

An aerial architectural rendering of a sustainable city development. The foreground shows a cluster of modern, multi-story residential buildings with dark roofs and light-colored facades, interspersed with lush green trees. A winding river or canal flows through the development, with several small boats and docks. In the background, a dense forest of green trees separates the residential area from a distant city skyline under a hazy sky.

Net Zero Cities

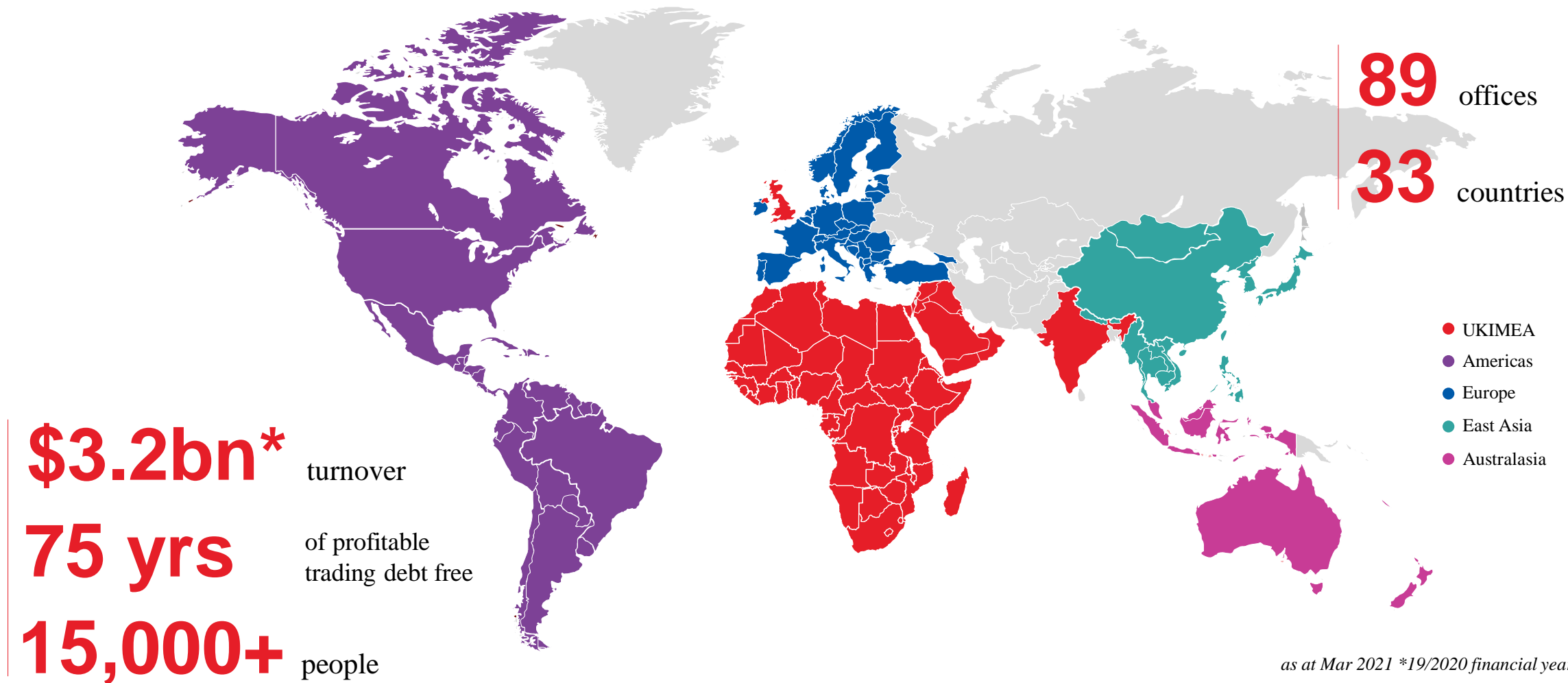
Murali Ram, Arup Malaysia

About Arup

Arup is an independent firm of multidisciplinary designers, engineers, architects, planners and technical specialists working across every aspect of today's built and natural environment. Founded in 1946 with an enduring set of values, our unique trust ownership fosters a distinctive culture and an intellectual independence that encourages collaborative working. This is reflected in everything we do, allowing us to develop meaningful ideas, help shape agendas and deliver results that frequently surpass the expectations of our clients. The people at Arup are driven to find a better way and to deliver better solutions for our clients.

We shape a better world..

Our global presence

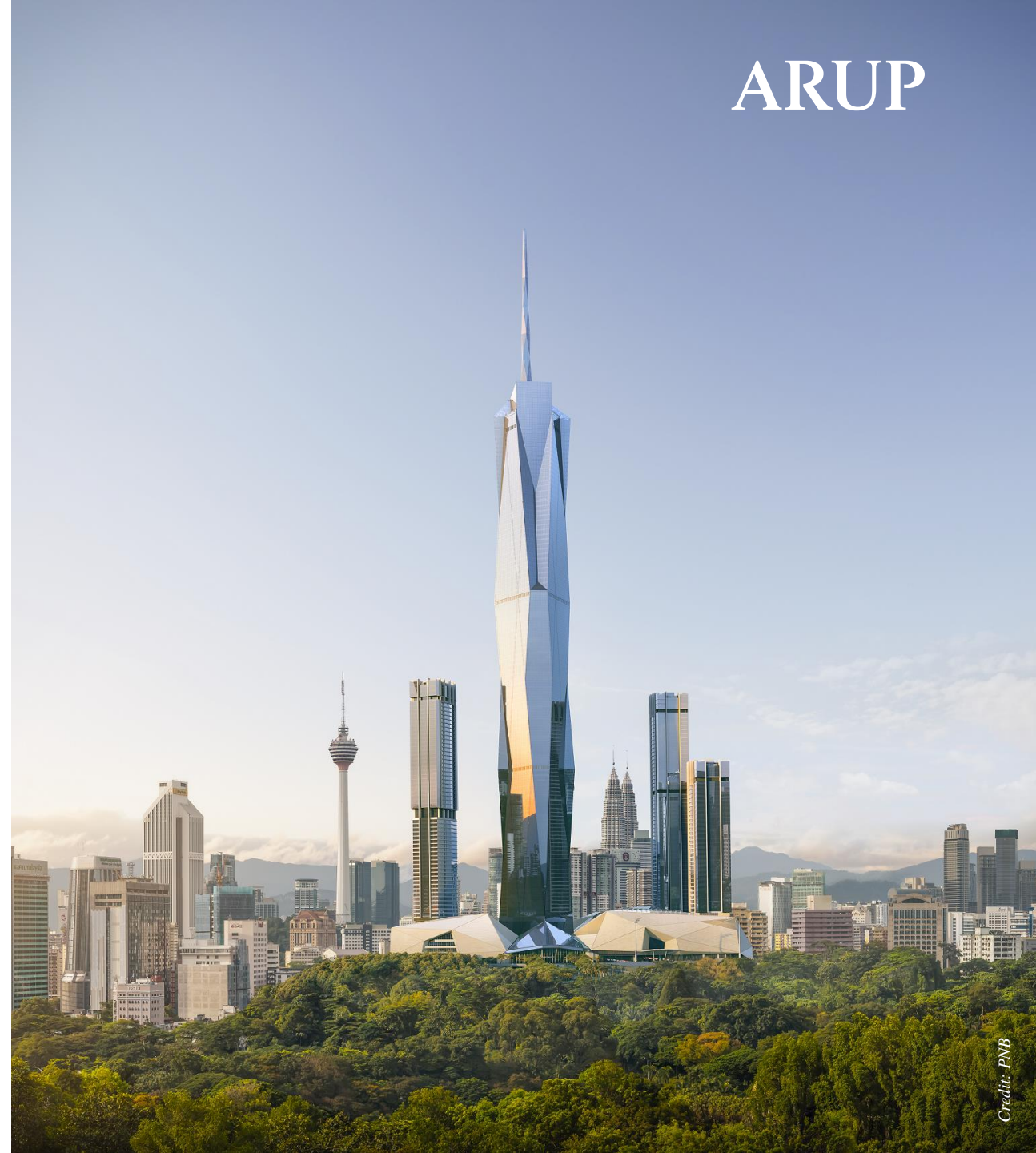


Arup in Malaysia

Operating since 1964

Arup's success is founded on delivering global expertise locally. The firm now has over 1,000 staff based in Cambodia, Vietnam, Indonesia, Malaysia, Philippines, Singapore and Thailand. Arup has been operating in Malaysia since 1964 with offices in Kuala Lumpur and Penang. We have shaped some of the country's most iconic developments and strategies, e.g. the Merdeka 118, MRT Line 2, Setia SPICE Convention Centre, KL Climate Action Plan 2050, UK Partnering for Accelerated Climate Transitions Malaysia, and the Malaysia Smart City Handbook.

ARUP



We must **act** now

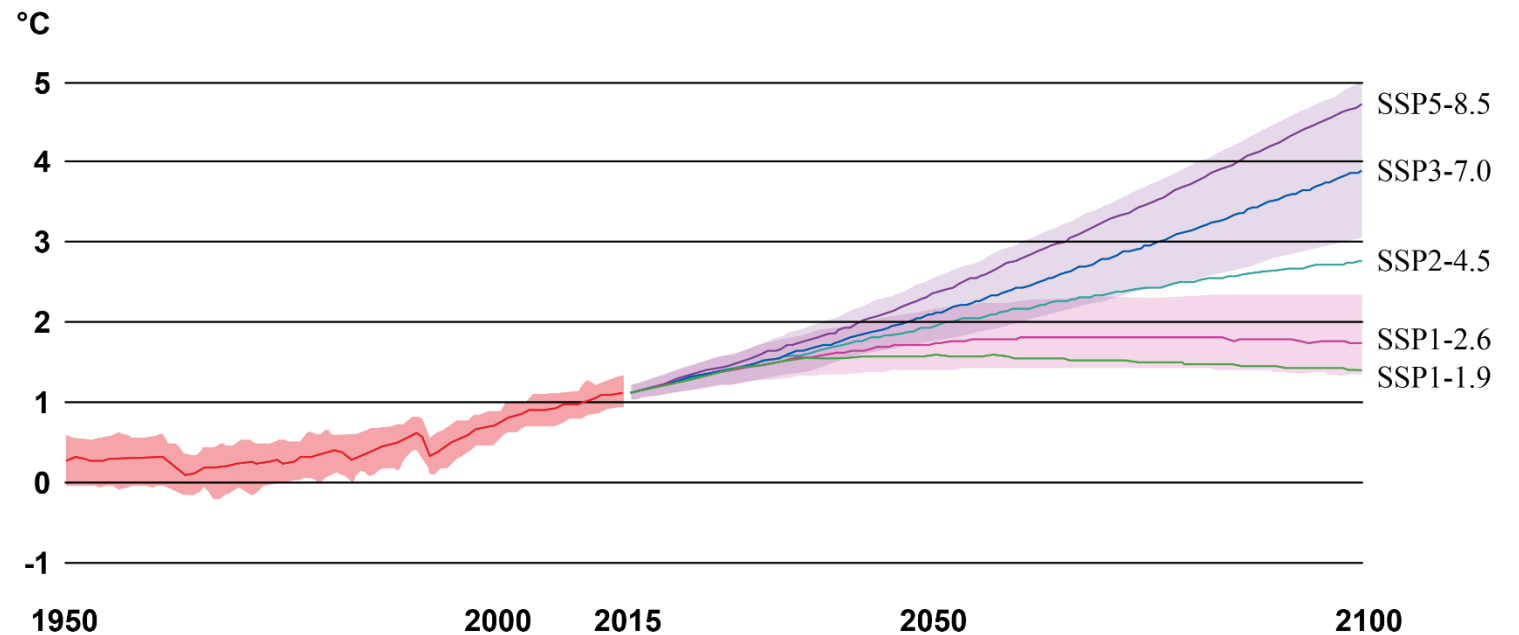
Human activity is causing irreversible changes to our climate

