CONSULTATION DRAFT

CLIMATE POSITIVE PERTH

A vision for a low carbon, connected & liveable city











This report was produced on stolen Whadjuk land, and we pay respects to their elders past and present. Their ancestral ties to Country have never been extinguished, and sovereignty never ceded. Our deepest gratitude to the elders and First Nations representatives who contributed to the production of this report.

Front cover image credits: People sitting under tree canopy (row 2/3); Two people walking a dog through a park (row 2/3) – Peter Bennetts and Hassel Studios. Hand touching a turtle sculpture (row 4); children in a park (row 4) – Robert Frith and Hassel Studios. Terrace Green, White Gum Valley (row 2); Booyeembara Park (row 2) – Tim Oliver.

CLIMATE POSITIVE PERTH

Consultation Draft


Bitton

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Preface

Over many decades I have been involved in writing reports about sustainable cities, globally and here in Western Australia.

20 years ago I helped pull together WA's first *State Sustainability Strategy*, written for the Gallop Government to map out a way forward for WA.

While much has changed since then, too much remains the same and Perth is still a city that is more car-dependent and sprawled than it needs to be.

Shifting the conversation and raising the ambition of the low carbon transition for metropolitan Perth is timely. Later this year we expect WA to release its *Sectoral Emissions Reduction Strategies* having failed to legislate emissions targets, and this report will be a useful contribution to the much-needed discussion about the changes that need to happen for WA to adequately address the challenge of climate change.

This report has a range of detailed recommendations that all need further discussion. Most of all it is important to see that they are seeking to fulfil three major overall objectives to enable a Climate Positive Future Perth:

- Carbon Positive initiatives in energy, transport, and greening that can be expressed in every new urban development, every neighbourhood and in each business and household.
- Nature Positive initiatives that can ensure the city is cooler, healthier and more able to support its special biodiversity.
- Community Positive initiatives that ensure the places where we live, work and recreate are sensitive to the ancient culture that supported this area for thousands of years as well as being safe in times of global heating, and expressing the kinds of community values that are treasured.

The debate over Perth's future must therefore enable us to create a community-based process that can address in each new urban development and each new infrastructure project, how to include these three core factors.

I hope this consultation draft of Climate Positive Perth leads to many good conversations and ideas for Perth's future that can be picked up by the government and community alike.

Distinguished Prof Peter Newman OA

Curtin University Sustainability Policy (CUSP) Institute

Our Expert Reference Group

This report was developed in collaboration with a roundtable of WA's leading research, practice, and policy experts in urban development, transport, planning, energy, and urban greening.

Thankyou to the many individuals from the following organizations who lent their expertise and advice to this report through a series of roundtables that were held at Parliament over the last two years.

In recognising their contribution, we want to be clear that this does not mean that they endorse everything in this report. There have been many contributions and ideas, together they form a starting place for further discussion. Many of the great ideas are theirs, while any mistakes are mine.

We thank each of them for volunteering their time and expertise.

Hon Dr Brad Pettitt MLC

- Australian Electric Vehicles Association
- Australian Institute of Landscape Architects
- Curtin University
- Hesperia
- Murdoch University
- New Normal Melbourne
- Nic Brunsdon
- Perth South West Metropolitan Alliance
- PJA Australia
- Planning Institute of Australia (WA)
- Property Council of Australia
- Shelter WA
- TheFulcrum.Agency
- WA Climate Leaders Inc.
- Westcycle
- WA Tree Canopy Advocates
- The Office of Brad Pettitt MLC

First Nations Roundtable

In August 2023 we held a roundtable with First Nations leaders from around Perth and WA to get their insights into what a climate-positive Perth should include. This session was informative and many of the excellent ideas raised are included in the report.

Perth's transition from fossil fuels will require access to large areas of land and waters. While many of the most impactful, including new transmission lines and access to critical minerals, are largely outside of metropolitan Perth, this process must be managed carefully and with the full involvement of traditional owners.

Roundtable members were also clear that enabling and empowering First Nations to play a central role in the transition goes beyond just a social license and must also include embedding First Nations peoples as partners in Perth's transformation to deliver ongoing mutual benefits for the whole state.

Roundtable members were particularly interested in how local Whadjuk knowledge could help rebuild the natural corridors and linkages that existed before invasion and settlement.

We thank them for their insights and wisdom.

Left to right: Brett Collard, Sharron Calgaret, Aunty Betty, Desmond Burton, Daniel Garlett, Uncle Ben Taylor, Tina Hayden, Heidi Mippi, Gerrard Shaw, Brad Pettitt.

CHAPTER 1

Introduction

> **"The decade between 2020 and 2030 is recognised as a critical window of opportunity for climate policy to fulfil the Paris targets. Substantial policy acceleration must occur throughout this window for us to reach net zero by 2050."**
>
> Achieving Net Zero Emissions, PIA

Cities matter. Three numbers — 2, 50, and 70 — succinctly sum up why. Cities take up just 2% of the land mass, but over 50% of the global population currently lives in urban areas. More than 70% of global carbon emissions are linked to cities and urban areas.

A recent report in Scientific American stated that: "*Residents of just 100 cities account for 20 percent of humanity's overall carbon footprint.*" It is not an overstatement to say: "*In our cities lies the future of the planet*".

While Perth is a relatively small city by global standards in terms of population, our physical footprint and carbon emissions make us a big city, even by global standards. This disproportionate impact, and unsustainable trajectory, were key drivers for the original *#designperth* and *WA2.0* research that Climate Positive Perth builds upon.

The motivation for *#designperth* and *WA2.0* was to create a joint vision — with unexpected collaborations — for a more connected, liveable, and sustainable Perth.

#designperth summarised key challenges of Perth's urban development and growth pattern, reviewed current policy settings, and recommended policy solutions to overcome institutional barriers, inertia, and mixed messaging.

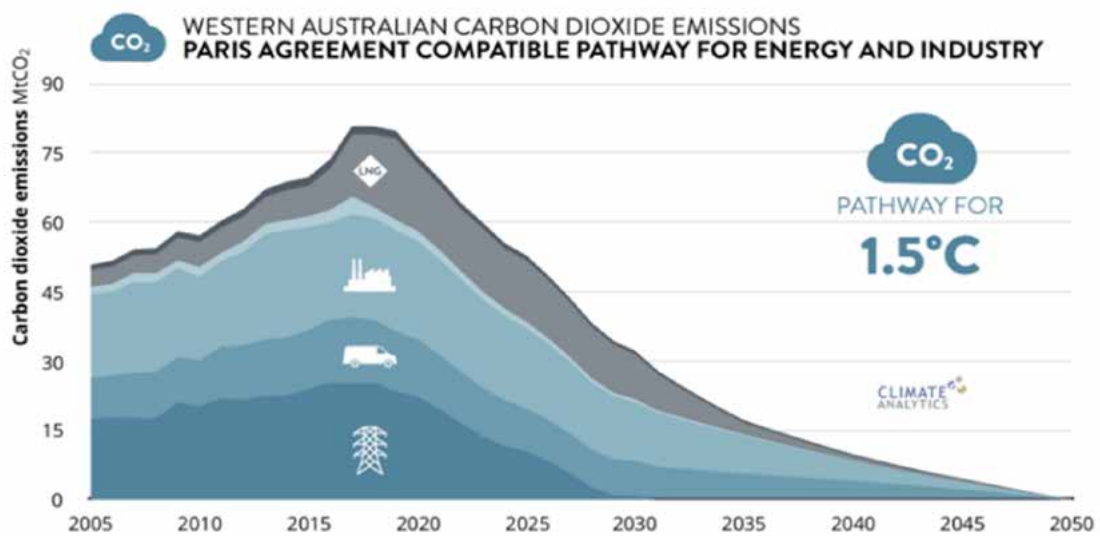
These studies, and earlier offerings like *Transforming Perth* (2013), provided examples of what sustainable, world-class infill could look like, focusing on the optimal development options for sites along Perth's key transport corridors. These options demonstrated how well-designed and innovative density can transform these corridors with a mix of housing, employment opportunities, and services. It was an exciting blueprint for creating a connected, liveable, and sustainable Perth into the future.

Now, in 2023, Climate Positive Perth picks up where these reports left off by connecting the latest data, policy recommendations, and design examples with a focus on rapid decarbonisation across the metropolitan area in a manner consistent with climate science.

Over the last decade, we've seen some successful examples of sustainable developments, including WGV in White Gum Valley, East Village at Knutsford, and the Nightingale developments. We have also seen the growth of renewable energy and a major investment in public transport via Metronet.

Despite these encouraging shifts towards creating a more sustainable urban form, Perth's footprint continues to grow, and WA's emissions continue to rise (see Figure 1.1).

Figure 1.1: WA's emissions



Source: Climate Analytics

To reduce emissions, mitigate the impacts of climate change, and sustainably accommodate 3.5 million people in Perth by 2050, we need to address our energy use, transport mix, housing density, planning laws, urban greening, and liveability by creating a new positive, low-carbon roadmap for the future of metropolitan Perth.

Put simply, Climate Positive Perth is about how we do things better in energy, transport, greening, built-form — and the smart intersections in between.

We originally planned to call this report Net Zero Perth, but over the last two years 'net zero' has increasingly come to mean plans that rely heavily on the offsetting of carbon emissions, hence the "net" before the "zero". In contrast, this report is focused on changes that can make actual emission reductions across Perth, without using carbon offsets. We also wanted to highlight that addressing climate change, if done well, can be positive for a city.

This report sits within the broader framework of the UN Sustainable Development Goals (SDGs). The interconnected nature of the Sustainable Development Goals provides a useful framework to enable thinking about the necessary urban sustainability transition.

Figure 1.2: The UN Sustainable Development Goals (2015)

Understanding the interconnectedness of the transition is a central element of the report, but for the ease of understanding the report also breaks down the different aspects into some more digestible key ingredients. Transforming metropolitan Perth into a low-carbon city might feel like a big and at times dauntingly complex task. For the ease of understanding we have broken down the chapters into the following key categories.

1. Planning and Built From

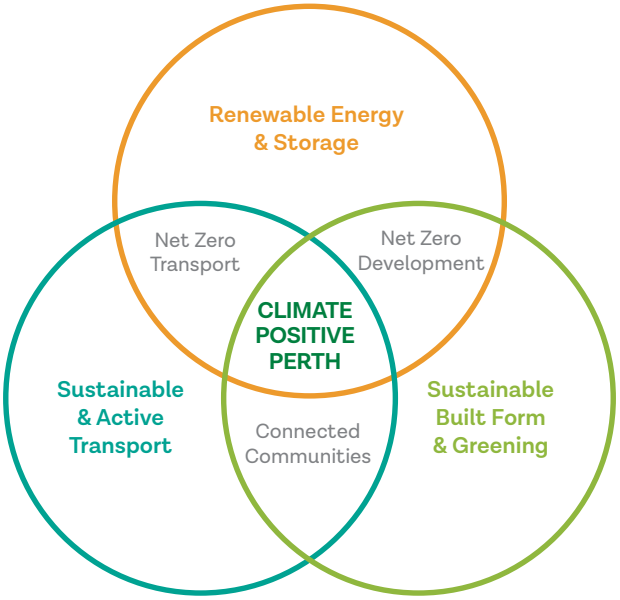
2. Transport

3. Urban Greening

4. Energy

Each of these four areas is examined at three different levels: metropolitan, neighbourhood and household, making up the 12 central chapters of the report.

Figure 1.3: Each topic examined in Climate Positive Perth intersects with the others.



Of course, the reality is that these elements are often interrelated, and it is where the issues intersect that some of the best solutions for a Climate Positive Perth sit. The final chapter will briefly consider these intersections and how we can make the most of synergies to speed up the transition, making it more efficient and more effective.

Finally, some of the chapters in this report are necessarily dense and complex.

For example, the energy chapters unpack in detail how to better embrace the clean energy transition that will underpin and enable a low-carbon Perth. What you need to know is that complex modelling shows we could rapidly transition to 87% renewable energy with a lower cost energy mix than we have today from our coal and gas-dominated grid. It also shows that a grid as high as 98% renewable energy is possible with the right investment. If you want to know the technical detail behind this read the chapters, otherwise feel free to just read the recommendations and jump to sections that interest you.

> **This is a consultation draft only, and we look forward to your views on its contents. We will be capturing feedback in the coming months and using the pull together a more polished final version of Climate Positive Perth in 2024. Please let us know what you think should be in it.**

There is no silver bullet to the climate change challenge. Instead, it is going to involve many changes to our city's design, to the technology we use, and changes to our behaviour. Together we can create a low-carbon city and improve our quality of life.

The good news is that it is not only possible but also desirable, cheaper, and healthier. We can do it if we overcome our crisis of imagination and start to see the challenge ahead of us not just as a burden but as the New York Times put it:

> "*The climate crisis is, above all else, an opportunity to change how we think about our relationship with nature and build a happier, healthier, more just world.*"

Perth, too, can be part of this.

Transformative Moves for a Climate Positive Perth — Our Recommendations

Planning and Built Form Recommendations

METROPOLITAN SCALE RECOMMENDATIONS

1. **Develop and fund an Urban Consolidation Plan** that includes genuine and interactive stakeholder and community engagement on how we plan for, design, and build infill across Greater Perth. This Urban Consolidation Plan would include:

   a. A clearly defined urban growth/ development boundary for greater Perth to put the brakes on sprawl and ensure a strong majority of new residents are in infill areas.

   b. Clearly defined, robust, and ambitious density targets including transparent public reporting on interim targets.

   c. A plan for Transit Oriented Developments (TODs) including required funding for implementation. This is likely to have a particular focus on Perth's heritage train lines.

   d. A plan for Transit Activated Corridors (TACs), including requiring funding with a clear link to mid-tier transit in the central sub-region.

2. **Provide incentives for new, well-located apartment developments.** This could include full stamp duty exemptions, removal of foreign buyer surcharge, reduction of financial disincentives to downsizing from houses to apartments, prioritised approvals processes, and state government direct funding to apartment projects.

3. **Provide incentives for local governments to meet density targets** through infrastructure funding pools exclusively for those local governments who meet and exceed targets.

NEIGHBOURHOOD SCALE RECOMMENDATIONS

1. **Plan and build for Perth to be a series of 15–20 minute, complete walkable centres and neighbourhoods.** Reactivate existing activity centres with much higher densities and insert a mix of uses into our neighbourhoods and suburbs to enable walkable distances for many more activities.

2. **Ensure that centres and neighbourhoods have a well-planned mix of uses.** Centres need a diverse balance of jobs, residents, and services. Where possible make spaces adaptable over time, so that as demand for uses change, buildings can change with them.

3. **Focus most new apartment development into current activity centres and other transit-connected locations rather than ad hoc suburban streets.** Target density close to transit and services to maximise its benefits and reduce negative impacts.

4. **Separate parking bays from apartments on titles.**

5. **Encourage diverse but gentle density in existing suburbs.** Reject destructive density like triplex and quadraplex villas. Instead incentivise more diverse, smaller, and sustainable new housing as the preferred model for suburban infill in areas where redevelopment for higher density is not the preferred option.

6. **Do limited greenfield developments well.** If Perth creates new greenfield developments, limit them and do them well with walkable streets and centres.

7. **Trial greening the greyfields and enable it to spread wherever it works.** The integrated approach to medium density development in middle suburbs that are looking to work in a more neighbourhood or precinct scale approach can also be ideal for low-carbon opportunities.

HOUSEHOLD SCALE RECOMMENDATIONS

1. **Mandate beyond 7 stars BCA immediately** for all new housing with a clear pathway to zero emissions for all new housing.

2. **Fund a zero/low-cost loan housing retrofit program** for 100,000 WA homes every year to align with higher energy performance standards, including switching to clean energy.

3. **Make low-income housing energy efficient** — Fund a State Government program to insulate and electrify (with solar PV) all government-owned low-income housing in WA by 2030.

Transport Recommendations

METROPOLITAN SCALE RECOMMENDATIONS

1. **Set ambitious mode share targets** for WA that are reported on annually.
2. **Ensure at least 20% of transport funding goes towards active transport** including an integrated metro-wide bike network.
3. **Plan for and invest in mid-tier transit** in Perth's central subregion in collaboration with local governments in the region, and create a process that will integrate low-carbon urban development into every corridor it runs through.
4. **Electrify all new Transperth buses** and stop buying gas and diesel buses immediately.
5. **Begin to electrify metropolitan freight trucks** entering Fremantle Port with clear targets that increase over time.
6. **Support and advocate for strong fuel efficiency standards for Australia** with an aim of 100% of new cars sold to be zero emissions by 2035 at the latest.
7. **Investigate a well targeted scrappage scheme** to speed up the uptake electric cars.
8. **Fund and support a major expansion of EV charging infrastructure** to ensure this does not become a block to rapid uptake.
9. **Encourage smaller, more efficient new electric cars** with well-designed policies and incentives.
10. **Reform the Transport Portfolio legislation and governance frameworks** so that the Department of Transport is responsible for multi-modal transit planning for Perth and Peel and Main Roads WA is no longer the primary planner and designer of urban transport infrastructure projects. Ensure key performance indicators are linked to lower carbon footprint of transport sector and more balanced mode-share.
11. **Set a target for reducing Vehicle Kms Travelled in all road planning**, so that traffic is being reduced into the future.

NEIGHBOURHOOD SCALE RECOMMENDATIONS

1. **More neighbourhood-scale focused bike infrastructure funding.** Make major investments in safe cycling and walking infrastructure with a stronger focus on the 'last mile', especially to schools, activity, and neighborhood centers.
2. **Fairer cost sharing for active transport projects.** Make State Government transport infrastructure funding at least mode neutral, if not weighted towards funding for active transport.
3. **Stronger focus on funding protected bike lanes.** The State Government could provide explicit funding for protected lanes and this new funding program would support local governments to expand this improved infrastructure.
4. **Expand programs enabling EV charging in our neighbourhoods and workplaces.** Not all houses or apartments are set up to charge electric cars and bikes so more public and workplace charging will be needed.
5. **A dedicated state government body to support more walkable, greener and safer neighbourhoods for everyone to enjoy.** Metropolitan Perth needs a plan and new governance to enable calmed, connected and walkable transit in our streets and neighbourhoods.

HOUSEHOLD SCALE RECOMMENDATIONS

1. **Ensure electric car, e-bike, and e-mobility parking and charging is available for all apartment buildings**, including enabling apartment retrofits where required.
2. **Establish a program of e-bike subsidies** for households to increase their uptake. Research shows a return on investment of $2–$3 for every $1 spent on these incentives.

Urban Greening Recommendations

METROPOLITAN SCALE RECOMMENDATIONS

1. **Establish a lead state agency and taskforce that plans, measures and maintains Perth's Urban Forest**. As per the State Infrastructure Strategy, assign a lead state agency and taskforce to provide overarching coordination, resourcing, and funding mechanisms The taskforce will involve First Nations elders, botanists, ecologists and policymakers to establish strategies for bushland preservation and revegetation. It will support the development, implementation and co-funding of state and local council Urban Forest Plans.
2. **Set a 30% target by 2040 for Perth's tree canopy**. Invest in new street and park plantings to link greenways together and increase biodiversity in every suburb. Include a series of interim tree canopy targets for Perth and a transparent progress reporting framework. Provide incentives for private landowners to plant and care for suitable trees and native plants on their property.
3. **Protect trees on private land** by amending the Perth Planning and Development Act 2005 so that planning approval is required to significantly prune or cut down any mature tree on private land.
4. **Set a target to protect 90% of remaining urban bushland**. Give statutory protection to Bush Forever sites and increase funding for adequate management of these sites. Introduce an Acquisition Fund to purchase natural areas of high conservation value in urban areas.
5. **Rebuild a network of green corridors and ecological linkages between existing natural habitats and parks by 2029** with a city-scale green retrofitting strategy of rebuilding green corridors. This metropolitan-scale planting schedule should include formal recognition of ecological linkages in our planning system.

NEIGHBOURHOOD SCALE RECOMMENDATIONS

1. **A street tree on every verge:** Mandate opt-out rather than opt-in processes for tree planting on verges. Plan for continuous street trees will cool Perth's suburbs and make them more liveable.
2. **Bigger verges in road reserves:** Mandate sufficient room in Perth's road reserves to place large street trees.
3. **Insert greenery into neighbourhoods:** Enable strategically located linear parks, pocket parks and greened pedestrian walkways to improve a neighbourhood's permeability.
4. **Review public open space requirements** with a view towards increasing the quality and quality of the land devoted to public open space, especially in higher-density neighbourhoods.
5. **Canopy cover and biodiversity:** Ensure more of Perth's green spaces are designed to provide canopy cover and biodiversity benefits including food for key species such as black cockatoos.

HOUSEHOLD SCALE RECOMMENDATIONS

1. **Mandate expanded deep planting zones and the planting and ongoing maintenance of large trees** on all residential lots.
2. **Encourage and fund native verge gardens** in collaboration with local governments and households.

Energy Recommendations

METROPOLITAN SCALE RECOMMENDATIONS

1. **A 2030 renewable energy plan and transition for the SWIS**. Invest in renewable energy, transmission infrastructure and storage.
2. **An ambitious renewable energy target (RET)**. WA needs a RET for 2030 and out to 2040, this will drive renewable energy investment and speed up progress. Keep an option to modify the RET target up or down should an additional incentive be required.
3. **Focus on increasing wind generation**. Wind generation with a wide geographical dispersion will be important for a stable renewable energy SWIS. This will mean a range of new and expanded wind assets from Kojanup to Collie to the Mid West.
4. **Proactively fund transmission** to the north of Perth and mid-west to enable privately funded wind to be built at scale.

NEIGHBOURHOOD SCALE RECOMMENDATIONS

1. **Enable shared solar PV** (also known as solar gardens) so that solar PV ownership is possible for everyone. This could easily be made a reality in WA through changes to government policy to direct Synergy accordingly.
2. **Enable shared community-owned neighbourhood scale batteries** that community investors can reap the benefits from. Like solar PV, not everyone has a home in which they can install a battery, but everyone could be a shared owner of a community battery.
3. **Mandate or, at the very least, strongly encourage gas-free neighbourhoods**. At a minimum, new reticulated gas should not be put into new neighbourhood scale developments.
4. **A LED streetlight replacement program** that is accompanied by a clear plan from the State Government (co-funded with local governments) to ensure all streetlights in WA are LED by 2030.

HOUSEHOLD SCALE RECOMMENDATIONS

1. **Make all Perth homes electric only** with no new reticulated gas connections after 2024.
2. **Incentivise heat pumps and batteries alongside home solar PV**. One of WA's great renewable energy success stories is the uptake of rooftop solar. This program needs to be expanded to include heat pumps and home batteries enabling home solar PV above 5kw when accompanied by an appropriately sized battery.
3. **Ensure there are no regulatory barriers to Vehicle-to-Home and Vehicle-to-Grid**. Vehicle-to-Home and Grid enable electric vehicles to be used much like a home battery system to store excess solar energy and power homes and the grid.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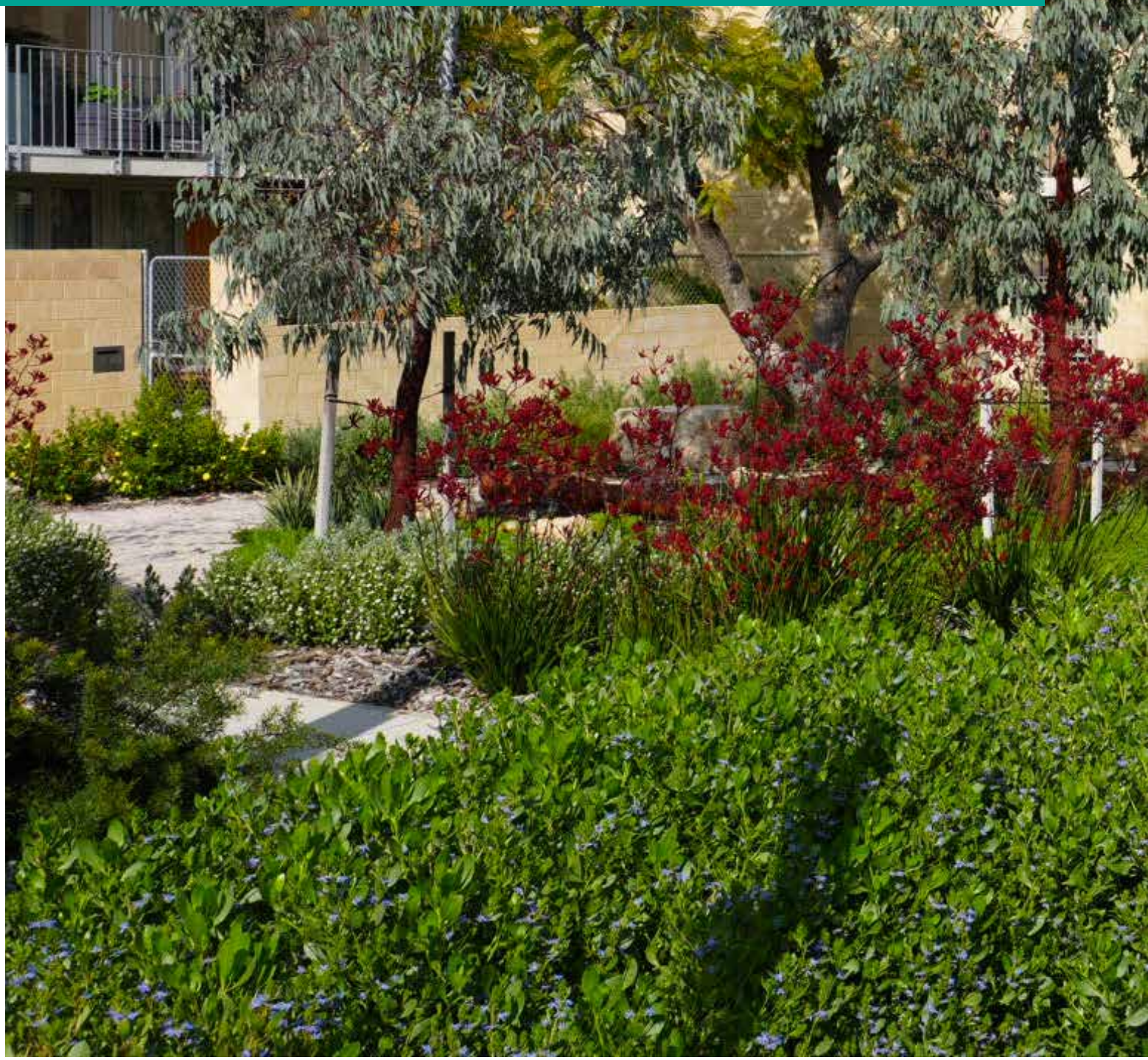
CHAPTER 2

Planning and Built Form

Ending the sprawl and revitalising our communities with sustainable homes and thoughtful density.



2.1 Planning and Built Form — Metropolitan Scale

"...low-density growth of urban areas in Western Australia has resulted in a car-focused transport network which has directly resulted in the growth in transport emissions and land use planning and infrastructure is a factor in the growth of other emissions."

PIA WA, 2021, Climate Conscious Planning System

2.1.1 Introduction

In 2013, the Property Council of Australia, the Office of Senator Scott Ludlam, and the Australian Urban Design Research Centre released *Transforming Perth*. It was a ground-breaking report which found that medium-density development along transport corridors could easily meet Perth's 'entire infill target'. It also demonstrated how activity corridors could transform Perth's congested, car-heavy roads into vibrant and attractive high streets and urban villages.

Its partner report, *#designperth*, explained the hidden cost of business-as-usual sprawl; the cost of infrastructure in greenfield sites. It demonstrated the potential for huge savings if the government placed greater emphasis on infill. It found that increasing Perth's infill target from 47% to 60% would save $23 billion by 2050. A 100% infill target would save $53 billion by 2050.

Despite this compelling analysis, Perth continues to sprawl ten years after the original report.

The scale of the problem was well recognised in the Medium Density Planning work by the Department of Planning, Lands and Heritage (DPLH):

> It is expected that by 2050 there will be an additional 1.5 million people living in the Perth and Peel regions. To accommodate this level of growth it is estimated that 800,000 new homes will be needed across the 19 local government areas in Perth's metropolitan area. Some 380,000 new homes will be built in existing suburbs to limit urban sprawl.

A sprawled Perth is a more expensive city, and it makes the transition to a low-carbon, more sustainable city much harder. As Newman and Newton explain:

> More compact cities require up to 40% less transport energy to operate and can save similar amounts of carbon dioxide emissions from urban transport. Medium-density housing is typically 25% more energy efficient than detached. There are a range of other environmental benefits that relate to reduced water and material use and waste generation as well as preservation of farmland and green space at the edges of the city.

In this section, we show how Perth shifting from a sprawled car dependent city to a more compact city based on transit and walking can benefit all of us.

Figure 2.1: Relative inputs in different city transport scenarios

	INPUT (PER PERSON PER YEAR)	AUTOMOBILE CITY	TRANSIT CITY	WALKING CITY
Resource	Total energy use (GJ)	64.1	47.2	32.2
	Water (Kl)	70	42	35
	Land (m^2)	547	214	133
	Total Building raw materials (T)	288	189	147
Waste	Greenhouse gas emissions (T CO2eq)	8.01	5.89	4.03
	Waste heat (GJ)	64.1	47.2	32.2
	Household waste (T)	0.63	0.56	0.49

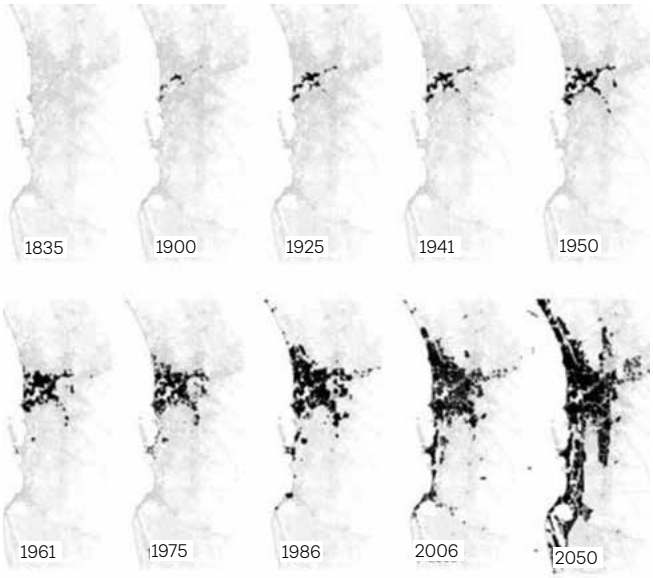
Source: Adapted from Thomson and Newman, (2018)

2.1.2 Where is Perth now?

In the seven years since *#designperth* was published in 2016, Perth has continued to stretch to approximately 150km along the coastline. Greater Perth's population grew by around 280,000 (or 14%), yet it got 30 km (25%) longer as it cleared hundreds of hectares more of one of only 36 global biodiversity hotspots, Earth's most biologically rich — yet threatened — terrestrial regions.

Perth now holds the dubious distinctions of being the world's longest city but also a relatively low density city by world standards with a world, with an average density of around 12 inhabitants per hectare.

Figure 2.2: The growth of Perth from 1835–2006 including a 2050 projection if the city continues to grow at current rates



As Transforming Perth said a decade ago:

> *Perth's metropolitan area is now one of the largest cities in the world by land size. Unlike other cities of a similar physical size we are very sparsely settled. Perth's physical size is roughly the same size as Los Angeles and Tokyo, but has only one tenth and one twentieth of their populations.*

In comparison, Tokyo has a land area size of 2,194km^2, with a population of 13.96 million. New York City, with a population of 8.42 million, takes up just 783.8km^2.

Figure 2.3: Expansion of Perth's metropolitan fringe 1995–2020

Perth's northern metropolitan fringe (1995)

Perth's northern metropolitan fringe (2020)

Sprawl is not healthy for the future of our city. It creates car dependency and congestion, undermining liveability and community, and destroys our region's unique biodiversity. The Environmental Protection Authority described the cost of continuing urban sprawl as 'incalculable'. The State Infrastructure Strategy reveals that "*...the cost of providing infrastructure to greenfield lots is 2 to 4 times more than infill development...*" (page 131). Traffic congestion cost Perth an estimated $1.5 billion in 2016, according to Infrastructure Australia. That's $4 million every day (ABC, 2022).

To reduce Perth's urban sprawl, the Perth and Peel@3.5million frameworks set an infill development target of 47% by 2040. Infrastructure WA notes that Perth's urban "*...infill target is low compared to those set for some other Australian cities — 85 per cent in Adelaide by 2045 and an aspiration of 70 per cent in Melbourne by 2050*".

Infill targets for major Australian Cities

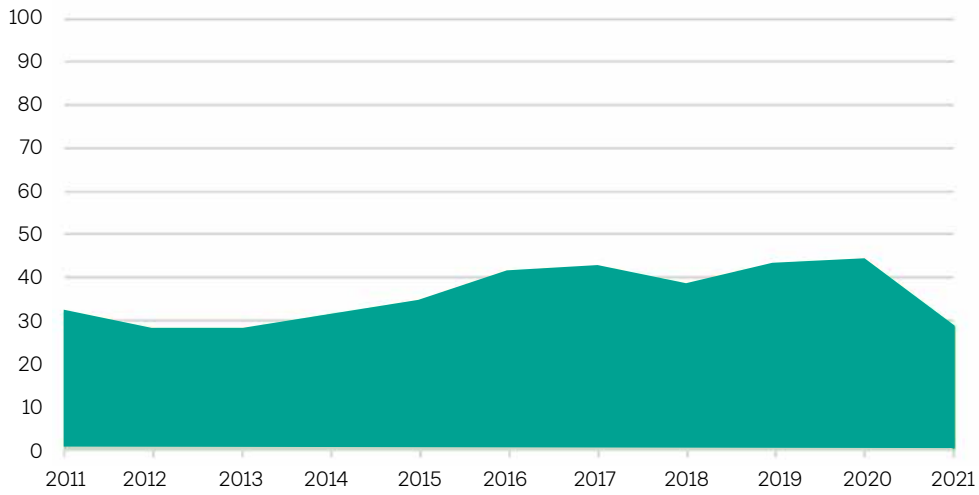
In the last ten years has not Perth met its infill target of 47%, or the original 60% target set under the previous Network City plan. In fact in recent years, infill has fallen to its lowest level in a decade.

Figure 2.4 Infill targets for major Australian cities

CITY	STRATEGIC PLAN	TIMEFRAME	TARGET NO. DWELLINGS	PERCENTAGE FROM INFILL
Sydney	Greater Sydney Region Plan — A Metropolis of Three Cities	2016–36	725,000	NA
Melbourne	Plan Melbourne 2017–2050	2015–51	1,550,000	70%
South-East Queensland	Shaping SEQ 2023 Update*	2021–46	863,600	70%
Adelaide	30-Year Plan for Greater Adelaide	2017–45	248,000	85%
Perth	Perth and Peel@3.5million	2018–50	800,000	47%

*The 2023 update to ShapingSEQ 2017 is currently in draft form. Finalisation expected late 2023

Figure 2.5: Percentage net infill



In 2020, net infill reached its highest level of 44%. This is the closest WA has got to achieving the bi-partisan infill target of 47%. By 2021, net infill dropped to 29%, according to the Urban Growth Monitor. Infill in Perth's Central sub-region fell to a mere 2,820 dwellings — the lowest level since 2013.

This means more than two-thirds of all new housing is currently being built on Greater Perth's expansive urban fringe. This is housing a long way from services and facilities. Bunbury could become Perth's most southern suburb at the rate we're going.

Figure 2.6: Urban Growth Monitor data

DWELLINGS	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Gross infill	6740	5600	5940	7790	9980	11480	8580	6540	6350	5720	4150
Net infill	4560	3360	3580	5280	7810	9570	6670	4440	4400	3980	2450
Greenfield	9790	8860	9340	11670	15020	13750	9160	7280	5930	5150	6110
PERCENTAGE INFILL	31.78	27.50	27.71	31.15	34.21	41.04	42.14	37.88	42.59	43.59	28.62

Perth's failed attempts to tackle sprawl over the last few decades are the result of poor government planning, policies, and infrastructure investments. Poor planning, combined with recent incentives to stimulate housing construction, Metronet, and the 2022 public transport fare cap, have all contributed to Perth retaining its dubious honour as the longest city in the world.

In particular, the 2020 state government devised building incentive grants that heavily favoured new housing on the urban fringe, turbo-charging sprawl. Infrastructure WA's draft State Infrastructure Strategy finds that:

> *(r)ecent incentives to stimulate housing construction activity as part of the WA Recovery Plan … fuelled a spike in single house construction in greenfield residential development.*

What kind of infill are we getting?

The short answer is we are getting more single-dwelling developments as infill rather than apartments or townhouses. According to the Urban Growth Monitor, two-thirds of all infill development delivered to date are probably single dwellings. Single-dwelling developments are 52% of all infill development over the last decade and 15% are developments of between 2 to 5 dwellings.

As a result, Perth has a disproportionately low number of apartments being built. Since 2011, only 13% of all dwelling approvals in Greater Perth have been apartments, and apartments have consistently declined as a percentage of all dwelling approvals since 2016. As the UDIA tell us in their *Housing Ready — WA Housing Supply Report 2022*, "*(a)partments currently sit at just 2% of all dwelling approvals*".

According to the latest census data, just under 7% of Greater Perth's 851,322 dwellings are flats and apartments — the lowest percentage of any Australian capital city.

Figure 2.7: Australian capital city dwelling types 2021

	HOUSES	TOWNHOUSES	APARTMENTS OR FLATS
Greater Sydney	51.20%	11.74%	28.19%
Greater Darwin	57.22%	9.46%	22.60%
Greater ACT	59.00%	16.03%	18.11%
Greater Melbourne	61.00%	14.57%	14.02%
Greater Brisbane	68.42%	10.59%	13.69%
Greater Adelaide	69.80%	15.19%	7.60%
Greater Hobart	78.88%	5.63%	7.57%
Greater Perth	71.12%	12.96%	6.99%

Source: Australian Bureau of Statistics

To make matters worse the small number of apartments that we are approving are mostly being built in troubling locations, far away from high-quality transit. Locations are not being thought through and the scale and design is often inconsistent with local planning schemes. The fact that apartments, especially the ones near train stations, are being sold shows that there is demand for such transit-oriented urbanism. However, they are not nearly enough to prevent the urban sprawl in Perth from continuing apace.

As a result, we have created the double failure of allowing most of our housing to be built in outer suburban sprawl developments while simultaneously allowing too much of Perth's infill to be built in local communities which do not support them because they are often not properly planned, well designed or considered. Apart from the new apartments at Claremont, Subi Centro and, to some extent, Canning Bridge.

Figure 2.8: Transit Oriented Developments like Claremont (left) are rare in Perth; Limited density like Queens Park Train Station (right) is common

These outcomes show that business-as-usual planning in WA can't deliver the foundation for a decarbonised, connected, and liveable Climate Positive Perth. There is a consensus amongst experts in WA that:

> (n)aively allowing Perth to expand north and south to accommodate everyone is not an option in the coming decades.

Likewise, the Property Council's *Close to Home Report* looking at Western Australian's attitudes towards urban density tells us:

> *We can't continue as a low density, suburban sprawl capital; instead, we need to be able to provide homes for people at all life stages, and we need to house key workers close to employment centres and in areas well serviced by existing health, education and transport infrastructure.*

In the next section, we will look at what needs to happen to create a Climate Positive Perth.

Figure 2.9: A new, treeless development in Perth's southern suburbs

Image credit: Murray Slavin

2.1.3 What needs to happen for a Climate Positive Perth

Perth's population is expected to grow from 2.2m in 2022 to 2.9m by 2031, and then to 3.5m people by 2050, becoming the third largest city in Australia after Sydney and Melbourne. All the key stakeholders involved in Climate Positive Perth have agreed that this new boom of population and people need to be provided with housing in well-located, high-quality infill as a priority. This would avoid adding to Perth's sprawl and low-density urban form with its impact on carbon emissions and liveability. To achieve this it's recommended that Greater Perth does the following:

Develop an Urban Consolidation Plan

In 2022 Infrastructure WA, the independent body set up by the WA Government to advise the government on infrastructure priorities, brought down its first report. It noted Perth's low infill target and recommended the WA Government prepare and implement an 'urban consolidation action program' including 'identifying significant barriers to increasing urban consolidation', 'reviewing and adjusting policy settings to support infill locations', and 'planning incentives that support infill development'.

Unfortunately, the WA Government did not support the preparation and implementation of such an urban consolidation action program because it considers the existing *Perth and Peel@3.5million plan* to have met 'the recommendation's intent'.

That conclusion was unjustified given the lack of success of consecutive WA Governments in meeting Perth's modest urban consolidation targets. With this in mind, what would a better urban consolidation plan likely include?

A clearly defined urban growth boundary

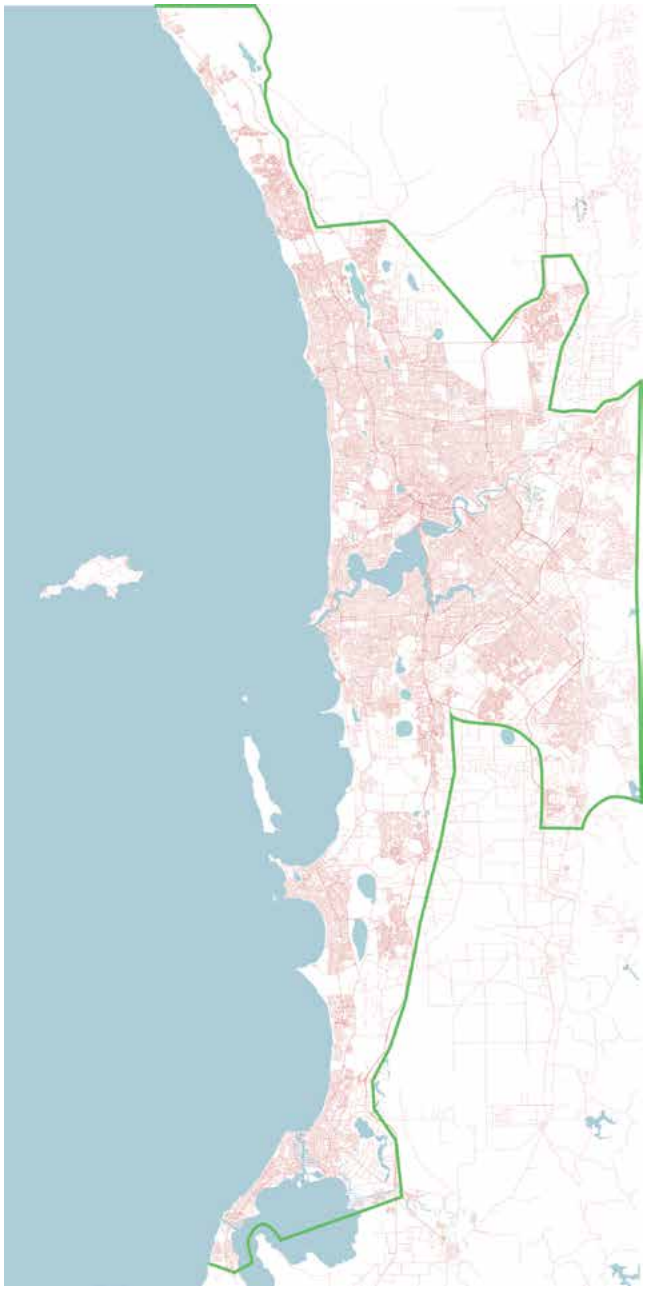
In 2020, it was estimated that it would take 33 years to build on all the vacant land earmarked for development in the Perth metropolitan area. More recent analysis shows this could take as little as six years. This is because up to two-thirds of all urban deferred zoned land across Greater Perth is designated as Bush Forever sites, which generally excludes future development. 85% of urban deferred land contains some catchment coverage of a Threatened Ecological Community, which doesn't preclude future urban development but does make it more problematic and difficult and if it were developed puts highly vulnerable ecological communities at greater risk of extinction.

