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Advisory**

Report

**Fishermans Bend Net Zero Emissions Strategy
Baseline assessment**

Prepared for:
Department of Environment Land Water and Planning

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The findings in this report have been formed on the above basis.

1 VERSION CONTROL

Version	Date	Author	Project Director
V1	19 September 17	C. Brulliard	C. Knaggs
V2	23 September 17	C. Brulliard	C. Knaggs
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1 CONTEXT AND OBJECTIVE

1.1 Context

Keeping the world average temperature increase under 2°C, and preferably under 1.5°C, is an imperative for humanity, and, after the Paris Conference of the Parties (COP21), leading cities around the world are increasingly and formally committing to align their carbon reduction strategies with these goals.

The Fishermans Bend urban renewal area (FBURA) presents a unique opportunity to put in place strategies and structures able to deliver superior greenhouse gas (GHG) emission performance without compromising on other sustainability and liveability goals. There are challenges to achieving this outcome – most notably the multiple ownership structure of FBURA and the fact that it was rezoned prior to planning controls being put in place to encourage sustainable development outcomes.

A Taskforce led by the Victorian Department of the Environment, Land, Water and Planning (the Department) has been formed to oversee the planning work for the Fishermans Bend and has engaged the Point Advisory – Aurecon consortium to assist with the development of a Net Zero Emissions Strategy for the area (by 2050 or earlier). As many uncertainties remain and planning decisions will need to be made, the strategy will necessarily be high level and is likely to propose different pathways. It will be flexible enough to be easily updated in the future.

Coordination with other projects currently in train, in particular the Taskforce’s submission to Green Star Communities will also inform this work.

A methodology framework for the strategy has been developed, dealing with the boundary and high-level carbon accounting methods for various components of the precinct’s GHG footprint.

1.2 This document

A model for modelling the baseline GHG footprint of the FBURA has been developed, which incorporates several assumptions. The objective of this document is to complement the baseline model and document:

- the assumptions made, based on information available at the time
- the difficulties or gaps encountered
- key considerations for the rest of the strategy development.

The baseline model is transparent and can be updated as the planning and development of FBURA evolves.

1.3 Next steps

Once the emissions baseline is finalised, the next step in this project is to develop a “database” of options for emissions reductions within the FBURA that could be implemented through direct action (such as planning requirements), incentives and voluntary programs. The options will be characterised as much as possible and presented to the Fishermans Bend Taskforce for screening and prioritising before being included in the Net Zero Emissions Strategy.

2 BOUNDARIES FOR THE PRECINCT’S CARBON NEUTRALITY

2.1 Fishermans Bend as a precinct

The FBURA is effectively a collection of five precincts:

- residential and mixed-use precincts: Montague, Sandridge, Lorimer, Wirraway
- one employment precinct of national importance: National Employment and Innovation Clusters (NEIC).

The definition of a precinct is not strict and is defined by the GHG Protocol for Community-Scale Emissions (GPC) based on “geography, unified planning or management intents and a sense of place”. It is therefore deemed appropriate to consider the FBURA as a single precinct to plan a strategy towards carbon neutrality.

2.2 NCOS for precincts as a reference for FBURA

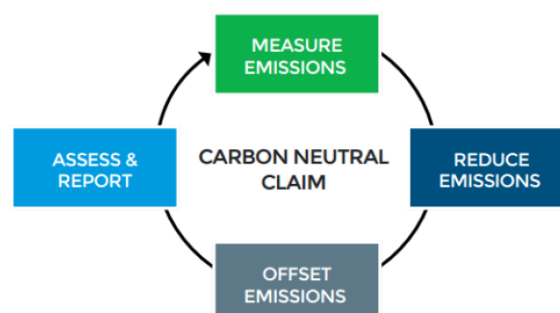
The Taskforce has made it clear that the draft National Carbon Offset Standard (NCOS) for Precincts should be the main point of reference for the Net Zero Emissions Strategy and hence limited time was spent exploring other possibilities. This does not mean that there is any commitment for FBURA to become certified carbon neutral under NCOS; simply that there is a desire to align with a scheme that:

- is robust
- is comprehensive
- encourages emission reductions and continuous improvements before any offsets are considered: the standard is supposed to be able to be used as a reference even in the absence of commitment to carbon neutrality (Figure 1 below presents the NCOS carbon neutrality process)
- has been used as a reference for other projects (e.g. Barangaroo South in Sydney)
- is consistent with international best practices guidelines (the GPC in particular)
- aligns with industry standards and trends (Green Star and NABERS in particular).

The NCOS for Precincts therefore underpins the carbon inventory for the FBURA.

It was however flagged by the Taskforce’s working group that construction and demolition operations should be considered in the strategy, although they are not specifically included in the NCOS for Precincts which focuses on the operational phase.

Figure 1: The NCOS carbon neutrality process



2.3 Emissions boundary for FBURA

Defining the emissions boundary means deciding on inclusions and exclusions of sources of emissions. As mentioned in 2.1 above, FBURA’s “geography, unified planning or management intents” (as evidenced by the mandate of the Taskforce) fits within the NCOS definition of a precinct, with clearly defined geographic boundaries (which exclude, for example, the river-front area leased to the Port of Melbourne Corporation). Emissions from sources and activities occurring within these geographical boundaries should therefore be examined for possible inclusion in the carbon inventory of the precinct.

The GHG Protocol and the NCOS for Precincts establish **relevance** and **materiality** as key principles governing the inclusion or exclusion of emissions from a carbon account. In practice, these two concepts overlap and are most useful for the consideration of scope 3 emissions, as scope 1 and 2 emissions occurring within the geographical boundaries of a precinct are automatically considered as relevant (see box below for a definitions of scopes).

Emissions “scopes”

Emissions included within the emissions boundary can be classified into ‘scopes’ by reference to the Greenhouse Gas Protocol to ‘help delineate direct and indirect emissions sources’ (WBCSD and WRI, 2013).

- **Scope 1** emissions include all direct greenhouse gas emissions from sources that are within the precinct’s emission boundary. These could be emissions from fuel use, refrigerants and electricity generation.
- **Scope 2** emissions include purchased electricity, heat and steam i.e. energy produced outside the boundaries of the precinct but used within the precinct (unless they are purchased for resale).
- **Scope 3** emissions are all indirect emissions that occur as a result of the activities of the precinct, but occur from sources not necessarily within the precinct’s boundary.

Source: NCOS for Precincts, draft for consultation

The NCOS for Precincts and the GHG Protocol Corporate Accounting Standard specify that scope 3 emissions sources should be included when two or more of the following conditions the are met:

- the scope 3 emissions from the source are likely to be large relative to the precinct’s scope 1 and scope 2 emissions
- the scope 3 emissions from the source contribute to the precinct’s greenhouse gas risk exposure
- the scope 3 emissions from the source are deemed relevant by key stakeholders
- the responsible entity has the potential to influence the reduction of scope 3 emissions from the source
- the scope 3 emissions from outsourced activities that were previously undertaken within the precinct’s boundary or from outsourced activities that are typically undertaken within a precinct’s boundary for comparable precincts.

This approach does leave some scope for interpretation and is more flexible than the GPC. However, the appendix to the NCOS for Precincts provides some guidance on carbon accounting for key activities of the precincts, which has informed the recommended inclusions in the FBURA’s emissions boundary presented in Table 1.

