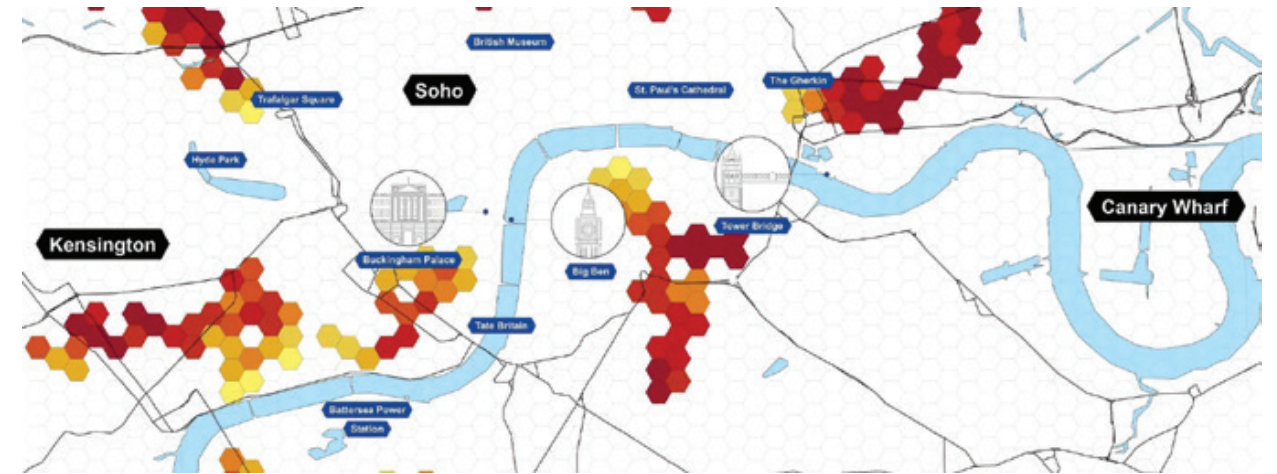
Technologies such as artificial intelligence (AI), digital twins, and advanced data analytics are improving the way we plan, build, and manage our cities.

Digital tools bring scale and acuity to the insights we develop. At Arup we have developed a digital tool called UHeat that uses satellite imagery to identify the sources of intensifying heat in our cities. We also have a tool called Terrain that reveals why and where cities face growing flood risks, to help them prioritise natural 'sponge city' solutions.

These innovations enhance our ability to model and simulate various scenarios, allowing cities to anticipate and prepare for a wide range of potential challenges, from natural disasters to economic disruptions. This predictive capacity empowers cities to make faster and more informed decisions as well as better allocate resources during unforeseen events, making it a more compelling destination for investment.



ARUP's Digital Twin of the Hague City Hall.  
Image: Arup



ARUP's heat detection digital tool—UHeat.  
Image: Arup

Moreover, digital tools also help to streamline project development and implementation. By providing accurate data and detailed analyses, these technologies help ensure that projects are both viable and attractive to investors. This, in turn, can unlock innovative financing mechanisms and attract substantial investment, driving economic growth and development.

Used effectively, digital tools also improve transparency and accountability. By making data accessible and understandable, they can engage communities, policymakers, and investors in

the urban development process. This collaborative approach builds trust and confidence, further incentivising investment.

The application of digital tools demonstrates a city's commitment to innovation and progressive thinking. Cities that embrace technology are seen as dynamic and forward-looking, qualities that are highly appealing to investors looking for stable and promising opportunities.

Nowhere is this more important than in our most fragile and vulnerable communities. Arup's

pilot study in the informal settlement of Surat, India, as part of the Roof Over Our Heads (ROOH) campaign, combines global and local expertise with technology to gather and analyse data to support the settlement in preparing for and dealing with extreme weather events.

But "digitalisation" is just one of the ways for making informed decisions and building resilient cities that can adapt to and mitigate the impacts of climate change. Working together, Decarbonisation towards zero emissions, Disclosure through transparent reporting, and



Roof Over Our Heads campaign.  
Image: Arup





Hunter's Point South.  
Image: Arup

Digitalisation help cities to not only reduce their environmental footprint but also enhance their overall resilience and sustainability. By integrating these three strategies—decarbonisation, disclosure, and digitalisation—cities can create a more attractive investment environment, showcasing their commitment to sustainability, transparency, and innovation.

### Embracing New Practices

Of course, realising this investment potential is not simply a matter of aligning investment and technology with the right intentions. What cities all over the world are now discovering is the need to develop new ideas and design interventions that can deal with the range of threats they are facing. Traditional assumptions underpinning urban development for the last century are no longer the best fit for a warming world, where extreme weather, higher temperatures, rising sea levels, and other risks have become part of everyday life. As designers and engineers, this baseline recognition of a changed environment and climate is also a spur to innovation.

One tangible example of the resilience challenge at scale can be seen through the work Arup has

been doing with the New York City Economic Development Corporation to strengthen local flood protection.

At Point South in Long Island, which was a victim of Hurricane Sandy in 2012, we developed new ideas for coastal resilience—ones that take advantage of nature-based absorption of potential flood risks while transforming a former industrial area into a parkland for the community. Our team adopted a “living with water” ethos across every element of this development, deploying solutions such as streetside stormwater planters, porous pavements, enhanced tree pits, and a constructed stormwater wetland, among others.

On a fundamental level, projects like this demonstrate how climate adaptation can drive innovation

Resilience is not just about robust infrastructure or efficient systems, but ultimately about improving quality of life and creating environments where all residents can prosper.

### The Challenge (and Opportunity) Ahead

that leads to beneficial city development—improvements for the community, with resilience embedded at all levels. By making resilience central to the DNA of a project’s scope, design, and implementation, we strengthen the business case for these investments, while also developing beneficial outcomes for communities and natural habitats.

Every city’s resilience journey begins at a different point.

To achieve resilience, every city needs to constantly challenge established thinking, embrace change, and deepen collaboration with other cities, governments, and private sectors. Otherwise, they risk making their cities un-investable.

I remain optimistic. In the last 20 years, our understanding of city resilience has matured, and there is

now an agenda for vital, scalable, and effective innovation. As cities develop their own resilience strategies, let us also remember that resilience is not just about robust infrastructure or efficient systems, but ultimately about improving quality of life and creating environments where all residents can prosper. By keeping this human-centred approach at the centre of our efforts, cities can truly become sustainable for generations to come. 🌱





URBAN TECHNOLOGIES

**JACQUES BELTRAN**

Jacques Beltran is the Vice President, Global Head of Cities and Public Services at Dassault Systèmes, where he heads worldwide business and solutions portfolio for smart cities, national and local administrations, and public contractors.

# Building Climate-Resilient Cities: How Virtual Twins Can Empower Urban Leaders



Illustration of Dassault Systèmes' Virtual Twin as a Service.  
Image: Dassault Systèmes

**Cities all over are undergoing profound transformation. As urban populations grow, the strain on infrastructure, housing, and services has also intensified. Compounding the problem is climate change, which has introduced new challenges such as flooding, rising sea levels, and extreme weather events. Today, 58% of cities are already highly vulnerable to natural disasters. By 2050, however, over one billion people could become climate refugees, displaced by environmental crises.**

To address these challenges, city leaders need to make reducing carbon emissions and adapting to climate change their critical priorities. At the same time, they also need to equip themselves with the right tools to make informed decisions. The advent of big data and generative AI provides a valuable opportunity for cities to make data-driven decisions—and at the forefront of this technological shift is the Virtual Twin.

A city virtual twin is an exact digital replica of an urban area—one that integrates real-time data from sensors, IoT devices, and other sources, enabling simulations, analytics, and informed decision-making.

## **The Value of the Science-Based Virtual Twin in Sustainable City Planning**

It is important to differentiate between traditional 3D modelling and the virtual twin. Unlike conventional 3D models that focus solely on visual aesthetics, a city virtual twin is a science-based dynamic replica of an actual city. Within one integrated model, the system is able to conduct advanced analyses, such as evaluate airflow patterns to combat urban heat islands, assess flooding risks, and monitor traffic policy impacts on air quality and noise pollution.

The true value of the technology behind the virtual twin lies in its ability to provide city leaders with



a comprehensive understanding of their urban environment, offering a holistic view of the interconnected systems that make up their cities. Virtual twins enable authorities to 'crash test' new public policies in the virtual world before actual implementation, thereby ensuring that decisions are made according to the scientifically sound data points available.