Increasing issues with fringe development means that urban-zoned vacant land on Perth's fringe should be the last suburban land set aside for new suburban housing. Anything situated beyond this should be the firm urban growth boundary for greater Perth.

A well-defined and permanent urban growth boundary for Greater Perth will fundamentally shift thinking about new housing in Perth from an easy-to-deliver but unsustainable sprawl approach toward more thoughtful infill and density. It will ensure the remaining greenfield sites are developed appropriately and that planning for urban consolidation is given greater priority as undeveloped land on the fringe becomes increasingly rare.

As we've already outlined, almost everyone agrees that good planning for Perth means far less building on the urban fringe. It is time to meet the challenges on this and set a firm urban growth boundary.

Figure 2.10: A possible, clearly defined urban growth boundary for Perth



A clear plan and funding for targeted density — Transit Oriented Developments (TODs) and Transit Activated Corridors (TACs)

With a clearly defined urban growth boundary in place the next question is: where should density go to create a more liveable, connected, and sustainable Climate Positive Perth?

The answer to this question is that density should be focused around transit which can create communities that are walkable instead of car-dependent — a more sustainable form of urban growth. Two key approaches are Transit Oriented Developments (TODs) and Transit Activated Corridors (TACs).

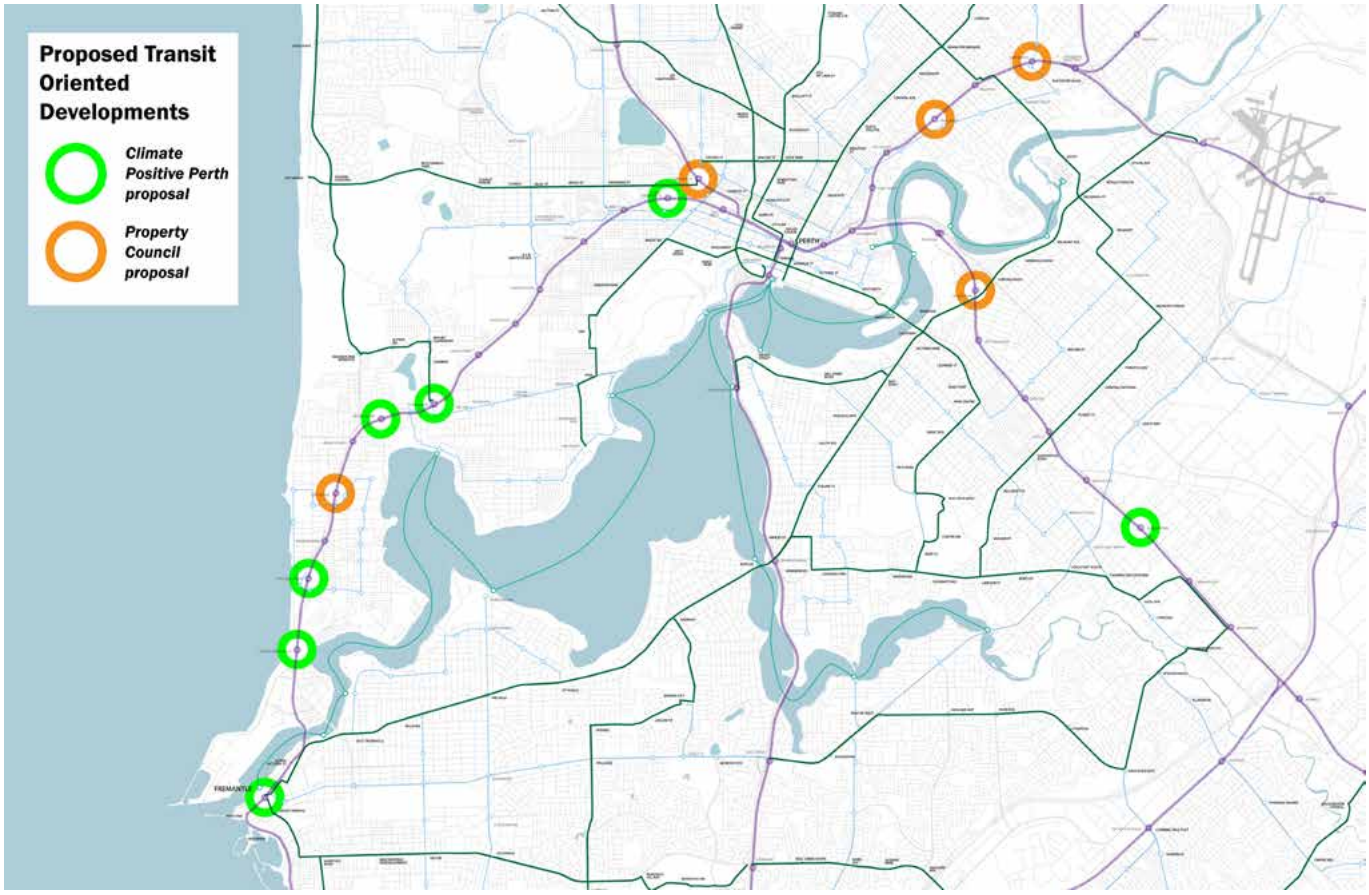
Transit Oriented Developments (TODs)

As the Property Council wrote in their 2023 report on transit precincts:

> Urban and infrastructure planning experts recognise that the optimal approach to facilitate population growth is to build housing, employment and services around public transport systems. Essentially, to promote Transit Oriented Developments (TODs).

The Property Council report also demonstrates that most of WA's Metronet projects are unlikely to deliver TODs in the short or medium term. Put simply, they are mostly too far from the centre to be developable. Instead, we need to identify existing train stations that are more TOD ready. Unsurprisingly the report concludes that "*...inner city locations in Perth and established high-amenity locations along the heritage train lines are the most attractive choices.*"

Figure 2.11: Possible Transit Oriented Developments in Perth. Property Council proposed TODs in orange, Climate Positive Perth TODs in green



In addition to the five priority locations that the Property Council identifies (Leederville, Bayswater, Maylands, Burswood, and Cottesloe) there is potential for additional locations on the Fremantle line at Fremantle, North Fremantle, Victoria Street in Mosman Park, Swanbourne, Claremont, and West Leederville. There is also an opportunity on the Armadale line at Queens Park.

Too much of Perth's recent density is often not close to, nor integrated with, high-quality transit. Density or high rise by itself is not sustainable, especially if poorly located. Density that is not transit-orientated leaves its residents car-dependent and locks them into actions which get in the way of a more sustainable Perth. It risks becoming the equivalent of a kind of vertical sprawl.

A clear and well-funded plan to develop a range of transit-orientated developments ensures Perth's approach to density creates liveable, sustainable, and low carbon infill.

Transit Activated Corridors (TACs)

In addition to TODs around train stations there needs to be a focus on what Newton and Newman (2022) refer to as 'transit-activated corridors' (TACs):

> Just as TOD's role was to help transform rail policy relative to its role in urban densification around stations, the role of TACs is to help transform road policy. The similarity lies in the need to integrate quality transit technology with quality precinct-scale land development on, in, and around transit stops, and to include last-mile integration. TACs are thus a corridor created from currently car-oriented activity centres (often represented by ageing shopping strips) by linking them with quality mid-tier transit. (page 92).

The importance of mid-tier transit for a Climate Positive Perth is examined in the transport section of this report but it is worth noting here the "…strong nexus between mid-tier public transport such as light rail and trackless tram technology and the development of housing diversity such as apartment development".

Utilising Perth's Activity Corridors was also looked at in the original *Transforming Perth* report, which showed that Perth's entire infill target could be easily met through medium-density development along just seven activity corridors.

Figure 2.12: Transit Oriented Development before and after (from *Transforming Perth 2013*)

Before After

Focusing infill and density largely in activity centres, TODs and TACs are central to a sustainable, liveable and Climate Positive Perth. Smartly planned density of this kind assists Perth to build a series of fifteen-minute communities which hold the promise of accelerating decarbonisation, improving affordability, reducing climate and health risks, and fostering social inclusion. At the heart of this is a more compact, and sustainable Perth. We will go deeper into the benefits of 15 minutes cities in the next section, which looks at Climate Positive Perth and the built form at a neighbourhood level.

2.1.4 Conclusion

For decades expert bodies and all sides of politics have acknowledged that Perth should not continue to sprawl at the rate it is and should instead densify. Despite this Perth continues to fail to meet even its modest infill targets, and the infill that Perth is getting is rarely adding high-quality well-located density. We need density orientated towards frequent, high-quality transit.

The alternative is neatly summed up by the PIA position statement 2022:

> *PIA supports strategic planning for the location and servicing of more diverse and medium to higher density housing where there is good amenity, open space, vegetation and sustainable transport access.*

Both the 2013 Transforming Perth report and the 2016 #designperth reports describe a range of benefits from replacing sprawl with well targeted density for Perth, including "*…reducing car dependency, delivering jobs and services to local communities, strengthening, and diversifying the local economy, increasing social inclusion, reducing the cost of living, and preserving urban bushland and coastal habitats*". All of these remain relevant today for Climate Positive Perth.

The evidence for less sprawl and more density is widespread and compelling. A Climate Positive Perth is only going to be achieved if this change is embraced. A more liveable, connected, and sustainable city depends upon it.

2.1.5 Metropolitan Scale Planning and Built Form Recommendations

1. **Develop and fund an Urban Consolidation Plan** that includes genuine and interactive stakeholder and community engagement on how we plan for, design, and build infill across Greater Perth. This Urban Consolidation Plan would include:
   a. **A clearly defined urban growth/development boundary** for greater Perth to put the brakes on sprawl and ensure a strong majority of new residents are in infill areas.
   b. **Clearly defined, robust, and ambitious density targets** including transparent public reporting on interim targets.
   c. **A plan for Transit Oriented Developments** (TODs) including required funding for implementation. This is likely to have a particular focus on Perth's heritage train lines.
   d. **A plan for Transit Activated Corridors** (TACs), including requiring funding with a clear link to mid-tier transit in the central sub-region.
2. **Provide incentives for new, well-located apartment developments**. This could include full stamp duty exemptions, removal of foreign buyer surcharge, reduction of financial disincentives to downsizing from houses to apartments, prioritised approvals processes, and state government direct funding to apartment projects.
3. **Provide incentives for local governments to meet density targets** through infrastructure funding pools exclusively for those local governments who meet and exceed targets.

2.2 Planning and Built Form — Neighbourhood Scale

"The cities that are doing amazing things are the cities that have stopped making excuses."

Melissa & Chris Bruntlett, *Modacity*

2.2.1 Introduction

There are many good reasons to rethink Perth's urban form.

As we found in the previous chapter, decisions by consecutive state governments have exacerbated suburban sprawl and it's growing at an unsustainable rate. New greenfield housing incentives, freeway expansion, and even well-intentioned but sprawl-enabling Metronet projects have made the longest city on the planet even longer.

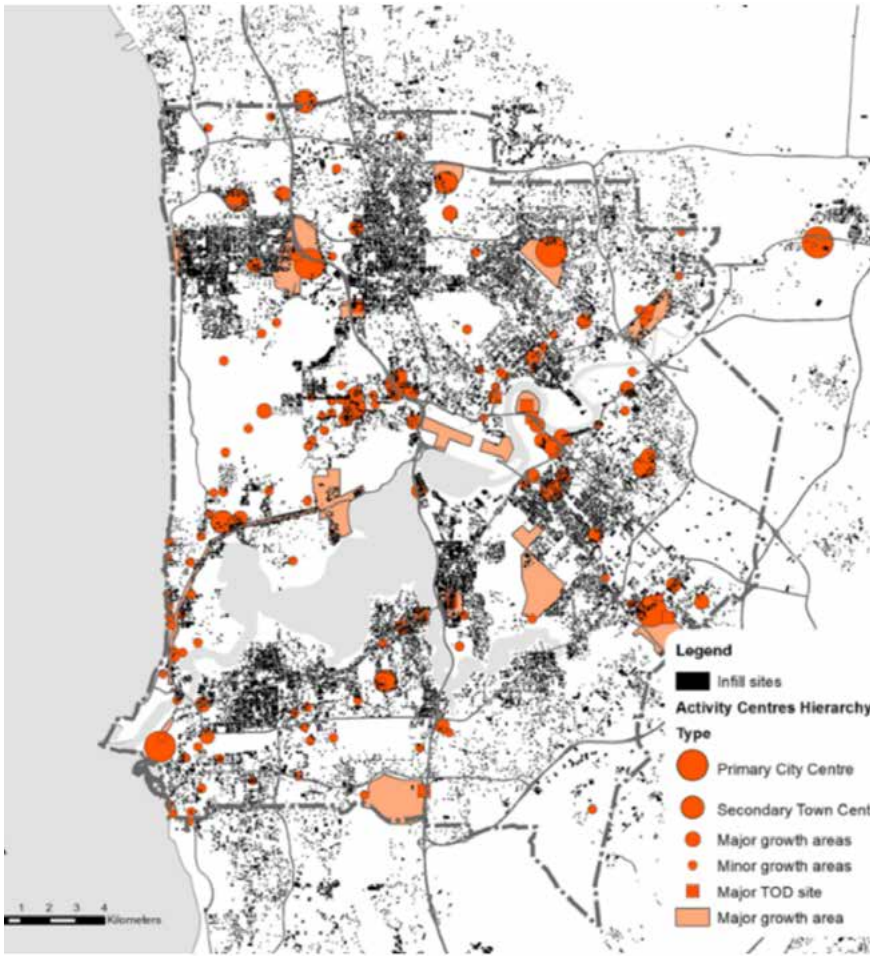
This sprawl is bad for the environment and its facilitating climate-damaging emissions. It's also creating poor social and environmental outcomes. Placing most of Perth's population growth on the urban fringe, far from existing centres and many jobs, is having the unintended consequence of unduly white anting Perth's existing centres while new neighbourhoods often feel isolated and incomplete. More people and activity make our neighbourhoods and urban centres more attractive and safer. People attract people, while empty streets repel them. As shown in the metro-level chapter, its not good economics either.

In this chapter we imagine a Climate Positive Perth in which, instead of adding to sprawl, tens of thousands of new dwellings are built within a close walk to our existing centres, filling them with life and activity, day and night. This is an opportunity to activate Perth's urban centres and make its main streets work again, both in key activity centres and Perth's suburbs. We need these changes to happen in built form to create centres and suburbs that are more liveable, efficient, connected, and low carbon.

At the neighbourhood scale, this includes a city of 15—20 minute by bike or foot proximity mixed-use centres and neighbourhoods, accompanied by a diverse range of smart densities, all linked by high quality and frequent public transport (check out the transport chapter for more info on those links).

Next up we are going to examine the need for change and explore how this transformative, but all too rare in Perth, set of built forms might look like.

Figure 2.13: Activity centres and infill in Perth metropolitan area



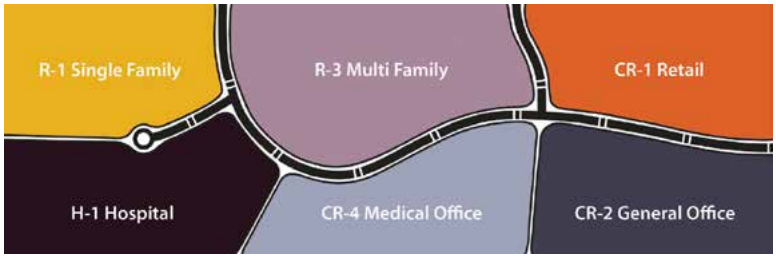
Source: Bolleter (2016)

2.2.2 The problem

Perth in 2023 is a long way from a 15- or 20-minute city by bike and foot. It's more like a 30-plus minute city by car. According to the RAC, Perth's peak-hour drivers spend 38 minutes a day on average commuting. Those who regularly drive or are a passenger in a car during peak hours spend almost 16 hours per week or 34 days per year sitting in a car.

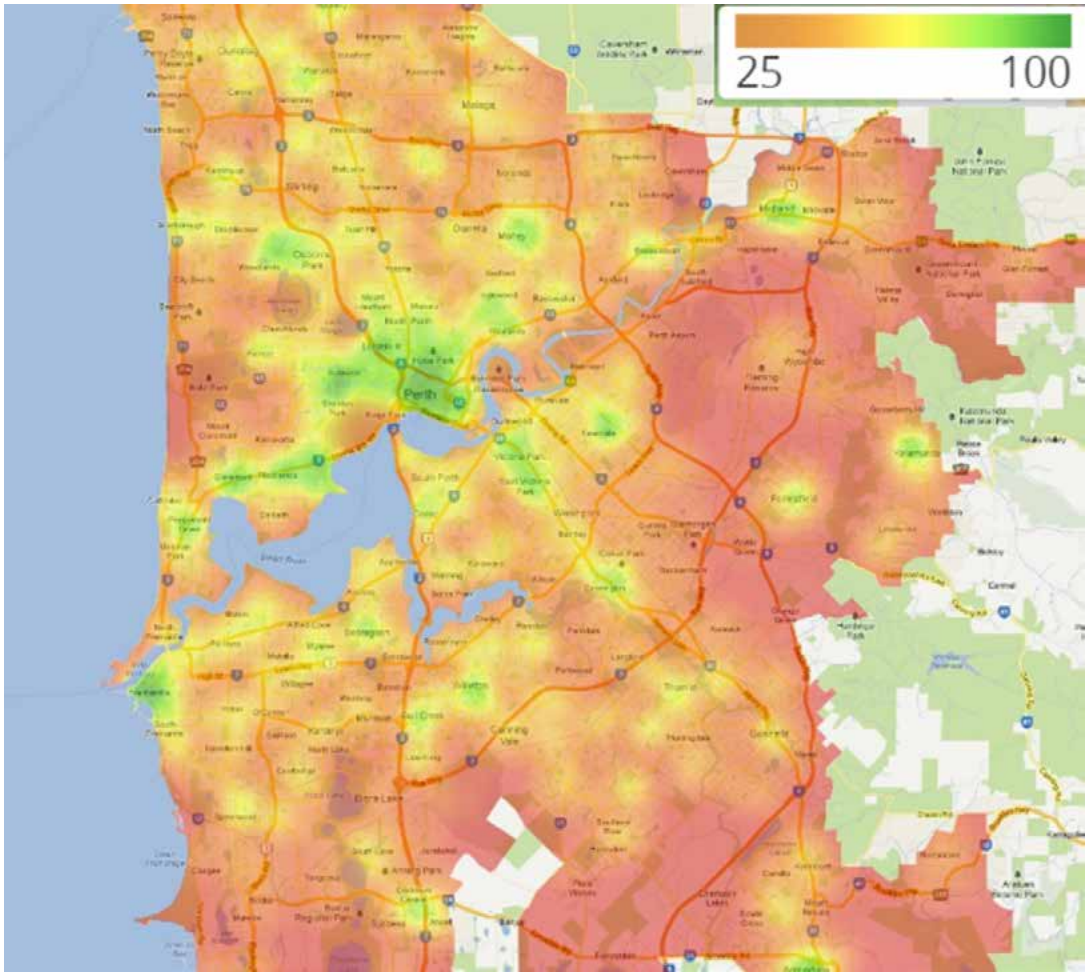
One reason for this is that most parts of Perth have far fewer jobs than people. Instead, the jobs are located elsewhere, often far from where people live. As Jeff Speck simplifies in *Walkable City Rules* (2018, p.20) Perth is not alone in this, as it is common characteristic of many Australian and North American cities.

Figure 2.14 Typical American-style land use map with land use separation into large zones



In Perth, where large parts of the metropolitan area are single residencies, the result is a city which is less walkable and more car dependent. This is reflected in the low Walk Scores in most areas of metropolitan Perth except the more walkable older areas of the city that were built before car focused planning took over.

Figure 2.15: 'Walkability' map of Perth



Source: walkscores.com

2.2.3 What might low-carbon, more liveable and connected centres and neighbourhoods look like?

More liveable and connected centres and neighbourhoods that are easier to decarbonise will be places with a diverse mix of uses alongside a mix of housing types and sizes.

Creating complete centres

Living close to work and school, walking, or cycling to meet daily needs, and having a social life in your local community is not a really radical or new idea. But its pretty remarkably rare in metropolitan Perth, where a small percentage of suburbs have as many jobs as people of working age. Instead, most people need to travel by car to get to their job and other key activities like going out.

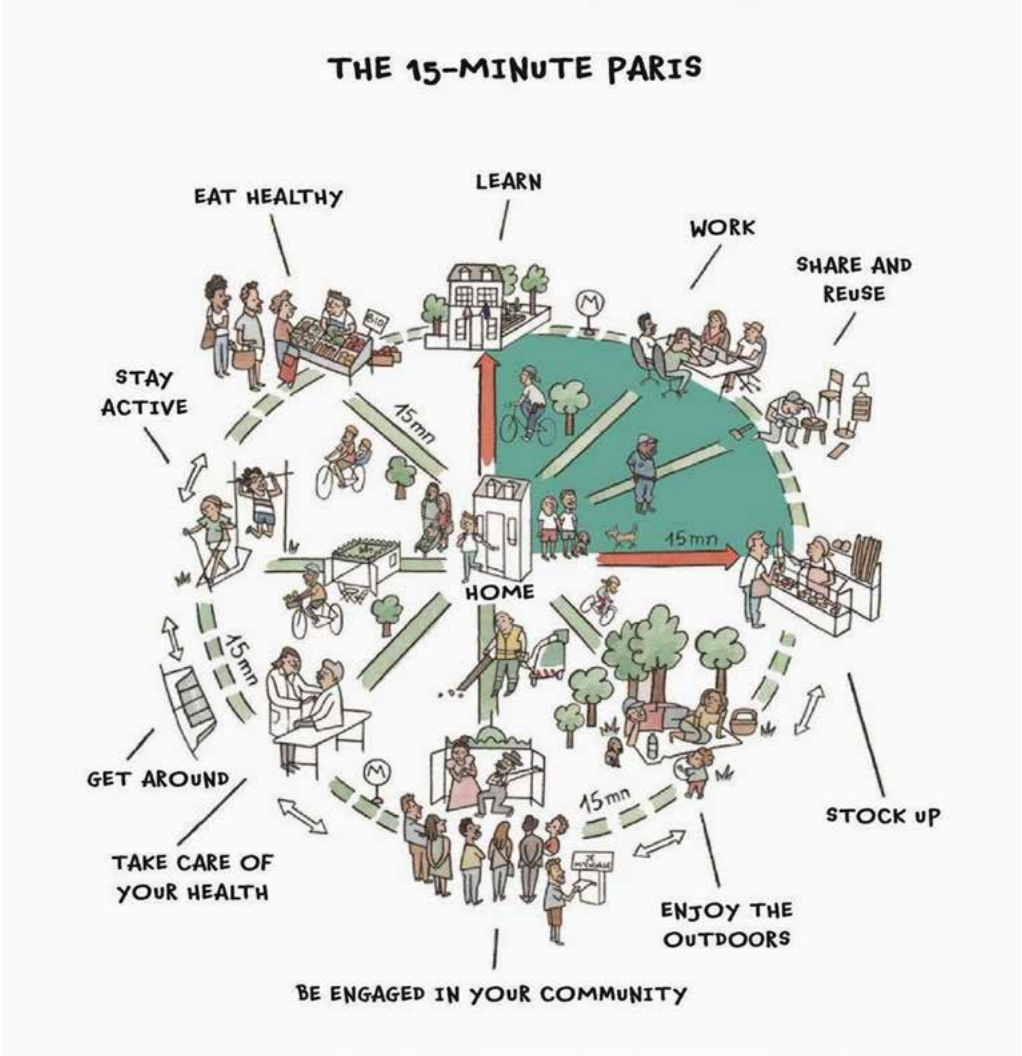
The alternative is neighbourhoods and centres in which jobs and services are close by. There's quite a few terms for mixed-use neighbourhoods and centres in which everything you need is within a short walk or ride. Whether its a plan for a 15-minute city, like Paris, a 20-minute neighbourhood like *Plan Melbourne*, or 'complete neighbourhoods' like the City of Portland, they all have in common an aim where people access daily necessities by foot or bike within 15 to 20 minutes.

What they have in common is decentralised centres where people access their homes, workplaces, shopping, health, education and cultural facilities within a walkable radius of around 800m. For example for *Plan Melbourne 2017–2050*:

> *The 20-minute neighbourhood is all about 'living locally' — giving people the ability to meet most of their everyday needs within a 20-minute walk, cycle or local public transport trip of their home.*

These mixed-use, complete neighbourhoods have the benefits of reducing carbon emissions and air pollution, offering people physical health benefits, and reducing their commute times to help them achieve a better work-life balance.

Figure 2.16: The 15-minute city concept



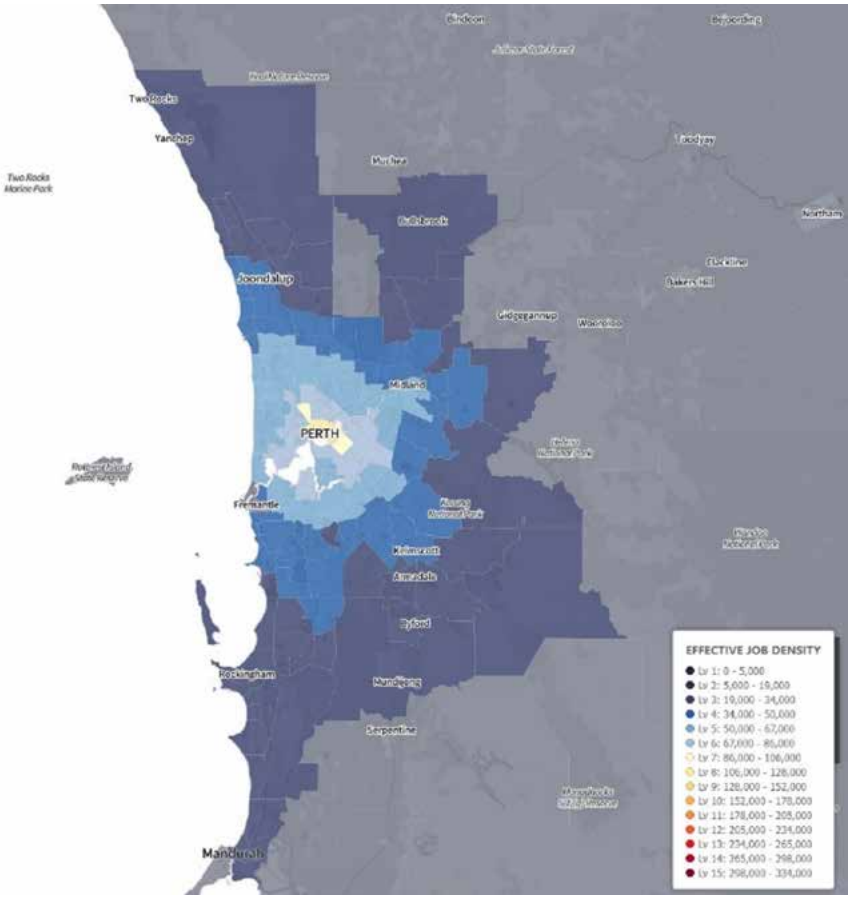
Source: Micael, 15-Minute City concept by Carlos Moreno

If Perth is going to move towards also being a 15–20 minute city that is liveable and low carbon, it will need to plan for a finer grain mix of uses. This applies both to Perth's centres and our suburbs. Perth's CBD and many of its key activity centres are underperforming. But this can be turned around by building up a more complete mix of uses in Perth's CBD and activity centres. These centres offer some of the best opportunities to create more diverse, mixed-use, walkable communities.

The Perth CBD and key centres would all benefit by adding a significant amount of new residential development. The Property Council and Urbis recently outlined a plan for the Perth CBD to reach a population of 90,000 residents. This is ambitious given there are only around 30000 people living in the Perth of the CBD and only a few thousand have been added to the Perth CBD population in the last decade. This slow progress to up population in centres is not unique to the Perth CBD, it is common to all of Perth's activity centres, all of which need thousands more people living downtown.

Perth's key activity centres like Armadale, Midland, Joondalup, and Fremantle, would benefit from getting more jobs into their centres. This would mean fewer jobs in the Perth CBD and a greater distribution to these centres. The Perth CBD would still have tens of thousands of jobs but not to the imbalanced extent it currently has with four to five jobs for every person living in central Perth. This may sound radical until put into perspective — Perth is the most monocentric capital city in Australia. Enabling a more polycentric city means fewer long commutes and more activated urban centres day and night. In connected, liveable, low-carbon cities, jobs are close to where people live.

Figure 2.17: Effective job density map of Perth (2011)



Getting Perth's key metropolitan centres to work needs proactive and well-funded planning to ensure all of its centres can function as 15–20 minute centres with more dense and diverse ranges of housing, jobs, shops, schools and key services.

This is something that is backed by the experts and would have strong community support. For example, sustainable urban design which delivers walkable, accessible built-form outcomes are one of the key climate fixes recommended by the Planning Institute of Australia (2021). The RAC identified in their *2019 Urban Planning and Connected Communities Survey* strong community understanding of the benefits of well-designed, well-located, compact mixed-use precincts. Meanwhile, the Heart Foundation found people favour easy, walkable and connected access to important places and amenities over having a larger backyard or garage and have a strong desire for 'living locally' in their neighbourhoods.

The missing middle: smarter, gentler density

Walkable, mixed-use neighbourhoods are a key ingredient of 20-minute neighbourhoods, but only one part. Increased densities are also key. The evidence is we need to get more people living closer to 15 to 20-minute centres and neighbourhoods.

Building denser housing doesn't require skyscrapers — although they do have a place in carefully planned locations. While some of Perth's key activity centres can easily embrace and benefit from high-rise developments, many others would be better served by gentle density.

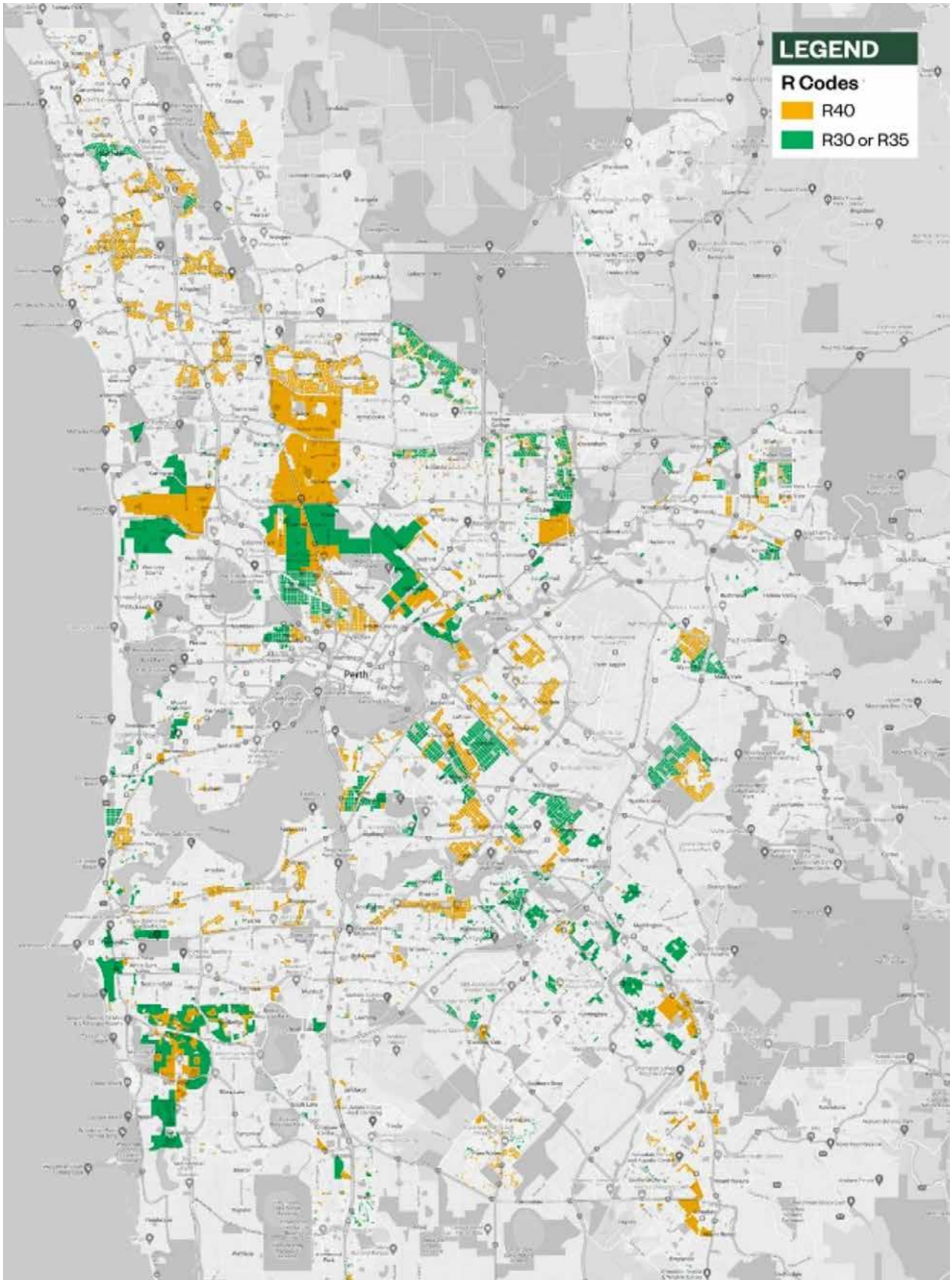
This gentle medium density is often the best approach at a neighbourhood level. 'Gentle density' or the 'missing middle' are terms used to describe housing types that sit between detached houses and high rises. It includes housing such as Fonzie flats, duplexes, terrace housing and low-rise apartments. Missing middle housing or gentle density allows for greater diversity and density and offers a more compatible form of housing within lower and middle-density areas.

While most of metro Perth is zoned around R20 and R25, the medium-density zonings are also significant. For example, R30, R3,5 and R40 areas comprise approximately 21% of all R-Coded land in the Perth metro (Mecone, 2023).

Unfortunately, too much of the R30–40 density has resulted in villa-style triplex and quadruplex developments consisting of three or more units squeezed onto a single suburban block with long driveways, no room for trees, and only hard surfaces with little consideration for the impact on neighbourhoods. This form of 'destructive density' has been so prevalent in some suburbs that it has changed their entire character.

Figure 2.18: Destructive medium density

Figure 2.19: Perth R codes



Credit: Mecone

Destructive medium density is also bad for the state budget in the longer term. This is because each new 'business as usual' cleared and subdivided backyard infill dwelling in Perth results in more than $29000 of direct costs to residents and the community, as highlighted in the State Government commissioned report by SGS Economics & Planning on *Wider Costs of Medium Density Development*. That's more than $117m each year because of decisions on housing in Perth. This kind of development also negatively impacts the liveability of our suburbs.

There is also considerable evidence that every house on the urban fringe costs 3 to 4 times as much in government supported physical and social infrastructure. Most recently the NSW Productivity Commission, showed that:

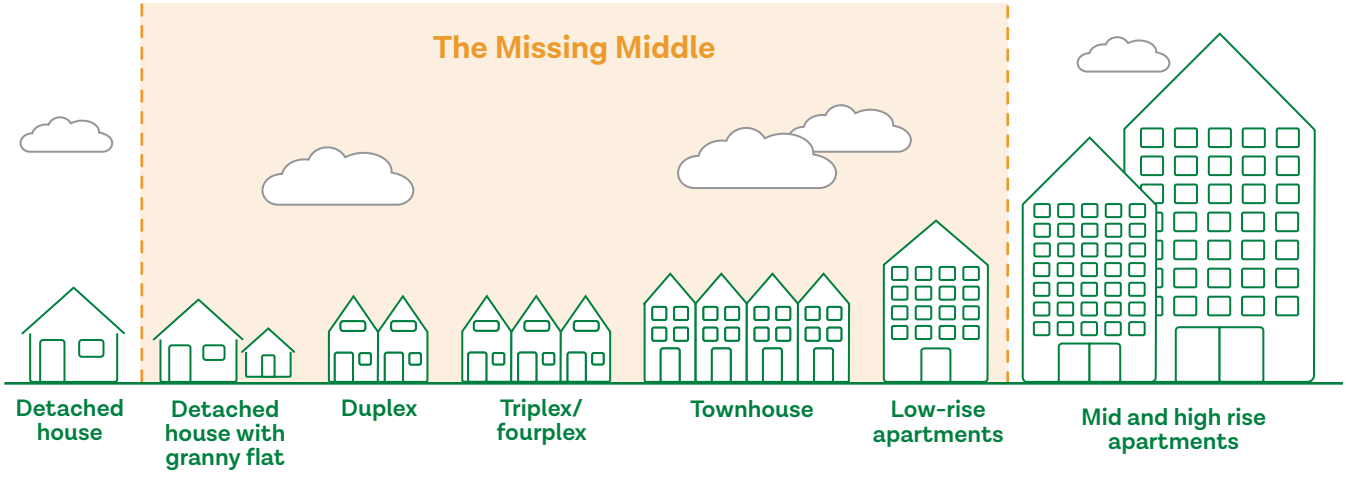
> The infrastructure costs of building new homes are lowest near Sydney's CBD, increasing as development moves north, south, and west. The infrastructure-related costs of building further away can be up to $75,000 more per dwelling.

This 'destructive density' is outdated. There are examples of smart density that are more gentle than ad hoc high-rise apartments in our suburbs and triplexes or big single houses on small blocks.

Figure 2.20: Poor infill of suburban blocks

Source: Western Australian Planning Commission (2021)

Figure 2.21: The 'missing middle' of smart density options that Perth lacks



Some worthwhile work on the missing middle densities was done in preparation for the *Medium Density Housing Code* which was due to be gazetted in September 2023. Unfortunately, in August 2023 this was indefinitely deferred and there is no replacement, sadly, destructive density is entrenched for now.

Medium Density Planning is based on the expectation that by 2050 an additional 1.5m people will need 800,000 new homes in greater metro Perth. A target of 47% infill means at least 380,000 new homes will be needed in existing suburbs. If we have a more ambitious 60% infill target, consistent with other Australian states, it will mean 560,000 infill homes.

The danger and opportunity for metro Perth is whether these hundreds of thousands of new dwellings are examples of high quality and diverse density or all-too-common destructive density.

Examples of smart infill

While good infill is not as common as it needs to be, there are some great examples across Perth that point towards the necessary direction that metropolitan Perth could take. For now these are just stand alone examples of excellence and sustainability that need to be celebrated and replicated.

The City of Fremantle has some worthwhile examples of good infill in our suburbs and neighbourhoods. In the suburb of White Gum Valley they are all within a short distance of one another — maybe excellence inspires excellence.

Granny flats without grannies

In 2011 the Fremantle Council passed an award winning small ancillary dwellings amendment to its planning scheme. This meant residents in the City of Fremantle could build a small dwelling (i.e. a granny flat without the need for a granny) so long as the block size was above 450m^2. This potential could enable up to 5000 new small dwellings in the suburbs around Fremantle. The WA Planning Commission went on to create similar changes to ancillary dwellings schemes across WA.

The 'Freo Alternative — Big Thinking About Small Housing' example

The Fremantle amendment change pioneered gentle density, and created smaller infill developments that added density and also protected the amenity that people valued in their neighbourhoods. Each dwelling could have a maximum floor area of 120m^2 and a minimum of 30m^2 of outdoor living area, with 70% of the entire development to be open space and they had to include at least one large tree. This meant up to three smaller dwellings could be built on lots of 750m^2 or less. The changes won the Best Planning Idea — Small Project category at the Planning Institute Australia WA 2019 Awards.

Figure 2.22: Detached house with granny flat

Figure 2.23: Three affordable apartments contained in the envelope of one house, White Gum Valley

Figure 2.24: Terrace Green, White Gum Valley

Figure 2.25: Evermore Apartments, White Gum Valley

Town houses with greenery

Well-designed town houses can provide gentle infill over twice the density of single housing. For example, recently completed town houses in White Gum Valley have more vegetation, less cross overs and better sustainability outcomes than most lower density housing. These town houses are the equivalent of R48, meaning they offer more than double the density of most of the surrounding suburb (which is zoned R20/25), but the adept design is cleverly incorporated into the local surroundings.

Midrise apartments

Well-placed three and four-storey walk-up apartments in our neighbourhoods and centres can bring more sustainable and affordable gentle density into our city. For example, Evermore, a 24-apartment development by Yolk Property in the WGV infill precinct, was the first apartment project in WA to receive One Planet Community certification.

This project provides missing middle housing diversity in a low-density suburb and also leads the way on sustainability. Shared solar PV and battery technology means that 80% of the energy used by the building is renewable energy.

Mixing it together — WGV

White Gum Valley's WGV is a great example of an infill project that has successfully created a range of densities and housing types within an existing suburb, from compact single residential homes, to townhouses, and to apartments like Evermore (above) and those for artists (like SHAC). These sit alongside innovations like the Gen Y House, in which three separate small homes are smartly contained within one house. WGV recognised by the Planning Institute at the Australian Urban Design Awards 2016, describing it as a:

> *...diverse, highly sustainable infill development that reflects and enhances its suburban surrounds... and has initiated a new nationally significant model for higher density infill development.*

There are many good and inspiring examples of better and smarter infill and density, across Perth. But they are just not widely spread, they are like small islands of sustainable development in a sea of otherwise unsustainable housing. There is an opportunity to ensure that infill across Perth rejects endless treeless villas, disproportionately large houses on small blocks, and luxury apartments with too many carparks. We can instead scale up the kinds of sustainable infill which we now have in White Gum Valley to put Perth back on track for a lower-carbon, more liveable future.