Table 1: Recommendations for FBURA GHG inventory

Sources category	Scope 1 and 2 inclusions	Scope 3 inclusions	Comments
Proposed inclusions			
Transport	Intra-precinct private and public transport	Transport induced by precinct maintenance or management activities	The rationale for including half of the precinct’s transport activities of the occupants is to be able to consolidate transport from different precincts
	Transport induced by precinct	Half of the extra-boundary transport	

Sources category	Scope 1 and 2 inclusions	Scope 3 inclusions	Comments
	maintenance or management activities	generated by the activities of the occupants of the precinct	(into a city’s inventory for example) without double counting. <i>Note that the inclusion of all forms of transport is challenging.</i>
Water and wastewater	On-site treatment of wastewater, sewer mining (if any)	Distribution of reticulated water, including “third pipe” recycled water Off-site treatment of wastewater Vacuum sewer energy, if required	Energy embodied in recycled water provided through third pipes may also need to be considered – although it is displacing freshwater and thus contributing to a different sustainability goal. Establish link with organic waste if “in-sinkerators” are used to deal with these.
Waste	On-site treatment of waste (if any)	Off-site treatment of waste, including waste transportation	
Co and tri-generation	Include if the unit is located within the precinct, even if energy is exported Use scope 2 grid factors for imported co- and tri-generation		
Energy consumption by occupants (residential and industrial) and precinct infrastructure (streetlights)	On-site consumption of fuels, gas, and electricity to be included		Under NCOS, depending on the reporting entity, tenant energy use may be considered as scope 3 emissions.
Proposed exclusions			
Residents’ consumption (food, clothing, assets, etc)	The NCOS opens the possibility to include any “relevant and material” sources of emissions from products and services consumed within the precinct. PAS 2070 includes a “consumption based” method for calculating cities’ carbon inventories.		
Consumables and products for economic activities	However, beyond energy systems (gas and electricity) and other utilities, consumption from residents and corporates in a district are typically not tracked (e.g. Barangaroo).		

Sources category	Scope 1 and 2 inclusions	Scope 3 inclusions	Comments
Construction energy consumption			Typically, a target to achieve better lifecycle GHG emissions is incorporated in precincts where a developer or development authority has full control.
Embodied emissions in buildings and infrastructure			While there is no such control in FBURA, there is a strong feeling amongst the Taskforce Working Group that reference should be made to lifecycle impacts, including embodied emissions and emissions from the construction phase of buildings and infrastructure.
Renewable energy consumption eligible for emissions reduction (under NCOS for Precincts)			
Renewable energy generated under the Small-scale Renewable Energy Scheme (SRES)			Regardless of whether Small Technology Certificates (STCs) have been created, sold or transferred to any other party, energy generated by these systems can be considered as “zero emissions”.
Renewable energy generated under the Large-scale Renewable Energy Target (LRET)			<p>Large Generation Certificates (LGCs) are created based on the amount of eligible renewable electricity produced by a power generator and can be sold or traded to LRET liable entities to assist them in meeting their obligations.</p> <p>LGCs can effectively be used to make electricity from the grid “zero-emissions”, if they are retired rather than sold.</p> <p>Behind-the-meter usage of energy generated by the system can only be considered as zero-emissions energy if the equivalent amount of LGCs is voluntarily retired.</p> <p><i>Note that the building industry has contested this position.</i></p>
GreenPower			The purchase of GreenPower is equivalent to the direct use of renewable energy, and can therefore be considered “zero emissions”.
Australian Carbon Credit Units (ACCUs) under the Emissions Reduction Fund			ACCUs from emissions reduction projects occurring within the boundary of a precinct can only be claimed as a reduction if the ACCUs from the projects are voluntarily retired.
Other eligible energy reduction activities			
Emissions reduction activities under the Victorian Energy Upgrades scheme			Creating and selling Victorian Energy Efficiency Certificates (VEECs) does not impact the validity of emissions reduction under NCOS.

3 THE BASELINE

3.1 Purpose of the baseline

The precinct baseline's main purpose is to present a reference scenario from which opportunities for emissions reductions can be calculated. It should therefore incorporate all components of the carbon inventory considered "within boundary" (see section 2), broken down in the most practical way to enable the characterisation of emissions reduction opportunities. The reference scenario should reflect the most likely scenario for now and the future, in the absence of further changes to the policy and regulatory environment, incorporating controls and policies already in place.

For FBURA, the precinct baseline is essentially a hypothetical scenario where the precinct would be fully developed (housing 80,000 residents and 80,000 jobs) but with the controls, conditions and standards currently in place. Therefore, for the rest of the document, the baseline will be referred to as the "Business as Usual" (BAU) trajectory.

Assumptions will then be made to create a BAU scenario incorporating some tightening of standards (primarily based on the Building Code) and conditions (emission factors) over time, reflecting what is likely to happen in the absence of any FBURA-specific action.

3.2 Components of the "Business as Usual" trajectory

All energy use and emissions from the following sources will be considered in the BAU trajectory, insofar as they are included in the FBURA Precinct Plan:

- Residential buildings (multi-storey)
- Commercial buildings (offices)
- Commercial buildings (retail)
- Commercial buildings (warehouses – employment precinct only)
- Commercial buildings (light industry – employment precinct only)
- Community services buildings (and indoor sport facilities)
- Public Infrastructure (streetlights and outdoor sport facilities)
- Transport (mode share)
- Waste transport and management
- Water and wastewater
- Space for local renewable energy generation capacity: mainly roof space, plus Building Integrated Photovoltaics (BIPV) as relevant.

As mentioned above, only "operational" energy and emissions have been considered: no embodied emissions or energy use for construction activities will be considered.

3.3 Structure of the model

The lead document setting key planning directions for the precinct is the confidential Fishermans Bend framework. This document and a suite of more detailed analyses (documented in the methodology framework) has been used to define the BAU model (and some of the emission reduction opportunities).

To enable the model to be easily updated (and in particular, scaled up and down), it has been built in such a way that the number of jobs (FTEs) and the number of residents drive most components of the footprint. The only components that are fixed are:

- the public lighting infrastructure, as the roads and hence the streetlights are fixed infrastructure largely independent of the density of the precincts, and

- community buildings, which have been planned in response to the anticipated demand from precinct occupants but could not be made as directly scalable as the other impacts.

The rate of development of the precinct is therefore a key assumption (see section 3.4) that will have a bearing not only on the overall footprint of the precinct in 2050, as emission levels are “locked in” when buildings are approved and built. The overall “carbon budget” of the precinct, as represented by carbon emissions from now to 2050, will be all the higher than the precincts develops early and under lax building standards (see **Error! Reference source not found.** for an illustrative diagrammatic representation of the difference).

