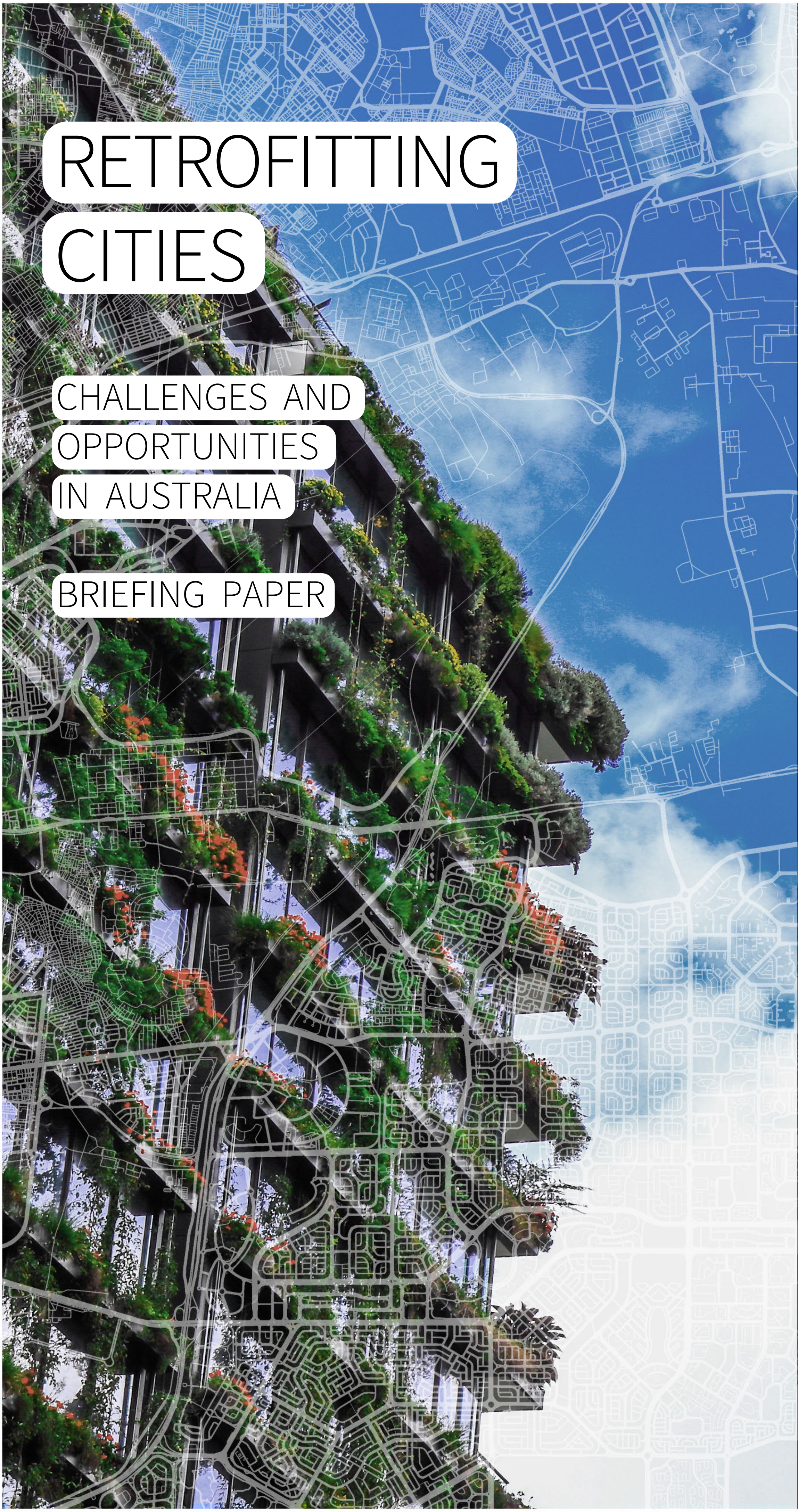
RETROFITTING CITIES

CHALLENGES AND OPPORTUNITIES IN AUSTRALIA

BRIEFING PAPER



THE RETROFIT LAB

THE UNIVERSITY OF MELBOURNE

Melbourne Centre for Cities

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RETROFITTING CITIES IN AUSTRALIA