Figure 2.26: WGV is an excellent example of sustainable infill development and a coordinated neighbourhood-scale

Don't give up on the suburbs (it's where we (mostly) live)

While all the evidence demonstrates that sprawl is not good for our health, the environment, or decarbonisation, the reality is that the outer suburbs are still going to be where most of Perth's residents will live, even if we turn things around and ensure most of our new development is in present urban areas rather than on the fringe.

While the most effective solution is planning a more compact and better city, we can also make a positive difference by creating pockets of walkable urbanism in suburban areas where it is obviously not ready for large scale, density increases. This is referred to by Jeff Speck (2018) as creating 'park-once environments', meaning you might need to drive to get to these places, but you will only need to park your car once, as the rest of the time you are there you can travel on foot. This means focussing on at least ensuring a 'core of walkability' that could lift the entire communities through the creation of walkable destinations in the heart of car-dependent suburbia.

Rebuilding Neighbourhoods in older middle suburbs through precinct scale development.
Most of the infill issues in Perth that we have called destructive density have happened because the scale of the development is just one or two blocks. In the middle suburbs many of these blocks are quite large and houses are ready for re-development so the only options have been battle-axe infill. There is an alternative called Greening the Greyfields developed by Swinburne and Curtin Universities (Newton et al, 2021). This model sets out to find groups of housing, more like 20 or 30, which can be created into a neighbourhood-scale or precinct scale redevelopment.

The approach suggests that the community should be fully engaged in this process so that owners and friends can become residents along with a lot more residents in well designed medium density dwellings. The approach will need to involve local government planners in an active approach to engaging the community and seeking design and development options. This has been demonstrated in Melbourne.

This approach can better enable improvements to public transport and mixed uses like health care or small shops. It can also be easier to enable net zero design with shared solar, batteries and EV recharging.

Jindee: Perth's best example of new suburbia done well

Located 40km north of Perth on the coastal side of Butler, Jindee is surrounded by many of the numerous cookie-cutter, treeless and monotonous post-2000s housing estates that make up our far northern suburban sprawl.

But Jindee feels fundamentally different to the suburbs around it. The streets and houses aren't like a generic new Perth suburb, there's more of a sense that it is a kind of contemporary version of some of Perth's favourite suburbs and places including Fremantle, Cottesloe, and even the old Rottnest settlement.

The streets are narrower, focussing on pedestrian movements rather than cars. Some streets feel like suburbs used to be before cars were king. There are no driveways facing the street, similar to the older parts of Fremantle. Instead of crossovers, the streets are full of trees and are connected by landscaped walkways that will eventually connect every house to parklands and the beach.

'A Sense of Place' is an often-misused term in development, but Jindee has had a good crack at creating it in a part of the northern suburbs that at times feels placeless. It's not perfect — it's still car-dependent, too low density, and is yet to deliver more diverse housing options, but even so, it's an example of contemporary Australian neighbourhood design that feels more human and community friendly. It presents a challenge to developers, planners, and policymakers: why can't the design of every new suburb to be more like Jindee?

2.2.4 Conclusion

There needs to be a significant shift in the kinds of neighbourhoods Perth builds. What we've got is a lot of low density, single-use, poorly connected, unsustainable outcomes that, as well as creating poor environmental and social outcomes, brings long-term financial costs for the State Government and residents.

The financial benefits of good infill development have been well demonstrated to show that there are huge infrastructure savings to governments if they build new housing close to the metropolitan centre instead of further away.

The environmental benefits are clear. For every sustainable apartment, townhouse or granny flat built, less energy is used, less waste is created, less natural bushland is destroyed, and more trips are likely to be taken by public transport.

Social benefits are clear too, including less social isolation and better connection. The benefits of good infill development flow on to the health and mental health of residents.

As we have explored here, Perth does have islands of excellence and sustainable infill and good density in its sprawling sea of underperforming centres and single-use suburbia. Perth's challenge is to shift away from building more of the usual. Instead, we need a stronger planning framework creating denser, mixed-use centres and diverse housing options better linked to smaller households (which a becoming more common).

If we create this and link it with renewable energy, more urban greening and better active and public transit options we can create a Climate Positive Perth.

2.2.5 Neighbourhood Scale Planning and Built Form Recommendations

1. **Plan and build for Perth to be a series of 15–20 minute, complete walkable centres and neighbourhoods.** Reactivate existing activity centres with much higher densities and insert a mix of uses into our neighbourhoods and suburbs to enable walkable distances for many more activities.
2. **Ensure that centres and neighbourhoods have a well-planned mix of uses.** Centres need a diverse balance of jobs, residents, and services. Where possible make spaces adaptable over time, so that as demand for uses change, buildings can change with them.
3. **Focus most new apartment development into current activity centres and other transit-connected locations rather than ad hoc suburban streets.** Target density close to transit and services to maximise its benefits and reduce negative impacts.
4. **Separate parking bays from apartments on titles.**
5. **Encourage diverse but gentle density in existing suburbs.** Reject destructive density like triplex and quadraplex villas. Instead incentivise more diverse, smaller, and sustainable new housing as the preferred model for suburban infill in areas where redevelopment for higher density is not the preferred option.
6. **Do limited greenfield developments well.** If Perth creates new greenfield developments, limit them and do them well with walkable streets and centres.
7. **Trial greening the greyfields and enable it to spread wherever it works.** The integrated approach to medium density development in middle suburbs that are looking to work in a more neighbourhood or precinct scale approach can also be ideal for low-carbon opportunities.

2.3 Planning and Built Form — Household Scale

2.3.1 Introduction

The cheapest energy is that which is not required. Energy efficiency for our homes is one of the most neglected tools for decarbonisation. It has been calculated that energy efficiency strategies could have a similar impact on emissions as renewable energy but for a lower cost and with a 20% return on investment.

Better house design and investment in energy efficiency are needed for new houses and to retrofit existing housing.

There is an opportunity to set the built environment on a trajectory to zero emissions; a major shift from business as usual.

2.3.2 New homes

More than 50% of the buildings expected to be standing in 2050 will be built in the next three decades. So long as West Australian building requirements continue to fail net zero-aligned energy standards then, every year, tens of thousands of buildings are constructed which are unfit for a warming climate. Sadly, too many of the new homes Perth builds are energy inefficient, and neglect even the simple adjustments such as a north-facing living areas, cross ventilation, and insulation

Renew, a non-profit organisation providing advice on energy efficiency, have said:

Australia is overdue for a change to the National House Energy Rating Scheme.

Since the 6-Stars requirement was introduced, Australia's performance has fallen behind comparable countries, where the energy efficiency of new buildings is typically 40 per cent better than Australia's.

Unfortunately, WA was one of the few states to hold off on a shift to 7-star BCA, delaying this to 2025. One of the recommendations for Perth to decarbonise at a rate consistent with a safe climate is that WA immediately implement 7-star requirements for all new housing, followed by an ambitious and clear pathway to zero emissions for all new housing.

Analysis has found that it costs a bit more than $2000 a year to cool and heat a six-star home in Sydney using gas and electricity. If this home was instead a seven-star rated, fully electric house with solar, that bill would plummet to less than $600 a year. These numbers would be similar for Perth.

Importantly, the payback period to make your home energy-efficient is only about four to five years. But there needs to be the right up-front incentives and regulations to ensure that this investment happens.

2.3.3 Existing homes

Existing buildings, which unsurprisingly make up 99% of the current building stock, need significant upgrades to be low carbon. If WA is to meet targets that align with a 1.5-degree pathway, a housing retrofit program to lift the 2-star average of Perth's existing buildings to at least 7 stars is needed. WA has no program of this kind right now.

It is recommended that WA implement a program to retrofit 100,000 homes every year.

2.3.4 Low-income housing

Social housing has typically been built as cheaply as possible, resulting in some of the least thermally efficient housing stock available today. This forces tenants to choose between diverting money from essentials such as food, clothing, and children's education toward paying unaffordable energy bills, or suffering through the heat of summer and the cold of winter. This is why a particular focus is needed on making low-income housing energy efficient with renewable energy.

A WA Government program to insulate and electrify all government-owned low-income housing through solar PV would have both social and decarbonisation benefits, and substantially improve tenant's quality of life by reducing their energy bills and improving the liveability of their homes.

There have been some tentative steps towards this. The Smart Energy for Social Housing trial announced in July 2020 as a partnership between the Department of Communities and Synergy will install solar systems on 500 social housing dwellings. Although it is scheduled to be completed by 30 June 2024, as of September 2023 only 281 social housing dwellings have had solar panel systems installed. In a State Government trial, public housing tenants saved up to $200 in six months from the commencement of the pilot.

This trial could be scaled up as an investment in all social housing, alongside retrofitting insulation and other energy efficiency measures, resulting in better outcomes for the health and well-being of tenants, as well as promoting the transition to cleaner energy and savings.

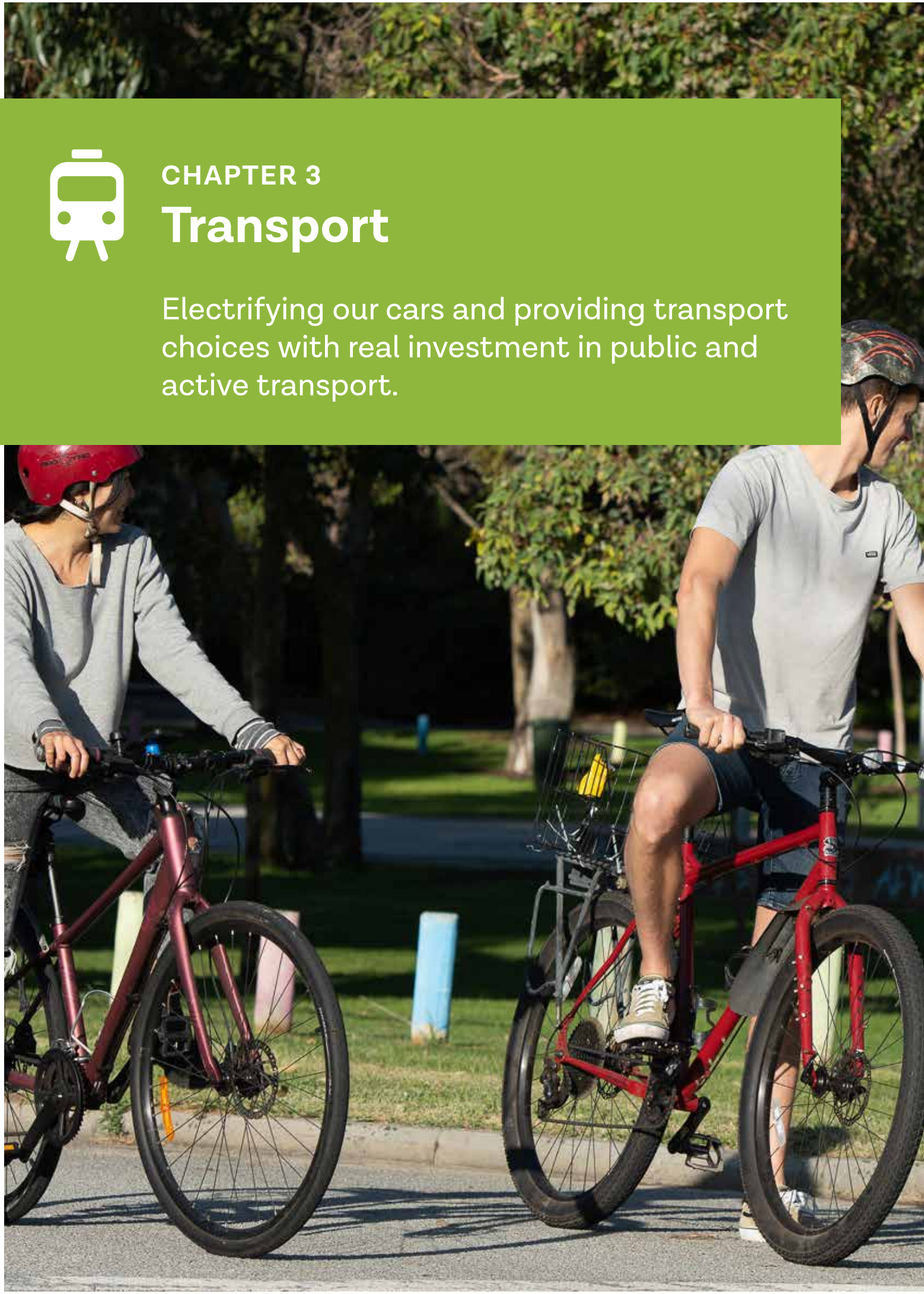
2.3.5 Household Scale Planning and Built Form Recommendations

1. **Mandate beyond 7 stars BCA immediately** for all new housing with a clear pathway to zero emissions for all new housing.
2. **Fund a zero/low-cost loan housing retrofit** program for 100,000 WA homes every year.
3. **Make low-income housing energy efficient** – Fund a WA Government program to insulate and electrify with solar PV all government-owned low-income housing in WA by 2030.

CHAPTER 3

Transport

Electrifying our cars and providing transport choices with real investment in public and active transport.



3.1 Transport — Metropolitan Scale

"While it's critical to go electric, at the same time, we must make every move necessary to ensure that we achieve fewer cars, less driving, more inviting alternatives, and better cities."

Brent Toderian, 2022

3.1.1 Introduction

In 2014 planning expert and urbanist Brent Toderian came to Perth to advise on how to make a more sustainable city. His words from almost a decade ago still resonate today:

> *(Perth is like a) wealthy addict who is rich enough to hide the implications of his addictions… But the consequences — like congestion and the lack of reasonable transport options — can't be hidden forever and are already showing through. If you put more money into walking, cycling and public transport you can break your addiction, be more successful in addressing congestion, and move more people with less money and less space.*

A decade on, Perth is still addicted to cars. While more money is being spent on public transport, largely via Metronet, State and Federal governments are also putting record amounts into extending roads and freeways. This chapter examines Perth's transport investment at a metropolitan area-wide level and shows how we can recover from being one of the most spread out and car-dependent cities in the world.

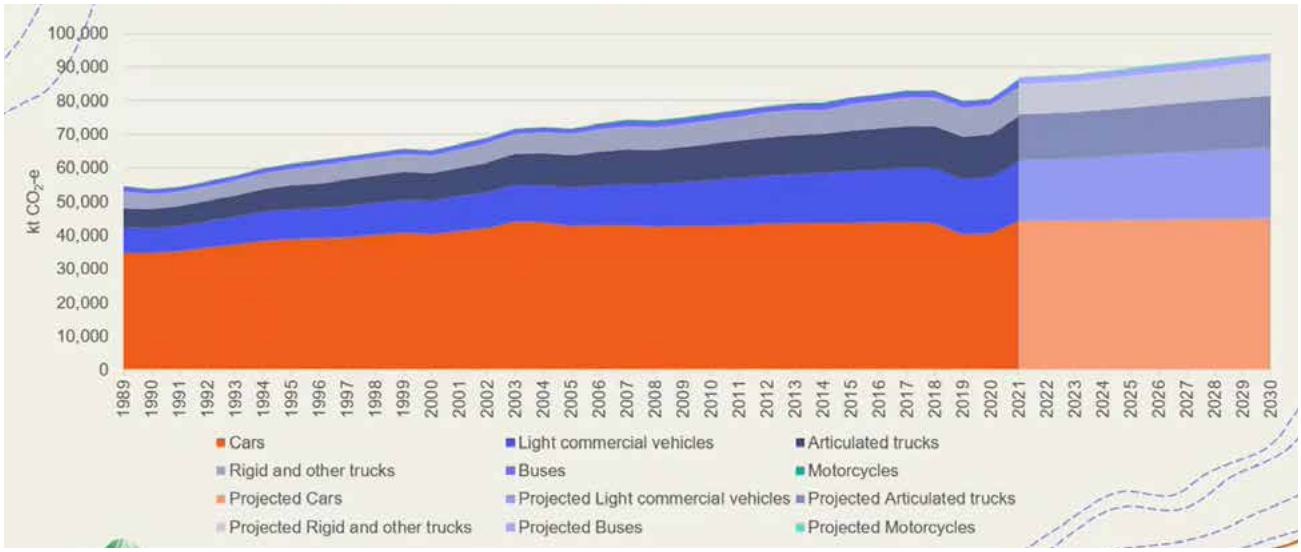
3.1.2 Transport: the current state of play and why we need change

Decarbonising transport is essential to Perth becoming climate positive, and a key way we can meet our national climate commitments. This is because transport is Australia's third largest source of emissions and they've continued to rise over the last decade apart from a small (3–4%) decline in the COVID years. Projections for future emissions also continue to rise.

As a result, the transport sector isn't doing its share to ensure Australia meets its current 43% emissions reduction target. Transport emissions need to drop to 54, 675 kt co2-e down from the 95,921 kt co2-e emitted in 2005. Given the emissions load is around 120,000 kt co2-e today, we need strong commitments to reduce this by more than half within the decade.

Road transport sector emissions in Australia, which make up 80–85% of total transport emissions are also projected to continue to rise over the decade ahead. Driving these emissions down will be central to achieving a Climate Positive Perth.

Figure 3.1: Past and projected road transport emissions in Australia



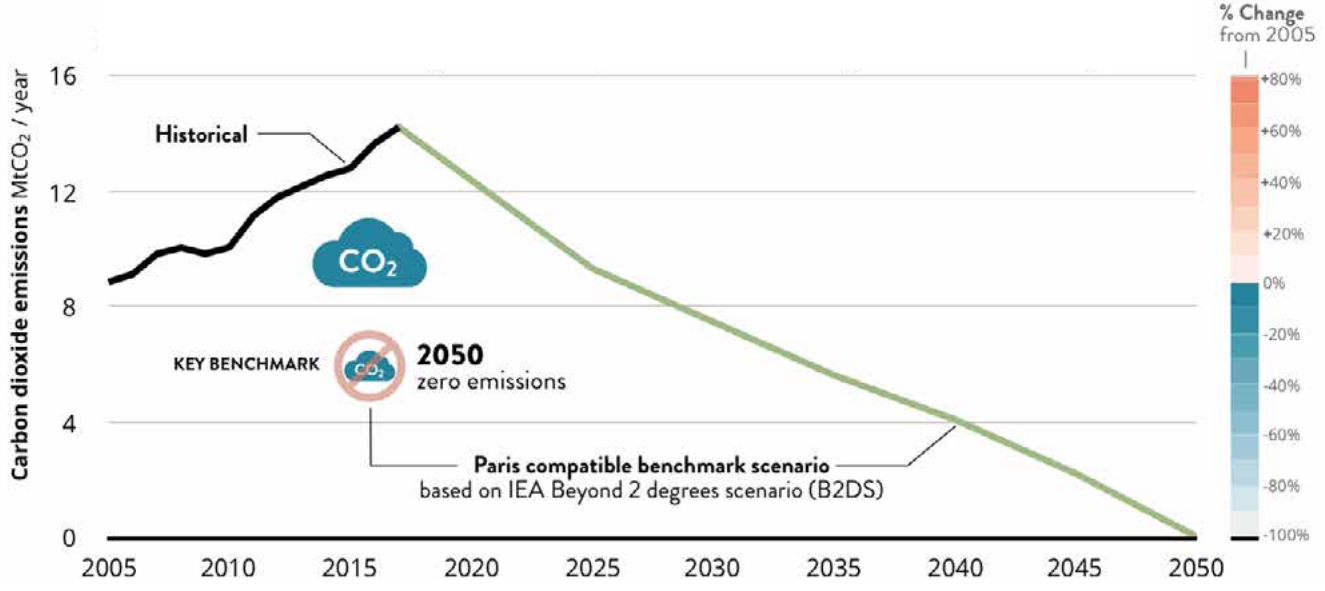
Source: Institute for Sensible Transport

The WA context

Australia has not performed well on transport emissions overall, but Western Australia has been singled out as one of the worst-performing states when it comes to rising emissions. While most states' transport emissions declined between 2009 and 2019, according to the Climate Council's 2022 Transport Scorecard, WA's per capita road transport emissions increased by over 20%. As a result, WA has the highest per capita road transport emissions in Australia.

Transportation is the third largest contributor to Perth's carbon footprint, representing around 17% of emissions. Over half of these emissions or about 10% of WA's total emissions are from cars and light commercial vehicles. Significantly, transport emissions in WA are continuing to rise. We are going to need a major step change to shift the current trajectory to a Paris Agreement-compatible outcome as outlined by Climate Analytics below:

Figure 3.2: Transport sector emissions in Western Australia, under a Paris Agreement compatible scenario aiming for zero emissions by 2025

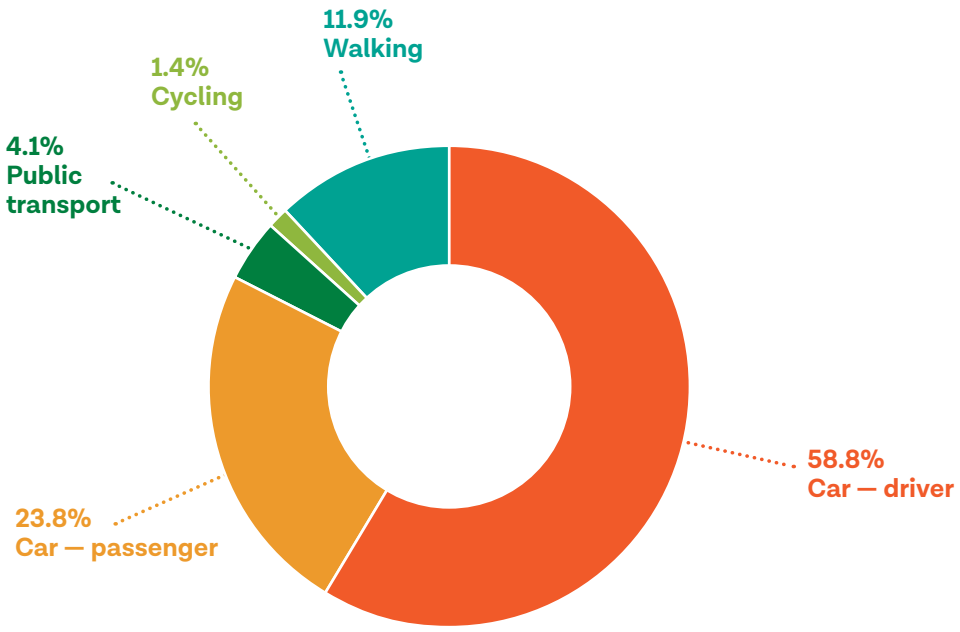


On average, each Western Australian car drives around 13–14000 km annually, together emitting about five million tonnes of Co2e per year in WA.

At the heart of Perth's transport emissions and congestion problems is a heavy reliance on private vehicles for transport. For example, greater Perth's journey to work mode split for those not working from home at the 2021 census was 10.3% public transport, 2.6% active transport, and 87% private transport.

While a mode split for greater Perth of around 11% public transport, 3% active transport, and 85–87% private transport has been consistent across multiple censuses and surveys, the latest data released to Parliament in June 2023 from the first three years of the four-year Perth area travel and household survey shows a mode split as follows:

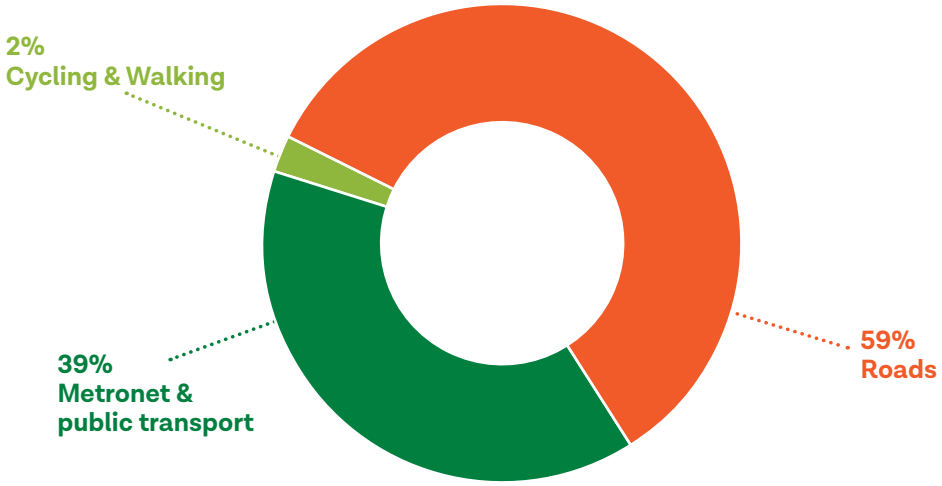
Figure 3.4: Mode split for greater Perth to 30 June 2023



Metropolitan Perth's high percentage of private car use for transport makes the transition to a Climate Positive Perth much more difficult and resource-intensive. Underlying this car heavy mode share are the disproportionately large amounts of public money that continue to be spent on Perth's road network.

The transport sector comprises the largest portion of the State's investment in infrastructure, forming approximately 45% of the State Government's Asset Investment Program from 2021–22 to 2024–25. Over the forward budget a majority of funding is going to roads with $9 billion (59%) for major road projects and upgrades across WA. $6 billion (39%) is planned to go towards Metronet, and $347 million (2%) will go towards pedestrian and cycling infrastructure.

Figure 3.3: State Government transport funding by mode share



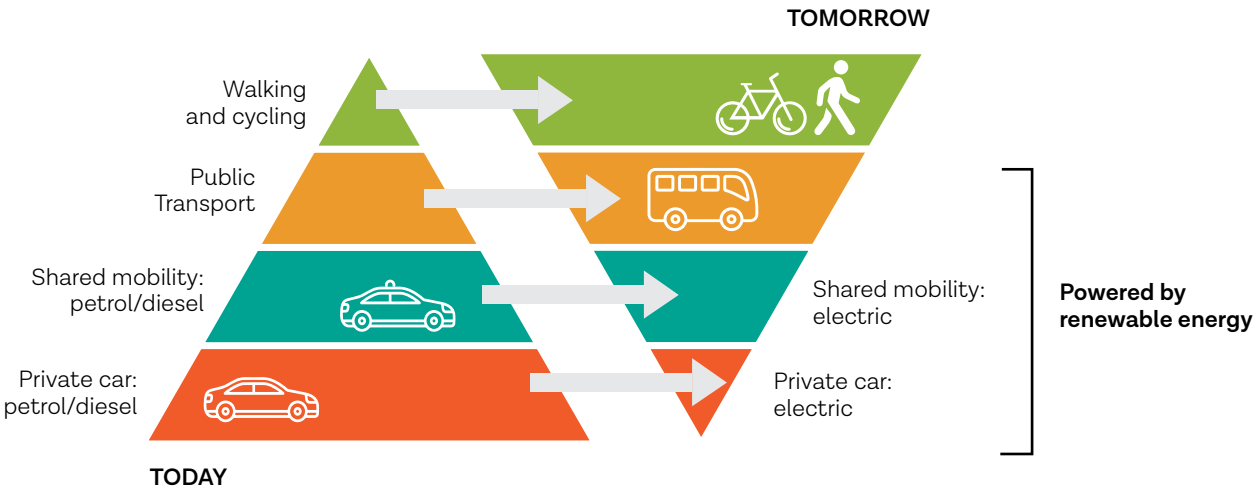
This is making the carbon heavy transport sector even less sustainable. As the WA State Infrastructure Strategy states, "the transport sector faces a number of challenges… Public transport patronage is falling, while peak demand on the road network is increasing".

There needs to be a change in approach and investment if Perth's transport system is to shift to a more liveable, connected, and climate-positive Perth.

3.1.3 What needs to happen to make Perth's transportation Climate Positive?

In addition to redesigning our city in way that will phase out long commutes (as discussed in the Planning and Built Form section), we need to be making investments that will entice commuters out of their cars and into active and public transport. This means turning the current transport funding hierarchy on its head:

Figure 3.5: Reversing Perth's transport mode share



Perth needs to electrify its existing transport options. Let's take a look at each of these in turn.

Active transport

Active transport needs go from being the worst-funded mode of travel to being a priority.

The UN recommends that governments invest 'at least 20 per cent of their transport budgets in walking and cycling infrastructure to save lives, reverse pollution and reduce carbon emissions'. The State Government's budget allocation's is currently only at 2%.

Biking and walking are the most energy efficient forms of transport, and are also good for our health and our city as a whole. The key to enabling this mode change is providing safe and pleasant infrastructures for all ages and abilities to make walking and riding part of daily life. We know 62% of people who ride a bike at least once per month would ride more often if it felt safer.

At a metropolitan transport level, it is the principal shared path walking and cycling network that becomes an essential part of shifting mode-share (the share of all the ways we move ourselves and goods around the city) away from cars to favour active transport. So far, only 41 percent of the Principal Shared Path network has been built. This means the state government needs to speed up funding and construction of this crucial bike network.

The Office of Auditor General's December 2021 report into Viable Cycling in the Perth Area notes:

> *...while the State has added 85 kilometres to its network of principal paths, completing the remaining 100 kilometres will take time, with only 21 kilometres planned to be built by 2025.*

This slow rate of completion is not due to cost. At an average cost of less than $2 million a kilometre, Perth could have a complete network for under $200 million. This is equivalent to less than the cost of just 6 kilometres of a regional highway like the Bunbury Outer Ring Road which cost $37 million per kilometre.

Figure 3.6: Shared path projects for Perth 2013–2023

Public Transport

Perth is spending more on public transport than ever. However there are serious questions to ask around where this money is being spent and how effective it will be in giving people the option to get out of their cars and into public transport.

To understand how WA's big public transport spend might be missing the mark it is worth going back to the original concept of Metronet that was released in 2013 (Figure 3.7).

Figure 3.7: The original Metronet plan Labor took to the 2017 election

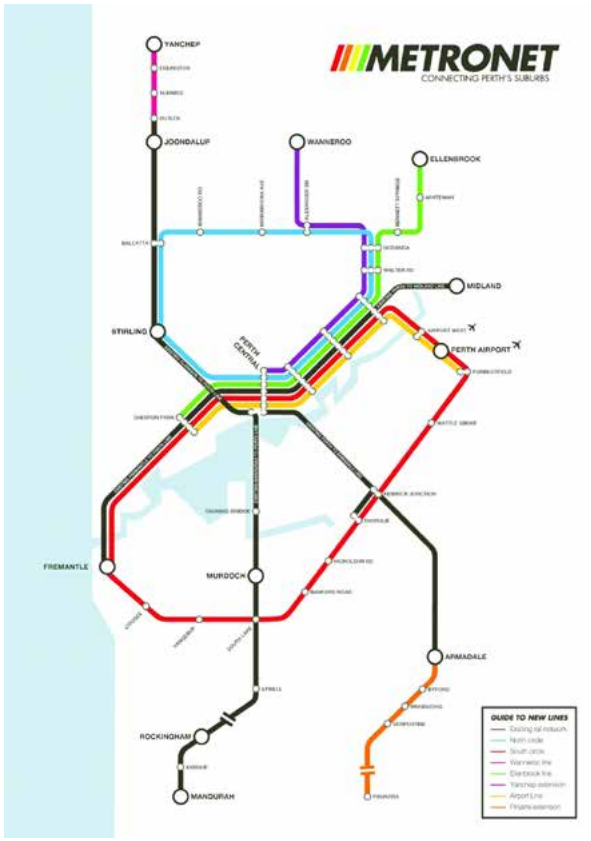
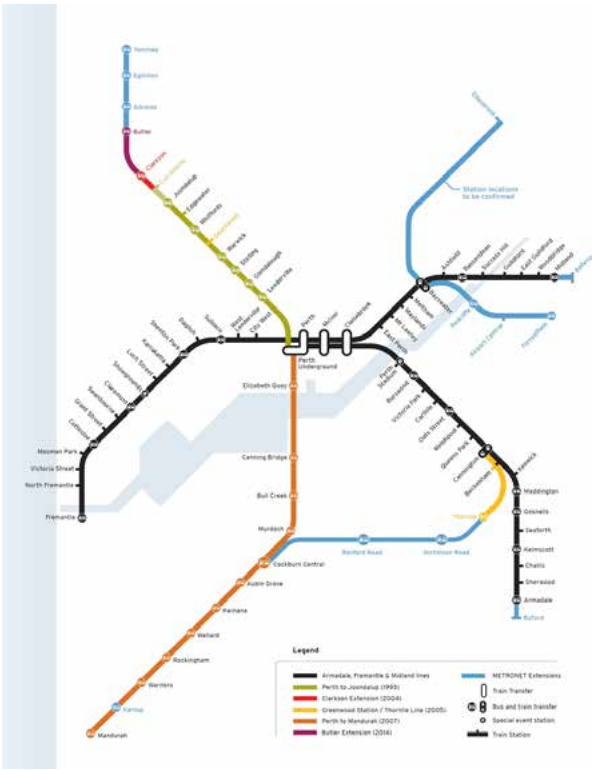


Figure 3.8: The pared-back Metronet being implemented.



Ten years later Metronet has been substantially pared back (Figures 3.7 & 3.8) to largely focussing on expanding the public transport network to the suburban fringe. As a result, it is failing to address most east-to-west movements and fails to improve public transport in the central sub-region where most urban density should be going.

Metronet projects are heavily weighted towards pushing public transport to the underserviced urban fringe by building rail lines out to Ellenbrook, Byford, and Yanchep. Putting aside whether these projects are enabling, if not encouraging, more sprawl, they have been funded at the expense of any planning or investment for inner urban transit. As Western Australian transport expert Professor Peter Newman says:

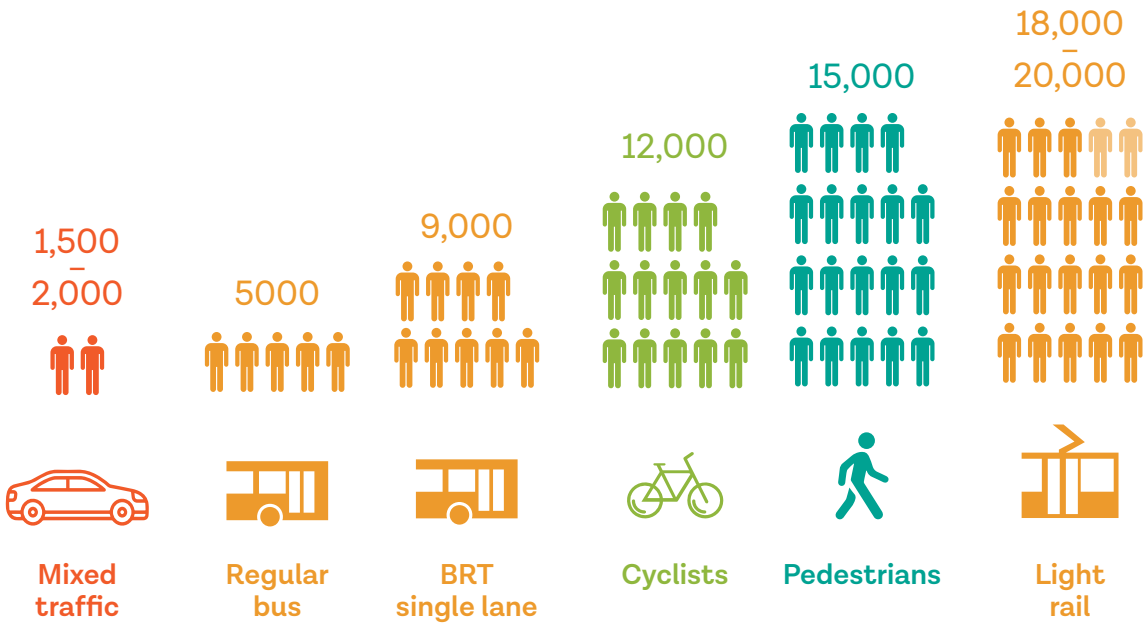
> *"We've got Metronet [planned] with a very big commitment to servicing the outer suburbs, which are rather scattered and less oriented to public transport…and the inner and middle suburbs have not had much investment for the past few decades."*

The need for mid-tier transit

As we will unpack below, Perth needs more than private electric car uptake to solve its transport decarbonisation challenge. Central to this is the problem of congested roads and the efficiency of moving people in a growing city.

A car lane can only take up to 2000 people per hour but mid-tier transit, which includes dedicated lane Bus Rapid Transit (BRT), light rail, and trackless trams, can take between 9000 and 20,000 people per hour. With Infrastructure Australia expecting congestion to cost Perth $3.1 billion per year by 2031 there's a growing urgency to address both emissions and congestion impacts of car-dominated transport investment.

Figure 3.9: Per-hour capacity of transit modes



More mid-tier transit in Perth's inner suburbs would give people more transport choices and encourage better targeted infill and density. Unfortunately, there's been no State Government action on this for the past six years despite early promises.

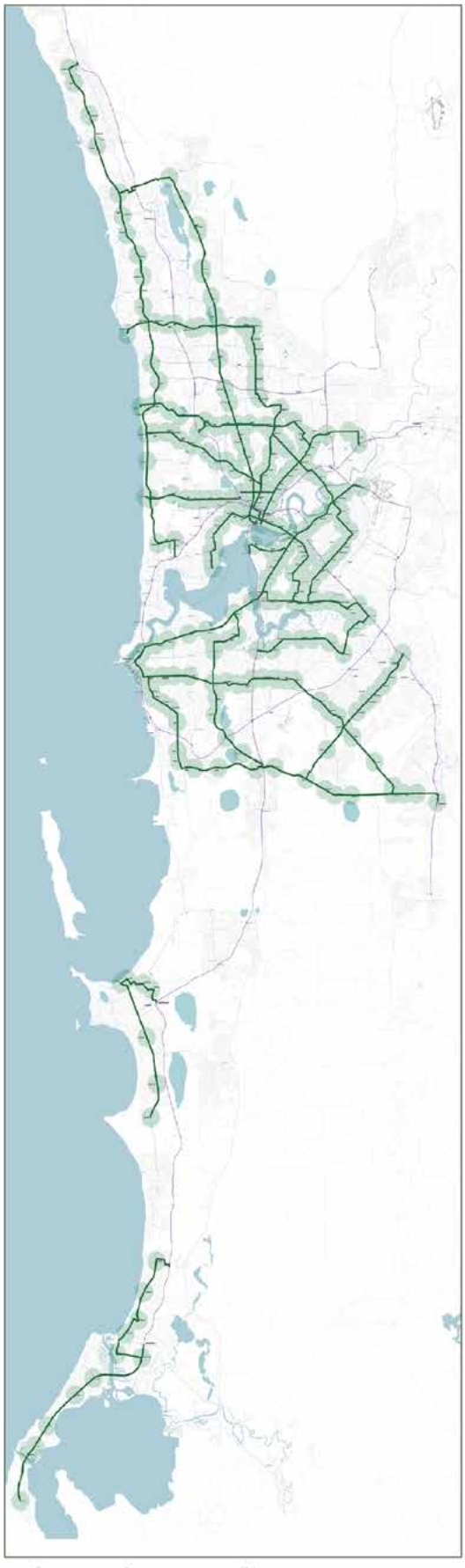
This is not for a lack of advocacy effort by local governments in the central metro area. A Local Government Consortium consisting of 15 local governments have worked together to create a preliminary Mid-Tier Public Transport Network Plan for the central sub-region of the Perth Metropolitan area. Their focus on a mode-neutral mid-tier transit makes a lot of sense and could include light rail, trackless trams or dedicated BRT services together with ways to enable the redevelopment set out in the built-form sections.

Light rail historically has the benefit of improving land use and the built form, while BRT has the advantage of being cheaper to install than conventional light rail but not being as useful at enabling urban regeneration. Trackless trams are still a new hybrid technology which don't run on rails but operate like trams, including having stations to stop at rather than a bus stop. Trackless trams may just offer the best of both light rail and BRT.

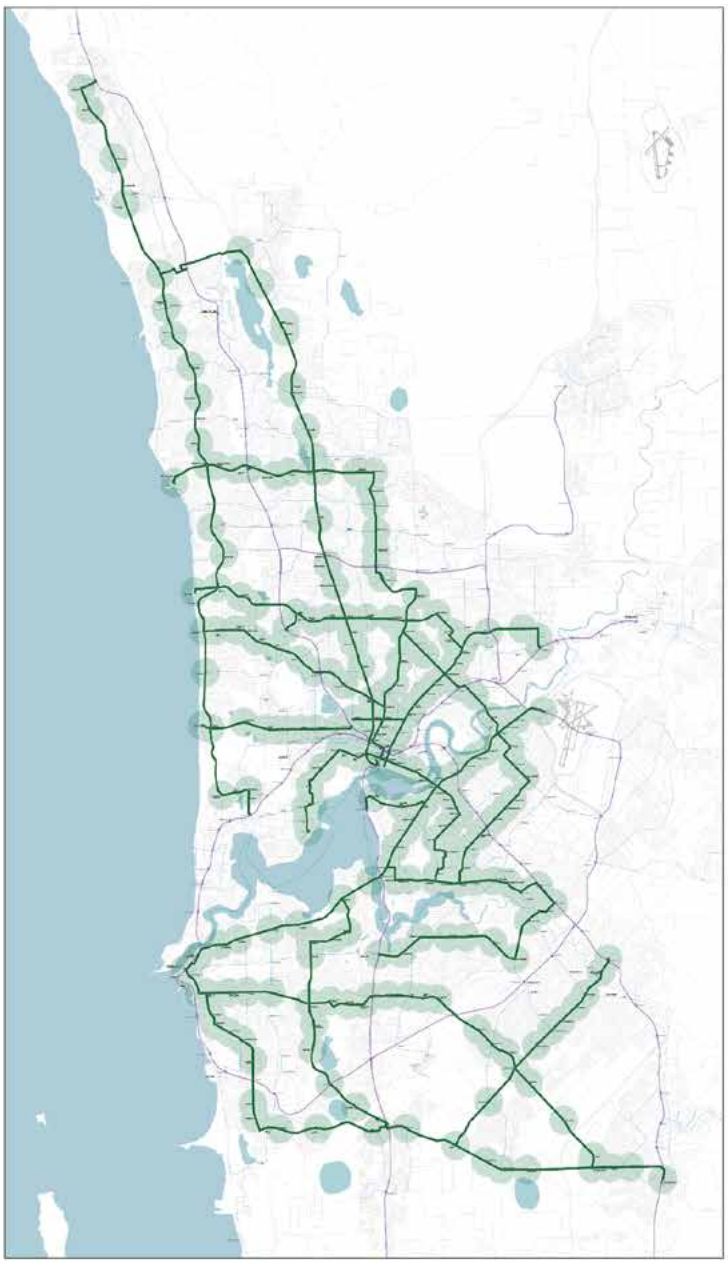
Figure 3.10: Proposed mid-tier transit corridors by local governments in Perth central sub-region

Source: South West Group

Figure 3.11: Expanded mid-tier transport proposal showing catchment areas



Perth Metropolitan Area - Full Extent



Metro Area - Central, East, North

Rockingham - Port Kennedy

Peel - Mandurah

Figure 3.12: Mid-tier Transit corridor in concept using a trackless tram and integrated station precincts as illustrated by City of Liverpool in Sydney for SBEnrc project.

