

INTEGRATING GREEN URBANISM INTO THE TRANSIT-ORIENTED DEVELOPMENT IN AUSTRALIA

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ABSTRACT

Can the combination of green urbanism and transit-orient development (TOD) shrink the environmental footprint associated with vehicular oriented transport? This is just one of the several questions that may be asked when thinking of measures to provide a carbon neutral future. Not only is transport Australia's one of the primary sources of greenhouse gas emissions, but cars alone are accountable for almost half of those emissions. In recent years, the Australian government has made significant investments in the transit systems and the policy agenda has embraced TOD initiatives driven by green concerns. Yet there are some unique challenges in the Australian context. TODs have occurred occasionally in Australian urban development and have not been strategically or statutorily planned. Factors such as rapid transit, density, and mixed use necessary to guarantee the provision of TOD has not yet been put in place in any Australian city. Moreover, while buildings are increasingly consuming more energy in both construction and operation, the execution of green open spaces within and around the TOD is inadequate with the development areas missing on potential environmental benefits and sustainable outcomes. There should be an increased focus on ecological and environmental dimensions of urban development so that the combined effect of pursuing TODs and green urbanism could become a reality in the future.

Keywords: Transit-orient development, green urbanism, vehicular oriented transport, Green TOD, Australia.

INTRODUCTION

The environmental footprint associated with vehicular oriented transport has surged significantly following the proliferation of suburban development in the post-war era in both the developed and developing countries [1]. According to Downs [2], one key but undesired feature of an urban sprawl is over-reliance on automobiles for ground movement with people living in the low-density development areas increasingly using private vehicles to access services. By the 1990s, however, many scholars started to question the viability of such a pattern of suburban development as vehicular oriented transport turned out to be one of the main contributors to the greenhouse gases (GHG) emission globally. While the search for a sustainable model of urban growth was inevitable, transit-orient development (TOD) emerged as a novel concept to deal with the challenges posed by the sprawl of modern cities.

The term TOD first appeared in 1993 in *The New American Metropolis: Ecology, community, and the American dream* - the book written by a well-known American Architect and Urban Planner Peter Calthorpe. In the book, TOD is presented as a technique to "create more compact, walkable communities" configured around rail transit stations [3], with a focus on the growth-friendly components such as, density, mixed-use and public spaces [4]. According to Cervero and Sullivan [5], over the past three decades, TOD has proved to be a promising tool to break "the vicious cycle of sprawl and car dependence feeding off of each other, replacing it with a virtuous cycle: one where more and more trips shift from cars to transit and compact station-area development slows the spread of sprawl". This growth model is now viewed favourably as a sustainable approach to urbanism.

However, despite its popularity, there are concerns about adaptability of TOD across all development contexts and its environmental responsiveness. For instance, Yang and Pojani [6] argue that "TOD is not a panacea", and the model has not always been successfully implemented in cities across the globe [7]. It is also argued that TOD does not adequately respond to the ecological and environmental dimensions of the development pattern [8]. Bajracharya et al. [9] believe that "as a design concept, TOD has evolved as the growth machine risks colliding with ecological limits, necessitating more sustainable planning practices". While these barriers suggest there is a need for a more adaptive and responsive approach, the need to incorporate green dimensions into the conventional TOD has been strongly

recognised in recent decades. Noticeably, urban scholars and practitioners have already started to advocate for integrating green urbanism into the TOD, giving birth to a new concept called “Green TOD”. One of the early and strong proponents of Green TOD, Cervero and Sullivan [5], describe it as an environmentally friendly version of a TOD, in which the combination of TOD with green urbanism can “create synergies that yield environmental benefits beyond the sum of what TOD and green urbanism offer individually”.

It is not surprising, however, to note that Green TOD has not received much attention in the Australian context in both research and practice. It is possibly so because TOD in Australia is limited in practice in the urban development process and has often been adopted as a fad [9,10] rather than a comprehensive strategy to cope with the sprawl. As a consequence, evidence suggests that Australian cities have been less successful in reaping the benefits of the TOD until now. But this realisation leaves us with some important questions. How can the barriers to wider implementation of TOD in Australia be eliminated to better achieve its goals? Does the answer lie in the marriage of green urbanism with TOD? In recent years, the Australian government has made significant investments in the transit systems in place and the policy agenda has embraced TOD initiatives driven by green concerns. Yet there are some unique and emerging challenges in the implementation of the Green TOD. This paper explores such challenges by reviewing the TOD policy measures and the prospect of Green TOD in Australia. It examines how green urbanism may be integrated into TOD and how Green TOD may help in achieving the current goals of sustainable urbanism in the Australian cities.

This paper is organised into four sections. Following this introduction, the next section reviews literature to better understand the concept of green urbanism and its environmental benefits. The third section examines TOD in Australia and engages in the case study of the integration of green urbanism into the TOD in Melbourne by examining the development nodes centred around the rail transit stations in two locations namely, Brunswick and Footscray. The final section concludes the paper by discussing the findings of the case study and offering some insights into the potential measures of integrating green urbanism into the TOD in Australia.

