WATTBLOCK

Electric Vehicle Recharging in Residential Strata Buildings

City of Sydney Environmental Innovation Grant

Ross McIntyre
Research Director

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Wattblock NSW
Michael Crouch Innovation Centre
Gate 2, High St, UNSW, 2052

Wattblock Queensland
River City Labs
The Precinct, 315 Brunswick St
Brisbane QLD 4000

Wattblock Victoria
Gurrowa Lab
242 Exhibition St
Melbourne Vic 3000

Phone: (02) 9977 1801
Email: support@wattblock.com.au
www.wattblock.com

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NSW member

Wattblock Research Report

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Prepared by:

Ross McIntyre
Chief Data Officer
Wattblock
Michael Crouch Innovation Centre
Gate 2, High St, UNSW, 2052

Ross is the Co-founder and Chief Data Officer of Wattblock. Winner of the SCA Innovation of the Year in 2016, Wattblock has developed a “smart city” analytics platform to reduce energy waste in high density urban environments. Previously Ross spent 10 years working for First Data in Australia, Hong Kong, Singapore and China. He has consulted to tier 1 banks on high volume transaction data for ATMs and merchant acquiring. Ross has a masters in finance and an honours degree in product development and innovation from the University of NSW.

About Wattblock:

Wattblock provides sustainability reports for strata buildings covering energy efficiency, solar, batteries, smart meters, electric vehicle recharging, gas and water. Wattblock has assisted strata buildings across Australia from its head office is based in Sydney. Wattblock is a member of Strata Community Australia NSW, which awarded Wattblock with Innovation of the Year in 2016.

Wattblock has received an Environmental Performance Innovation Grant from the City of Sydney. Technology development has been supported in part by the Department of Industry, Skills and Regional Development through the Innovate NSW program, private technology investors, and through Telstra's muru-D startup accelerator program.

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Other Contributors: Kristian Handberg, Nicola Farrell, Charlotte Argue, Julia Bronson, Kristine D’Arbelles, Cara Clairman, Desmond Russell, Mitchell Baxter, Frank Groot, Kyle Lyons

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Executive Summary

This study has been funded by the City of Sydney Environmental Performance Innovation Grant program to examine the issues around Electric Vehicle (EV) charging in residential strata buildings. The research work conducted by Wattblock consists of three broad components;

- Resident surveys to gauge interest and attitudes toward electric vehicle charging in strata
- Secondary research including literature review and observation of other more developed EV markets
- Site assessments of 20 participating strata schemes to understand practical issues

The residential survey examined the attitudes and intentions of Australia residents. The survey started in the City of Sydney and was later extended into Brisbane, Melbourne and other cities to establish a broader comparative data set. Overwhelmingly respondents were in favour of installing electric vehicle charging facilities. For the City of Sydney 81% voted in favour compared to 79% for the overall survey study results from 112 strata schemes. Further statistics from the residential survey include the following;

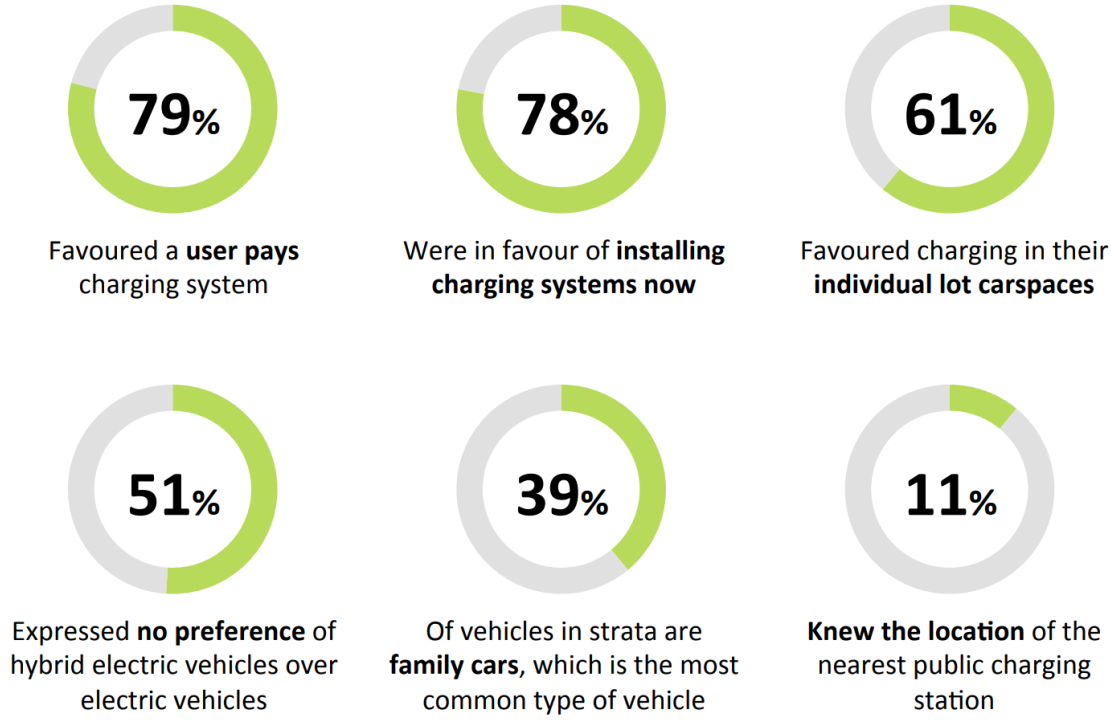

Figure 1: Survey findings for electric vehicle charging in strata

With respect to public electric vehicle charging, the survey results indicate:

- **12% of respondents** know where the nearest public charging station is even though only 1% have electric vehicles. There are 15 public charging stations (2 solar powered) within close proximity to Sydney CBD with another four public chargers farther afield in Redfern, Moore Park, and Zetland.
- **45% of respondents** with electric vehicles use public charging facilities. Private chargers are used by 37% with a smaller proportion using charging facilities at work (8%) or using common area power (11%).
- **98% of respondents** were against their building offering a public charging facility.

Secondary Research

Wattblock looked to the Norwegian and Canadian EV markets. Norway is a world leader in EV adoption with 80% of condominiums (residential strata equivalent) in the city of Oslo already having EV charging infrastructure. In Canada, British Columbia is of particular interest because it has a similar strata model for property ownership in what is locally referred to as Multi Unit Residential Buildings or MURBs. In particular, Fraser Basin Council has been running a program called Plug-In BC for the broader British Columbia area.

From these more developed EV markets Wattblock has been able to obtain information on working electric vehicle charging solutions, different commercials models, strata by-laws, and government incentive programs to promote uptake. In addition, we cover research looking at how utility companies can play a role in avoiding localized power outages due to 'EV clustering' and the impact of EV charging Demand Management (DM) solutions. Further information is contained in the conclusions and recommendations.

Site Assessments

Finally, Wattblock selected twenty (20) strata schemes from within the City of Sydney as a representative sample for examining the practical concerns with electric vehicle charging. Site visits were conducted in addition to analysis of energy bills, strata plans, single line diagrams and other relevant data. The participating strata schemes all received a customised assessment report. Aggregated findings are presented in this report.

The key findings in the report are summarised as below:

- There are a total of **3,317 apartments** represented across the 20 participating strata schemes.
- Using the Electric Vehicle survey results and other research projections, the average strata scheme has **2 Electric Vehicles** today and the number will grow to **45 by 2027**, giving a total of 900 electric vehicles.
- In most cases electric vehicle charging will need to be integrated with common area power supply.
- Existing electrical sub-boards in the car parking levels could support charging for a total of **290 Electric Vehicles** at 32 Amps before risking the disruption of power supplies. On average it is estimated that upgrade of electrical infrastructure would be required **by 2027** assuming buildings become energy efficient.
- Across the 20 strata schemes, energy efficiency upgrades, solar installation, and charger restrictions could allow an additional **605 Electric Vehicles** to charge simultaneously without spending on switch board upgrades. Additional benefits include **saving $675k p.a**. in operating costs with a **payback of 4.1 years**.
- Investment to provide full access to EV charging is estimated to cost **$4.2 million** in total with a **payback of 2.9 years**. This is approximately $1,260 per apartment including $600 for EV charging infrastructure and $660 for setting up an embedded network. Optimal solutions may vary for each strata scheme.
- "EV Ready" buildings may attract a **premium property valuation** on market. There is some case study evidence from San Francisco, such as the Lumina building, which shows there is a strong demand for EV charging facilities in apartments. Australian developers like Sasco are now marketing "EV Ready" buildings.

The individual participant building assessments included background information on electric vehicle charging for residents, an overview of benefits, projections and capacity assessments. The reports covered issues such as how to bill owners for charging, which location is the best, how to set it up, types of charging equipment, and risks around overloading the common area power supply. The reports also provided some analysis around the location and impact of public charging stations as well as the carbon impact with the deployment of electric vehicles.

Assisting Decision Process in Residential Strata

Through further participant engagement Wattblock has studied what Owners Corporations require to assist them in effectively navigating the issue of electric vehicle charging. Based on this research study, Wattblock provides the following recommended process for individual strata schemes to look at electric vehicle charging.

1. Conduct a resident survey to gauge EV charging intentions and attitudes
2. Engage a low cost energy assessment which covers EV charging impacts
3. Implement energy efficiency initiatives to realise savings and create more headroom for EV charging
4. Potentially conduct a more detailed assessment including site audit to determine potential site specific complications, switch board location and capacity for EV charging
5. Run a tender for install of EV charging infrastructure if deemed to be needed including such things as billing systems, demand management, distribution boards and switch board upgrades to increase capacity.
6. Have a plan for EV charging including by-laws, processes and budgets.

While detailed assessment reports have been provided, Wattblock is of the view that a shorter and easier digest summary is required for circulation with Owners Corporations to assist the decision making process. Wattblock has developed a simple one page EV charging summary report which is now integrated within its low cost sustainability reporting service. The effectiveness of Wattblock's approach to sustainability assessments was previously demonstrated in a prior City of Sydney research paper.

We have also provided a high level decision tree diagram and checklists that can be further used to assist strata in working through the issues. More information on the development of these tools is contained in the Conclusions section along with discussion on incentive programs, carbon emissions targets, and public charging infrastructure.

The Recommendations section covers potential initiatives which the City of Sydney and industry participants might consider to further assist in guiding EV charging in strata schemes. Recommendations include:

- Launching an official EV charging in strata information web page
- Extending the resident EV charging survey tool
- Subsidising EV charging assessments
- Engaging utilities on network impacts of EV clustering
- Co-funding pilot EV demand management solutions for strata
- Potential funding for public EV charging stations on or near strata
- Integration of EV charging in NABERS for Apartment Buildings rating system

Secondary research indicates that electric vehicle charging in residential strata will have a material impact on local electricity networks. Potential for EV clustering can degrade or knock out local transformers. This risk is likely to be greater where there are high density buildings with rapid EV adoption rates. These recommended initiatives are suggested to assist in guiding strata schemes toward optimal community outcomes.

Ross McIntyre
Research Director
Wattblock

Contents

1.0 Introduction

Wattblock was awarded an Environmental Performance Innovation Grant in March 2017 by the City of Sydney to undertake a study of electric vehicle charging in strata buildings. The project ran over a period of six months commencing on the 1st April 2017 and concluding on the 30th September 2017.

Project Kick-Off	1st April 2017
Customer Engagement	2nd April 2017
Participant Selection	3rd June 2017
Project Implementation	3rd June 2017
Review & Acquittal	30th Sept 2017

This project was conducted with in-kind support and in association with:

- **Evercharge** is the leading electric vehicle recharge solution to condos (strata) in the U.S. Wattblock has met with in-kind partner, Evercharge, in San Francisco and Washington D.C.
- **AGL** has a dedicated electric vehicle recharging team.
- **Tesla**, is the leading supplier of electric vehicles in the Australian market

Wattblock is located in the Michael Crouch Innovation Centre at UNSW and has been able to draw on a pool of talented academic staff and students from multiple faculties.

Background

The rate of electric vehicle (EV) ownership is set to rapidly increase over the coming years. The Sydney residential property market has started to see the impacts of rising EV charging demands. High rise apartment blocks in the City of Sydney now have electric vehicle owners. The Owners Corporations responsible for managing residential strata are not sure if they should:

- Install standalone electric vehicle recharging stations
- Sub-meter electric vehicle charging off common area meters
- Connect electric vehicle recharge units to private apartment meters
- Install power management hardware, to prevent overloading the existing main switchboard
- Upgrade the main switchboard to a higher capacity to cater for electric vehicle recharging, or
- Do a combination of these things in sequence, as the number of electric vehicles increases.

Furthermore, besides existing strata schemes, Property Developers are not investing in and marketing electric vehicle recharge as a feature of new high rise developments. The Lumina case study from San Francisco is an example of what we need to be seeing from Australian property developers. See Appendix A.3 for more detail.

Objectives

The aim of the study has been to assess electric vehicle recharging impacts and solutions for residential apartment building car parks. This study looks at how data analytics can be used to develop an electric-vehicle recharging roadmap for Owners Corporation and Property Developers to assist them in navigating the problem. The developed tools should have the ability to deliver rapid and cost-effective electric vehicle recharging reports to a wide-range of strata buildings. The objective is to create a solution that is scalable nationally and internationally.

The proposed benefits for the City of Sydney are:

- Adopt learnings from City of Sydney sister city, San Francisco, on EV recharging in strata.
- Inform policy decisions by council on the best mix of public and private (e.g. strata) electric vehicle recharging facilities across the city.
- Close the gap with other global cities which have already made visible strides on electric vehicle recharging.
- Assist energy retailers to better understand the challenges of electric vehicle recharging in strata and tailor future service offerings.
- Assist Owners Corporations with managing the requests from residents who purchase electric vehicles.
- Work with Sydney-based tech startup, Wattblock, contributing to CoS Tech Startups Action Plan.
- Continue City of Sydney's leadership in sustainability at it moves towards Sustainable 2030.

The City of Sydney may use the results of the study to assist in planning for the future impact of electric vehicle charging in residential strata.

Project Scope

The scope of the study encompasses detailed assessment of twenty (20) participant strata schemes within the City of Sydney LGA of 33 suburbs. Each participating strata building received an electric vehicle recharging report.

Table 1: Participant Buildings

Participant Buildings	Age (Years)	Blocks	Units	Residential Levels	Commercial Levels	Carparking Levels	Survey Reponse
Waterloo	5	5	289	10	1	2	15%
Alexandria	12	1	45	5	0	1	53%
Haymarket	25	3	646	31	0	6	4%
Millers Point	11	1	83	24	0	9	18%
Ultimo	19	1	328	7	1	9	25%
Erskineville #1	1	6	197	6	0	1	20%
Rosebery	16	1	288	7	0	1	4%
Rushcutters Bay	17	2	139	15	1	2	27%
Glebe	12	1	75	3	0	1	21%
Surry Hills	47	1	54	3	0	1	52%
Erskineville #2	10	1	48	4	0	1	40%
Woolloomooloo	3	3	76	7	2	3	18%
Pyrmont #1	9	2	104	5	2	1	24%
Pyrmont #2	17	2	118	9	1	3	21%
Sydney #1	21	1	199	25	1	5	33%
Darlinghurst	6	2	86	23	0	3	48%
Sydney #2	20	1	131	22	1	7	
Sydney #3	18	4	238	12	3	4	26%
Sydney #4	117	1	61	7	0	2	10%
Redfern	39	1	112	6	1	2	14%
Average	21	2	166	12	1	3	19%

Following a two month promotional period a representative sample of buildings was selected on the 3rd June 2017 with a range of ages, sizes, types, location and demographics. Table 1 provides a summary of the characteristics of the participating strata schemes. Within the twenty strata schemes selected there were a total of 3,261 apartments across 40 buildings with 64 levels of car parking in total. For privacy reasons Wattblock is unable to publish the names and addresses of participating strata schemes. Results of the study are redacted or provided in aggregate.

Methodology

The study was broadly divided into four components. Firstly, secondary research work was conducted to understand the issues and the commercially available solutions. Secondly a physical site assessment was conducted for each participant strata scheme. Thirdly, data analysis was completed for each strata scheme. Finally, a survey was designed and implemented to gauge the intentions and attitudes of owners and residents toward electric vehicle charging. Further details on Project Management are contained in Appendix A.1.

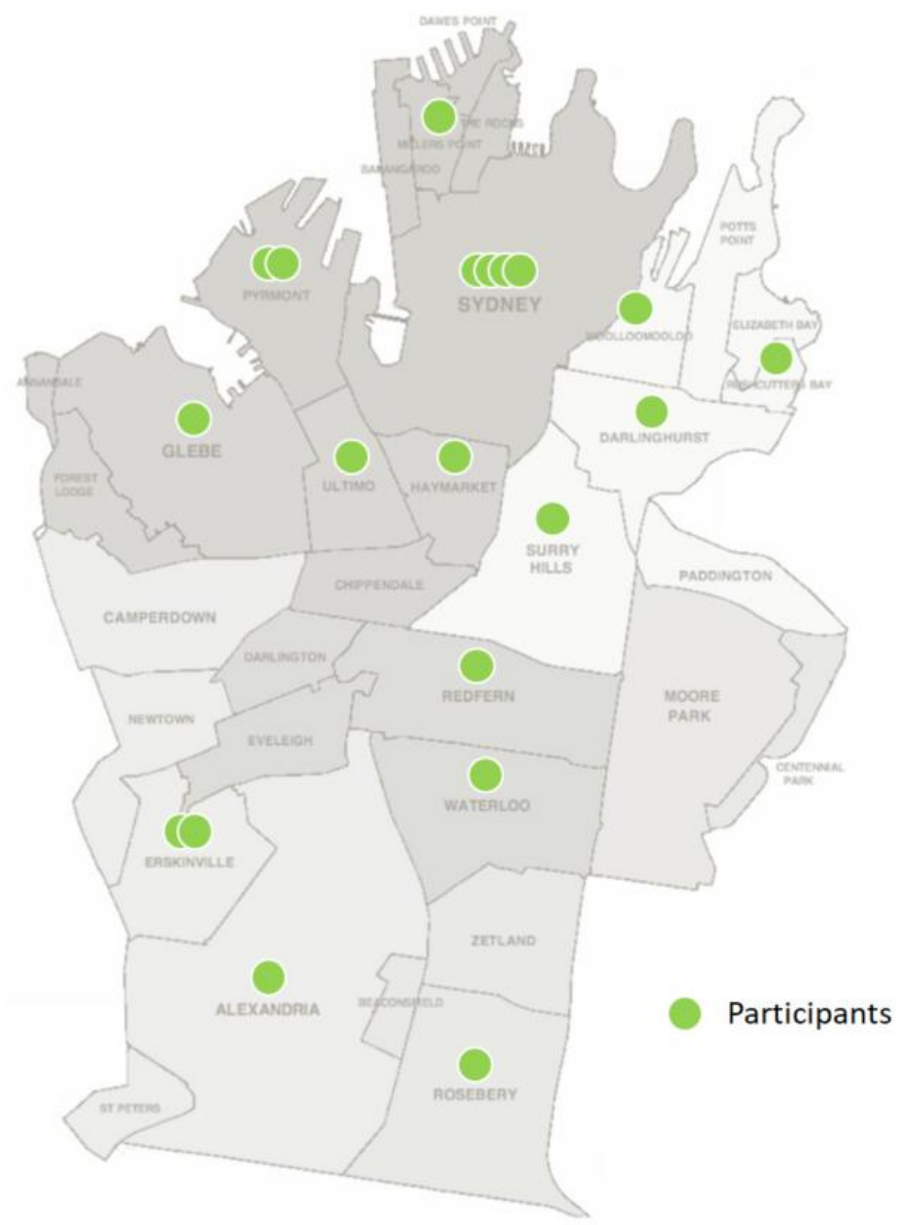

Figure 2: City of Sydney LGA

The physical site audit was conducted at each building site to inspect the energy consuming assets, car parking area and electrical switchboards. To assist Wattblock in the study strata managers provided access to electricity bills and interval data for the common area energy assets. Based on the site observation and the available information provided, Wattblock then tailored an electric vehicle roadmap for each participant building.