The Retrofitting Cities Briefing Paper summarises current definitions, opportunities, and challenges for retrofitting in Australia. It emphasises an integrated, systems approach to retrofit at several scales, which can rapidly increase the resilience and sustainability of cities. It also calls for the urgent need to reprioritise retrofitting over demolition, to mitigate and adapt to climate change and addresses a range of other environmental and social issues in Australian cities today.

KEY FINDINGS

- Retrofitting is the process of upgrading existing physical systems after they have been created. It associated with similar terms and practices of refurbishment, renovation, repair, adaptive reuse, and regeneration.
- Modifying the buildings, infrastructure, and landscapes that already exist is paramount in the face of climate change, biodiversity loss, and pollution, as a means of both mitigating and adapting to these challenges.
- Retrofitting retains embodied emissions whilst also reducing operational requirements of buildings and infrastructure.
- Approaching retrofit from an integrated systems perspective can bring a range of benefits to communities, by seizing opportunities outside of traditionally isolated building, infrastructure, and landscape projects. Integrated, urban retrofit approaches are especially important to deliver resilient, sustainable cities through precinct scale interventions.
- Environmental, health and economic benefits of retrofitting depend on the scale and scope of projects with larger scale, integrated approaches yielding greater, longer-term benefits and greater capacity for future-proofing.

AN URGENT NEED TO RETROFIT

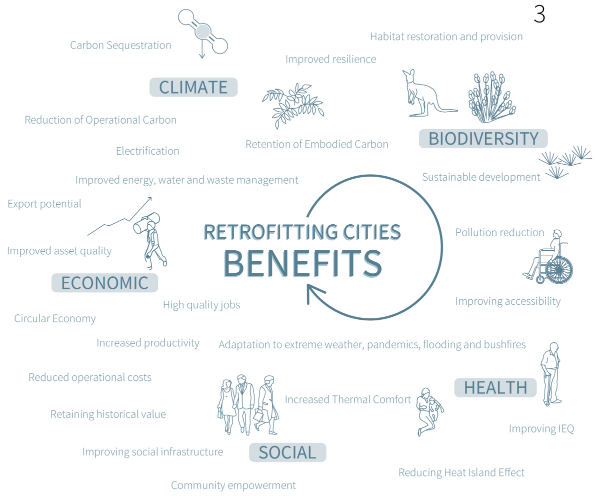
'Established cities will achieve the largest GHG (greenhouse gas) emissions savings by replacing, repurposing, or retrofitting the building stock, strategic infilling and densifying, as well as through modal shift and the electrification of the urban energy system.'

Climate Change 2022: Mitigation of Climate Change (Technical Summary of IPCC Assessment Report 6)

The UNFCCC has defined the triple planetary crisis as three interrelated issues: climate change, pollution, and biodiversity loss. Australian cities must reduce their environmental impacts to mitigate these issues whilst upgrading what already exists for changing urban requirements, aligned with the IPCC AR6 calls for Climate Resilient Development (IPCC 2022). Australian cities need to rapidly decarbonise, addressing not just operational emissions but also the large amount of emissions embodied in cities that currently exist. Cities, their infrastructure, and particularly their buildings have already required immense amounts of materials, carbon emissions, energy, water and waste to be created. If net zero is to be achieve, Australia must rapidly reconsider the demolition and rebuild approach that is currently business as usual.