Another key benefit of virtual twin technology is that it streamlines data access across different organisations, enhancing inter-departmental collaboration. For city leaders, this facilitates the designing of sustainable cities that balance between urban growth and environmental stewardship goals. Additionally, virtual twins also improve crisis management by generating simulated outcomes for better decision making.

More than just a tool for city planners, virtual twins also serve as a powerful communication bridge between governments, stakeholders, and citizens. Through realistic 3D models, diverse stakeholders can get a clearer understanding of public policies and urban projects, thereby fostering greater transparency and community support for new governmental initiatives.

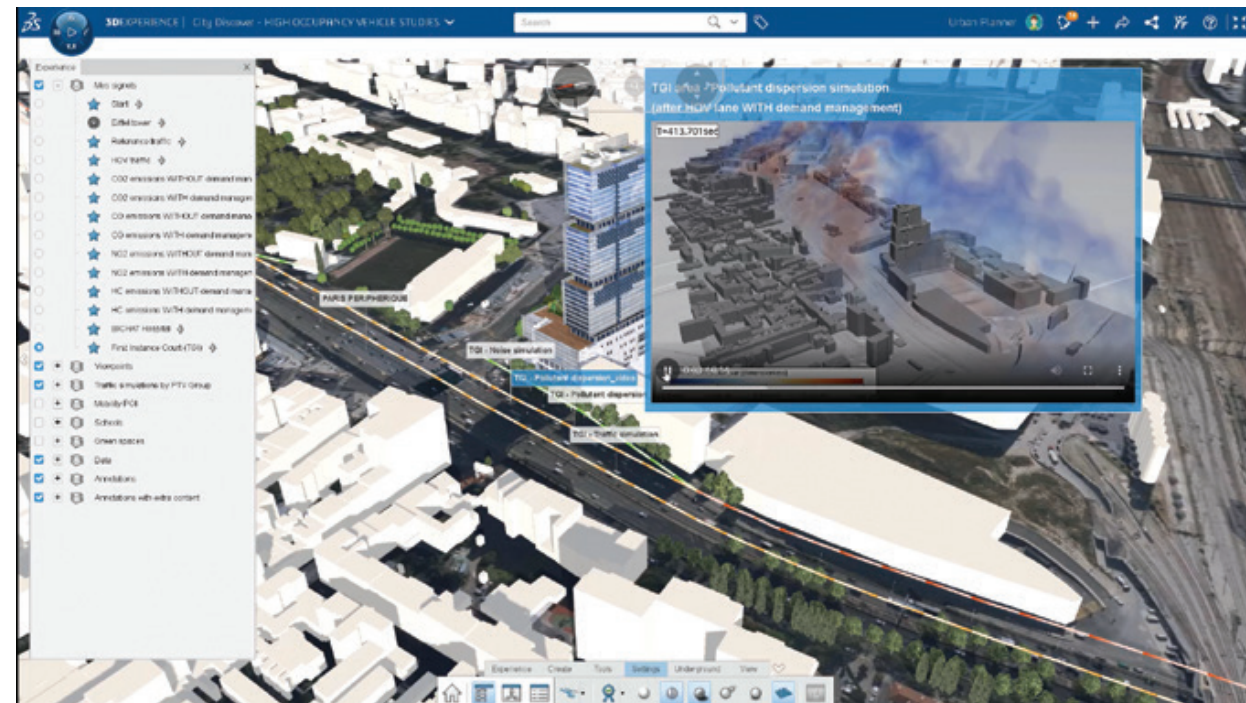
### Future-Proofing Cities: Addressing Pollution, Extreme Heat, and Flooding

Today, many cities are already embracing virtual twins. Singapore, Barcelona, Dublin, Seoul, Chengdu, and Porto are among the cities leading the way, each harnessing virtual twin technology to solve their unique challenges. Here are a few examples from Dassault Systèmes:

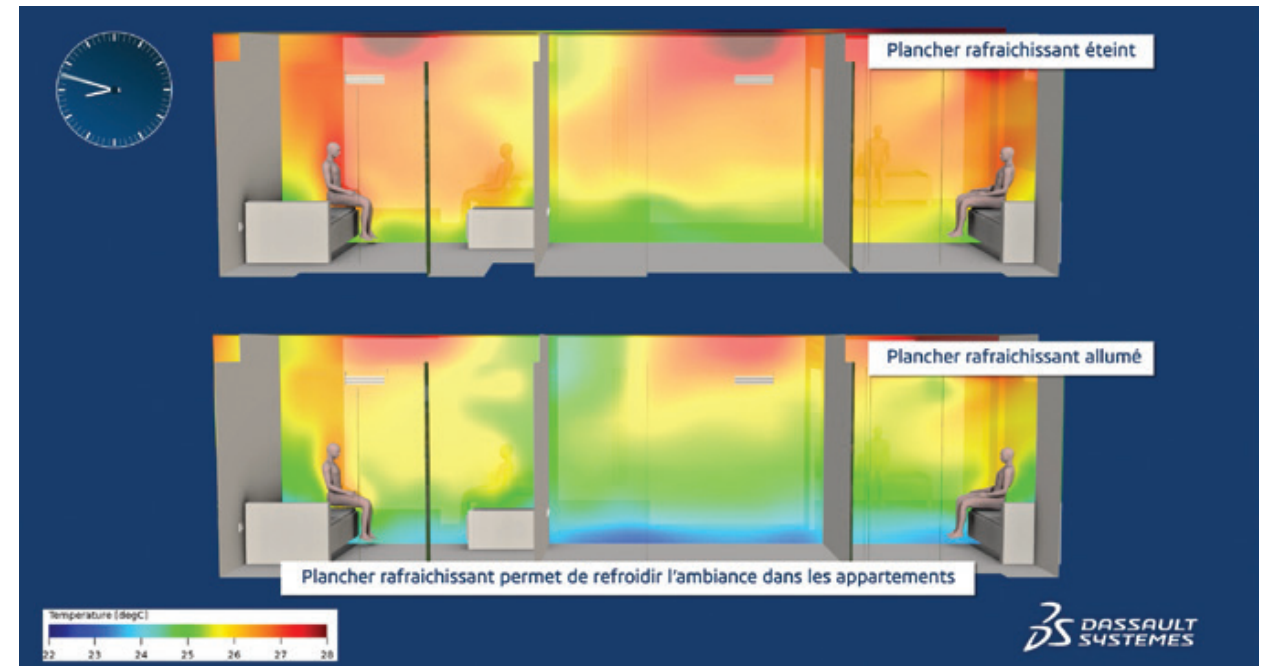
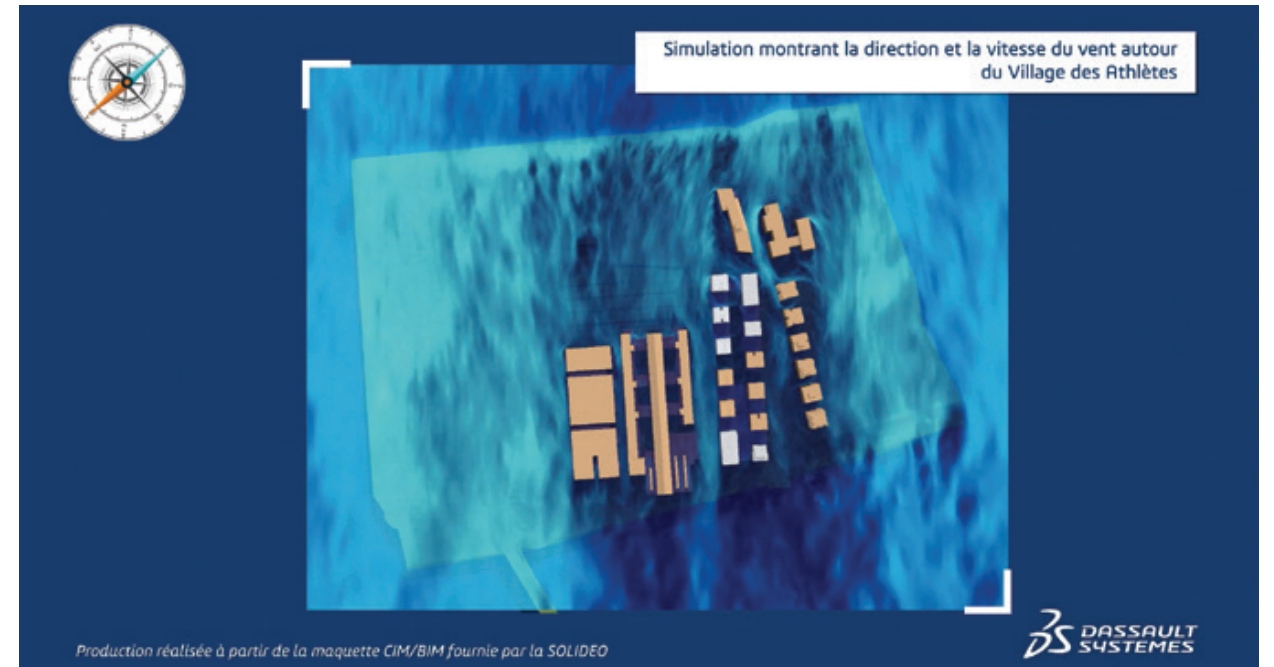
#### Traffic, Air, and Noise Pollution

One city that faces significant levels of pollution and traffic jams is Paris. Over 1.1 million trips take place along the ring road each day, which put residents living near the road at risk of toxic air pollution. In light of this, city authorities introduced an Olympic Lane for buses, taxis, and carpools to fluidify traffic during the 2024 Paris Olympics.

