UrbanIdeas

A PUBLIC INTEREST MAGAZINE FROM URBAN TASKFORCE AUSTRALIA

JANUARY 2022

STANDING TALL

HIGH RISE BUILDINGS TO HELP SYDNEY BECOME A GREEN METROPOLIS

Urban Taskforce AUSTRALIA

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STANDING TALL:

High Rise Buildings to Help Sydney Become a Green Metropolis

Australia 108 - Designed by Fender Katsalidis, Multiplex has built the tallest residential building in the southern hemisphere. It fits into the definition of High Rise.

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Preamble

Tom Forrest, CEO
Urban Taskforce

As political leaders and policy makers from around the world struggle with the many dilemmas posed by climate change, the impact of population growth and the look, size and shape of our cities has become increasingly important.

Pressure is building around the world for governments, corporations, private companies and citizens to reduce their carbon footprint. Inevitably, this will become a key shaper of public policy. In the Australian context, this dilemma poses significant challenges. While the days of the fabled quarter acre block have long since past, the "Australian dream" of a home with a back yard and space for the kids to play remains, at least to some extent. But the climate debate and declining home affordability have thrown new factors into the equation.

Urban sprawl is recognised as inefficient and damaging to the climate. While it offers *"the dream"*, it comes at high cost for governments in terms of infrastructure as well as having a significant impact on the environment. Urban Taskforce Australia (UTA) has always stood for choice and the availability of multiple housing options. House and land package sub-divisions have played, and will continue to play, an important role as Sydney's population grows. But those concerned about climate change are looking more closely at the benefits of more compact, high density solutions. This paper discusses the impact of each of the different types of housing on the environment. It finds that high rise buildings have lowest embedded carbon-emissions compared with other developments, such as townhouses or suburban homes, and provide the best opportunity for increased energy efficiency.

This paper examines the carbon footprint associated with the construction and operation of different types of dwellings. It refers to detailed modelling undertaken by Christopher Drew, Katrina Fernandez Nova and Keara Fanning of Adrian Smith + Gordon Gill Architecture, using typical construction standards for each type of dwelling and modelling the carbon footprint associated with the operation of each type of home over 20 years. The findings are instructive.

While mega-tall towers result in high carbon (emissions of tons CO_2) per dwelling, the most environmentally friendly dwelling type is high rise (58 stories) apartment buildings while the second-best green option came in at 34 stories. Suburban separated households represent the poorest option in terms of greenhouse gas emissions, due to the embedded carbon footprint through construction and the operation of the typical home.

While millennials are increasingly looking to get a foot on the housing ownership ladder, they are turning to apartment living as an affordable option which is well serviced by public transport and neighbourhood amenity. It turns out that this trend is also good for the environment. This is a lesson that policy makers and politicians will ignore to their peril.

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Introduction

Climate change poses a great challenge and is one that is increasingly prominent in public debate. In November 2021, the Glasgow Climate Pact set the global agenda on climate change and emission reduction for the next decade, with a larger goal for the world to reach net zero emissions by 2050. The question of delivering sustainable growth and reducing carbon emissions is increasingly important for governments, companies and individuals. Sustainable development has become a driver of decision making among policy makers and industry as we strive to deliver emerging market choices. This is slowly but surely having an impact on the way we live and plan for the future, including how we shape our cities.

Sydney's growth poses a dilemma. In the last decade, Greater Sydney's population grew by 15.1% while the population of NSW grew by 12.5% over the same period.[1]

The population of the Greater Sydney Area is 5,252,611 and two decades from now it is expected to reach 7,103,091.[2] The considerable growth projections for Sydney along with increased interest in sustainable housing choice among millennials will drive increased attention to sustainable growth options.

Global cities similar to Sydney are implementing de-carbonisation strategies and their residents are increasingly demanding 'green' urban environments. Without a strategy for environmentally sustainable growth Sydney risks reputational damage and, in the long term according to the Greater Sydney Commission, faces the risk of being left behind by the group of 'green' metropolises actively fighting the global issue of climate change.[3]

The global momentum for sustainable growth has created a steady convergence of interests between all levels of government, developers and equity providers, homebuyers and tenants.