Cumulative building emissions over time (10,000m² NLA)

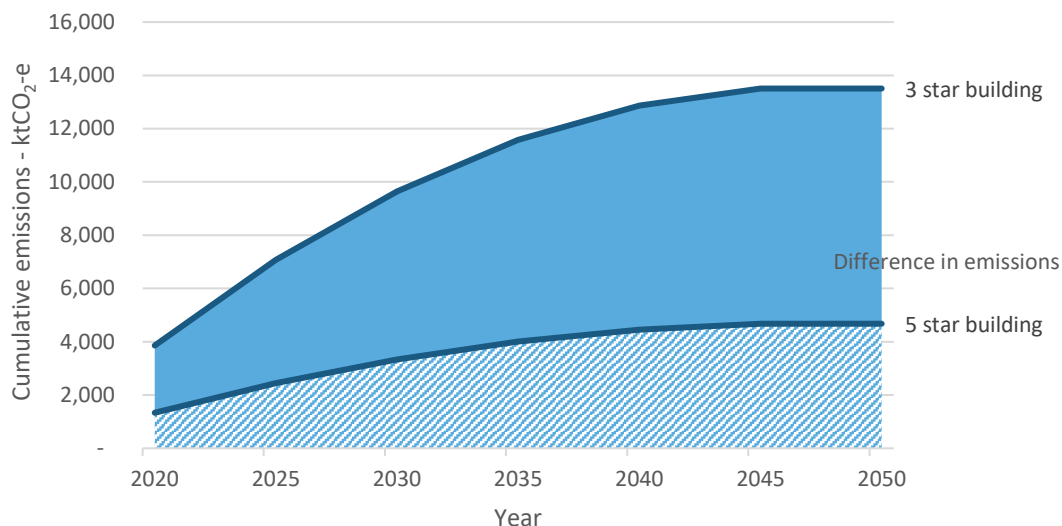


Figure 2: Cumulative difference in emissions for a building

To provide some sense of the uncertainty surrounding emissions modelling, “optimistic” and “pessimistic” projections have been provided wherever possible for each component of the model. It is acknowledged that a level of judgment and hence subjectivity has been applied when defining the parameters of these projections.

3.4 Key assumptions and drivers

This section outlines the assumptions that have the greatest bearing on the model. It must be highlighted that not all assumptions used in the model are documented here, however they have been fully referenced in the model.

3.4.1 General assumptions

3.4.1.1 Rate of development or redevelopment

The rate of development of the FBURA has been modelled in 5-yearly time intervals, based on:

- the Fishermans Bend Framework’s population figures for the mixed-used precincts for 2018, 2025 and 2050 and a linear extrapolation of these figures for the dates in between
- a linear development of the employment precinct to 40,000 FTEs by 2050, aligned with the industry category split developed by SGS economics for that date.

The tables below show assumptions around the rate of development of the precinct.

Table 2: FBURA population over time

Population		2018	2020	2025	2030	2035	2040	2045	2050
Residential	Sandridge	520	623	880	6,624	12,368	18,112	23,856	29,600
	Lorimer	280	1,183	3,440	5,152	6,864	8,576	10,288	12,000
	Montague	280	1,471	4,450	7,720	10,990	14,260	17,530	20,800
	Wirraway	200	246	360	3,808	7,256	10,704	14,152	17,600
	Total residential	1,280	3,523	9,130	23,304	37,478	51,652	65,826	80,000
Workers	Sandridge	5,200	6,880	11,080	14,064	17,048	20,032	23,016	26,000
	Lorimer	1,820	1,954	2,290	3,032	3,774	4,516	5,258	6,000
	Montague	3,240	3,286	3,400	3,520	3,640	3,760	3,880	4,000
	Wirraway	2,410	2,504	2,740	2,992	3,244	3,496	3,748	4,000
	Employment district	17,880	19,263	22,719	26,175	29,631	33,088	36,544	40,000
	Total commercial	30,550	33,887	42,229	49,783	57,337	64,892	72,446	80,000

Table 3: FBURA commercial and industrial development over time

Roll out	2018	2020	2025	2030	2035	2040	2045	2050
Sandridge	0%	8%	28%	43%	57%	71%	86%	100%
Lorimer	0%	3%	11%	29%	47%	64%	82%	100%
Montague	0%	6%	21%	37%	53%	68%	84%	100%
Wirraway	0%	6%	21%	37%	52%	68%	84%	100%
Employment precinct	0%	6%	22%	38%	53%	69%	84%	100%

Note: this assumes that as existing buildings are redeveloped, employees would be temporarily shifted to different buildings.

To model the BAU case, it was further assumed that:

- Every building would be redeveloped one way or another (heritage buildings are assumed to be upgraded, albeit at higher costs and/or will not represent a material impact)
- Buildings developed at the start of the period (e.g. between now and 2030) would not be replaced or undergo a major upgrade by 2050
- No commercial building has yet been built in FBURA (i.e. current employees occupy buildings that will eventually be replaced by new buildings meeting the new standards)
- The few residential buildings already built meet the minimum standards documented in our baseline assumptions below.

3.4.1.2 Residential buildings

The assumptions above and the data collected from Hodyl+Co result in the following multi-unit residential building areas across the four mixed-use precincts by 2050.

Table 4: Multi-residential areas by 2050

Precinct	Residents	Dwellings	Average dwelling size (m ²)	Total GFA (m ²) excluding parking*	Already approved dwellings GFA (service)**
Sandridge	29,600	6,822	81	690,728	64,881
Lorimer	12,000	14,949	74	1,382,783	139,277
Montague	20,800	9,244	77	889,735	362,093
Wirraway	17,600	5,882	74	544,085	108,225
Total	80,000	36,897	76	3,507,330	674,476

* Including 25% floor area for circulation / service

** These buildings may not be built and have been assumed to meet current building standards.

3.4.1.3 Commercial building types

The types of buildings presented in the table below have been derived from the SGS report (2016) on employment by industry categories in the FBURA, manually matched to assumed types of building. This is however highly uncertain, as some manufacturing companies may need more warehouse type buildings and / or may incorporate some office type of buildings.

Table 5: Commercial building types by 2050

Building type	Employment (FTE)			Area per employee (m ²)*	Total area by 2050 (m ²)
	Total	Employment district	Mixed used districts		
Office	46,639	11,181	35,458	31	1,445,809
Warehouse	14,700	14,700		73	1,073,100
Light industrial	12,606	12,606		43	542,058
Retail	6,055	1,513	4,542	51	308,805
Total	80,000	40,000	40,000		3,369,772

*Source: USBG.ORG

3.4.1.4 Electrification

Full electrification of buildings (as opposed to using gas for heating / hot water) may happen under a BAU scenario, driven simply by market forces, but it is difficult to predict. The switch from gas to electricity opens the opportunity to source zero emissions renewable electricity to displace grid electricity.

A “switch” has therefore been introduced in the model to model a “100% electricity” scenario with no on-site gas consumption. This may not be accurate in the earlier years but provides the ability to update the level of electrification as time progresses to explore its potential role in achieving carbon neutrality.

3.4.1.5 Emissions factors

Emissions factors for grid electricity change over time as the grid generation mix changes. While the current emissions factor for the Victorian electricity grid is set by the National Greenhouse Accounts factor document published by the Commonwealth Government each year, the rate of “decarbonisation” of the grid over time is unknown and surrounded with high political, and to a lesser extent, technical uncertainty.

The model therefore incorporates three trajectories for Victorian electricity grid emission factors, which can be explored as three separate scenarios (high / medium / low decarbonisation). These factors are distinct from “optimistic” and “pessimistic” scenarios defined for each component of the footprint. The three scenarios have been derived from work done by the Climate Change Authority. It is assumed that the Victorian grid factor – currently the highest in Australia – would converge to the average Australian grid factor by 2030 as policies in favour of renewables are rolled out in Victoria. Projected emission factors are shown in the table below. A sensitivity scenario with a “flat” emission factor will also be explored to provide a scenario showing the impact of energy efficiency and emissions

reduction in the absence of grid emission reductions. Scope 2 and 3 factors have been combined to include whole-of-lifecycle emissions.