UNDERSTANDING GREEN URBANISM AND ITS CONTRIBUTION TO TOD

Green urbanism is a growing topic of interest both in urban research and practice. In the simplest term, it is about bringing nature and/or natural lifestyle into the city. But more than that it challenges our current understanding of urban planning and design discipline and recommends considering issues that would have a direct impact on resilience and sustainability such as, green buildings, water sensitive urban design, sustainable transport, walkable cities, high-density and in-fill development, liveability and healthy communities. According to Newman [11], green urbanism refers to the “settlements that are smart, secure and sustainable”. Lehman [12] defines green urbanism as a “conceptual model for zero emissions and zero waste” that contributes to a more energy efficient city with a lighter ecological footprint that is more beneficial to the environment and the people. In fact, green urbanism stresses on re-evaluating our current approaches to urban development by considering energy consumption and prioritising green areas so that this may lead to the development of truly sustainable cities, both environmentally and socially, and to a carbon neutral future [13].

Integration of Green Urbanism into the TOD

The consideration of green urbanism within the TOD strategies were relatively undervalued until the recent past although growing evidence suggests that there are additional benefits. Huang and Wey [8] argue that the underlying focus of green urbanism on reduced energy use and a more sustainable approach to urban design and landscape architecture can substantially shrink the environmental footprint associated with vehicular oriented transport, resulting in reduced GHG emissions. While the promotion of transit usage also promotes a better mix of urban land uses, creating a network of green transit lines ensures that the population has access to high quality and convenient transportation modes by reducing the dependence on private transports [5]. In addition, this strategy would also result in the reduction of parking spaces on site to increase open space and community gardens so that it would encourage the use of the development area for pedestrians or cycling.

Improving walkability is a major incentive of green urbanism. While much of the development area could be taken up by roads, green urbanism ensures that enough open spaces can be provided to build high quality pedestrian pathways, with the addition of urban landscaping and outdoor seating areas in an effort to encourage public use and activity [14] that are inviting, visually stimulating and well-lit at night [9]. At the same time, the inclusion of continuous segregated

cycling lanes would encourage accessibility to public spaces, creating a network of pedestrian and cycling paths to improve the connectivity between locations and access to goods and services. The execution of urban green open spaces within or around TOD aides in the economic value and the sociability of the area, and promotes environmental benefits within the same framework that encourages pedestrian and cycling for a better and more efficient environment.

Environmental benefits of Green TOD

With a growing focus on the significance of green urbanism in examining the role of TOD and its wider impacts on the quality of the built environment, Green TODs have emerged as a combined effort with additional environmental and other benefits. According to Niu et al. [15], Green TOD is “an evolution of the TOD theory, influenced by sustainable development and green urbanism” and “expands the environmental and ecological dimensions of conventional TOD”. The carbon footprints of Green TOD can be 35% less than those of conventional developments, by significantly improving walkability and carbon neutral mobility [5]. This has become possible because:

Green TOD emphasises the coordinated development of transportation, society, and the environment, to build a sustainable and liveable transit-oriented community. Conventional TOD injected new thinking at the social and environmental dimensions by integrating green urbanism and ideas associated with an ecological community [15].

Cervero and Sullivan [5] make a similar observation on the environmental benefits of the Green TODs:

Green TOD offers a form of urbanism and mobility that could confer appreciable environmental benefits. It emphasises pedestrian, cycling and transit infrastructure over automobility. It mixes land uses, which not only brings destinations closer but also creates an active, vibrant street life. And through building designs and resource management systems, it embraces minimal waste, low emissions, and to the degree possible, energy self-sufficiency (p. 216).

They suggest that the benefits of combining TOD with green urbanism can deliver “energy self-sufficiency, zero-waste living and sustainable mobility” and may be realised in terms of: a) higher densities; b) mixed land uses; c) reduced surface parking and impervious surfaces; and d) solar energy production at stations (Table 1).

Table I: Environmental benefits of Green TOD

TOD	Green urbanism
Mobile sources	Stationary sources
Transit design: world-class transit (trunk and distribution); station as hub; transit spine	Energy self-sufficient: Renewably powered – solar, wind, organic waste converted to biogas; energy efficiency; district heating/cooling; combined heat and power
Non-motorised access: bike paths; pedestrian ways; bike-sharing/carsharing	Zero waste: recycling and reuse; methane digesters; rainwater collection for irrigation and grey water use; bioswales
Minimal parking: reduced land consumption; building massing and impervious surfaces	Community gardens and open space: composting; tree canopies; water-table recharging
Compact development mix of uses	Buildings: green roofs; orientation (optimal temperatures); insulation; glazing; air-tight construction; low-impact and recycled materials

From Cervero and Sullivan (2011)

TOD AND GREEN URBANISM IN THE AUSTRALIAN CONTEXT

Australia has one of the highest per capita carbon footprints in the world. In 2018, Australia’s GHG emissions were 15.5 metric tons per capita as compared with 5.5 in the UK and 8.6 in Germany [16]. Some reasons for this include large dispersed cities, energy inefficient buildings, a reliance on fossil fuels for most energy, high volumes of fossil

fuel exports and emissions from agriculture. Transport makes up 19% of total Australian emissions and half of that or around 9.5% is estimated to be due to the private car usage alone (figure 1) [17].