Emissions continue to rise

The built environment contributes at least **40%** of annual carbon emissions¹

We must limit temperature rise to **1.5°C above pre-industrial** levels to avoid the worst effects of climate change²

Our current trajectory will **overshoot 1.5°C by 2030**^{3,4}



Global average surface temperature change
Relative to 1850-1900 for five emissions scenarios,
from IPCC 2021 (figure SPM.8a)

A pathway **through** net zero

Reduce, Restore, Remove

To limit warming to 1.5°C, atmospheric carbon must stop rising and decline.

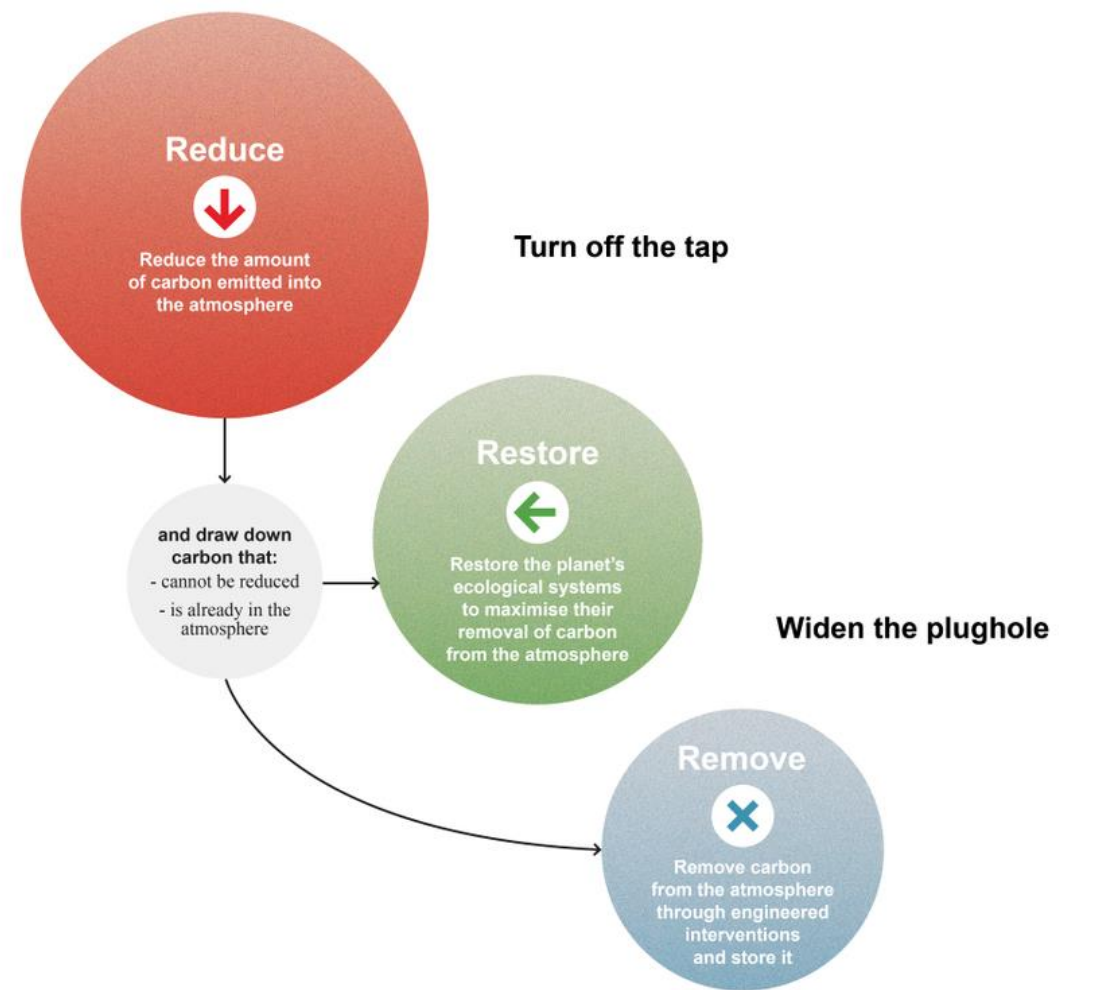
Net zero emissions is a key milestone but not the destination.

We must achieve:

45% reduction in global CO₂ emissions from 2010 levels by **2030**⁵

Net zero CO₂ emissions by **2050**⁶

Atmospheric carbon declining from 2050



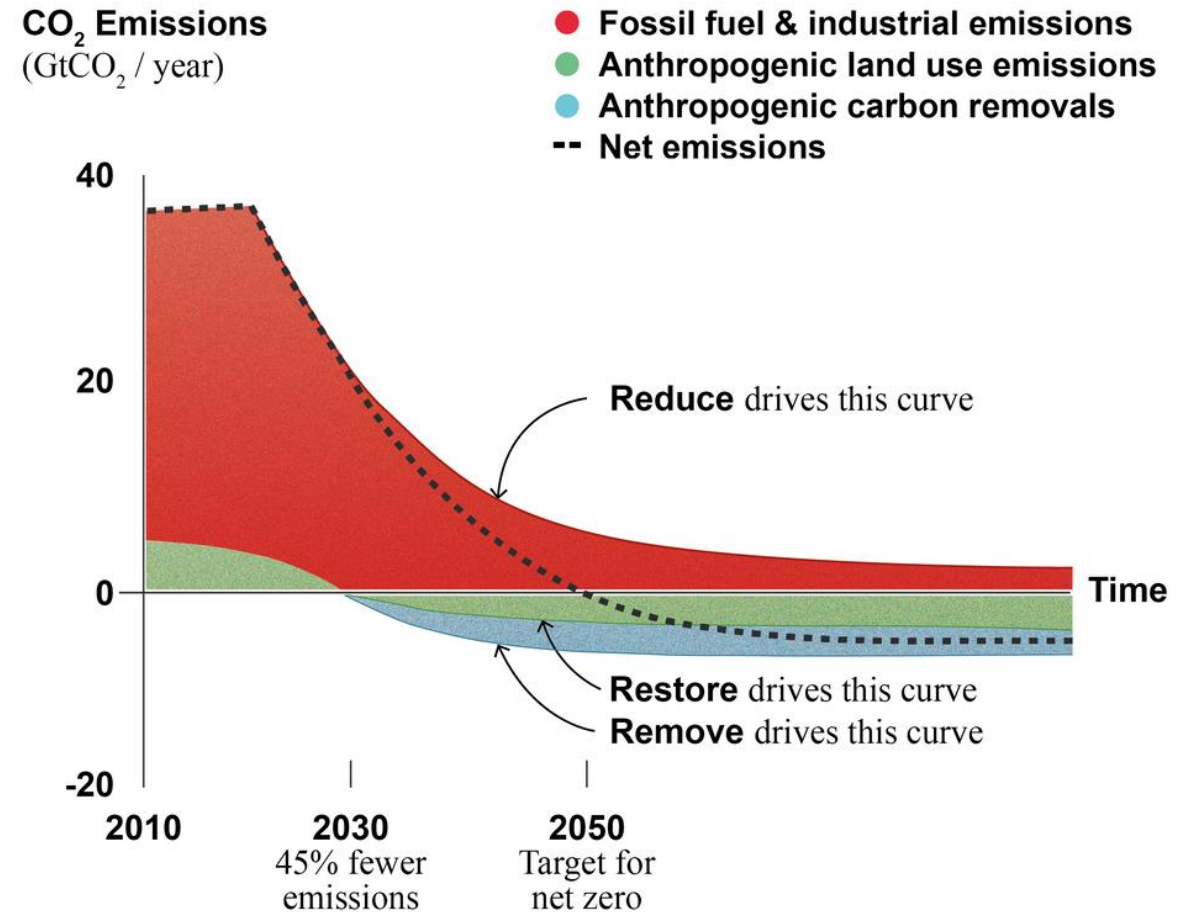
A pathway **through** net zero

Impact of the 3Rs on net emissions over time

Reduce methods must be implemented today to have an immediate impact

Restore methods must be scaled up now

Remove methods must be developed simultaneously



IPCC P2 pathway to limiting global warming to 1.5°C
from IPCC 2018 (figure SPM.3b) annotated with the 3Rs

Carbon-neutral, net-zero, climate positive?

Net-Zero carbon emissions mean that an activity releases net-zero carbon emissions into the atmosphere.

Carbon neutral means that any CO₂ released into the atmosphere from a company's activities is balanced by an equivalent amount being removed.

Net-Zero emissions balance the whole amount of greenhouse gas (GHG) released and the amount removed from the atmosphere.

Climate neutral refers to reducing all GHG to the point of zero while eliminating all other negative environmental impacts that an organisation may cause.

Climate positive means that activity goes beyond achieving net-zero carbon emissions to create an environmental benefit by removing additional carbon dioxide from the atmosphere.

Carbon-neutral countries



Bhutan

became the first carbon negative country by 2021. This means it removes more CO₂ from the air than it emits into it. It consists primarily of forest and agricultural land.



Suriname

became the second carbon negative country. Mostly tropical rainforests cover its area.



Panama

probably carbon negative as of 2021, certification expected to arrive.