Making our buses all-electric

In addition to new mid-tier transit, Perth needs to rapidly invest in electric buses. Electrifying the Transperth bus fleet represent an enormous potential to reduce the carbon footprint of WA's transport sector. Perth's current bus fleet is aging and needs renewing.

Mostly powered by a mix of fossil fuels, WA has 1,138 diesel buses and 512 gas buses, running up huge fuel bills worth around $40 million every year. The exception is four all-electric buses that recently finished a trial in Joondalup. Over the 12 month trial the four electric buses ran more than 140,000 km, saving approximately 230 tonnes of carbon dioxide emissions.

In April 2023 the State Government announced a $250 million spend on 130 electric buses. In the 2023/24 budget $22 million is set aside for 18 new electric buses but the State Government will also purchase around 70 diesel buses to make up the around 90 new buses it buys each year. In the forward estimates WA is likely to continue to buy two to three diesel buses for each electric bus purchased.

This is a lost opportunity given most buses on Perth's metropolitan routes travel 80–90 km a day, making them ideal for conversion to electric.

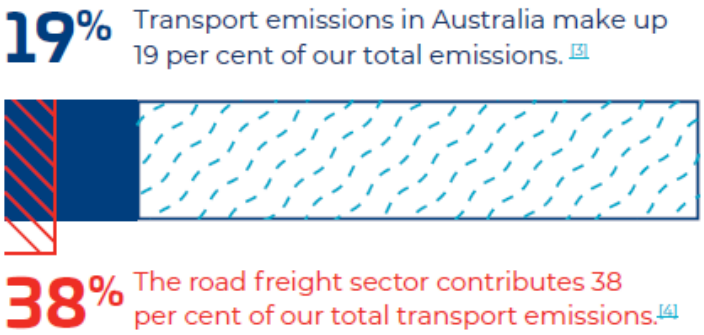
There has been a global push in recent years to ban diesel buses from city centres, with Paris, Madrid, Mexico City and Athens committing to achieve this by 2025. Sydney and Brisbane have committed to all-electric bus fleets.

The EV revolution is well underway with more electric buses than diesel models expected to be sold globally in 2023. WA needs to join the party if we're going to reach net zero.

Making our freight transport electric

Freight matters to decarbonising transport, with the road freight sector contributing 38 per cent of our total transport emissions.

Figure 3.13: Transport emissions as a component of overall transport emissions



Government projections indicate that emissions from articulated and rigid trucks will increase in the next decade, producing 22 MT CO2-e by 2030, a 6 MT CO2-e increase from 2005 levels.

To address this, we need to immediately accelerate the uptake of electric trucks across Perth. Research shows that achieving this will need regulatory incentives including increasing allowed truck widths to align with standards used by major supplier economies, alongside a steer axle mass of at least one tonne concession for electric and zero emission trucks.

There is also an opportunity for Fremantle Port to follow the lead of ports in California and Europe which have introduced clean fleet regulations requiring a certain percentage of trucks accessing the port to be electric, with these percentages rising over time. This could be complemented by the State Government exempting electric and zero emission trucks from night-time truck curfews.

Just like electric cars and buses, there needs to be incentives to reduce the cost of installing charging infrastructure specifically for freight vehicles.

Another strategy for decreasing freight transport emissions is to regulate to enable all diesel freight trains to become electric as has happened in India with now 82% of their diesel trains electric, China is now 70% and the EU is 62%. There also needs to be an increase the percentage of freight on rail. Why not make the around 800,000 containers leaving Fremantle Port move by rail? Currently around 20% are moved by rail. This in combination with plug-in battery-electric trains has the capacity to speed up the low carbon transition for freight movements.

Making our transport electric — Cars

Our personal car use matters as light vehicles produce more than half of all of Australia's transport emissions. But electric vehicles (EVs) are a necessary — but not sufficient — solution to fixing transport for a Climate Positive Perth.

Although Australian EV sales almost doubled between 2021 and 2022, and then doubled again in the first half of 2023, they still represented only 8.4% of all new vehicle sales this year. That's well below the global average of nearly 20%. And it's way behind world leader Norway where 87% of cars sold now are electric.

Electrifying our cars is going to be essential to Climate Positive Perth. Thankfully EVs are much more efficient than internal combustion engine (ICE) vehicles. Renewable energy expert Saul Griffith tells us in *Cars and Castles* (page 12) that:

> *Electric vehicles are approximately 3.5 times more efficient at converting energy into motion, and therefore unlock significant energy savings per household, and significant long-term cost savings when fuelled by (or charged with) cheap renewable electricity.*

We need to ramp up the speed of this transition and ensure that everyone can access an EV who needs it. The good news is EVs have the potential to save households money especially when combined with home produced renewable energy.

While the State Government's major response to driving down emissions in the transport sector has been encouraging EVs via a direct subsidy and providing charging stations, there is a long way to go and we need to get there faster. WA was the last state to put in place EV incentives, but these are starting to have an impact with EV sales growing from 1.6% of overall new vehicle registrations in 2021, to more than 7.5% of total new vehicle sales with incentives in place.

Whilst incentives matter, an ambitious EV strategy, needs to be backed by robust fuel-efficiency standards. Major changes to fuel efficiency standards across the country could be the most important singles change that the Federal Government can make to speed up the decarbonisation of Australia's passenger vehicles.

Strong fuel efficiency standards already cover over 80% of the international car market and are a proven way of driving down pollution from new cars. Australia and Russia are the only OECD countries without these standards, and this has limited the models of electric vehicle available in Australia and has led to Australia potentially being a dumping ground for more polluting, dirty vehicles. National fuel efficiency standards will also lead to improved air quality and reduce Australia's dependence on fossil fuels and imported oil.

EVs: necessary but not enough

EVs are an essential step towards a Climate Positive Perth but are not going to be the most efficient way of lowering emissions and making Perth more liveable and connected. In other words, EVs are important but only part of of the solution. An efficient and effective path to a Climate Positive Perth will need to be more than just an EV solution.

Firstly, EVs are not going to reduce our emissions quickly enough to meet stated targets. One key reason for this is that according to the Institute for Sensible Transport we only swap out 4% of our vehicles each year meaning that they stay in our fleet for 25 years on average. Passenger vehicles stay in our fleet a for a little less time, up to 20 years on average. This means that changing the overall composition of our vehicle fleet takes a long time.

Take the example of Norway which, despite a world-leading take-up of EVs, has diesel and petrol cars still making up over 70% of Norway's car fleet by late 2022. Nevertheless, because of Norway's ambitious EV policies, transport emissions decreased by 8.9% from 2005 to 2019 and are trending down.

So we need to replace ICE (fossil fuel) cars with EVs cars as quickly as possible while also reducing our car fleet and how often we drive.

Net Zero Australia's report says that "*(v)oluntary purchases are unlikely to meet the modelled trajectories, so take-up would need to be stimulated…*". To do this WA will need well targeted subsidies for those sections of the community that are not able to afford to buy an electric vehicle, once the existing subsidy has been exhausted.

If the reduced cost of EVs and subsidies doesn't increase the uptake of EVs enough in the next few years, the State Government may also need to consider a scrappage scheme or a "cash for clunkers" program for ICE vehicles. Cities including London offer cars and motorbikes that are not low emissions a grant of up to 2000 quid for taking them off the road.

The uptake of EVs needs to be matched by the expansion of EV charging locations. Net Zero Australia have modelled that for every 1000 electric vehicles that there will be a requirement for 7 DC Fast chargers and 30 workplace chargers, a far higher ratio than currently exists.

There also needs to be a much more comprehensive electric vehicle recharge system. Governments need not provide all of these just as they do not provide refuelling stations for petrol and diesel vehicles. Little attempt has been made yet by the oil and gas industry (Ampol being the exception) to provide for electric vehicles in service stations. An investigation into the merits of incentives and regulation to enable more service stations to be used for fast recharge of electric vehicles.

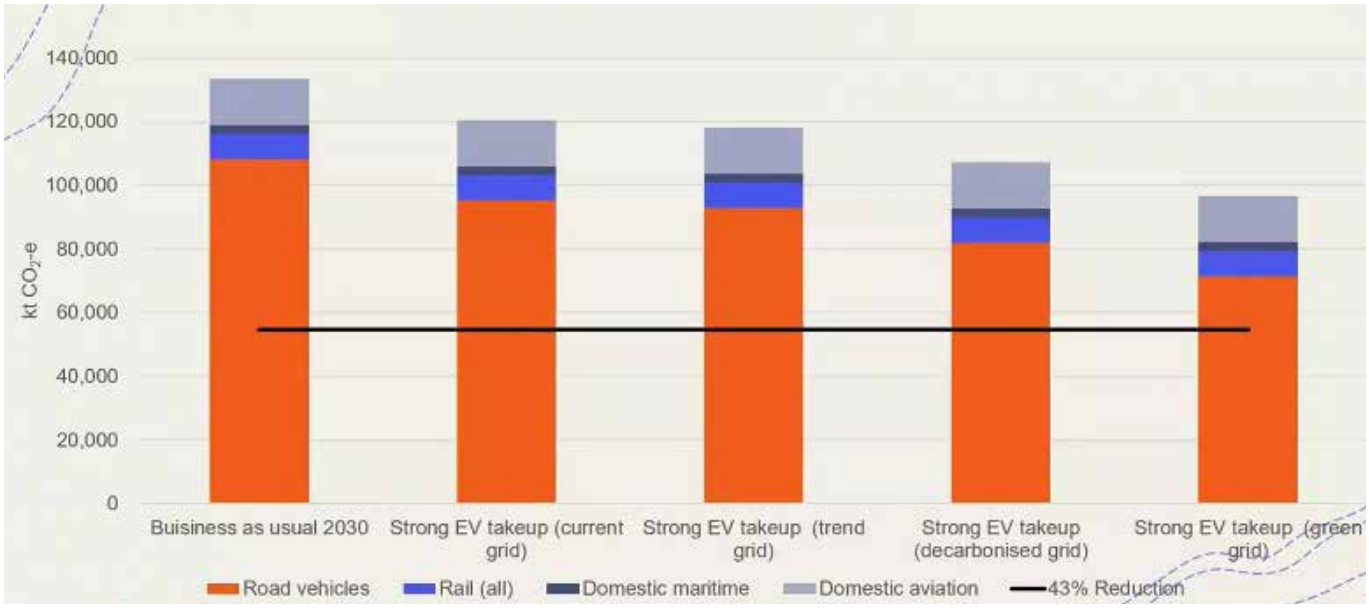
Finally, these policies need to be underpinned by improved fuel efficiency standards that limit greenhouse gas emissions for Australia's legacy fleet of ICE cars as well as the emissions intensity of EVs from manufacturing and energy use.

Perhaps the lesson of Norway is that with the right policies and incentives, we can speed up the transition toward EVs. But even when high levels of new vehicle uptake are EVs, the path to net zero is not quick. This is why a shift in transport mode share is essential too.

What this means is that even the modest 43% 2030 emissions reduction targets that the Australian Governments has set cannot be met with EVs even if there is a much stronger take-up and replacement combined with more renewables resourced electricity grid.

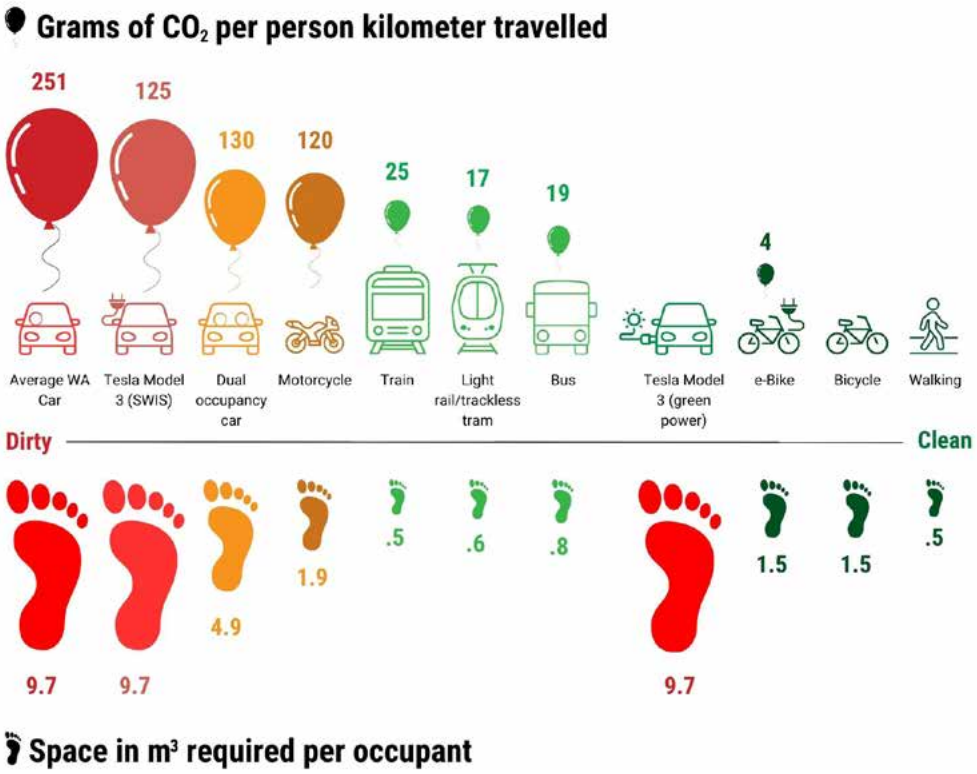
A policy, even an ambitious policy, of just swapping out EVs without aiming for a mode share with far more active and public transport use is not an efficient carbon emissions policy nor one that will create a more liveable and connected metro Perth. Perth needs to plan for EVs plus a city designed around transport choices for all that includes active and public transport.

Figure 3.14: Targets cannot be met through light EVs



Source: Institute for Sensible Transport

Figure 3.15: Per person emissions and spatial footprint of different transport modes



Source: Adapted from Institute For Sensible Transport

The role of electric vehicles in achieving Climate Positive Perth is not just about reducing emissions. There also needs to be a focus on how our city functions including reducing congestion. The cost of peak period congestion — estimated in the WA State Infrastructure Strategy will be $3.6 billion per annum by 2031. As the graphic shows, electric cars are worse for emissions but take up the same space as ICE cars. For a more liveable and connected Perth, we are going to need a transport mode shift as well as a shift to EVs.

There are 1.5 million cars in the Perth metro area. If we were to swap all of these for EVs this would mean Perth would require a huge 75Gw/h of battery storage or the equivalent of 375 Kwinana big batteries.

To address this, we need to have the right policy settings to encourage Perth's ICE cars to be replaced with smaller, more efficient EVs. This message is loud and clear from Net Zero Australia when they say that EVs "*...currently have a higher cost of abatement than other options, particularly a larger ICE vehicle is replaced with a similar sized EV*" (2023, page 32). They go on to say that there are more cost-effective options include downsizing vehicles.

Replacing our current light vehicle fleet with huge electric SUVs reduces the efficiency of the decarbonisation process and importantly creates other problems that include making our city streets less safe, especially for active transport users. For these reasons we will need incentives to encourage smaller, more efficient electric vehicles where possible.

Policy and Governance

Underpinning Perth's poor performance on transport is governance and how infrastructure dollars are allocated.

Roads-focused Main Roads WA (MRWA) too often leads transport planning in this State, with the Department of Transport (DoT) reduced to a less well funded role and a focus largely on water transport and behaviour change, alongside some strategic cycling and pedestrian planning.

For Perth to shift away from car dominance, Main Roads should no longer be the primary planner and designer of urban transport projects. For Main Roads, almost every problem can be solved with a bigger road. The global evidence is that bigger roads is the last thing low carbon aspirational cities need. In fact recent analysis from the US Climate Center across 12 US states found that "*minimizing further highway expansion was the most important lever to avoid putting upward pressure on transportation emissions*".

The MRWA and Public Transport Authority (PTA) have enabling legislation that establishes their authority and powers. This means that the MRWA Commissioner can simply instruct certain things be done without going through the Minister. The Department of Transport planning team has no such statutory powers to undertake major planning for Perth.

WA needs to consider governance solutions that will facilitate effective metro-level transport planning, including the need for enabling legislation delegates adequate powers and responsibilities to an appropriate body (not MRWA) for planning for greater Perth.

Professor Peter Newman has suggested there needs to be an integration of planning agencies (the Department of Planning, Lands & Heritage and Development WA) with Metronet and PTA for a Mid-Tier Transit Review. This would make sure that a review does not just consider the

technologies of vehicles but also wider issues and opportunities in transport planning: "*the opportunity to save money, save land on the urban fringes, save greenhouse gases, and save travel time, can all be integrated*".

For these reasons there needs to be reform of DoT's and MRWA's legislation and governance frameworks that empowers DoT to be responsible for multi-modal transit plans and designs and refocuses MRWA from primary planning and design of urban transport infrastructure projects to delivery.

Furthermore, MRWA, needs to be given a clear focus on giving people ways to travel other than by car, as has been done with its Victorian counterpart VicRoads. Key performance indicators and incentives linked to reducing Vehicle Kilometres Travelled (VKTs), alongside improving the transport sector's carbon footprint and mode-share should also be linked to DoT and MRWA reporting.

The evidence is that reducing VKTs often necessitates building fewer roads. In Wales this metric was used as part of a review of the entire roads construction program which saw only projects that would enable the reclaiming of central land for walkability and reduction of traffic. VKT reduction is a target of the Western Australian RAC's Vision 2030 project, and New South Wales has also adopted them.

In New South Wales (NSW), as highlighted in the WA State Infrastructure Strategy, the NSW Department of Transport, is responsible for overall governance of transport systems, including policy, planning and funding allocation. The integrated structure of the NSW Department of "*supports a focus on cross-modal, long-term future transport planning*". This department produced the highly innovative policy to have a target of reducing VKT in the future planning of Sydney with a requirement that every new road proposal will show how VKT is reduced. This is a goal that Perth should seek as well.

Case study — Wales

The Welsh government has decided that all future roads must pass strict criteria, which means they can't increase carbon emissions, need to decrease the number of cars on the road, not lead to higher speeds and higher emissions, and can't negatively impact the environment.

Wales will not consider new projects unless they reduce carbon emissions and support a shift to public transport, walking and cycling, improve safety through small-scale change and help the Welsh government adapt to the effects of climate change.

They must also provide connections to jobs and areas of economic activity in a way that maximises the use of public transport, walking and cycling.

Deputy Minister for Climate Change Lee Waters said the approach of the last 70 years was not working: *"We will not get to net zero unless we stop doing the same thing over and over... None of this is easy but neither is the alternative*".

3.1.4 Conclusion

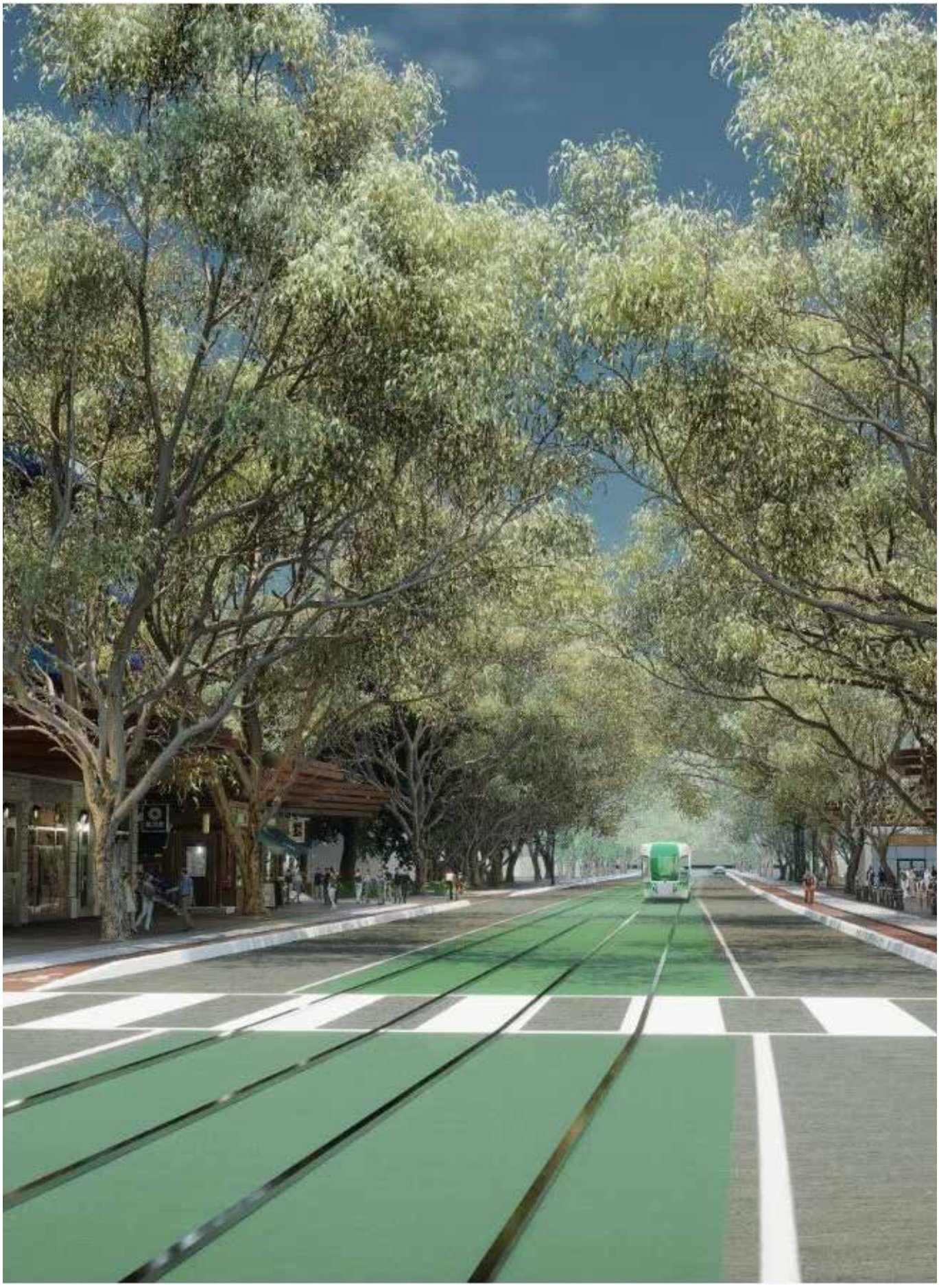
Transport emissions are still growing in Perth but with the right investments and policy settings we can speed up the Climate Positive Perth transition.

The transition to EVs needs to happen at a greater rate by changing national fuel standards, bringing a stronger focus to EV charging at workplaces, and faster, stronger State Government investment in electric buses.

But we also need to go beyond EVs, and this will require a clear mode share target and a much bigger investment in mid-tier transit and active transport because EVs alone will not get us to a more liveable and connected Perth. To do this we need to fundamentally alter the balance of how transport planning is done in WA, with a refocusing of agencies to their proper roles.

A transition at a speed and scale consistent with climate science is possible for Perth, but it is going to require some big shifts in transport investment and governance at a metro level.

To summarise: electrify all of Perth's transport and make more of Perth's transport mode-share active and public.



3.2.5 Metropolitan Scale Transport Recommendations

1. **Set ambitious mode share targets** for WA that are reported on annually.
2. **Ensure at least 20% of transport funding goes towards active transport** including an integrated metro-wide bike network.
3. **Plan for and invest in mid-tier transit** in Perth's central subregion in collaboration with local governments in the region, and create a process that will integrate low-carbon urban development into every corridor it runs through.
4. **Electrify ALL new Transperth buses** and stop buying gas and diesel buses immediately.
5. **Begin to electrify metropolitan freight trucks** entering Fremantle Port with clear targets that increase over time.
6. **Support and advocate for strong fuel efficiency standards for Australia** with an aim of 100% of new cars sold be zero emissions by 2035 at the latest.
7. **Investigate a well targeted scrappage scheme** to speed up the uptake electric cars.
8. **Fund and support a major expansion of EV charging infrastructure** to ensure this does not become a block to rapid uptake.
9. **Encourage smaller, more efficient new electric cars** with well-designed policies and incentives.
10. **Reform the Transport Portfolio legislation and governance frameworks** so that the Department of Transport is responsible for multi-modal transit planning for Perth and Peel and Main Roads WA is no longer the primary planner and designer of urban transport infrastructure projects. Ensure key performance indicators are linked to lower carbon footprint of transport sector and more balanced mode-share.
11. **Set a target for reducing Vehicle Kms Travelled in all road planning**, so that traffic is being reduced into the future.

3.2 Transport — Neighbourhood Scale

> **"The first thing one learns in city planning school is that how we move determines how we live. If our society is going to slow climate change, it will be by reorientating our cities around transit, biking, and walking."**
>
> Jeff Speck, Walkable City Rules 2018

3.2.1 Introduction

Transport at the neighbourhood scale matters. Our neighbourhood is where most of us travel most of the time, taking trips of just a few kilometres. Decarbonising these shorter, most common trips can have a substantial impact on our carbon footprint.

As with metropolitan scale solutions, the most effective and efficient community/ neighbourhood-level responses will be ones that go beyond merely electrifying our cars towards those which enable transport choice and mode shift. At a neighbourhood scale, using active transport will be especially important. This is good for reducing carbon emissions and climate change, and helps create better connected and healthier communities.

3.2.2 Current State of Affairs

As discussed in the metro-scale transport section, according to the Climate Council Perth has one of the lowest participation levels in active transport (cycling, walking and e-rideables) trips of all Australian major cities at less than 4.5% of mode share.

A five-kilometre bike ride takes about 20 minutes, a three-kilometre bike ride just 12 minutes. Despite this, of the 4.2 million private car trips made in Perth daily, around 2.8 million or two-thirds are less than 5 kilometres.

Perhaps even more disturbing is some of the long-term trends away from active transport at a neighbourhood scale such as the percentage of children who walk or cycle to school. According to the WA Department of Transport:

> **(f)ewer Australian children walk and bike ride to school than ever before. Over the past 40 years the national rate of active travel to school has declined from 75 to 25 per cent. In Perth, the rate is as low as 20 per cent and one-half of children travel to school by car despite living less than one kilometre away.**

Many of the millions of trips we currently make by car represent opportunities to bike, walk or e-ride. Unfortunately, Perth's infrastructure rarely supports this shift. While at a metro scale, 41% of Perth's primary bike paths are complete, at a neighbourhood scale only 34% of secondary paths are fit for purpose. 1,564 km of identified possible secondary bike networks are either non-existent or require significant upgrades and replacement.

3.2.3 What needs to happen?

At the neighbourhood scale, how we design our local streets and centres can make a big difference and can tackle car dependence by giving people a choice of how they travel. A successful, liveable and connected low-carbon neighbourhood is one of the keys to a Climate Positive Perth.

Recent evidence suggests the following actions are important steps.

Greater investment in local infrastructure

While there has been a recent increase in WA State Government investment in cycling infrastructure it is still low at around 2% of total transport infrastructure spend. As discussed in the metro-transport chapter, it's just not enough to achieve a substantial shift in mode share.

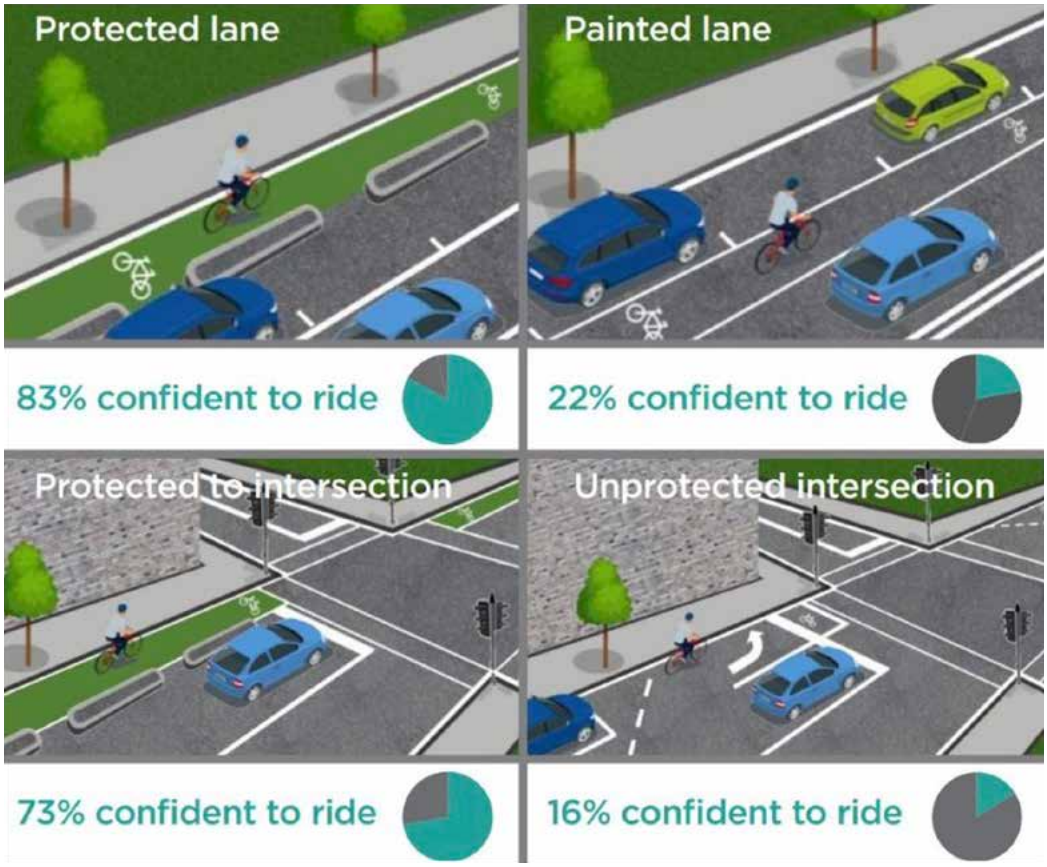
Worryingly, investment by the State Government is largely focused on the Principle Shared Path (PSP) network and other major projects around bridges and freeways instead of towards making local streets safe and comfortable. Given local streets are where most people ride most often, greater investment in local bike infrastructure is required if Perth is to achieve high levels of active transport. Fundamentally, Perth needs to address the fact that most of its local streets — often referred to as the 'first and last mile' in the US — do not invite people to walk or ride, especially more vulnerable road users including children.

More protected or separated bike lanes

One way to turn this around is greater investment in more protected or separated local bike lanes. Protected bike lanes limit interactions between cyclists and car drivers, minimising the risk of cyclist injury from motorists. A 13-year study of a dozen cities found that protected bike lanes led to a drastic decline in fatalities for all users of the road. Despite these benefits, it is estimated that 99% of all bike lanes remain unprotected in some Australian cities, including Perth.

More recently, a study highlighted the critical importance of protected bike lanes in encouraging more female cycling participation. In particular, women with children in their care described wanting to make trips by bike in their local areas but were concerned about the lack of continuously separated bike paths that leave them vulnerable to motor vehicle traffic.

Figure 3.17: Networks of protected bike baths and bike lanes in low-traffic neighbourhoods are one solution to make bike riders feel safer



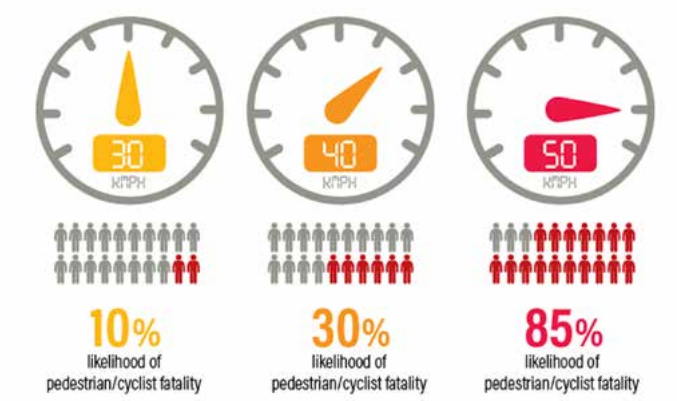
Source: Christopher Samuel/AAP

Low speed neighbourhoods

While building protected or separated bike lanes across all parts of Perth may not be practical, another option to make our neighbourhoods safe and appealing for cycling and walking is low-speed neighbourhoods. These could have 30km/h speed zones and/or be low-traffic neighbourhoods. Ideally, these low-speed streets and neighbourhoods across Perth should then be connected by a network of protected bike lanes that stitch the city together for a safe and continuous cycling network.

Lower default speed limits in 'residential areas, shopping streets and school zones' was one of the three transport priorities put forward in 2022 by an alliance of health organisations including ASAP, the Heart Foundation, Telethon Kids Institute, and We Ride Australia. Lower speeds are essential on several levels. First, they make our streets safer. The evidence for lower speeds and pedestrian safety is compelling. Australia Studies have shown that reducing speed limits by 10kmh has led to a decrease in casualties by 12% and up to 40% decrease in fatalities (Nanayakkara et al, 2022). International evidence is even stronger:

Figure 3.18: Higher speeds increase likelihood of pedestrians/cyclists dying in collisions



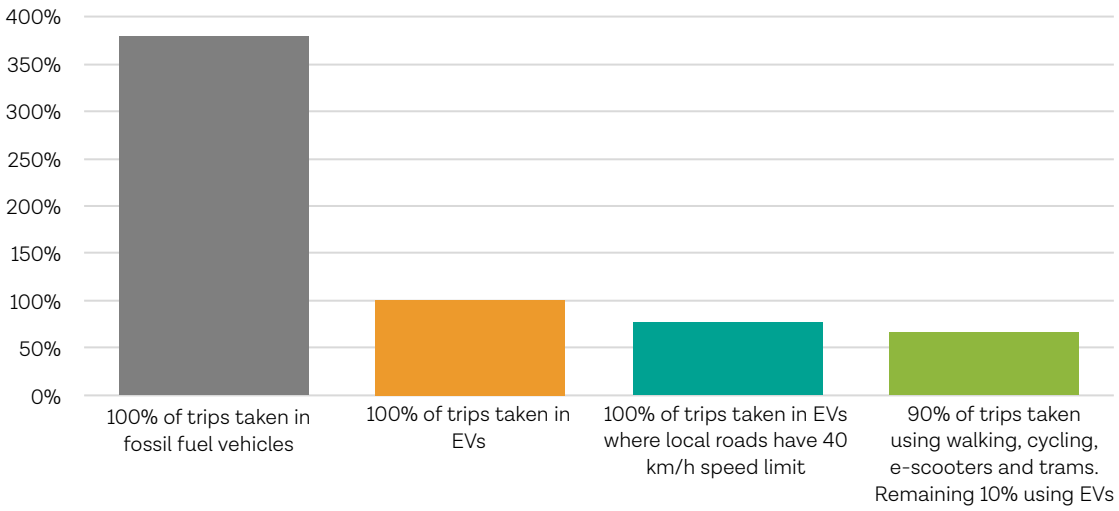
Source: Cities Safer by Design (2015)

There is strong evidence that slower streets aren't just safer but are also better for emissions reduction.

As Saul Griffith maps out in his 2023 Quarterly Essay, slower is better. While substantial transport emissions reductions come from electrifying our cars, there are also major emissions reductions from lowering the speed limit: "*slowing to 40kmh gets us a huge gain on energy use, a further reduction of 23 per cent.*"

Speed reduction on local streets would give metro Perth substantial energy and efficiency wins and enable a higher uptake of walking and cycling, and other active transport activities creating a virtuous cycle. The lowest energy cost of all transport options is when most trips under 20km are done with bikes, scooters and public transport. We will look at how to encourage more fully in the chapter on households.

Figure 3.19: Energy Cost by transit mode share using four different models



Calming residential neighbourhood streets

Redesigning suburban streets will lead to increased perceptions of safety and community connection. Some examples of low-cost neighbourhood traffic 'filters' that can be executed quickly and easily in our neighbourhoods are illustrated below. What they have in common is that they include street trees for shade and amenity and reallocate more road space to cyclists and pedestrians.

Figure 3.20: Woonerf (living street) strategies for traffic calming

Pocket parks

Modal Filter

Diagonal filter

Easements for active transport

Woonerf
Translated as "living street," a woonerf employs strategies like traffic calming devices and low speed limits to force drivers to slow down and safely share street space with pedestrians, cyclists, and others, often without raised curbs separating cars and pedestrians.

Locally appropriate combinations of these solutions, in conjunction with lowering speed limits can provide people with the safety and security they need to take up more active modes of transport in our residential and neighbourhood streets.

Figure 3.21: Unremediated vs calmed residential street

Source: Mclaughlin et al (2022)

Traffic calming neighbourhood centres

In addition to slowed and traffic calmed neighbourhoods, we need to make sure our urban centres, including neighbourhood centres encourage a better mode share too. In centres with higher-speed roads there needs to be more substantive separation of transport modes.

Where this is not possible due to road width constraints or other reasons, a safe active street redesign in urban shopping and dining hubs provides a solution that local government can implement — but this will require State Government support and approvals.

Up until this point Main Roads Western Australia (MRWA) have rejected most local government requests to reduce local speed limits to 30kmh. This nicely imagined artist's impression of South Terrace in Fremantle showing how introducing on-street dining and providing a safe cycling space can bring about a vibrant community (Mclaughlin et al, 2022) was not supported by Main Roads WA.

Figure 3.3: Proposed traffic calming for South Terrace, Fremantle

Source: Mclaughlin et al (2022)

Neighbourhood Streets as Place not just Movement

In a better-connected Climate Positive Perth, streets aren't just for getting through — they are places in their own right, designed for people, businesses, lingering and living. All of the examples we've given seek to reimagine and utilise streets as places and destinations, not just as tarmac we move over on the journey. Liveable cities with a good mix of transport modes are about both movement and place. Perth has been better at the former than the latter up until now.

With this in mind, lower speed limits and calming streets make sense: they protect and enhance the quality of neighbourhood life. Where cars move slowly, sharing of space can happen more easily and safely. How we redesign and reimagine our streets at the neighbourhood scale will go a long way towards giving Perth people better transport choices.

As we do so we create better conditions for businesses. The economic benefit of increasing walking and cycling and reducing car use can equate to greater advantages for businesses, especially from increased patronage (URBIS, 2021). Replacing traditional kerbside car bays with bike parking or outdoor dining increases activity.

Figure 3.4: Revenue generated per day by different kerbside users

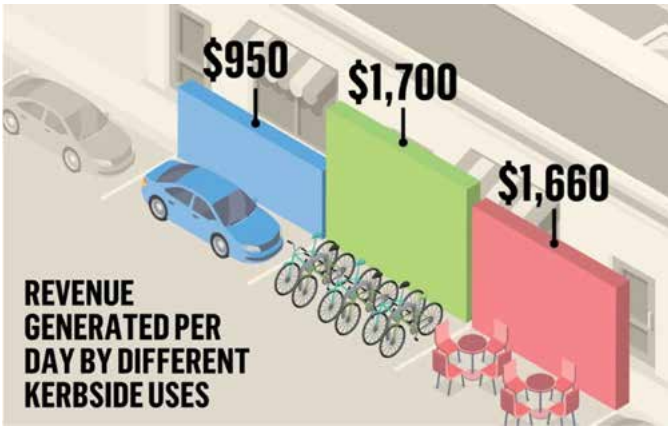


Figure 3.5: On-street EV charging

Making EVs easier at a Neighbourhood Scale

Greater mode-share in favour of active transport will be essential for Net Zero Perth but we also need to ensure we make it easy for EVs to help speed up the transition. As Sydney Mayor Clover Moore said: "*not all trips can be completed on a bike or public transport, so electrification of high-impact fleets such as delivery and service vehicles, as well as private vehicles, will help complete the journey to net-zero transport*".

Supporting EV charging at neighbourhood scale is an important part of this.

Workplace charging has a range of benefits. Not only will this ensure that those that need to drive to work can charge their electric vehicles, but they will also be able to charge during the day when the sun is out and there is surplus renewable energy (largely solar) on the grid.

Because not all houses or apartments are set up to charge EVs, it will be important that our neighbourhoods, particularly in inner-urban areas, have a network of chargers will include local chargers on our streets and in suburban centres. Neighbourhood chargers will normally be AC 22kW which will add between 40 and 100km of range per hour, meaning they will top up average daily vehicle use in an hour or deliver a full recharge overnight.

In addition, in some areas with limited off-street parking there will need to be street pole chargers. These need to be installed in a way that doesn't hinder pedestrian access or add to ways to obstruct flow in the streets. The first of these solutions was rolled out in Newcastle and Sydney in late 2022/early 2023 and Ausgrid plan to deliver up to 30,000 pole-mounted EV chargers across its network by 2029.

3.2.4 Key steps to make Perth's neighbourhood transport Climate Positive

More neighbourhood scale focused bike infrastructure funding for a Climate Positive Perth

Stronger focus on neighbourhood-scale bike funding from the State Government will be crucial. The 2022 State Infrastructure Strategy final report notes that while a 5,570 km Perth cycle network has been developed and agreed to by the State Government and metropolitan councils, and that more than $265 million in funding has been allocated to pedestrian and cycling infrastructure over the next 4 years, there is a major problem with delivery of this network. As Infrastructure WA says:

> *...the majority [of funding] (is) going to the cycling components of major road and rail projects, and CBD projects such as the new Causeway Pedestrian and Cycling Bridge.*

Funding for neighbourhood-scale or local cycling infrastructure projects is relatively low at an average of $5 million a year and currently this must be 50% co-funded by participating local governments. As a result, the local bike network at a neighbourhood scale is only growing at *"just over 18 km of local cycling infrastructure annually, on average, between 2015–16 and 2019–20"* (Infrastructure WA (2002), p238).

Fairer cost share for active transport projects

Currently, local cycling and pedestrian infrastructure projects are required to be 50% co-funded by local governments. By contrast, local road-only projects are often funded at 65% or even 90% by the State Government.

There is an opportunity to make State Government transport infrastructure funding at least mode neutral, if not weighted towards funding for active transport. The State Government continuing to fund car movement at a higher funding rate than it funds biking or walking is not tenable in a Climate Positive Perth.

Stronger focus on funding protected lanes

Very few of the planned bike paths are protected lanes as recommended by international best practice. Most of the new bike path proposed are made up of painted lanes or shared paths. So we need more funding to create protected neighbourhood bike lanes.