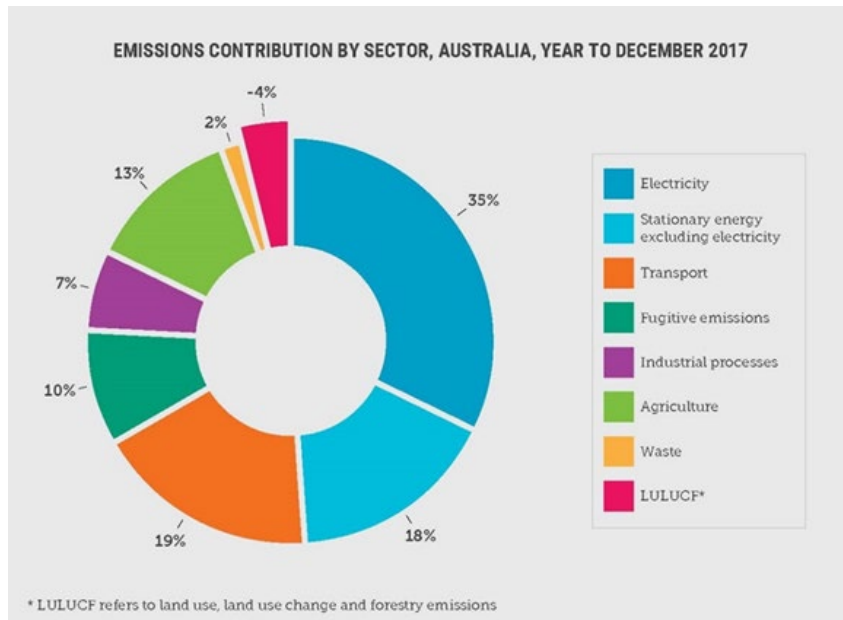


Figure 1. Contribution to GHG emissions in Australia by sector (Source: Climate Council, 2017)

Buildings contribute to a significant amount of GHG emissions too in Australia [18]. Large house size, poor passive solar design and poor insulation coupled with a coal-based electricity supply, the common usage of gas for heating and the now ubiquitous air conditioner all contribute to this. It is worth noting that Melbourne's primary source of electricity is the brown coal of the La Trobe Valley, 140 km to the east, which is burned in huge, inefficient and highly polluting power stations fast approaching the end of their serviceable lives.

Green TOD can assist in improving urban sustainability outcomes in several ways - through reduction in car usage and through more energy efficient building design. At least in theory, flats and apartments should be more sustainable than standalone houses as they are generally smaller, and therefore, consume less resources to build and service. Further, apartment developments generally have a lower ratio of external walls in proportion to floor area than a standalone house as each apartment in large part abuts the adjacent unit, and thus become self-insulating to some degree. In practice, however, while a reduction in car usage is likely in TOD, other sustainability goals have been more elusive. For instance, most residential construction in Australia is privately developed for profit, whereas there has been little investment in public and social housing for decades (although this is now changing). There is also a tendency for many developers to 'max out' the site and to building as tall as possible in order to maximise returns to investors. In the context of Green TOD, this tends to produce high and medium rise buildings with a high embodied energy (the primary materials being concrete, steel, aluminium and glass), which require energy hungry elevators, air conditioning and heating operate. The favoured façade is the (single glazed) curtain wall, and appropriate shading and passive solar design are uncommon. Tall buildings also overshadow the streets, and can create wind tunnels, making them uninviting in winter. Although by 2018, more than 2 million domestic roof top solar PV systems had been installed on Australian houses [19], the uptake of solar in the multi-residential market, such as found in green buildings, has been much slower.

Being profit driven, developers are often reluctant to contribute to the greater common good beyond the confines of their own development sites. In a 2014 study of development in one part of the Melbourne CBD (arguably, a TOD in itself, although a very large one), Hodyl [20] documents how Melbourne developers were allowed to more intensively develop sites, with much higher plot ratios and far less give back to the community, than in five 'high density' global cities including Hong Kong, New York, Vancouver, Seoul and Tokyo. This means that state and local government must provide amenities such as community facilities (schools, child care, etc.) as well as parks and 'green infrastructure'. The environmental credentials of Green TOD developed along these lines may, therefore, be questioned.

THE MELBOURNE CASE STUDY

A metropolis of more than five million people, Melbourne has been experiencing rapid development over the past 30 years. In the past decade (until COVID and associated border closures) an average of 180,000 people moved to Melbourne per year, either from interstate or from other countries, with a rate of 3.69% annual increase in 2020. Despite a boom in high rise apartment towers in the inner city, the bulk of new residents have been accommodated in new, low-density suburbs on the urban fringe, much of which have been built on the fertile farmlands of the western plains or pushing into the bush land of the east and north (figure 2).