The Australian Government recently published its pledge to reach net zero emissions by 2050. All Australian state governments have developed similar strategies while local councils across NSW have adopted the *Race to Zero* platform.

Many involved with private sector housing development are promoting their developments as having a positive impact on climate change by reducing carbon emissions. Many developers in Australia have adopted the *Task Force on Climate-Related Financial Disclosures* (TCFD) recommendations that represent leading practice on climate-related financial risk disclosures. Listed companies report to their shareholders how they view commercial implications of climate change and what they are doing in response.[4] Developers increasingly offset carbon emissions from their activities, use low carbon materials and pledge to achieve net zero carbon targets within two decades.[5]

The values of buyers and tenants are also changing. The current generation is environmentally conscious and consumers are increasingly making purchasing decisions that have less impact on the environment. Similarly, the emerging generation of homebuyers and tenants are the thousands of high school protesters from earlier in 2021 that demanded a decisive action and response to climate change.

The alignment of interests of almost all relevant actors presents an opportunity to consider the most sustainable growth strategy for Sydney and its 7 million residents. The best strategy for Sydney with minimal environmental impact and the least carbon emissions is the development of high-rise buildings.

Urban Taskforce is concerned to highlight how 'green' modern buildings really are, and why increased density in the city is a step forward in confronting global climate change. This article does not aim to demonstrate the most sustainable or desirable way of living and will not argue for a testbed of specialist green precincts. Instead this special edition of Urban Ideas seeks to offer some insight into a practical, feasible and affordable way forward for the development of the Greater Sydney Area, in line with the current and emerging trends and market choices.

Comparing different dwelling structures

To understand the *'most green'* strategy for Sydney's growth, this paper explores the difference between various dwelling structures. Comparing different homes is not a simple task as there are numerous risks in the assumptions and the choice of dwellings to include in the comparison. The choice of the size, construction material, infrastructure and energy use for each dwelling, be it a house in the suburbs or a CBD apartment, can significantly change the results. Therefore, it is important to ensure that the different structures are comparable, and the analysis embeds controls for significant contributing factors (thus ensuring no in-built bias).

An excellent investigation with convincing results has been undertaken by Adrian Smith + Gordon Gill Architecture (AS+GG)[6] and it will be referred to extensively here. Their analysis compares the following different buildings: supertall, high-rise, low-rise and single-family homes for their environmental impact. Specifically, the designed nine hypothetical communities are: suburban home, urban home, 3-storey 3 flat building (i.e. each apartment is an entire flood), 4 storey courtyard, and buildings with 16, 34, 58, 123 and 215 stories. To ensure the types of structures are comparable, AS+GG have designed the models by

using standard materials and mechanisms and each dwelling type is said to have 2,000 individual dwellings.

The different types of buildings were then analysed against the following environmental indicators: land use, energy demand and life cycle carbon emissions.

The land use indicator included the footprint of the structure together with required infrastructure such as roads, sidewalks, water, wastewater and storm distribution networks. To model energy consumption, the designed structures were run through software (Energy Plus) to calculate the energy consumption, while also controlling for other factors such as the orientation of the building, overshadowing, etc. Lifecycle carbon emissions were calculated over a period of 20 years and included the embedded carbon for the building and the associated infrastructure.

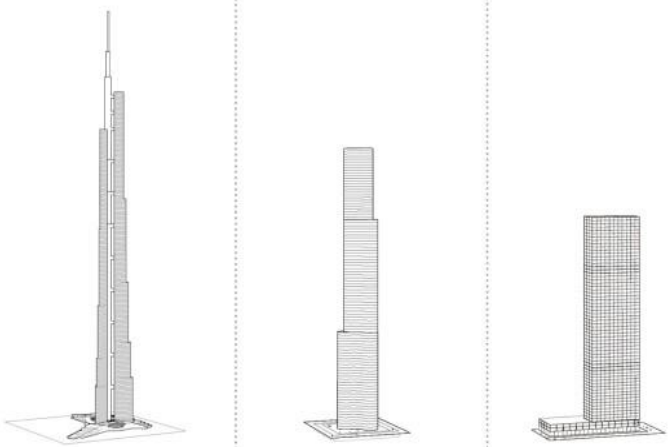
While looking at each of the indicators in isolation may provide valuable insights, it is the overall performance across all indicators that accurately presents the total environmental impact.