Embodied in Australia's existing buildings there is more than 3.8 billion tonnes of material, emitted 1804 million tonnes of CO_2e, consumed 24,218 terajoules of energy and 31.5 million m^3 of water. If current building practices continue, projections to 2060 indicate Australia will require more than the current total amount of building materials again to replace end of life buildings, upper estimates could mean doubling the current quantity already in cities. (Soonsawad et al. 2022) Another important projection suggests if Australia continues at the current rate of constructing new detached dwellings, by 2050 the cumulative life cycle GHG emissions will equate to 3.6 billion tonnes of CO_2e, greatly exceeding Australia's current climate commitments. (Schmidt et al. 2020) Furthermore, Construction and Demolition waste accounted for 44% of all waste in Australia from 2018-2019, 27Mt from the total 74.1Mt of waste in Australia. (DCCEEW 2019) These embodied and operational emissions, as well as quantities of waste from buildings continue to have detrimental impacts on the planet, local ecologies and their human and non-human inhabitants.

To achieve building stock decarbonization by 2050, the IPCC assumes 'deep' retrofit rates between 2.5% to 10% of a country's building stock per annum. The current EU28 renovation rate (2019) is around 1%, with minor variation between members. For Australia's buildings, in 2019 it was estimated that by 2050 that 7 million existing homes and a third of commercial buildings would not be subject to improved energy efficiency measures in the National Construction Code. Locally, in the City of Melbourne currently 7 buildings a year undergo deep retrofit, but 77 buildings need to be retrofitted each year to achieve net zero carbon targets by 2040. If Australia is to become climate resilient, prepared for the new environmental impacts of the future, retrofit must be a priority. Urban retrofit, upgrading at a larger scale than single buildings, is a more comprehensive approach to resilient development which can address the range of environmental issues Australian cities face today.



BENEFITS OF URBAN RETROFIT

Retrofitting can provide numerous environmental, health, and economic benefits to communities. Importantly, it is an effective strategy for reducing the amount of greenhouse gases required to create and sustain cities. By reducing the embodied and operational emissions in buildings and infrastructure, retrofitting helps to mitigate climate change. (Olgyay et al. 2010) It further promotes adaptation and improved resilience of the built environment to floods, fires, and other extreme weather events that are increasing in frequency and intensity. (VBA 2014)

New construction can also provide some of these benefits but generally require more upfront (embodied) emissions and result in other environmental impacts throughout their life cycle. Integrating green infrastructure in cities, on and in between buildings, urban retrofit can provide more habitat to increase biodiversity and increase the sequestration of carbon emissions. (Ariluoma et al. 2021) Retrofitting can also improve energy, waste, and water management systems for reduced and efficient resource usage, supporting the transition to a circular economy. (Muhammad et al. 2017)

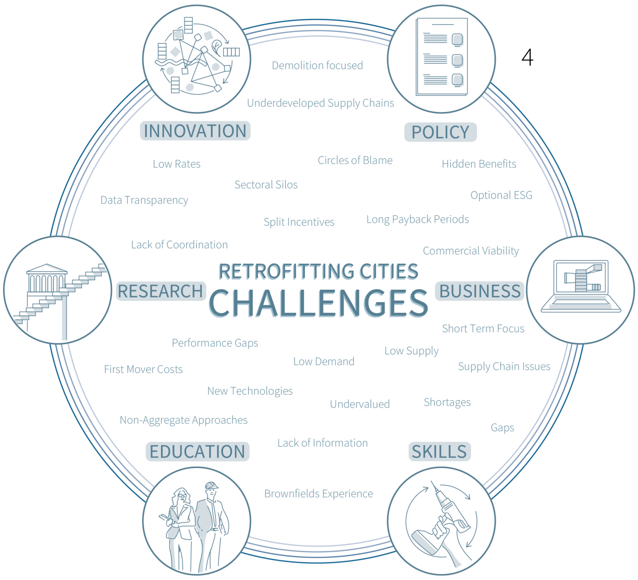
Retrofitting provides numerous health benefits. Improving Internal Environmental Quality (IEQ) is an important benefit for users, particularly as the risk of pandemics, bushfire smoke, and extreme weather events are increasing (Camacho-Montano et al. 2019). Additionally, the Urban Heat Island effect (UHI) can be mitigated through retrofitting with green infrastructure, keeping humans and non-humans cool and protected in an increasingly extreme climate (Baldwin et al. 2020, Douglas et al. 2012). This can also be provided within structures, providing improved thermal comfort for dwellings with reduced energy demand. Adapting the functional requirements of buildings for aging populations and people with disabilities can also be achieved through retrofitting (AHRC and MADA 2022). Increased biodiversity through green retrofits of buildings or infrastructure increases urban habitats for the health of flora and fauna, as well as reduce air pollution. (Williams et al. 2014)