Figure 2. Tract Housing, Truganina, 17 km west of the Melbourne CBD

Melbourne consists of a relatively dense 19th century core surrounded by successive rings of low-density automobile dependent suburbs, stretching more than 50 km from the centre. With the exception of the City Loop, the suburban railway system is entirely radial - all suburban lines radiate from the Central Business District (CBD), out to a distance of 40 km from the city centre. Melbourne's famous tram system is based on the 19th century cable car network, which is largely confined to the inner rings of suburbs built before World War II. While there have been many additional rings added since then, the tram network extends no more than 15 km from the city centre, covering one tenth of the metropolitan area.

TODs have been a central feature of Melbourne metropolitan planning since the release of the Melbourne 2030 report in 2002 [21]. In the report, there is a plan for metropolitan Melbourne along with its various revisions and updates (e.g. Melbourne @ 5 Million, 2008) that have been issued since then and are generally referred to as 'Plan Melbourne'. Six Central Activity Districts (CADs) were identified as sites for TOD in the report - the aim being to transform Melbourne into a polycentric metropolis. The current version of Plan Melbourne, which was formulated in 2017, refers to Metropolitan Activity Centres (MACs), and identifies several more 'MACs' than in the 2008 version, as well as some future MACs (figure 3) [22]. All MACs lie on major rail lines, and connect to various other modes of transport such as, bus, tram, cycle paths, pedestrian networks, and the private car. All the CADs identified for development and intensification utilise existing suburban nodes as their 'seed stock'. Surprisingly, only two of the six CADs will be connected into the proposed suburban rail loop as part of the plan to turn Melbourne's radial railway into an interconnected network. The nine MACs are augmented by a hierarchy of numerous smaller 'activity centres', both of which have the potential to incorporate some elements of TOD and green urbanism.

Plan Melbourne has formalised a process already well underway as most MACs were pre-existing suburban centres and several of which had histories as independent towns before they were swallowed up by the relentless expansion of the suburbs. By identifying the MACs as sites for high density development, the state government may simply have given the 'green light' to yet more speculative developers, without necessarily maximising community and environmental outcomes. In the next sections, we examine the prospect of green urbanism and its potential integration into the TOD in Brunswick and Footscray.

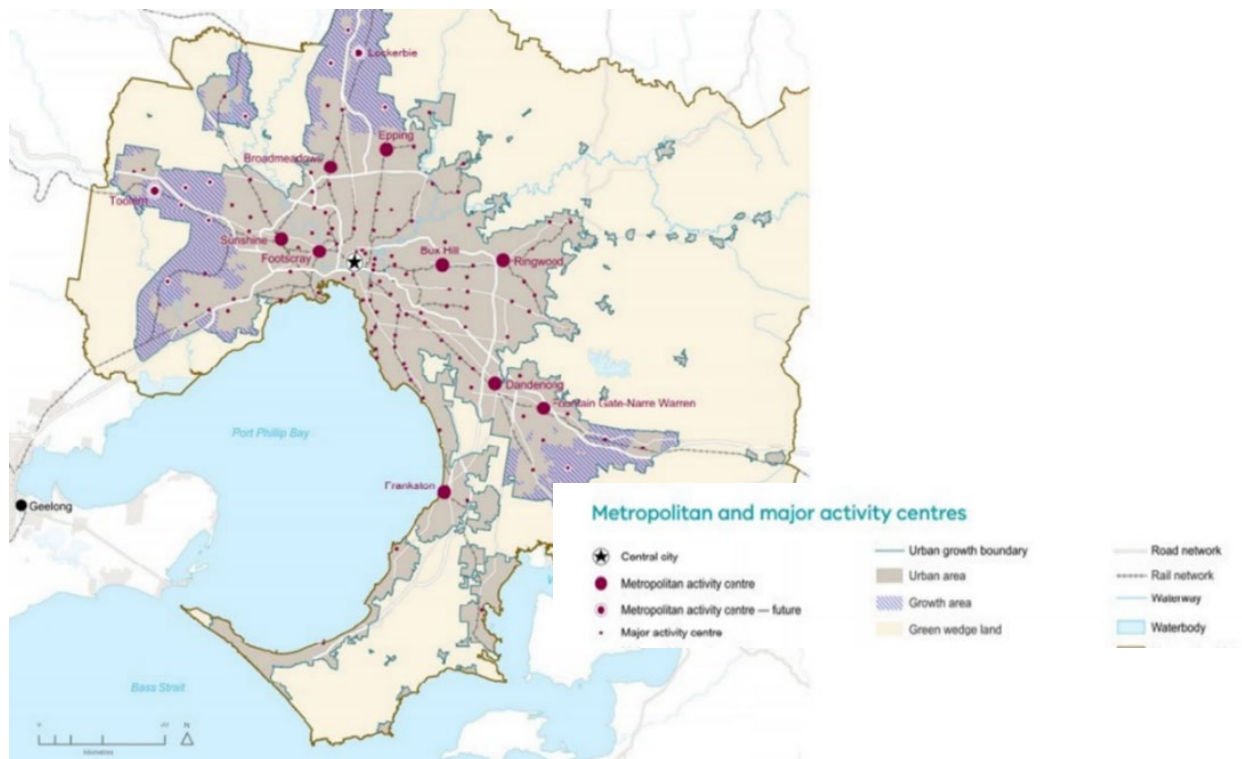


Figure 3. Metropolitan Activity Centres (Source: Plan Melbourne, 2017)