Wattblock also ran a resident survey to gauge attitudes and intentions of residents toward electric vehicles and charging facilities. Providing further context for the City of Sydney, the survey was extended to 112 strata schemes with responses from the broader Sydney, Melbourne, Perth, Brisbane, Sunshine Coast and Gold Coast. Survey results from City of Sydney residents were similar to other cities in Australia.

Figure 3: Broader survey into electric vehicle charging in strata

Project Outcomes

Through this project Wattblock has developed and improved several tools to assist both Owners Corporations and Property Developers in planning for the impact of electric vehicle charging. These tools include:

- Low cost and scalable resident survey to gauge intentions and attitudes toward EV charging
- Low cost and scalable 'one page' EV charging impact summary based on data analytics (integrated with Wattblock Sustainability Reports)
- Decision tree diagram, checklist and "how to" guides
- Sample by-laws and processes for managing EV charging in strata (from British Columbia)
- More detailed EV charging assessment report service

In addition Wattblock has provided further secondary research which may be of assistance to the City of Sydney in planning for electric vehicle charging in residential strata. The report also highlights the strong demand for EV charging in residential strata both for Owners Corporation and Property Developers to consider.

Report Structure

The report commences with background information on electric vehicles, market trends, charging solutions, and issues with residential strata. This is followed by a discussion on the resident survey results highlighting current intentions and attitudes toward electric vehicle charging in strata.

The report then moves into coverage on the findings from the physical site assessments and data analysis from the twenty participant buildings. This includes analysis of electrical infrastructure of the strata buildings, capacity for handing EV charging, physical constraints in connecting EV chargers, commercial solutions on the market, and recommended projects to prepare for EV charging in strata.

The conclusions further explores tools that can assist Owners Corporations in preparing for EV charging in strata and the role of government programs in assisting EV adoption. Recommendations are for the City of Sydney and industry participants to assist in guiding EV charging adoption in residential strata.

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Background on Electric Vehicles

Types of Electric Vehicles

Benefits of Driving Electric Vehicles

Types of Electric Vehicle Drivers

Electric Vehicle Charging Options

Public EV Charging Stations

Electric Vehicle Charging Behaviour

Car Parking Administration in Strata Buildings

Benefits and Barriers in Preparing for Electric Vehicle Charging

2.0 Background on Electric Vehicles

The Electric Vehicle (EV) revolution has arrived. According to AEMO Insights (2016) by 2035-36 Australian EV sales are forecast to reach 277,000 vehicles a year (27.1% of vehicle sales) and total EV's on the road is estimated to reach over 2.8 million (18.4% of all vehicles) . With more people moving into apartments, many of these EV owners will live in strata. Charging an EV at home is convenient, but for many apartment residents, this is a challenge due to the concern in regards to the **overloading** of common area power supply, how to pay for the use of electricity and expensive installation costs.

Figure 4: Top EV Model Sales in Australia 2016-17 (CarAdvice 2017)

Table 2: Indicative Data for Popular Electric Cars

	Battery Range	EV Type	Upfront Cost	Seats	Body Type
Tesla Model S	407km	Pure Electric	$120,000	5	Sedan
Tesla Model 3	345km	Pure Electric	$60,000	5	Sedan
BMWi3	300km	Pure Electric	$64,000	5	Hatch Back
Nissan Leaf	175km	Pure Electric	$40,000	5	Hatch Back
Chevrolet Volt	65km	Pure Electric	$60,000	4	Sedan
Mitsubishi Outlander	53km	Hybrid	$50,000	5	Wagon

2.1 Types of Electric Vehicles

The majority of the passenger vehicles on the road today are Internal Combustion Engine Vehicles (ICEV). Electric vehicles were first produced in the 19th century and out-numbered gasoline based vehicles. This shifted in the 20th century with the rise of oil. In recent years there has been a growing interest in Electric Vehicles (EV) as being more socially and environmentally conscious combined with advances in battery and charging technology.

Hybrid Electric Vehicle (HEV) – Hybrid technology uses conventional combustion engines in conjunction with battery power to maximise the time an engine operates close to the point of maximum efficiency. Eg Prius. In these vehicles the battery for the electric engine is charged from the motion of the vehicle.

Plug-in Electric Vehicle (PEV) – Vehicles can be recharged from an external source of electricity with the electricity stored in a rechargeable battery that contributes to drive the wheels. Three broad sub categories include:

- **Battery Electric Vehicle (BEV)** –Vehicles that are powered entirely from an on-board rechargeable battery, generally re-charged through plug-in. e.g. Nissan Leaf, Mitsubishi iMiev.
- **Plug-in Hybrid Vehicle (PHEV)** – Conventional hybrid vehicle that has a battery that can be re-charged from mains electricity. E.g. Holden Volt.
- **Neighbourhood Electric Vehicle (NEV)** – Low speed all-electric vehicle.

Electric vehicles also encompasses motorbikes, mopeds, buses, trucks and generally all types of vehicles. Many special purpose vehicles have long been electric, such as golf buggies and fork lifts. This research report is focused on passenger vehicles typically found in the basement car parking of residential strata. Other than electrically powered mopeds, EVs are in the very early stages of adoption by strata residents.

2.2 Benefits of Driving Electric Vehicles

Research has found that people choose to drive electric mainly for the reasons below:

i. Cost Savings

- Electricity cost for charging EVs is about $400 p.a., typically 70% lower than petrol. (Chargepoint, 2017)
- Conventional cars use an internal combustion engine which has more than 2,000 moving parts, while EVs use less than 20 which drives significantly lower maintenance costs.
- In comparison with a standard ICEV vehicle, driving an electric car can save $13,000 over the life of an EV. (Union of Concerned Scientists, 2015)

ii. Environmental Benefits

- Better air quality can result in health benefits.
- Potential to cut greenhouse gas emissions in half or more, depending on how electricity is generated where drivers live.

iii. Other Features

- EVs often have cutting-edge software and the latest features.
- No engine noise.
- Quick acceleration with instant torque.
- Have the ability to park themselves in the future.
- Ability to self drive in the future.

2.3 Types of Electric Vehicle Drivers

As the diversity of electric vehicle brands and models increases, so too does the degree of customer market segmentation. The following table from ChargePoint provides a high level picture of the current types of customers and their buying considerations. In 2017 we have seen the release of the Tesla model 3 which is targeting a lower cost point and broader market. We have also seen announcements from most vehicle manufacturers regarding electric vehicle plans from compact vehicles such as Mini to sports vehicles like Porsche. Ultimately we would expect electric vehicles to permeate into all vehicle categories.

Figure 5: Who Drives Electric (ChargePoint 2017)

Penny Pincher Cost Savings	**Gene Green** Environmental Benefits	**Tina Techie** Bells & Whistles	**Oscar Office** Carpool Convenience
EV's don't need oil changes and are less expensive to maintain than internal combustion engine (ICE) vehicles. Plus, charging is much cheaper than gas.	Driving electric cuts greenhouse gas emissions in half or more, depending on how electricity is generated where drivers live. Many drivers are also interested in EV's for energy independence.	Tech fanatics want their cars to have the latest features, from cutting-edge software to falcon wing doors. EV's also have instant torque and are fun to drive, plus they're completely quiet so drivers can fully enjoy the pristine sound of a high-end stereo.	Several states offer carpool lane access to EV drivers, which can save tons of time, especially for people with tough commutes. A hybrid offers these folks the convenience of a back-up petrol engine.

2.4 Electric Vehicle Charging Options

When purchasing an electric vehicle, the means by which to charge the vehicle quickly becomes an important consideration. Most electric vehicle vendors are selling a range of chargers that can be purchased along with the vehicle. Different electric vehicle brands tend to have their own proprietary connection nozzles. However, there are also third parties that are offering charging equipment on the market with adaptors for different vehicles.

Table 3: Indicative EV Charger Performance

Type	Amperage	Charge Rate	Range / Hour
Level 1	10 Amps	1.5 kW/h	7-10km
Level 2	16 Amps	3.3 kW/h	15km
Level 2	32 Amps	7.6 kW/h	30km
Super Charger	100 Amps	23.8 Kw/h	94km

Electric vehicle chargers are rated based on the amount of electrical current, measured in Ampere (Amps) they deliver to the vehicle. The larger the current, the faster the vehicles battery will charge up. The energy stored in the batteries is measured in Kilowatt hours (kWh) and 1 kWh of stored power will deliver approximately 5-6kms of

driving range for a typical electric vehicle in normal driving conditions. Car chargers generally convert source Alternating Current (AC) into Direct Current (DC) to charge the cars battery.

Figure 6: Example plug-in Level 1 (Left) and wall mount Level 2 (Right) chargers

Level One: Standard 10 Amp Charging Adaptors

The most basic chargers on the market are designed to be safely plugged into standard 10 Amp power outlets. 10 Amp power outlets are commonly provided in basement car parks for using vacuum cleaners. Standard electrical extension cords will also work with these basic EV charging adaptors. Charging vehicles at 10 Amps can be a very slow process. A 10 Amp charger will deliver 1.5kW of charge per hour, which is equivalent to about 7-10 kms of driving range.

Level Two: Wall Mount Solutions (16-50 Amps)

Common faster charging solutions on the market are in the 16-50 Amp range, single phase. They are usually fitted on a wall and require installation by a qualified electrician. These are usually sufficient to meet the needs of private overnight charging. Wall mounted chargers are sometimes referred to as “Electric Vehicle Service Equipment” (EVSE). There are higher capacity ‘super charger’ solutions (eg 100 Amp) also available on the market. However, it should also be noted that charging rates can also be limited by vehicle model as well as the charger.

DC Fast Charging (3 Phase)

More suitable for public charging stations or shared charging facilities these systems can deliver 80% vehicle charge in 20-30 minutes by converting high voltage AC power to DC power for direct storage in EV batteries. Installing DC Fast Charging is a capital intensive project costing $20,000 to $100,000 depending on power availability at the site. These systems can also have a huge impact on peak energy demands when in use which can drive up energy supply charges. In most residential strata schemes DC Fast Chargers will not be viable.

Besides basic charging equipment, further technology exists to assist with power management. Usually a combination of hardware and software technology, these solutions can smooth energy loads from larger numbers of electric vehicles to avoid overloading power boards. Furthermore these types of solutions can also include integrated metering and billing services. These are important considerations for high density strata schemes.

2.5 Public EV Charging Stations

Electric vehicles can also be charged at public charging stations. The City of Sydney has invested in a number of public charging stations within its LGA. Other local governments and electric vehicle manufacturers have invested in providing public charging throughout Australia and this is important infrastructure for EV adoption. Typically public charging facilities offer higher amperage fast charging as they are not designed for a single vehicle to charge overnight.

There are 15 public charging stations within close proximity to the Central Business District of Sydney with another four public chargers farther afield in Redfern, Moore Park, and Zetland. Two of these charging stations are also solar powered, which has a direct impact on carbon emission reduction of vehicles.

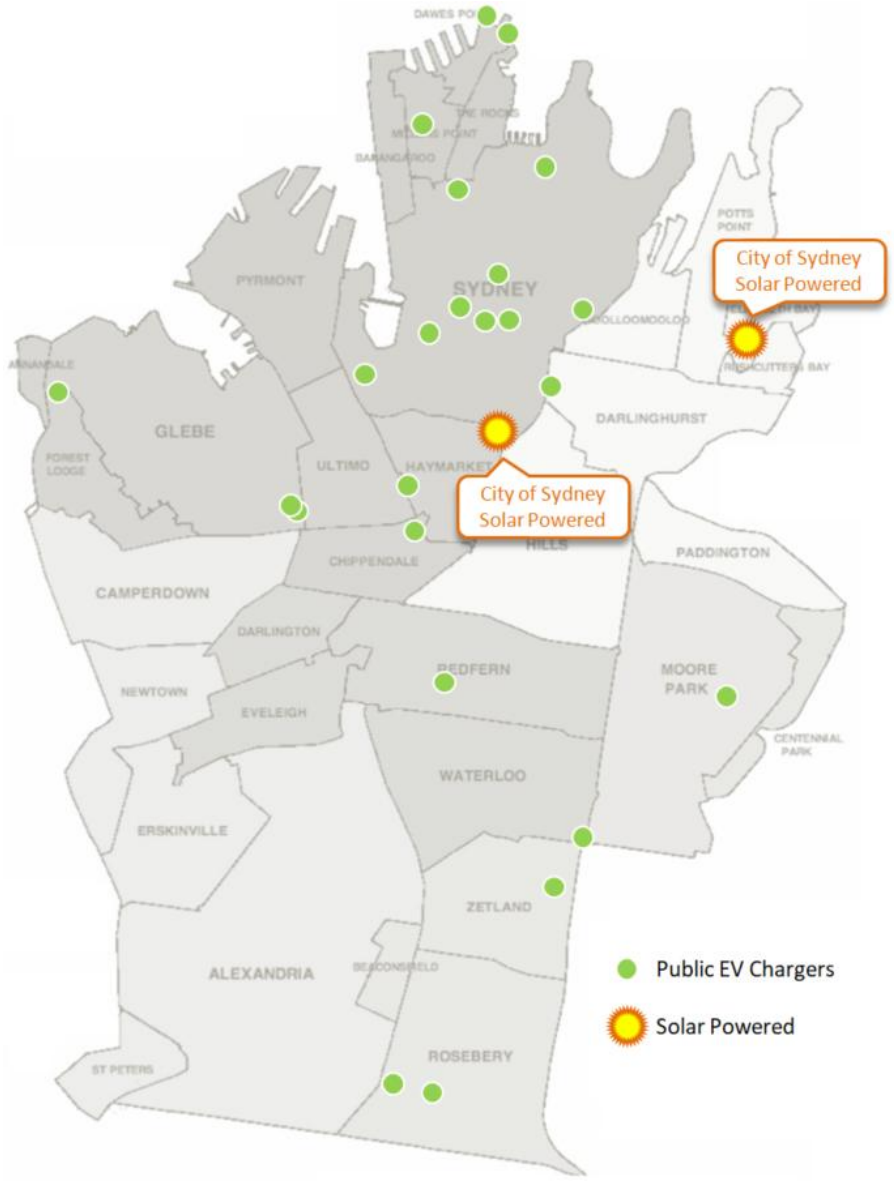


Figure 7: Public Electric Vehicle Chargers in City of Sydney

2.6 Electric Vehicle Charging Behaviour

As electric vehicle adoption gains traction in Australia we will need to consider the impact this will have on electricity demands. The behavior around when people charge their vehicles is an important consideration. While there is limited data available in Australia, there are case studies available from other first world cities which are more advanced in the adoption of electric vehicles.

According to research conducted by the US Department of Energy in 2014, residential EV chargers tend to be used overnight during off-peak periods and public EV charging stations are more often used during peak periods. The research looked into potential impacts on the electricity grid during peak and off peak periods of 270 public charging stations and 700 residential charging units. The majority of residential chargers were used overnight during off-peak periods, further encouraged where time-of-use based electricity rates were applicable. On the other hand public charge stations tended to be used during peak periods, were more frequently used for charging plug-in hybrids, and where often free. The research also indicated that the electrical power industry, represented by six participating utility companies, was forecasting a 400% growth in the annual sales of plug-in electric vehicles by 2023.

Figure 8: Electric mopeds being charged in a strata building

The average power demand to charge most vehicles was 3-6 kilowatts, roughly equivalent to powering a small residential air conditioning unit. However, some models draw as much as 19 kilowatts, more than the load of most large single-family homes.

2.7 Car Parking Administration in Strata Buildings

Residential strata buildings often have internal and/or external car parking for the convenience of the apartment property owners and for visitors. Private car spaces are typically attached to apartment lots as part of the unit entitlement. However, the car spaces are generally contained within a shared car parking facility in which most of the physical infrastructure is the common property of the strata scheme. This can include the ceiling, floors and walls around the private car spaces and any amenities such as car park lighting, electrical power outlets and ventilation systems. Furthermore, due to the physical separation of private apartments and carspaces it is most often the case that energy consuming equipment within car parks are powered off common area power supply rather than private meters.

Private car space entitlement and management is therefore subject to the by-laws and processes of individual strata schemes. Apartment lot owners considering the installation of electric vehicle charging on their private car space will need to do so in accordance with the agreed processes and by-laws or otherwise engage with the Owners Corporation to gain approval. For most Owners Corporations this raises a lot of questions and often results in no decision being formed and frustration for prospective EV owners. As covered in this study, there are a number of factors that an Owners Corporation should take into account in forming by-laws and processes, and making investments that will allow EV charging facilities to be installed and operated on private lots. By-laws and processes can encompass installation and removal, connection, and user pays schemes. For sample By-laws and flat rate user pays example see Appendix A.8 and A.9. (Disclaimer: Advice should always be sought from a strata lawyer)

Shared electric vehicle charging is also an option for Owners Corporations to consider. However, provision of a shared charging facility will generally require designated car spaces for charging vehicles. For visitor car spaces and cleaning bays, this will require an application to the local council for a change of use. Furthermore, the resident surveys conducted during this study indicate that the majority of owners and residents prefer private chargers to shared chargers and do not want to make charging facilities available to the public.

While this study covers many of these considerations, any strata by-laws should be drafted with the assistance of appropriately qualified legal counsel.

2.8 Benefits and Barriers in Preparing for Electric Vehicle Charging

Not all apartment owners are interested in driving an EV in the future. However, everyone can benefit from proper preparation for EV recharging:

- Increase in property valuation of all apartments in a block which is EV charging ready.
- Increase in rental income and more attractive for green minded residents (see case study in appendix).
- Reduce emissions from combustion engines in enclosed basement car parking for all residents

Barriers to introducing EV charging in residential strata include:

- Capacity and physical space limitations of power distribution boards
- Cabling distances and access
- User pays considerations

WATTBLOCK

strata community australia NSW member

Resident Survey

Methodology

Survey Design

Distribution of Survey Results

Survey Response Rate

Resident Comments and Suggestions

Attitudes Toward Electric Vehicle Charging

Resident Driving Profiles

Electric Vehicle Buying Intentions

Electric Vehicle Charging Preferences

Awareness and Attitudes to Public Charging Facilities

3.0 Resident Survey

3.1 Methodology

Wattblock set up resident surveys for each of the twenty participating buildings and provided the contact person with an information flyer including QR code for quick access via mobile phones. In most cases the contact person was an on-site building manager. The flyer was typically printed and posted on common area notice boards. Where possible it was also sent out via internal resident email lists or in some cases posted in mailboxes. Further details about the process are contained in Appendix A.1 and the final survey used is provided in Appendix A.12.

3.2 Survey Design

The survey was developed and tested on a sample building outside the City of Sydney prior to being deployed with the participating building sites. Based on feedback from the survey trial there were some refinements made to the final survey design. A priority of the survey was to minimize drop off rates in favour to being more comprehensive.