Some of the economic benefits that retrofitting provide are high quality jobs, (Jagger et al. 2013) increased productivity in upgraded workplaces,(UKGBC 2022) improved quality of assets (Wilkinson 2013) and significant reduction in building and infrastructure operational costs (ASBEC and Climateworks 2016). Furthermore, retrofitting often improves rental yield through increased building ratings and higher paying tenants (Wilkinson 2018). Preventing obsolescence and stranded assets is also an important benefit today, as the requirements of cities and their communities are shifting in response to new technologies and global issues, retrofit can, in some cases, also require less labour and material costs for project (Sayce et al. 2023). Retrofit products and strategies for resilience in cities has significant export potential, particularly in the ASEAN (Association of Southeast Asian Nations) marketplace.

Some additional benefits retrofitting can bring to Australian cities are adapting offices to evolving, digitizing workplaces and education spaces, improving social infrastructure such as ventilation and energy sources in schools, pools, and hospitals, and widespread electrification to reduce gas usage (GCBA and Cundall 2022). Retaining historical buildings for cultural heritage is also important while simultaneously improving their environmental performance (Mazzarella 2015).

INTEGRATED RETROFITTING FOR SUSTAINABLE, RESILIENT CITIES

Retrofitting, as a practice of improving what already exists rather than demolishing and starting anew, can provide countless benefits to Australian cities. These benefits are not solely financial, they make cities more sustainable, resilient, climate conscious, low-waste, healthy, and biodiverse. They are needed more than ever, as global climate, biodiversity, and pollution emergencies continue to shock urban systems. Australia urgently needs to focus on retaining and improving existing buildings, infrastructure and landscapes for it's current and future communities, non-human and human.



CHALLENGES PREVENTING WIDESPREAD RETROFIT

The knowledge and technology to decarbonize buildings already exists and there are also proven innovative policies and incentives to promote a low-carbon shift, however, retrofitting is often overlooked in favour of demolition and redevelopment despite the range of benefits listed above.

NEW SKILL AND EDUCATION REQUIREMENTS

Retrofitting requires new skills across the construction workforce, including technical skills in working in existing buildings and brownfields sites, and the use of constantly evolving digital tools (Infrastructure Australia 2021). Techniques such as surveying existing conditions of structures using innovative technologies make these processes easier but require new specialized technical skills, as well as training the workforce for electrification (Bevan et al. 2020). Broader implementation of new digital technologies such as design and manufacturing automation, digital twins and product platforms will mean changing labour requirements, with some skills becoming obsolete (Infrastructure Australia, 2021). Skills in communicating the benefits of retrofitting are also crucial (Rauland et al. 2015 and ASBEC 2017).

ECONOMIC HURDLES

Retrofitting is often perceived as too challenging and or too costly. Unknown variables and increased perceived risk result in decisions to start again i.e. demolish and rebuild (Sayce et al. 2023). Broader economic challenges such as labour and material shortages due to various global and local forces, have resulted in significant increases in project costs. Furthermore, sectoral silos and poor collaboration also mean retrofit projects are challenging, with issues commonly arising from split incentives and fragmentation. Supply chains are significantly less developed for retrofit projects that traditional new construction. Long payback periods for some projects can make a retrofit project unjustifiable in economic terms. Occupancy barriers also prevent deep, more impactful retrofits from taking place due to relocation issues and disruptions to tenants and users (Rauland et al. 2015).