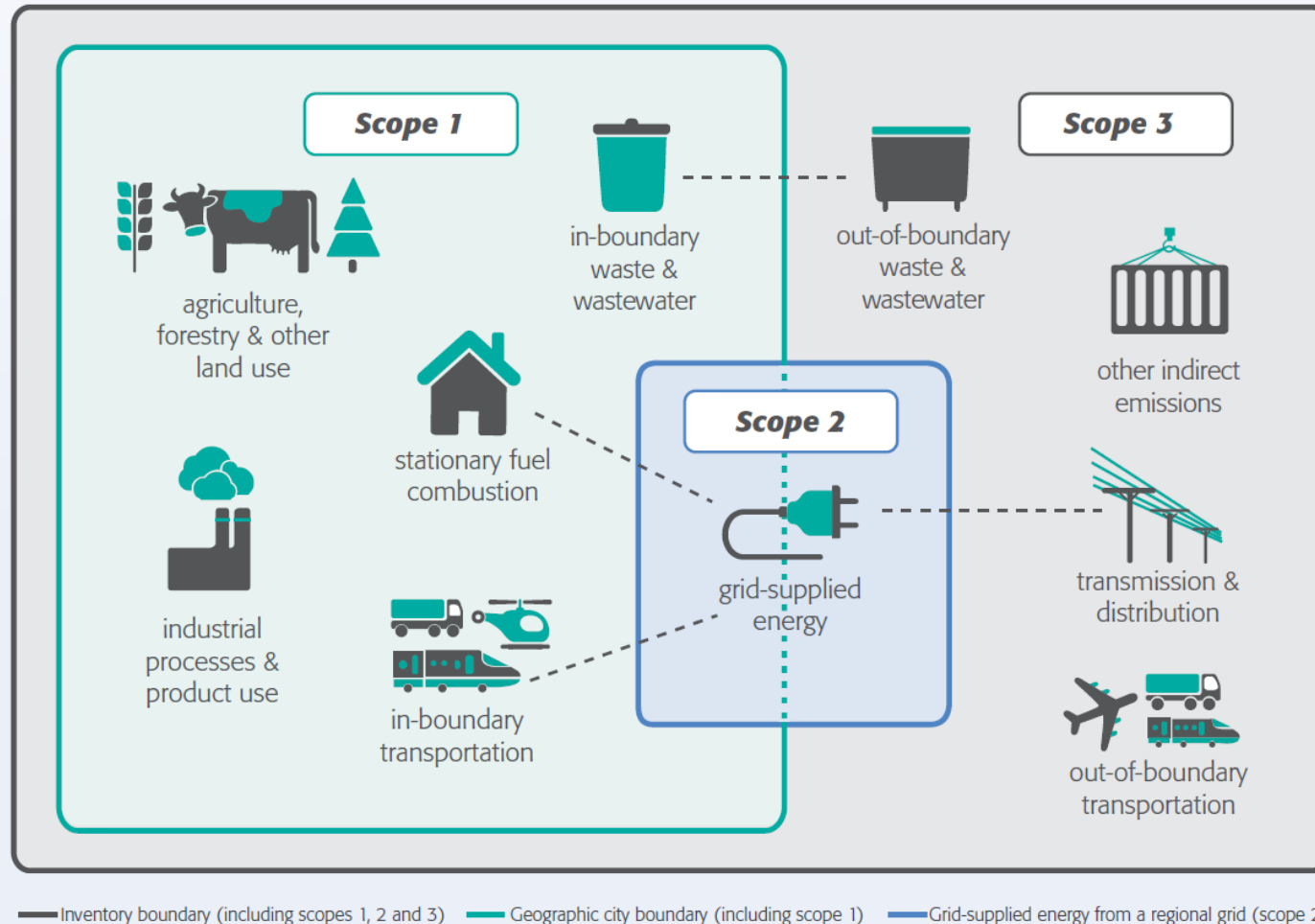


Costa Rica

aims to be fully carbon neutral by 2050. 94% of its electricity generated from hydroelectric power, wind farms and geothermal energy.

The GPC Framework

Figure 1 Sources and boundaries of city GHG emissions



The GPC framework, often described as “production-based” or territorial accounting, captures GHG emissions associated with major urban activities within physical city boundaries, i.e. transport; buildings and industries; agriculture; forestry and other land uses (where applicable); as well as waste disposal and wastewater treatment.

Kuala Lumpur Climate Action Plan 2050

Carbon Emission Profile

GPC Method is used to measure and report municipal greenhouse emissions in 2017 to establish a base year profile.

Sources of emission included in the inventory are stationary energy, transportation and waste.

Carbon Emissions Profile of Kuala Lumpur

KLCH used the GPC method to measure and report municipal greenhouse emissions in 2017 to establish a base year profile. The BASIC¹ level within the GPC methodology estimates the following sources of emissions:

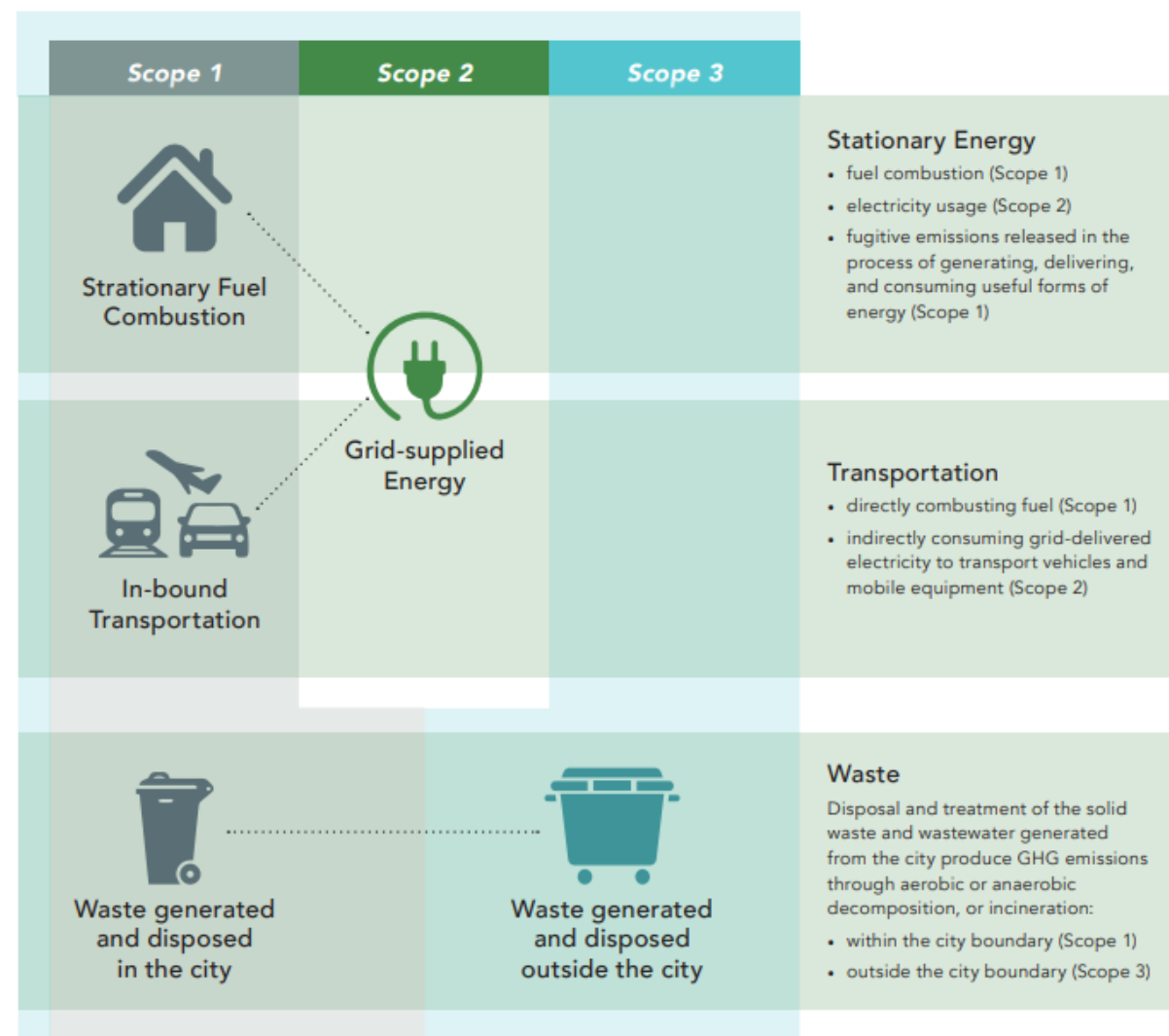


Figure 9: Sources of Emissions Included in the 2017 Inventory for Kuala Lumpur

Kuala Lumpur Climate Action Plan 2050

Carbon Emission Profile – by Sector and Sub Sector

Sector	Sub Sector
Stationary Energy	Residential
	Commercial
	Industrial
	Fugitive Gas
Transportation	On-road Transportation
	Railways
Waste	Landfill
	Incineration
	Composting