To simulate potential impacts of the new mobility policy on traffic, air quality, and noise levels, Dassault Systèmes used the 3DEXPERIENCE



Dassault Systèmes modelled the Paris Mayor's decision to allocate a lane of Paris Ring Road to car sharing to help with traffic and decrease carbon emissions. The simulation allowed for analysis of impact on traffic. Image: Dassault Systèmes



(Top) Wind simulation for the Athletes' Village. (Bottom) With data provided by SOLIDEO (Olympic Delivery Authority), Dassault Systèmes created a 3D model of a floor in the Athletes' Village to calculate indoor temperature. Image: Dassault Systèmes

platform to simulate impacts of this new mobility policy, on traffic, air quality, and noise levels, to test various mitigation actions such as placement of soundproof walls.

#### Urban Heat and Extreme Temperatures

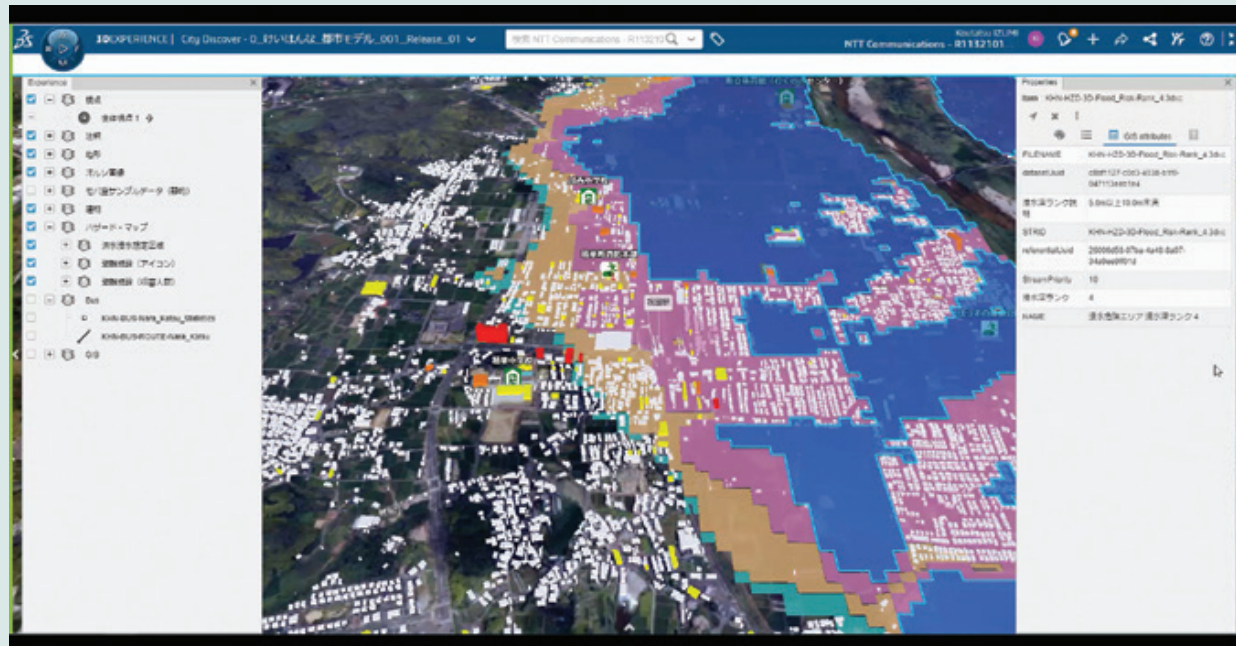
Urban areas are typically hotter than rural ones due to the "urban heat

island" (UHI) effect, caused by the energy consumption, materials, and reduced vegetation in cities. As climate change intensifies, extreme temperatures occur more often causing the UHI effect to worsen.

To address this phenomenon, cities need to minimise the UHI effect

early in the urban planning process. This can be done by increasing the presence of nature and water in development projects, as well as by implementing suitable building materials and cooling options. Virtual twins can then be used by cities and construction companies to assess the effectiveness of their planned mitigating strategies





The Keihanna digital twin was a result of collaboration between Japan's NTT Communications.  
Image: Dassault Systèmes

for combatting rising indoor and outdoor temperatures,improving citizens thermal comfort through urban planning.

As an illustration, Dassault Systèmes recently supported SOLIDEO, the public agency tasked with financing, supervising, and delivering the Paris Olympics facilities to select the best construction choices that would limit the impact of extreme temperatures within the Paris Olympics athletes' village.

Two simulations were ran—the first to assess the impact of wind speed and direction on surface temperature and heat convection, and the second, a 3D model to simulate parameters such as insulation, ventilation, solar shading, and an ecological floor-cooling system on one of the village's floors.

These simulations demonstrated the efficiency of the solar shades, which adapt based on position and time of day, as well as the

effectiveness of the cooling floors in regulating indoor temperatures throughout the day. As a result, SOLIDEO was able to gain crucial insights into how to enhance comfort within the buildings, even during heatwaves.

**Flooding Risks**

Flooding is one of the primary risks driven by climate change that poses significant human, social, and economic challenges. To better manage these risks, modelling and simulating of potential flood scenarios have become an essential component of urban planning for cities at risk.

In the riverside city of Keihanna, Kyoto, Dassault Systèmes partnered with NTT to demonstrate the power of virtual twin technology in simulating flood risks across various neighbourhoods. Their solution provided authorities with 3D hazard maps, allowing them to develop detailed flood evacuation plans.

As cities strive to balance growth with sustainability, adopting science-based virtual twins can empower the leaders of today to create resilient, climate-ready urban environments that support both current and future generations.

**Is Virtual Twin Technology Suitable to Cities of All Sizes?**

Virtual twin technology is relevant for cities of all sizes, not just major metropolises. Smaller and medium-sized cities, too, face challenges that require agile solutions for crisis management and long-term sustainable development.

Hence, to cater to smaller cities with limited fiscal and manpower resources, Dassault Systèmes came up with a virtual twin as-a-service offering, “Sustainability and Resilience Cockpit for Cities” by Dassault Systèmes offers ready-to-use solutions that fit within a limited budget. This solution provides cities with limited technical expertise and which might be hesitant to invest in large-scale IT projects a chance to experiment the power of 3D simulations and data analytics in a virtual twin technology.

**Shaping the Future**

As cities strive to balance growth with sustainability, adopting science-based virtual twins can empower the leaders of today to create resilient, climate-ready urban environments that support both current and future generations. This powerful solution promises to become a cornerstone for modern urban planning, enabling cities to evolve into smarter, more sustainable environments. It will shape how cities, regardless of their size, anticipate challenges, optimise resources, and enhance the quality of life for their residents.





## ENERGY TRANSITION

**MIKE HAYES & DEVEN CHHAYA**

As Global Head of Renewable Energy at KPMG, Mike Hayes is actively involved in leading Climate Change and Decarbonisation. Dr. Deven Chhaya, a Partner at KPMG in Singapore, leads the Infratech advisory services with a focus on technology, decarbonisation, and digital transformation in the infrastructure sector.