This investment should include agreed standards and mechanisms to ensure the affordable rollout of infrastructure, such as curbing. The State Government could provide funding explicitly for protected lanes and support local governments to expand this improved infrastructure.

Enabling EVs charging in our neighbourhoods

EV charging at neighbourhood scale will be central to a Climate Positive Perth. Not all houses or apartments are set up to charge EVs. Including street pole chargers along streets with limited off-street parking will be an important requirement in many of our neighbourhoods, particularly in inner-urban areas. This will require collaboration between Wester Power, the State Government and local governments to ensure EV uptake is not constrained by charging availability.

A dedicated body to support calmer neighbourhood streets

Perth needs a plan to calm and slow transit in our streets and neighbourhoods. Having to put approvals for lower speed limits sit through Main Roads who have largely resisted such changes is not working.

A dedicated fund and approval body that can facilitate the implementation of slower calmer streets when requested by communities and local governments is essential. This will enable Perth to implement slow speed neighbourhoods and neighbourhood centres alongside the Woonerf template and other shared space models for our streets. If metro Perth embraces calmer neighbourhood streets then we can create streets which are less energy intensive to use, as well as creating new neighbourhood places, and with this connection a healthier community.

3.2.5 Neighbourhood Scale Transport Recommendations

1. **More neighbourhood-scale focused bike infrastructure funding**
   Make major investments in safe cycling and walking infrastructure with a stronger focus on the 'last mile', especially to schools, activity, and neighborhood centers.
2. **Fairer cost sharing for active transport projects**
   Make State Government transport infrastructure funding at least mode neutral, if not weighted towards funding for active transport.
3. **Stronger focus on funding protected bike lanes**
   The State Government could provide explicit funding for protected lanes and this new funding program would support local governments to expand this improved infrastructure.
4. **Expand programs enabling EV charging in our neighbourhoods and workplaces.**
   Not all houses or apartments are set up to charge electric cars and bikes so more public and workplace charging will be needed.
5. **A dedicated state government body to support more walkable, greener and safer neighbourhoods for everyone to enjoy.**
   Metropolitan Perth needs a plan and new governance to enable calmed, connected and walkable transit in our streets and neighbourhoods.

3.3 Transport — Household Scale

3.3.1 Introduction

Getting our homes ready for electrification of all our transport and orientated towards more active and public transport is a wonderful opportunity to make them hubs for a healthier, better-connected city.

3.3.2 Making our houses and apartments EV-ready

Perth's households will need places to charge their electric cars and e-rideables (including e-bikes and e-scooters). For most homes, an outside power point on the property is all you'll need.

Older homes and apartments without driveways and carports are a bigger challenge, making investment in streetside charging necessary in these areas.

Apartments with car-bays and garages also need to become EV-ready. Charging for EVs and e-rideables is not available in many existing apartment buildings so installing these as quickly as possible will ease the EV transition.

The RAC estimates that around 2.5 million Australians — 10% of the population — live in an apartment. In Perth, this percentage is a bit lower but still accounts for more than a hundred thousand people and this number will continue to grow as infill targets get closer.

Arup's research shows that:

> *...the response from Owners Corporations (OCs) on providing charging infrastructure is mixed. Some are trying their best to keep up, while others seem unprepared or even unwilling. With EV ownership on the rise and over 80 percent of owners preferring to charge at home, the pressure is on to resolve it.*

Better and clearer regulations on the provision of EV charging in all new apartments is needed to speed up this transition as EVs, e-bikes and other electric vehicles become increasingly common. Retrofitting is much more expensive than installation when an apartment is being built.

Incentives for EV charging in apartments could also be considered. The government of Norway offers up to 50% off the purchase and installation price for a slow charger in a home or office building. Subsidising EV charging assessments undertaken by an electrical professional or manufacturer would make it more attractive for OCs to understand their charging capabilities. Introducing a state-managed standard user agreement for billing purposes would promote equitable uptake for both OCs and building users.

3.3.3 Incentivise e-bikes and e-mobility

The best way to get to a Perth that is Climate Positive while enjoying healthier and better-connected lives is by embracing e-bikes and e-mobility

The evidence is that e-bikes are used for much longer trips than conventional bikes and are more likely to act as a replacement for motor vehicle trips than conventional bikes. Research shows that E-bike users can increase their average daily bicycle use from 2.1km to 9.2km — a 340% increase. E-bikes also account for 49% of user's overall transport, up from the 17% previously undertaken by conventional bikes.

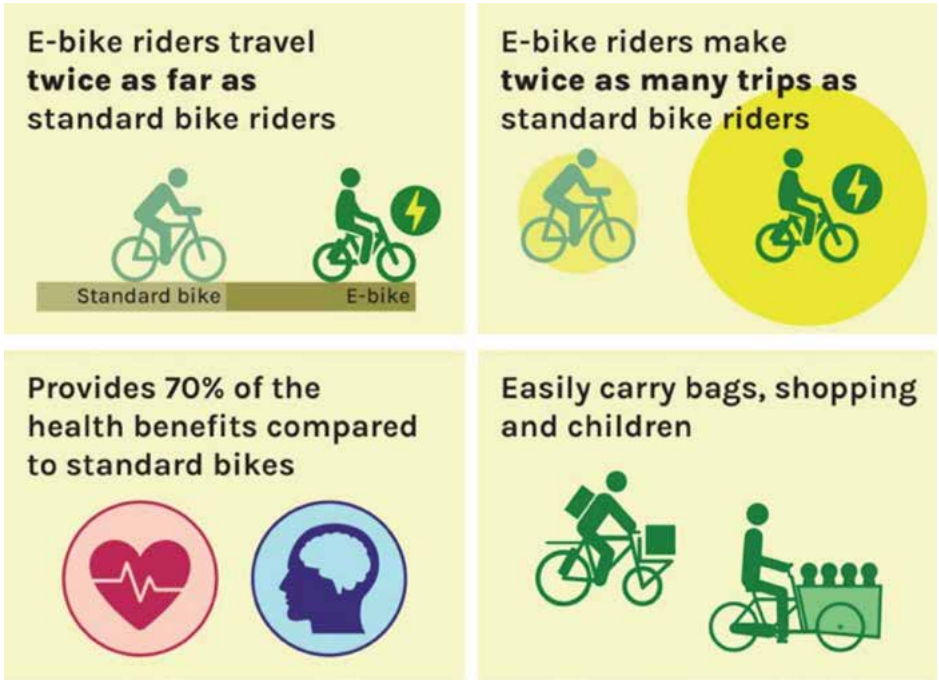
E-bikes use 40 times less energy per kilometre than the average car and only cost 15c to fully charge using a regular power point. On average, this means it costs $8 per year in electricity to charge an e-bike that does 80km per week. E-bikes also do all this using just a 6th of the road space of cars.

As Perth moves towards a low-emission, healthier, and more liveable future, e-bikes offer an important opportunity to help us make affordable and sustainable transport choices.

But one of the main barriers to the uptake of e-bikes/e-cargo bikes in Australia is the upfront purchase price. A key solution for the state government is to offer e-bike subsidies. Subsiding e-bikes is much cheaper than subsidising EVs, and a much greater proportion of the population could afford a subsidised e-bike than a subsidised EV.

Successful e-bike incentive programs in the US, Sweden, Germany, Austria, and the UK have been proven to increase rates of active travel and reduce rates of transport-related emissions.

Figure 3.6: Benefits of e-bikes



The most common model is a 25–30% subsidy, up to the value of $4000. This means that if an e-bike costs $4,000, the buyer receives a $1,000–$1250 subsidy at the time of purchase. While these incentives are common all over the world, they do not yet exist anywhere in Australia. Such incentives are critical to ensuring a greater number and diversity of women ride a bike.

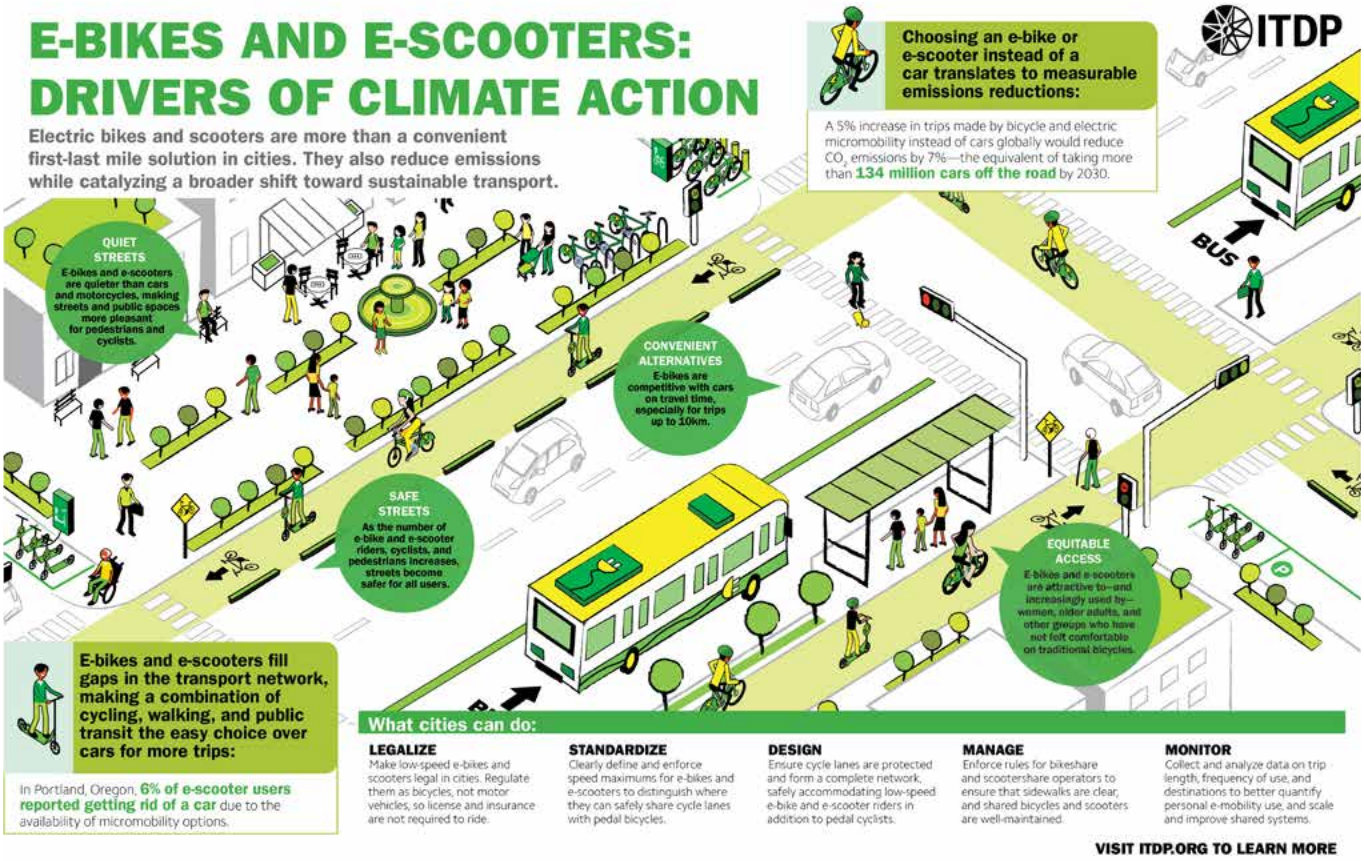
With bike riding surging during the pandemic, people's on-going hesitancy to use public transport, and the need to set ambitious climate targets, now is a perfect time to start subsidising e-bikes. There are calls to make e-bikes part of the National EV Strategy. Data modelled by the independent Institute for Sensible Transport shows that a government incentive to get more people riding e-bikes would return up to $3 for every $1 invested.

Encouraging private electric bike uptake through discounts at point of sale and government-funded try-before-you-buy programs would benefit society, reduce congestion, and provide equality in a decarbonising Perth (CC, 2022).

The many compelling reasons that apply to e-bikes also apply to e-rideables in general. Electric micro-transport has the potential to reshape urban sustainable transport. E-rideables have gained incredible momentum due to a range of benefits including being accessible, affordable, convenient, quiet, zero emission, safe & equitable.

Integrating this travel mode can provide the last kilometre linkage between home and public transport. As more people choose active local lifestyles, the local economy will improve from businesses emerging around new stations and neighbourhood hubs (ITDP, 2021).

Figure 3.7: Uptake of E-Bikes and scooters is beneficial for climate, road safety and accessibility



3.3.4 Behaviour change

Finally, on the back of improved pedestrian and cycling infrastructure and assistance for all households to access bikes, e-bikes, and e-mobility devices, we need investment in behaviour change.

There is good evidence that reducing car use in favour of increased walking and cycling can be achieved through personalised advice and support for individuals. A study in the UK showed that:

> 60% of participants in adult cycle training go on to increase their levels of cycling and…17–41% of people walk more for everyday journeys when they are motivated to walk for leisure with walking groups or with information about places to walk.

In WA there is a behaviour change program called Your Move run by the Department of Transport that 'supports individuals, schools, and workplaces to start swapping a few car trips each week for walking, riding a bike or catching public transport'. This is a worthwhile program, but it is not sufficiently funded nor complemented by the necessary walking and cycling infrastructure to make this as effective as it might be.

3.3.5 Conclusion

Perth households will enjoy substantial savings and healthier lifestyles on the path to net zero transport emissions. While cars will seem likely to continue for some journeys because of the distances involved greater active transport can be achieved. Electrifying cars and moving a far greater proportion of Perth's car-based transport to active transport and e-mobility will be central to a Climate Positive Perth.

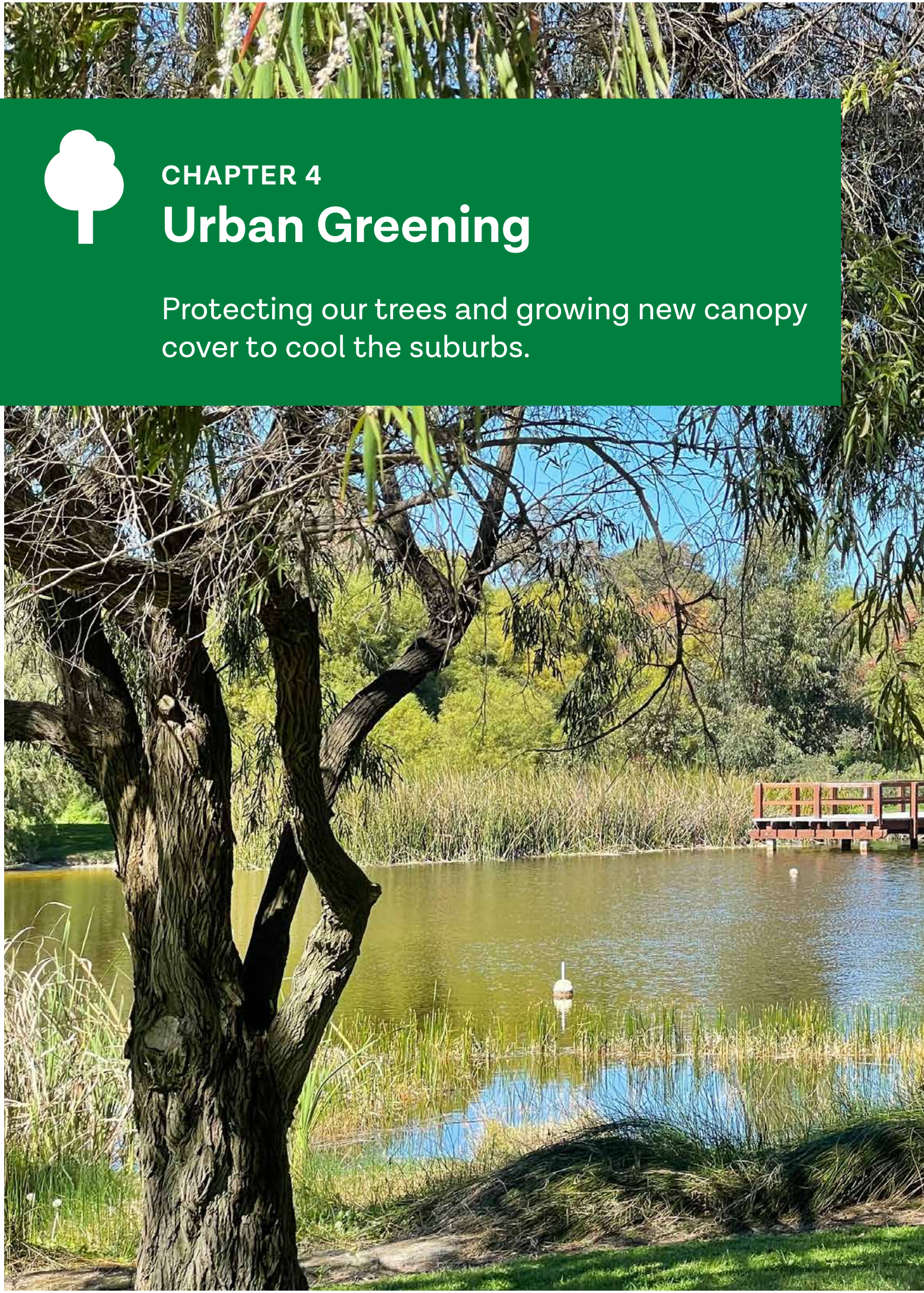
3.3.6 Household Scale Transport Recommendations

1. **Ensure electric car, e-bike, and e-mobility parking and charging is available for all apartment buildings**, including enabling apartment retrofits where required.
2. **Establish a program of e-bike subsidies** for households to increase their uptake. Research shows a return on investment of $2–$3 for every $1 spent on these incentives.

CHAPTER 4

Urban Greening

Protecting our trees and growing new canopy cover to cool the suburbs.



4.1 Urban Greening — Metropolitan Scale

"If you only do one thing to improve our city, plant trees."

Adrian Fini (2023)

4.1.1 Introduction

Perth is situated inside one of only 36 globally recognised biodiversity hotspots. Originally rich in chains of wetlands, banksia woodlands, and coastal heath, Perth remains home to an abundant biodiversity found nowhere else in the world. The region includes tuart and banksia forests and more than 1,700 different species of flowering plants.

The custodianship and cultivation ethic employed by Noongar people for over 60,000 years was largely ignored by colonial arrivals from 1829. So began the systematic clearing of land and wetland drainage to implant European-style agriculture and urban development.

Almost 200 years on, much of Perth's native bushland has been lost. As of 2023, Perth has the worst tree canopy cover of any capital city in Australia and its still declining in many parts of the Perth metropolitan area (Figure 4.1).

Figure 4.1: Statistics for Perth and Peel Local Governments in Western Australia

A low-carbon city will be hard to achieve without increasing Perth's tree canopy. A biodiverse and liveable low-carbon city will be impossible to achieve without it. This chapter examines what is currently happening for Perth in terms of urban greening, and the opportunities and benefits of increasing tree canopy cover.

Solutions to Perth's poor canopy cover fall into two categories — preserving Perth's remaining trees and green spaces, and accelerating new planting.

The evidence is in that Perth needs to better protect our remaining urban bushland and trees. This urgently requires a strong metro-wide tree and bushland protection plan along with better laws and regulations to protect mature trees on privately owned land.

It's also time for Perth to get planting. The largely treeless outer suburbs of Perth's expansive metro area especially need the right planning changes and incentives to see millions of new trees planted in backyards and on public land including streets and parks. In short, Perth needs regreening.

4.1.2 The problem — WA's current state of play and why change is needed

It's widely known that liveable cities need tree canopy cover of at least 20% and ideally 30%. This is the recommended minimum target for tree canopy cover to ensure effective cooling and health benefits. However, an Australia-wide report by Greener Spaces, Better Places in 2020 noted that "*69% of our urban places still have less green cover than in 2013*". This confirms the efforts made in recent years have not been enough to reverse the long-term trend of tree loss in Australian neighbourhoods.

Data on Perth's canopy cover changes is relatively limited and inconsistent. The Department of Planning, Lands and Heritage's Urban Tree Canopy dashboard reports little fluctuation in Perth's canopy cover between 2014 and 2020, remaining consistently low at 15–17%. The latest data from 2020 shows Perth's suburbs had 16% tree canopy coverage on average.

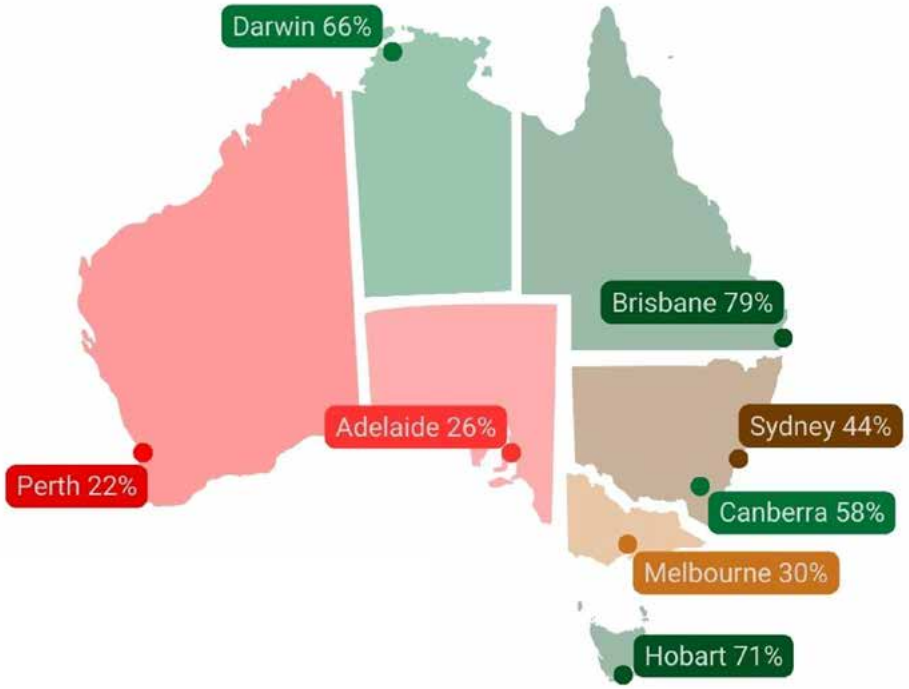
By contrast, a 2017 national benchmark report of Australia's urban canopy cover published by 2020 Vision showed a sharp decline in established vegetation across Perth and Peel. Of particular concern was the decline of larger trees on private land, which make up to 85% of Perth's tree canopy. While only a small percentage of this canopy cover is made up of trees more than 8 metres in height, these large trees deliver the most significant community benefits.

Perth's biggest local government, the City of Stirling highlighted Perth's loss of canopy cover in their Urban Forest Plan:

> Each year the City of Stirling loses four times more canopy than we grow. In the last six years the City has lost 1.2 million square metres of canopy. Two-thirds of this loss has occurred on residential land, primarily as a result of development. If these trends continue, many suburbs will lose between 50 and 85 per cent of tree canopy on residential land in the next 10 years.

Recent analysis by Nearmap (2021) looked at the percentages of the populations of Australia's capital cities living in 'leafy' suburbs (defined as suburbs with more than 20% tree cover). It revealed Perth's population has the lowest canopy cover in the country, with just 22% of us living in 'leafy' suburbs compared to 30% of Melbourne's population, 44% of Sydney, and 79% of Brisbane (Figure 4.2).

Figure 4.2: Urban tree coverage in Australia — percentage of suburbs with at least 20% canopy cover



Source: Nearmap (2021)

To make a bad situation worse, over the next 30 years a further 18,000 hectares of native vegetation is expected to be cleared across metropolitan Perth.

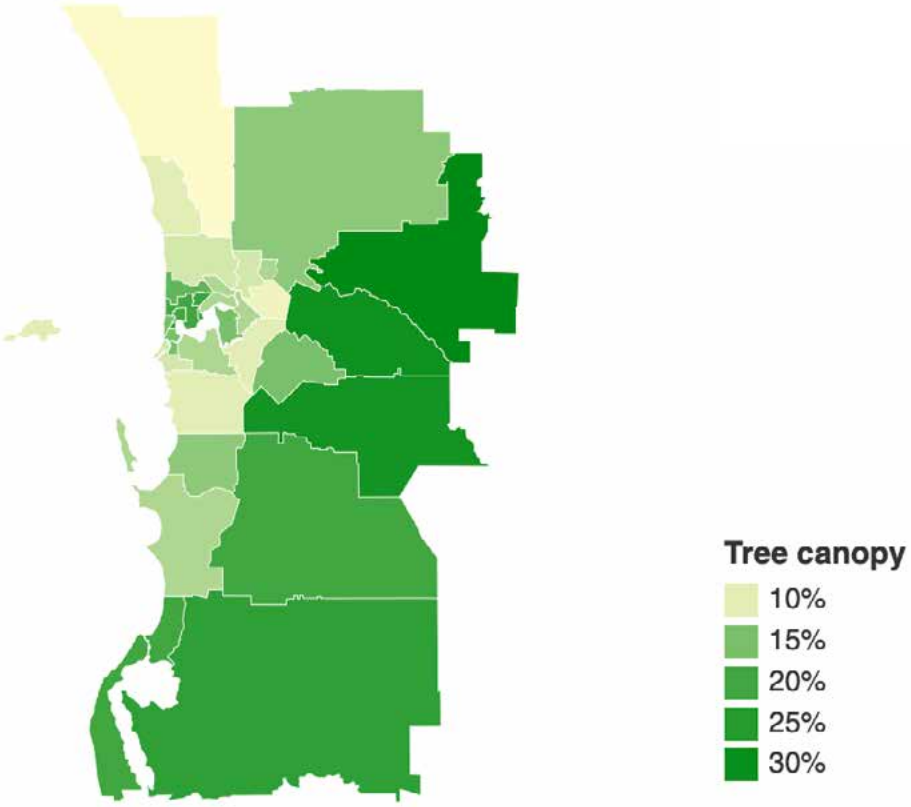
The Heat Island Effect

The loss of Perth's large trees and green space is creating the heat island effect which significantly impacts the liveability and health and wellbeing of our communities.

Trees cut down in urban areas are often replaced with hard surfaces that absorb and store heat during the day and then release it at night, resulting in higher local temperatures after dark. The results is city dwellers are being exposed to much higher temperatures for longer periods each day. As climate change takes effect, our cities are heating up at a much faster rate than rural areas.

Perth's low canopy coverage and the corresponding urban heat island effect are not equally distributed across the metropolitan area. Tree canopy cover is significantly lower in some newer suburbs. Those created as part of Perth's coastal-focused urban expansion often have very low levels of canopy, with places like Butler having only 1.8% canopy cover (see Figure 4.3).

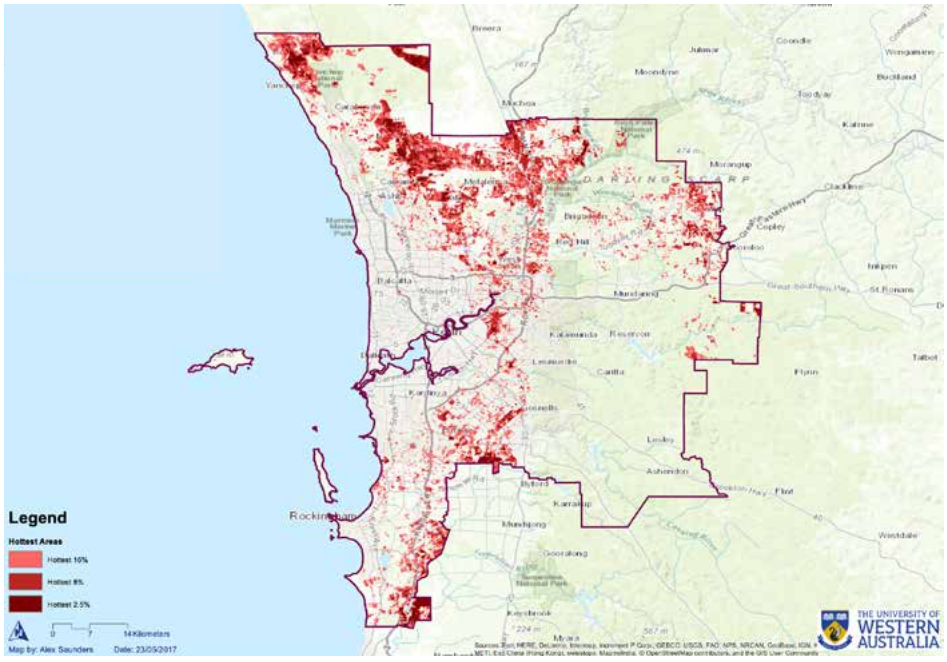
Figure 4.3: Percentage tree canopy coverage by Local Government Area



Source: CSIRO

This affects of this low canopy cover is reflected by heat records, as shown by a map of the urban heat island effect across the Perth (Figure 4.4).

Figure 4.4: Urban heat island effect across Perth metro



Source: Greener Spaces, Better Places (2017)

4.1.3 Benefits of Urban Greening

A study by AILA has shown that shade trees can drop surface temperatures by up to 19°C and cool air temperature by 5–7°C on a hot day. This means that on the same day of a typical summer heat wave, residents in 'leafier' suburbs might experience 36°C while those in areas without adequate canopy cover may suffer a much more extreme 43°C.

The benefits of urban greening and canopy cover are well documented, including in the WA State Infrastructure Strategy:

> Urban tree canopy is increasingly being recognised as valuable to infrastructure resilience as it can take pressure off an increasingly strained built environment. Greater tree coverage reduces air pollution, provides oxygen and reduces the urban heat island effect by an average of 6°C. The health benefits of trees in urban environments are also significant. The presence of trees promotes mental wellness and reduces stress, heart rate, blood pressure and the incidence of obesity, asthma and diabetes. More urban tree coverage brings an increase in the use of public spaces and improved social cohesion, physical activity and active transport usage. Urban forests also connect urban bushland and support biodiversity.

The environmental benefits of urban greening can also include cleaner air and water, increased resilience in flooding or extreme heat events and vital habitat for native flora and fauna. Importantly, nature-based solutions (including urban greening) have the potential to provide up to 30 percent of the necessary emissions reductions.

Urban greening's social benefits include creating more inviting spaces for people to socialise and be active, making it less expensive to cool homes, and improving health and well-being (including reducing the exposure of the very young, sick, and elderly to risks of heat-related illness or death due to the urban heat island effect). One study estimated that by doubling leafy areas we could prevent 28% of heat-related deaths.

There are also economic benefits to urban greening including increases to property values and the lifespans of local built infrastructure. On average, broad leaf street trees increase the property values of Perth homes by $17,000, adding between $3 and $13 for every dollar spent maintaining them. Overall, each tree contributes $117,000 of wellness benefit over its life span.

4.1.4 What needs to happen to realise a greener Climate Positive Perth

Increased trees, bushland, and canopy cover will be essential to a liveable and sustainable climate-positive Perth. To encourage this, Perth needs to better protect existing urban bushland and enhance public green spaces, including planting more trees in parks and streets. There is also a need to better protect trees on private land and incentivise new developments to include greater canopy cover. We will look at each of these solutions on public and private land in turn.

Protections on public land

Metro Perth crucially needs to first find ways of identifying and preserving our remaining urban bushland on public land. It is estimated that 75% of Perth's original 284,000 hectares of native bushland has been lost.

The State Government's Strategic Assessment of the Perth and Peel Regions (SAPPR), which commenced in 2011 and was originally known as the Green Growth Plan, was meant to map the high-quality native vegetation remaining in the Perth region and develop a clear plan for what could be lost and what should always be kept. The State Government spent $7 million on the SAPPR before it was officially abandoned in late 2022 with no robust replacement plan. As a result, much of metropolitan Perth's native bushland and biodiversity remains under threat from urban development which is often sporadic and ad-hoc.

Perth is still in need of an immediate and comprehensive program that will strategically identify and plan for remaining urban bushland rather than considering it on a parcel by parcel basis without broader context. A well-funded overall strategy is needed to protect what high-quality urban bushland remains from clearing. This includes giving statutory protection to Bush Forever sites and increasing funding for their adequate management.

Growing our public urban canopy cover

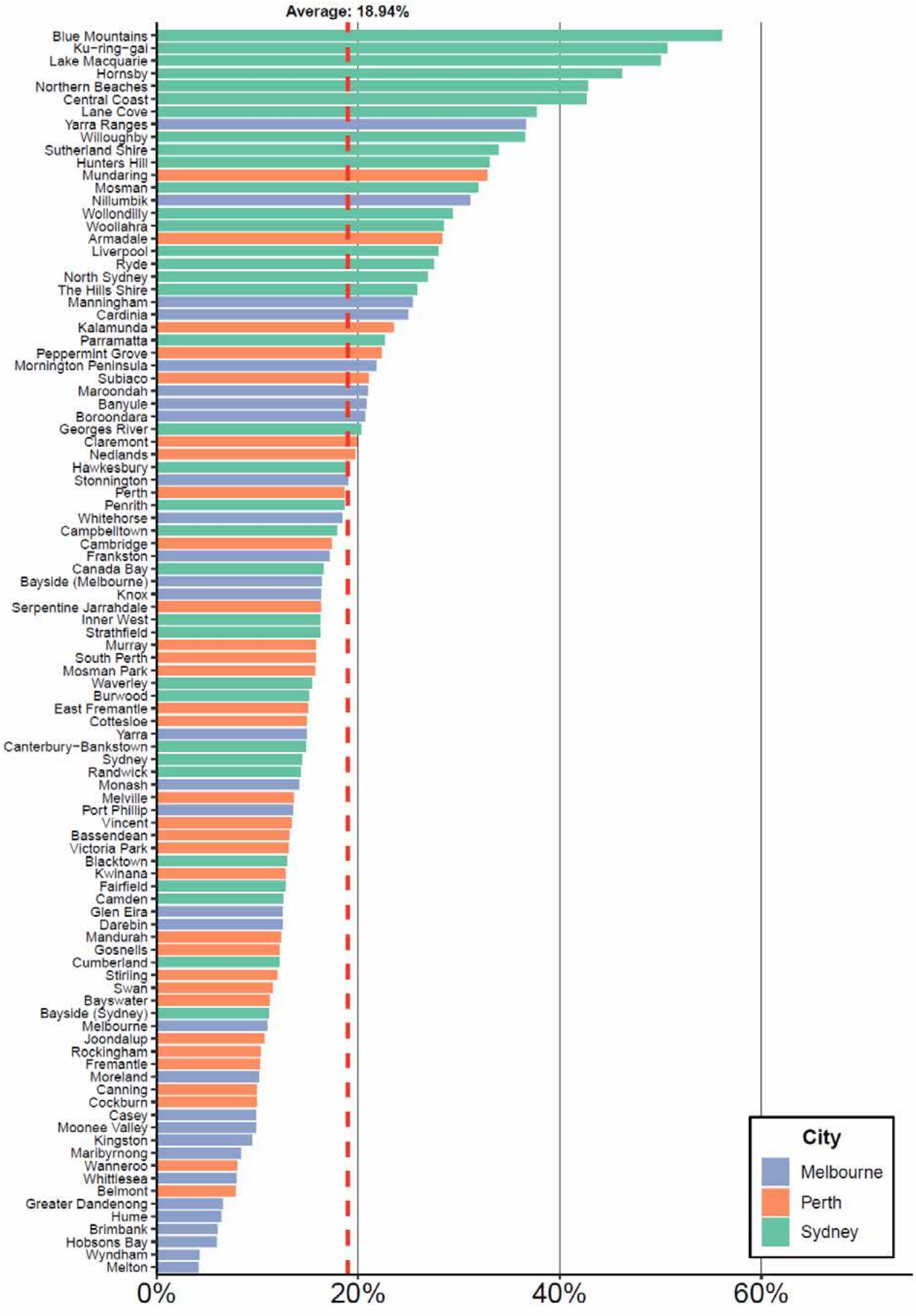
In addition to a plan to protect what mature trees we have, we also need a plan to grow our urban canopy cover. We need minimum targets for 30% canopy cover across all of Perth's suburbs to reduce the urban heat island effect and reap the benefits previously outlined in this chapter because research consistently shows that Perth is lagging behind (Figure 4.5).

So far there has only been limited investment in greening Perth, and the majority of this has been funded by local governments. A rare exception was in 2021 when the Western Australian Local Government Association and the WA Water Corporation jointly administered a one-off Urban Tree Canopy Grant Program to support local governments' urban forest projects.

On the back of this program's success, WALGA advocated for an expanded program of around $20 million that would enable approximately 60,000 trees to be planted. The WA State Infrastructure Strategy recommended that "*(f)unding and scope for this program should be extended to ensure more strategic and equitable outcomes, in continued partnership with local government*".

Unfortunately, the WA State Infrastructure Strategy's recommendations that the State Government fund the program and assign a lead agency were not supported by the State Government. Local governments are pursuing urban greening solutions on public land but there is now no state funding for urban greening.

Figure 4.5: Tree canopy cover (%), all LGAs in Study



Protecting trees on private land

Despite metro Perth's low-density urban form, fewer than 22% of Perth residents are living with beneficial urban canopy cover. While increased street trees, parks, and other forms of public green spaces can offer some relief, these spaces alone are not enough to mitigate the urban heat island effect and reduce energy demand within our homes and buildings.

Our households and private land have significant capacity for city-wide greening action, as residential land accounts for up to 70% of total land use in the Perth metro area and 85% of Perth's tree canopy is on private land. Our residential gardens currently accommodate almost half Perth's total tree canopy cover, however it's here Perth has seen some of the largest declines in urban tree canopy.

Without significant trees in the gardens of almost all Perth homes, 30% urban tree canopy cover is difficult to achieve. This is why there needs to be a particular focus on protecting existing large trees on private land across the Perth metro area.

Central to this is the need for effective state-wide regulation of the removal of large trees in our urban areas. The WA planning framework does not currently require development approval for the removal of large trees from private land. Trees that have taken decades to grow and deliver huge environmental, social, and economic benefits can disappear in hours without any regulation or regard to shared community consequences.

Recent analysis of tree protection mechanisms across Australia by the Conservation Council of South Australia assessed WA as having the nation's weakest protections for trees on private. Cities such as Sydney, Melbourne and Canberra have successful tree regulations in place which strike a better balance between urban consolidation and preserving precious green spaces and trees.

It is essential that Perth catches up with the rest of the nation by moving to practically and effectively regulate the removal of large trees (generally meaning trees taller than 8 metres). In the last year, several local governments have sought to amend their local planning schemes to protect large existing trees on private land. For example, the Cities of South Perth and Nedlands introduced requirements for a development approval to be obtained from the respective City for the removal of large canopy trees on private land in low density areas. Both scheme amendments had strong community support.

Similarly, the Town of Bassendean has said they will seek similar amendments once their new town planning scheme is gazetted. The City of Kalamunda has taken a different approach and introduced similar requirements through policy rather than their town planning scheme, and it will be interesting to see if these provisions can hold up to appeal when tested.

These changes are important and worthwhile but are likely to create a landscape of inconsistent tree retention legislation and policy across metro Perth. A better pathway for such regulation — and one that aligns with the State Government's Planning Reform agenda by providing consistent regulation across all local governments — is for the Minister for Planning to amend the Deemed Provisions of the Planning and Development (Local Planning Scheme) Regulations 2015 to add a provision to require development approval for the removal of large trees.

State-wide legislation such as the ACT's proposed Urban Forest Bill could provide a consistent approach to achieving more ambitious tree canopy targets that include residential land.

ACT Urban Forest Bill
New legislation is being introduced in the ACT government which will improve protections for trees on both public and private land, helping to grow and maintain the urban forest and reach a 30% canopy cover target by 2045. It comes after reviewing their 2005 Tree Protections Act, which was limited in scope and effectiveness. The new Bill includes regulation for all public trees, regardless of size, and more trees on private land including all med-large trees (>8m tall or with >8m canopy width or >1.4m trunk circumference).

The Bill also contains a Canopy Contribution Framework to ensure any trees which do obtain removal authorization will be replaced through new planting on site, or provide adequate funding for the planting and maintenance of trees nearby. While homeowners will see a set rate for their requirements, those for developers will vary depending on the size and location of the tree, and increase depending on the zoning and urban density level of the area to compensate for the greater community impact of tree removals.

Lastly the Bill establishes a bond system for trees that might be damaged in nearby development. This places a financial value on established trees for developers and incentivises more sustainable and careful development approaches.

New infill developments in existing suburbs often destroy mature trees. Medium density up-coding has seen a reduction in the sizes of residential blocks while the houses are getting proportionately much larger, leaving little to no space for gardens and deep planting zones that can accommodate trees.

These poor outcomes were recognised in the State Government's recent review of the Residential Design Codes (R-Codes). The current R Codes fail to ensure the provision of sufficient new trees on new builds and in many cases the R-Codes allow patios, verandas and paved parking to be included in meeting their 'open space' requirements.

The now indefinitely deferred Medium Density Codes would set improved specifications for deep planting zones and tree planting requirements which the State Government's Design WA modelling shows would have led to a huge 1700% improvement in terms of canopy cover. Tree canopy for medium density infill would increase from the extremely low base of 0.35% achieved by a business-as-usual approach to a greatly improved, but still too low, 6% canopy cover according to Design WA.

New state-wide requirements for minimum tree planting, and maintenance of those trees, for new developments are needed if metro Perth's canopy cover is to improve in the longer term.

Create a network of green corridors and ecological linkages

The final recommendation for creating a greener Climate Positive Perth is rebuilding a network of green corridors and ecological linkages between existing natural habitats and parks.

This metropolitan-scale greening plan will require strong collaboration between the State and local governments and would ideally be driven by a permanent and appropriately funded Urban Forest taskforce committee.

Successfully creating a network of green corridors and ecological linkages will also require new legislation to provide legal protection and recognition of ecological linkages in our planning system including by creating a new Greenways Zone in the Metropolitan Region Scheme.

The recommendation builds on the recommendations made by the Auditor General in their 2009 report *Rich and Rare: Conservation of Threatened Species*.

Members of the Climate Positive Perth First Nations roundtable suggested that a green retrofitting strategy to rebuild metro Perth's green corridors could be a fitting investment for WA's bicentenary in 2029.

4.1.5 Conclusion

The climate crisis and biodiversity loss are deeply interlinked. As the world accelerates toward implementing net zero plans, greening will be an essential element in creating a low-carbon, liveable city.

As we have seen, Perth is failing when it comes to urban greening and tree canopy and lacks a robust plan to turn this around. This is a significant barrier to realising a more liveable decarbonised Perth.

Thankfully, there is plenty that can be done. Perth needs a clear plan to protect its remaining urban bushland. It also needs state-wide laws to better protect mature trees on private property.

The State Government must then work with local governments to fund a hugely expanded urban canopy program for streets and parks.

Urban greening initiatives represent a great opportunity for collaboration and would have strong support across the political spectrum, making them arguably some the easiest changes needed to create a Climate Positive Perth.