POLICY BARRIERS

Australia has seen policy incentives that drive a demand for increased sustainability such as the Commercial Building Disclosure program, Energy Efficiency Certificates, and energy upgrade schemes. Though there has been significant focus on upgrading existing buildings for energy efficiency, they are frequently light retrofits that are not as effective as deep retrofits (Zhivov et al. 2020) Standards also remain lower than required to achieve decarbonisation for the built environment. Furthermore, the range of costs (environmental, social, economic) of embodied materials and waste impacts is not frequently reported (Crawford et al. 2019). Certification tools quantify such hidden benefits however, they focus largely on new construction and require more widespread uptake (ASBEC 2017).

RESEARCH AND INNOVATION CHALLENGES

Low uptake in combination with underdeveloped supply chains and slow policy developments presents issues for innovating retrofitting practices. First-movers in the retrofit space are at a disadvantage, needing to jump through regulatory hoops to develop new practices (Rauland and Newman 2015). Reluctance toward data collection, transparency, platforming and sharing is also common. Digital integration of 3D scanning, AI supply chains and digital twins have already been implemented in some Australian companies, but broadly the sector remains slow to innovate (ARUP 2019).

CASE STUDIES

ENERGIESPRONG NET ZERO RETROFIT IN NOTTINGHAM, UK, 2019 - ENERGIESPRONG INTERNATIONAL, VIA FLICKR

HAMMARBY SJÖSTAD, STADSPARTERREN, SWEDEN - HANS KLYBERG, VIA WIKICOMMONS

AGGREGATE RETROFIT PROGRAMS

THE NETHERLANDS' ENERGIESPRONG INITIATIVE

Overview: Launched in 2013, The Energiesprong is a market-led initiative for retrofitting homes to net zero energy using prefabricated elements and innovative technologies. Prefabrication allows for these retrofits to be installed in an average of under 2 weeks. Typically, a retrofit through the Energiesprong model uses insulated facades and modules integrated with renewable heat sources and PV panels.

Dates of Retrofit Program: 2013 - Ongoing

Objectives: Energiesprong retrofits emphasize aesthetics, health and comfort which in turn improves property value, and optimise designs for repeatable manufacturing and installation of specific building typologies.

Main Benefits: Net Zero Carbon over a 30-year period (with a set allowance of hot water and electricity consumption) Carbon reduction through energy efficient whole house upgrades, innovative business and policy model. Average energy use reductions of 150 kWh/m2 and 70% reduction in total energy consumption (20,000kWh to just over 6,000kWh). Speed of retrofit that avoids occupancy difficulties and provides benefits rapidly for tenants.

Shortcomings: The project still requires public subsidies, meaning the cost of retrofits per unit is not low enough to be financially self-sustaining. It is estimated that 40,000EUR per retrofit would mean the business model could sustain itself in a privatized context.

SWEDEN'S HAMMARBY SJÖSTAD PRECINCT

Overview: Hammarby Sjöstad translated as *Hammerby Lake City,* located in Sweden is a sustainable precinct located in Stockholm's inner city on the shores of Lake Hammarby Sjo. It was originally intended to be the Olympic Village for the 2004 Olympics but became a regeneration project after losing the bid to Athens. The precinct comprises 12 sub-neighbourhoods across 200-hectares, residential and commercial areas, and open green spaces commended for it's integrated systematic approach to urban retrofit/renewal.

Dates of Retrofit: 2004 - Ongoing

Objectives: The goal of Hammarby Sjöstad is to create a sustainable precinct. Aim is for 80% of residents to commute to work using public transport, walking, or biking. The Hammarby Model, inspired by the Bo01 project in Malmö, was developed to achieve effective precinct scale sustainability. It includes features like a centralized waste management system, 100% renewable energy generation, and a storm water remediation system.

Main Benefits: Hammarby Sjöstad prioritizes urban green areas, including parks, green corridors, and nature reserves. It also protects valuable natural areas and compensates for development by creating biotopes. The project promotes urban biodiversity conservation and features eco-friendly infrastructure like planted viaducts and green roofs. Pedestrian-friendly green corridors and accessible public transportation options encourage low-carbon transport. However it should be noted, the transformation of Hammarby Sjöstad led to a quick rise in property values, which has been criticised for social exclusion and unaffordability.