# Powering Urban Energy Transition Through Innovation and Industry Expertise



The energy transition must be handled in a phased approach that guarantees grid stability, resilience, and efficiency.  
Image: Emel Green Power

**As cities face mounting pressure to fast-track their energy transition, the quest for novel solutions has never been more critical. What can governments do to steer innovation and industry participation to create an enabling environment for sustainable and resilient urban energy landscapes?**

## Imperative for Novel Energy Solutions in Cities

Cities are dynamic hubs where diverse sectors and systems converge and interconnect. This interconnectedness, combined with the increasing electrification of these sectors and the rapidly growing energy demands of urban populations, makes cities major electricity consumers.

To meet this demand, cities must accelerate their energy transition by adopting innovative solutions. Traditional energy systems, while prevalent in most major global cities, often fall short in managing contemporary urban environments' flexibility and high-density requirements. There is a need to adopt novel solutions that facilitate the *Decarbonisation* of electricity through *Decentralisation* and *Digitalisation*. Such solutions include photovoltaics, urban wind turbines, energy-efficient buildings, clean mobility technologies, and sophisticated digital platforms for real-time energy management.

## But Innovating and Implementing Novel Solutions Isn't Easy

The widespread adoption of novel solutions in urban areas remains elusive. Two primary challenges toward accelerated energy transition in cities are the significant innovation gaps across sectors and the lack of synchronisation across industries toward cost-effective deployment of such solutions.

### Innovation Challenges

Growth trajectories in innovation within sectors such as power and transport have seen stronger progress as compared to building and industrial sectors. This is despite the latter having significantly higher carbon mitigation costs (International Renewable Energy Agency, 2017). Furthermore, corporate innovation tends to occur in silos, slowing progress and hindering the adoption of innovations from adjacent sectors (World Economic Forum, 2024). Compounding these issues is the cautious financing environment for innovative small companies, as investors avoid riskier bets on new technologies amid rising interest rates.





Carbon dioxide emissions from fossil fuels are at an all-time high.  
Image: Jose A. Bernat Bacete / Getty Images



Daqo's polysilicon plant in Shihezi, Xinjiang.  
Image: Daqo New Energy

||

There are three big implementation challenges. The first is infrastructure installation... the second is renewable energy deployment... and the final barrier is the lack of resilient and reliable supply chains...

||

**Implementation Challenges**

There are three big implementation challenges. The first is infrastructure installation, which is hampered by limited private sector investment. Energy storage projects often struggle without contracted revenue or long-term agreements, deterring investors.

The second is renewable energy deployment, specifically the installation of more renewable capacity, which is hindered by slow and complex permitting procedures, grid congestion, and inadequate policy support. This has resulted in long grid queues in some European countries.

The final barrier is the lack of resilient and reliable supply chains, which delays project deliveries and drives up costs. Scaling novel solutions like solar panels, wind turbines, energy storage systems,

and other clean energy technologies requires cost-competitive access to an unprecedented volume of raw materials such as cobalt, nickel, graphite, copper, and lithium. In 2023, the IEA projected that demand for these critical minerals would increase four-fold by 2040. However, access to these high volumes remain restricted due to limited mining capacity and processing facilities. Furthermore, supply chain constraints exist for critical materials for solar panel production as production is predominantly centred in China.

**Creating an Enabling Environment Through Innovation and Industry Collaboration**

A strategic and coordinated effort from governments and the industry is needed to create an enabling environment for the development and scaling of novel solutions. Collaboration can take place in three ways:

**#1 – Strengthening Public-Private Collaboration**

Public-private sector collaboration is a powerful mechanism for driving innovation and deploying market-relevant solutions at scale. Such collaborations open doors to cutting-edge technologies, facilitating cost-effective and distinguished innovations. Features of such collaborations include:

- Accelerated innovation with the right price signals due to improved information flow between industry and innovators (e.g., national labs and universities)
- Alignment of public and private sector innovation efforts with market requirements spotlighting projects with high commercial viability
- Market access for public sector innovators
- Promotion of commercial mindsets necessary to scale innovations rapidly

Public-private collaboration is also pivotal in developing the infrastructure necessary for energy transition. As urban projects grow more complex and costly, relying solely on public finances creates investment gaps. Involving the private sector in infrastructure





Toyota tests their new EV pickup truck, which is slated to begin manufacturing in Thailand from 2025.  
Image: Reuters / Arton Pookasook

development fosters the adoption of innovative models throughout the project lifecycle, ensuring efficient and timely completion of energy-related infrastructure projects.

London is one city where public-private collaboration has proven effective. In view of the rising number of EVs on its roads, the city came up with the 2030 EV Infrastructure Strategy to eliminate barriers to EV infrastructure implementation and to actively engage the private sector to deploy charging points across the city (Mayor of London, 2021). As a result, London successfully increased its rapid charge points from just over 300 in 2020 to 1,140 in mid-2024.

Asia, too, has made waves for its public-private efforts. At COP29 in Baku, the Monetary Authority of Singapore (MAS) and BlackRock signed a Statement of Intent to unleash regional decarbonisation investment opportunities through a blended finance debt initiative. This Industrial Transformation infrastructure debt programme was first launched by MAS in COP28, under the FAST-P initiative to mobilise up to US\$5 billion from public, private, and philanthropic partners to finance transition opportunities in Southeast Asia.

Likewise, Thailand's "30@30 Policy", which aims to make EVs 30% of domestic automotive production by 2030, has resulted in a new public-

private partnership to introduce standardised swappable batteries in small electric cars. This partnership increases efficiency and supports domestic EV manufacturers and operators of EV battery charging/swapping stations nationwide.

Another advantage of partnering with the private sector is the potential for innovative market designs and long-term contracts that provide stability and assurance to investors. In the UK, such contracts have successfully facilitated the development of large-scale, long-duration storage solutions.

II  
The complex value chains required for energy transition cannot be developed solely through the efforts of energy companies. Private players from diverse sectors—such as mobility, mining, and manufacturing—must join forces.

## #2 – Embracing the Industrial Cluster Model

The complex value chains required for energy transition cannot be developed solely through the efforts of energy companies. Private players from diverse sectors—such as mobility, mining, and manufacturing—must join forces to deliver an equitable, competitive, and clean energy transition.

One effective approach is the industrial cluster model, in which private sector participants adopt a unified and systematic approach to optimise innovation of solutions and facilitate deployment. Companies within these hubs share technology, investments, and risks in large infrastructure projects.

One example of this is Europe's largest integrated chemical cluster at the Port of Antwerp-Bruges. The port hosts cooperative infrastructure for cross-border carbon transport and storage, and is focused on expanding the low-carbon hydrogen value chain (World Economic Forum, 2024).

Beyond the industrial clusters, industry players are also forging partnerships with cities to support energy transition in cities. One such initiative is the London Business Climate Leaders initiative, where 11 leading businesses are working closely with representatives from the city to focus on thematic areas such as sustainable buildings, renewable energy, and circular economy and waste (CDP City-Business Climate Alliances, 2019).



Port of Antwerp-Bruges.  
Image: Port of Antwerp-Bruges





Located in the Groningen region of the Netherlands, HyNetherlands is one of Europe's largest hydrogen plant projects.  
Image: Engie Group



Breakthrough Energy Fellows – Southeast Asia is a three-year joint funding commitment announced in 2024.  
Image: Breakthrough Energy

More can be done towards innovating and deploying novel solutions for cities to meet their energy transition imperatives. Collaboration between the government and industry counterparts will be essential.



**#3 – Creating an Ecosystem for Innovation**

By combining existing technical knowhow and technologies from different sectors and companies with various policy instruments such as incentives and smart policies, governments can help to catalyse innovation.

Netherlands is a good illustration of this with its success in building a strong network of internationally renowned centres of excellence, including the Top Consortium for Knowledge and Innovation Offshore Wind (TKI Wind op Zee), the Energy Research Center of the Netherlands (ECN), and Delft University of Technology. Steered by the Dutch 2019 Climate Agreement, favourable governmental policies and incentives have helped the Dutch innovation ecosystem to attract both domestic and foreign companies to collaborate in these research institutes.

As a result, the Netherlands has emerged as Europe's second-largest producer of hydrogen and Europe's first 'hydrogen hub', with a capacity of 9 million m<sup>3</sup>. It also has one

of the highest densities of solar panels in the world and a significant presence in offshore wind power.

Beyond the power sector, it is crucial for innovation efforts to also encompass end-use sectors, such as buildings and industry. Additionally, there should be a focus on developing infrastructure and business models in tandem to support the deployment of these novel solutions.