High rise buildings have lowest embedded carbon-emission compared with other developments, such as townhouses or suburban homes and provide the best opportunity for increased energy efficiency.

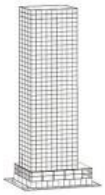
The results from the AS+GG analysis conclude that high-rise buildings perform best overall, with the 58 storey performing best, followed by the 34 storey buildings. The analysis finds that high-rise structures provide the best land use with the lowest embodied carbon. While operational carbon emissions and energy demand can be higher for tall buildings, as a result of their use of lifts and water pumps, taller buildings also provide an opportunity to improve their efficiency via digital management systems and reduced reliance on energy generated from fossil fuels. This is discussed in greater detail later in this paper.

AS+GC also published a table of the results from a comparable analysis which demonstrated similar results. This table (reproduced at Figure 1) examines only the embedded carbon associated with the construction of each building type.

Figure 1: Different dwelling types



	Megatall	Supertall	High-Rise
Number of Buildings	1	2	4
Number of Units per Building	2,000	1,000	500
Number of Stories (Above Grade)	213	121	65
Building Height (M)	766	435	229
Building Floor Area (M^2)	495,880	231,869	110,184
Building Embodied Carbon (Tons CO_2)	238,971	110,597	26,048
Embodied Carbon per Unit (Tons CO_2)	119	111	52
Infrastructure Embodied Carbon (Tons CO_2)	1,462	1,762	1,322
Total Embodied Carbon (Tons CO_2)	240,433	222,957	105,513
Structure (%)	93%	93%	85%
Window/Wall Ratio (%)	40%	40%	40%

			
	Mid-Rise	**Low-Rise**	**Courtyard**
Number of Buildings	10	20	100
Number of Units per Building	200	100	20
Number of Stories (Above Grade)	38	20	4
Building Height (M)	134.5	71.5	14
Building Floor Area (M^2)	42,896	24,300	3,756
Building Embodied Carbon (Tons CO_2)	10,904	6,945	1,360
Embodied Carbon per Unit (Tons CO_2)	55	69	68
Infrastructure Embodied Carbon (Tons CO_2)	1,844	2,383	5,562
Total Embodied Carbon (Tons CO_2)	110,882	141,274	141,496
Structure (%)	84%	90%	73%
Window/Wall Ratio (%)	40%	40%	14.6%

			
	Three-Flat	**Urban Single-Family**	**Suburban Single-Family**
Number of Buildings	667	2,000	2,000
Number of Units per Building	3	1	1
Number of Stories (Above Grade)	3	2	2
Building Height (M)	10.5	5.6	8.6
Building Floor Area (M^2)	554	216	233
Building Embodied Carbon (Tons CO_2)	218	74	71
Embodied Carbon per Unit (Tons CO_2)	73	74	71
Infrastructure Embodied Carbon (Tons CO_2)	8,742	16,023	30,529
Total Embodied Carbon (Tons CO_2)	154,016	164,823	172,932
Structure (%)	78%	47%	53%
Window/Wall Ratio (%)	9.6%	8.9%	10.9%

Source: AG+GG, published in the Architect (2020)[7]

The results from AS+GG analysis demonstrate that high-rise buildings perform best overall, with the 58 storey performing best, followed by the 34 storey buildings. This analysis concludes that high-rise structures provide the best land use with the lowest embodied carbon.

What does the comparative analysis of different dwelling structures mean for Sydney and its future?