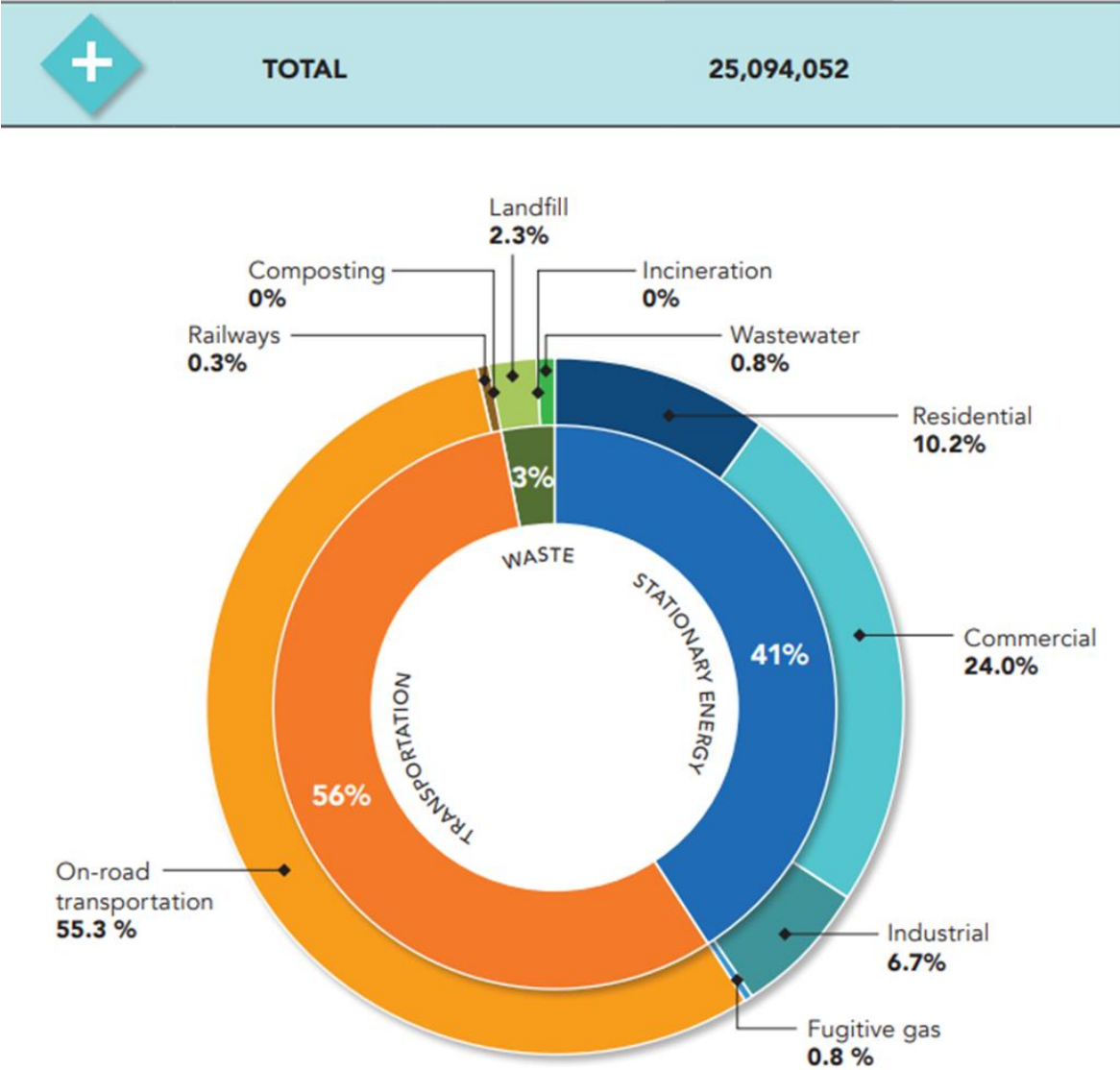
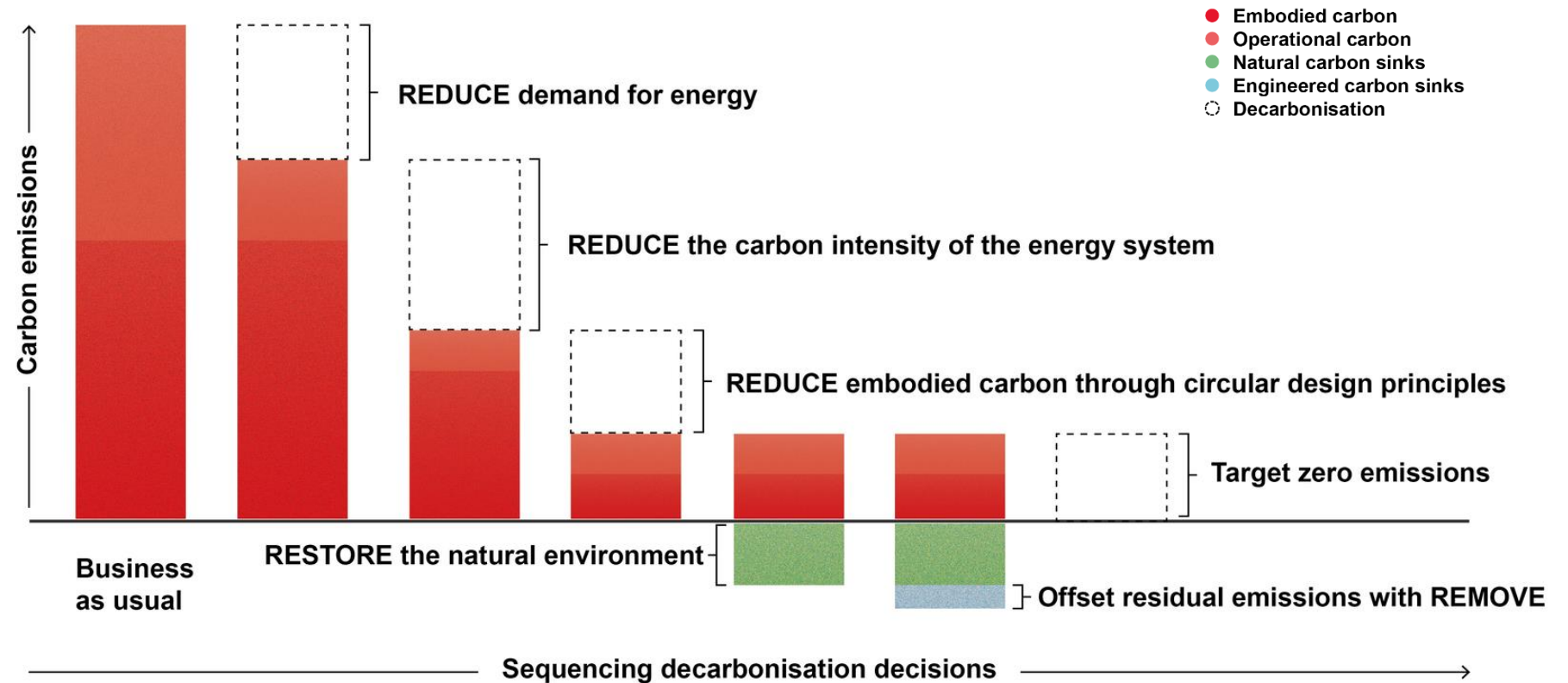


Figure 10: Emissions by Sector and Sub-Sector Estimated in Kuala Lumpur BASIC GPC Inventory for 2017

A pathway **through** net zero

The approach to decarbonisation in the built environment

We must work at a **whole-life** and **whole-system** scale



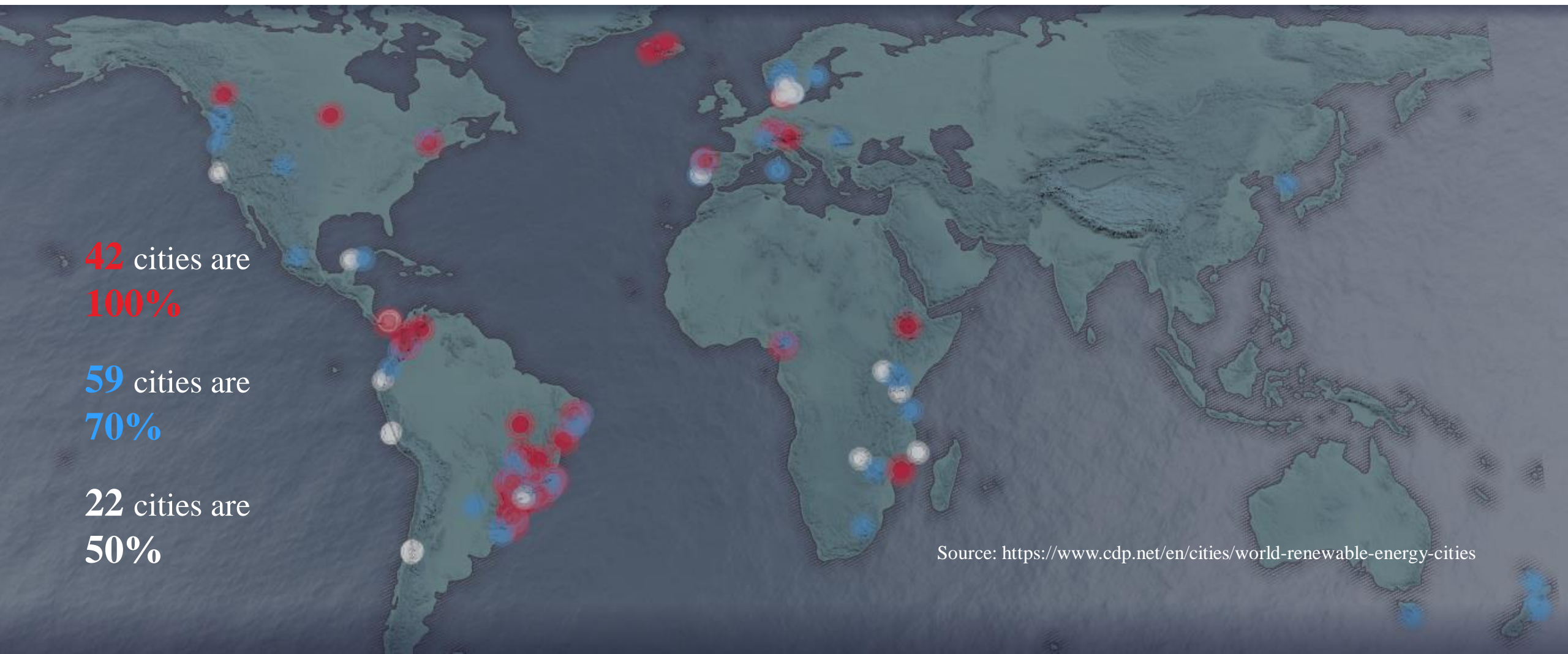
Over 100 cities now get at least 70% of their electricity from renewable sources such as hydro, geothermal, solar and wind.