One effective strategy is to nurture an ecosystem that supports early-stage start-ups innovating in sectors like mining and minerals. Connecting these start-ups with established companies not only amplifies the impact of innovation but also facilitates the rapid scaling of new technologies.

In Singapore, this is seen in the partnership involving Breakthrough Energy, a climate organisation founded by Bill Gates, Enterprise Singapore, and Temasek to nurture deep-tech climate start-ups in the renewable energy and carbon footprint space in Southeast Asia.

**A Concerted Effort is Required**

The irreversible energy transition is underway in cities globally. While governments are already driving this shift, more can be done towards innovating and deploying novel solutions for cities to meet their energy transition imperatives. Collaboration between the government and industry counterparts will be essential for all stakeholders to effectively leverage innovation and private expertise for truly energy-efficient urban spaces.





CLIMATE FINANCING  
**LAUREN SORKIN & VALERIE BROWN**

Lauren Sorkin is the Executive Director of the Resilient Cities Network, the world's leading urban resilience network. She leads RCN to bring together global knowledge, practice, partnerships, and funding, empowering network members to build safe and equitable cities. Valerie Brown is Manager of Climate Resilience at RCN. She specialises in heat, flooding, and biodiversity challenges.

# Heat Resilience: A Gateway to Solving Urban Challenges



Illustration of the Oasis schoolyards project that aims to create healthy, green spaces for children, and simultaneously provide an accessible “cool island” area for residents during heatwaves.  
Image: Urban Sustainability Exchange

**In the past two decades, heatwaves have become the deadliest weather-related events across the globe and the risk of heat related deaths during extreme summer temperatures has increased rapidly. In the Nature Communications article, “Rapid Increase in the Risk of Heat-Related Mortality”, the authors warned that in many regions if no adaptation takes place under a 2°C warmer climate, what used to be a 1-in-100-year heat mortality event in the year 2000 could be expected roughly every other year.**

||  
**Cities looking for low-cost, high-impact actions can begin by improving citizens’ awareness and preparedness through nonstructural interventions.**

In addition to the rising temperatures driven by climate change, city populations are growing rapidly, and urban landscapes are being transformed to accommodate this growth. Herath and Bai, in their article, “Benefits and Co-Benefits of Urban Green Infrastructure for Sustainable Cities”, described how these changes created distinctive urban climate conditions, including the urban heat island effect, which amplified extreme heat events, reduced thermal comfort, increased energy demand for cooling and heating, and led to greater health risks and heat-related mortality.

Many cities recognise this urgent need for adaptation measures, but often face challenges of restricted budgets and limited timeframes. We argue that city leaders do not need to choose between financing heat resilience building programmes, and other essential initiatives. By focusing on heat resilience, we see how our member cities are tackling a range of interconnected issues that achieve larger social, environmental, economic, health, and governance objectives.





Beyond its role as a climate shelter, the Centre of Contemporary Culture of Barcelona (CCCB) takes part in various programmes to integrate sustainability into all facets of its work.  
Image: Barcelona City Council



The Museu Frederic Marès (left), and Biblioteca Montserrat Abelló (right) are part of Barcelona's network of climate shelters.  
Image: Barcelona City Council

### Strengthening Urban Resilience with Low-Cost Preparedness Measures

Cities looking for low-cost, high-impact actions can begin by improving citizens' awareness and preparedness through non-structural interventions. These types of interventions are often less expensive than structural actions and can quickly improve disaster response and save lives.

According to "The 2024 Europe Report of the Lancet Countdown on Health and Climate Change" report in *Lancet Countdown Europe*: during extreme weather events, children and the elderly are among the most at-risk populations. In particular, elderly groups are often hard to reach due to lower technological knowledge and social isolation.

The city of Athens is addressing this problem through the reuse of two existing programmes. The Help at Home programme, which was started during the COVID-19 pandemic to offer isolated people

counselling, medical care, as well as the delivery of basic goods such as medicines and groceries, has been extended through partnership with the Hellenic Red Cross volunteer groups. In addition, the programme now also helps to prevent and treat symptoms of extreme heat for residents in their homes.

Athens has also repurposed its Friendship Clubs—public spaces for elderly people to gather and participate in activities. During extreme heat events, these air-conditioned spaces are open from 9:00 a.m. to 9:00 p.m. to all residents.

In a similar vein, the city of Barcelona has opened an extensive network of 350 Climate Shelters. Now more than 90% of the most-at-risk residents can reach a climate shelter within a 10-minute walk. These climate shelters are situated indoors, such as in libraries,

museums and civic centres, as well as outdoors, in parks and gardens. They are free of charge, accessible to people with reduced mobility, safe, and equipped with comfortable relaxation areas and free water. These spaces not only act as a refuge during heat events but are also used during intense cold events, and are generally open all year.

For Milan, their strategy involves increasing climate awareness through creative risk information campaigns. To challenge the perception of climate change being abstract and distant, the city created a climate story about heat. The narrative follows Ambrogio and his granddaughter Gaia during an extreme summer heatwave as they seek shade in a park after poor sleep due to a lack of nighttime cooling.



## Redesigning the Urban Environment

The story uses visualisations and maps to show how heat will shape Gaia's future and highlights the urgency of taking action. Green space and distance-to-cooling maps within the story clearly demonstrate the effectiveness of tree planting in protecting cities from heat. The story concludes by encouraging users to learn what Milan is doing to green the city and how residents can contribute to making it more climate resilient.

The success of this climate story extends beyond the positive feedback received from Milan's residents. Because the development of the climate story narrative involved cross-departmental collaboration within the city administration, it ended up initiating a collective effort for not only the project but also towards new resilience building activities.

Beyond immediate actions for preparedness and awareness, cities need to adapt and redesign much of their built environment. In cities that are already dense with infrastructure, this change can begin by understanding the risks and modifying the public spaces already available to residents. A truly inclusive process is essential, both for conducting a comprehensive needs assessment through citizen engagement and co-creation, and for ensuring interdisciplinary collaboration between experts to design innovative and effective solutions.

The Urban OASIS Schoolyards programme in Paris is one such innovative initiative, which came about as a response by the City of Paris to climate projections predicting more frequent and longer heatwaves. It aimed to address the high level of soil sealing and lack of access to green cool spaces, which were making schoolyards increasingly vulnerable to heatwaves.

The schoolyards in this programme are co-designed by school communities, including students, parents, and teachers, as well as design professionals in consultation with stakeholders such as government, academia, and community organisations. The transformed schoolyards offer lower temperatures and function as a space for the community outside of school hours, enhancing community cohesion and reducing social isolation.

So far, 75 schoolyards have been transformed, and the city plans to expand the programme to all of its public schoolyards. These reimagined spaces offer a dual benefit: reducing temperatures during heatwaves and creating vibrant, multipurpose spaces that promote community interaction and social inclusion in Paris

Following the success of the OASIS programme in Paris, it is now also being implemented in Quezon City in the Philippines. While set within a very different context, the Quezon City OASIS schoolyard programme is able to adapt the core principles of Paris's OASIS initiative to address its own unique challenges. This cross-continental application of the OASIS programme demonstrates its flexibility and potential for global adaptation, contributing to more resilient urban environments in diverse settings.



Oasis Schoolyards in Paris act as cool spaces of respite from heatwaves by integrating nature-based solutions for shading and storm-water management.  
Image: AIPH



## The Broad Benefits of Expanding Green Space in Cities

Cities all around the world are focusing on urban greening as a proven way to adapt to heat impacts. Increasing green space in a city not only helps to provide shade and lowers temperature through evapotranspiration but also improves soil permeability, reduces risk of flooding, lowers demand for air conditioning, and positively influences citizen's mental health. Furthermore, by leveraging Water Sensitive Urban Design, green infrastructure can also be used to help manage stormwater.

In Liu and Russo's article, "Assessing the Contribution of Urban Green Spaces in Green Infrastructure Strategy Planning for Urban Ecosystem Conditions

and Services", they found that green spaces also benefitted urban development by increasing property values, boosting tourism, and creating job opportunities.