Table 6: Electricity emission factors projections (kg CO₂-e/kWh)

Scenario	2018	2020	2025	2030	2035	2040	2045	2050
High emissions, low decarbonisation	1.19	1.1	0.90	0.69	0.69	0.69	0.68	0.67
Medium emissions, moderate decarbonisation (~80% by 2050)	1.19	1.1	0.86	0.62	0.55	0.47	0.37	0.26
Low emissions, high decarbonisation (~90% by 2040)	1.19	1.1	0.63	0.25	0.18	0.10	0.10	0.09
Flat (for reference)	1.19	1.19	1.19	1.19	1.19	1.19	1.19	1.19

The emissions factors for gas, diesel and other fossil fuels are assumed to remain the same for the period as these are determined by chemistry and it is assumed that no technologies to capture carbon emissions at the point of combustion could be implemented on a small scale (for example, in vehicles). Fuel efficiency may improve, but the emissions factors for a unit of fuel will remain the same. Scope 2 and 3 factors have been combined to include full-cycle fuel emissions.

Table 7: Fuel emission factors projections

Fuel	Emission factor	Unit
Distributed gas (Victoria)	55.43	kg CO ₂ -e /GJ
LPG	1.69	kg CO ₂ -e /GJ
Diesel fuel	2.86	kg CO ₂ -e /GJ

3.4.2 Assumptions by source of the footprint

Note that the Energy Use Intensity (EUI) represents the average energy intensity of buildings built in the five-year period following the implementation of the standards. Hence, a requirement to achieve a NABERS rating of 5 Stars for residential dwellings in 2035 would result in an average EUI of 114 kWh/m² for all buildings built between 2035 and 2040.

3.4.2.1 Multi-unit residential buildings

Residential building carbon emissions have been calculated based on:

- the number of square meters built, as per the development rate defined in Table 2 above and based on the average m² per dwelling defined in the Hodyl+Co (June 2017) analysis
- The average energy usage per m², as per the assumed performance benchmark for the year of construction (see Table 8 below).

Only one category of building has been considered: multi-storey residential buildings.

An optimistic and a pessimistic scenario have been defined, assuming a quicker / slower (respectively) tightening of building standards.

Two sub-scenarios have been defined depending on whether the building is assumed to use only electricity as a source of energy or whether gas is still use for some of the space and water heating (assumed to be 79% electricity and 21% gas in the mixed scenario).

Table 8: Multi-unit residential building energy use (average)

	2018	2020	2025	2030	2035	2040	2045	2050
Reference	NatHERS 6 star / NCC	NatHERS 6 star / NCC	NABERS 4.5 Star	NABERS 4.5 Star	NABERS 5 Star	NABERS 5 Star	NABERS 5.5 Star	NABERS 6 Star
EUI (kWh/m²) Gas & electric	267	267	152	152	114	114	85	57
<i>Electricity (kWh/m²)</i>	211	211	120	120	90	90	67	45
<i>Gas (MJ/m²)</i>	202	202	115	115	86	86	65	43
EUI (kWh/m²) Electric only	267	267	123	123	92	92	68	55

Note: NCC = National Construction Code

For the above figures:

- An energy model was created to determine multi-unit building energy use over a period of a year.
- This includes HVAC, lighting, appliances, domestic hot water, lift and external lighting energy use.
- Apartments were modelled to NCC requirements.
- Energy use is representative of 2017 residential units.
- The building of residential buildings that have already obtained approval (about 20% of the projected residential dwellings in 2050) was estimated stretch beyond 2025; hence enforced standards would make no difference until 2030.

Sources

Australian Bureau of Statistics

<http://www.abs.gov.au/AUSSTATS/abs@.nsf/Previousproducts/8752.0Feature%20Article1Jun%202013>

Climate Works Australia Low Carbon. High Performance Modelling Assumptions <http://www.asbec.asn.au/research-items/low-carbon-high-performance-report/>

3.4.2.2 Commercial buildings – offices

Commercial office building carbon emissions have been calculated based on:

- The number of square meters built, as per the development rate defined in Table 3 above and based on the number of target employees by 2050 (80,000 including 40,000 in the employment district)
- the average m² floorspace per employee defined in the Hodyl+Co (June 2017) analysis for office buildings and assumptions made for other types of buildings (see table below)
- The average energy usage per m², as per the assumed performance benchmark for the year of construction (see table below).

Table 9: Commercial building energy use (average)

	2018	2020	2025	2030	2035	2040	2045	2050
Reference (medium)	NABERS 4.5 Star	NABERS 5 Star	NABERS 5 Star	NABERS 5.5 Star	NABERS 6 Star	NABERS 6 Star	NABERS 7 Star*	NABERS 7 Star*
EUI (kWh/m²) gas & electric	181	149	149	111	75	75	75	75
<i>Electricity (kWh/m²)</i>	143	118	118	88	59	59	59	59
<i>Gas (MJ/m²)</i>	137	112	112	83	58	58	58	58

EUI (kWh/m²) electric only	149	123	123	92	61	61	61	61
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* Renewables, GreenPower and continual improvements in building energy efficiency performance can be used to move from NABERS 6 star to 7 star.

For the above figures:

- 2015 data from ClimateWorks Modelling Assumptions Document was used to determine whole of building energy use for a typical office. Current average NABERS rating for an office is 3 stars.
- NABERS Energy Reverse Calculator utilised to determine minimum required energy intensity per m² to achieve stated BAU NABERS energy targets. EUI is for whole of building. Can be divided in to base building and tenancy if required.
- Assumed total energy mix of 79% electricity and 21% natural gas, with HVAC energy use mix at 30% gas and 70% electricity.
- Assumed 15 W/m² for computer equipment density for purposes of NABERS reverse calculation.
- Equivalent all-electric building EUI included. EUI required for full electric building is lower than for mix gas and electricity.
- NABERS 7 star energy target is currently not available but conversations with the NABERS Administrator indicate a 7 star NABERS building will be net zero emissions.

Sources

NSW Office of Environment and Heritage Reverse Calculator:

<https://nabers.gov.au/public/webpages/ContentStandard.aspx?module=40&template=3&include=Reverse.htm&side=CommitmentAgrTertiary.htm>

Climate Works Australia Low Carbon. High Performance Modelling Assumptions

<http://www.asbec.asn.au/research-items/low-carbon-high-performance-report/>

Pitt & Sherry, 2012, Baseline Energy Consumption and Greenhouse Gas Emissions in Commercial Buildings in Australia.

Available via: <http://www.industry.gov.au/energy/energyefficiency/nonresidentialbuildings/Pages/CommercialBuildingsBaselineStudy.aspx>

3.4.2.3 Commercial buildings other than offices

While it is not possible to predict what industries will eventually move in to the FBURA, in particular in the employment precinct, it is important to recognise the diversity of operational energy use of different types of buildings housing these varied economic activities (this includes the energy required to carry out these activities, not only the base building energy). They could range from light industrial to data centres and from fast food outlets to clothing retailers. The assumed mix of activities will have a major impact on the carbon footprint of the FBURA and the opportunities to reduce it. Different scenarios may therefore need to be considered.

For other types of buildings, a high / medium / low range of energy use has been determined for various types of business activity (as well as creating two profiles: one for all electric energy use and one for a mix of electricity and gas). These are summarised in the tables below.

The floor area used to calculate the overall footprint for warehouses and light industrial is presented in Table 5 above, as well as the overall areas assumed to be allocated to retail. To be able to apply the energy use assumptions presented in Table 10 below, it was necessary to make assumptions about the mix of retail types. This is presented in Table 11.