Figure 4.6: How a typical Perth thoroughfare could be transformed

4.1.6 Metropolitan Scale Urban Greening Recommendations

1. **Set a 30% target by 2040 for Perth's tree canopy**. Invest in new street and park plantings to link greenways together and increase biodiversity in every suburb. Include a series of interim tree canopy targets for Perth and a transparent progress reporting framework. Provide incentives for private landowners to plant and care for suitable trees and native plants on their property.
2. **Protect trees on private land** by amending the Perth Planning and Development Act 2005 so that planning approval is required to significantly prune or cut down any mature tree on private land.
3. **Set a target to protect 90% of remaining urban bushland**. Give statutory protection to Bush Forever sites and increase funding for adequate management of these sites. Introduce an Acquisition Fund to purchase natural areas of high conservation value in urban areas.
4. **Rebuild a network of green corridors and ecological linkages between existing natural habitats and parks by 2029** with a city-scale green retrofitting strategy of rebuilding green corridors. This metropolitan-scale planting schedule should include formal recognition of ecological linkages in our planning system.

4.2 Urban Greening — Neighbourhood Scale

4.2.1 Introduction

The neighbourhood level is where we can make some of the most effective changes to create a greener, more liveable Climate Positive Perth. The key ways we can do this are by ensuring new suburbs have sufficient parks and green spaces, existing suburbs have continuous street trees, and we have the right mechanisms across both to keep mature trees. Urban greening is essential for integrating other parts of a liveable, connected, and decarbonised Climate Positive Perth, and making sure it happens.

The evidence is that people are much more likely to walk and ride short distances from their homes if they can do so along a shaded street. Cooling our homes is harder if the surrounding surfaces and air are extremely hot due to a lack of shade. Treed and cooler streets make a climate-positive neighbourhood easier to achieve and more liveable too.

Figure 4.7: Urban greening provides enormous benefits at a neighbourhood level

4.2.2 WA's current state of play and why change is needed

As we saw in the Metropolitan Scale Greening Chapter, the current recommended minimum target for tree canopy cover to be effective for cooling and health benefits is 30%. Very few Perth suburbs have reached this target — only 22% of suburbs have even 20% canopy cover. In most of Perth's suburbs, the already low canopy cover is in decline. There is some serious work to be done to turn this around and the neighbourhood level is where much of this can happen.

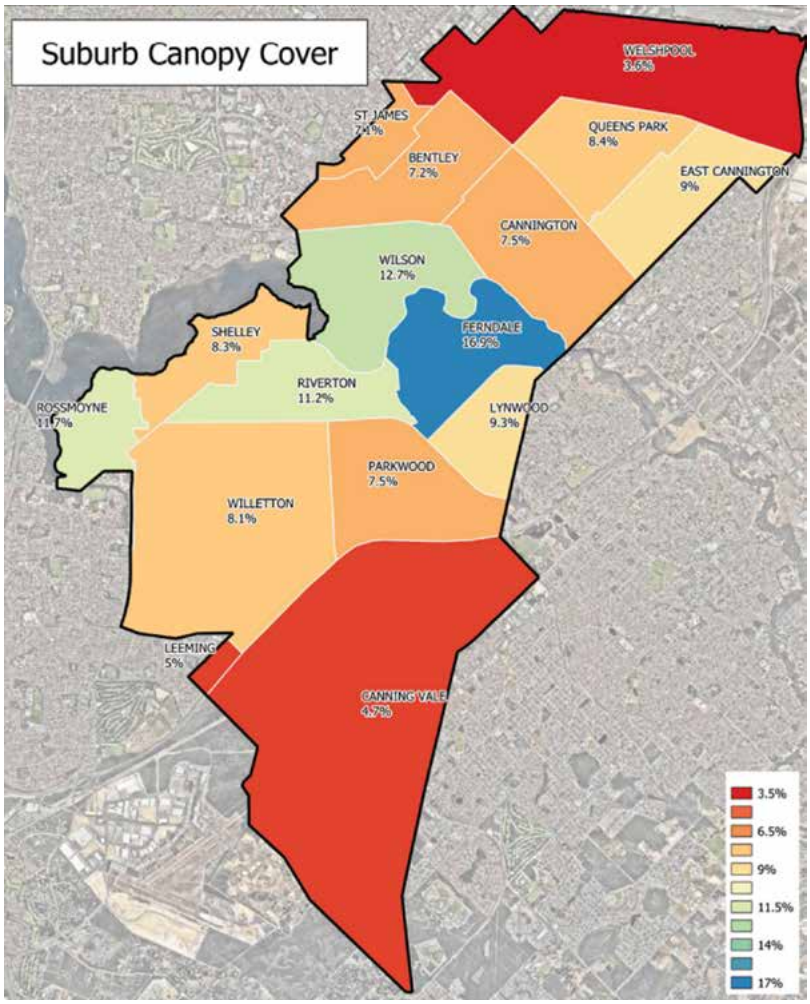
When we zoom in from broader Perth metropolitan area down to individual suburbs it becomes obvious that tree canopy is very unequally distributed. Lower socio-economic areas typically have far fewer trees than wealthier ones, and new suburbs are also less likely to have canopy cover than established ones.

Figure 4.8: Streets and neighbourhoods without adequate trees are exposed to hotter temperatures

Source: Lotte Henn (2022)

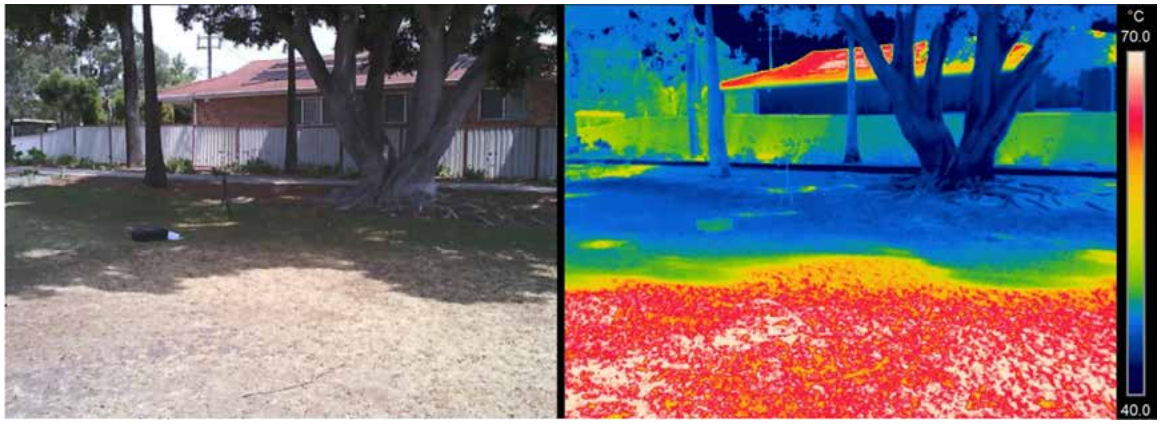
However, even some of Perth's well established areas have low and uneven levels of canopy cover as can be seen in the City of Canning's Urban Forest Strategy.

Figure 4.9: Canopy cover (%) in each suburb within the City of Canning



Increased canopy cover is essential for overcoming the urban heat effect in our suburbs. As we saw in the metro-scale urban greening chapter, shade trees can drop surface temperatures by up to 19°C and cool air temperatures by around 6°C on a hot day. Canopy cover can make a huge difference at the local level to our suburbs as seen in imagery by the Climate Council Figure 4.10).

Figure 4.10: Trees can reduce ground temperatures by up to 19°C and air temperatures by around 6°C



Source: Climate Council

4.2.2 What needs to happen for greening at the neighbourhood level?

As with metro-wide greening, greening our suburbs will require keeping existing trees and speeding up the planting of new ones. However, the drivers and levers needed to do this at the neighbourhood level are different to the metropolitan level.

More Verges and Street Trees

At a neighbourhood level, street trees and verges may provide the greatest opportunity to green our suburbs. As we have seen, exposed roads and pavements are major sources of heat absorption and retention in our suburbs. Lining these spaces with trees dramatically reduces urban heat islands while creating safer and more comfortable environments to move through without a car.

As suburban verges are co-managed by residents and local governments, strong communication and collaboration are required to increase tree canopies in these spaces. While many local governments across Perth offer incentives such as providing free verge trees to residents on request, uptake for these schemes is patchy and many people remain unaware or unmotivated to take part.

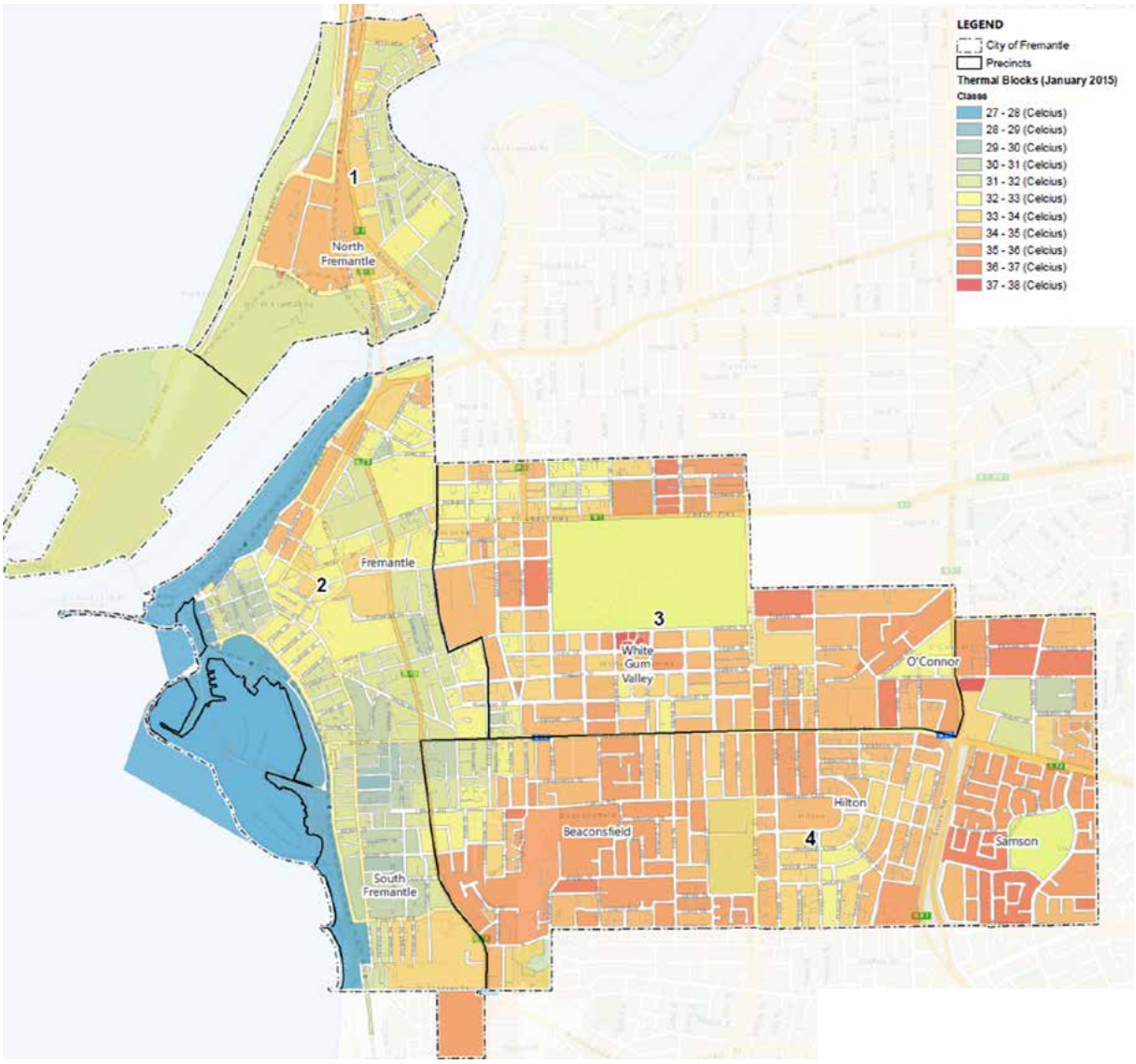
The City of Bayswater discovered that opt-out rather than opt-in processes for tree planting on verges resulted in a 63% increase of dead verge trees being replaced in the area from one year to the next. Instead of requiring people to be proactive in applying for and planting trees, our systems should be geared to require only those against trees on their verges to put in opposition requests.

Similarly, the City of Fremantle took a similar approach when retrofitting street trees in the suburb of Samson by requiring people to actively opt out of getting a new street tree on their verge. As a result, Samson had the highest number of tree plantings across the City of Fremantle. This approach was driven by mapping undertaken for the City's Urban Forest Plan which identified Samson had some of the lowest canopy coverage in Fremantle. This meant Samson was on average two degrees hotter than nearby suburbs due to the urban heat island effect (Figure 4.11).

These kinds of local government strategies for planting more street trees assume, as a basic requirement for urban greening, that there is room in our road reserves to plant street trees. Unfortunately, WA's planning system has in recent years allowed road reserves to become much smaller. This has limited and even excluded street trees, especially larger trees with a substantial canopy cover as can be seen in these street view photo from the City of Gosnells (Figure 4.12).

This issue was identified in the City of Gosnells Public Tree Strategy Greening Gosnells as an obstacle to improving canopy cover in their neighbourhoods. They add they will now "*(a)dvocate for the Western Australian Planning Commission (WAPC) to increase the minimum width of road reserves to facilitate increased tree planting*".

Figure 4.11: City of Fremantle Thermal Heat Map



Source: City of Fremantle (2015)

Figure 4.12: City of Gosnells — no room for a street tree

Source: Google Street View

This problem is not confined to Gosnells and any solutions will require State Government and WAPC leadership to ensure new suburbs are created with enough room for significant and even levels of tree canopy.

The Department of Planning, Lands and Heritage understands that: "*each street tree contributes to wellness with about $117,000 benefit over its lifespan, providing a high return on investment*". Research also shows that in Perth "*broad-leafed street trees generate an enhanced economic value to residential properties of around $17,000*".

With such clear benefits, it makes sense for the WAPC to ensure space for street trees is designed into our suburbs alongside footpaths and services.

Figure 4.13: The benefits of street trees are clear

Source: Cool Streets (accessed 2023)

Biodiverse Parks and Green Corridors

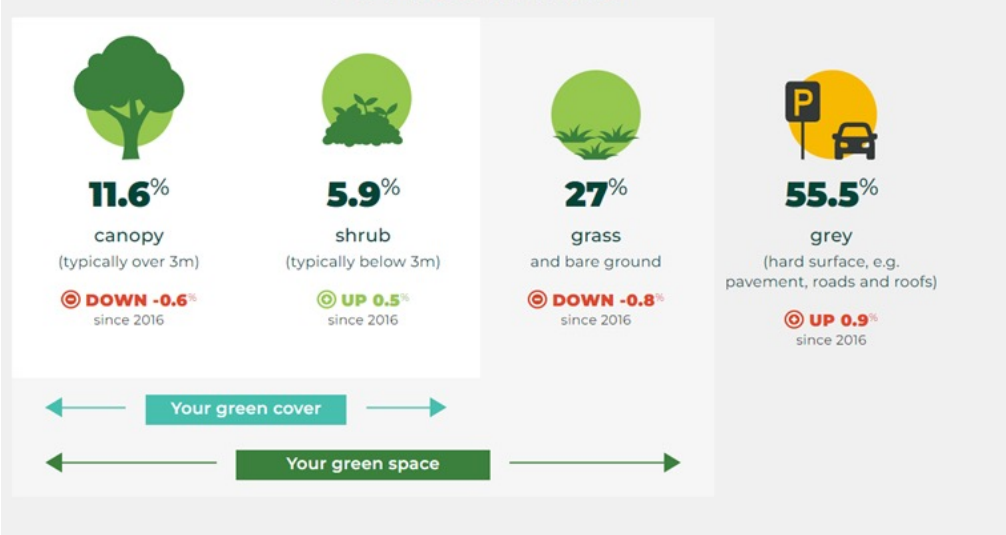
Perth's parks are another key opportunity for neighbourhood-level greening. Unfortunately, many of our parks lack the kind of diversity that supports healthy ecosystems or provides food for threatened species like Black Cockatoos.

Putting Biodiversity back into our Parks

Many of Perth's public green spaces (i.e. sporting grounds, dog parks and other typical suburban parks) provide highly turfed areas with only a narrow range of benefits while contributing little to biodiversity, urban cooling and public space equity. Maintaining them also requires large amounts of resources including water, fertiliser and mowing.

As this graphic describing Belmont's public land use shows us (Figure 4.14), many of Perth's suburbs are dominated by hard grey surfaces, while their green spaces are mostly just grass and don't provide biodiversity or canopy cover.

Figure 4.14: City of Belmont Ranking



Source: Green Spaces, Better Places

Eco-zoning is one way Perth's drying climate can be turned into an opportunity whereby local green spaces are adapted to provide biodiversity benefits. Eco-zoning converts existing turfed areas into native gardens.

Eco-zoned areas are easy to maintain and water-wise, with local native plants sitting on beds of mulch. These areas introduce biodiversity and aesthetic variety into parks and reserves while reducing water use. Newly eco-zoned areas are designed to become self-sufficient within one to two years of installation, after which irrigation stops. The Cities of South Perth, Bayswater, Fremantle and Vincent among others have all adopted this approach.

Figure 4.15: White Gum Valley Green Link

Source: Tim Oliver

Figure 4.16: Green Space Reisfield, Freiburg

Source: Brad Pettitt

Neighbourhood Green Links and Pocket Parks

Strategically located linear parks and greened pedestrian cut throughs can improve a neighbourhood's liveability and connect residents to local amenities and public transport via pleasant, shaded walks or cycle journeys. These newly green zones cool and connect our communities and offer a key way to decrease short car trips.

Parts of Perth that have insufficient public open space within walking distance of every home could benefit from building pocket parks for greening as well as creating important spaces for people to interact within local communities.

Density with Greening

Perth will need much more public open space (POS) as it moves towards higher densities. Perth has a current requirement of 10% POS in new developments.

For higher-density housing to be liveable and appealing it will need to be accompanied by a larger provision of high-quality green public open spaces. Looking at best practice globally, this means up to 30% of the total land area would ideally be devoted to public open space.

While the WA Property Industry has expressed concerns about further POS contributions by developers, there is broad agreement that well-located POS is essential and the Perth metropolitan area needs to embark on a robust process to ensure all neighbourhoods have sufficient POS.

It is also not just a question of the quantity of POS but also the quality and location of this open space. Diverse green spaces across a neighbourhood are important. Like different rooms in a house, some large open spaces like playing fields are desirable but also, and more often, smaller and more intimate spaces.

4.2.3 Conclusion

Our suburbs are where we spend most of our time, we connect with our neighbours and walk the streets with our kids. All good reasons to green them up and keep them cool. With the right macro-level planning of infrastructure and investments in street trees, verges and parks, we can make suburbs that are greener, cooler and more liveable. Suburbs that help us transition to a Climate Positive Perth.

To go back to where this section on urban greening started, the best thing we can do is to plant trees in parks and streets now. Trees in our neighbourhoods are a no-risk investment with many benefits, we just need them to take root.

Figure 4.17: If we start planting trees in parks and streets now, our neighbourhoods will be transformed in years to come.

4.2.4 Neighbourhood Scale Urban Greening Recommendations

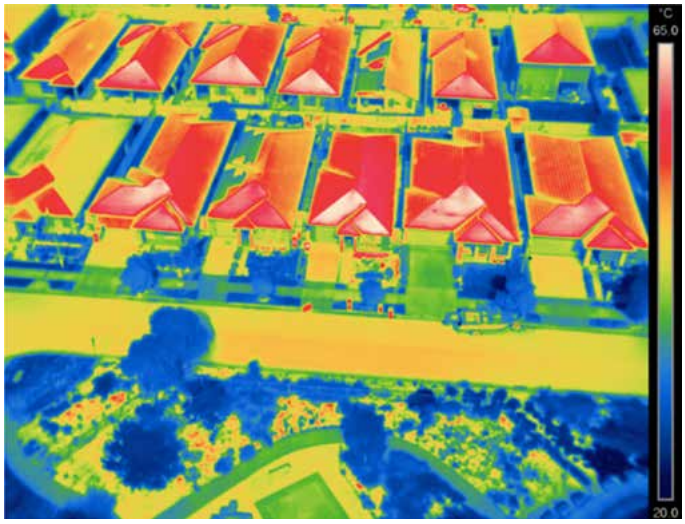
1. **Establish a lead state agency and taskforce that plans, measures and maintains Perth's Urban Forest**. As per the State Infrastructure Strategy, assign a lead state agency and taskforce to provide overarching coordination, resourcing, and funding mechanisms The taskforce will involve First Nations elders, botanists, ecologists and policymakers to establish strategies for bushland preservation and revegetation. It will support the development, implementation and co-funding of state and local council Urban Forest Plans.
2. **A street tree on every verge:** Mandate opt-out rather than opt-in processes for tree planting on verges. Plan for continuous street trees will cool Perth's suburbs and make them more liveable.
3. **Bigger verges in road reserves:** Mandate sufficient room in Perth's road reserves to place large street trees.
4. **Insert greenery into neighbourhoods:** Enable strategically located linear parks, pocket parks and greened pedestrian walkways to improve a neighbourhood's permeability.
5. **Review public open space requirements** with a view towards increasing the quality and quality of the land devoted to public open space, especially in higher-density neighbourhoods.
6. **Canopy cover and biodiversity:** Ensure more of Perth's green spaces are designed to provide canopy cover and biodiversity benefits including food for key species such as black cockatoos.

4.3 Urban Greening — Household Scale

4.3.1 Introduction

We know that trees, and public green spaces play a significant role in cooling our neighbourhoods. The thermal image below shows rows of exposed suburban roofs that are a huge 45°C hotter than the trees below.

Figure 4.18: The summer 2019/20 temperatures in Jordan Springs, near Penrith, an area suffering from the urban heat island effect



Source: Dr Sebastian Pfautsch

Trees can directly shade and shelter homes, resulting in decreased energy use for air conditioning in our hot Perth climate. As heatwaves become more intense and frequent, it's sobering to think that the loss of urban trees will result in greater urban heat island effects and more heatwave-related illnesses, hospitalisations and deaths.

Poor greening around our homes results in excessive energy bills and a higher risk of experiencing physical and mental health challenges. Studies show that each tree planted in a community is associated with significant reductions in non-accidental and cardiovascular mortality for people living nearby. The yearly economic benefits of planting trees dramatically exceed the cost of maintaining them by a factor of more than 1000.

To create a Climate Positive Perth and a thriving, equitable and resilient city, we must make space for the cooling, filtering 'green' infrastructure at a household level too.

WA has some of the largest homes in the world at the expense of private green space, so providing and promoting well-designed smaller footprint homes with trees and better garden spaces will be important.

Figure 4.19: Current open space regulations do not always require trees or permeable 'soft-scape' gardens

Current
- No view of sky
- No place for a tree
- Hard surfaces
- No opportunity for solar access
- No outlook

Desired
- Open to sky
- Space for a tree
- Mix of surfaces
- Northern solar access
- Outlook to gardens

Source: Dr Sebastian Pfautsch

Put simply we need to mandate deep planting zones that will enable large trees around houses in Perth and require that they be maintained. Every house should ideally have space for at least one mature, large tree.

4.3.2 Greening household verges

Shifting to a Climate Positive Perth is a fantastic opportunity to encourage verges that are planted out with native flora instead of just grass or hard surfaces. This lower vegetation strata can also be an important part of the urban forest.

Biodiversity, local plants, green cover, and reduced water usage are all good reasons to consider converting verges over to native gardens. Native verge gardens can showcase and normalise the use of local native plants in landscaping, as well as provide additional habitat and foraging space for native fauna.

While individual front verge gardens are small patches, collectively they can add up to larger areas - particularly when linked with vegetated corridors in public green spaces. Research in other cities has found that verge gardening is 'contagious' along streets — as verge gardens appear, more residents are inclined to also take up the practice.

4.3.3 Household Scale Urban Greening Recommendations

1. **Mandate expanded deep planting zones and the planting and ongoing maintenance of large trees** on all residential lots.
2. **Encourage and fund native verge gardens** in collaboration with local governments and households.

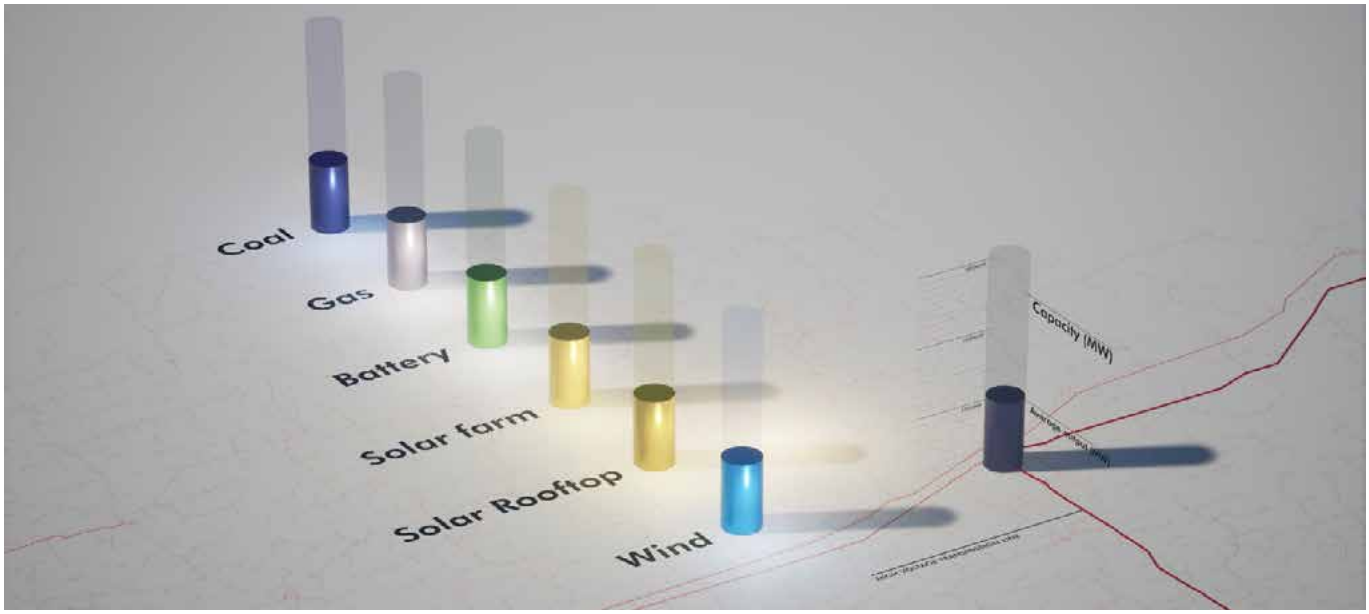
CHAPTER 5

Energy

A grid with 95% renewable energy through investment in transmission, wind generation and storage.

5.1 Energy — Metropolitan Scale

Figure 5.1: The key below will be used throughout this chapter to show how Perth's energy mix could be transformed



5.1.1 Introduction

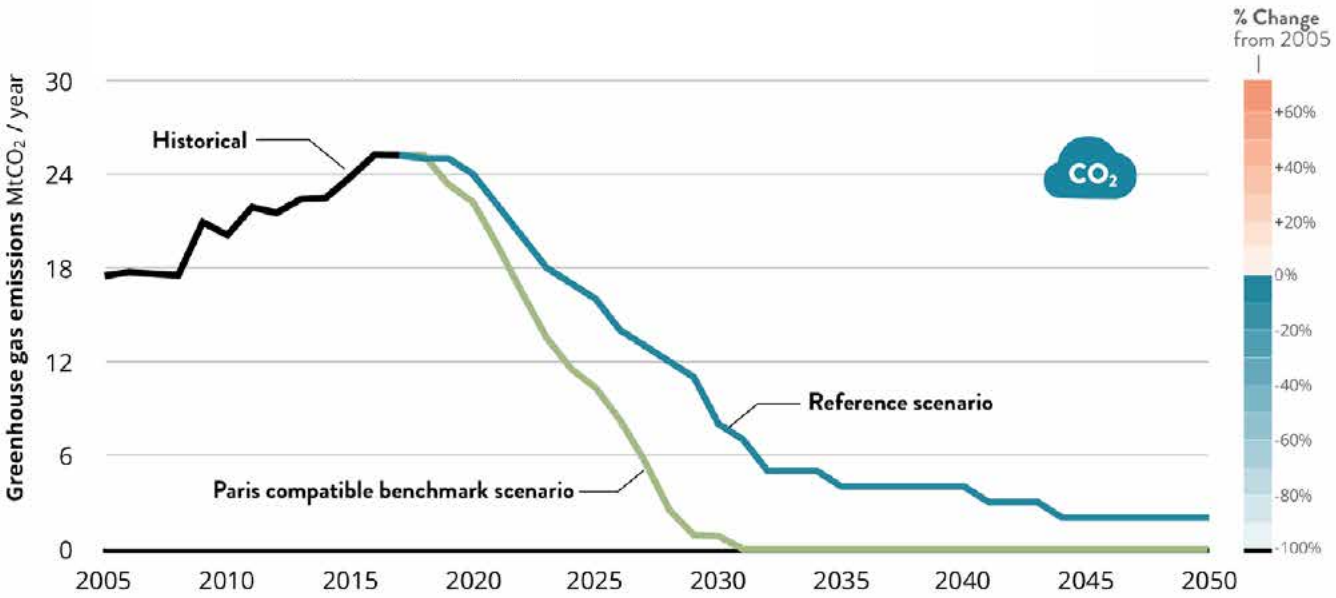
Renewable energy is the foundation for a climate-positive, zero-emissions city. If you get energy and electricity generation right then decarbonising other sectors of the economy like building, transport, or industry, can be done much more easily and efficiently. Making Perth's energy low carbon means Western Australia's main electricity grid, the South West Interconnected System (SWIS), needs to change to using close to 100% renewable energy as soon as possible.

The SWIS covers a huge area from Kalbarri down through Perth, down to Albany, and out to Kalgoorlie (as shown in Figure 5.2). It is one of the largest isolated grids in the world, which means there are opportunities and challenges when considering its future capacity and the changes needed. Decarbonising the SWIS with renewable energy and storage, while simultaneously rapidly transitioning out of gas and coal-fired electricity generation, will be the key to making a Climate Positive Perth happen.

Electricity generation is the WA's second largest source of Greenhouse Gas (GHG) emissions (after industry) and contributes 27% of total carbon emissions each year (25.05Mt CO_2-e). WA is currently not on track to meet agreed international targets when national energy accounts are considered. We are well off a Paris Agreement-compatible scenario for the electricity sector (as shown in Figure 5.3) but transforming to a renewable energy-led grid this decade is possible as the chapter will explore.

Figure 5.2: Current energy mix of WA's main electricity grid, the South West Interconnect System

Figure 5.3: Electricity Emissions in Western Australia under a Paris Agreement compatible scenario

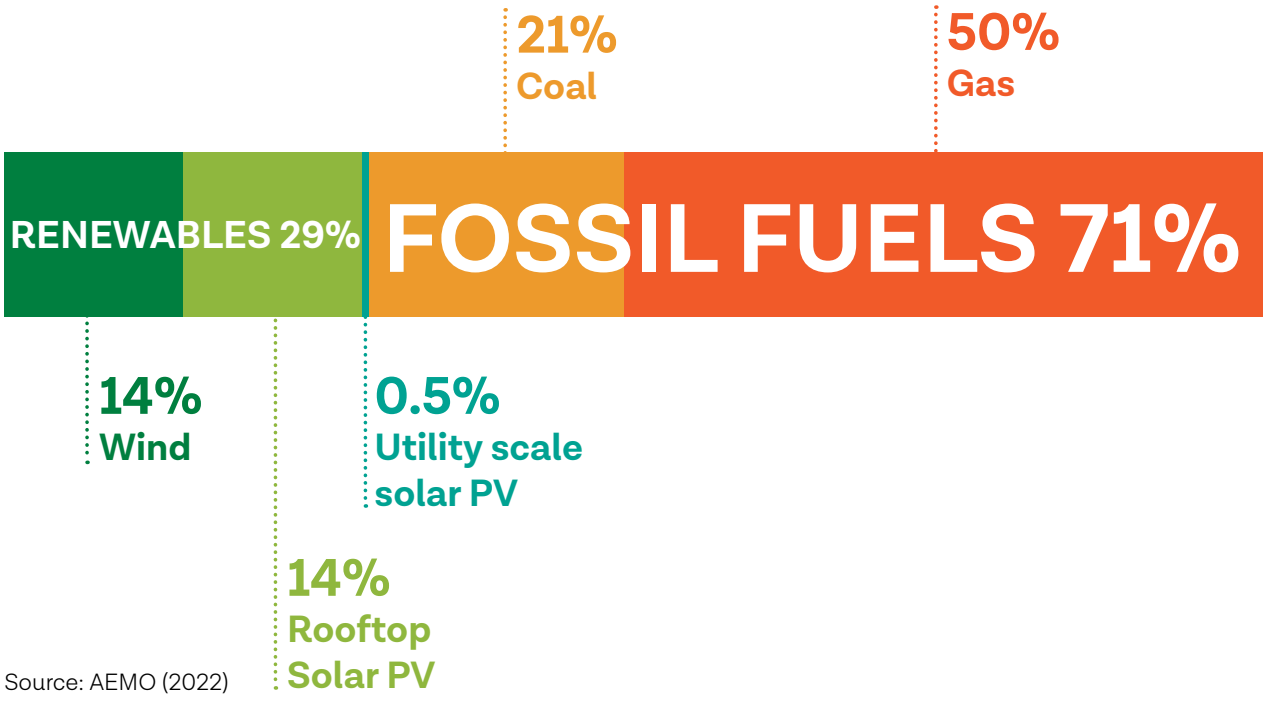


Source: Climate Analytics Australia (2019)

5.1.2 WA's energy supply context

Renewables make up around 29% of the electricity generation delivered on the SWIS. Wind (14%) and rooftop solar photovoltaic panels (solar PV) (14%) generate most of this with a small amount coming from larger scale solar PV (0.5%). The remaining 71% of electricity on the SWIS comes from fossil fuel generated sources: gas (50%) and coal (21%).

Figure 5.4: Electricity sources in the SWIS



Source: AEMO (2022)

The SWIS has a power capacity of 5,700 megawatts (MW) and an annual consumption of 25 million megawatts per hour (MWh). This electricity is generated from the following fuel types.

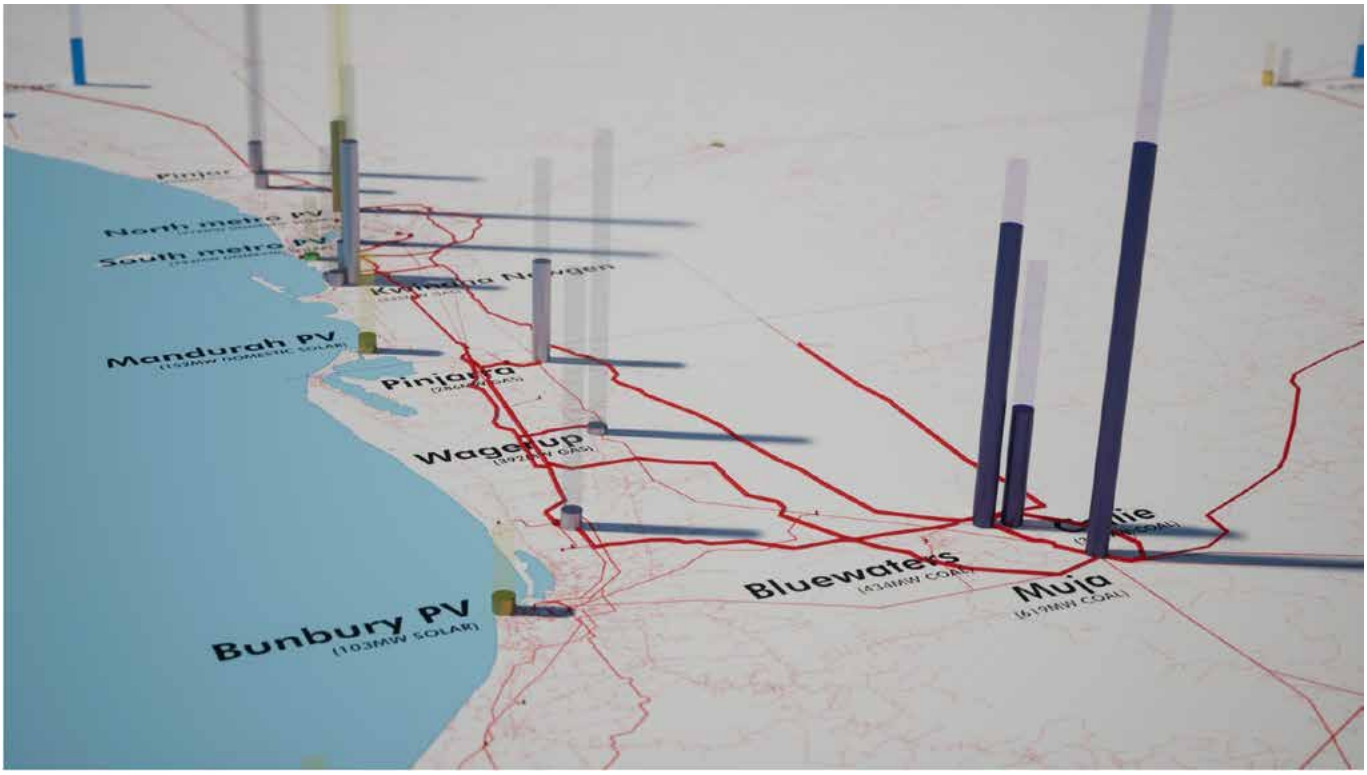
Figure 5.5: Electricity generation in the SWIS by technology

FUEL TYPE	MAXIMUM CAPACITY (MW)	FUEL TYPE	MAXIMUM CAPACITY (MW)
Distributed PV*	2,042.0	**Solar**	150.8
Gas	1,647.1	**Distillate**	132.2
Coal	1,371.1	**Electric storage**	100.0
Dual (Gas / distillate)	1,326.0	**Waste-to-energy**	65.0
Wind	1,1010.8	**Landfill gas**	21.6

*Mostly residential rooftop solar
Source: AEMO (2022)

Figure 5.6 visualises the geographical locations and relative amounts of the different electricity generation types in the SWIS closest to Perth. As you can see, coal and gas dominate WA's energy landscape.

Figure 5.6: Current energy mix close to Perth in the South West Interconnected System



In 2019, the State Government set up The Energy Transformation Taskforce to oversee planning of the transition to a better energy supply system and in 2020 the taskforce prepared a Whole of System Plan (WOSP).

Ultimately the WOSP was overshadowed as the State Government committed to closing the remaining 932MW of state-owned coal power utilities that dominate generation on the SWIS. The future of the privately owned Bluewater coal-fired power station is uncertain, but this could remove a further 434MW of generation out of the SWIS. Taking each unit's generating capacity into account (as shown in Figure 5.7), this is closer to the removal of 400MW of state-owned generation, and around 600MW in total if Bluewaters is included.

Figure 5.7: Current generation across state and privately-owned coal-fired power stations in WA

	NAMEPLATE (MW)	GENERATED — 12 MONTH (gWh)	INTERVALS GENERATING	AVERAGE CF
Muja 6	193	772	73%	46%
Muja 7	211	778	69%	42%
Muja 8	211	814	65%	44%
Collie	317	984	53%	36%
Blue 1	217	931	53%	36%
Blue 2	217	1100	53%	58%
Total	1366	5379	60%	45%

Data including Bluewaters and excluding Muja 5
Average generating capacity (MW) = 616

The planned coal power plant closures highlight the need for substantial investment in new renewable energy as well as an infrastructure network that can handle different sizes and kinds of energy storage, better transmission, and a smart grid.

Distributed Energy Resources

The term 'distributed energy resources' (DER) describes small-scale energy generating assets like solar panels, batteries, wind power units and car batteries which can flow energy back into the grid. If WA is going to get new renewables into the system as fast as possible, we're going to have to make much better use of the available capacity in Perth's distributed energy resources.

Community and commercial scale distributed renewables (with the right energy storage and control settings) have a huge role to play — not just in terms of carbon and cost reduction, but also toward improving the reliability of the electricity grid and social equity.

As part of a concerted program of development, DER can achieve similar purchasing efficiencies as large-scale renewable energy developments. There are also opportunities for local industry development, jobs, and technology commercialisation under a DER-focused model.

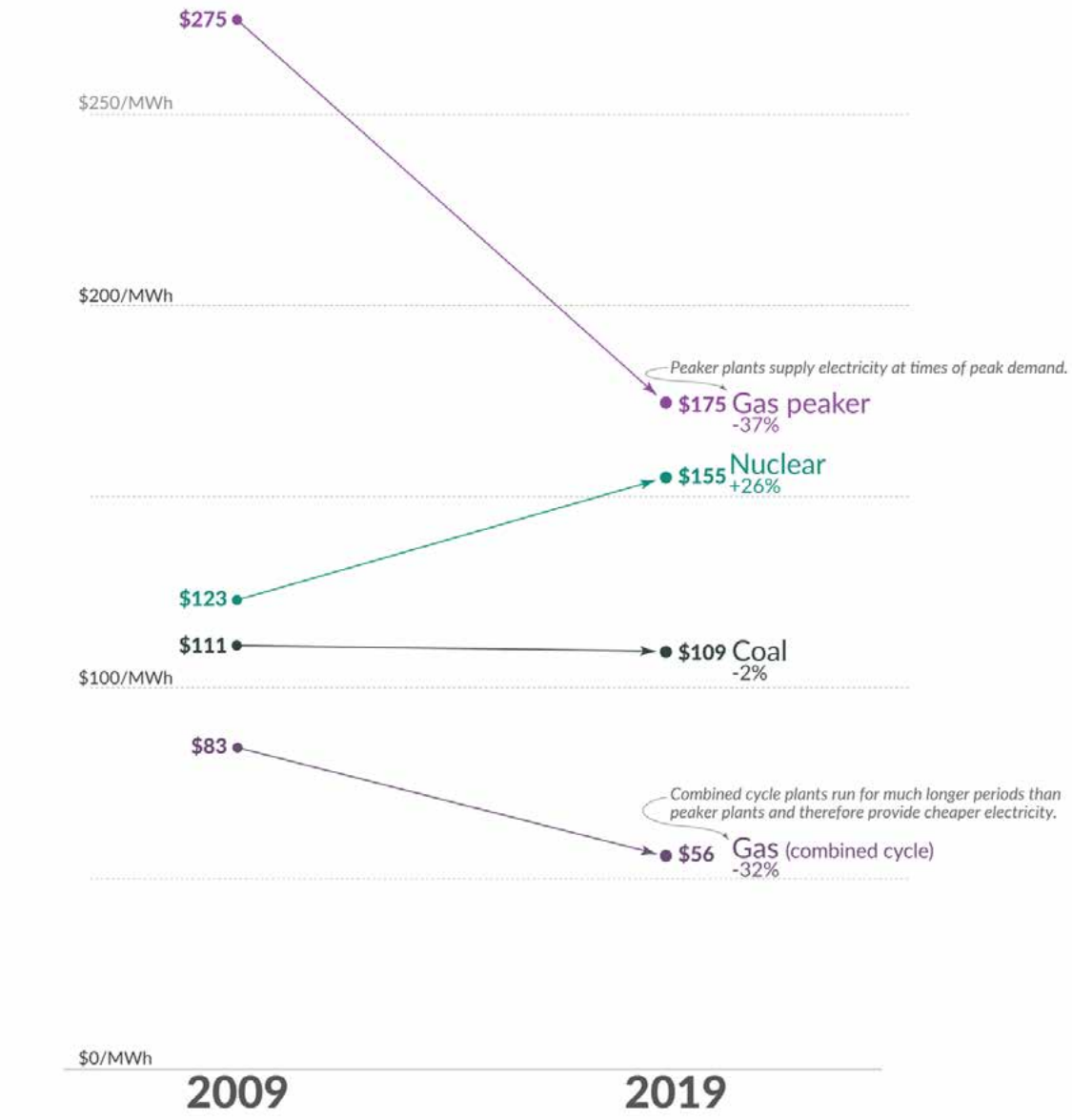
Importantly, investment in DER can also lessen the need for transmission system expansion, which is expensive and isn't always desirable or practical in locations of environmental or cultural significance.