Chennai is one example of a city that has been using urban farming to protect its most vulnerable communities from the intensifying heat while also providing essential, healthy food. Urban heat disproportionately affects residents who live in poor housing conditions. Many of these areas lack green spaces, which help mitigate heat, and are situated near heat-absorbing infrastructure like concrete and asphalt, further intensifying the heat burden. Since 2021, the Chennai Resilience Centre

has been running the Chennai Urban Farming Initiative, which creates rooftop and public gardens in daycares, schools, and homeless shelters to bring more greenery to the city and fresh food to the table. This project has resulted in cool spaces for residents and education opportunities for children, while also ensuring nutrition for youths and the greater at-risk community. These urban farms are enhancing community physical and mental health, improving food self-sufficiency, and improving social cohesion by addressing multiple urban vulnerabilities simultaneously.

West Gorton Community Park, also known as "The Sponge Park" in Greater Manchester is



First residential complex of the Smart City—drone view of the Smart Village.  
Image: Groundwork UK

By focusing on heat resilience, city leaders can protect their residents from the immediate dangers of extreme temperatures while also improving overall quality of life in the longer run.

another example of how a city has leveraged green space development to enhance flood resilience and biodiversity. Created as part of the GrowGreen Project, the park showcases Sustainable Urban Drainage Systems, including bioretention tree pits, wildflower meadows, and permeable paving. Co-designed with the local community, the park provides social, environmental, and economic benefits such as increased physical activity, improved mental health, and enhanced property values.

Based on data provided by project partner, the University of Manchester, the Sponge Park has demonstrated a significant reduction in water runoff, a 48% increase in biodiversity, and lower ground temperatures. Additionally, the park has also fostered community cohesion through its design and local events, creating a model for green infrastructure in other urban areas. The success of this project is now informing other developments in the city, including Mayfield Park, highlighting the effectiveness of nature-based solutions in urban planning.

## Addressing Multiple Urban Challenges over the Long Term

Interventions to address extreme heat can be used to address multiple urban challenges beyond just cooling. By focusing on heat resilience, city leaders can protect their residents from the immediate dangers of extreme temperatures while also improving overall quality of life in the longer run. These efforts help reduce health disparities, improve climate awareness, and promote community cohesion, creating more equitable and liveable urban environments.

Cities must therefore prioritise heat resilience as a central pillar of urban planning. From awareness campaigns to structural interventions, they can tackle the interconnected issues of urban change, ensuring their cities are prepared for future challenges while fostering resilient communities that are more inclusive, sustainable, and adaptable to a changing world.





SYDNEY | ADAPTIVE REUSE

# Carbon-Sensitive and Socially-Driven Transformation: Quay Quarter Tower

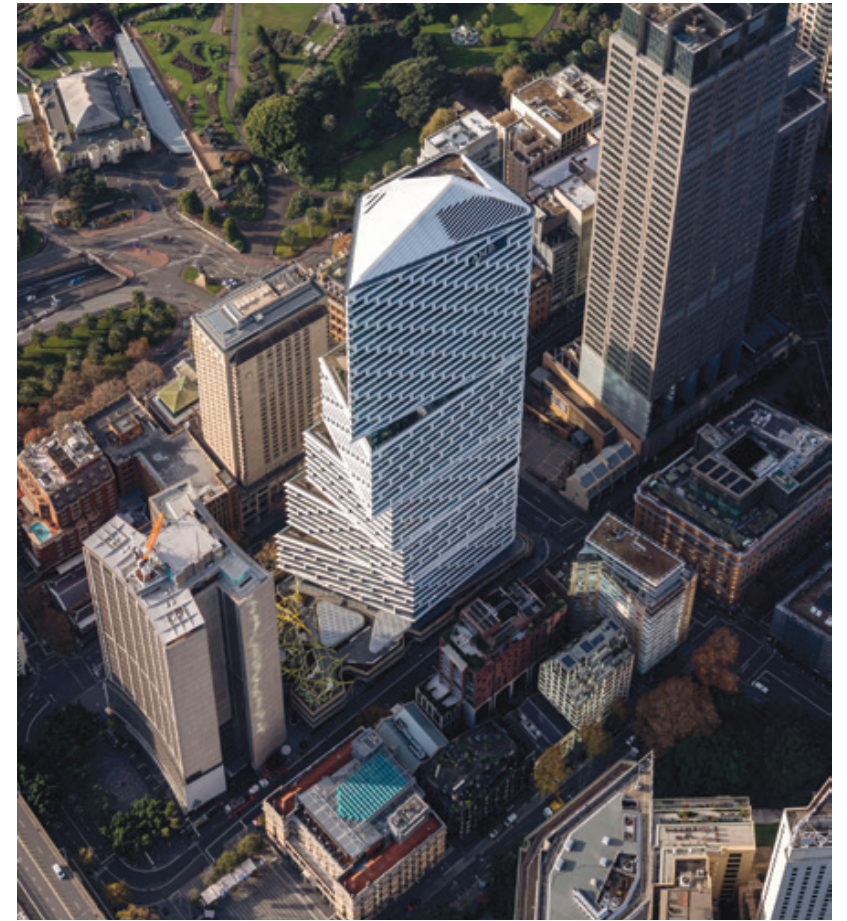
Sydney's Quay Quarter Tower (QQT) is an adaptive reuse project of an existing underused 50-year-old high rise building, the 1976 AMP Centre. QQT achieved significant embodied carbon savings and reduction in construction waste, reducing overall environmental impact while elevating user experience.



Jannie Krall Johnsen is the Director for Operations and Strategy APAC at 3XN—which is a renowned architectural firm known for building projects that push the boundaries of aesthetics and functionality, connecting people with their built environment.



Fred Holt & Dan Cruddace are Partners at 3XN Australia.



The Quay Quarter Tower and surrounding precinct.  
Image: 3XN

## The Challenge

The architecture and construction industry faces two fundamental and seemingly opposing responsibilities: the need to drastically reduce the industry's carbon footprint, while also developing healthy cities to accommodate a growing and increasingly urban global population. For 3XN/GXN, the transformation of existing buildings offers an opportunity to unite these two responsibilities, ultimately providing flexibility in our response to changing social and urban dynamics—without that need for change coming at a high cost to the environment.

Located on the edge of Sydney's bustling Circular Quay and within view of the Sydney Opera House, Quay Quarter Tower (QQT) is a 102,000 m<sup>2</sup> adaptive reuse project which radically 'transforms' the 1976-built AMP Centre tower. The original tower, like other mid and late 20th-century towers, was reaching the end of its usable lifespan, but rather than simply tearing it down and starting over, the project team set out to achieve the ambitious goal of reusing as much of the existing building as possible and set a lofty new standard for adaptive re-use in architecture. Today, the project is the world's first adaptive re-use of an existing high-rise.



## Quay Quarter Tower's Regenerative Strategy

QQT retains over 65% of the original structure (beams, columns, and slabs) and 95% of the original core, resulting in an embodied carbon savings of over 12,000 metric tons or around three and a half years of operational carbon for the completed building. Working within the solar envelope and other contextual constraints, the design doubled the existing floor area, primarily on the north side of the building, by grafting on new floorplates to the existing slabs.

The QQT project provides an example of retaining and transforming existing assets as an effective regenerative strategy in tackling ageing infrastructure. With QQT, the impact of transforming the former AMP Centre can be described in three

broad categories: social, urban, and environmental transformation.

**Social:** Avoiding the usual conventions of traditional, uniform high-rise design, QQT was developed around a 'vertical village' concept. It features a social spine and is designed from both the inside-out and the outside-in, with the user experience top of mind.

**Urban:** Advances in high-rise construction and changes in office/residential needs are rendering some 20th-century towers obsolete. This creates a cycle in which assets lose value, owners stop investing, districts deteriorate, and the public loses attention, ultimately encouraging new development on cities'

outer edges where infrastructure must then be extended. It is a process that is occurring the around the world, and one that emits enormous amounts of carbon. By transforming an existing asset and keeping the urban centre dense, QQT shows how to break this cycle.

**Environmental:** The radical re-use of the existing structure reduces QQT's embodied carbon footprint. Its more salient design feature, the façade's external sunshade hood, reduces solar gain by more than 30%. This not only gives the building its identity, but reduces its operational carbon by lowering mechanical loads needed for cooling.



The extended height atrium which functions as a social connector.  
Image: 3XN



Old and rejuvenated AMP Building.  
Image: City of Sydney



### Social Transformation: An Architecture That Shapes Behaviour

QQT's vertical village concept places users at the centre of the design. By dividing the building into five separate volumes, an optimal balance between intimacy and connectivity is achieved, while also reducing the bulk form of the tower.