Consideration also was given to the expectation that there may be survey bias toward people that want electric vehicle charging. To mitigate this care was taken to encourage responses from those who may have a negative attitude toward electric vehicle charging. In particular the opening question of the survey "Are you in favour of installing electric vehicle charging?" allows respondents to express their opposition immediately and feel that their voice is being heard. Furthermore the wording on the flyer was designed to provoke a response from detractors. The survey flyer invited people to have their say, and they certainly did so in the final comments question. An example of the flyer used is provided in Appendix A.11.

Other considerations in survey design included:

- Dividing the survey into logical groups of questions to enhance contextual understanding
- Asking about current vehicles and driving habits first to avoid interpretation of "vehicle" meaning just cars
- Providing easy to understand interval based responses to gauge difficult questions like driving distances
- Favouring simple question wording to being overly specific
- Keeping the survey short to ensure completion
- Allowing respondents to skip questions such as brand preferences

The care taken in the survey design yielded excellent participation rates with as many as 53% of residents completing the survey. Following the extension of the survey to other strata schemes in Queensland and Victoria this survey is the largest of its kind conducted in the Australian strata market.

3.3 Distribution of Survey Results

Each participating strata scheme was provided with a separate six page benchmark report covering survey responses. These reports compared the results of the survey for the given participating strata scheme against the overall survey population. The report was designed to assist the owners corporation understand the intentions and attitudes of residents and help to promote further engagement in planning the best outcome and gaining buy in to move forward with planning. There was a high level of interest (48%) among participants in receiving a copy of the final survey results. A sample report has been provided in Appendix A.13.

The survey reports were provided separately to the more detailed assessment report. However, data from the surveys were used to in the assessment report. This includes taking intentions around electric vehicle ownership and the number of vehicles into consideration in projecting future demand on common area energy loads over time.

3.4 Survey Response Rate

The survey response rate ranged from 4% to 53% for participating buildings with an average response rate of 19%. In total there were 591 respondents to the survey. This shows an extremely high level of engagement from residents on this topic. Furthermore, the highest levels of responses came from buildings which had some form of intranet, on-line forum or email lists to engage residents. Buildings with low response rates were generally unable to engage their residents in an effective way. Letter box drops and posters in common areas proved to be un-effective in getting through to residents.

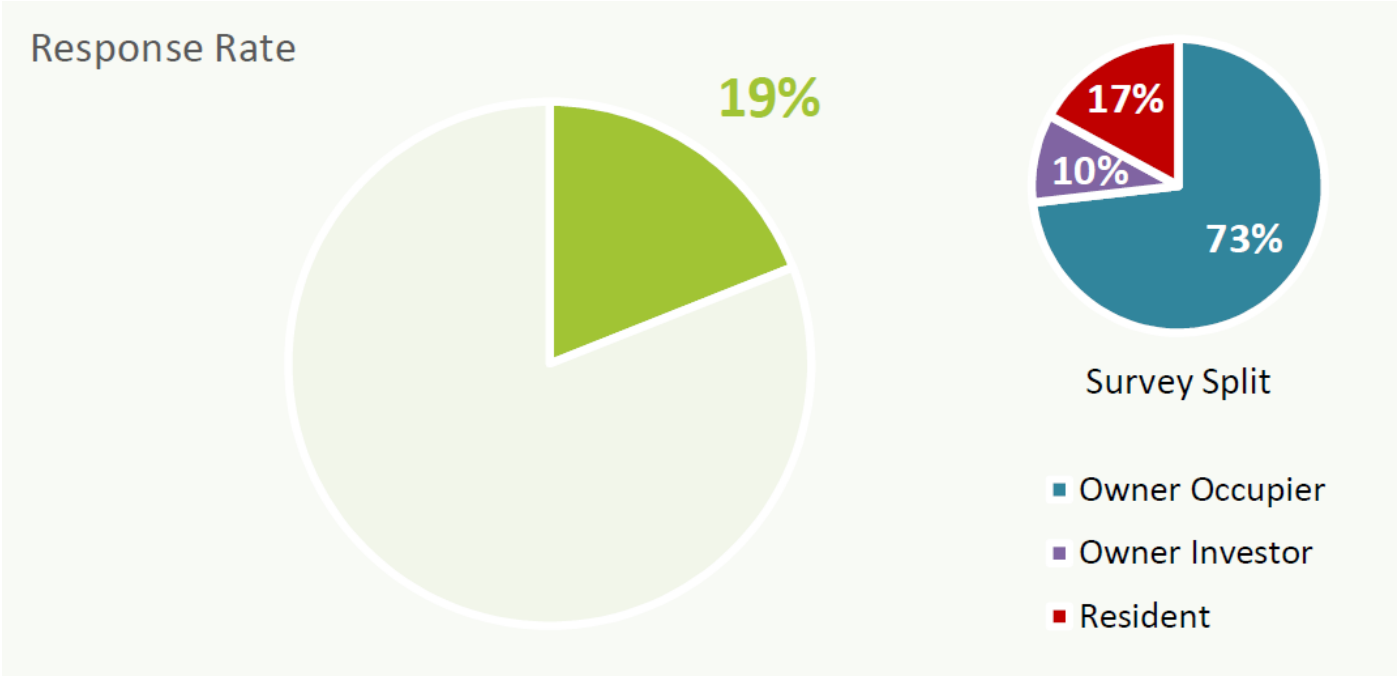


Figure 9: Participant Building Survey Response Rate and Split of Respondent Type

For the participant buildings the survey ran for a total of 105 days starting from 21st June 2017. Survey respondents tended to be Owner Occupiers (73%) with a smaller response rate from Owner Investors (10%) and Residents (17%).

3.5 Resident Comments and Suggestions

The high level of engagement on the survey was further evidenced by a good number of written comments. This provides some useful insights into the current thought processes and attitudes people have around electric vehicle charging. A full listing of all comments provided by City of Sydney participants is provided in the Appendix A.14.

3.6 Attitudes Toward Electric Vehicle Charging

Overwhelmingly respondents were in favour of installing electric vehicle charging facilities. For the City of Sydney participating buildings, 81% voted in favour with only 6% against. Of the respondents only 13% were undecided. This result compares to the overall survey study results from 112 strata schemes whereby 79% were in favour and with 8% against. The overall result was slightly skewed by more negative responses from Melbourne. Some commentary on the Melbourne survey indicated that the existence of a free tram service should discourage residents from having vehicles in the city.

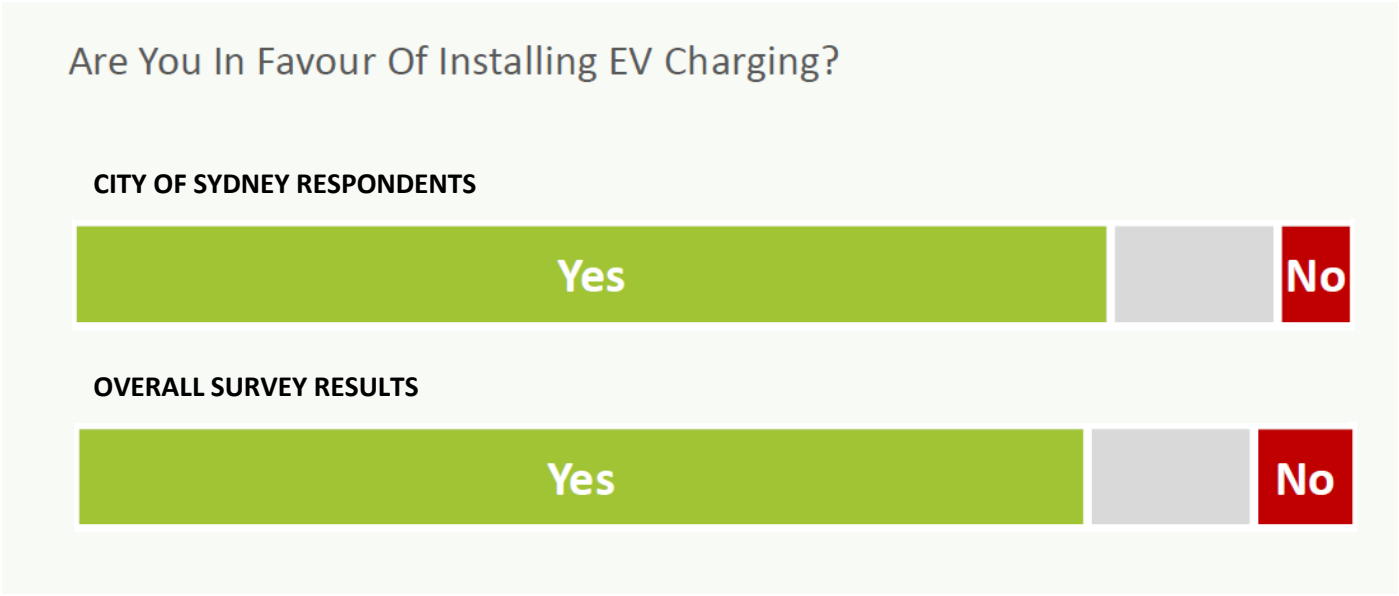


Figure 10: Attitudes towards installing electric vehicle charging facilities

3.7 Resident Driving Profiles

Participating respondents to the City of Sydney survey kept an average of 1.2 vehicles on their lot, which is broadly consistent with the overall survey results from 112 strata schemes. This includes 13% of respondents that do not have any vehicle on their lot, slightly higher than the broader survey result of 11%. Most respondents had one vehicle (63%) with a small number having two (18%) or more (6%) vehicles.

Three quarters of the vehicles were either Small Cars (39%) or Family Cars (36%). The City of Sydney respondents showed slightly more inclination to Small Cars than the broader sample where Small Cars and Family Cars were more equally weighted at 38% each. A smaller proportion had Large Cars (18%) or Motorbikes (6%), approximately in line with the broader survey.

Respondents from the City of Sydney drive fewer kilometers on average than the broader survey sample. On average City of Sydney respondents drive 111 km per week versus 115 km for the broader survey. Less than 4% of respondents drive more than 400 km per week on average.

Extrapolating survey responses provides an approximation of 3,920 vehicles within the 20 participating strata schemes. Based on survey responses, these vehicles are further estimated to be driven a total 22.64 million kilometers per year and consume 2.5 million litres of petrol at a cost of $3.26 million per year.

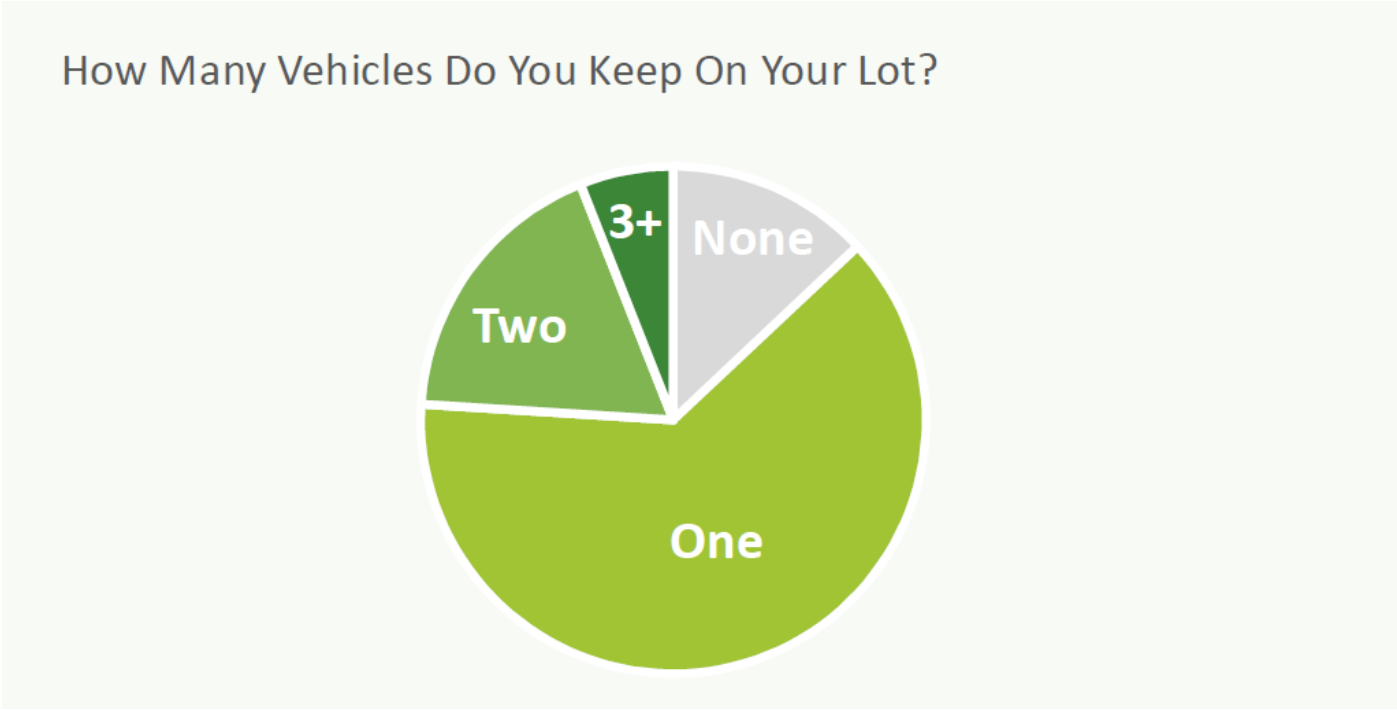


Figure 11: Vehicle Distribution

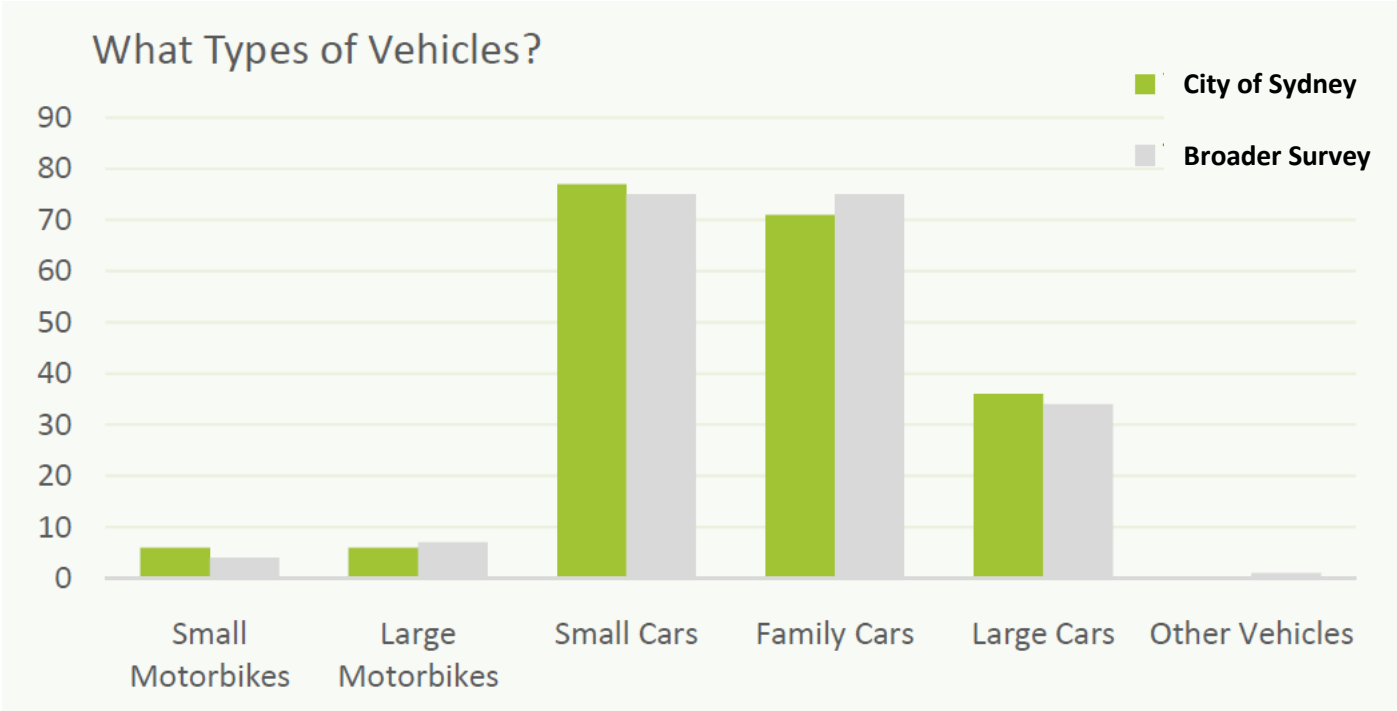


Figure 12: Vehicle Types

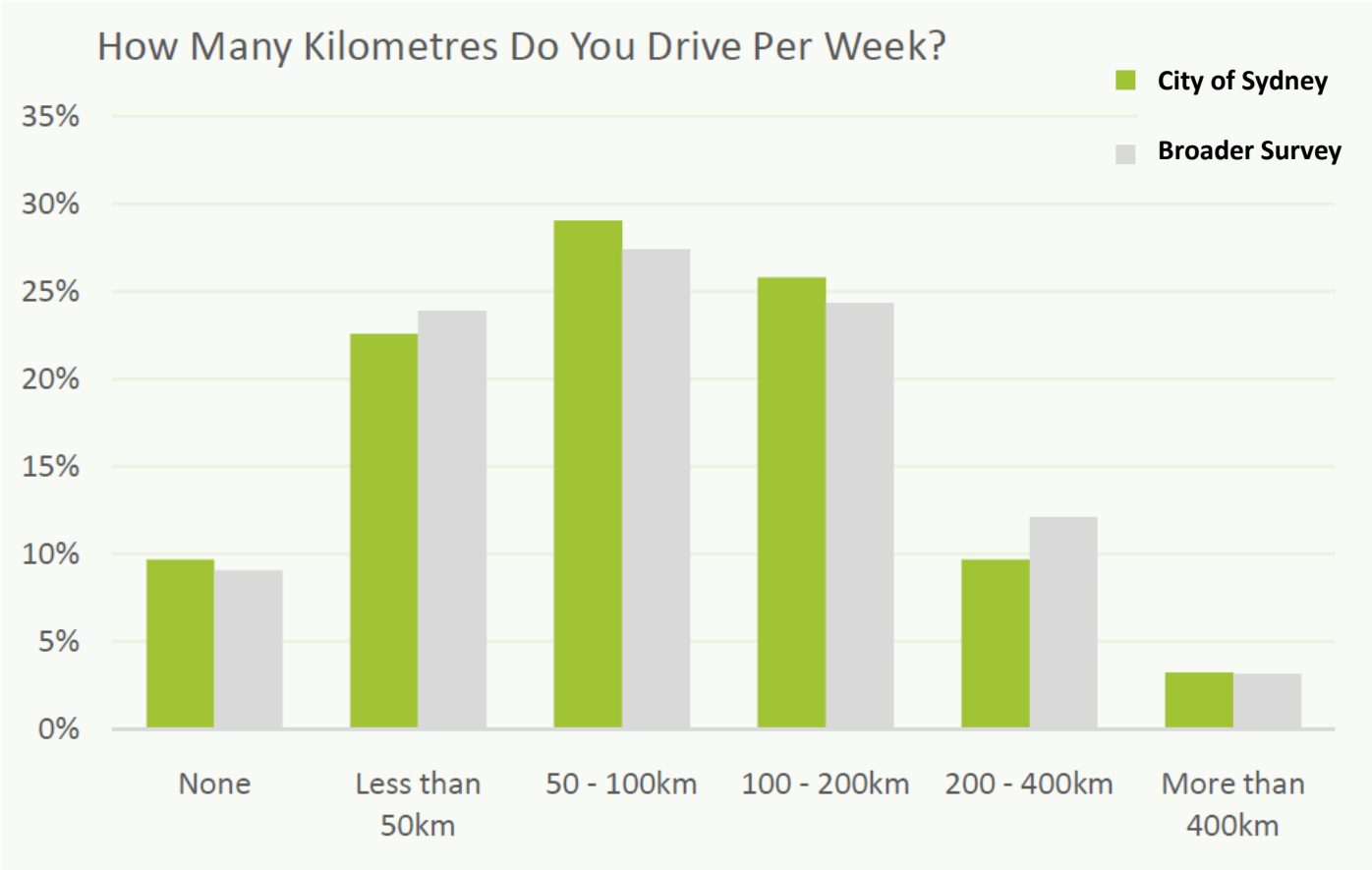


Figure 13: Average Driving Distances

3.8 Electric Vehicle Buying Intentions

Less than 1% of survey respondents in the City of Sydney indicated that they already have an electric vehicle. However, City of Sydney survey responses show that 58% of residents plan to have an electric vehicle within the next ten years. This is slightly higher than the broader survey result of 56%. The results show 22% intend to have one within two years, growing to 48% within 5 years. Only 10% indicated they plan to push the decision out beyond 5 years. However, there were another 42% of respondents that indicated they do not have any plans at the time of the survey. These results will clearly be dependent upon a number of market factors including;

- Availability,
- Range and
- Pricing of suitable electric vehicles over these time frames.