Table 10: Commercial building energy use (average) – retail

	2018	2020	2025	2030	2035	2040	2045	2050
High energy intensity restaurant/fast food EUI (kWh/m²) Gas & electric	1,937	1,937	1,840	1,743	1,646	1,550	1,453	1,356
<i>Electricity (kWh/m²)</i>	<i>1,298</i>	<i>1,298</i>	<i>1,233</i>	<i>1,168</i>	<i>1,103</i>	<i>1,039</i>	<i>974</i>	<i>909</i>

	2018	2020	2025	2030	2035	2040	2045	2050
Gas (MJ/m ²)	2,300	2,300	2,185	2,070	1,955	1,840	1,724	1,609
Street retail EUI (kWh/m ²) electric	187	187	178	168	159	150	140	131
Supermarket EUI (kWh/m ²) electric	937	937	890	843	797	750	703	656
Shopping centre retail EUI (kWh/m ²) gas & electric	444	444	407	395	359	346	309	297
Electricity (kWh/m ²)	351	351	322	312	284	273	244	235
Gas (MJ/m ²)	335	335	306	299	270	263	234	223

For the above figures:

- Retail in shopping centre is a combined tenancy and base build EUI.
- Renewables, GreenPower and continual improvements in building energy efficiency performance to form part in achieving a rating from NABERS 6 star to 7 star
- Assumed total energy mix of 79% electricity and 21% natural gas unless otherwise stated

Table 11: Areas per type of retail

	2018	2020	2025	...	2050	Assumption
Retail - mix used precincts						
High energy intensity restaurant / fast food	-	827	2,894		10,238	1 per 263 households or 760 residents and adding 30% to account for workers patronage, then assuming 75m ² per outlet
Street retail / low intensity food retail	-	14,975	52,412		185,405	Assumes half as many outlets as mix used district
Shopping centre retail	-	840	2,940		10,400	Difference / remainder
Supermarket	-	2,068	7,237		25,600	1 supermarket (3,200m ²) for 10,000 residents

	2018	2020	2025	...	2050	Assumption
Retail - employment precinct						
High energy intensity restaurant / fast food	-	320	1,120		5,119	Assumes half as many outlets as mix used district
Street retail / low intensity food retail	-	3,678	12,872		58,844	Difference / remainder
Shopping centre retail	-	625	2,188		10,000	One large shopping centre for employment district
Supermarket	-	200	700		3,200	1 supermarket (3,200m ²)

Table 12: Commercial building energy use (average) – other

	2018	2020	2025	2030	2035	2040	2045	2050
BAU (Medium)	NCC	NCC	-5%	-5%	-5%	-5%	-5%	-5%
Warehouse EUI (kWh/m²) electric *	71	71	67.5	63.9	60.4	56.8	53.3	49.7

Light industrial EUI (kWh/m²) electric **	144	144	137	129	122	115	108	101
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* Non-conditioned warehouse. All electricity assumed for calculation purposes is lighting.

** Green Star Energy Consumption and Greenhouse Gas Emissions Calculation Guide - operation profiles used for equipment load utilisation and NCC used to determine average energy use for equipment load as it is impossible to determine amount of equipment energy use for a typical light industrial building.

Sources

NSW Office of Environment and Heritage Reverse Calculator

<https://nabers.gov.au/public/webpages/ContentStandard.aspx?module=40&template=3&include=Reverse.htm&side=CommitmentAgrTertiary.htm>

Pitt & Sherry, 2012, Baseline Energy Consumption and Greenhouse Gas Emissions In Commercial Buildings in Australia. Available via: <http://www.industry.gov.au/energy/energyefficiency/non-residentialbuildings/Pages/CommercialBuildingsBaselineStudy.aspx>

Energy Star Technical Reference – U.S. Energy Use Intensity by Property Type

<https://portfoliomanager.energystar.gov/pdf/reference/US%20National%20Median%20Table.pdf>

ASHRAE 1651-RP Development of Maximum Technically Achievable Energy Targets for Commercial Buildings

CIBSE Guide F – Energy Efficiency in buildings

Green Star Energy Consumption and Greenhouse Gas Emissions Calculation Guide

3.4.2.4 Community buildings

Community facilities will only contribute marginally to the overall footprint of the precinct, given their minor floorplate. However, as they will be controlled directly by local government, the levers for action to reduce emissions at these facilities will be much more direct. Their energy use per m² is assumed to be higher than commercial buildings, primarily due to a higher utilisation profile.

Table 13: Community building energy use (average)

	2018	2020	2025	2030	2035	2040	2045	2050
BAU (Medium)	NCC	NCC	-5%	-5%	-5%	-5%	-5%	-5%
Community facility EUI (kWh/m²) gas & electric	287	287	273	258	244	230	215	201
<i>Electricity (kWh/m²)</i>	227	227	216	204	193	182	170	159
<i>Gas (MJ/m²)</i>	216	216	205	194	184	173	162	151
Community facility EUI (kWh/m²) electric only	236	237	225	214	198	187	175	163
Sport facility EUI (kWh/m²) electric only	360	360	342	324	306	288	270	352

For the above figures:

- Assumed energy mix of 79% electricity and 21% gas for community buildings and 40% electricity and 60% gas for sport facilities.
- “Electricity only” numbers are scaled from electricity/gas based on the % for other commercial

3.4.2.5 Carparking

Carparks are assumed to be of similar type for residential and commercial buildings, i.e. it is assumed that carparks are all multi-storey enclosed carparks, requiring lighting and ventilation (as opposed to open-air carparks), and likely to be enclosed in the podium of multi-storey buildings (underground carparks are unlikely because of the geology).

However, as energy use is dependent on the intensity of use (hours of occupancy, lighting power density and ventilation energy), different profiles have been created for residential and commercial building car parks (see Table 14 and Table 15 below).

It is also important to note that naturally ventilated car parks for residential premises are common when they are above ground. Most residential apartment buildings use natural ventilation as they are located above ground. Below ground car parking requires mechanical ventilation along with lighting. This however creates the challenge of street activation, which in turn may impact on the ability to naturally ventilate carparks).

Two scenarios have been defined for both residential and commercial car parking, including an option for naturally ventilated carparks that could be used for some of the buildings, depending on technical constraints (see tables below, with the option vary the mix of naturally vs mechanically ventilated car parking for sensitivity analysis).

As for other components of the footprint, an optimistic and pessimistic scenario have been defined (but are only presented in the spreadsheet model).

Table 14: Residential car park energy use (average)

Electricity use	2018	2020	2025	2030	2035	2040	2045	2050
Assumed efficiency gain	-	-	5%		5%		5%	
Mechanically ventilated (kWh/m ²)	9.4	9.4	8.9	8.9	8.4	8.4	8.0	8.0
Naturally ventilated (kWh/m ²)	5	5	4.7	4.7	4.5	4.5	4.3	4.3

Table 15: Commercial / retail car park energy use (average)

Electricity use	2018	2020	2025	2030	2035	2040	2045	2050
Assumed efficiency gain	-	-	5%		5%		5%	
Mechanically ventilated (kWh/m ²)	24.5	24.5	23.3	23.3	22	22	20.8	20.8
Naturally ventilated (kWh/m ²)	5	5	4.7	4.7	4.5	4.5	4.3	4.3

3.4.2.6 Transport

Several key assumptions underpin the transport model. These have been developed to align with the assumptions adopted by Arup in earlier transport modelling undertaken for FBURA¹, and with the current Integrated Transport Plan². The key assumptions are:

- That the residential and working populations will grow, as shown in Table 2.
- That the distance travelled per person per year, as assumed by Arup, remains consistent across future scenarios. In applying this distance, standard carbon accounting practice has been adopted in that 50% of the total distance (i.e. one leg of each two-way journey) has been included in the Fishermans Bend footprint. Assumed average travel distances (i.e. half the distance travel) are:
 - Residents: 2,689 km/person/year.
 - Workers: 3,358 km/person/year.
- That fuel efficiency for fossil fuel powered vehicles will continue to improve into the future. Optimistic, average and pessimistic improvement scenarios have been developed by extrapolating historic trends in the average on-road fuel consumption of Australian new light vehicles³. The same improvement curves have been assumed to apply to buses (Table 16).
- That electricity consumed for trams is assumed to follow the forecast Victorian grid factors until 2025, when it is assumed that renewable energy will power Yarra Trams' network⁴.
- That electricity consumed by trains and electric vehicles will follow the forecast Victorian grid factors.
- Two electric vehicle uptake trajectories were included, starting from almost 0% in 2018 and progressing to:
 - 25% EV uptake by 2050

¹ Arup 2015 – Testing new approaches to city-shaping urban renewal – Fishermans Bend Environmental Footprinting Study

² DEDJTR 2017 - Fishermans Bend Integrated Transport Plan

³ BITRE 2014 – New passenger vehicle fuel consumption trends, 1979 to 2013. https://bitre.gov.au/publications/2014/files/is_066.pdf

⁴ <http://www.yarratrams.com.au/media-centre/news/articles/2017/world-first-solar-to-power-melbourne-tram-network/>

- 70% EV uptake by 2050.
- Five scenarios were developed for potential mode-share splits. All scenarios adopt a 2018 starting point of 93% car, 5% bus and 2 % walking/bicycle, and evolve in-line with the earlier Arup modelling and the Integrated Transport plan to the following end-points:
 - 7% sustainable transport by 2050
 - 44% sustainable transport by 2050
 - 62% sustainable transport by 2050
 - 72% sustainable transport by 2050
 - 80% sustainable transport by 2050.

Table 16: Forecast improvement scenarios for fossil fuel powered vehicle fuel economy

	2018	2020	2025	2030	2035	2040	2045	2050
Pessimistic	100%	99%	97%	95%	93%	91%	89%	86%
Average	100%	98%	94%	89%	84%	80%	75%	70%
Optimistic	100%	98%	92%	86%	81%	75%	70%	64%

3.4.2.7 Water and wastewater

The water and wastewater models are primarily driven by the number of people (residents and workers) in the precinct.

Average water use per person is assumed to be 193L per person per day for residential, which is assumed to be stable over time. The data has been sourced from the planning analyses done by South East Water (SEW). An emissions factor for each litre of water delivered to a retail customer is then applied to the volume of water calculated (2005 Melbourne Water, published by City of Melbourne).

The average wastewater generated is a percentage of the water use. This will only change if wastewater is recycled on site, which is not assumed to occur under BAU.

Under BAU, recycled water will be provided to FBURA through a third pipe and will be used for outdoor use (private and public green spaces) and indoor use (toilets and laundry). This is only assumed to occur in 2030 when a Sewer Mining Plant will be built and operated, mining wastewater from the Melbourne main sewer line bringing sewerage to the Western Treatment Plant, through Fishermans Bend. As such, the Sewer Mining Plant will extract volumes of wastewater from the sewer that are likely to exceed the volumes of wastewater produced by the FBURA, and this wastewater will come from the whole of Melbourne. The table below shows the volume of water considered as “substitutable” with recycled (non-potable) water.

It should be noted that the average volume of water assumed by SEW is relatively high, compared to the latest (2015/16) average consumption published by Melbourne Water (166L/person/day) or the target water consumption per person set during the drought (155L/person/day). See section on challenges below.

Table 17: Commercial building water and wastewater (average)

Water use	Unit	Demand	of which substitutable	Wastewater as a % of demand	Source
Residential	L/pers/day	193	85	91%	South East Water / ARUP
Commercial (offices and others)	L/pers/day	95	50	91%	South East Water / ARUP
Active open space	ML/ha/year	5.5	5.5	0%	South East Water / ARUP
Passive open space	ML/ha/year	1.6	1.6	0%	South East Water / ARUP
Streetscape	ML/ha/year	1	1	0%	South East Water / ARUP

Table 18: Assumed area of open space

Open space	2018	2020	2025	2030	2035	2040	2045	2050
Active open space	-	-	0.01	0.03	0.61	0.81	1.00	1.20
Passive open space	55.9*	59.9	67.8	77.3	86.7	96.1	105.6	115.0
Streetscape	-	1.56	5.47	9.38	13.28	17.19	21.09	25

* This includes 40ha of existing park (Westgate park).

Source: FB framework

Emissions factors

Emission factors for water and wastewater are derived from full lifecycle figures from Melbourne Water from some years ago:

- 0.173 tCO₂-e / ML of potable water (source: Melbourne Water 2004/05)
- 0.875 tCO₂-e / ML of wastewater (source: Melbourne Water 2004/05)

Whether these numbers improve over time is uncertain, as the concentration of nutrients in wastewater may increase over time as buildings become more water efficient (although total nutrient load released to the sewer would remain the same). Therefore, it has been assumed that the emissions factor would remain constant to 2030, after which it will drop to zero as South East Water (and probably Melbourne Water) has pledged to become carbon neutral by then.

In this context, the emissions from the Sewer Mining Plant will not actually have to be offset, hence emissions calculated are only provided for information and the large uncertainty around energy consumption of the plant will not have an impact on the net footprint.

3.4.2.8 Solid waste

Waste emissions are driven by:

- the volume of waste generated by each person (residential or commercial waste), hence they are proportional to population growth
- the proportion of waste going to landfill vs recycling (for the baseline) and the proportion of waste potentially going to an organic waste treatment facility (for emission reductions opportunities)
- assumptions on technical waste treatment, and hence emissions per tonne of waste from these treatments.

Emissions from waste transportation also contribute, to a small degree, to overall emissions. This was included in the model to check that it was indeed not material.

Table 19: Solid waste volume generation

Waste generation (t/person/year)	Garbage	of which organics	Recyclables	of which residual fraction going to landfill
Residential	0.26	40%	0.15	7.8%
Commercial (offices and others)	0.57	22%	0.68	7.8%

Emissions factors

Emission factors for waste types were obtained from the National Greenhouse Accounts and Point Advisory's own calculations (for recycling). They are not considered variable over time, although options to improve the processing of waste will be considered when identifying emission reduction options. These factors are presented in Table 20.

Table 20: Solid waste emission factors

Type of waste	Emissions factor (kg CO ₂ -e/t waste)
Residential (MSW) to landfill	1,400
Commercial (C&I) to landfill	1,200
LFG (methane) combusted in landfill - kg CO ₂ /m ³	0.18
For alternative treatment of organics (not in BAU)	
Food	1,900
Paper and cardboard	2,900
Garden and green	1,400

3.4.2.9 Street lights

This part of the footprint is assumed to include general street lights and public lighting, including lighting for outdoor sporting infrastructure. Note that no major sporting facilities (e.g. outdoor stadiums) has been factored into the footprint at this stage, as opposed to smaller facilities (as per Table 21 below).

Both the City of Melbourne and the City of Port Phillip have committed to sourcing 100% renewable energy for streetlights, hence this part of the footprint is carbon neutral.