Greenland Centre Sydney, CBD
Source: Greenland

Sydney is the 37th tallest city in the world, according to completed 150m+ buildings, but it does not have any "megatall" or "supertall" buildings (215 and 123 stories respectively). The tallest residential mixed-use building is 67 stories, located in the CBD and completed in 2021.

These towers together with many other examples across Sydney fit the profile of the 58 and 34 storey models found in the AG+GG analysis that were recognised as the best performing structures when compared to 3 storey flats, town-houses and suburban homes.

These vertical residential developments are becoming increasing efficient over time with lower embodied carbon and operational carbon emissions. The reasons behind this are the current trends in construction, emerging technologies and methods which make high-rise developments increasingly 'greener', the ability to offset the carbon emission and the changing energy generation mix which includes more renewable energy generation.

Building *clever* by choosing low-carbon materials and smart design is reducing embodied carbon emissions in high rise developments. A report from November 2021 from Clean Energy Finance Corporation (CEFC) analysed the extent to which improvements are being

made to reduce embodied carbon emissions in construction in Australia.[8] The report shows that new buildings have between 3% to 15% less embodied carbon due the choice of design and usage of low carbon materials. The highest reduction of 15% was seen in the residential sector, followed by industrial, office, mixed use buildings and offices. CEFC's report reveals the significant impact of the commitment by industry to reduce carbon emissions and move closer to the goal of net zero.

Operational carbon emissions in modern buildings can also be reduced by utilising intelligent energy management systems and the Internet of Things (IoT). Current systems use technologies to combine data on occupants' behaviour, energy prices, building data and weather information to understand the energy behaviour of the building and offer cost-saving and energy reduction solutions to the residents.[9] This includes use of lights and minimising HVAC energy consumption based on occupants' behaviour. Similar systems with predictive use of energy can be developed for high-rise buildings where there is a significant amount of data. Other innovations such as energy recovery from lifts and creating synergies between different systems in high-rise buildings can also improve energy efficiency. While smart waste systems and water usage are also possible to make buildings more sustainable, further innovation and research is needed to reach the full potential of these systems.[10]

Altitude, Parramatta
Source: Meriton

Carbon emissions can also be offset by generating renewable energy to recover some of the energy usage of the high-rise buildings. Australia has favourable solar radiation for use in solar photovoltaic (PV) energy generation and the country already has one of the best adoption rates for rooftop solar in the world. Buildings are also designed to use the sun for generating a portion of their energy demand. Recently, a development application for an office tower in Melbourne proposes to generate 20% of its energy requirements through the use of its 'solar skin' - a PV cladding that will wrap a significant part of the building.

Improvements in energy efficiency are complemented by the changing energy generation mix which will increasingly provide electricity from renewable sources.

The energy generation from renewables in Australia has almost tripled in two decades – from 8.6% in 2000 to 24.4 in 2020.[11] Over the next decade renewables will rapidly increase their share in the generation mix due to, among other factors, the large-scale renewables development pipeline. Renewable share of generation in NSW will increase even faster than the national average for Australia, as seen at the table below.

Figure 2: Renewable share of generation, projection until 2030, %

Percentage of renewables	2025	2030
National Electricity Market	51	69
Queensland	*37*	*43*
New South Wales/ACT	*46*	*84*
Victoria	*50*	*61*
South Australia	*97*	*96*
Tasmania	*100*	*100*
Western Australia Wholesale Electricity Market	37	45
Other grids, including off-grid	8	13
Whole sector	**45**	**61**

Source: *Australia's emissions projections 2021*, Department of Industry, Science, Energy and Resources, Australian Government (October 2021)

To put things in perspective, at the beginning of the next decade, high rise buildings can be powered by a grid that generates 84% of the electricity from renewable sources, thereby significantly reducing their operational carbon emissions. This reduction is in addition to their own energy generation systems that tall buildings may have.

The small footprint of high-rise buildings and the significant opportunities to improve both the embodied carbon and operational carbon emissions, as well as the increasing capacity to offset the energy use, makes these dwellings the most sustainable structures. It is therefore likely that the developers of these projects will achieve their net zero carbon moment before the rest of Australia and continue building on that momentum.