42 cities are
100%

59 cities are
70%

22 cities are
50%

Source: <https://www.cdp.net/en/cities/world-renewable-energy-cities>



Building Impact

39%

of global energy
related carbon
emissions are from
buildings

28%

from operational
emissions, from energy
needed to heat, cool
and power them

11%

from materials and
construction



ARUP

CITY POLICY FRAMEWORK FOR

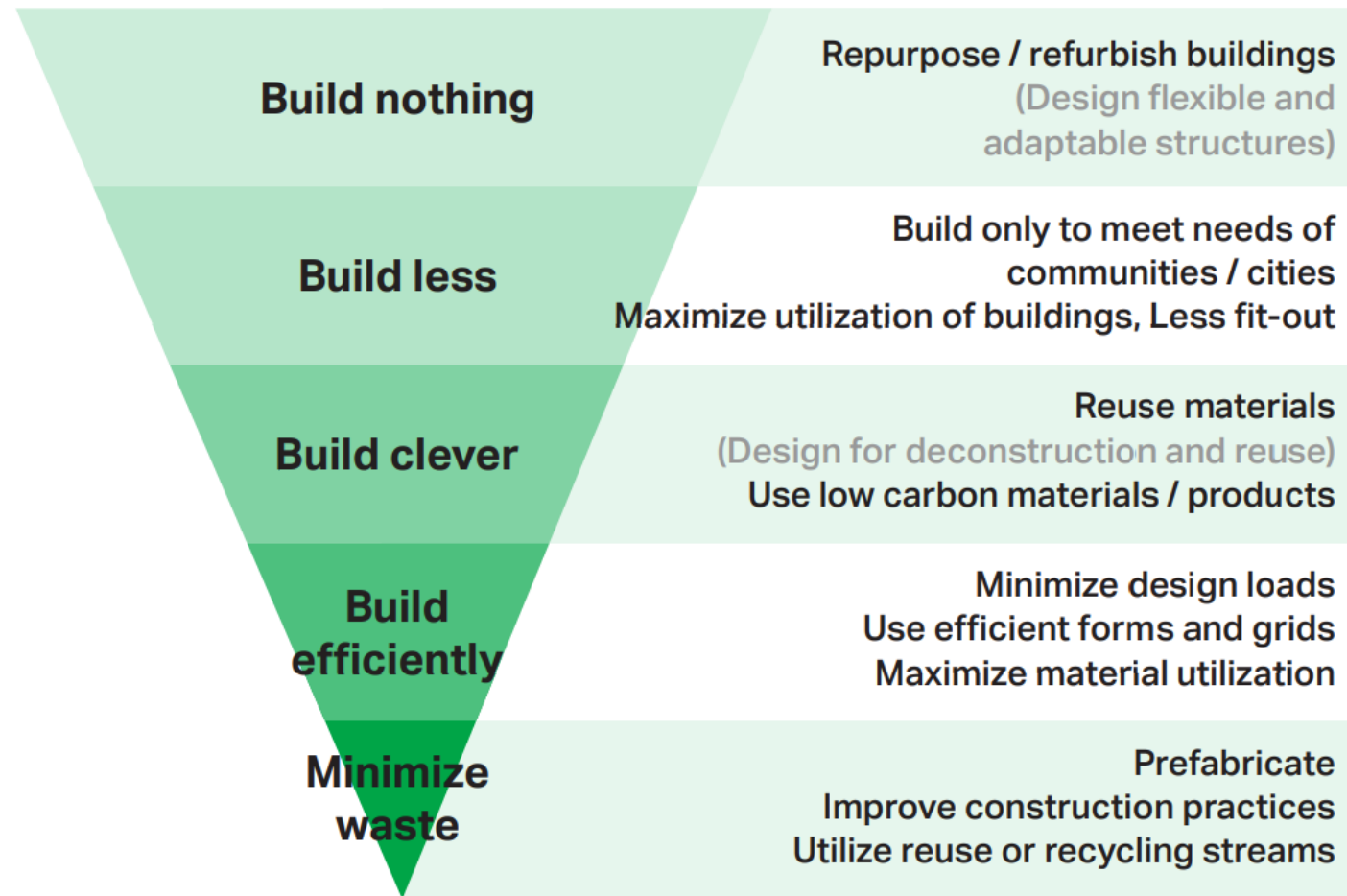
DRAMATICALLY REDUCING EMBODIED CARBON

52 detailed policies to reduce embodied carbon

embodiedcarbonpolicies.com

Decarbonising the built environment

The hierarchy of embodied carbon reduction strategies (source: IStructE Design for Zero, 2021)



Rejuvenating a CBD precinct

Adaptive
reuse of
1970s
tower

>10 years
involvement
from project
inception
through to
construction

\$20M
fees earned

Rejuvenating
a lapsed Client
relationship
with AMP

UX and Digital
consultancy

\$40K
One Arup
engagement



Retrofit = Decarbonised

68%

of the existing
structure maintained

10,000

aeroplane flights from
Sydney to Melbourne
save in embodied carbon

7,738t

of CO₂e saved through
reuse of building fabric

Original
building



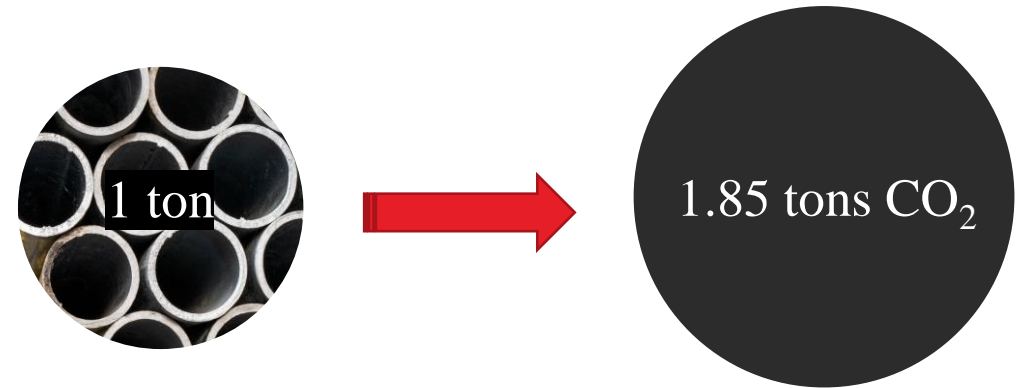
Embodied Carbon

Project Example of a Township: Buildings

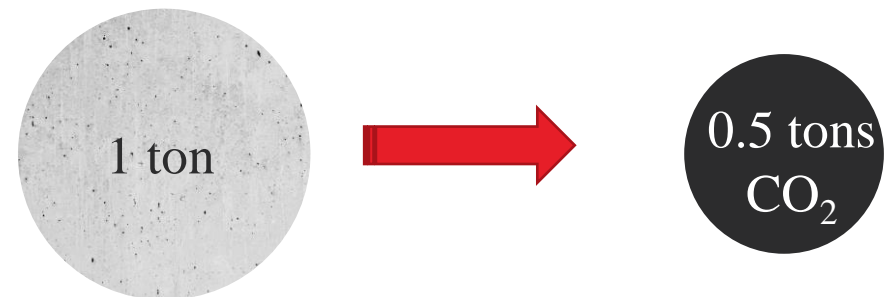
92% of embodied carbon involved in the Township comes from Buildings.

85% of the total embodied carbon emissions needed to build a two-storey house come from **concrete** and **steel**.

In multi-storey buildings, **aluminium** and **glass** are also key contributors.



In 2018, for one ton of steel produced, 1.85 tons of carbon were emitted, equating to 8% of global carbon emissions. (McKinsey & Company)



For every ton of concrete produced, 0.5 tons of carbon are emitted, also equating to around 8% of global carbon emissions. (ULI)

Embodied Carbon

Infrastructure: Roads / Highways

From research examining the carbon footprint of the La Abundancia highway in Costa Rica

- Each lane-kilometer of road made up of hot mix asphalt generated **66 kg** of carbon emissions from the construction and production stages.
- Considering construction and production stages only, **98% of carbon emissions were from the production stage**, and 2% were from construction. Using recycled materials can reduce this source of embodied carbon.
- **Bitumen** (a component of asphalt) contributed **38% of total GHG emissions** to the road project.



In the news

What is happening

City of London sets out new planning guidance to tackle embodied carbon

8 JUNE 2022 • BY HARRIET THORPE



Newly approved buildings featured in the images include: 50 Fenchurch Street, 55 Gracechurch Street, 60 Aldgate High Street, 70 Gracechurch Street and 2-3 Finsbury Avenue.

Source: Didier Madoc Jones of GMJ and City of London Corporation

The City of London Corporation has begun consultation on a draft planning advice note tackling the assessment of whole lifecycle carbon for all new major projects

The authority's proposed guidance spells out how it expects developers to calculate and report the whole lifecycle carbon emission impacts of a scheme at an early stage, even before designs are finalised.



Investa Announces 100% Green Finance Target by 2025 As Part of New ESG Strategy – Transform Tomorrow

May 26, 2022

Investa this week announced it is targeting 100% green finance across its core funds by 2025.

Jason Leong, Group Executive, Head of Investment Management said: "Investa has consistently led the way in real estate green finance in Australia and continues to capitalise on its ESG performance and leadership, to meet investor demand for climate action.

We are committed to playing a leading role in the transition to a low carbon economy. Green debt links our funding with an emissions intensity standard for our portfolio, creating financial opportunity via strong environmental

CLIMATE CHANGE

Siam Cement plans building material with 50% less CO2 emissions by 2030

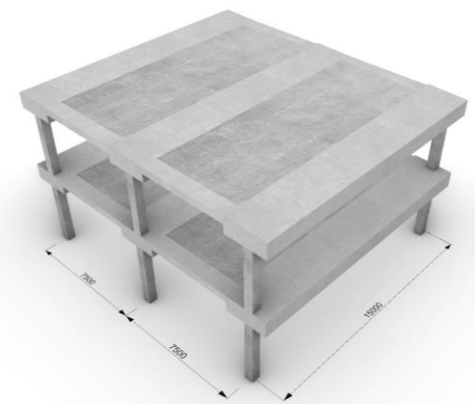
New cement will help achieve Thai industrial group's net-zero goal



Cement and construction materials generate about 30% of Siam Cement Group's revenue. © Reuters

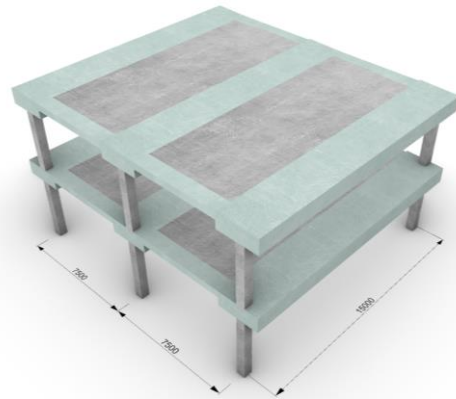
Changing the building materials brief

Embedding low carbon materials from the beginning (source: previous Arup project)



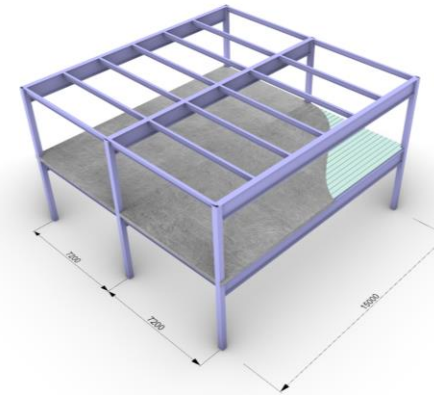
PT concrete structure
Grid: 15 m x 7.5m

400-450 kgCO₂e/sqm



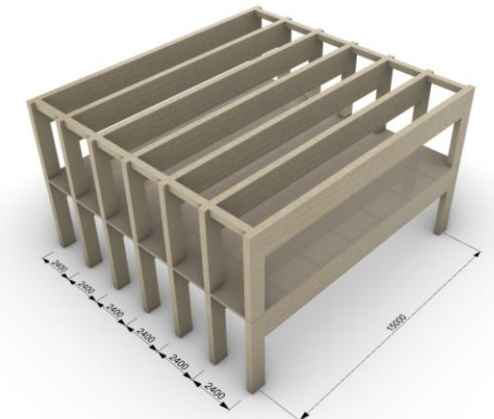
PT with SCM Concrete
Grid: 15 m x 7.5m

371 kgCO₂e/sqm



Steel frame + Concrete
Grid: 15 m x 7.5m

347 kgCO₂e/sqm



Timber structure
Grid: 15 m x 2.4m

272 kgCO₂e/sqm

The Future of Tall Wood

TF2000 (UK)
(6 floors, 20m)



2000

Stadthaus
(London)
(8+1 floors, 29m)



2008

Treet (Norway)
(14 floors, 52m)



2012

Brock Commons
(Vancouver)
(18 floors, 53m)



2017

HAUT
(Amsterdam)
(19 + 2 floors, 73m)



2019

In the news

What is happening



May 22, 2022

**SINGAPORE'S LARGEST MMC MASS TIMBER
BUILDING TAKES SHAPE**



Scan to read our guidebook and find out more



Operational

Annual emissions due to energy used in buildings, public spaces and transportation, or from processing waste.