The Brunswick Spine

Brunswick is a rapidly gentrifying ‘hip’ inner suburb located 4 km north of the Melbourne CBD. From the early 20th Century, Brunswick was an industrial suburb that provided employment for a large working-class population. It became a migrant dominant neighbourhood in the post war era with the population largely drawn from southern Europe and the middle-east. Linear shopping strips serviced by the trams are a characteristic of Brunswick. The Sydney Road shopping strip, at 4.5 km in length with the trams running north - south, is the longest in Melbourne and is a classic example of the 19th century transport-based urbanism. Running roughly parallel to Sydney Road is the Upfield Railway line. The distance between the two varies from 200 to 250 m. The land between Sydney Road and the railway line forms a ‘spine’ of mostly former industrial land, mixed with other uses that runs from Brunswick Road in the south to Moreland Road in the north at a distance of around 2.4 km (figure 6). There are three railway stations, Jewell, Brunswick and Anstey in the Spine, as well as the recently redeveloped Moreland Station just north of the area. Alongside the railway line is a bicycle path, which connects with the University of Melbourne and medical precinct and the Melbourne CBD to the south and to Coburg to the north. Six bus lines cut across the Spine in an east-west direction. Nowhere in the Spine is more than 100 m from either the railway, bike path, bus, or tram.

The Spine represents a TOD precinct. It shows some promising signs of green urbanism and sustainable development and may set an example to be emulated elsewhere in Australia. Over the past decades, the industrial sites in the Brunswick Spine have been increasingly redeveloped for residential use. The dominant mode of development has been medium rise buildings of 5 to 10 storeys in height, with architectural and sustainability outcomes of mixed quality. While all new residential developments must meet minimum environmental standards, most do no more. Some apartment blocks have PV solar panels on the roof, but often orientation of windows is determined more by site constraints and maximising yield than by basic passive solar design principles. Insulation and appliance efficiency is generally what is required by building code and no better.

There are, however, some signs of changes. Starting in 2014 a series of residential apartment blocks have been built in the Spine challenging the prevailing development model. The Commons, an architect-initiated development based on the German *Baugruppen* model, took advantage of a ‘problem site’ adjacent the railway line, which was cheap to buy because of perceived noise issues, and where a lack of neighbours allowed a greater volume than might be allowed

elsewhere in the Spine (figure 7). This type development model is new to Australia. But the Commons broke new ground in regards to sustainability. Arguing proximity to multiple forms of public transport and the bike path, the Commons was exempt from standard car parking requirements. The building achieves a 7.5-star rating for energy efficiency (2.5 stars higher than required), uses low toxicity materials (for example, chrome was forbidden), and boasts communal vegetable garden, BBQ and laundry and as well as solar panels on the roof. Car ownership is forbidden. Instead of underground car parks, there is ample on-site bike parking and two shared car spots in the street. Because of its not-for-profit approach to development, a refusal to engage with estate agents, publicists and marketing, and the elimination of underground car parking (at \$40,000 per space according to Breathe founder Jeremy McLeod), the Commons was able to deliver highly sustainable, compact and community-oriented housing at market competitive prices.