Never the less, these results show expectations at the time of the survey.

The survey results further indicate a preference for fully electric vehicles (67%) over hybrid vehicles (33%). However, this excludes 42% of respondents that did not indicate any preference. The broader survey respondents were slightly more inclined toward fully electric vehicles (69%).

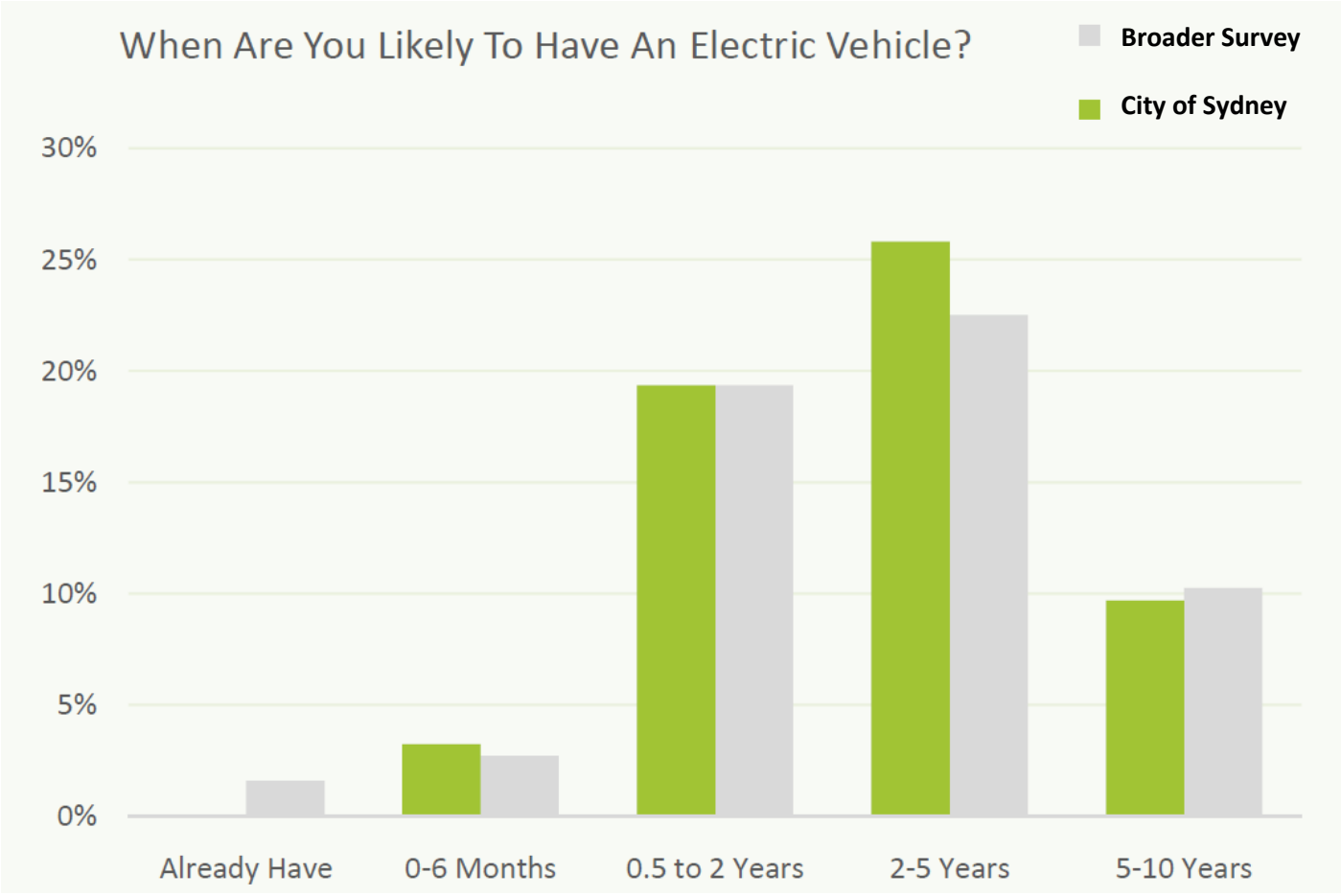


Figure 14: Electric Vehicle Intentions

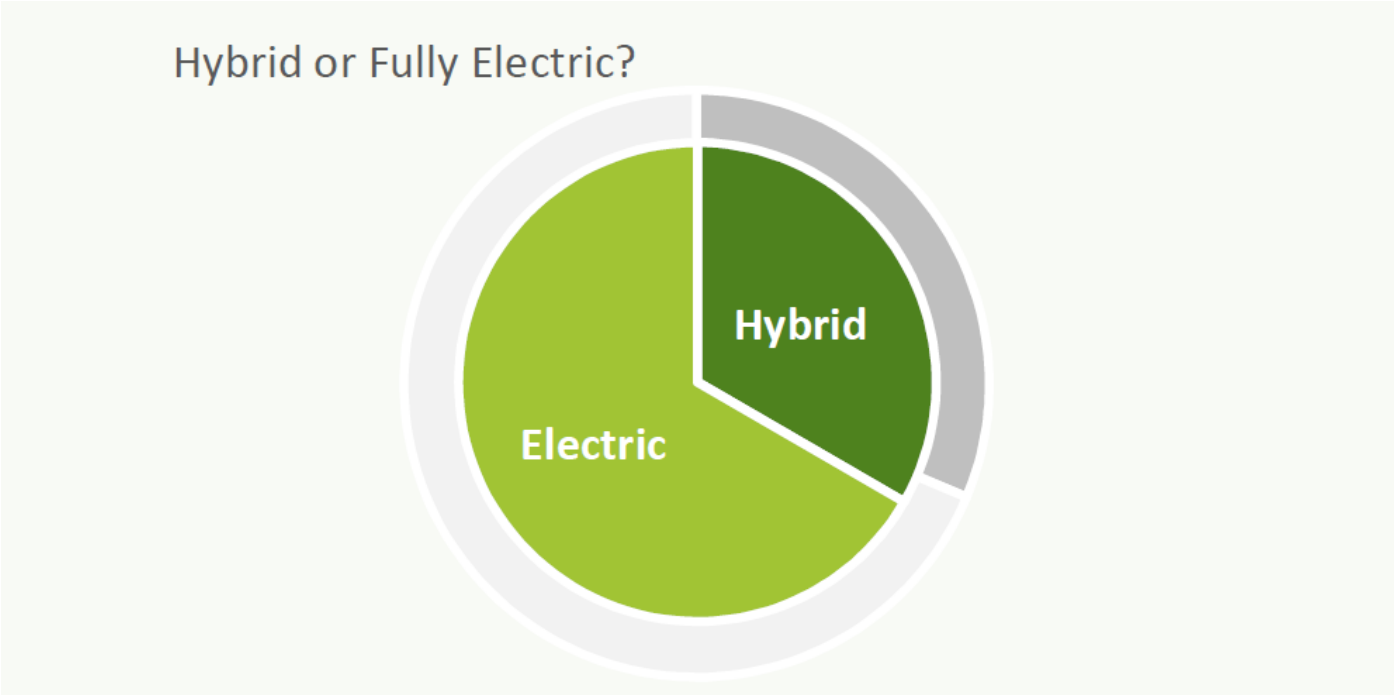


Figure 15: Electric Vehicle Type

The survey also asked an open question about preferences toward make, model or brand of electric vehicle. While only 16% of respondents answered this question, 85% of the responses included the keyword "Tesla" and 11% of responses included the keyword "BMW". There were a small number of responses indicating other brands including Nissan, Jaguar and Mitsubishi. Some respondents provided very specific feedback on the precise make and model.

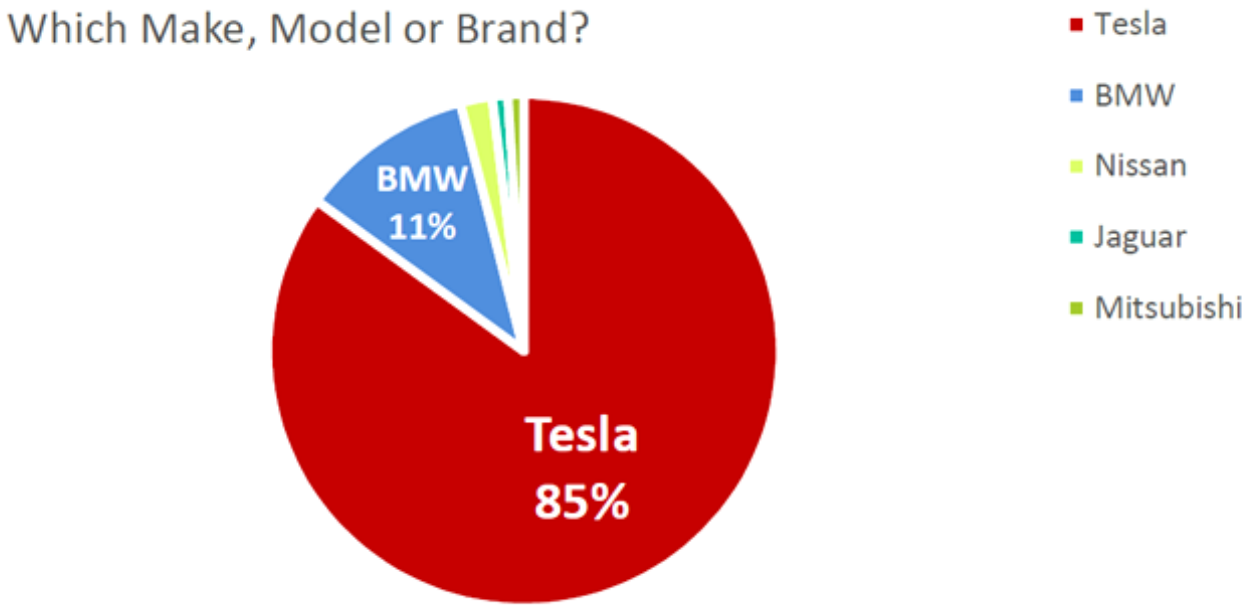


Figure 16: Electric Vehicle Brands

There has been a lot of hype around the announcement of the Tesla Model 3 vehicle going into production this year. To some extent the response to this question reflects the vehicle brands that are available on the market today and the amount of marketing behind these brands. Other vehicle manufacturers have made commitments to offer electric vehicle options as part of their range. As these vehicles are launched into production we would expect that the mind share of other electric vehicle brands will grow. Never the less Tesla has established considerable brand equity as the leader in the electric vehicle segment.

3.9 Electric Vehicle Charging Preference

Electric vehicle charging systems can be set up in many different ways. The survey tested preferences toward two critical issues.

- Firstly, there is the question of whether or not residents want to have their own individual charger directly on their car space and/or
- Share a charger installed on a common parking space such as a visitor parking space.

These are not mutually exclusive options and some respondents indicated that a combination of both would be appropriate for their building.

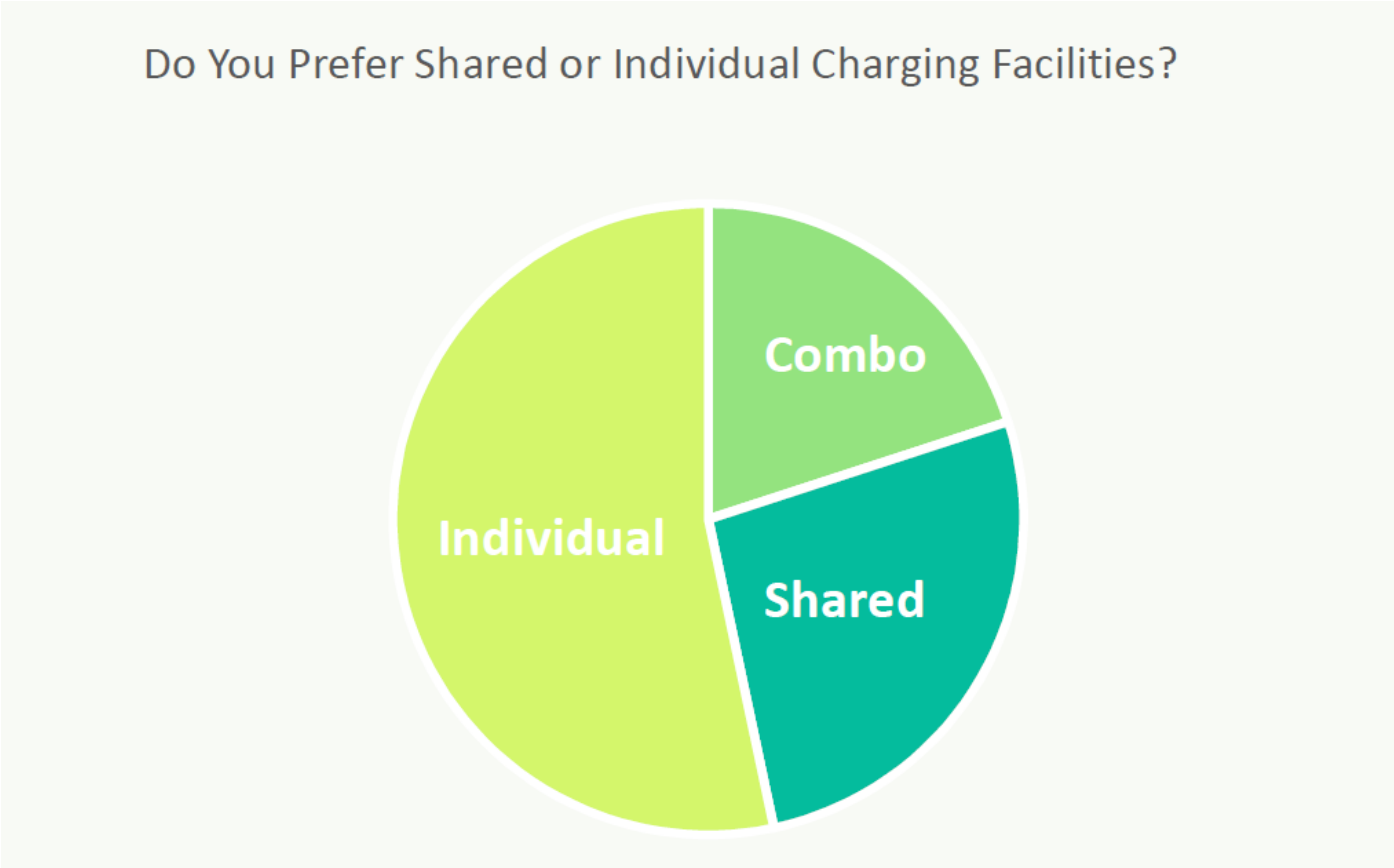


Figure 17: Electric Vehicle Charging Set-up

For the City of Sydney respondents 53% indicated a preference individual chargers only. A combination of both individual chargers and shared chargers was preferred by 20% of respondents while 27% preferred only having shared chargers. This compares with the broader survey results in which 63% of respondents preferred individual chargers only, 16% a combination, and 21% shared chargers only.

Respondents were also asked if they preferred a user pays or a free service paid for by the strata. Again the question was not mutually exclusive and some respondents indicated a combination might be appropriate. City of Sydney respondents preferred a user pays service (76%) over a free service (19%) or combination (5%). The overall survey responses were slightly more favourable to user pays (79%), and less favourable to free (15%) or a combination (6%). A combination service might mean partially paid for by the strata such as a limited number of free shared chargers or that costs are subsidized in some way. Furthermore the survey question was intended to gauge general attitudes and does not distinguish between upfront and on-going costs. These could be broken down further into infrastructure investments and end user equipment and services.

In general most strata schemes operate on the basis of user pays for services. However, in some cases there are shared facilities such as hot water systems whereby the residents have agreed to these costs being covered by the strata and therefore recovered by way of strata levies. In these cases there tends to be strong case towards overall cost benefits of implementing a shared system. In the case of electric vehicle charging implementations the same may be true. Clearly some residents feel that there is a case to be made. It is also arguable that people who invest in electric vehicles benefit other residents by reducing carbon monoxide and nitrous oxide emissions in the car park and should therefore be incentivized. If government incentives were provided this might also be a factor.

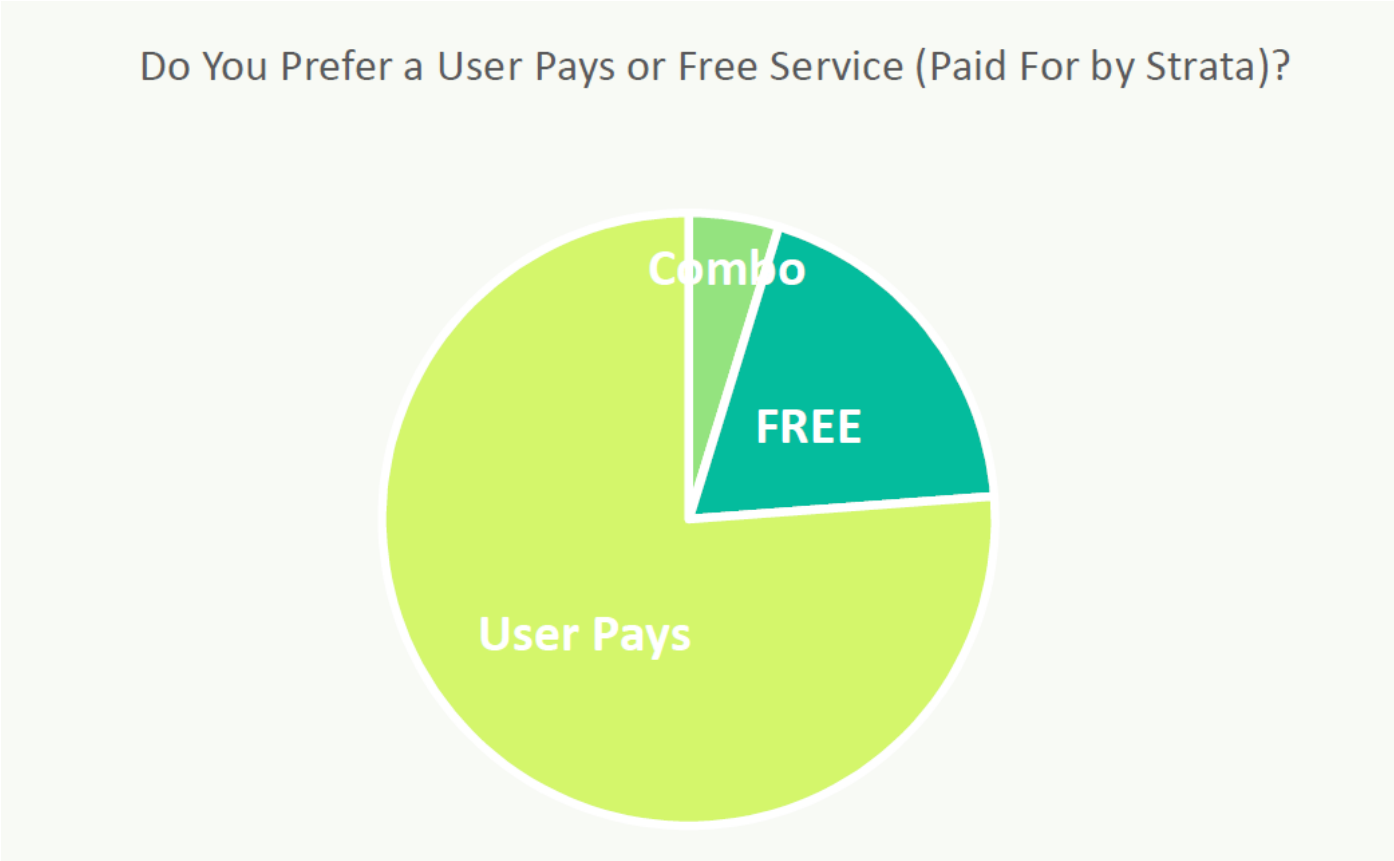


Figure 18: Electric Vehicle Charging Payment

In the case of electric vehicle charging a free service will more likely been seen to benefit a minority of residents that have electric vehicles in the short term. This is likely to be an overriding consideration that may result in some strata committees blocking any proposal to implement a free charging service. It should also be taken into consideration that EV owners may already be charging their vehicles using common area power sockets. The survey results indicate that there is likely to be a negative attitude towards this behavior, assuming residents are aware of it.