Target

Net zero new buildings now
Net zero existing buildings by 2050



Embodied

All emissions from any construction activity over the lifecycle of either buildings or infrastructure.

Target

Lifecycle emissions assessments now
Reduce emissions by 50% now



Consumption

The emissions impact of the goods and services people in the neighbourhood consume.

Target

A few ambitious, measurable actions

Operational Carbon

Townships: Densities



Suburban 7 units per acre



Density of 6-8 du/acre is the minimum required to support a regular bus service* (CRCOG)



Suburban 15 units per acre



Density of 15 du/acre is the minimum required to support a regular bus service with pedestrian access (not park and ride)* (CRCOG)



Suburban 32 units per acre (1) mixed use



At densities of 30 du/acre, there is a tripling in ridership levels, making a transit system more economically feasible.* (CRCOG)

*Based on research and travel behaviors found in the United States

The neighbourhood scale in a city offers some unique opportunities to accelerate towards net zero.



Anna König Jerlmyr
Mayor of Stockholm
Vice-Chair of C40 Cities



A green and thriving neighbourhood should enable residents of all ages, backgrounds and abilities to meet their daily needs close to home.



Anne Hidalgo
Mayor of Paris
Former chair of C40 Cities



Thriving

Resilient, people-centred places

Meet the **essential needs** of people at the neighbourhood scale

Support **'human scale' local life** which encourages healthy, sustainable lifestyles

Prepare people, businesses and systems to **adapt and prosper** no matter the shocks, stresses or climate related impacts

The “15-minute city” model is an increasingly valuable urban planning paradigm, emphasizing the importance of the hyper-local environment to support quality of life.

15-minute cities



1. Complete neighbourhood

Prioritise local life where people access what they need within a short walk or bike ride



2. People-centred mobility

Encourage active travel with well-designed spaces, infrastructure and services



3. Connected place

Enhance city-wide connectivity with stronger physical and digital links



4. A place for everyone

Tackle climate change, improve living standards and create better jobs for all

Superblock Poblenou, Barcelona

A transformative vision for the entire city making spaces and streets greener, giving priority to pedestrians and cyclists by closing streets to through traffic and introducing tactical urbanism interventions.

With temporary street furniture, reversible painted ground signs, and mobile tree planters, the pedestrian area increased by 80% and the area occupied by cars reduced by 48%. New children's playground areas were created, and the green area was increased by 91%.



Clean and green



5. Clean construction

Make the most of existing assets, then design and build efficiently for the long-term



6. Green buildings and energy

Minimise energy demand, invest in high-efficiency infrastructure and decarbonise supply



7. Circular resources

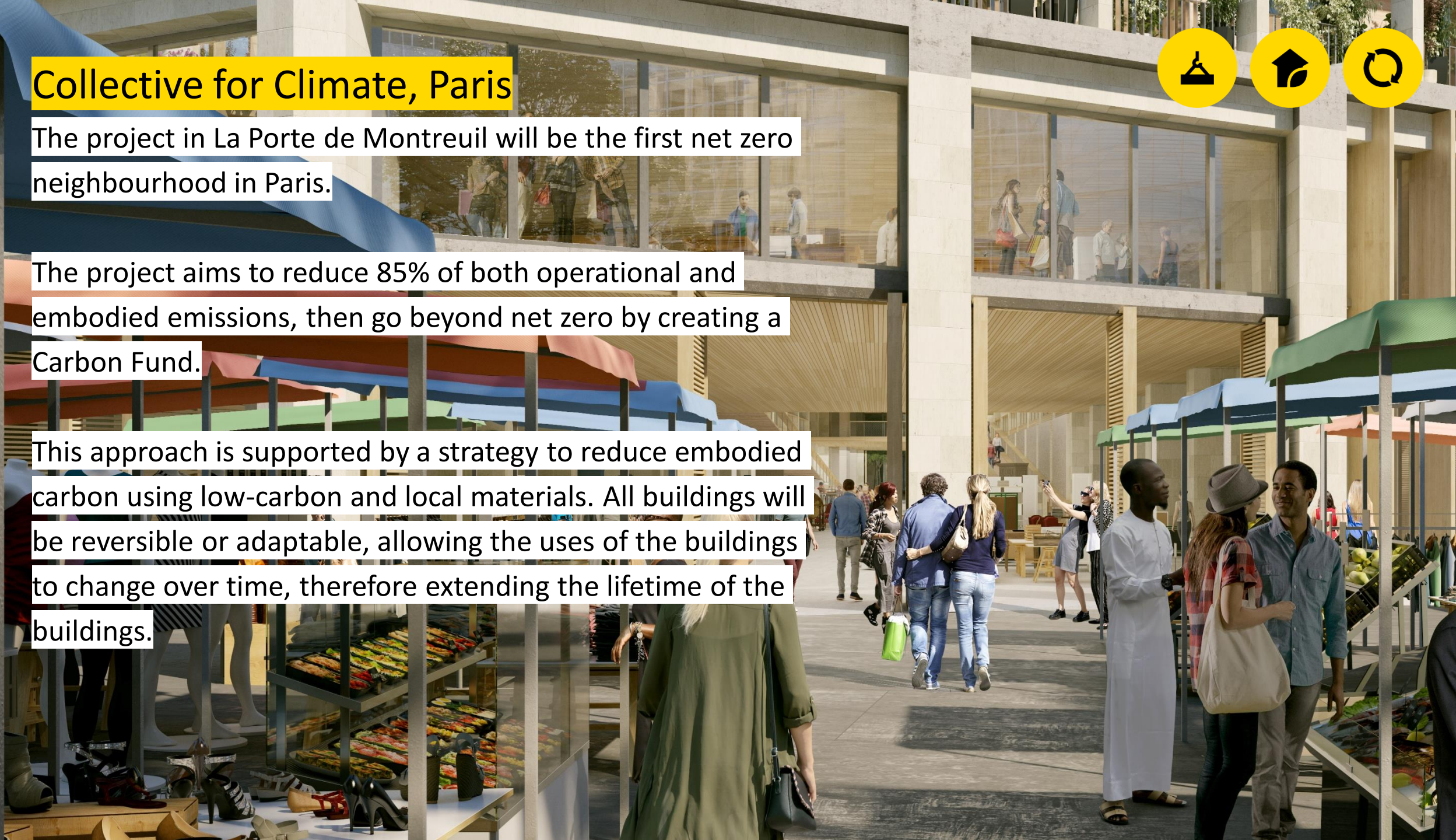
Minimise resource use and waste, and create long-term value chains for materials

Collective for Climate, Paris

The project in La Porte de Montreuil will be the first net zero neighbourhood in Paris.

The project aims to reduce 85% of both operational and embodied emissions, then go beyond net zero by creating a Carbon Fund.

This approach is supported by a strategy to reduce embodied carbon using low-carbon and local materials. All buildings will be reversible or adaptable, allowing the uses of the buildings to change over time, therefore extending the lifetime of the buildings.



Sustainable future



8. Green & nature-based solutions

Promote health and wellbeing, create community, increase biodiversity and climate resilience