In addition to the specific characteristics of high-rise buildings, it is also important to consider the wider environmental benefits from high density developments. One key limitation of the AS+GG comparison discussed earlier is that the analysis did not consider the environmental impact of the communities and the lifestyle promoted by the different types of dwellings. It is well documented that residents in high-density communities are more prone to using public transport (where it is available), as opposed to driving a car, than their counterparts who live in suburban homes.

The sustainability of high-density communities is convincingly argued by David Owen in his book *Green Metropolis: Why Living Smaller, Living Closer, and Driving Less Are the Keys to Sustainability.* Owen

concludes that life in the big city (in his case, New York City) is “a model of environmental responsibility” and much more sustainable than rural communities.[12] One of the main reasons for this is because urban residents use public transit, ride bicycles or walk to work and therefore emit much less CO_2 than the rural residents who depend on their vehicles as the primary and often the only means of transport.

High rise buildings also provide the necessary patronage for expanding the infrastructure network and justify the cost of the new train connections early on. The link between tall buildings and use of public transport is well established, provided that the development is within walkable distance.[13] As such, high rise buildings are not suitable only for the heart of the urban centres but can also assist in growing new urban cores and also reduce the number of vehicles on the roads.

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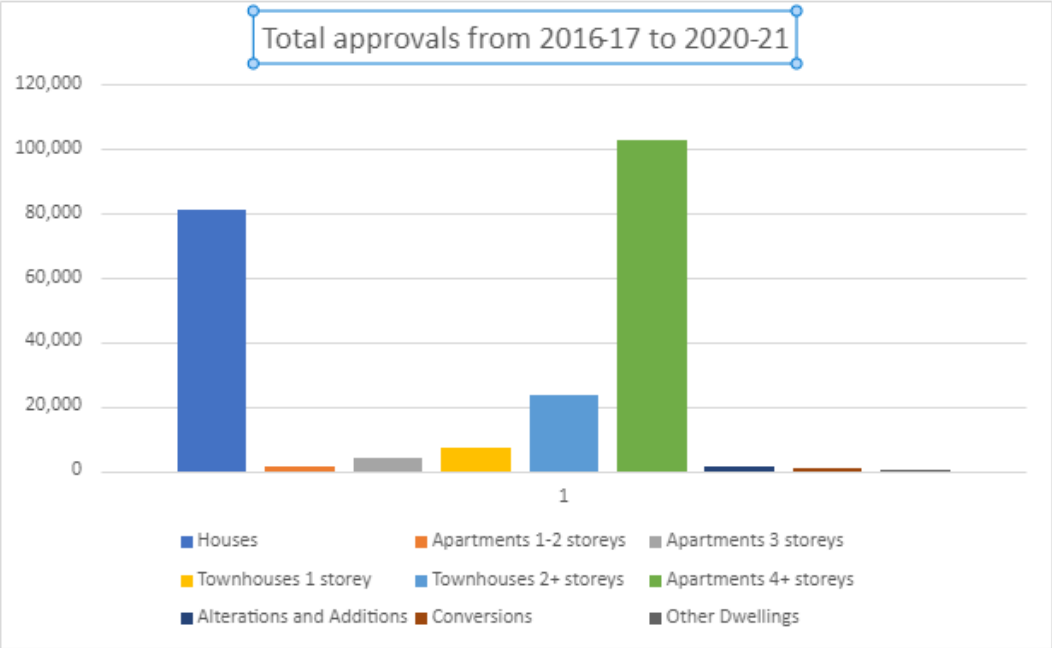
It is important to note that the least environmental impact is caused by a development that requires less new infrastructure. The obvious truth is that 100% of the embodied carbon can be saved if no new infrastructure is built. By focusing on infill development, rather than expanding the city limits, the existing infrastructure can be improved to enable maximum use leading to minimal environmental impact.
What is the current pattern of Sydney’s growth? A snapshot of the last five years shows that most development approvals were issued for either tall buildings (made up of multiple dwellings) or free-standing houses.[14] It is important to note that the Department of Planning, Industry and Environment’s Metropolitan Housing Monitor classifies all approvals for buildings of 4 stories and above as “high rise approvals”.