3.10 Awareness and Attitudes to Public Charging Facilities

A map was provided in the final survey results provided to participating strata schemes showing the nearest public charging stations to them.

While there is a small overall sample of respondents that already have electric vehicles, the survey results show that 45% of those respondents do use public charging facilities. Private chargers are used by 37% of respondents with electric vehicles with a smaller proportion using charging facilities at work (8%) or using common area power (11%).

Otherwise City of Sydney survey respondents were typically unaware (88%) of where the nearest public charging station is to their building. Considering that more that 99% of respondents do not already have an electric vehicle, it should be viewed favourably that 12% of respondents actually do know where the nearest charging station is. This further supports strong awareness and intentions toward having an electric vehicle in the future. This is slightly better than the overall result that shows 11% of respondents were aware of the nearest public charging station.

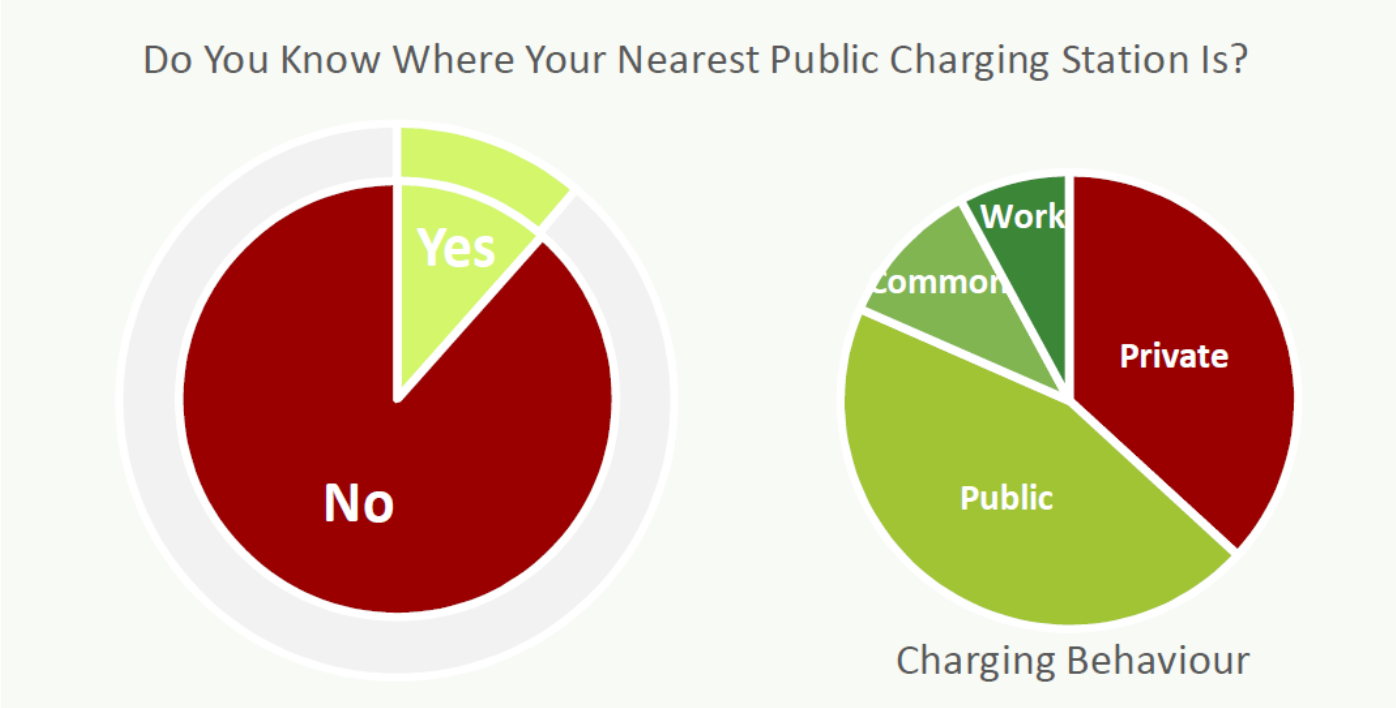


Figure 19: Awareness of Public Charging Stations and Behaviour

From the City of Sydney respondents 98% were negative toward the idea of their building offering a public charging facility. This is broadly consistent with the overall survey results. The survey did not dig deeper into reasons why people are negative about this. It is reasonable to expect there to be negative attitudes toward private property being opened up to public access. Attitudes may differ depending on the particular location proposed. If public charging provided a source of revenue to the owners corporation this might also influence thinking.

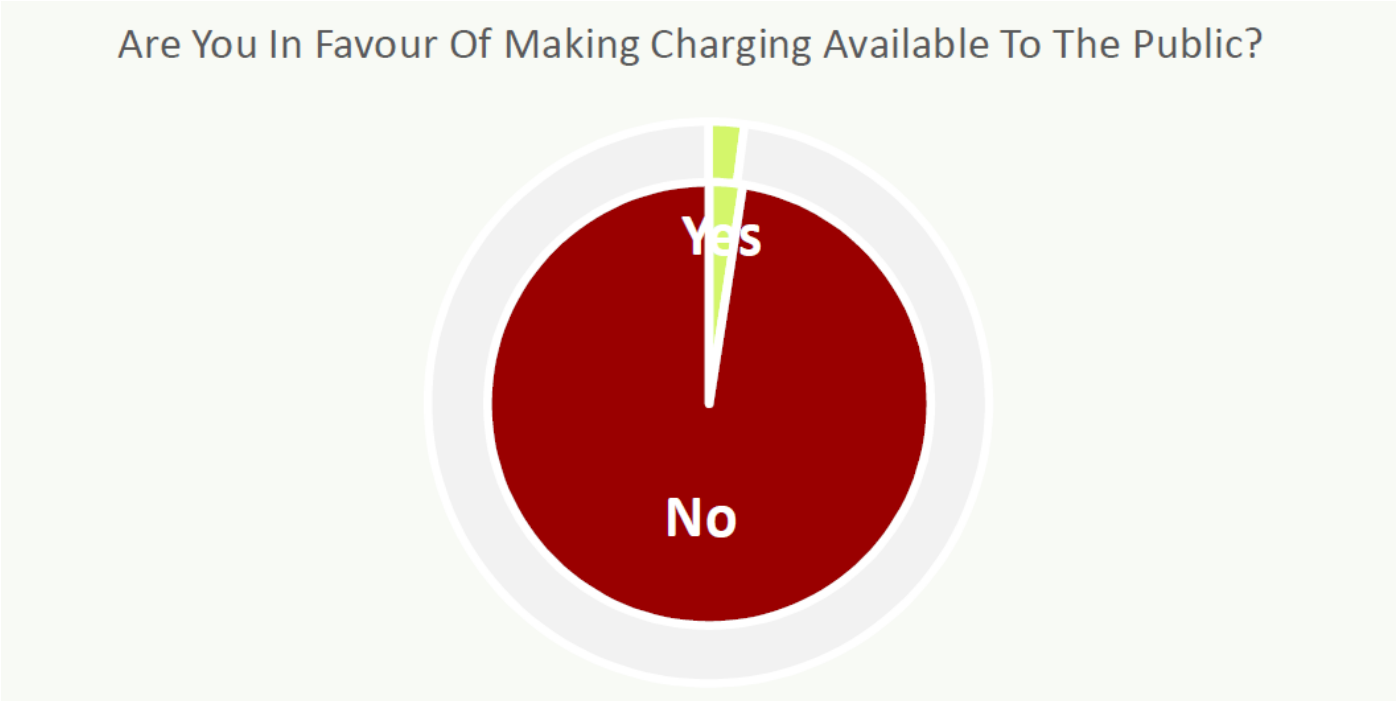


Figure 20: Attitude Toward Providing Public Charging Facilities

Site Assessments

Site Assessment Scope

Site Visit Observations

Challenges with Electric Vehicle Charging in Strata

Electrical Infrastructure in Strata

Increasing Capacity for Electric Vehicle Charging

User Pays Commercial Models

Top Recommended Projects

Summary Participant Building Results

4.0 Site Assessment Scope

Wattblock co-ordinated site visits to all 20 strata schemes to gain an understanding of the potential issues presented by each building. While there was a lot of commonality there were also notable differences that would lead each strata scheme to different conclusions on how to implement electric vehicle charging.

Prior to site visits Wattblock requested a number of documents to help us prepare. In particular we reviewed up to 12 months of common area electricity and gas bills to gauge the energy usage profile and to determine the number of meters and meter rooms. We also examined strata maps to positively identify the location of switch rooms and distribution boards. Where possible we also obtained single line diagrams which provide information about the electric circuits in the building including how and where they are connected, sizing of circuit breakers and busbars, and an indication of spare poles and capacity on existing distribution boards.

Site visits typically took 2-3 hours to complete. Once on site with the site contact person the visit usually commenced with a brief walk around the car parking area. Notes were taken to record to location of special purpose car bays such as visitor car parking or cleaning bays and other features such as the presence of general 10 amp power outlets, lighting circuits, and cable trays throughout basement carpark roofing. We kept a look out for any existing electric vehicles and any charging stations or evidence of general power outlets being used for charging.

A critical part of the site visit was to observe the switch rooms. In most cases the strata schemes did not have a single line diagram to provide the full detail about the electricity infrastructure of the building. However, in most cases a reasonably complete picture could be determined by visiting the switch rooms. Most switch rooms have a well labelled breaker panel or even a documented table showing what electrical assets exist on the different circuits and the power rating of each circuit. We also reviewed the cable access situation and other relevant equipment in the switch room such as power factor correction units.

Finally we were escorted to various plant rooms around the building to obtain further data about specific equipment being run off the common area power boards. This allowed us to review the overall efficiency of existing electrical services and any interrelationship with gas services such as common hot water systems. This was an important part of the process in understanding current and future available capacity for electric vehicle charging and the potential impact on other services.

In completing each site analysis Wattblock activities included the following.

- Complete basic building meta-data capture
- Complete energy consumption profiling using interval data, site data, energy bills
- Check location of main switch room for distance calculations
- Available space in switch room for recharging, batteries, inverters etc
- Type of communications infrastructure in building and switch room
- Type of meters … common area and apartments
- Presence of multiple meter boards throughout the building
- Levels and dimensions of basement car parking for distances
- Presence of risers and other channels for cabling
- Presence and location of visitor car parking spots
- Suitability of rooftop for solar including area, surface and accessibility
- Number and location of common area power sockets (standard 10 Amp)
- Are power sockets in car spaces connected to common power or private

- Number, type and location of any existing recharge facilities
- Number, type and location of any electric vehicles (look and ask)
- Ask about resident demographics? Working / Retired / Holidays / Family / Affluence
- Ask about driving behaviour? Number of daily drivers vs weekend drivers + typical distances
- Does the building have valet parking services?
- Does the building have any existing renewable energy facilities? Solar / Trigen etc
- Switch board capacity assessment checklist
- Photographic documentation

Further information on site visit activities is contained in Appendix A.1.

4.1 Site Visit Observations

While Wattblock has encountered buildings with car lifts and stackers, most car parking areas generally extend several floors underground but can also extend upwards taking up part or all of some of the lower levels of the buildings. Outside of the central city areas there are also often external car parking spaces or a combination of both. Underground car parking typically have ducting and high powered fans to extract carbon monoxide and other hazardous fumes. This is also required to meet fire safety standards. Upper levels are sometimes open to external airflows. Internally car parking levels are often staggered in half levels. In all cases there is extensive lighting throughout car parking areas often running 24 hours at full strength while some have dimmable lights.

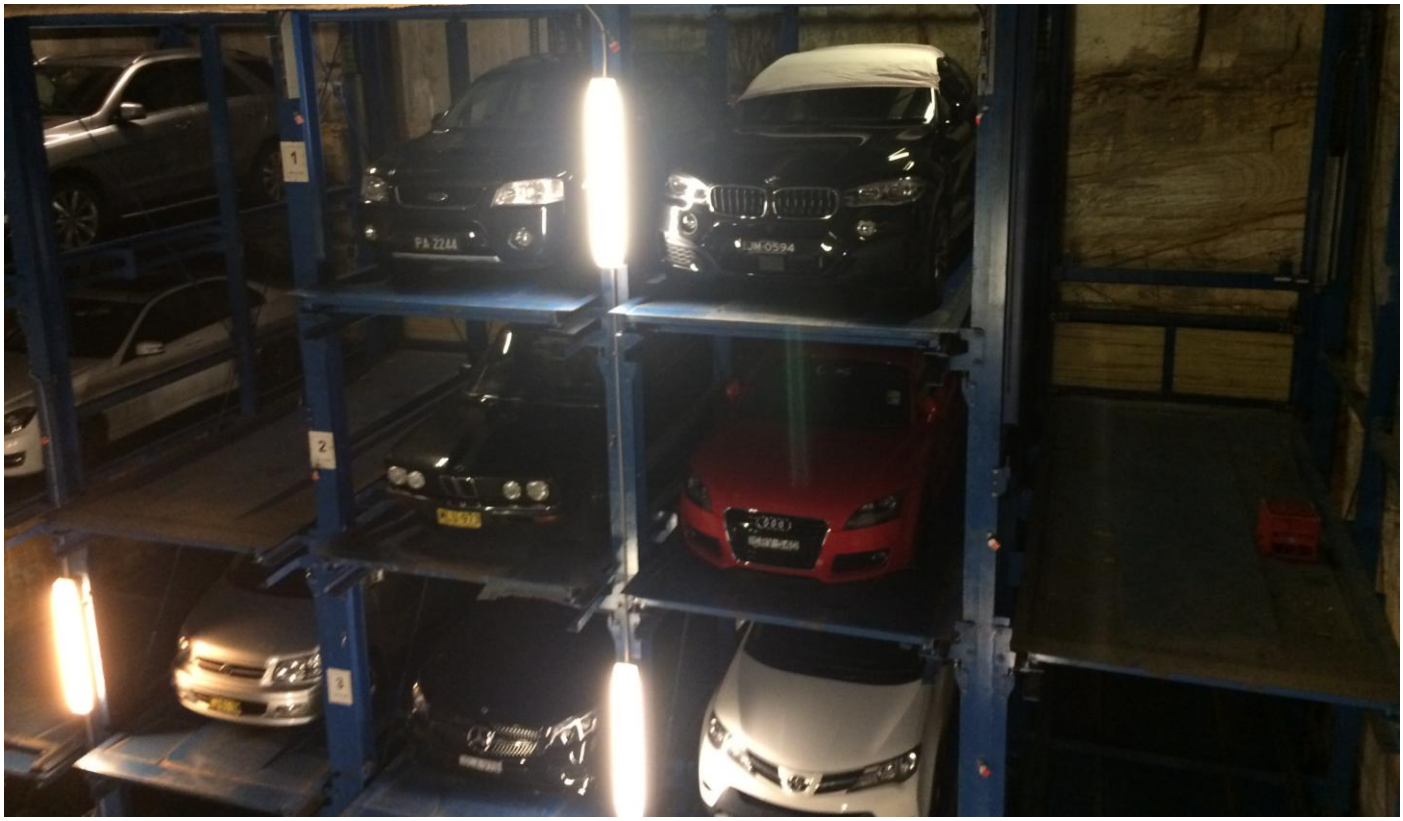


Figure 21: Possible future trend toward car lifts and stackers

Most already have or can be expected to implement LED lighting in car parking areas and fire escapes which generally means these lighting circuits are often over sized in their original design specifications and represent free electrical capacity for other purposes. Internal car parking areas typically also have electrical gates for security purposes and general power outlets distributed throughout the car park or in special purpose locations like visitor car spaces and cleaning bays.

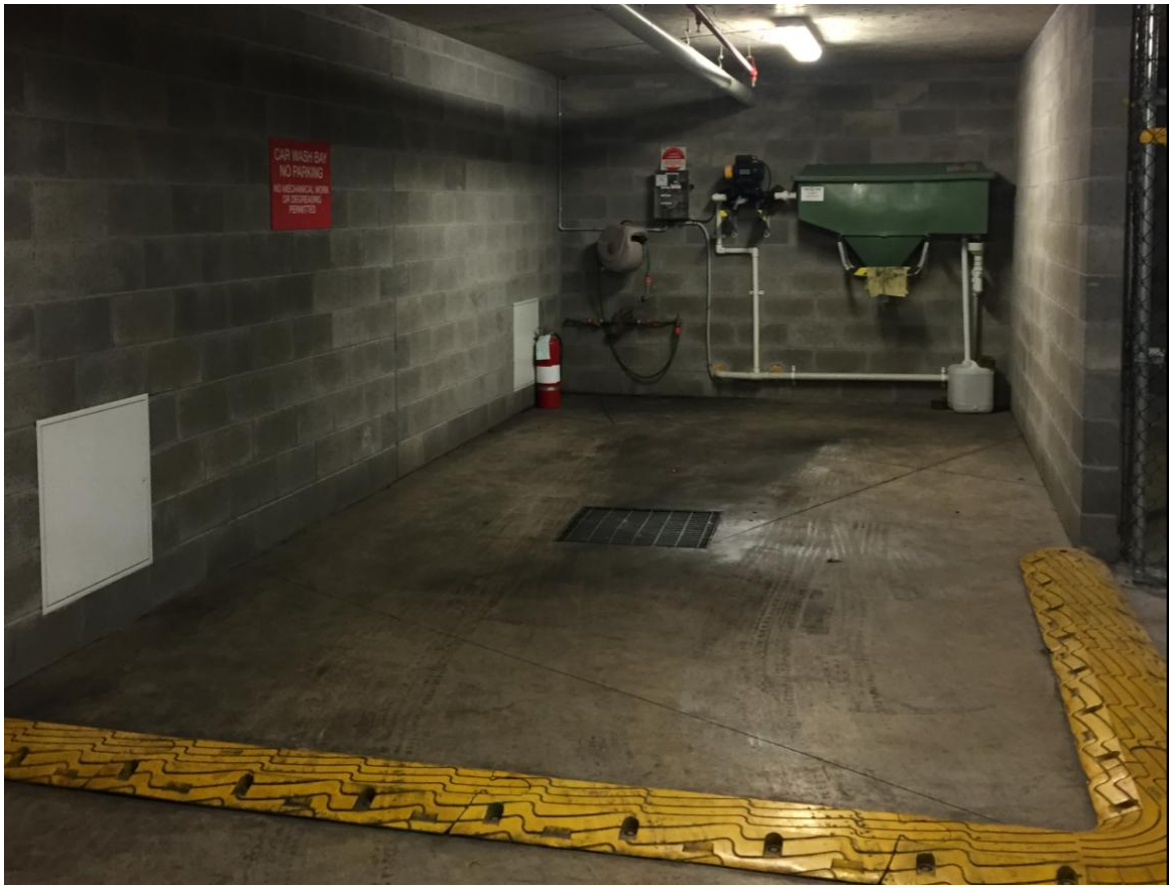


Figure 22: Example of a shared car wash bay

Generally speaking apartment buildings are fairly predictable in terms of the structure of electrical power infrastructure. A switch room is usually located on ground level internal car parking where the cable comes in from the nearest electrical substation. This is generally a large three phase power supply which splits off into three or more busbars; one for apartment meters and several others for common area services, generally split between essential services and non-essential services.