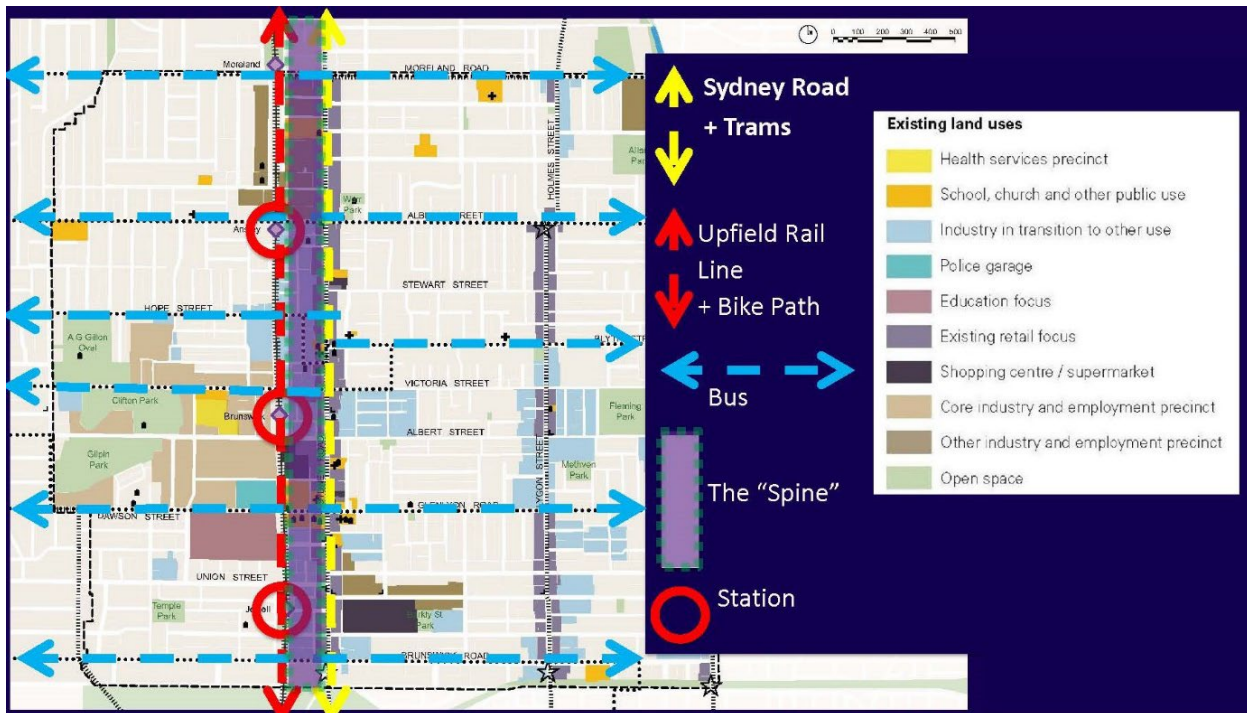


Figure 6: Brunswick Spine: adapted from Brunswick Structure Plan (Source: City of Moreland, 2020)

A second development based on the Commons, the 'Nightingale', was built immediately across the road a few years later. The success of the Commons and the Nightingale were used to launch the Nightingale model of housing development. Four projects have now been completed, twelve more in construction, and more are in preparation. Many of these are being built near the Commons and the original Nightingale in the Brunswick Spine at the new Nightingale Village. Each project is designed by a different architect and many of the leading lights of Melbourne architectural community are now involved in Nightingale projects. As with earlier Nightingale projects the buildings in the new Village will include the high levels of sustainability - all are certified carbon neutral and powered by Green Power, use passive solar design and cross ventilation (figure 8).

The original plans for the Nightingale Village included provision of a future park, which has now been built. The construction of Bulleke-Bek Park in the village demonstrates, in miniature, a vision for future sustainable development, combining the benefits of TOD with sustainable, high density development and green urbanism (figure 9). Developed by Moreland City Council, over several years of community consultation, Bulleke-Bek provides much needed green open space in what, in Australian terms, is a high-density urban environment. If this model were to be adopted more widely, both in the Spine and beyond, it would help improve the urban environment, provide high quality sustainable housing and establish a new benchmark for sustainable urbanism in Australia. Indeed, the Moreland City Council is planning for a further five new parks, including three in or near the Spine [23].



Figure 7. The Commons, Florence Street Brunswick (Source: Breathe Architects, 2014)

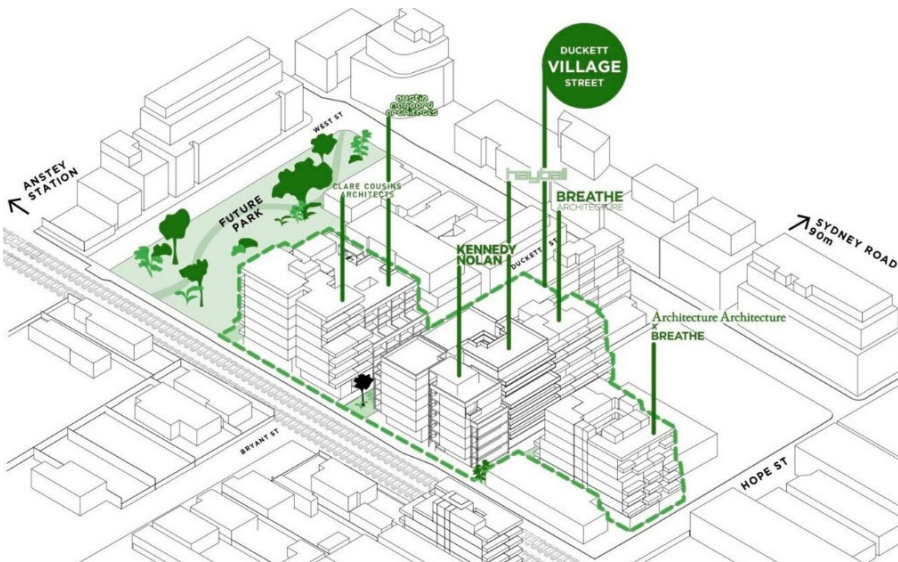


Figure 8. The Nightingale Village in the Brunswick Spine (Source: Nightingale Housing, 2021)



Figure 9. Bulleke-Bek Park in Brunswick

Footscray

Footscray is a working-class inner suburb located 5.5 km west of the Melbourne CBD. It is bordered to the north and east by the Maribyrnong River. Footscray was a formerly a manufacturing centre, but has now largely deindustrialised and is gentrifying. It has a highly diverse population, and high levels unemployment and disadvantages. Footscray station has been recently redeveloped and is a major focal point in the rail network, servicing three suburban rail lines as well as regional lines to Geelong, Bendigo, Ballarat and Warrnambool. The station connects to multiple suburban bus lines, as well as the Moonee Ponds tram line and the urban bicycle network.