The typology used in this sophisticated AS+GG analysis shows up the naivety of planning nomenclature use by the NSW Department of Planning. Inexplicably, buildings of 4 stories and above are designated “high rise” by our planning system. That would make every building within the Périphérique of Paris high rise. Ridiculous. This is indicative of a planning system that is rooted a vision of Sydney from the early 1970s. Nonetheless, the data below is necessarily based on this naive NSW typology.

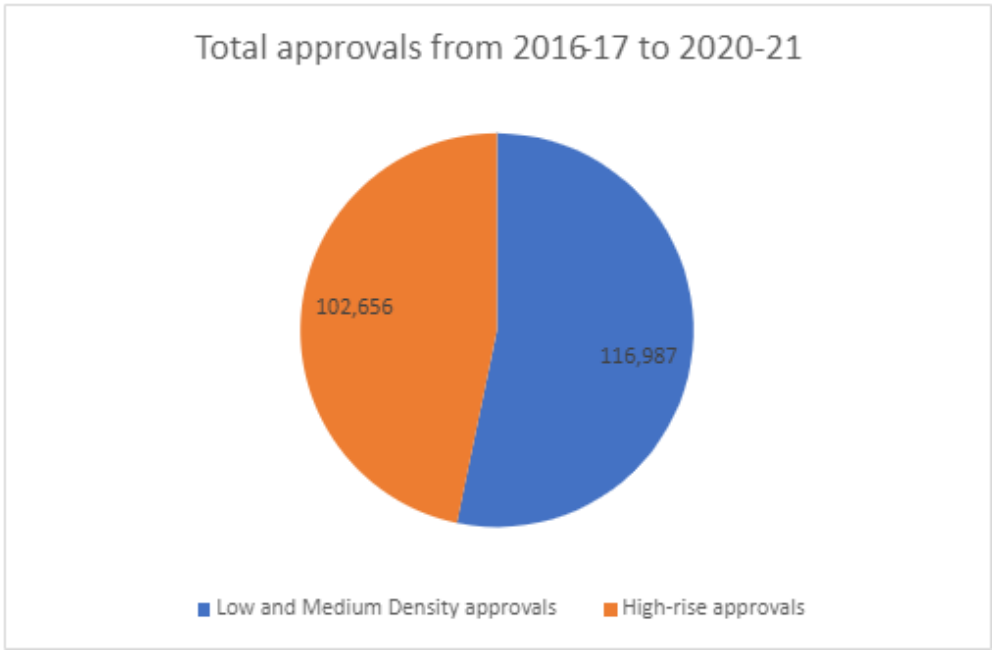
Figure 3: Total approvals (per dwelling) for different types of dwellings in Greater Sydney Area



Source: Metropolitan Housing Monitor, DPIE, 2021

When aggregating the data for low and medium density on the one hand, and high-rise developments on the other, it shows that a total of 102,656 low and medium density approvals and 116,987 high-rise approvals were issued.

Figure 4: Total number of approvals (per dwelling) for Low and Medium Density and high-rise dwellings in Greater Sydney Area



Source: Metropolitan Housing Monitor, DPIE, 2021

Over the last decade there has been an almost even split between the two categories.

Figure 5: Percentage of total approvals for different types of dwellings in Greater Sydney Area

	% of total approvals from 2011-12 to 2015-16	% of total approvals from 2016-17 to 2020-21
Low and Medium Density approvals	47.05%	53.26%
High rise approvals	52.95%	46.74%

Source: Metropolitan Housing Monitor, DPIE, 2021

Based on the Central Base Case Forecast Scenario, the current projections by NSW Department of Planning, Industry and Environment forecast annual growth of around 31,000 new homes per year for the next three years. The projected growth is clearly well below the target of 40,000 new homes per year set by the NSW Housing Strategy 2041.