Apartment meters sit behind the busbar on each individual circuit and are either located in a single switch room with everything else, or distributed throughout the building(s) often on each floor. For common areas there is typically a single meter that sits in front of everything which is located in the switch room. However, in some buildings there are several meters for common area services and they can be located in different switch rooms as well. Furthermore common area supply can branch out to different distribution boards particularly where there are several buildings on the strata scheme. Without exception there is at least one services distribution board with sub-circuits for different electrical services such as lifts, HVAC, water pumps, common hot water systems, and common area lighting being typical common area services.

Following are some anecdotal differences that we have observed between the participating strata schemes.

- **Waterloo** – Massive complex with multiple buildings
- **Alexandria** – Already has solar PV connected to common power.
- **Haymarket** – LED Lighting increased EV capacity from 35 to 48 vehicles.
- **Millers Point** – Car lifts. One Tesla charging off 10 Amp. One Porsche on tickle charge.
- **Ultimo** – Largest number of survey responses with 83 responses.
- **Erskineville #1** – Three Goget spots accessible to the public.
- **Roseberry** – Seven different common area meters. IGA carpark option for charging after hours.
- **Rushcutters Bay** – Jimmy T from FlatChat filled out the survey. Turnaround. A/C is the issue.
- **Glebe** – BMC owns car space. City of Sydney owns car parking spaces in basement (not used).
- **Surry Hills** – Committee printed flyer and put under windscreen wipers. Only 2x EV capacity today.
- **Erskineville #2** – Urban renewal. Star Printery turned into apartments
- **Woolloomooloo** – Has a Tesla dealer in the commercial space.
- **Pyrmont #1** –The Owners Corporation Chairperson is a Tesla owner.
- **Pyrmont #2** – One EV Owner.
- **Sydney #1** – Already moving ahead with electric vehicle recharging quotations.
- **Darlinghurst** – Tesla owner arriving.
- **Sydney #2** – Maseratti on trickle charge, not billed as user pays.
- **Sydney #3** – BMW i3 owner.
- **Sydney #4** – Old building with limited car spaces
- **Redfern** – Catherine Lezer on SCA board requested a different Bylaw.

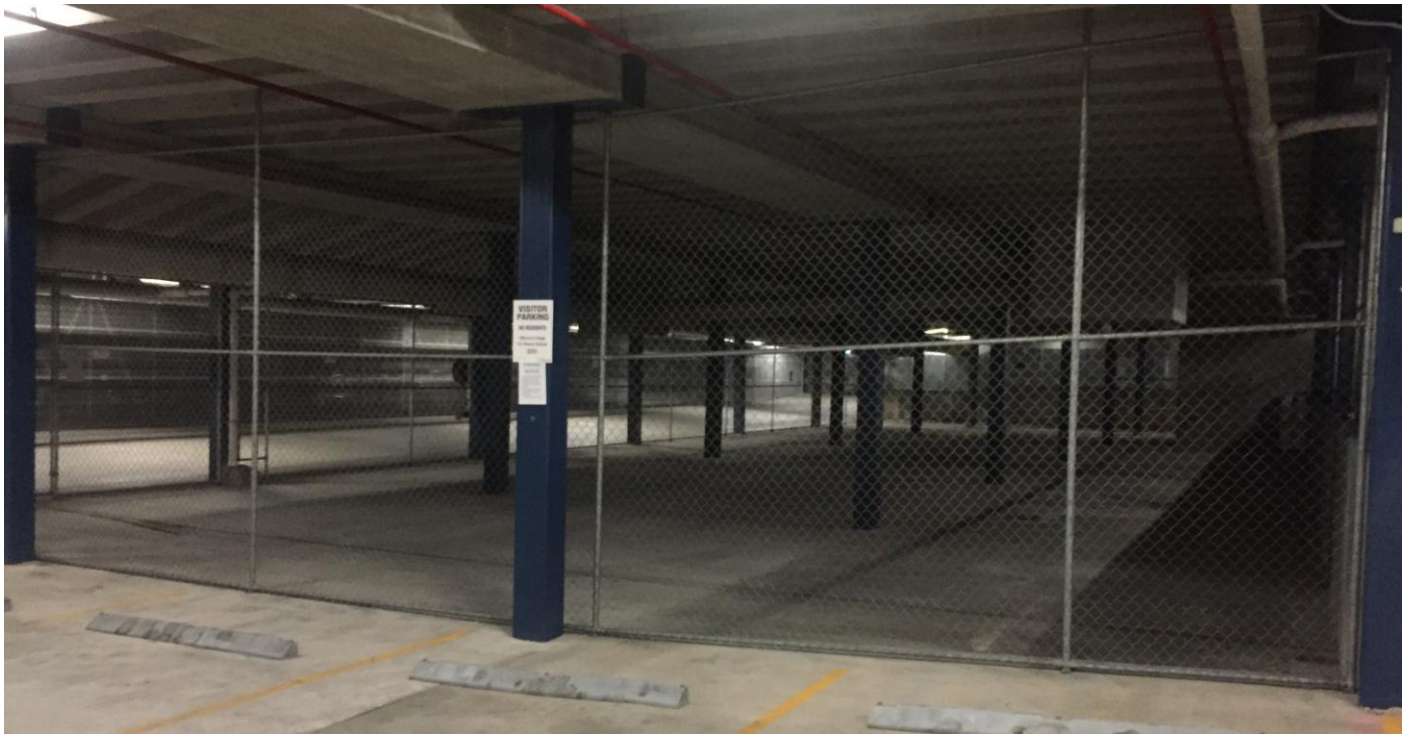


Figure 23: Car park with unusable extra space owned by the City of Sydney

4.2 Challenges with Electric Vehicle Charging in Strata

Location of Charging Equipment

EV charging stations could potentially be installed near visitor car parking spaces for shared use or at resident's individual car parking bays for private use. Different by-laws and processes should be set up for the Owners Corporation to govern usage, payments, charger capacities, installation and de-installation depending on the decisions made about where to locate the charging stations. For some strata schemes, visitor car parking is not available. Installing a shared charger will also impact availability of existing visitor car spaces and will require local council approval for a change of use. In addition, the use of shared charging is less convenient for residents. According to the survey results there is an overwhelming preference for individual charging facilities.

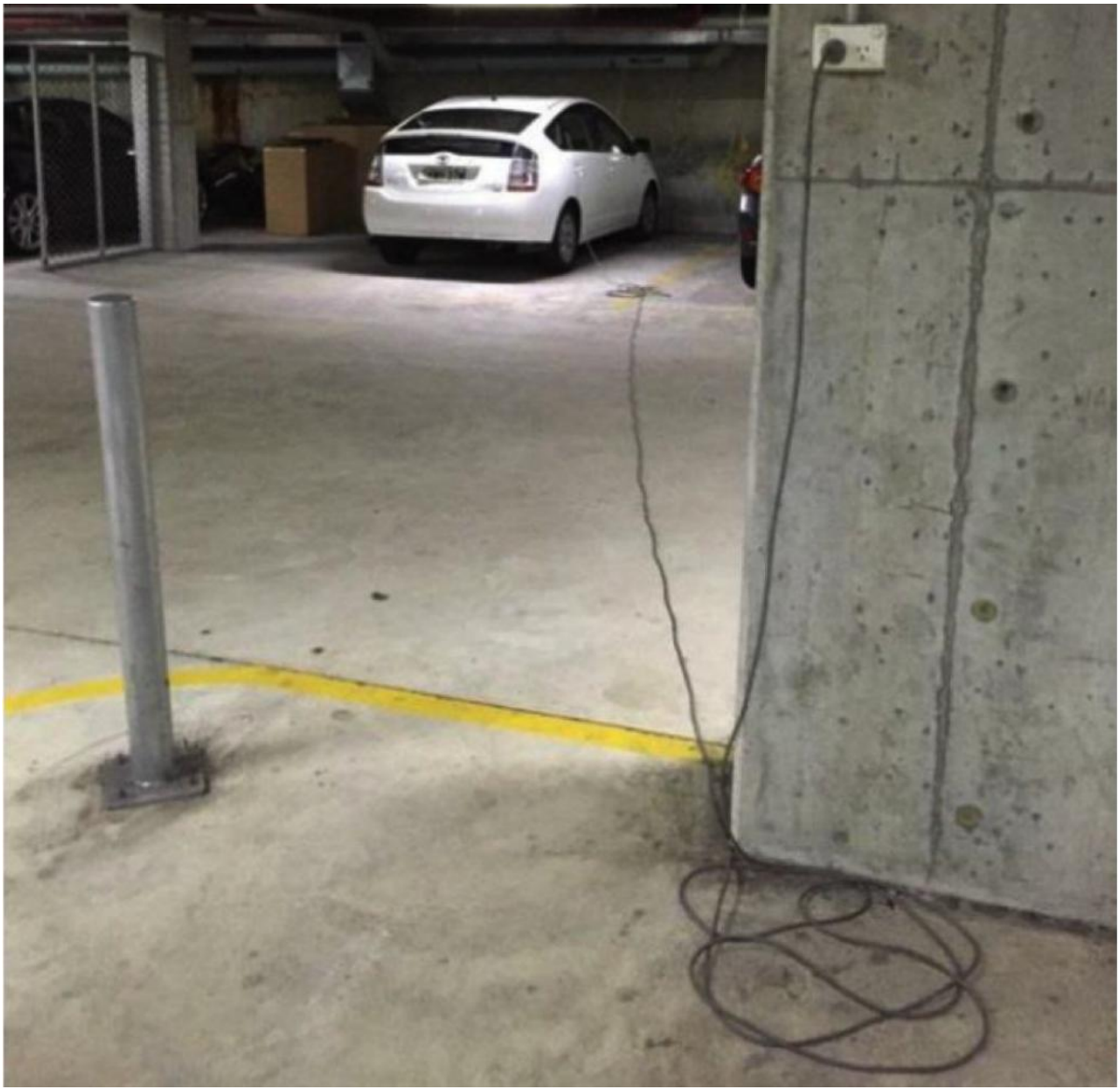


Figure 24: Electric Vehicle Using Standard 10 Amp Power Socket

Connection to Tenant Meters versus Common Area

Connection of an electric vehicle charger to a tenant's own apartment meter generally has the benefit of being able to directly pay for and monitor the electricity usage. Depending on the set-up proposed and location of meter rooms the set-up can be expensive. It may be necessary to apply for a revenue grade meter installation from the network operator, which will all require Body Corporate involvement to review and approve each installation.

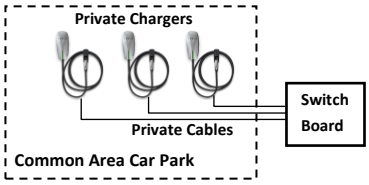
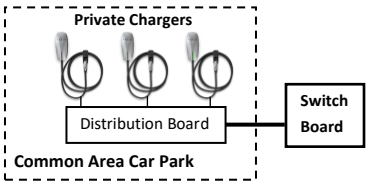
Connection to the common meter board is usually more economical in terms of both installation costs and on-going electricity usage costs. In the longer term with increasing EV adoption this offers the best value to owners and tenants and may be easier for the Owners Corporation to effectively manage. Apartment blocks with more than 20 units, typically will need an EV recharge solution connected on common power.

Figure 25: Electric Vehicle with dedicated charging unit installed

Charging Solutions and Set Up Arrangements

EV owners can charge their vehicle using common power sockets or set up a private charger on their car space. There are different types of set up arrangements and the benefits and drawbacks of each are summarised below.

Table 4: EV Charging Solutions and Set Up Arrangements

	Common Area Power Socket	Private Charger With Private Cable Connection	Private Charger With Shared Cable Connection
Conceptual Diagram			
What is it?	• Use standard 10 Amp EV charging adaptor with existing power socket or, Install new power socket and connect to either residential or common area electricity boards	• Install EV charger in private car spaces and connect to existing electricity boards via private cables • Use either the residential or common area electricity boards based on the lowest set up cost option	• Owners Corporation set up new common electricity boards and shared cabling throughout all car park levels, making the building EV ready • Residents can connect the 'last mile' of cabling into their individual car space
How to bill for charging Electric Vehicles?	• Install a new electricity sub-meter behind power sockets. Requires administration (reading & billing) or, • Flat-rate annual fee based on driving distances (see appendix). • Billing not required if the charger is connected to residential metering	• Install a new electricity sub-meter behind the private cable. Requires administration (reading & billing) or, • Flat-rate annual fee based on driving distances (see appendix). • Billing not required if the charger is connected to residential metering	• Install EV charger with smart meters and engage a third party billing service ($30/month) to reimburse electricity costs to the Owners Corporation. No additional administration for strata management. • DIY billing off individual meters by building manager
Who pays for set up costs?	• EV Owners • Est. Set Up Cost Per Socket: $0 - $1,000	• EV Owners • Est. Set Up Cost Per Charger: $1,500 - $8,000	• EV Owners & Owners Corporation • Est. Set Up Cost Per Charger: $500 - $800
Who should use this solution?	• Small apartments and inter-mediate solution for larger buildings • Proven to be successful in Canada • Cannot be used for a supercharger	• Small apartments and inter-mediate solution for larger buildings • Provides faster charging speeds in comparison to using power sockets	• Long term solution for large apartment buildings • Owners benefit from increased rental return and property valuation uplift • Increased adoption rate for EV as its easy for residents to set up a charger at home
Drawback	• Additional administration cost for billing to Owners Corporation • Difficult to manage a large number of meter readings • Slow charging speed	• Capacity in existing electricity boards can only accommodate a limited number of EV chargers • Difficult to manage a large number of meter readings	• Capital spending for Owners Corporation

4.3 Electrical Infrastructure in Strata

Electrical Layout Options

Generally speaking residential apartment building energy supply is split between resident energy meters and common area services. Common area services are usually further split between Essential and Non-essential services, both of which sit behind one or more common area energy meters. Services are connected off busbars with circuit breakers that limit the Amperage load within Australian Standards.

Figure 26: Sample – Main switch room

In planning for electric vehicle charging facilities it is possible to set-up dedicated distribution boards running off either the apartment busbar or the common area essential or non-essential services busbars. We recommend connection to the non-essential services busbar. Firstly, this limits any potential disruption to essential services in the building such as the lifts. However, secondarily the common area supply is recommended because there is no need to set up a new power supply contract and capacity can be directly impacted by improving energy efficiency of other common area services.

If an Owners Corporation wants to investigate setting up electric vehicle charging distribution off the apartment busbar, they should keep in mind that a new meter would need to be installed, similar to adding a new apartment meter. Furthermore a new energy supply contract would need to be established and paid for by the Owners Corporation for that meter.

The electricity rate for supply to the new meter will be higher than the existing common area meter due to the bulk rate discounts available. On the plus side, this may make overall energy cost more transparent for electric vehicles and assist in cost recovery. However, it should be taken into account that the apartment busbar and circuit breakers generally will have been sized for apartment energy usage. The growing demands from electric vehicle charging may risk disruption of energy supply to apartments over time.

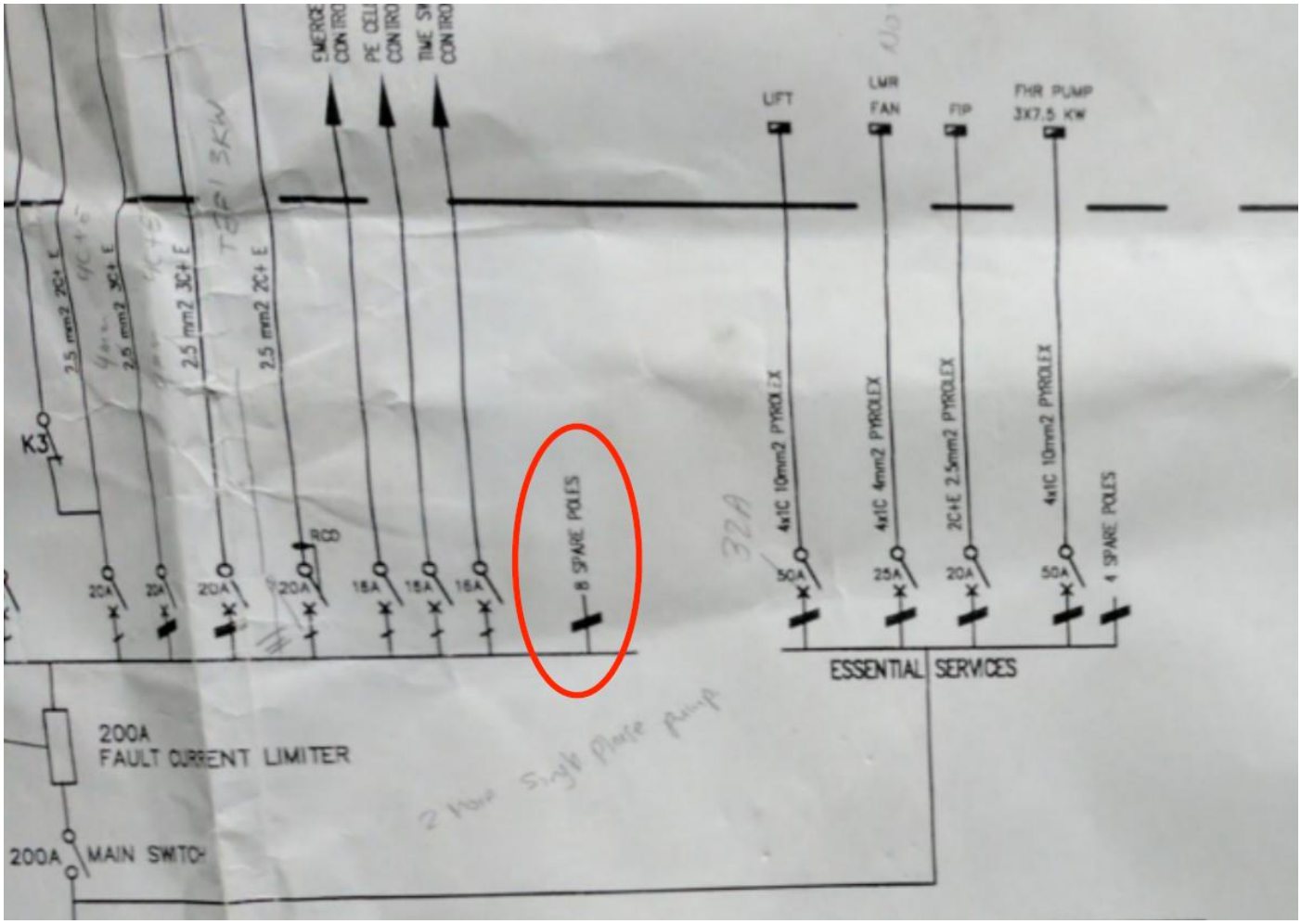


Figure 27: Sample – Single Line Diagram

For the purpose of cost recovery there are multiple solutions available. Generally speaking the solutions, costs and administrative effort will be the same regardless of whether the EV chargers run from the apartment busbar or common area busbars.