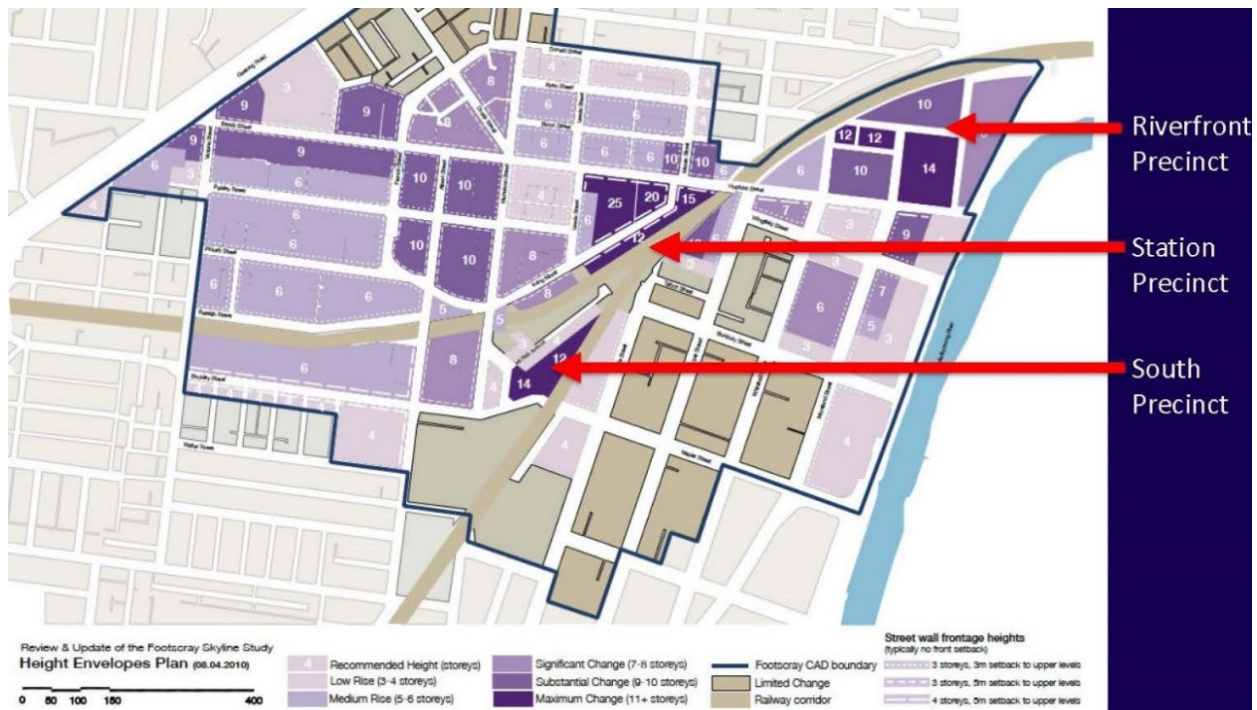


Figure 10. Central Footscray Structure Plan showing proposed heights (Source: Maribyrnong City Council, 2014)

Footscray was identified as a TOD in Melbourne 2030 [21] and development has been proceeding rapidly over the past decades. Central Footscray is slated for redevelopment, with building heights from six to ten storeys proposed, some of which are already built [24]. Three precincts are set aside for more intensive development. The South Precinct, a short walk from Footscray Station, has already been developed with the 14 storey State Trustees Building - a glass box (figure 10). There is a small park, and a Railway Reserve to the north of the building between it and the station. Although Footscray Station itself has recently been redeveloped, the Station Precinct is yet to see much new residential or commercial development. There is a bus interchange and small plaza in front of the station and the Moonee Ponds tram terminates there. There is limited open space in the area. Maddern Square, a small urban park is several few blocks away as is the Nicholson Street Mall. There are no plans for new open spaces in the Station Precinct [25].