Greater use of DER is an important means of optimising investment in the grid. Encouraging more distributed solar, batteries and smart metering will be a key part of clean energy transition.

The Falling Cost of Renewable Energy Generation

Until recently, it was cheaper to produce electricity from fossil fuels than renewables. This has changed dramatically in the last 10 years as shown in Figure 5.8. As renewable energy projects continue to scale up, the cost will continue to fall.

Figure 5.8: Changes in electricity prices, 2009–2019



Source: Our World in Data (2020)

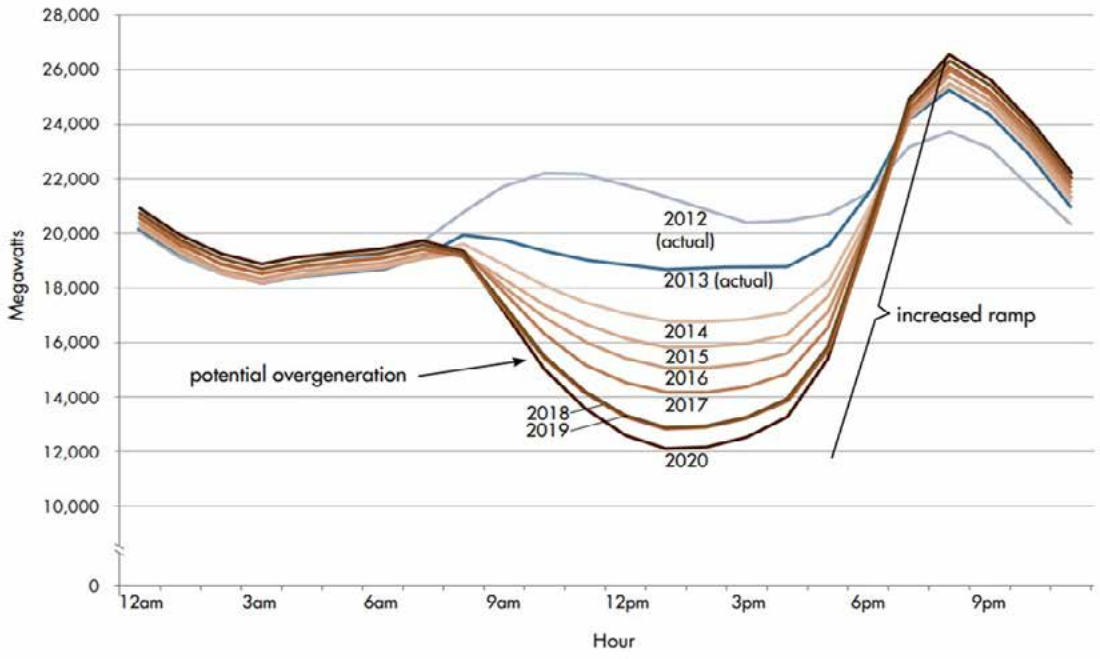
Rooftop Solar and the 'Duck Curve'

Rooftop solar on the SWIS is growing at a rate of about 1MW per day or 350MW per year. Currently, 36% of customers (441,000 homes) have grid-connected rooftop solar systems connected to the SWIS, with a total installed capacity of more than 2042MW. Rooftop solar is the single largest generator in the grid and represents more capacity than the six largest fossil fuel generators combined.

The rapid growth in rooftop solar led the State Government to require, from February 2022, newly installed solar systems to have the capability to slow output to maintain grid stability and tackle the so-called 'Duck Curve'.

But what exactly is this Duck Curve?
As rooftop solar generation increases, so does the saturation of energy in the middle of the day. The daytime slowing of operational demand from power stations — the Duck Curve — means that rooftop solar is crowding out fossil fuel power stations at the sunniest time of the day — especially in spring when appliances like air conditioners aren't used as much. The most recent minimum operational demand record of 626MW was observed 16 October 2022. Without any intervention, AEMO estimates operational demand will be as low as 11MW by 2027. Traditional fossil fuel generators of coal and combined-cycle gas have technical limitations which mean they are unable to ramp up from this low midday energy need to meet higher evening demand when the generation of solar power naturally slows.

Figure 5.9: Rooftop solar generation 'Duck Curve'



Source: Synergy (2021)

Large-scale battery storage

The Duck Curve phenomenon and our renewable energy transition in general, needs major investment in storage to soak up some of the generation from solar PV during the day and to buffer the evening demand peaks. The current lack of grid storage and network capacity is also causing large-scale solar- and wind-generated surplus supply to be wasted to balance the system.

Until recently, WA lagged behind the rest of the country with only one 100MW/200MWh battery in Kwinana connected to the SWIS. The 2023/24 State Budget saw a major shift with the state government announcing a 500MW/2000MWh battery in Collie and a 200MW/800MWh expansion to the Kwinana battery.

This $2.3 billion investment is an important step in the right direction and will take large-scale battery storage to 3000Mwh. At the Annual Report Estimates Hearings for Synergy in 2023, their CEO said they were planning for 4400MWh in total for storage. This investment is important, but we need more — the reasons why are below.

Large Scale Renewables Development

Large-scale renewables — especially wind energy — saw strong growth from 2019 to 2021, but investment has since slowed to a trickle. The 2023/24 State Budget showed Synergy's King Rocks Wind Farm (with 150MW of capacity) as the only confirmed State-owned project development.

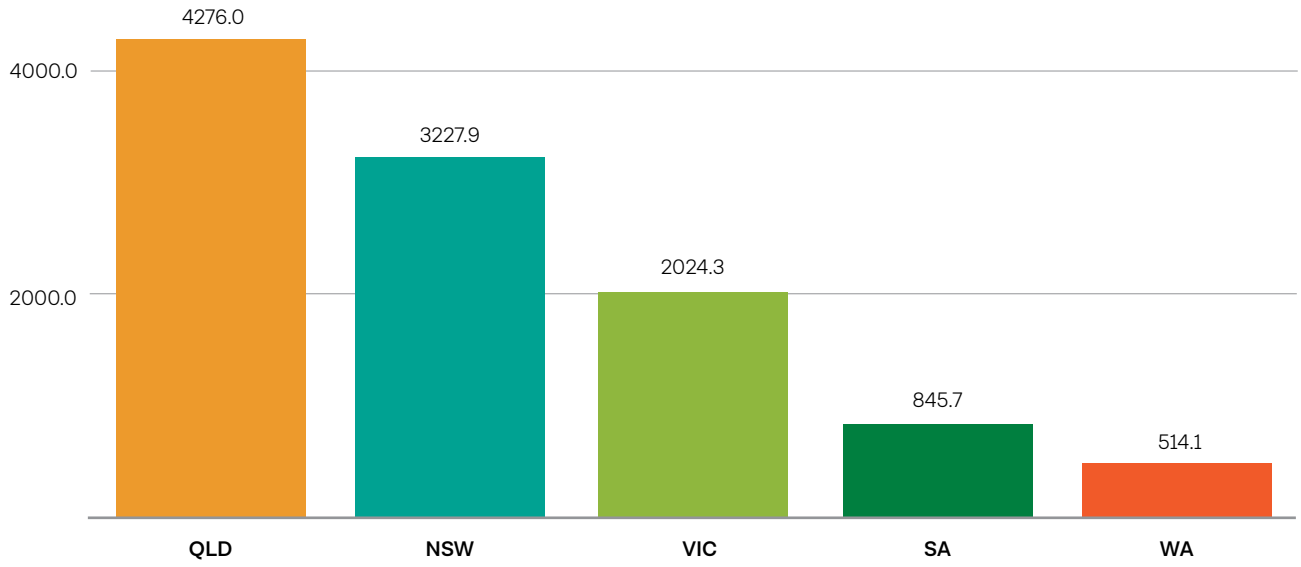
Synergy has committed to adding 410 MW of wind generation and the Water Corporation is intending to build 400MW of wind generation for desalination, bringing total planned wind generation to 810MW.

A recent review by the Clean Energy Regulator (CER) shows WA's pipeline of new large-scale renewable energy projects is barely running at a trickle. Only 3% of nationally 'committed' projects will be connected to the WA grid and that number falls to less than 1% if only the more 'probable' projects are included. Aside from King Rocks Wind Farm, none of these are wind-generated projects.

This 2023 graph published by the Clean Energy Council and another by the CER shows just how far WA is falling behind the other states in terms of renewables project developments (Figure 5.10).

The result is that based on existing commitments, WA's renewable energy share is estimated to reach just 56% by 2030 — the lowest of any Australian state (as shown by Figure 5.11).

Figure 5.10: Renewable energy projects in WA compares to other states



Quantities are in megawatts
Source: Clean Energy Council (2023)

Figure 5.11: Current renewable energy commitments

JURISDICTION	RENEWABLE TARGET / ESTIMATED SHARE / ACHIEVEMENT
National	Target of 82% renewable generation by 2030.
NSW	Estimated 68% renewable generation by 2030 based on existing commitments.
Victoria	Target of 65% renewable generation by 2030 and 95% by 2035.
QLD	Target of 70% renewable generation by 2032.
WA	Estimated 56% renewable generation by 2030 based on existing commitments.
SA	Target of 100% renewable generation by 2030.
Tasmania	Target of 200% renewable generation by 2040. Was the first Australian jurisdiction to achieve 100% renewable generation.
ACT	Achieved 100% renewable generation in 2020.
NT	Target of 50% renewable consumption by 2030.

Source: Planning Institute of Australia, *Achieving Net Zero Emissions* (2023), citing ClimateWorks Centre (2023)

The State Government's March 2023 Reserve Capacity Mechanism Review surprisingly predicts there being no newly built renewable energy capacity between now and 2029, with some solar added from 2030 onwards (Figure 5.12).

Figure 5.12: Generic New-build Capacity (MW, Cumulative)

YEAR	GAS	WIND	SOLAR	BATTERY
2025	200	0	0	200
2026	350	0	0	300
2027	350	0	0	400
2028	350	0	0	500
2029	350	0	0	600
2030	350	0	1,010	700

Source: Energy Policy WA (2023)

The bottom line is that without significant development of new renewable energy projects in the next few years it is hard to see how the decarbonisation of the SWIS can be realised.

The stakes are very high if we don't get it right. In August 2023, AEMO predicted that within three years the SWIS will have a large shortfall in generation of 945MW, increasing to 4000MW by 2032–33. This is more than ten times the prediction in AEMO's 2022 outlook.

Transmission networks: the lifeblood of energy supply

The WA Government's Energy Policy SWIS Demand Assessment 2023 to 2042 told us that:

> *Investment in the transmission network is essential to enable the supply of low emissions electricity to meet demand from all SWIS customers. It is integral to achieving a Government-wide emission reduction of 80 per cent by 2030, and to help the whole economy move towards the net zero emissions by 2050 target.*

Areas north of Perth are the best places for future windfarm development as the winds there are stronger and more consistent. However, the transmission network north of Perth just hasn't got enough capacity to take on the potential for new renewables, which in turn is deterring private renewable energy developers. Windfarms in that area already have their capacity to supply cut short because transmission capacity for growth is constrained due to technical limitations. Without more investment into these lines and networks, any extra energy supply won't be able to reach consumers.

This has led to the concern that the WA Government intends to enable most new wind investment solely where transmission capacity already exists like around Collie. There's a catch though — wind generating prospects are generally not as good in these southern locations as those north of Perth.

A wide geographical dispersion of wind generation assets will be important for a stable grid. This will mean developing a range of new and expanded wind generating assets and upgrading

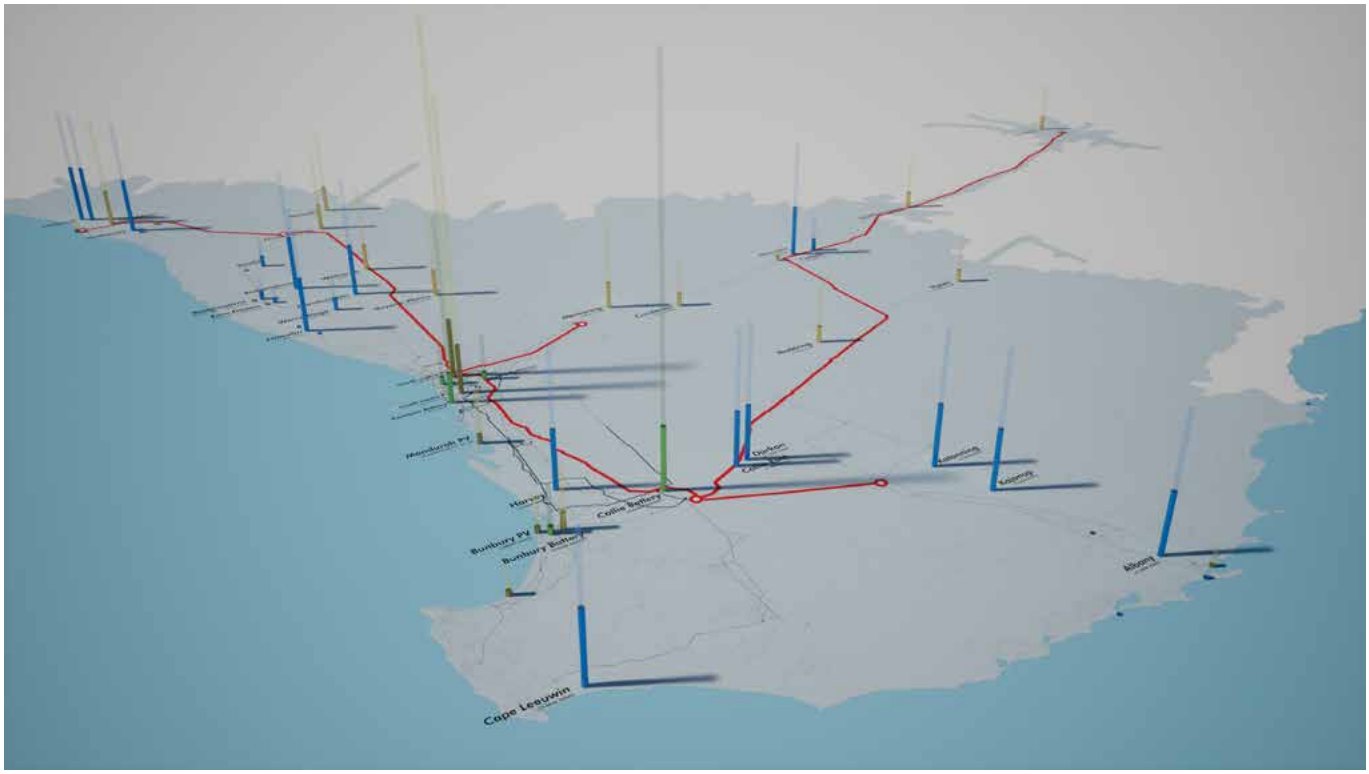
and providing associated network infrastructure from Kojonup to Collie and to the Mid West, Wheatbelt and Kalgoorlie.

WA needs more wind energy generation (geographically dispersed in the best locations to optimise performance) and upgrades to the main transmission grid, in addition to extra wind farm connections.

There needs to be immediate upgrades to the high voltage transmission north of Neerabup to the Mid West further east to enable more wind across the SWIS. Without it, this will deter private sector investment by raising the cost of capital and the overall risk to development.

Long connection times for projects needing to access the SWIS grid are also undoubtedly slowing the rate of renewable energy investment. With a typical connection process already taking up to four years, there needs to be substantial reform to allow more than 50GW of new renewable and firming capacity to come online in the next two decades. This major private capital investment is necessary for the transition.

Figure 5.13: SWIS Nodal Map: Potential network augmentation to 2042



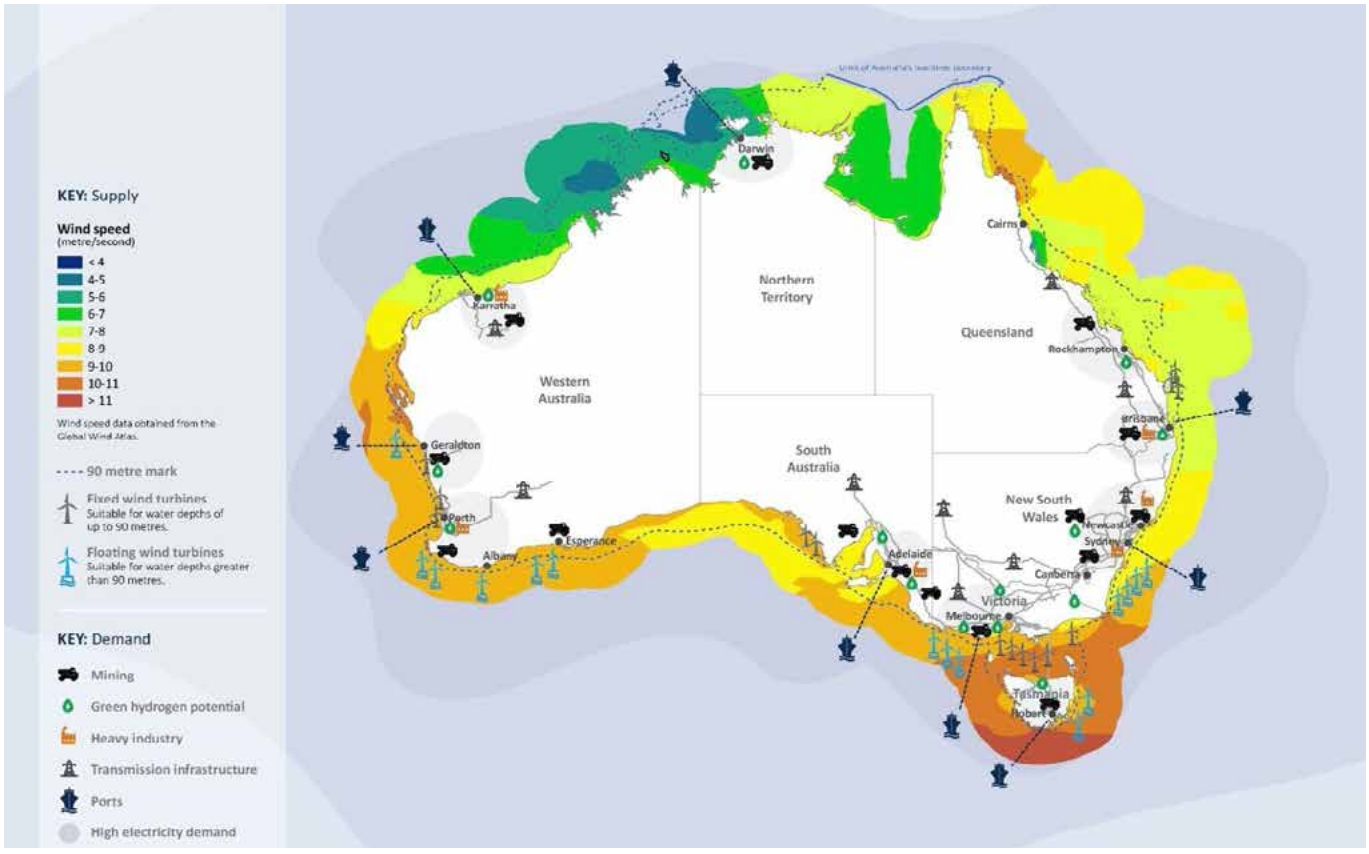
Source: EPWA (2023)

Beyond 2030 Offshore wind

Recent changes in federal legislation mean offshore wind farms can now be developed. These projects are likely to have a very long lead time into the 2030s, beyond the scope of the Climate Positive Perth project.

There is already interest from major energy providers in the South West including Leeuwin Offshore Wind, a subsidiary of Danish developer Copenhagen Energy, who have unveiled plans to build a 3,000MW wind farm off the coast of Bunbury. If developed, this wind farm would offer the equivalent of half of the current SWIS power capacity. While offshore wind farms have higher capital and operating costs, they tend to be better accepted by local communities and stakeholders than onshore wind and associated transmission projects.

Figure 5.14: Supply and demand potential for offshore wind in Australia



Source: ANU reproduced from NOPSEMA.

Other renewable energy technologies

Other renewable energy technologies that were once expected to be relevant to supplying the SWIS included wave energy and large-scale solar thermal. While they looked hopeful when WA 2.0 Energy 2030 was being written, both have been eclipsed by mature solar PV, wind, and storage technologies. For this reason, we've decided to only mention them rather than do a deep dive.

Thankfully, there are plenty of effective and affordable opportunities to decarbonise the SWIS. But this important transition is being held back by the lack of a clear and coherent energy transition policy and state investment to unlock private investment. This is something we will unpack in the next section.

5.1.3 What needs to happen to provide renewable energy for Climate Positive Perth

Despite having an independent electricity system and market, Western Australia is one of the few states without a clear energy plan or even a renewable energy target. WA needs a clear 1.5°warming-consistent plan and renewable energy target to enhance the uptake of renewable energy and decarbonise the SWIS in a timely, well-managed, and fair way. A new plan able to provide the energy foundation for a Climate Positive Perth is needed, and would ideally include:

Lots more renewable energy electricity generation

According to recent modelling by Sustainable Energy Now (SEN), based on all WA coal-fired generation ceasing by 2030 and AEMO 2023 load profile, the lowest cost scenario for the SWIS is an energy mix of around 87% renewable energy (including distributed/rooftop PV). This would require around 4,800MW of new wind, 1,500MW of new large-scale solar PV energy generation and the continuing current growth in rooftop solar.

Figure 5.15 shows that this combined 6,300MW of new large-scale renewable energy is a sweet spot in which the system Levelized Cost of Electricity is one-third less than the current modelled system Levelized Cost of Electricity based on today's energy mix.

Figure 5.15: Cost of Energy, Lowest Cost Scenario for WA

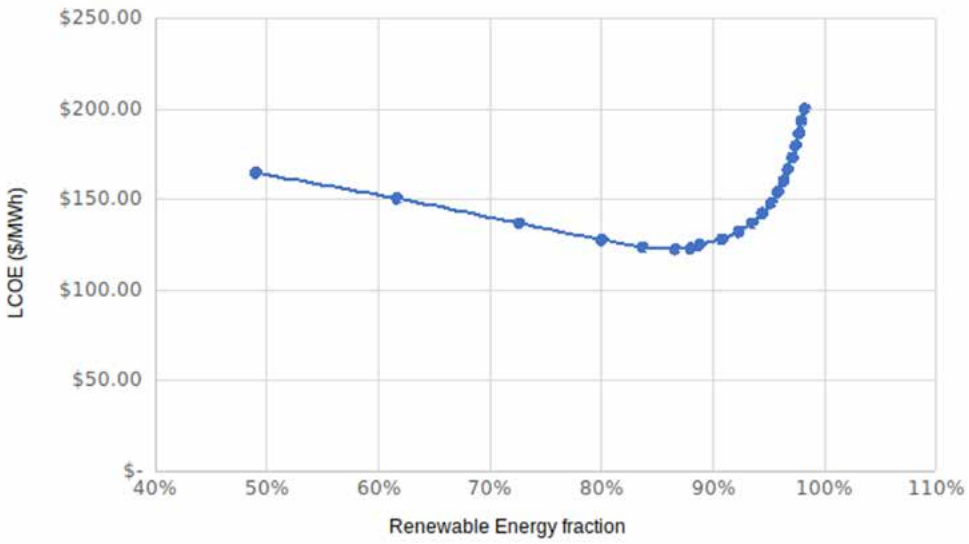
Wind (MW) \ PV (MW)	0	300	600	900	1200	1500	1800	2100	2400	2700	3000	3300	3600	3900	4200	4500	4800	5100	5400	5700	6000	6300	6600	6900	7200	7500
0	202.33	197.12	191.95	186.96	182.15	177.82	174.22	171.52	169.61	168.33	167.05	165.81	164.63	163.53	162.52	161.58	160.71	159.88	159.07	158.32	157.61	157.20	157.04	157.11	157.32	157.67
300	195.56	190.36	185.28	180.32	175.67	171.61	168.35	166.00	164.40	163.13	161.79	160.55	159.39	158.32	157.32	156.39	155.52	154.67	153.86	153.09	152.52	152.25	152.22	152.40	152.67	153.11
600	188.68	183.57	178.50	173.65	169.22	165.49	162.60	160.55	159.17	157.81	156.47	155.23	154.09	153.05	152.05	151.13	150.25	149.42	148.70	148.16	147.78	147.67	147.77	148.02	148.42	148.94
900	181.78	176.67	171.68	167.00	162.90	159.51	156.95	155.19	153.83	152.43	151.11	149.88	148.77	147.73	146.75	145.85	145.09	144.50	144.06	143.75	143.63	143.64	143.87	144.22	144.69	145.28
1200	174.78	169.73	164.91	160.48	156.72	153.66	151.41	149.89	148.46	147.02	145.72	144.52	143.43	142.44	141.63	140.97	140.47	140.12	139.95	139.93	140.03	140.25	140.61	141.05	141.62	142.27
1500	167.75	162.85	158.25	154.15	150.71	147.96	146.00	144.56	143.07	141.65	140.40	139.30	138.37	137.61	137.04	136.66	136.47	136.44	136.52	136.74	137.07	137.49	137.97	138.58	139.25	139.97
1800	160.82	156.13	151.79	148.02	144.89	142.44	140.75	139.25	137.78	136.52	135.46	134.60	133.91	133.47	133.25	133.18	133.24	133.40	133.72	134.12	134.63	135.26	135.95	136.72	137.53	138.40
2100	154.14	149.66	145.64	142.16	139.33	137.14	135.66	134.27	132.98	131.96	131.18	130.67	130.37	130.23	130.25	130.38	130.64	131.04	131.56	132.20	132.91	133.69	134.55	135.48	136.45	137.47
2400	147.90	143.77	140.06	136.92	134.38	132.49	131.17	129.99	129.02	128.41	127.98	127.71	127.61	127.69	127.90	128.27	128.81	129.46	130.19	130.99	131.86	132.78	133.76	134.78	135.84	136.96
2700	142.41	138.60	135.25	132.48	130.20	128.59	127.56	126.69	126.05	125.62	125.39	125.35	125.51	125.85	126.35	126.97	127.67	128.46	129.33	130.26	131.23	132.25	133.32	134.44	135.60	136.79
3000	137.63	134.20	131.24	128.76	126.77	125.45	124.68	124.08	**123.68**	**123.50**	**123.50**	**123.74**	124.14	124.70	125.36	126.13	126.99	127.89	128.84	129.84	130.91	132.02	133.17	134.35	135.55	136.78
3300	133.64	130.55	127.93	125.73	124.03	**122.95**	**122.40**	**122.06**	**121.89**	**121.95**	**122.24**	**122.68**	**123.28**	123.99	124.80	125.67	126.59	127.57	128.59	129.68	130.82	132.00	133.20	134.42	135.67	136.95
3600	130.46	127.68	125.33	**123.39**	**121.99**	**121.15**	**120.77**	**120.62**	**120.70**	**120.99**	**121.43**	**122.03**	**122.74**	**123.56**	124.46	125.40	126.40	127.44	128.56	129.72	130.91	132.14	133.39	134.66	135.95	137.26
3900	127.92	125.43	**123.36**	**121.70**	**120.52**	**119.84**	**119.60**	**119.69**	**119.96**	**120.41**	**121.00**	**121.69**	**122.48**	**123.38**	124.35	125.38	126.45	127.57	128.75	129.97	131.21	132.47	133.74	135.04	136.37	137.71
4200	125.87	**123.65**	**121.82**	**120.39**	**119.40**	**118.91**	**118.81**	**119.08**	**119.50**	**120.09**	**120.78**	**121.56**	**122.45**	**123.44**	124.49	125.58	126.71	127.89	129.11	130.36	131.63	132.91	134.23	135.57	136.92	138.28
4500	124.29	**122.32**	**120.70**	**119.47**	**118.68**	**118.34**	**118.39**	**118.75**	**119.31**	**120.01**	**120.79**	**121.67**	**122.66**	**123.72**	124.81	125.96	127.14	128.36	129.61	130.88	132.19	133.51	134.86	136.21	137.56	138.93
4800	**123.18**	**121.41**	**119.97**	**118.90**	**118.31**	**118.08**	**118.24**	**118.69**	**119.35**	**120.15**	**121.03**	**122.00**	**123.05**	124.16	125.30	126.49	127.71	128.96	130.25	131.56	132.89	134.23	135.59	136.95	138.32	139.70
5100	**122.41**	**120.80**	**119.50**	**118.66**	**118.21**	**118.12**	**118.38**	**118.91**	**119.63**	**120.50**	**121.48**	**122.51**	**123.63**	124.78	125.98	127.20	128.45	129.74	131.04	132.37	133.72	135.07	136.44	137.82	139.20	140.58
5400	**121.94**	**120.49**	**119.41**	**118.75**	**118.43**	**118.47**	**118.82**	**119.43**	**120.20**	**121.12**	**122.13**	**123.22**	124.38	125.57	126.79	128.05	129.33	130.63	131.95	133.29	134.65	136.01	137.38	138.76	140.14	141.53
5700	**121.76**	**120.50**	**119.61**	**119.08**	**118.89**	**119.03**	**119.47**	**120.12**	**120.96**	**121.92**	**122.95**	124.07	125.25	126.47	127.72	128.99	130.28	131.59	132.93	134.28	135.64	137.01	138.38	139.77	141.15	142.55
6000	**121.83**	**120.72**	**120.01**	**119.61**	**119.53**	**119.77**	**120.29**	**121.01**	**121.89**	**122.88**	**123.95**	125.09	126.29	127.52	128.79	130.08	131.39	132.72	134.06	135.42	136.79	138.17	139.55	140.94	142.33	143.73
6300	**122.13**	**121.21**	**120.66**	**120.38**	**120.41**	**120.76**	**121.35**	**122.12**	**123.05**	124.07	125.17	126.34	127.55	128.80	130.08	131.38	132.70	134.04	135.39	136.76	138.14	139.52	140.91	142.31	143.70	145.11
6600	**122.70**	**121.96**	**121.54**	**121.36**	**121.50**	**121.93**	**122.57**	**123.40**	124.37	125.42	126.54	127.72	128.95	130.21	131.51	132.82	134.15	135.50	136.86	138.24	139.62	141.02	142.41	143.82	145.22	146.64
6900	**123.52**	**122.92**	**122.58**	**122.51**	**122.74**	**123.24**	**123.95**	124.82	125.83	126.91	128.04	129.25	130.49	131.77	133.07	134.39	135.73	137.09	138.47	139.85	141.25	142.64	144.05	145.45	146.87	148.29
7200	124.51	124.01	**123.76**	**123.80**	124.11	124.69	125.48	126.39	127.43	128.52	129.68	130.90	132.16	133.45	134.77	136.10	137.45	138.82	140.21	141.60	143.00	144.40	145.81	147.22	148.64	150.07
7500	125.67	125.24	125.09	125.23	125.65	126.32	127.15	128.09	129.15	130.25	131.43	132.66	133.93	135.23	136.56	137.89	139.26	140.63	142.02	143.42	144.82	146.23	147.64	149.06	150.48	151.91

Source: Sustainable Energy Now (2023)

This lowest cost outcome would require some moderate amount of new gas-peaking generation that would only operate when needed during low renewable energy generation/ high-demand peaks. These gas-peaker generators would replace WA's current open cycle and combined cycle gas generators, some of which are reaching end of their operational life.

Sustainable Energy Now also modelled a more ambitious renewable energy scenario which showed that the SWIS could reach 98% renewable energy for an estimated cost of $18 billion. This model requires an investment in 10,000 MW of wind and 5,200 MW of PV. This large cost increase is largely due to a large amount of spilled energy. This spilled energy really presents a huge opportunity to be exploited for loads that can be "time-shifted". The more wind generation that is enabled on the SWIS, the less storage and gas generation will be required.

Figure 5.16: Cost of renewable energy



Source: Sustainable Energy Now (2023)

In addition to major investment in large scale renewable energy, small scale solar will continue to add further significant generation. In late 2022, AEMO forecast rooftop solar PV to continue to grow at an average annual rate of 7.0% (238MW per year), to reach an *"estimated 4,716 MW of installed capacity by the end of the 10-year outlook period"*. This is over three times the combined size of all of WA's coal-fired power stations.

Ready set repeat: the need for a WA Renewable Energy Target

The modelling analysis by SEN reinforces the need for a strong Renewable Energy Target (RET). WA needs a target of more than 90% renewable energy generation that extends out to 2040 in order to drive investment and enable the transition to happen at the pace needed.

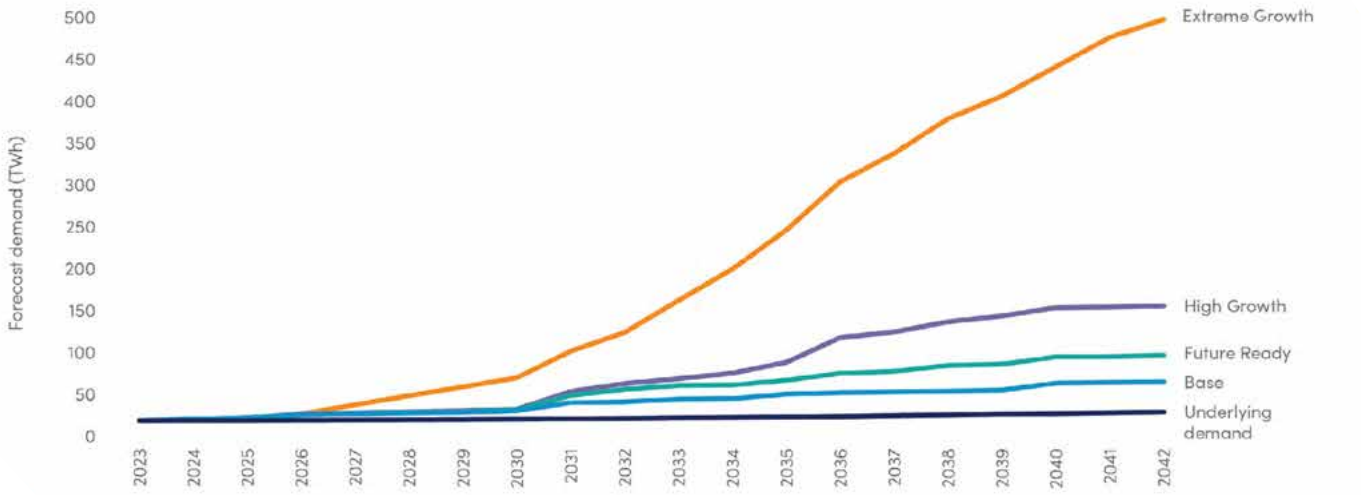
As Professor Ross Garnaut explains, there are many shovel-ready projects sitting idle because the proponents are unable to make the investment case stack up. This means that retailers, corporations and governments are unwilling or unable to enter into a power purchase agreement (PPA) at prices needed to finance projects.

A RET will immediately grow the investment case for many well designed, ready to build projects in WA. The RET is one of the most effective market mechanisms that can drive and speed up an efficient path to achieve the renewable energy transition needed.

Electricity demand

A lot more renewable energy will be needed to meet decarbonisation and growth in demand. In addition to needing to triple renewable energy generation from around 30% to close to 100% of the grid, we will need to meet a further threefold increase in electricity consumption resulting from the full electrification of industry, transport and buildings as fossil fuels are rapidly phased down, hopefully in the decade ahead.

Figure 5.17: Predicted growth in electricity demand for the SWIS



Source: SWIS Demand Assessment (2023)

Former Australian chief scientist Alan Finkel (*Powering Up*, 2023) and others predict that around nine times the current renewable energy generation amount will be required on both Australia's National Electricity Market (NEM) and WA's SWIS — just to meet domestic (non-export) demand.

Lots more renewable energy storage, including pumped hydro

What is also clear is that future energy storage requirements will be above the 3GWh announced in early 2023. It will also be above the 4.4GWh planned by the WA state government.

When it comes to storage SEN have demonstrated that a high penetration renewable energy grid would need 5200MwH (1250MW times 4 hour plus 100MW times 2 hour) of utility-scale batteries, assuming that this was complemented by the 4800MW of new wind and 1500MW of new large scale solar highlighted in the preferred renewable energy scenario above.

Visualising a renewable energy dominant SWIS

If we undertake investment in new renewable energy, storage, distribution and transmission then the SWIS could transition to a low carbon grid run almost entirely on renewables. This renewable energy dominant SWIS that could look like the visualisation below, with new solar and wind to the north of Perth, more distributed rooftop solar in Perth, and also more renewable energy to the southeast.

Figure 5.18: Rooftop solar and battery storage in inner-city Perth

Figure 5.19: New solar and wind generation with battery storage capacity across the SWIS

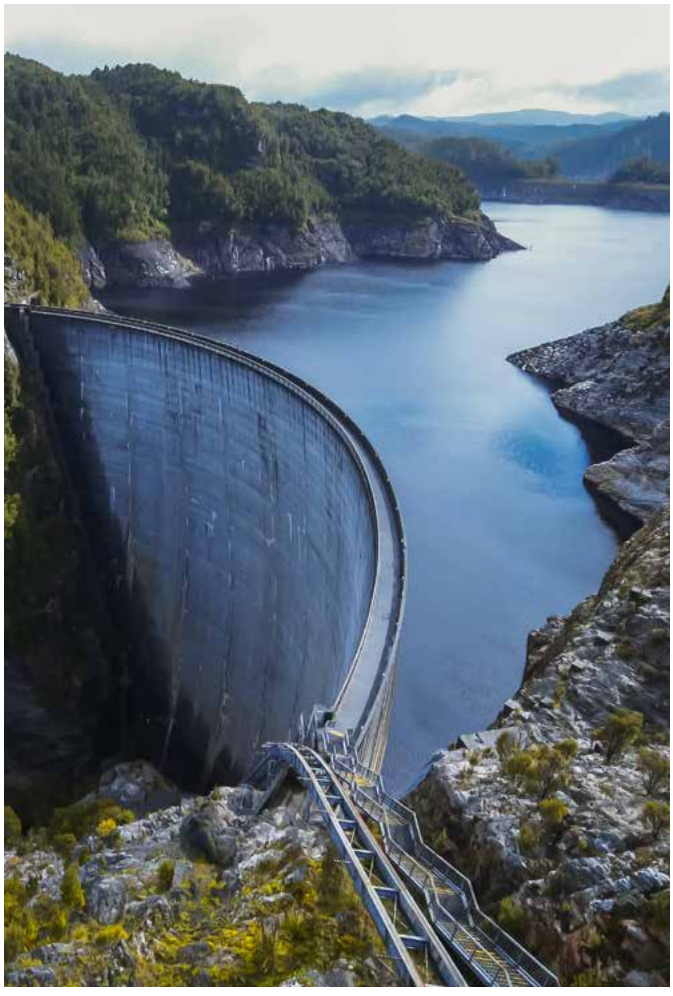
5.1.4 Follow the leader: where is best practice energy use already happening in Australia?

Tasmania has had 100% renewable energy from hydropower for many years.

Elsewhere, South Australia is leading the way in the positive switch to renewable energy. Their transition commenced in 2003 with the construction of South Australia's first wind farm, the 33MW Starfish Hill facility. By 2016 coal had been replaced in the system and the share of gas generation has since fallen to approximately 30%. South Australia now gets 64% of its electricity from wind and solar and, if this growth trend continues, they are on track to have 90% renewable energy by 2027.

The take-up of rooftop solar started in 2011 and it has since become so widespread in South Australia that it is able to supply 100% of demand when needed. South Australia was also the site of the world's first big battery, a 129 MWh grid scale battery constructed by Tesla at Hornsdale in 2017, and operates a Tesla Virtual Power Plant through which 50,000 homes with solar and batteries are connected via integrated software.

The South Australian Government's strategy was simple — welcome investment in wind and solar, and the projects will follow. Starting the transition more than a decade ago with a clear policy, plan and investment has allowed a managed exit from coal and gas.



Strathgordon Dam, Tasmania

Solar farm, South Australia

Lake Bonney wind turbine farm located in southeast South Australia

5.1.5 Where Internationally?

On the international stage some notable examples of a brilliant energy transition are Scotland and the US state of California.

Scotland has an ambitious and legally binding target to reach net-zero by 2045, as set out in the Climate Change (Scotland) Act 2009. Scotland is a windy place and has been dubbed the 'Saudi Arabia of renewable wind energy'. In 2020 renewable energy generation reached 97.4% of supply with onshore wind making up 70% of that, and hydropower and offshore wind making up the balance. Scotland has been building wind farms since the 1990s, but construction was increased in the 2000s to achieve a goal of 50% renewable energy by 2015. They now have 9,347MW of installed wind power and the last coal fired power station closed in 2016.

The State of California has a population of 39 million people and an economy worth $3.1 trillion dollars. On 8 May 2022 the state recorded a few hours where renewable energy met 103% of demand, mostly through solar (12000MW) and wind (5000MW). In 2019, 63% of California's energy was supplied from renewable sources. Like Perth, California has great solar energy potential and has seen a massive uptake of rooftop solar which now makes up 31% of their renewable capacity (9460MW). Their other renewable capacity sources are large scale solar (42%), wind (19%), and geothermal, hydro and biomass (19%).