9. Sustainable lifestyles

Make sustainable lifestyles attractive, affordable and easy to achieve



10. Green economy

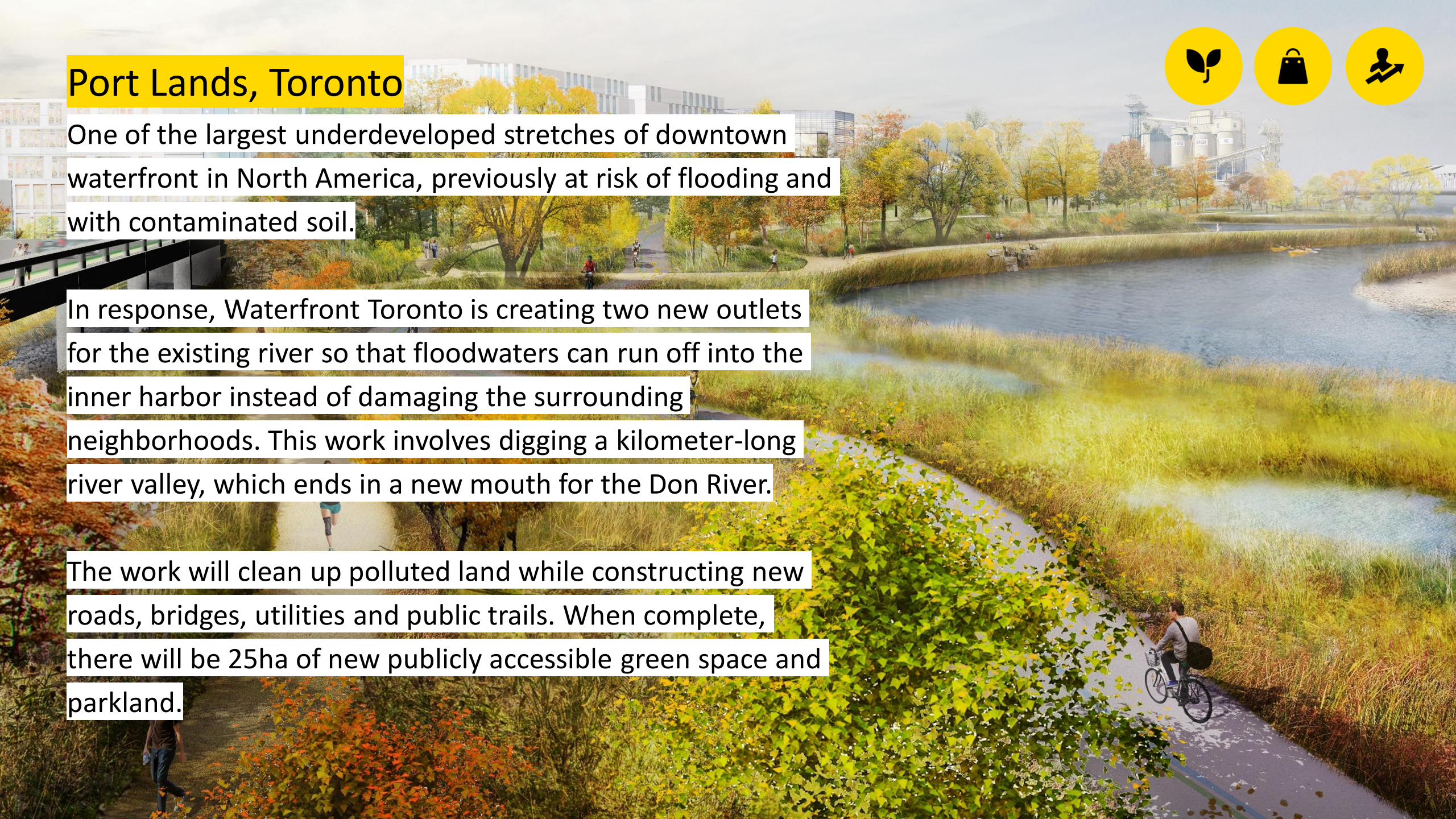
Create and support green jobs and contribute to long-term prosperity

Port Lands, Toronto

One of the largest underdeveloped stretches of downtown waterfront in North America, previously at risk of flooding and with contaminated soil.

In response, Waterfront Toronto is creating two new outlets for the existing river so that floodwaters can run off into the inner harbor instead of damaging the surrounding neighborhoods. This work involves digging a kilometer-long river valley, which ends in a new mouth for the Don River.

The work will clean up polluted land while constructing new roads, bridges, utilities and public trails. When complete, there will be 25ha of new publicly accessible green space and parkland.



L'Innesto, Milan

The first zero carbon “Housing Sociale” project in Italy. In addition to ultra-efficient buildings and low-carbon heating, L'Innesto will foster sustainable lifestyles.

The neighbourhood app is the platform that provides residents with advice on energy saving opportunities and energy monitoring in homes.

The neighbourhood will create value-added shared spaces for sustainable economic activity and enable relationships between residents. There will be a ‘Zero Waste Store’ and a ‘Community Food Hub’ helping the residents create a long-lasting sustainable community.



2. Establish a baseline

Pillar 1: Green

Determine the **factors** that impact emissions and calculate the **emissions profile**.

Pillar 2: Thriving

Review the social, economic and environmental **drivers** and agree **quality of life requirements**.

Tracking progress

Reporting

Site build out

350,000 sqm



Complete (%)

Annual operational emissions

15,000 tCO₂e



Buildings

12,250 tCO₂e



Transport

1,750 tCO₂e



Waste

Total embodied emissions

55,000 tCO₂e



Buildings

35,000 tCO₂e



Public Realm

Total offset emissions

25,000 tCO₂e



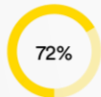
Emb. Emissions Offsets

Monitoring

15-Minute Cities



1. Close to home



Population <500m from key amenities



2. People-centred mobility

15 km



Cycle routes

Clean & Green



5. Clean construction

135 tCO₂e/sqm



New construction



Demolition waste



Demolition waste



6. Green buildings & energy

48 kWh/m²/yr



Average EUI

350

On-site renewable generation (kW)



7. Circular resources

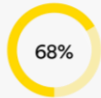
180 kg/capita/yr



Household waste



3. Connected place



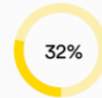
Trips by public transit



Broadband access



4. Place for everyone



Affordable homes (%)

230

Stakeholders engaged

Sustainable Futures



8. Green & NBS



Green coverage

476

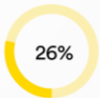
Local food production (tonnes/yr)



9. Sustainable lifestyles



Smart meters installed (%)



Residents accessing shared services (%)



10. Green economy

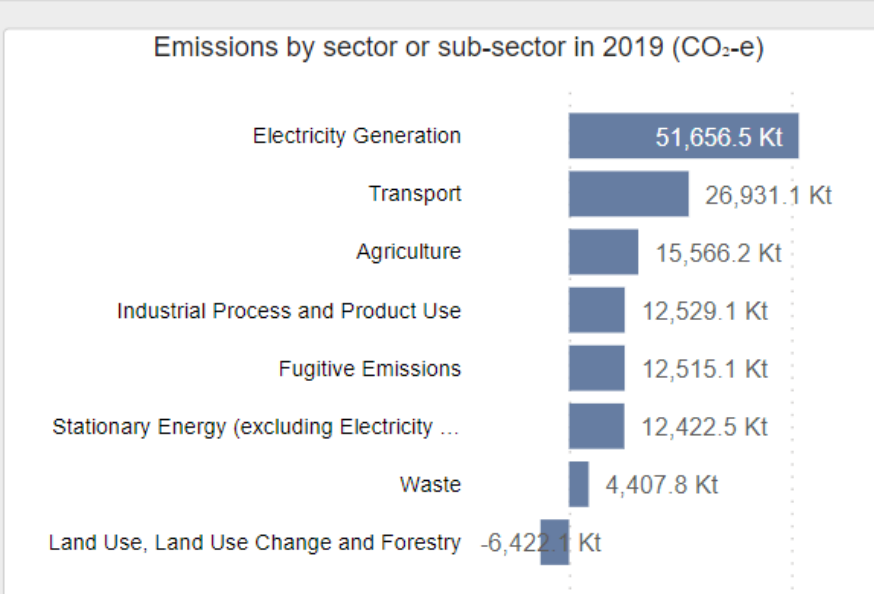
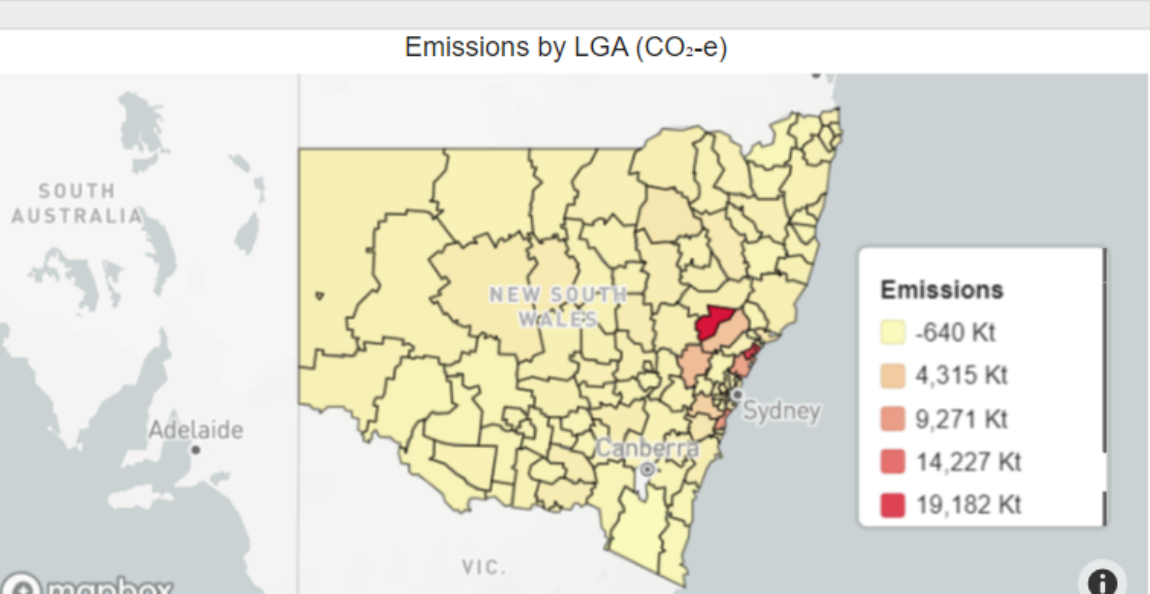
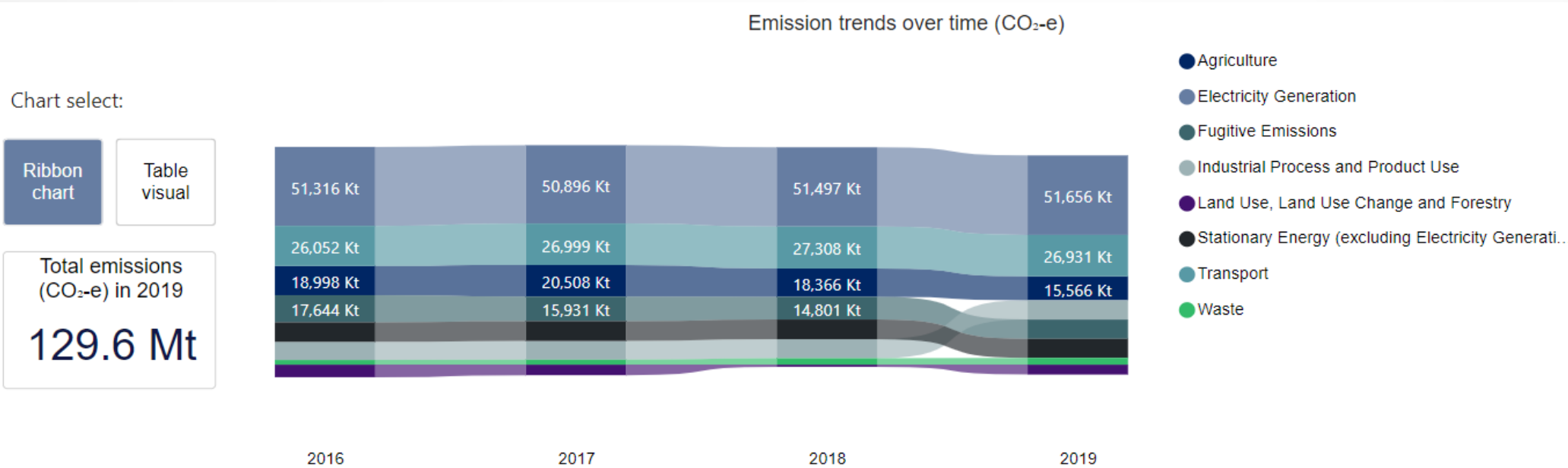
368