The largest scale development in Footscray has been on the Riverfront Precinct along Maribyrnong River - an area identified by the Footscray Structure Plan as available for 'maximum change', with height controls allowing for developments up to 14 storeys [24]. However, several of the newly built apartment towers exceed 20 floors in height (figure 11). The Riverfront Precinct is located around 800 m north east of the station, on Hopkins Street, one of the main roads to the CBD. Extensive development in the past five years has resulted in a large concentration of tall buildings at the 'gateway' to Footscray. The buildings are mostly curtain wall towers, built boundary to boundary. There is almost no attempt at appropriate orientation, sun-shading or basic sustainable design measures. In some cases, glazed walls are oriented to the west, maximising solar heat gain in summer. Solar panels are rare. The Riverfront Precinct takes advantage of the existing parkland along the river front, and has views of the river and the city. No new parkland is planned [25] although two small 'potential plazas' are suggested for the precinct in the Footscray Structure Plan [24]. The precinct is still being developed, but it is evident from the completed buildings that the back streets of

the Riverfront Precinct will be largely overshadowed, windswept and visually dominated by the bulk of the closely spaced towers.



Figure 11. Footscray development along the Maribyrnong River

DISCUSSION AND CONCLUSION

Findings from the examination of the two suburbs in Melbourne suggest a mixed outcome in terms of their potential for promoting and integrating green urbanism into the TOD. Overall, it appears that the inner suburbs are doing much better in their performance as a TOD as compared to the newly developed outer suburbs. But when it comes to the execution of green urbanism and its integration into the overall urban development pattern, there is a clear lack of policy measures and development guidelines for all urban areas. In turn, the ‘integration’ of green urbanism has been left up to the individual developers and their overall tendency towards implementing environmentally sustainable outcomes in the site planning and building design. Green open spaces are usually a priority in urban development in Australia as evident in both the cases, but their success is determined by proximity to the residential areas and integration with other services and urban amenities. These outcomes highlight the need for more sustainable urban planning principles in the future. We will now discuss the findings by briefly assessing the three main aspects of a Green TOD: a) urban layout and proximity to the services; b) green open spaces; and c) architectural design response.

Urban layout and proximity to the services

The Brunswick Spine suggests that inner city areas respond better to TOD principles and performs well to achieve excellent urban design with their compact and walkable neighbourhoods. There is no or very little need to use vehicular oriented transport to access the services. The urban layout also shows evidence of infill development with the conversion of industrial buildings into residential ones and this needs to be encouraged as it helps in achieving higher residential density. In contrast, although identified as a potential TOD site, the emerging pattern of urban development in Footscray suggests that Melbourne’s outer suburbs are less compact in layout and represent the development of an urban sprawl, which are highly automobile dependent and do not promote walkability. Yet, the development of the tall apartment buildings as seen in Footscray may help achieve medium residential density.

Green open spaces

Brunswick area shows some traces of existing green open spaces and the development of new parks through the initiatives of the local city council. Although there are areas of parkland outside of the neighbourhood to the south and west, there is a lack of green open space in the Spine suggesting that more is needed. The case is a little different in Footscray, where the existing green open spaces could perform better by adding a strong network of green corridors and establishing a better connection within the suburb.

Architectural design response

Green buildings are emerging in Brunswick as evident in the newly built housing complexes such as, the Commons and the Nightingale and indicate a new impetus in achieving green urbanism in an existing TOD friendly urban area. The architectural design response, despite the existing site constraints, has been highly favourable towards achieving energy efficient and sustainable building outcomes – the buildings performs well in energy rating. There is, however, a little response to the green dimension of building design in the case of Footscray, where, as evident in the building

façade, most curtain wall residential towers are less energy efficient, with a rare use of solar panels in them. In part, this is due to the fact that the prevailing residential development model is profit driven and built mostly by private developers, with a tendency to maximise individual profit over green concerns and public benefits. This suggests that green buildings are not easy to realise in a competitive market.

While the Brunswick Spine presents exciting possibilities as a linear TOD, with excellent public transport links at a variety of scales and green buildings, it is clear that the Footscray development has underperformed to date. Footscray may offer potential for green urbanism, but steps need to be taken to create more quality green open spaces and improve the environmental performance of the buildings. To date, maximising profit - and views - has clearly taken precedence over sustainability and community in the design of the buildings and the urban environment of the Riverfront Precinct.

Although the practice of TOD has been somewhat limited in Australia, it has now returned to the government policy agenda with a growing consensus on its apparent benefits among stakeholders. It is encouraging that the current policy agenda has embraced TOD initiatives driven by green concerns, but some unique challenges in the implementation of Green TOD have also emerged. Firstly, TODs need to be strategically and statutorily integrated in urban planning and development process. Secondly, this needs to be supported by execution of the integral factors of a successful TOD such as, rapid transit, density, and mixed land use. Thirdly, there has to be adequate and integrated execution of green open spaces within and around the TOD. Once such challenges are met, it is imperative that further steps are to be taken to move beyond the conventional TOD by engaging in a more adaptive and responsive approach. There should be an increased focus on ecological and environmental dimensions of urban development so that the combined effect of pursuing TODs and green urbanism could become a reality in the future. To achieve Green TOD in Australia, state and local governments should act to deliver policy measures and planning guidelines that ensure the wider environmental benefit by providing the green infrastructure, public services and amenities and energy responsive building design outcomes.

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