Each volume is arranged around a central atrium that faces the iconic Sydney Harbour. This atrium accommodates informal meeting and social spaces, thereby activating the workspace and bringing it in alignment with 3XN's design philosophy of "Architecture Shapes Behaviour". At the base of each of the stacked

blocks, the atrium volume opens northwards towards generous terraces, extending the workspace and creating spaces that focus on collaboration and well-being.

Each of the tower's five volumes are a hub unto themselves, with floors threaded together by a spiral staircase and arranged around stacked atria that bring daylight deep into the 2,000-2,200 m<sup>2</sup> floorplates. The transparency of the open atrium spaces distributed within each block allows for easy visual access to the surrounding floorplate departments and colleagues—thus, encouraging

knowledge sharing and social interactions.

Along the northern zone of the floorplate and visible from the surrounding precinct is the social spine consisting of a stack of 3- to 4-level atria, which are connected by spiral staircases for enhanced movement flow. To enable future adaptive re-use and flexibility, the structure in these floors can be dismantled, or assembled easily. Designed-for-disassembly, these floor systems allow spaces to be curated to match tenants' future growth or workplace requirements.





The 11m sloped terrain that Quay Quarter Tower sits on.  
Image: 3XN

## The separation of vehicular traffic from pedestrian pathways ensures clear spaces that are open and safe.

The social spine starts at various points at the base of the tower: the open space, the publicly accessible podium market hall, and the hospitality-focused lobby. There are multiple entry points located across different levels, which is a result of the building's circular design, intended to take advantage of the sloped terrain across the site. The building is strategically designed to make wayfinding easier as users can constantly orientate themselves with visual connections at each level of the podium as well as the tower's surrounding context.

The separation of vehicular traffic from pedestrian pathways ensures clear spaces that are open and safe. The creation of spaces for collaboration and well-being are represented by "Third Space" co-working lounges, retail offerings, bicycle parking, gymnasiums, and a fully accessible rooftop garden that comprises an open-air event space and a public art piece by world renowned artist, Olafur Eliasson.



A bird's eye view of QQT's multiple rooftop gardens.  
Image: 3XN

## Urban Transformation: The Quay Quarter Precinct & City Context

The success of the user experience for any high-rise starts at arrival. QQT's podium design creates a pedestrian-friendly environment, while creating a "moment of arrival" with the large, voluminous tower lobby visible from the multiple entrances.

The podium's visual and physical permeability encourages an active public domain. This plays out in the internal, market hall tenancies that connect to external terraces, where users can enjoy the favourable Sydney climate. Extending from the tower lobby, atop the two-level market hall's podium rooftop is a publicly accessible parkscape that features a roof top café and bar. Due to the site topography, which drops 11-m from the southern lobby

entry to the northern end of the podium, the rooftop garden can also be accessed directly from the ground level lobby. QQT's rooftop garden creates a place destination and a much-needed green space for Sydneysiders and visitors to enjoy the revitalised and reinvigorated precinct.

Connectivity was carefully considered with the integration of narrow laneways, new streets, and entrances across the entire Quay Quarter precinct and beyond. Furthermore, while Circular Quay's supporting infrastructure (e.g., ferry, train, and light rail, etc.) was good, the building was approaching its end-of-life and partially vacant. The Quay Quarter development was thus a catalyst for the regeneration

of the eastern end of Circular Quay. This involved many stakeholders as well as the City of Sydney which worked together with the developer to unlock the precinct's potential through innovative implementation of planning policy and pragmatic development controls.

At a city level, the visible expressive form, informed by the site solar access constraints and passive sustainability, is highly unique to QQT. The podium scale, form, and materiality are a nod to the Australian vernacular of the Sydney terrace house with protective verandas, while also sitting comfortably in the sandstone heritage context of Bridge Street and the adjacent Quay Quarter Lanes.



Multiple entrances converge at QQT's podium.  
Image: 3XN



## Environmental Transformation: The World's First Adaptive Reuse Skyscraper

The challenges of adaptive re-use of an existing tower or structural upcycling, comes down to three things:

- Does the existing structural strength capacity match or exceed its original design?
- Does it have the capacity for more load, vertical or horizontal?
- Does the existing floor-to-floor height match with the new use?

A comprehensive survey and concrete sampling need to be done to assess the exact location of the existing structure and its load bearing capacity. These assessments inform the design of the retrofit structure, carefully ensuring that it does not deteriorate the existing structure.

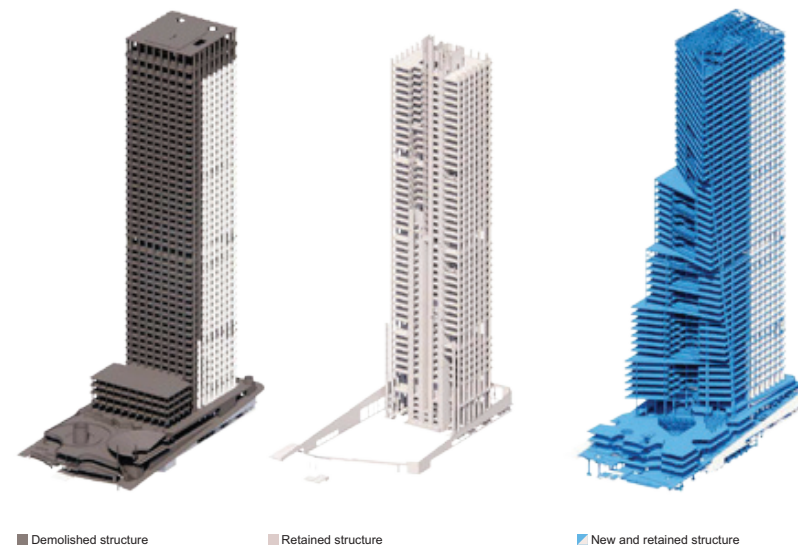
In the case of QQT, this was done by using concrete-filled tubular steel columns for the new structure, as this results in less shortening than a concrete-only structure would.

QQT also incorporated data from a “digital twin” simulation model during construction. This digital structural twin was continuously updated with results from core and concrete strength samples taken from the existing structure, as well as movement sensors on the building. This significantly reduced the risk associated with re-using the existing structure, as the computational testing of the structure and movements were compared with actual movements, allowing the new structure to be designed or altered prior to structure install. Where required, some areas of the existing structure were

strengthened using carbon fibre strips or steel-plates, particularly where the new program required additional space.

By retaining more than 65% of the existing structural frame and 95% of the existing core, significant carbon savings have been achieved. Furthermore, passive shading of the building has reduced solar radiance on the facades, which in turn lowers reliance on internal cooling and related operational costs and carbon.

Process Diagram  
Transformation



Transformation process of Quay Quarter Tower.  
Image: 3XN



Quay Quarter Tower.  
Image: 3XN

### The Future

QQT sets a new global benchmark as a sustainable and social example of how to radically re-use an existing high-rise in cities. 3XN/GXN believes that this approach can be adopted more widely, which is why currently more than 30% of our work is within the “transformation” space at various scales and typologies and with different levels of intervention.

In the typology of adaptively re-using high rise buildings, corporate firms will focus more on Collaboration and Well-Being, resulting in a need for larger space and floorplates in towers to handle the open environments and flexibility that tenants demand. There is a lot of tower stock globally from the 1970's to the 1990's, that due to their limited floorplate size, façade visibility, aspect, or performance, see a diminishing return on value. Moreover, because tenants are not seeking out large, long-term leases in these buildings, the asset's financial return is not as high. If, however, city planning

officials and developers work together to revise the allowable floor area of existing assets, either vertically or horizontally, then the value in the existing asset and the precinct in which it is located, can be retained. It is ultimately about leveraging what is already in place—transformation rather than demolition. After all, the most sustainable building is the one that already exists.

A more circular economy needs to benefit the economy. As the concept of “retain/partially retain” versus “demolish” becomes more globally applied, upfront carbon can be reduced, and construction time and cost can be saved. In the case of QQT, over A\$150 million was saved over 13 months. The asset was also able to take tenants earlier, and therefore, generate revenue faster than a full demo and rebuild.

Adaptive re-use is a great sustainability approach, which capital investors are starting to

tie to the price of investment. It is an interesting economic dynamic that extends beyond the embodied carbon number alone.

As one of the biggest contributors to carbon, the architecture and the construction industry has a responsibility to tackle climate change and social infrastructure issues. The radical re-use of existing high-rises will revitalise urban precincts and improve the socio-economic condition of their surroundings and do so with minimal environmental impact.