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The path towards a tall 'green' metropolis

Sydney has a lot of capacity for growth as its innermost suburbs have low density, compared to other global cities. As noted in the *Productivity Commission White Paper 2021: "*The densest local government area (LGA) is the City of Sydney, with just over 9,000 people per square kilometre. This contrasts with New York City's Manhattan borough, with around 27,000 people per square kilometre, the City of Paris with around 20,000 people per square kilometre, and inner boroughs of London at 11,000 people per square kilometre."[15] Considering the low density of Sydney and the growing demand for homes, the *White Paper* concludes there is not enough growth in areas of Sydney where people want to live.

To satisfy the growing demand for Sydney-based homes by local residents and that expected from the return of migrants in the near future, while also working to reduce carbon emissions, political leaders and policy makers must prioritise high rise mixed-use and residential apartment buildings in the Greater Sydney Area. This issue is particularly relevant to Greater Sydney given the topography and ecological surrounds of our city and the cost of greenfield infrastructure.

The new Central Sydney Planning Strategy from November 2021 will allow skyscrapers up to 330 metres high. Similarly, high rise buildings should be the new norm across all of Sydney and local councils should remove height limits other than those based on overshadowing of significant areas of public open space.

To enable this growth, all levels of government must coordinate efforts to invest in necessary infrastructure. Increased public transport services will be required not only to relieve pressure on traffic in the growing communities, but also to utilise the low carbon emission benefits from increased use of public transport and walkable communities created by the high rise buildings. Timely investment in well planned infrastructure will address some of the risks associated with high density growth strategy.

> *The small footprint of the high-rise buildings, significant opportunities to improve the embodied carbon and operational carbon emissions, as well as the increasing capacity to offset the energy use, makes these dwellings the most sustainable structures. It is therefore likely that the developers of these projects will achieve their net zero carbon moment before the rest of Australia and continue building on that momentum.*

Urban Taskforce understands the political risks that such a strategy would entail, especially on a local level. Local communities will almost certainly object to an increase in the number of high rise buildings and the effects these developments may have on the neighbourhood character.

With regard to these challenges, it is worth noting a policy paper from the Centre for Independent Studies which examined five examples of high rise developments across Sydney with a total supply of 20,000 new apartments.[16] The authors investigated if and how high rise developments damage neighbourhood character and concluded that despite often objections from local residents, there was “no discernible harm from this extra housing.”[17]

The objections to high density developments may be attributed to “fear of the unknown” according to Tulip and Laniganm, which are greatly reduced after the development project is built.[18]

The issue is often one of political leadership, or lack thereof. Both Paul Keating and John Howard showed that leaders of quality can drive unpopular change if they mount and argue the case for a better outcome.

Conclusion

STANDING TALL: High Rise Buildings to Help Sydney Become a Green Metropolis showcases the benefits of high density growth for Sydney as the most ‘green’ way forward. It explains that high rise buildings have lowest embedded carbon-emission and provide the best opportunity for increasing energy efficiency in the future.

High rise buildings have the lowest embedded carbon emissions compared with other developments, such as townhouses or suburban homes, and provide the best opportunity for further carbon emission reduction. Starting at the construction phase the embedded carbon can be reduced via the choice of building materials. During the operational phase of the building, energy efficiency can be improved by using smart systems and the IoT, as well as generating energy via innovative renewable energy generation solutions.

Further, due to the high density, high rise buildings are providing urban living with walkable communities and provide impetus for using public transport therefore reducing pollution through a reduction of vehicles on the road and less kilometres travelled. This applies to all urban areas that are well serviced by public transport.

Whether evaluated for their characteristics today or their potential for improvement in the next few decades, high rise buildings are the best option to cut carbon emissions and achieve Sydney’s net zero target. While supporting choice and a diversity of building supply type, any sensible growth strategy which aims to make Sydney a truly green metropolis should predominantly focus on construction of high rise buildings and provision of the required infrastructure.

Endnotes

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