Nevertheless for the sake of completeness, it is assumed that all the street light infrastructure in Fishermans Bend would be built as the precinct redevelops and that the most efficient equipment would be fitted at that stage and remain in place to 2050.

Assumptions are documented in the tables below.

Table 21: Public infrastructure - development rate

	2018	2020	2025	2030	2035	2040	2045	2050
Streetlights	50%	75%	100%	100%	100%	100%	100%	100%
Sportsgrounds (number of 1250m ² grounds)	0	0	0	0	4	6	8	9

Table 22: Public infrastructure – type of lights

	Parameters	Hours/day	Number	Type
Streetlights	25km of roads, lights every 30m	12	833	18w LED
Intersections	4 high lumen lights per intersection	12	25 x 4	VLED108
Sportsgrounds	4 high lumen lights per 1250m ² ground	6	9 x 4 by 2050	VLED108

3.4.2.10 Local renewable energy generation

Several key assumptions underpin the modelling of renewable energy in the FBURA. These have been developed to align with the Fishermans Bend Urban Design Strategy⁵.

⁵ Hodyl+Co June 2017 – Fishermans Bend Urban Design Strategy- Built Form and Density Framework.

For the purpose of estimating total on-site generation potential from renewables, only roof-top solar was examined. Three other technologies are seen as having the potential to contribute to the mix of on-site renewables, however these have not been covered in this estimate of overall potential capacity for the following reasons:

- Small-scale on-site wind: The effectiveness of such installations is highly dependent on interactions between local built forms. Not included due to a lack of information and a relatively small potential in an urban context compared with small scale solar.
- Solar PV facades and glazing: This is an evolving and promising technology, however the high degree of uncertainty in relation to future built forms and design makes it difficult to estimate the total area available. It is instead considered that this technology could contribute to the total precinct PV potential.
- Solar paving: Another evolving technology, which holds significant potential. This has not been included in current estimates due to the relatively high upfront cost and uncertainty as to applicability and acceptability by VicRoads.

Batteries could form a functioning component of precinct-based renewables. Batteries will impact the dispatchability of energy use but not the maximum generation capacity within the precinct.

The key renewable energy modelling assumptions are:

- The typical rooftop solar energy potential in Melbourne is approximately 3.67 kWh per day per installed kW.
- The typical solar panel has a generation capacity of 150W of peak power per m² in 2018, increasing to 300W peak power per m² in 2050
- 30% of developable areas will need to be open space and are unavailable for ground-mounted PV.
- The portion of roof space available for solar panels will depend on the building type. These assumptions have been developed by AURECON and take in to account the potential benefits of solar roofing materials. The following assumptions have been adopted for available roof space for each building type:
 - Low rise - 50%
 - Low-mid - 50%
 - Mid-rise - 50%
 - Tower (smaller) - 65%
 - Tower (large) - 65%
 - Industry - 65%.
- The net roof area available for solar panels is calculated from the Fishermans Bend Urban Design Strategy as per Table 23.
- The approximate proportion of each building type in each area was estimated from the Proposed Built Form Strategy (refer to Table 24).
- The portion of roof area not subject to shading was estimated for each area, again based on the Proposed Built Form Strategy (Table 25).

In total, these assumptions translate to 46% of all roof space within the precinct being covered in solar panels by 2050.

The potential total area of roof-mounted solar was calculated using these assumptions to estimate the maximum potential annual generation (Table 26).

Emissions from the consumption of electricity by activities within the FBURA are corrected to account for the contribution of any installed on-site renewables.

Table 23: Net building footprint areas (ha.)

	Wirraway	Sandridge	Montague	Lorimer	Employment precinct	TOTAL
Total land area (ha)	94	85	43	25	230	477
Gross developable area (ha)	49.7	61.3	24.7	19.7		
Net developable area (ha)	47	57	22	19	157	301

Net building footprint (ha)	33	40	15	13	110	211
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Table 24: Approximative split by building type

	Wirraway	Sandridge	Montague	Lorimer	Employment precinct
Low rise	0%	15%	10%	0%	0%
Low-mid	70%	25%	10%	0%	0%
Mid-rise	0%	0%	10%	45%	0%
Tower (smaller)	30%	0%	70%	55%	0%
Tower (large)	0%	60%	0%	0%	0%
Industry	0%	0%	0%	0%	100%

Table 25: Approximative portions of areas not shaded

	Wirraway	Sandridge	Montague	Lorimer	Employment precinct
Low rise	0%	50%	30%	0%	0%
Low-mid	50%	50%	30%	0%	0%
Mid-rise	0%	0%	30%	80%	0%
Tower (smaller)	80%	0%	80%	80%	0%
Tower (large)	0%	80%	0%	0%	0%
Industry	0%	0%	0%	0%	80%

Table 26: Maximum potential roof-top solar by 2050

	Wirraway	Sandridge	Montague	Lorimer	Employment precinct	TOTAL
Area of solar panels (m ²)	107,972	162,946	62,413	60,999	524,600	918,931
Peak installed capacity (MW)	32	49	19	18	157	276
Annual generation potential (MWh)	43,384	65,474	25,078	24,510	210,790	369,237

4 CHALLENGES AND OPPORTUNITIES

4.1 General

This first table presents the challenges related to multiple components of the footprint, whereas the next section presents remarks more specifically related to segments of the footprint.

These challenges will be further explored when developing emission reduction opportunities and pathways.

4.1.1 Challenges

Table 27: Key challenges

Topic	Challenge	Suggested resolution
Development rate	<p>The quicker FBURA develops, the higher “locked in” emissions are likely to be, in relation to building energy use.</p> <p>The overall “carbon budget” for FBURA will also be higher, the earlier the development.</p>	<p>As construction standards are likely to tighten over time, bringing forward more stringent standards through the Design Standards is a good strategy, provided it is acceptable to the industry.</p> <p>It was also assumed that the precinct would be fully redeveloped (as opposed to keeping some of the buildings at their current level of operational energy efficiency).</p>
Grid emission factor	<p>The grid emission factor will evolve over time and is highly dependent on policy choices at the State and Federal levels, as well as , to a lesser extent, technical constraints. Uncertainty is therefore very high.</p>	<p>Solutions and strategies will need to be tested to ensure they are flexible enough to perform in a vast range of future energy policy contexts.</p>
Employment district	<p>The employment district is currently occupied by various types of industries. It is likely to go through a transition and redevelopment.</p> <p>The extent and timing of this redevelopment, as well as the nature of industries that settle there, will greatly influence the precinct’s carbon footprint.</p> <p>Operational energy use for various industries, as well as the quantity of waste they generate (including wastewater) and the transport they induce, are likely to be the greatest source of uncertainty for FBURA’s carbon footprint.</p>	<p>Design Standards for buildings can assist in reducing base building energy use.</p> <p>For specific types of operations (e.g. data centres), reference could be made to international performance standards and solar PV / batteries could be encouraged.</p> <p>However, for most industries, reducing operational waste, energy use and transport will be a matter of engaging with each company separately.</p>
Construction related emissions and embodied emissions	<p>These emissions are not captured in the operational emissions model. They may, however, amount to a significant source of</p>	<p>Explore how some recommendations to minimise whole-of-lifecycle emissions during construction can be embedded in Design Standards or other planning controls. This</p>

Topic	Challenge	Suggested resolution
	emissions and thus minimising them is important.	would include: <ul style="list-style-type: none"> • C&D waste • carbon emissions embodied in materials • emissions from construction activities.