New green economy jobs

284

New green economy training positions

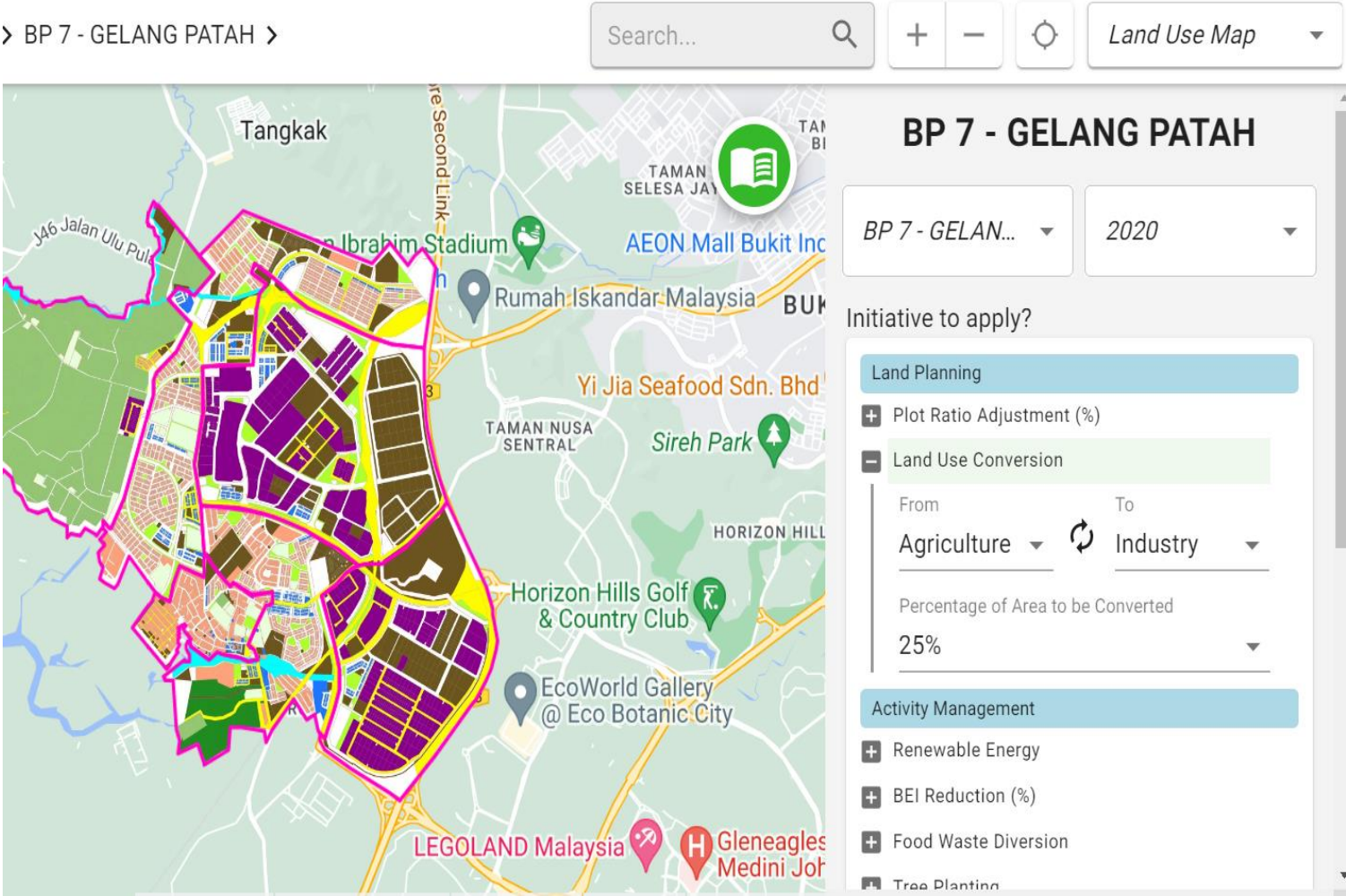
The NSW Net Zero Emissions Dashboard presents past and projected GHG emissions; provides state and local government, business and communities with insight into emission trends and progress being made towards the goals of reducing the state's emissions by 50% by 2030 and net zero by 2050.



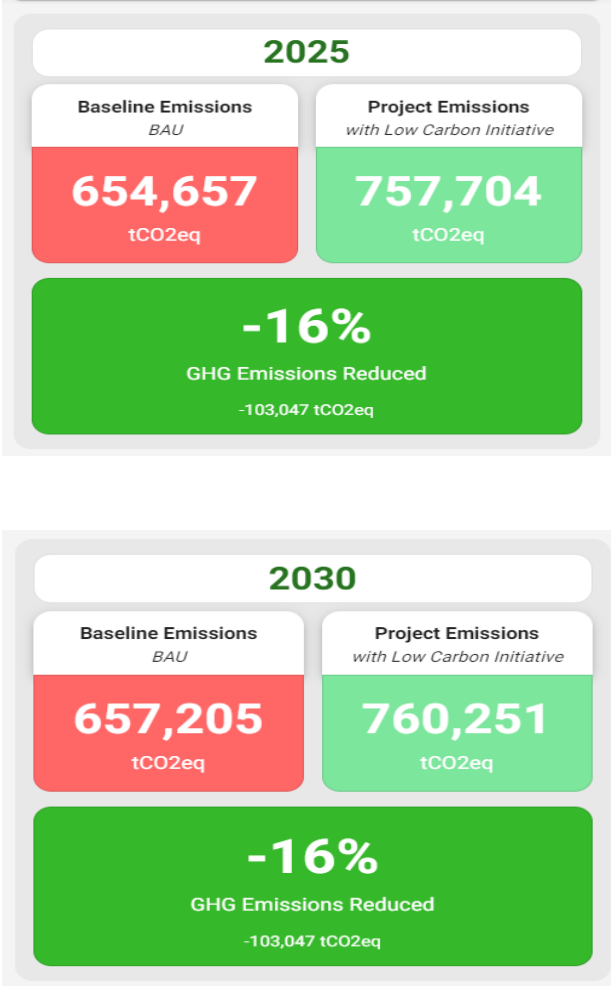
Plan Malaysia, MBIP, IRDA - MyEcoPlan

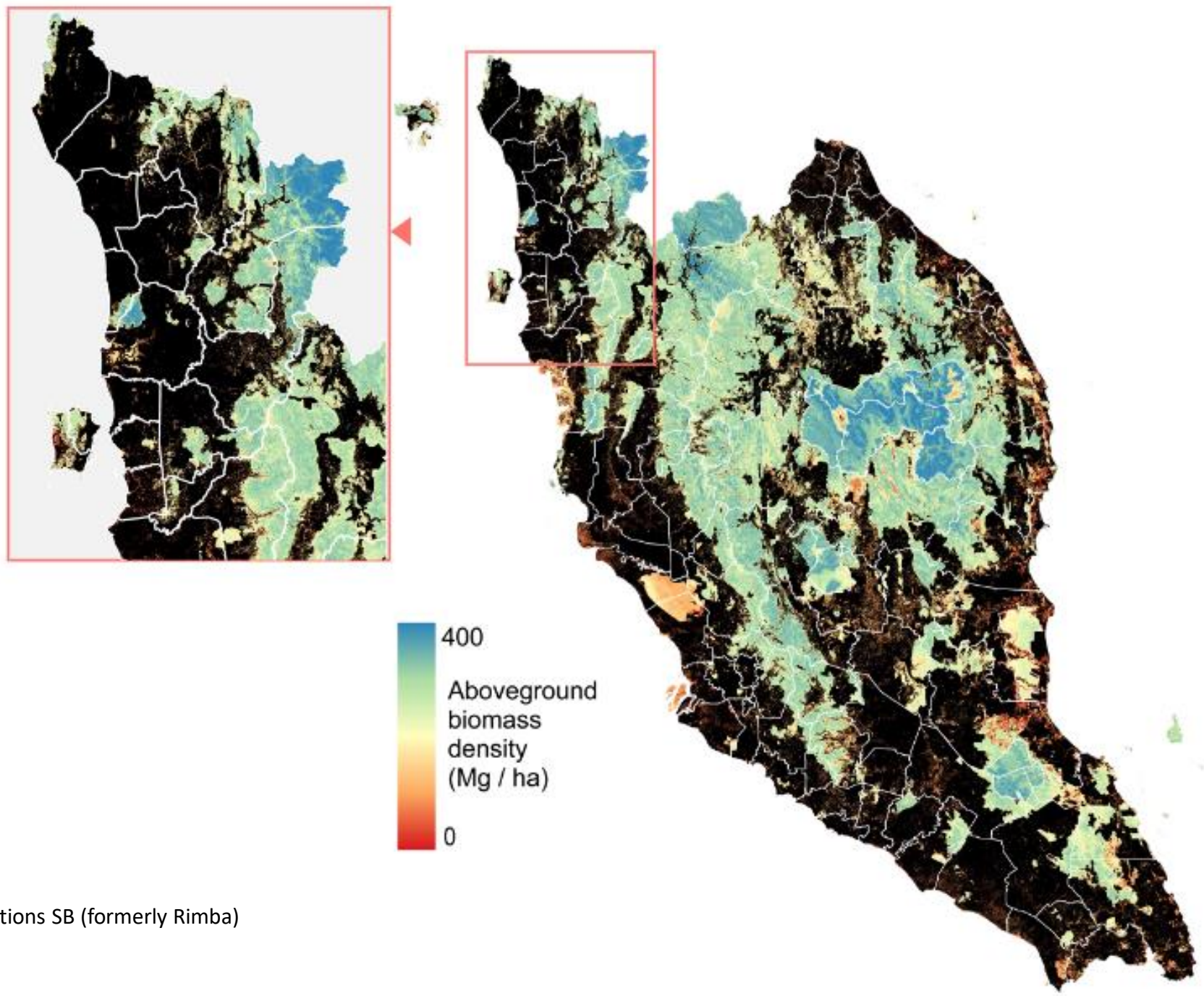
Source: Eco-Ideal SB

E.g. Land Use Conversion LCI expanded to also include Agriculture



Increase in GHG Emissions in the future because of land use conversions





Source: Nature Based Solutions SB (formerly Rimba)

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