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FURTHER READING

This briefing note is a condensed version of the Retrofitting Cities Issues Paper: www.unimelb.edu.au/retrofit

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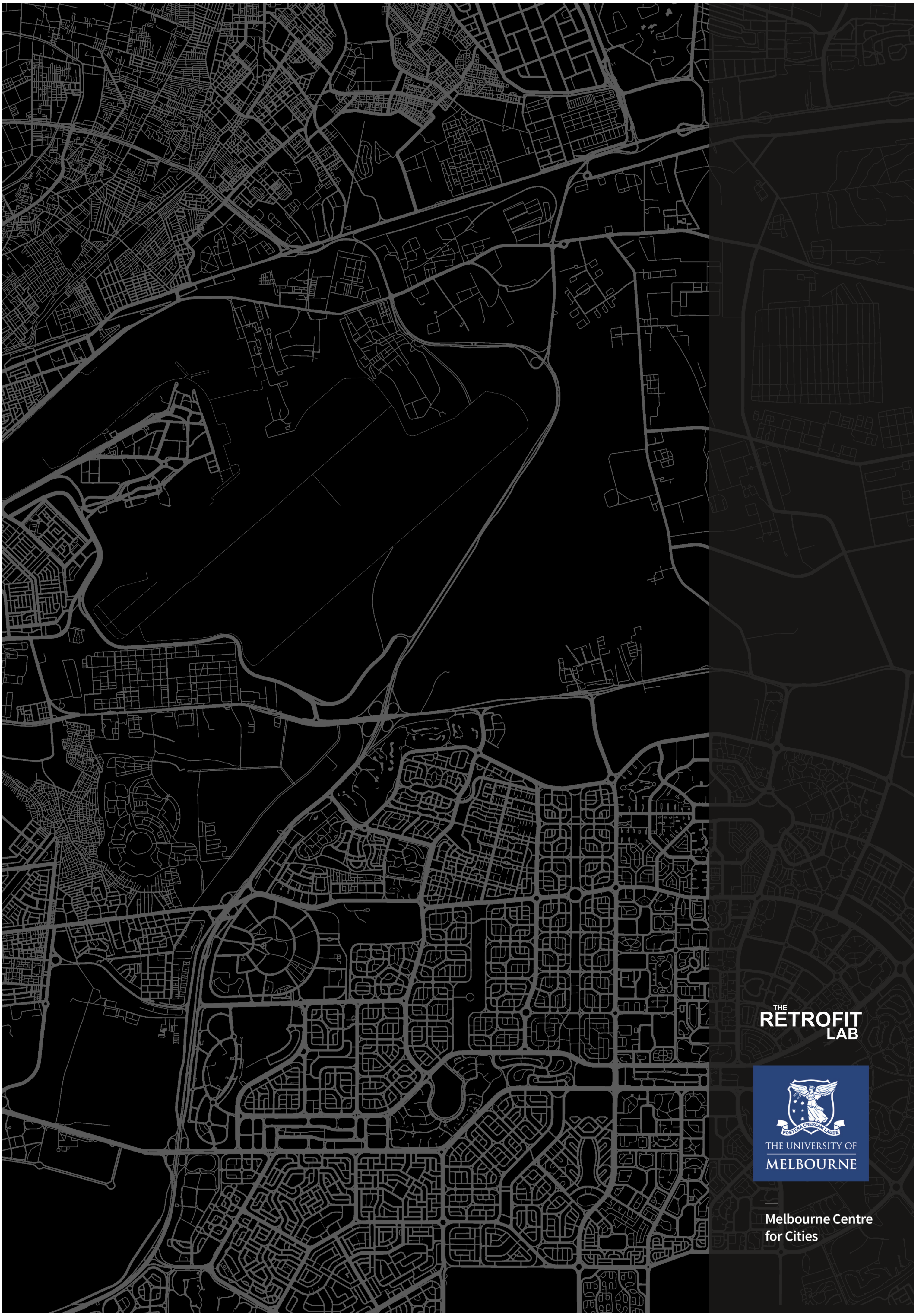

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