4.1.2 Opportunities

Table 28: Opportunities

Topic	Opportunity
Electrification	Electrification of buildings (from gas) and vehicles (from petrol/diesel) are only beneficial if either the grid factor for electricity drops or electricity is sourced from renewable energy. Electrification is modelled and analysed as a specific pathway.
Renewable energy and local networks	<p>Within the precinct</p> <p>The redevelopment of the FBURA presents an opportunity to implement new models combining renewable energy, storage and local distribution networks.</p> <p>Beyond the precinct</p> <p>It is unlikely that sufficient renewable energy can be generated within the precinct to cover the precinct’s consumption. However, an opportunity exists to use the forecast demand of the precinct to stimulate investment in large-scale grid-connected renewable energy elsewhere in Victoria. Potential mechanisms include:</p> <ul style="list-style-type: none"> • A requirement that all energy delivered to the precinct be procured under a power purchase agreement with a renewable power supplier • A planning overlay/requirement that all energy sold within the precinct by energy retailers be 100% certified GreenPower • A ‘<i>generation capacity levy</i>’ attached to the planning approval process for new developments. Proceeds from the levy could then be invested directly in corresponding large-scale grid-connected renewable energy installations sufficient to cover the additional electrical demand to be generated by the new development.

4.2 By source of the footprint

4.2.1 Challenges

Table 29: Challenges and opportunities relating to specific footprint components

Sources category	Challenge	Suggested resolution / opportunities
Residential buildings	Construction standards for residential buildings lag behind other standards, and most multi-storey residential buildings	Consider how best to engage with industry to ensure standards are adhered to and exceeded in Fishermans Bend without jeopardising affordability. For example,

Sources category	Challenge	Suggested resolution / opportunities
	<p>delivered recently are performing poorly even compared to standards.</p>	<p>create a new performance benchmark for multi-units residential buildings and position FBURA as leader in this space.</p> <p>Consider costs and benefits sharing mechanisms to overcome split incentives between developers / owners and residents.</p>
<p>Commercial buildings – offices</p>	<p>NABERS standards have been tightening and the construction industry delivers buildings that are ahead of the National Construction Code (NCC) requirements.</p> <p>However, some segments of the market are lagging (mid-tier buildings, etc).</p> <p>Moreover, efficiency gains from building envelope improvements are likely to soon hit a limit, signalling the need to use renewable energy sources rather than gas and grid electricity.</p>	<p>Bring forward improvements in NCC standards and present FBURA as a “test case” for the industry.</p> <p>Leverage GBCA / NABERS work and work with industry on most appropriate pathways to achieve net zero carbon with minimal recourse to carbon offsets.</p> <p>Enable easy access to renewable energy electricity through various mechanisms or joint initiatives (community solar or joint procurement of offsite renewable energy, or local storage facilities).</p>
<p>Commercial buildings - other</p>	<p>Operational energy use in light / heavy industry will depend on the types of industries that settle in Fishermans Bend. Projections over time are also highly industry-specific.</p>	<p>Use sensitivity analysis for modelling.</p> <p>Consider one-on-one engagement strategies.</p>
<p>Publicly-owned buildings and infrastructure</p>	<p>There is a risk that government-owned sites’ redevelopment may not demonstrate the government’s commitment to sustainability.</p>	<p>While the footprint for community buildings is not material, some significant sites in government’s ownership may offer opportunities to raise the standards and / or provide access to common infrastructure (community solar for example).</p>
<p>Car parking</p>	<p>It is not known at this stage whether naturally ventilated carparks will be feasible (depends on built form). These use significantly less energy.</p> <p>EV adoption also reduces the need for car parking ventilation.</p>	<p>Ensure car parks are planned to be as flexible as possible (zoning, upgrades, redevelopment) to leave options for car parking reduction or reduction in footprint.</p>
<p>Transport</p>	<p>A significant portion of transport-related emissions through to 2050 will be associated with private vehicles used for the operation of businesses within the FBURA, especially as Yarra Trams has committed to sourcing renewable energy for the operations of its trams and it is highly likely that other operators will have to follow suit as government will either source renewable</p>	<p>As reflected in the current target of 80% trips made by sustainable transport means, the Taskforce is already conscious of the need to minimise private vehicle use by commuting employees within the FBURA, by providing viable alternatives. Specifically, this will involve ensuring reliable and rapid public transport transfers within the CBD and travel to/from the FBURA, and reducing</p>

Sources category	Challenge	Suggested resolution / opportunities
	<p>energy directly or include provisions into transport operators’ procurement contract.</p> <p>Private vehicle transport includes commute travel by employees and travel induced by the operation of businesses. As many of these vehicles will be owned and stored outside the FBURA, there is little scope to influence their use or fleet mix directly.</p>	<p>car parking. It will also involve provision of safe and free-flowing cycle and pedestrian links.</p> <p>The transition from fossil-fuel vehicles to EVs can be encouraged by ensuring that business and commercial developments provide charging infrastructure.</p>
<p>Precinct-based renewable energy</p>	<p>Competition for space will be the primary challenge. Both solar and wind renewable technologies require sufficient access and exposure to respective resources. Overshadowing may also be an issue.</p> <p>This requirement competes with multiple other land uses and built forms (green roofs for example). Further, roll-out of larger scale installations can be hindered by a lack of capacity in the distribution network, metering arrangements and/or mismatch between site loads and generation potential.</p>	<p>Competition for space could be controlled through the imposition of minimum requirements for roof or site coverage with solar panels, and though consideration of solar and wind exposure in the design of the built form.</p> <p>On-site renewables can be maximised by proactively specifying distribution network upgrades to allow for metering and distribution of renewable energy within the precinct (i.e. designing to facilitate a micro-grid).</p>
<p>Waste</p>	<p>Most initiatives for reducing waste generation are not FBURA-specific and will require decisions at the Metropolitan level.</p> <p>Unlike some other parts of the footprint, which see efficiency gains over time, waste generation per person is forecast to remain constant over time. This makes the waste component of the footprint even more important to address as it appears to be the most intractable.</p> <p>Waste transport emissions were not found to be material compared to the overall footprint, but should be nevertheless minimised as much as possible.</p>	<p>Organics are responsible for the greatest part of waste emissions and local solutions such as in-sinkerators or digesters can be explored.</p> <p>Waste minimisation campaigns may produce valuable results but require ongoing reinforcement over time to remain effective.</p>
<p>Water and wastewater</p>	<p>Water recovery (from Sewer Mining) is likely to increase the gross footprint of fit-for-purpose water generation. It is however necessary to reduce the need for network augmentation and to reduce dependency on freshwater in the context of increased risk of drought. It will also allow the maintenance of green infrastructure.</p>	<p>As water companies are already planning to be carbon neutral before 2050, this part of the footprint should not be of concern for FBURA.</p>
<p>Local renewable energy generation</p>	<p>Roof space is limited and emerging technologies (glass or pavement generating power) are still unaffordable.</p>	<p>As mentioned above, there are opportunities to created new “whole of system” electricity management solutions</p>

Sources category	Challenge	Suggested resolution / opportunities
	<p>Local generation of renewable energy will compete with other uses of roof space (green roofs, use for recreational activities, etc).</p> <p>Arrangements such as community solar or common battery storage facilities are still unproven.</p>	<p>for FBURA but implementation (e.g. managed centrally through Energy Service Companies) regulatory and governance aspects (who pays for what part of the infrastructure) are likely to prove challenging in a context where the Taskforce does not have control all land in the precinct.</p>