In the case of some smaller buildings it may be practical to connect an EV charger directly to the apartments existing individual energy supply. In this case the problem of installing a distribution board and administering a user pays system is eliminated. However, it is recommended that the building continue to monitor energy demands on the overall apartment busbar and potentially upgrade capacity over time to avoid disruption to apartment power supply.

Switchboard Analysis

During the site visits, Wattblock identified the distribution boards that were most likely to be suitable for adding electric vehicle charging services for each participant strata scheme. The following figures show examples of a typical set up of a distribution board that could accommodate electric vehicle charging. There are a number of spare circuits which could be used to set up electric vehicle charging.

Table 5: Sample: Circuit Schedule of Distribution Board

Circuit Number	Fuse Rating (AMPs)	Description of Load	Switch State
1	20	Emergency Control Test	ON
2	20	Lights	ON
3	20	Lights	ON
4	20	Lights	ON
5	20	Lights	ON
6	20	Lights	ON
7	20	Lights	ON
8	20	Lights	ON
9	20	Lights	ON
10	20	Lights	ON
11	20	Gas Hot Water	ON
12	20	Garbage Exhaust Fan	ON
13	20	Lights	ON
14		Spare (Blanked Off)	N/A
15		Spare (Blanked Off)	N/A
16		Spare (Blanked Off)	N/A
17		Spare (Blanked Off)	N/A
18		Spare (Blanked Off)	N/A
19		Spare (Blanked Off)	N/A
20		Spare (Blanked Off)	N/A
21		Spare (Blanked Off)	N/A
22		Spare (Blanked Off)	N/A
23		Spare (Blanked Off)	N/A
24		Spare (Blanked Off)	N/A
25		Spare (Blanked Off)	N/A
26		Spare (Blanked Off)	N/A
27		Spare (Blanked Off)	N/A
28		Spare (Blanked Off)	N/A
29		Spare (Blanked Off)	N/A
30		Time Clock Control	ON

Circuit Number	Fuse Rating (AMPs)	Description of Load	Switch State
31	20	GPO	ON
32	20	GPO	ON
33	20	GPO	ON
34	20	GPO	ON
35	20	GPO	ON
36	20	GPO	ON
37	20	GPO	ON
38	20	Solar Hot Water	ON
39	20	Water Pump	ON
40	20	GPO	ON
41	20	GPO	ON
42	20	GPO	ON
43	20	Spare Roof	Off
44		Spare (Blanked Off)	N/A
45		Spare (Blanked Off)	N/A
46		Spare (Blanked Off)	N/A
47		Spare (Blanked Off)	N/A
48		Spare (Blanked Off)	N/A
49		Spare (Blanked Off)	N/A
50		Spare (Blanked Off)	N/A
51		Spare (Blanked Off)	N/A
52		Spare (Blanked Off)	N/A
53		Spare (Blanked Off)	N/A
54		Spare (Blanked Off)	N/A
55		Spare (Blanked Off)	N/A
56		Spare (Blanked Off)	N/A
57		Spare (Blanked Off)	N/A
58		Spare (Blanked Off)	N/A
59		Spare (Blanked Off)	N/A
60		Spare (Blanked Off)	N/A

For the installation of individual chargers, a major factor that can impact the cost is the distance between the resident's car space and the closest electrical board with sufficient capacity to accommodate the EV charging equipment. This should be considered in determining the best location for electric vehicle charging circuits.

In the absence of any EV charging consideration or governance, we examine the risks of unchecked behaviour of EV owners. From a risk perspective, we must consider probabilities with respect to types of charging installed and usage frequency and timing. Most EV owners are going to prefer higher 32-40 Amp charging installations, so we must consider this a likely choice. It has further been proven that EV owners have successfully negotiated with building

management and Owners Corporations to install their high amp chargers on available spare poles on existing distribution boards. The physical set-up of the distribution board itself provides a limit both in terms of the number of free poles as well as the rated amperage of the given distribution board.

Figure 28: Sample: Distribution board

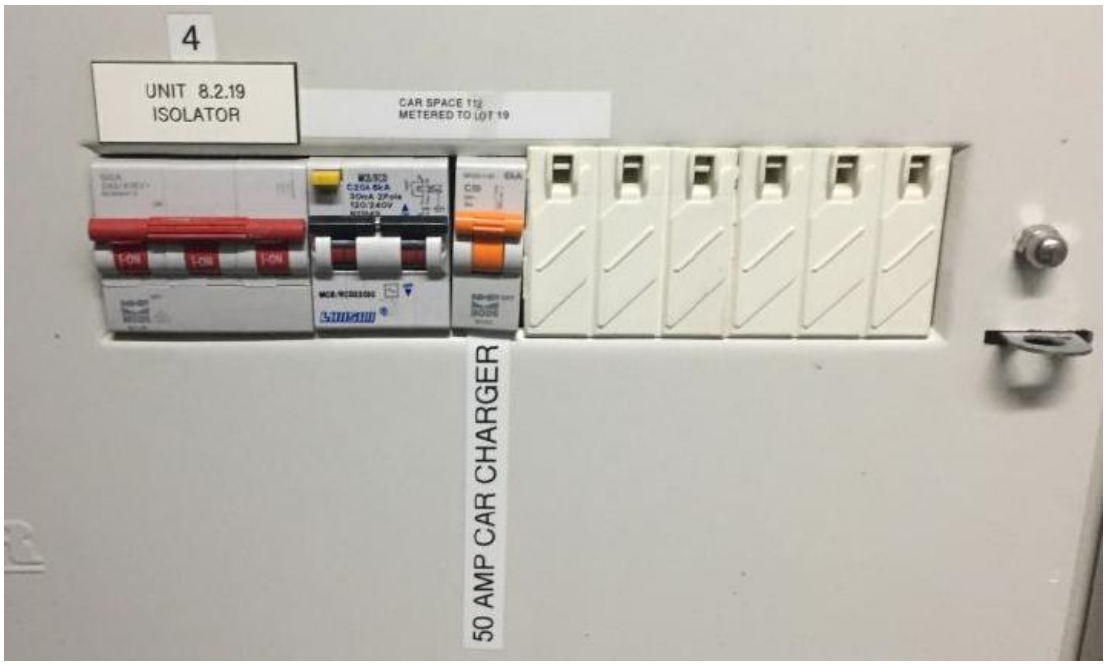


Figure 29: Sample – Individual 50 Amp charger installed on common area

Our analysis considers the probability of all vehicles being plugged in and charging at the same time. Given behavioural consideration that EV owners are more likely to plug in during 'after work' hours, it is almost certain that all EV chargers will operate concurrently at some point over the course of a year. Based on this analysis we then estimated the number of high amperage electric vehicle chargers that would represent a risk to other building services. This limit can be mitigated dramatically via a range of low cost strategies, including simply putting in place a by-law to limit individual charger amperage. This will be covered in the following sections.

Risks of Overloading Common Power

Unchecked and unmanaged, the installation of EV charging equipment in residential strata buildings is limited and the maximum threshold depends on two factors:

- Capacity of main switchboards and sub-boards in the carparking levels
- The speed used for charging the EV, which is related to the amperage used for charging. Common power sockets have the slowest charging speed of 10 Amps and are often used if accessible. Private EV chargers range from 16 Amps to 100 Amps but require an electrician to install them on common property and therefore approval from the Owners Corporation.

Based on on-site assessments for the common area switchboards (see appendix for detail) and the EV survey results, Wattblock examined the projected impact of electric vehicle charging on the participating buildings. Wattblock projected forward the uptake of electric vehicles year or year based on a combination of the survey responses and AMEO projections. Assuming vehicle charging at 32 Amps and during peak periods Wattblock further assessed the risk of overloading the common power supply. This provided an indicative guide as to the number of vehicles and likely year that EV charging would start to pose a risk.

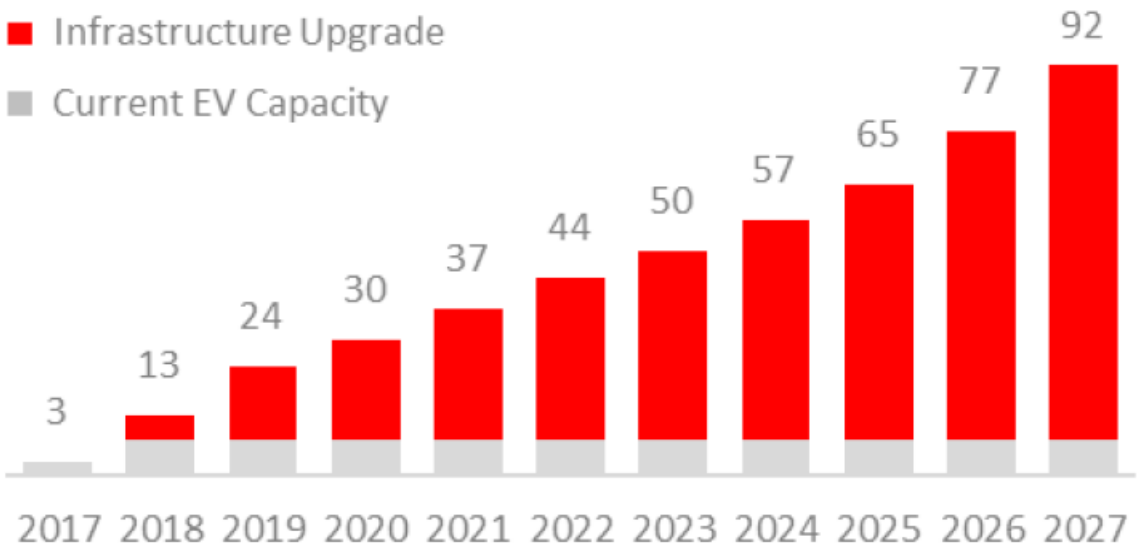


Figure 30: Sample: High growth rate of EV with low switch board capacity

The results demonstrated a considerable range. In some buildings the projected uptake of vehicles was particularly high, which coupled with low switch board capacity posed an imminent risk within the next year. In other cases the building could comfortably put off the switch board capacity issue for 10 years.

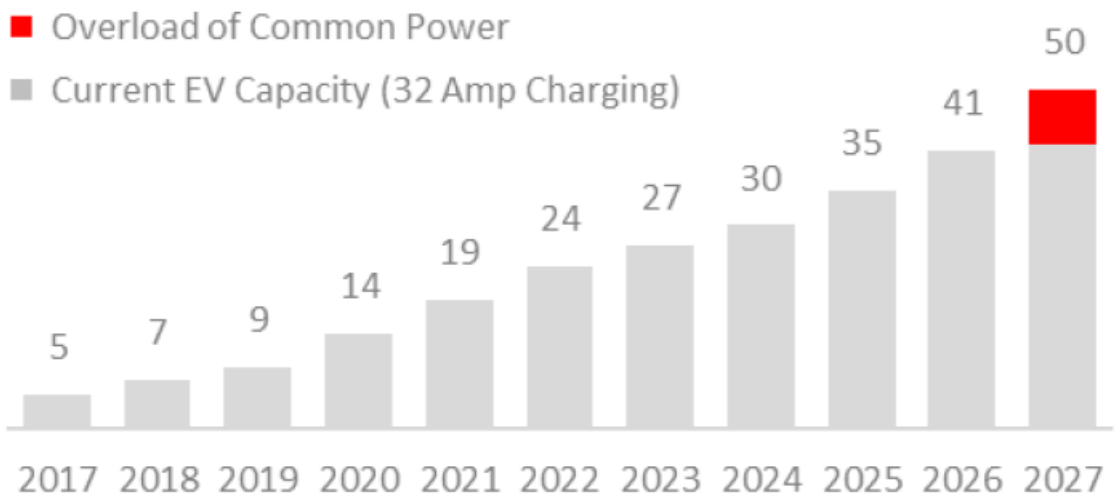


Figure 31: Sample: Low growth rate of EV with plenty of capacity

For the sample of participating buildings the year 2022 was the average year in which risks of overloading the common area switch board might become a problem. More than 30% of participating strata schemes were projected to be at risk within the next three years.

These projections were provided to the participating buildings as an initial gauge on capacity issue. However, the analysis uses simplistic assumptions and does not take into account the overall energy management of the building over time. In particular the trend in energy management in buildings is to improve the overall energy efficiency of other services. Those strata schemes identified to be at risk within the next few years have a number of mitigating strategies to extend the life of the existing power infrastructure of the buildings.

4.4 Increasing Capacity for Electric Vehicle Charging

The research identified several strategies that strata schemes could use to increase the capacity for EV charging over time. These were presented to the participating schemes for careful consideration to assist identifying the most cost effective way to plan and implement EV charging solutions for residents. Strategies covered included:

1) Using by-laws to limit charging speeds to 16 Amps or lower.
2) Running energy efficiency projects within the building (e.g. LED lighting) to reduce the baseload in the building and free up more capacity for Electric Vehicles.
3) Installing a solar system for charging Electric Vehicles.
4) Installing networked Electric Vehicle charging system with power management.
5) Upgrading the main switchboard, which is a costly exercise.

Restricting Electric Vehicle Charging Amperage

For individual car spaces, electric vehicles can be left to charge overnight. For this reason a high powered supercharger is not an appropriate solution. The Owners Corporation may consider drafting a by-law to restrict the charging speed to 16 Amps or lower.

Driver preference is most commonly for 'Level 2' 32 Amp fast charging as this will typically take only 1.5 hours to charge an average driving distance of 50km per day. Restricting this to 16 Amps would effectively double the projected EV charging capacity before costly upgrades are needed. Such a restriction would also double the time required to charge a battery for a typical daily driving distance to 3 hours. However, this should still be more than enough for the majority of drivers given vehicles can be left to charge overnight.

Figure 32: Tesla's Urban Supercharger (Photo: Teslarati, 2017)

As covered earlier in the report, suitable charger capacities are as follows:

- Level 2 (32 Amps) add up to 30km per hour at 7.6kW.
- Level 2 (16 Amps) add up to 15km per hour at 3.3kW.
- Level 1 (10 Amps) add up to 7-10km of range per hour at 1.5kW.

If restricting EV chargers to 'Level 1' 10 Amp chargers, note that this can be facilitated by existing 10 Amp power outlets, such as those used for plugging in vacuum cleaners. However, it can take 7 hours to charge up an electric vehicle for the typical driving distance using standard 10 Amp charging. These power sockets can be used with an adaptor plug for slow charging if the by-laws permit. If this is not covered in existing by-laws and process, then EV owners may already be using these power sockets.

The main limitation with using standard 10 Amp power sockets is that there are usually only a few of these available in the car park. Consideration could be given to providing more power outlets over time. If the existing power outlets are too far away from the desired car parking location, new connection points could be set up at a low cost if the plan allows for nearby circuit access. Installing more 10 Amp sockets is the cheapest way to set-up a car parking area for EV chargers. Furthermore, a simple user pays schedule can be put in place (see Appendix A.9), although this would require some administration by the Owners Corporation.

Participating buildings were provided with a sample electric vehicle charging by-laws for guidance. Sample by-laws are provided in Appendix A.8 (Disclaimer: Advice should always be sought from a strata lawyer). These were sourced from British Columbia where electric vehicle charging in strata buildings is more prevalent. Given differences in strata laws between Australia and BC the respondents were advised to seek legal guidance in tailoring any by-laws to suite their building and to be sure these were drafted in accordance with Australian strata law.

Improving Energy Efficiency of Other Services

Energy efficiency is describing the state of using less energy to deliver the same work. A reduction in common area energy use can free up capacity for EV charging without additional spending for infrastructure upgrades.

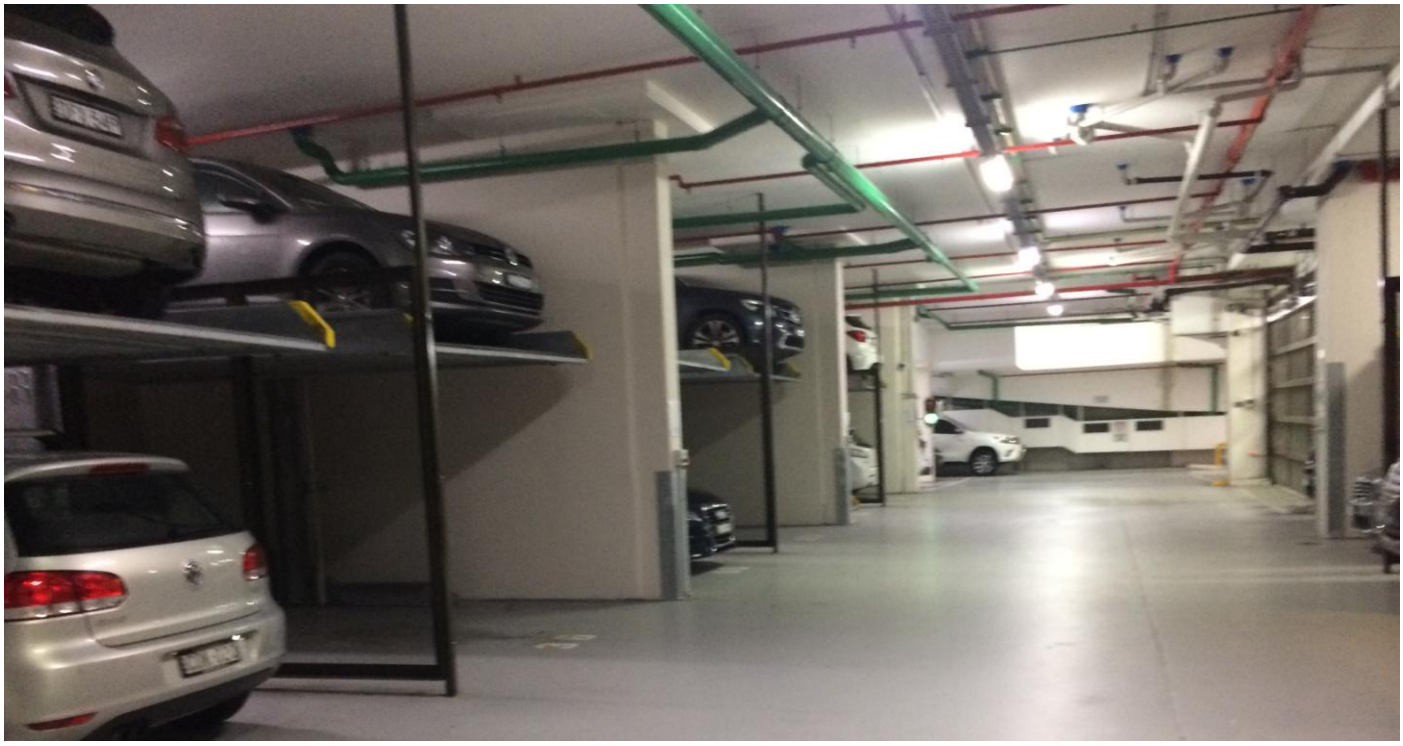


Figure 33: Common area power can include lights, ventilation and electrically powered car stackers

Following each site visit, Wattblock identified the major energy loads in each building. Wattblock utilised it's benchmark based analytics platform to disaggregate common area energy loads. This approach has previously been demonstrated by the City of Sydney funded Virtual Energy Assessments project in 2016. Using data analytics and benchmarking Wattblock provided the participating buildings with an approximate breakdown of energy consuming assets in their buildings.