For now, California still needs gas to support the grid and provide stability for long term storage, but they have started the massive investment needed to change that and have increased their battery storage 20-fold since 2019.

Wind Turbine Farm and Solar Panels, Southern California

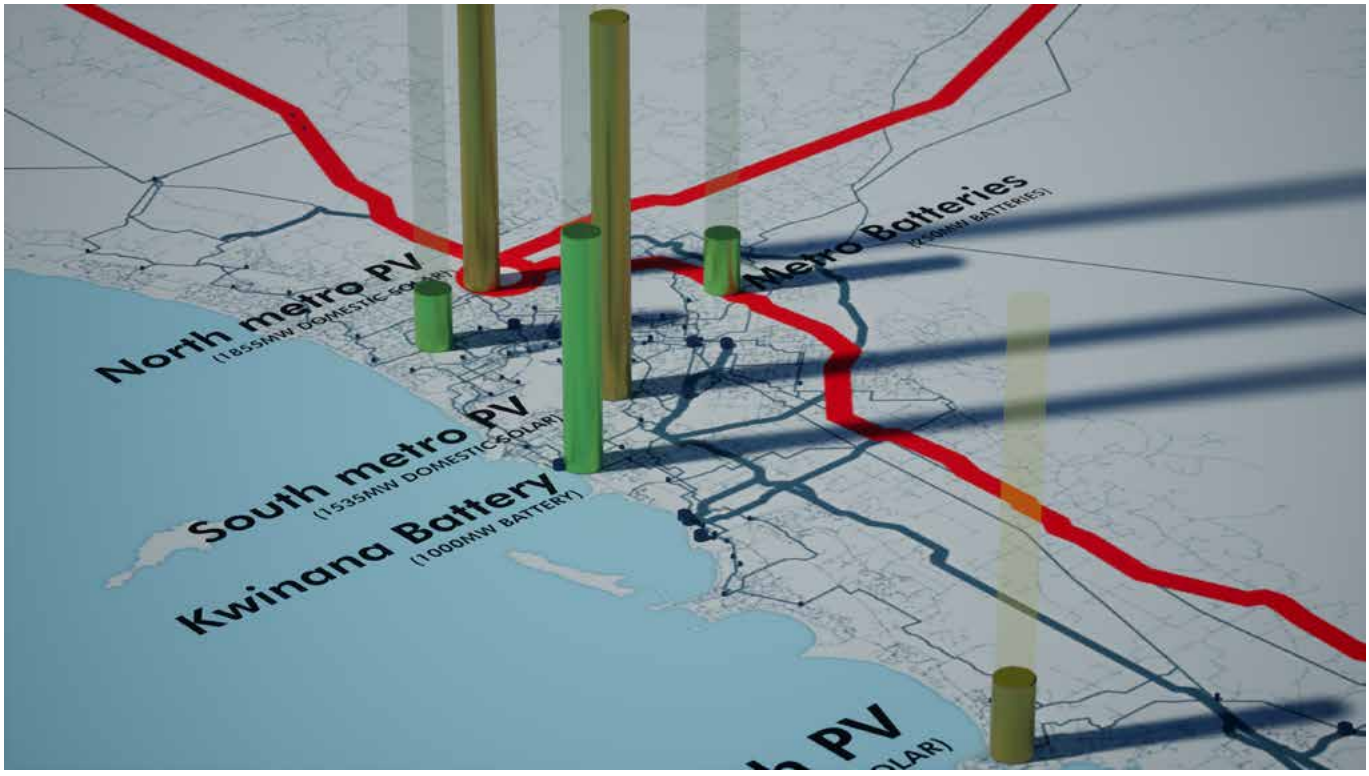
5.1.6 Conclusion

WA is moving towards a SWIS that can wean itself off coal and gas and move to renewable energy. However, despite some bold State Government announcements, renewable energy investment remains too low and too slow to achieve a Climate Positive Perth.

WA needs an energy plan and renewable energy target (RET) that is compatible with the Paris Agreement on climate change and holding warmer as close to 1.5 as possible. This energy plan needs to include definitive targets and strategies to ensure the necessary investment in storage, transmission, and grid services to enable new renewable energy to come onto the SWIS more quickly and at scale.

Central to this plan will be enabling geographically diverse wind energy generation to complement the growth in solar that is already underway, largely via WA households. Storage also needs a major expansion beyond the projects announced. This will need to be a combination of battery storage, community and home batteries. Finally, there needs to be a strategy that runs across sectors so that, for example, changes in the transport sector can help the energy sector reduce emissions and decarbonise and vice versa. Setting tariffs that encourage EV charging during the day can take a load off the grid and ensure EVs are charged from solar PV. Bi-directional charging of EVs will enable true sector coupling.

Clean energy is fundamental to a Climate Positive Perth. The right investment strategies now can drive positive change and charge the future.



5.1.7 Metropolitan Scale Energy Recommendations

1. **A 2030 renewable energy plan and transition for the SWIS**. Invest in renewable energy, transmission infrastructure and storage.
2. **An ambitious renewable energy target (RET)**. WA needs a RET for 2030 and out to 2040, this will drive renewable energy investment and speed up progress. Keep an option to modify the RET target up or down should an additional incentive be required.
3. **Focus on increasing wind generation**. Wind generation with a wide geographical dispersion will be important for a stable renewable energy SWIS. This will mean a range of new and expanded wind assets from Kojanup to Collie to the Mid West.
4. **Proactively fund transmission** to the North of Perth and mid-west to enable privately funded wind to be built at scale.

5.2 Energy — Neighbourhood Scale

5.2.1 Introduction

Renewable energy projects at the SWIS scale can provide the backbone of a decarbonised metropolitan electricity grid. But projects and investment at the neighbourhood scale driven by local communities and at less of a state capital cost can really transform the energy network.

This chapter explores opportunities at a neighbourhood level that can grow renewable energy and battery storage while proactively replacing inefficient energy use, such as in streetlights and reticulated gas networks.

The neighbourhood level is the Goldilocks zone of the opportunities for an efficient transition to a decarbonised Climate Positive Perth — a level not too big and not too small but just right.

5.2.2 The energy context at a neighbourhood scale in Perth

Distributed Energy Resources, or DER, is the State Government's preferred term for decentralised energy or as they put it: *"...smaller-scale devices that can either use, generate or store electricity, and form a part of the local distribution system, serving homes and businesses..."*.

In this chapter, we focus on DER at neighbourhood scale that is likely to be connected directly to the distribution network, or 'in front of the meter'. This can include some smaller solar PV and wind farms and neighbourhood-scale batteries.

Right now there is very little renewable energy at a neighbourhood scale in Perth. Mostly it is either large-scale generation a long way from the point of use or it is small rooftop solar.

One key downside of most energy on WA's SWIS being produced a long way from where it is used is the large losses that happen through transmission (up to 30%). While household rooftop solar PV (in which WA is a world leader) avoids this, many of the benefits are retained by individuals or spilled to the grid. Community-scale generated and stored renewable energy could provide a more resilient grid with community investment. There is a huge opportunity for the community to be actively involved in steering the renewable energy transition.

This is also true for battery storage which has tended towards investment in home batteries. There are very few examples of neighbourhood-scale energy storage in Perth. A successful example was the trial of community-scale energy storage at Alkimos Beach where rooftop solar PV systems were installed on around 100 houses and residents were able to collectively use the shared 1.1MWh community battery. This project saw an 85% reduction in the consumption of energy from the grid at peak times for participating households. This leads to the obvious question: Why aren't we doing more projects like this?

A different model of neighbourhood-scale batteries with a less explicit community element is

the ten batteries owned by Western Power across metropolitan Perth. This neighbourhood-scale delivery of battery storage is expected to expand with the Federal Government announcing a $224 million program rolling out 400 community batteries across Australia. Western Australia has been granted a further six community batteries (100kW/400kWh) as part of the Federal Government's Community Batteries for Household Solar Grant Program. There is a concern in WA, however, that this initiative, which would ideally support potentially more West Australians to participate in the transition to clean energy, is compromised by the batteries being granted to a WA Government Trading Enterprise (Western Power) rather than being community-owned or managed.

5.2.3 What are the opportunities?

Investment at a neighbourhood level in low-carbon energy solutions is an important way we can build a decarbonised Climate Positive Perth. There is substantial pent-up demand for community-led neighbourhood-scale renewable energy and batteries, and many good reasons to create no-gas neighbourhoods and invest in LED lighting. We will look at each of these in turn.

Community solar

In metropolitan areas, community solar is gaining the greatest momentum rather than wind. Solar PV is easy to install but not everybody has a sunny rooftop suitable for solar PV or owns the house that they live in — almost one-third of Perth's residents rent.

Community solar, colloquially known as 'solar gardens', step in to fill this gap. It's a great way that households who otherwise would love to benefit from owning their own solar panels can participate in the benefits of renewables. Community solar works by allowing a group of electricity customers to collectively own a solar array. Instead of being on a house the solar garden is located on vacant land or on the roof of a factory. The benefit of joint ownership of the solar garden flows to customers though the electricity retailer, and customers receive a credit for electricity their solar panels produce.

Figure 5.20: A community solar garden in the United States

There are various schemes which people can participate in. For example, participants could purchase shares in a solar garden with dividends paid in the form of units of stored power. Alternatively, electricity units could be credited to a participant's power bill according to their share of generation.

This model breaks the link between needing to own a sunny roof and ownership of solar PV. Community energy groups are already in discussion with friendly electricity retailers on the eastern seaboard of Australia. The first steps towards making community solar are becoming a reality, and with it, the possibility of solar ownership for everyone. Solar gardens are not yet possible in WA but if government policy is changed to direct the monopoly retailer, Synergy, the sky's the limit.

Community batteries

In addition to community solar there are many opportunities to increase the amount of community batteries. Community-scale batteries have the potential to play an integral role in Australia's transition to a more decentralised grid. These batteries would be connected to the distribution network with power capacities of up to 5 MW. For urban environments, these are often called neighbourhood batteries. Community-scale batteries provide access to storage, for energy self-consumption, to consumers without the high capital cost of installing their own battery.

Research from the ANU Battery Storage and Grid Integration Program tell us that community batteries are popular:

> *...people want to support decarbonisation and allow more renewables, seeing storage as an essential player in reducing grid congestion and supporting solar generation. Many people want to make energy more local, and are intuitively drawn to the potential to provide local economic value, employ local people, and keep battery profits in the locality... People also want to know how they can 'do their bit,' contributing to reducing or shifting energy use to support the energy transition. In doing so, they want to create a sense of community, building community connections and sharing the benefits of local renewable energy to promote fairness.*

It makes sense for households to share a larger battery instead of every household paying separately for the purchase, install, and maintain their smaller household batteries. Community battery storage can reduce the cost of battery storage per household and ultimately allow more rooftop solar.

Many batteries piloted in the community space in WA are owned by distributors or retailers. While these projects still seek to offer some benefit to community users, the benefits don't wholly flow back to the community. This is because they're primarily operated for the benefit of the distributor or retailer, not community members, and are therefore often referred to as network batteries to better reflect their ownership and governance. By contrast, a 'community battery' is a subset of neighbourhood or community-scale batteries that ensure some level of direct benefit, community ownership or control.

When renewable energy and storage happen at a neighbourhood scale you get the benefits of scaling up that go beyond the individual household level. Sharing with neighbours results in a more efficient use of solar and battery and avoids the inefficiencies of a centralised power system.

No Gas Neighbourhoods

A great step towards a decarbonised Climate Positive Perth at a neighbourhood level is removing gas from new developments.

With more households moving to full electrification in new subdivisions, it does not make sense — in economic or decarbonisation terms — to provide gas distribution networks. This represents a considerable saving to developers that could potentially be passed on to purchasers of residential lots.

The substitution of gas with electricity has significant health, cost, and emissions benefits that we discuss more in the household chapter. Policy initiatives supporting the transition from fossil fuels to renewables are necessary to fully benefit from these advantages.

In Perth, parts of the development sector are leading the way with progressive local developers choosing not to install gas. For example, Yolk have not included gas in their developments such as Evermore and Little Lane. Hesperia is now doing gas-free, all-electric homes in all new developments.

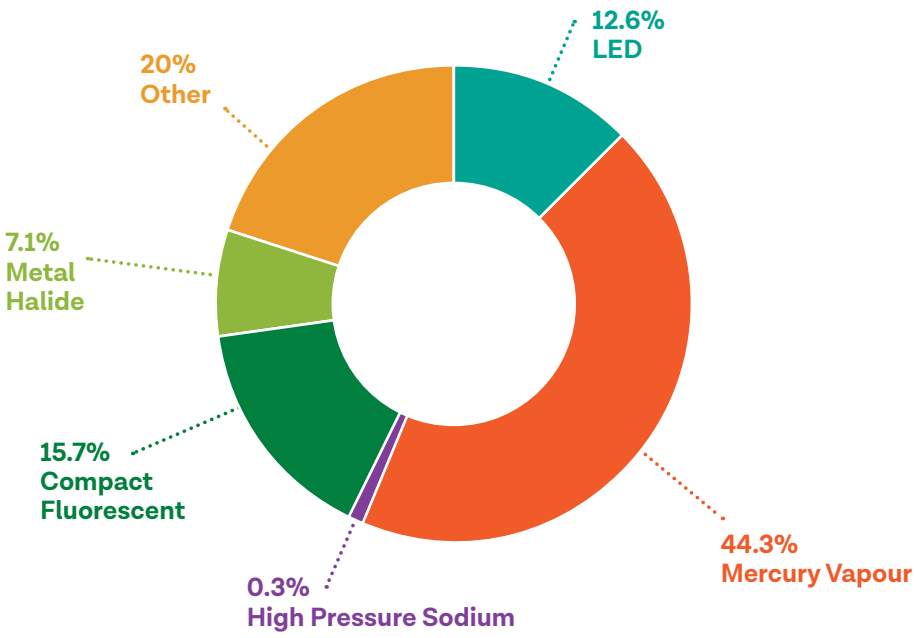
By contrast, the WA State Government committed $10.5 million in financial support for 258 private residential and 41 business customers to pull gas out of houses in Esperance. The transition program, managed by state-owned Horizon Power, offered financial assistance for existing gas customers to remove their gas appliances and replace them with new 'like for like' electric alternatives. These examples offer a compelling reason not to install gas in the first place when you are aiming for net zero emissions!

LED Streetlights

At the neighbourhood level there is also an opportunity to use less energy. One of the best and most cost-effective ways is through more energy-efficient street lighting.

There are almost 280,000 streetlights across the Western Power network.

Figure 5.21: Types of headlights across Perth local government areas



Mercury vapour globes are the most outdated and least efficient street lighting technology, emitting almost double the carbon of equivalent LED lights. Western Power estimate that *"streetlights currently create around 95,000 tonnes of Co2 emissions every year"*. Switching these in the 113 local government areas that are connected to the SWIS and replacing them with LEDs would mean greenhouse gas emissions would be reduced by 45,000–54,000 tonnes of carbon emissions/year. Over 30,000 tonnes of this would be in the Perth metro area.

While there's been some limited progress towards the introduction of more energy-efficient street lighting, further reforms are needed to overcome the remaining barriers. Western Power's current public lighting strategy is to reactively install LED street lighting when the existing streetlight fails. At this rate, it will be at least a decade before inefficient lighting is replaced.

As a result, WA has a higher proportion of mercury vapour lighting than any other Australian jurisdiction. There is an opportunity to proactively replace these inefficient lights with LED lights and this would see a 50% reduction in lighting emissions, in addition to large savings for local governments.

5.2.4 Where is best practice already happening?

There are pockets of excellence when it comes to energy at the neighbourhood scale in Perth.

Shared Solar and Battery

One of the most exciting of these are East Village and Evermore developments in the City of Fremantle.

East Village in Fremantle is a new development of 36 energy-efficient homes that use a 670kwh precinct-scale battery to store the energy from the 36 individual 6.6kw solar PV systems. This community battery will be shared between neighbours on a private embedded network and is expected to dramatically reduce grid energy consumption across the development with only minimal off-site imports of energy required — also from a renewable supply. This means that East Village will run on 100 percent renewable energy.

This innovative energy-sharing technology trial involving onsite energy generation and a shared community battery is the first of its kind in WA.

East Village follows on from an earlier shared solar and battery pilot program at the apartment level — Evermore Apartments in White Gum Valley. Evermore has a shared rooftop 50kW PV solar system and 150kWh battery. On-site renewable energy produces approximately 80 percent of the Evermore apartments' power.

The shared batteries in both Evermore and East Village store the solar energy that is mostly produced between 9am and 3pm, a time of day when many residents are not using their power. Most other Perth residents in this case sell 'middle of the day' energy to Western Power at rates as low as 3c/kWh rate but need to buy back energy from Synergy at around 30c/kWh in the evening.

By contrast in these developments, the shared solar power is stored in the shared battery system for use later in the day rather than them needing to buy it off Synergy at a higher rate. Residents with leftover energy can sell their power to their neighbours at a better rate than they would get from Synergy.

Both developments include partnerships with Curtin University, LandCorp, Australian Renewable Energy Agency, Low Carbon Living Cooperative Research Centre, Balance, and CSIRO to develop and test governance models to allow shared solar PV, battery and monitoring systems to be used beyond the individual household level.

Evermore and East Village are also gas-free developments.

Figure 5.22: Residents of East Village at Knutsford have access to a shared battery

Gas Free neighbourhoods

Hesperia's Rivermark is another example of sustainability leadership including for energy use. Rivermark is a Net Zero Carbon project which means that the housing estate is fully electric with no reticulated natural gas.

Instead, Riverpark is giving homeowners access to a fully maintained home battery for a low monthly service fee. They estimate that more than 90% of a typical household's energy requirements will be met from the rooftop solar system together with the battery service and that this will reduce carbon emissions by 4–5 tonnes per home each year. They also anticipate that the typical household will achieve net savings of $200 to $300 per year.

This is an innovative example of a development choosing to invest in solar and battery storage rather than gas at the neighbourhood level and shows what is possible with good leadership.

Proactively Installing LED streetlights

The City of Cockburn is planning to replace Western Power's 13,850 outmoded streetlights with Smart Enabled LED lamps that use 80% less energy.

Following replacement, the annual cost of street lighting — which was 60% of the City of Cockburn's annual electricity bill for 2020/2021 — will fall from $2.7 million to $1.56 million. Their annual streetlight CO2 emissions would also fall by 49% from 5,588 to 2,781 tonnes.

The program's net cost is $6.92 million, and the payback period is estimated to be just over six years. If the City of Cockburn does not embark on the program, street lighting costs over the next 20 years will be $68.2 million. If the City changes to LEDs, those costs are reduced to $39.8 million.

Sadly, this project looks like it is stalling due to the City being unable to negotiate a cost reflective tariff with the State Government.

Figure 5.23: LED Street lights on Fremantle's cafe strip

5.2.5 Conclusion

The neighbourhood level offers some of the best the opportunities for a decarbonised Climate Positive Perth. It presents a unique opportunity for an efficient transition to a zero emissions city. If it's done well, a wider range of people can be part of the transition through shared solar and shared batteries.

Setting up our neighbourhoods to be zero carbon means that they must be fossil fuel free, which in Perth will mean no new gas, allowing new apartments and housing estates to enjoy a clean energy future.

Speeding up the transition to LED streetlights is also a no-brainer if we can get the right government policy settings to drive and embrace a Climate Positive Perth.

5.2.6 Neighbourhood Scale Energy Recommendations

1. **Enable shared solar PV** (also known as solar gardens) so that solar PV ownership is possible for everyone. This could easily be made a reality in WA through changes to government policy to direct Synergy accordingly.
2. **Enable shared community-owned neighbourhood scale batteries** that community investors can reap the benefits from. Like solar PV, not everyone has a home in which they can install a battery, but everyone could be a shared owner of a community battery.
3. **Mandate or, at the very least, strongly encourage gas-free neighbourhoods**. At a minimum, new reticulated gas should not be put into new neighbourhood scale developments.
4. **A LED streetlight replacement program** that is accompanied by a clear plan from the State Government (co-funded with local governments) to ensure all streetlights in WA are LED by 2030.

5.3 Energy — Household Scale

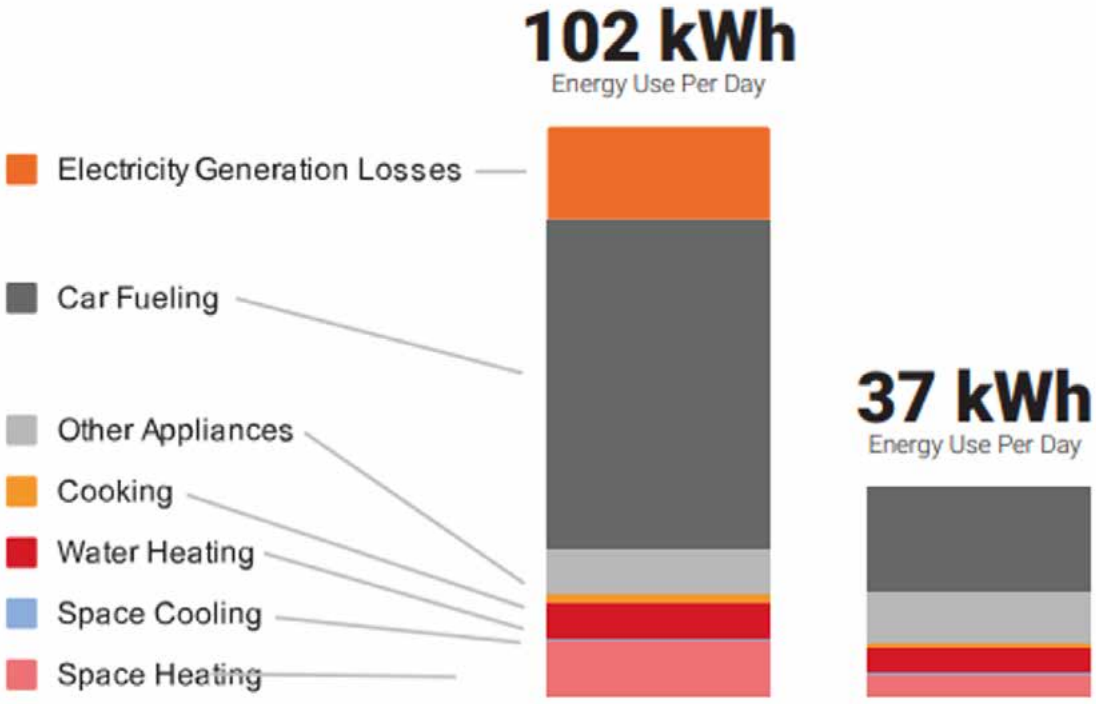
5.3.1 Introduction

Households offer some of the best opportunities to reduce energy use while also decarbonising and saving money. As Saul Griffith explains in *Cars and Castles*, the 'average' Australian household uses more than 100kWh of energy per day, costing over $5,000 each year while releasing 11 tonnes of CO2-e into the atmosphere. Mostly this is because of the inefficiency of conventional fuels like natural gas and petrol.

5.3.2 All electric houses

A significant portion of this energy use is due to the inefficiency of conventional fossil fuels. By contrast, if we electrify an 'average' Australian household with solar, a home battery, and an electric vehicle in the garage, energy usage significantly drops to around 37 kWh per day. This would create thousands of dollars in cost savings while cutting emissions to almost zero.

Figure 5.24: Difference in energy use per day in an electrified home



Source: Castles and Cars

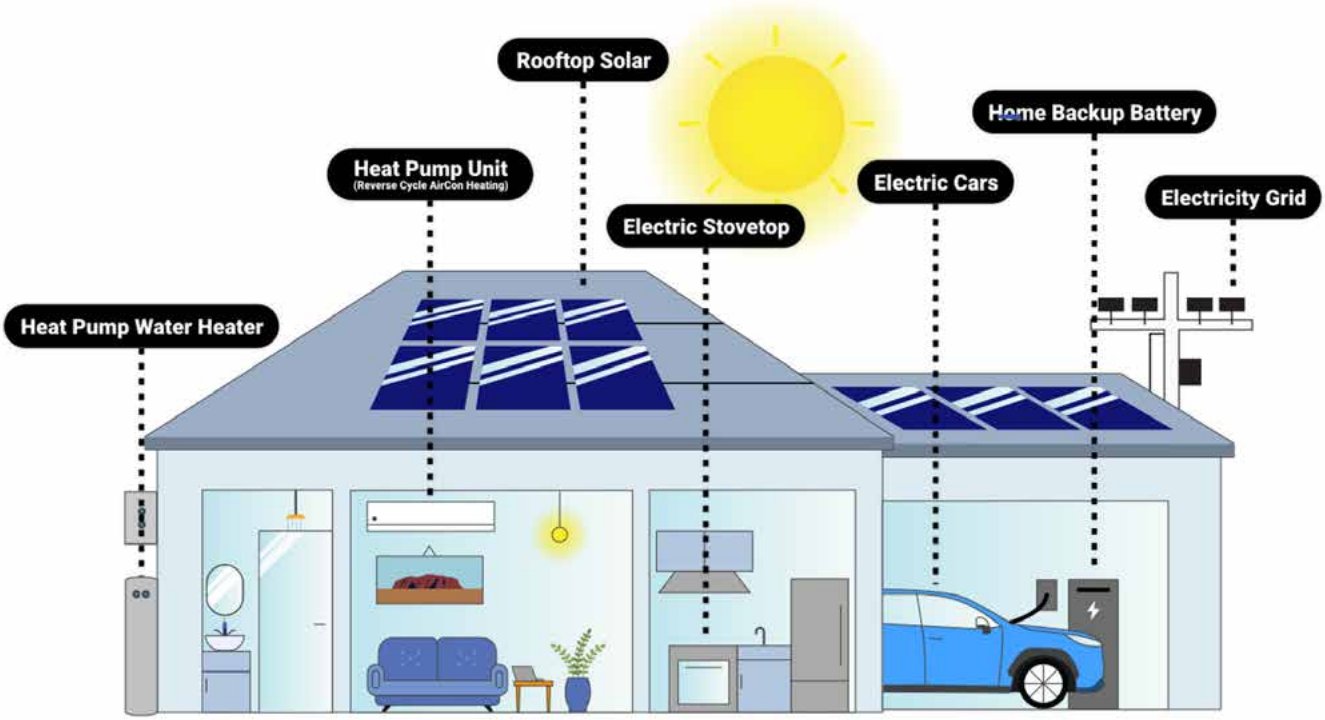
In an all-electric home, fossil-fuel devices such as gas heaters and petrol cars are swapped out for modern, clean, efficient, and low-maintenance electric replacements. Going all-electric makes the most of Perth's abundant sunshine by having solar on the roof and a battery to store the cheap energy made.

5.3.3 Heat Pumps and Home Batteries

In buildings, heat pumps can replace space heating and water heating as well as provide air cooling. A heat pump uses an electric compressor to extract and concentrate heat from outside and transfer it to where it is needed to raise the temperature. Relative to an electric fan heater or traditional electric hot water systems, a heat pump can save 60–85 per cent on energy costs. Heat pumps available today can produce three to four units of heat for each unit of electricity consumed, making them 300–400 percent efficient. The maximum efficiency of traditional electric and gas heaters is less than 100 percent.

One of WA's great renewable energy success stories is the uptake of rooftop solar. This program needs to be expanded to include heat pumps and home batteries. Appropriately sized home batteries could also boost the value of home solar by working around the current 5kw residential solar inverter cap, capturing the excess power at home without exporting it to the grid at times of low energy demand.

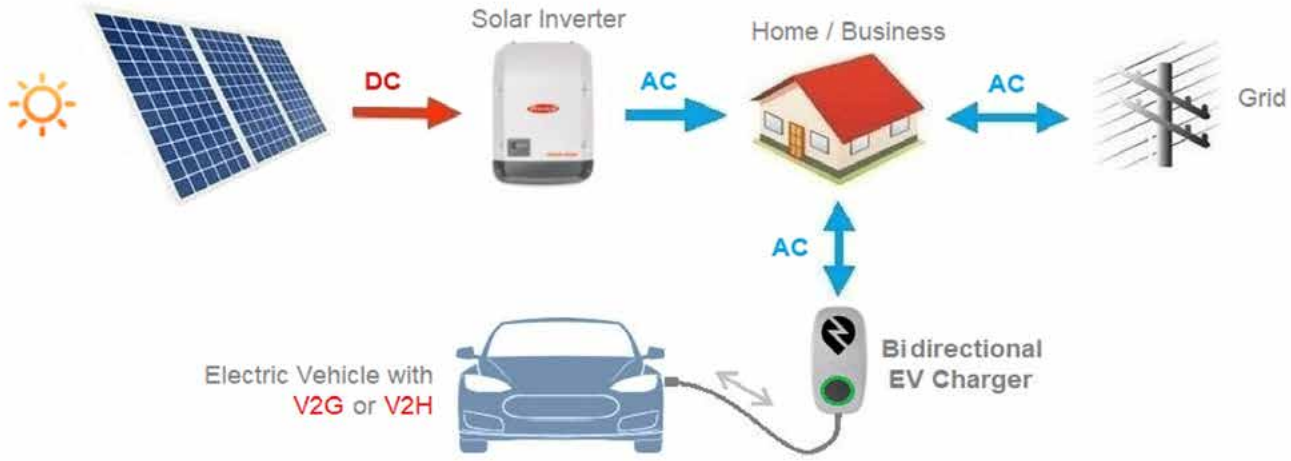
Figure 5.25: Different elements that make up an electrified household



5.3.4 Enable EVs to become home batteries

Battery Electric Vehicles (BEV) batteries are typically between four and ten times the capacity size of a typical home battery. For example, the Tesla Powerwall has a capacity of 13.5kWh, which is a fifth of the size of a base model Tesla Model 3 (68kWh). Due to the large battery capacity, a fully charged EV could support an average home for several days at a time, or much longer when combined with rooftop solar.

Figure 5.26: How a bi-directional EV charger can double as a home battery



Electric vehicle (EV) charging technology has advanced to support alternative uses of a vehicle's battery using a bi-directional (two way) charger. An EV is essentially a large battery on wheels; EVs with bi-directional charging capability can be used to power a home, feed energy back into the electricity grid and even provide backup power in the event of a blackout or emergency.

There is no technical barrier to bi-directional charging in EVs however some manufacturers may be waiting for commercial reasons or for legal and regulatory clarity before making the technology available.

Bi-directional chargers can be used for two different applications. The first is Vehicle-to-Grid or V2G. Vehicle-to-grid is where a portion of the EV battery energy is discharged and exported to the electricity grid when the demand is high in exchange for payment or for compensating the consumer through reduced electricity costs, depending on the service contract. EVs with V2G enable the owner to participate in virtual power plant (VPP) programs to improve grid stability. If thousands of vehicles with V2G technology are plugged in, this has the potential to transform the way in which electricity is stored and generated.

The second use of bi-directional chargers is for Vehicle-to-Home or V2H. As the names suggest, V2H enables an EV to be used much like a home battery system to store excess solar energy and power your home. V2H is like V2G but the energy is used locally to power the home, with your EV functioning much like a regular household battery, instead of being fed into the electricity grid. Another benefit of V2H is the ability to provide backup power in the event of a blackout.

5.3.5 Houeshold Scale Energy Recommendations

1. **Make all Perth homes electric only** with no new reticulated gas connections after 2024.
2. **Incentivise heat pumps and batteries alongside home solar PV**. One of WA's great renewable energy success stories is the uptake of rooftop solar. This program needs to be expanded to include heat pumps and home batteries enabling home solar PV above 5kw when accompanied by an appropriately sized battery.
3. **Ensure there are no regulatory barriers to Vehicle-to-Home and Vehicle-to-Grid**. Vehicle-to-Home and Grid enable electric vehicles to be used much like a home battery system to store excess solar energy and power homes and the grid.

CHAPTER 6

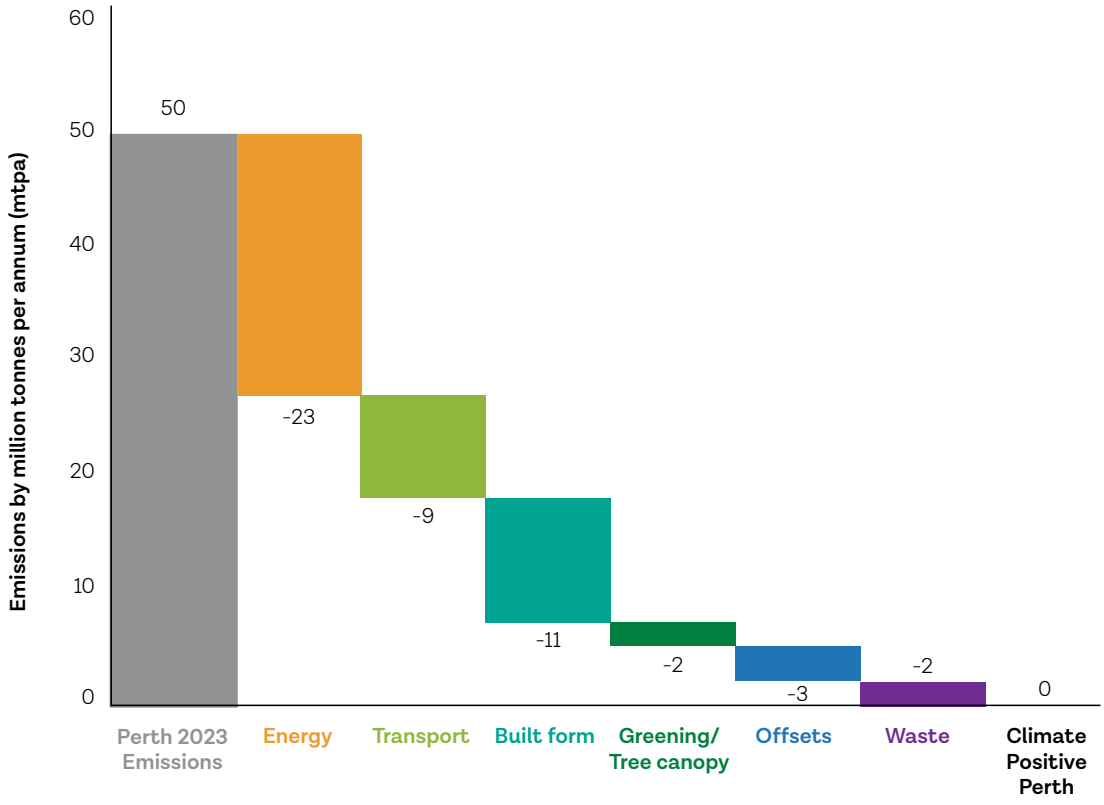
Conclusion

Perth is a great city, but we have challenges now and into the future that need immediate attention. As we have shown in this report, with careful consideration and action Perth can become an even greater place to live and work. A place which can meet the demands of our time and pave a better way for those who will inherit the impacts of our decisions.

We have seen how Perth can do things better when it comes to built form and planning, transport, greening, and energy in ways that will climate proof the city and make it more liveable and connected.

Explaining some of the practical and immediate solutions in the way we have hopefully makes the task of transforming metropolitan Perth into a low-carbon city less daunting. In its most inspiring aspect, the analysis laid out here can be viewed as a series of opportunities; key transformative changes that we can get on and do right away. Other challenges will no doubt emerge and take our attention but if we can get some of the fundamentals right, we can face the future with much more confidence.

Figure 6.1: Waterfall graph of greenhouse emissions reductions achievable through implementing Climate Positive Perth recommendations in each policy area, in addition to offsets and waste. Figures are approximate.



Emissions reductions from implementing Climate Positive Perth recommendations.

Please note that the data used in this graph is approximate.

The Energy section demonstrates that it is possible and desirable to significantly invest in renewable energy, transmission and storage to a far greater extent than WA is planning to do right now. This investment will give us a renewable energy dominated grid as the foundation for a decarbonised Perth and a lower cost energy supply.

In the section on transport we heard why we should electrify all of our transportation including Transperth buses, freight trucks and private cars. If we could shift mode-share towards active and public transport then this would make a major contribution towards a better connected, low carbon and more liveable city.

The transport task becomes easier if Perth also addresses its sprawling, car-dependent planning approach. As we saw in the section on planning and built-form, Perth has a great opportunity to better plan and consolidate new housing and developments into the central sub-region and around existing rail and new mid-tier transit such as electric trams.

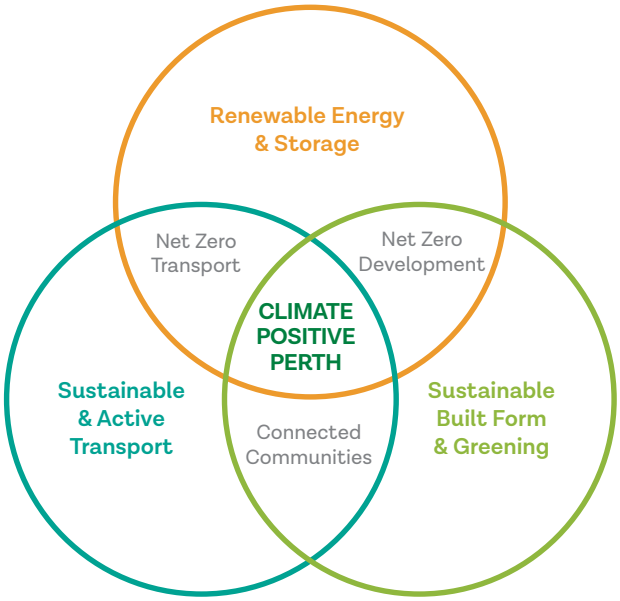
A liveable, cooler and biodiverse city is one that is green and full of trees. The section on urban greening shows us why better protection for the trees and urban bushland that Perth has left is just common sense. We also looked at how we could transform Perth's suburbs and centres through better planning and a major tree planting program.

Together these changes can take metropolitan Perth from one of the most fossil fuel dependent cities on the planet to one that's decarbonised, better to live in and in which all of us can face the challenges of the future.

Synergies and intersections

There are also many opportunities and synergies to come from the intersections between built-form, transport, greening, and energy. The reality is that these elements are often interrelated, and it is where the issues intersect that some of the most innovative solutions for a climate-positive Perth can be found.

Figure 6.2: The interconnected policy areas requiring action to achieve Climate Positive Perth



Reducing energy use is much easier when we live in cooler homes

Cooling our homes is harder if the surrounding surfaces and air are extremely hot due to a lack of shade. Treed and cooler streets make a Climate Positive neighbourhood easier to achieve and more liveable too.

There are also valuable synergies between greening and energy. A major barrier to tree planting in some areas is overhead power lines meaning that trees are either kept small or are not planted at all. Installing underground power lines would allow for more and larger street trees to be planted in areas that previously couldn't support them. The underground power transition can both encourage improved canopy cover and support the shift to LED streetlights.

Shade encourages active transport

Greening will be essential for enabling other aspects of a liveable, connected and decarbonised Climate Positive Perth to be realised. The evidence is in that people much more likely to walk and ride short distances from their homes if they can do that along a shaded street.

Transport is interconnected with built forms

Modelling has demonstrated that well-located public transport, especially fixed route mid-tier transit can support better public transport networks and also better opportunities for land development due to land value uplift. These opportunities could mean the next 30 years of urban development can happen without extending Perth's urban fringe.

The inextricable relationship between land use, urban density and transport needs was a key finding of the Planning Institute's Achieving Net Zero Emissions report showing that '(p)ublic and active transport should be coordinated with urban development to achieve climate change mitigation and other planning aims simultaneously.'

The energy grid is interconnected with private transport

There are strong synergies between energy and transport for a Climate Positive Perth. One example is how EVs intersect with the energy grid. The average vehicle kilometres travelled by each car in Perth is around 12,000 km per year. On average, an electric car will use around 17 kWh of electricity per 100 km, which works out to the average EV in Perth using around 2000 kWh per year. Given there are almost two million licensed light vehicles cars in Perth, and if all of these were electric, an additional 4 million MWh of electricity per year would be required as we decarbonise.

On one level this might seem like a problem but these same EV's also have the potential to be part of the energy solution. EVs can be used as virtual power plants (VPPs) that can help balance the electrical grid and provide ancillary services. The emergence of EVs has made it possible to add another source of decentralised energy to the VPP. EVs can be used to balance the electrical grid by storing energy during periods of low demand and high supply (mostly rooftop solar during the day) and providing energy during periods of high demand and lower supply, largely in the early evening.

There are many more synergies between the different elements of Climate Positive Perth. We hope to further explore and unpack these during the next consultation phase. We would love your feedback on potential synergies that you think should be in the final version of Climate Positive Perth.

A Climate Positive Perth and beyond

There are several elements in the transition to a decarbonised Climate Positive Perth that also sit outside of the key elements of the report that we have covered here.

Some sectors are left out of the analysis, which we plan to include in the final report. One of the sectors is waste which is responsible for just over 2% of Perth's emissions. While only a small percentage it will be a crucial ingredient to get right if we are to fully decarbonise our city. Linked to waste, and worthy of further research, is the food that we consume which also has a carbon footprint. Ways to lower food miles and access to more sustainable and secure food will be important to review. If there are any other areas of interest that you think should be included, please let us know.

A successful decarbonisation transition for Perth will be about sector strategies and projects. But importantly it will also require a clear, accountable and transparent policy-driven governance framework around it.

For Perth (and WA as a whole) to make the best decisions we need clear targets for emissions reductions for each of the sectors and the economy as a whole. This should include a long-term target of net zero by 2050 and also a range of short and medium-term targets for 2030 and before.

In addition to targets and transparent tracking of Perth's emissions, a dashboard of progress should be created and consistently updated. Clear tracking of progress for emissions, and for renewable energy, transport mode-share, infill development, urban greenery, and other areas will be important to check and inform budget decisions.

A good example of this is Wales' Commissioner for Future Generations which frames all policy decisions and expenditure through a decarbonisation agenda. These are the kinds of governance shifts that are going to be necessary as we move beyond business as usual.

If we give serious consideration and planning to the skills transition, then Climate Positive Perth recommendations can happen. There is going to be a need for a workforce with a different set of skills to make the transition to a climate-positive future. These skills will be in strong demand globally and WA would be well-placed if we have plan to attract these people as soon as possible.

Let's create a Climate Positive Perth

A Climate Positive Perth is possible. Almost all the good and inspiring things you have seen in this report already exist, we just need them to become a part of our everyday lives.

Climate change is an existential threat to our way of life, but it is also an opportunity to rethink and reimagine our cities for the better. Perth has the resources to make the most of the necessary transition ahead. If it's done well, a decarbonised Perth is a more liveable and connected Perth. Let's make it happen together.

We'd love to get your feedback!
Scan the QR code or visit
linktr.ee/climatepositiveperth
and share your thoughts.

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