With QQT showing what is possible, it is no stretch to imagine mid- and late-20th century buildings around the world being upcycled in the years to come. Transformation of existing buildings has the potential to help tackle the global issue of ageing infrastructure, while revitalising urban precincts and surrounding social infrastructure—all at minimal environmental cost. 📍



## SHANGHAI | URBAN REJUVENATION

# A Community for People: Regeneration of Shanghai's 228 Neighbourhood

228 Neighbourhood in Shanghai Yangpu District, albeit constructed 70 years ago, has withstood the test of time, adapting to the increase in standard of living, growing urban population, and evolving cultural shifts. It is proof that urban renewal can create opportunities for the harmonious coexistence of historical architecture with the evolving needs of future neighbourhoods.



Minghua Xue 薛鸣华 is a principal designer at the Shanghai AMJ Architecture and Urban Planning Co., Ltd.



Lin Wang 王林 is a tenured professor at Shanghai Jiao Tong University School of Design.



Before and after the rejuvenation of Changbai neighbourhood 228.  
Image: Shanghai AMJ Architecture and Urban Planning Co., Ltd.

## The Challenge

The history of 228 Neighbourhood can be traced back to the 1950s, when it was built as a residential area for the first generation of workers in China. Originally named "Changbai Village", the neighbourhood is part of the *Liang Wan Hu* ("两万户") or "20,000 households" programme, designed to cope with the impact of Shanghai's industrial development reaching new heights after the opening of its port. Then, the sudden influx of workers in Shanghai forced many workers into shanty towns with poor living conditions. New residential areas for workers were key to solving the housing crisis. In 1952, Chinese architects independently designed and built nine residential areas that could accommodate 20,000 families, giving rise to the name 20,000 households.

Built after the founding of the People's Republic of China, Changbai neighbourhood is today the only remaining complete Liang Wan Hu historical style residence in Shanghai. It represents a key chapter in Shanghai's urban development trajectory; more than just an example of Shanghai's early working-class housing type, Changbai signifies the beginning of Yangpu's century-long industrial history.





228 Neighbourhood bears witness to Yangpu's century-long industrial history.  
Image: Shanghai AMJ Architecture and Urban Planning Co., Ltd.

## Urban Renewal of 228 Neighbourhood

Restoration and renovation [of 228 Neighbourhood] meant prioritising the retention of the neighbourhood's past amid the creation of new functions.

70 years after the completion of 228 Neighbourhood, its limited space and living patterns could no longer meet the needs and improved living standards of residents. Self-constructed expansion and spontaneous remodelling emerged, and the need for urban renewal and renovation grew. Yangpu District recognised the problem and thus began its efforts to protect and renovate the neighbourhood. The neighbourhood underwent urban renewal from 2019 to 2023—guided by the principles of restoration and renovation, which meant prioritising the retention of the neighbourhood's past amid the creation of new functions.

Urban renewal plans for 228 Neighbourhood entailed the combination of existing built infrastructure with additional public services. This was to create a mixed-used neighbourhood with long-term rental apartments, everyday amenities like fresh food markets and a neighbourhood kitchen, recreational areas, and exhibition halls. Following its renewal, 228 Neighbourhood became a model for the "15-minute community life circle", exemplifying how proximity to public services can improve dwellers' quality of life and sense of community.

## Retaining the Essence and History of the 70-Year-Old Development

A key goal for the development was capturing 228 Neighbourhood's 70-year long history in its renewed landscape, through architecture and spatial form. The biggest challenge lay in figuring out how to better reflect and retain the functional characteristics and existing ambience of the neighbourhood, while improving residents' quality of life and creating a notable image for the neighbourhood.

Preliminary research by the design team underscored the importance of combining historical memory with contemporary functional needs, alongside optimising the

overall environment according to existing spatial patterns of the neighbourhood. 228 Neighbourhood was to be a living model of the workers' new village, showcasing the distinctive lives led by workers during the 70-year industrial revolution. The neighbourhood would consist of restored historical workers' new villages from the 1950s, modern workers' housing from the 1990s, and contemporary long-term rental apartments from the 2020s. These residential buildings of different periods and styles embody the collective lives led by the workers of New China, function as historical models of

workers' shared residences, and is of deep cultural significance to the Yangpu region.

Central to the rejuvenation of 228 Neighbourhood would be the full preservation of the unique style and environment of the block's 70-year history. The renewal sought to improve the environmental quality of the development by strategically lining its periphery with taller housing blocks and shorter multi-story residential buildings, creating a "project package" that would comprehensively shape 228 Neighbourhood and its surrounding areas.



Bird's eye view of the neighbourhood after renewal.  
Image: Shanghai AMJ Architecture and Urban Planning Co., Ltd.



## Its garden city concept... is aimed at integrating and synergising the built with the natural environment to the benefit of living communities.

### Building a Model Community

To achieve the underlying goal of architectural coexistence through renewal, the design team proposed three major overall improvement strategies: (1) continuing the neighbourhood's historical appearance and emphasising its cultural connotation; (2) strengthening functional improvement and improving service facilities; and (3) optimising the block environment and improving landscape quality. These strategies were aimed at transforming 228 Neighbourhood into a model community, guiding a new era of urban renewal which seeks to combine historical preservation with modern amenities to provide a holistic approach to urban planning and service.

A key feature of this new model community is its garden city concept, which is aimed at integrating and synergising the built with the natural environment to the

benefit of living communities. This prompted the design team to create a public square within the workers' new village—in the form of an open space with a garden environment—to balance the high-rise, densely populated urban surroundings.

The team designed a traditional-styled courtyard by combining wooden fences with green landscapes, setting up gardens outside according to the architectural space and functions to form a dynamic shared space for public use. These courtyards also improve the overall landscape quality. In addition, a large lawn space in the centre of the neighbourhood, open-air cinema, outdoor children's football fields, landscaped corridors, central stages, and other functional spaces were also created to integrate greenery with shared spaces, thereby creating an exchange centre for the workers' new village.



228 Neighbourhood's central square.  
Image: Shanghai AMJ Architecture and Urban Planning Co., Ltd.



Children playing in the large lawn space in the heart of the neighbourhood.  
Image: Shanghai AMJ Architecture and Urban Planning Co., Ltd.



228 Neighbourhood's logo, aimed at capturing the (re)development trajectory of the neighbourhood.  
Image: Shanghai AMJ Architecture and Urban Planning Co., Ltd.



The public often gather around the seating spaces adjacent to 228 Neighbourhood's logo, placed left of the entrance of the neighbourhood.  
Image: Shanghai AMJ Architecture and Urban Planning Co., Ltd.

## Urban renewal of 228 Neighbourhood involved not only the rejuvenation of the neighbourhood but also its surrounding environment.

### 228's Unique Brand Identity

To bring out Changbai neighbourhood's distinctive characteristics, the design team explored the evolution of the neighbourhood over three time periods—the 1950s, 1990s, and 2020s. The housing typologies over the three periods were ultimately incorporated into the neighbourhood's logo, with the aim of showcasing the historical significance and cultural uniqueness of Changbai. The entrance archway and cultural signs of the old workers' village around the neighbourhood were also retained, to serve as a reminder of Changbai's historical significance to industrial workers, as well as one of the nation's first developments post-independence.

Urban renewal of 228 Neighbourhood involved not only the rejuvenation of the neighbourhood but also its surrounding environment. This was done through the enforcement of strict regulations and consistent codes of design throughout the neighbourhood. The design combined the brand identity of 228

Neighbourhood with the renewed landscape, proposing targeted design strategies for surrounding residential buildings, street building facades, walls, green public spaces, urban furnishing, and even design of shop signs, doors, and windows to ensure a coordinated street facade. The facades of two existing substation buildings along the street were also optimised to transform the original negative environment into a beautiful urban public space for culture appreciation, interaction, and relaxation. All of these efforts served to visually coordinate and unify the planning of the entire area.

In sum, the renewal of Yangpu District's 228 Neighbourhood reveals the importance of an all-encompassing rejuvenation plan—one which involves the preservation and embrace of history and culture, revitalisation of housing and living conditions for people of the new age, injection of new public spaces for all ages, and rebranding of the neighbourhood—to best capture the nuances of the neighbourhood over its 70-year history. 🌀



At the Centre for Liveable Cities,  
we are committed to providing urban leaders  
and practitioners with the knowledge and  
support needed to make our cities better.

Join our conversation on social media #CLCSG