Common area facilities generally included the following categories:

- Common area lighting: Fire escapes, car parks, foyers, floors, and external lighting
- Mechanical: Lifts, car parking gates, vehicle stackers
- HVAC: Central cooling and extraction fans for foyers, fire escapes, car parks, and garbage rooms
- Water: Pumps for pushing water supply to upper floors
- Facilities: Pools, spas, saunas, gyms

Participants were provided with an "Energy Wheel" pie chart of common area energy consumption for their strata scheme. For illustrative purposes a segment for "EV Capacity" was included in the chart to assist in conveying the message around overall capacity and competing facilities.

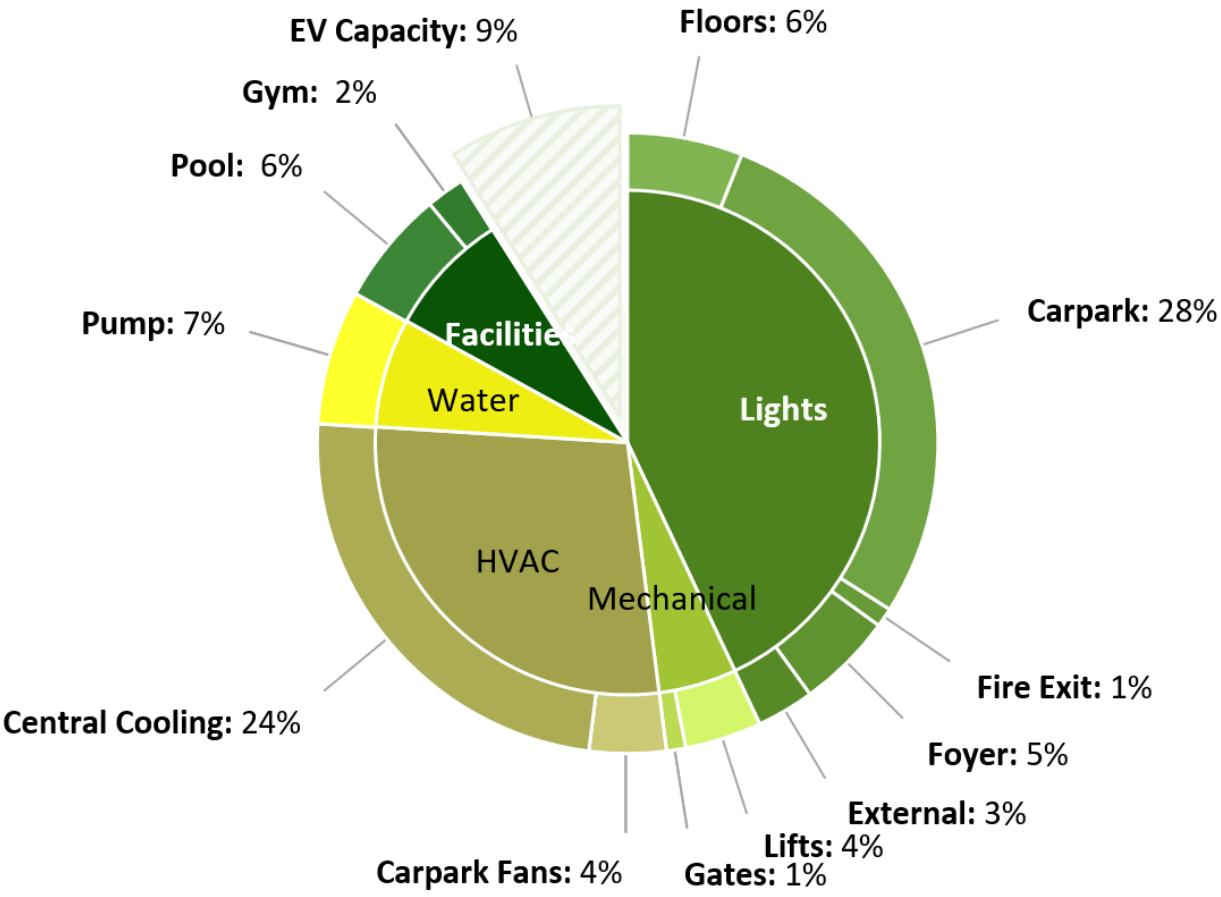


Figure 34: Sample: Common area energy wheel

The EV Capacity representation is based on a number of assumptions. In particular the capacity could be higher or lower depending on the timing of EV charging. The base case assumption is that un-managed charging would likely lead to a high distribution of charging activity during after work hours.

The chart conveys the message that EV charging capacity can be increased by improving energy efficiency of other services. For common area facilities, lighting was often a large proportion of the energy usage and represented the most cost effective way to increase spare capacity on the switch board. Many of the participating buildings had already implemented LED lighting projects achieving up to 80% power reduction is areas like fire escapes.

Generally buildings that had already taken measures to improve energy efficiency of other services had higher capacity for EV charging as a result. However, in most cases additional work was required to reduce the size of the circuit breakers on the distribution board to effectively realise that capacity for other purposes.

Installation of a Solar PV System

Owners Corporations may want to investigate the use of a Solar Photovoltaic (PV) system for charging EVs, which can remove or offset the power demand from common area power supply. Solar PV could be integrated to supplement all common area power usage including EV charging. This is likely to be the most practical solution for most buildings considering solar power.

Alternatively a dedicated circuit could be set up whereby solar energy is only used to charge vehicles during the day. This solution is only recommended for EV owners who often leave their cars at home during the day. EV owners who drive to work would not be able to utilize the solar power unless a battery storage system is integrated, which is still an expensive project today. Nevertheless, there are significant environmental benefits with the use of solar and batteries as discussed later in section of the report.

The participating buildings included a high proportion of tall buildings, particularly closer to the CBD, with very limited roof area relative to their common area energy consumption. In the case of these buildings a solar PV project would only produce a small amount of power which would be entirely consumed by existing common area facilities. Furthermore the height and access issues usually translate to high implementation costs.

Moving away from the CBD, or other built up areas, the strata schemes can have a much higher proportion of roof area relative to common power consumption. This tends to improve the economics of solar PV investments, although common power consumption may not be able to use all the output.

Setting up solar PV to offset common area power does not in itself increase the capacity for charging electric vehicles. Further consideration needs to be given to the structure of the distribution boards and the ratings of existing and proposed busbars and circuit breakers, as well as the potential use of power management systems.

Power Management Solutions

Power management is concerned with avoiding the risks of larger numbers of EVs charging at the same time so that the main switchboard will not be overloaded. As mentioned in earlier sections, the typical daily driving distance in a city environment is about 50km and 32 Amps standard charging takes about 1.5 hours to complete charging an electric vehicle. With power management this can be facilitated without restricting chargers to 16 Amps. Such solutions allow EV owners to connect their vehicle whenever they want.

Staggered Charging

One simplistic approach is to separate EV chargers into two or more circuits set up to charge on different time intervals. In-line timers can be used to stagger the charging cycles. For example one group of EVs might charge for 30 minutes at a time overnight with 30 minute breaks, while a second group of chargers kick in. This effectively doubles the maximum number of EV chargers with relatively minimal infrastructure cost. This can be achieved without a costly billing system if the Owners Corporation or Building Management is happy to administer a simple access charge fee as suggested in the appendices.

Demand Management Systems

A more advanced solution is to set up charging infrastructure with built-in power management functions. A smart power management system is capable of identifying the vehicles which have the highest priority for charging and supply power to those vehicles first. The use of power management charging stations can support up to 10 times more vehicles charging simultaneously than a traditional solution by intelligently allocating power.

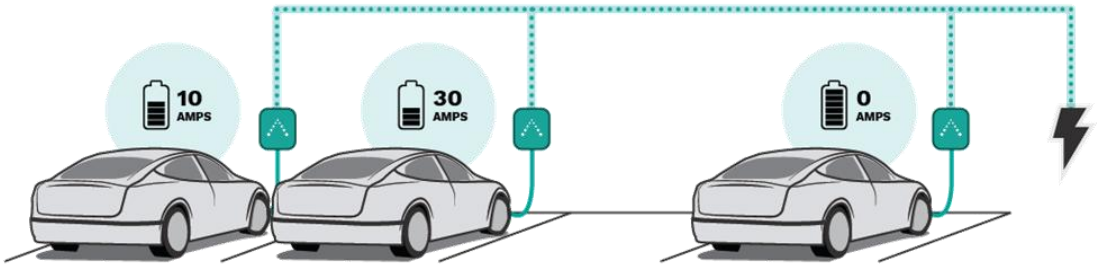


Figure 35: Power management of EV Charging (Image: EverCharge, 2017)

Assuming a "future proofing" scenario with 100% uptake of EV charging, Wattblock modelled the potential impact on electrical demand on the main power supply for each participating building. The following graphs illustrate the impact with and without the use of a power management solution for a sample strata scheme. The analysis shows that without power management the average load on the switch board could reach 666kW. The use of power demand management was expected to lower the peak load to 447kW, which significantly reduces the risk of overloading the power supply of the building.

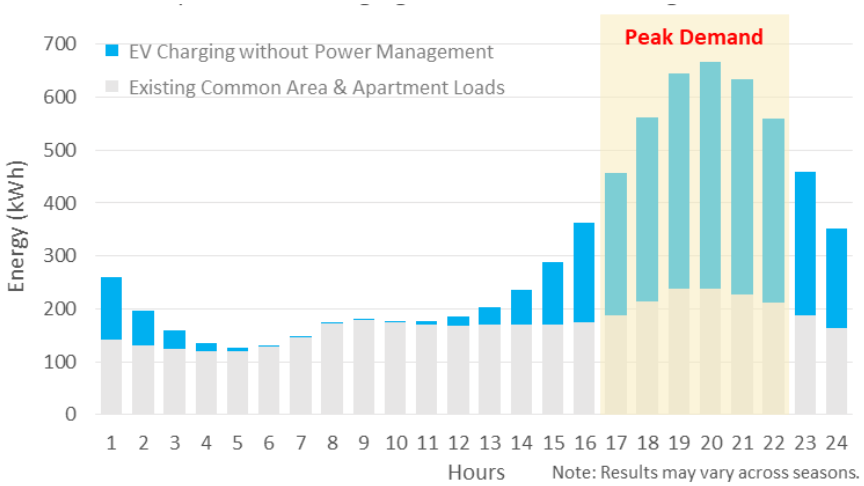


Figure 36: Sample: Impact of EV charging to the power supply without power management

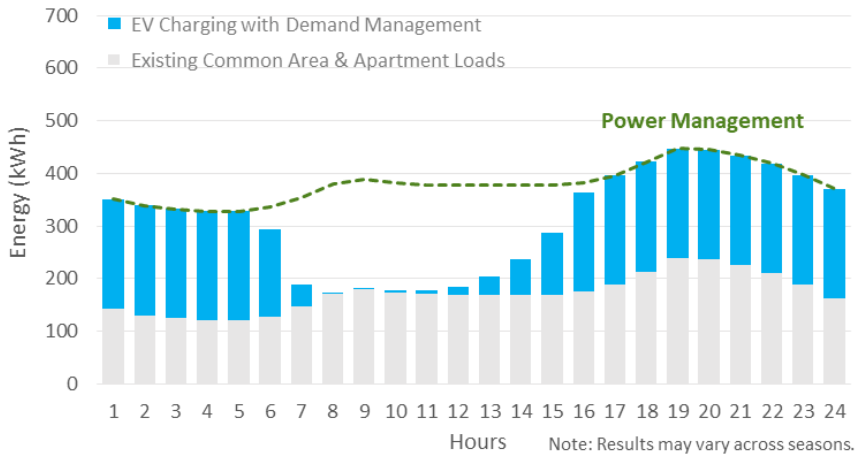


Figure 37: Sample: Impact of EV charging to the power supply with power management

Wattblock consulted with some industry suppliers to get an idea about where managed charging solutions are most suitable. According to industry suppliers, apartment blocks with 100 units or more are most common in the take-up of power management solutions. The upfront cost of a charger with built-in power management functions is typically around $1,800 per charger. There are a number of commercial solutions including EverCharge, Zapcharge and EV Safe Charge although limited options were available on the Australian market at the time of writing.

The use of power management can also reduce the overall set up costs of EV charging facilities for residents. In the case of the sample strata scheme above, without power management, Wattblock estimated that two new three phase 600 Amp sub-boards would have been required to meet the power demand for EV charging to all residents. After the use of power management, only two 300 Amp three phase sub-boards would have been needed, which significantly reduces the set up costs of the electrical equipment.

This demand analysis covers both residential and common area power demands. While actual interval data is available for common area facilities, apartments are assumed to have a load profile with an average 10kWh per day at 35c/kWh inc GST. To improve the accuracy of the analysis, a capacity assessment on the building's main power supply would be needed.

For electric vehicle charging without power management, the modelling includes assumptions around average driving frequency and distances, 16 Amp charging, and a normal distribution around typical "end of day" plug in time. It is important to highlight that the electric vehicle load profile is an average load. There may be scenarios as where all EV chargers will operate concurrently at some point over the course of a year, resulting in a higher than average peak demand for the building.

Market Pricing Signals

Most large strata schemes will pay electricity based on Time of Use (TOU) electricity supply tariffs and Peak Capacity Demand charges. These tariffs have been designed to incentivise the market to shift their energy demands on the electricity grid. In the Australian power market these pricing signals play an important role in grid management.

When implementing EV demand management across a common area meter, advantage should be taken of differential energy supply rates. Demand management solutions will generally allow for a range of settings that should enable optimisation of EV charging volume at the best pricing. Where a user pays system is being

implemented for EV charging, consideration should be given to whether or not pricing incentives should be passed on to users. This is not just to pass on the savings, but to ensure correct market response to pricing signals.

Code authority for power management

There are technical codes relating to power management systems published by UL. Electric vehicle charging solutions can be certified and listed by UL as Electric Vehicle Service Equipment (EVSE) or Energy Management Equipment under the following technical codes.

- UL 2231-1 EV Supply Circuits
- UL 916 Energy Management Equipment

Different systems operate in different ways. For example utilization of load management to enforce an upper limit of lead on a system, regardless of the number of chargers installed and how many are in use.

Participating strata schemes were advised to consider undertaking a more detailed capacity assessment at the time any new electrical sub-boards are to be installed as they are designed to accommodate a large amount of power. It may be necessary to upgrade circuit breakers for increased capacity on the distribution board.

Utility Management of EV Charging

Strata schemes need to consider EV charging impacts on their common area power supplies. However, more broadly utilities need to manage the impact on energy infrastructure. Electric vehicle charging is expected to have a dramatic impact on energy infrastructure and may result in costly projects such as replacement of transformers. This is particularly pertinent where there is "EV clustering", such as might occur where a given strata scheme with a high uptake of EV charging causes overloading and damage to a local electrical distribution transformer. This could knock out or degrade power supply to other energy consumers in the neighbourhood.

The Smart Electric Power Alliance (SEPA) published a case study (Myers, SEPA 2017) discussing potential solutions allowing utility providers to remotely manage power supply to Electric Vehicle Servicing Equipment (EVSE).

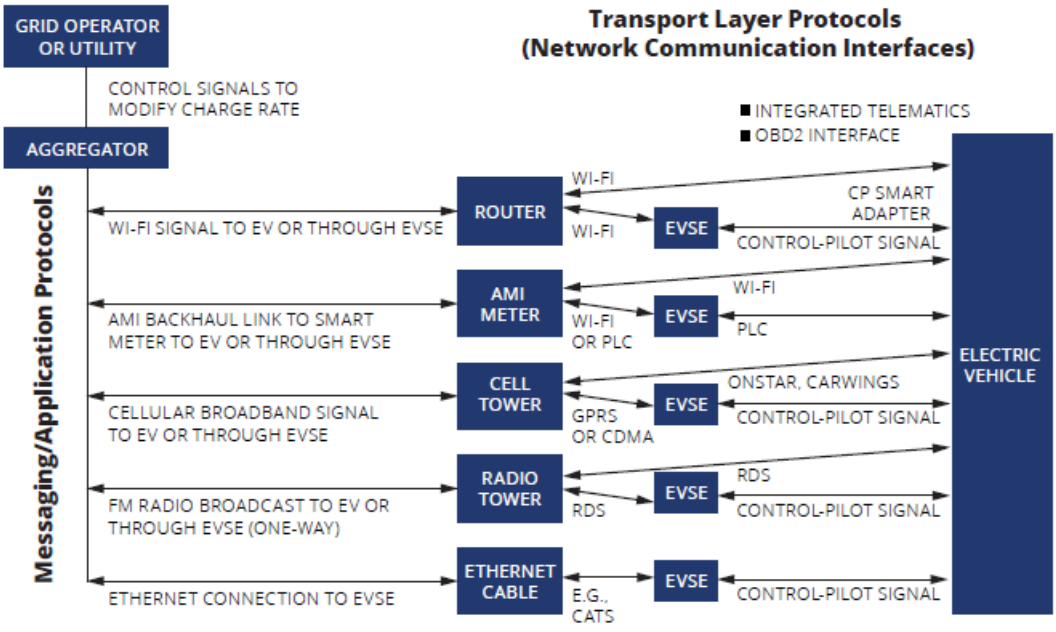


Figure 38: Managed Charging Network Communication Interface Options (Image: Myers, SEPA 2017)

Research shows that the majority of utility companies are currently looking at Demand Response (DR) solutions to manage electricity demands across their networks and avoid costly infrastructure upgrades. In particular Distribution Network Operators (DNO) in Norway, a world leader in EV adoption, have also been very progressive in experimenting with various "behind the meter" EV charging solutions.

Strata schemes looking at electric vehicle charging solutions could therefore be affected by future policies, regulations and standards that could be put in place to govern the charging of electric vehicles. Potential solutions have variously been referred to as V1G, intelligent charging, adaptive charging and smart charging. Such systems will require communications infrastructure to be put in place to enable remote management of equipment. Furthermore, this may also enable Vehicle to Grid (V2G) applications, whereby EV vehicles owners may be compensated for use of their battery for network Demand Response management.

It is likely that the development of such solutions will require extensive and lengthy government and community consultation by utility companies. However, there is a strong case for such high level engagement for electrical infrastructure management, grid stability and reducing carbon emissions. With respect to carbon emissions, remote management of EV charging could allow for network wide alignment to renewable power generation periods including solar PV and wind. There are numerous trials of such "behind the meter" solutions underway in Norway (Mikaelsson, 2017).

Electricity Switchboard Upgrade

Extension of Electricity Sub-boards

There are broadly two types of upgrades to electrical switchboards to accommodate increasing EV charging demand. The first type of upgrade is where new sub-boards are extended from the main board to each car parking level. In most of the participating strata schemes this would be required to overcome voltage drops where more than 60m of cabling would otherwise be running out to individual chargers.

By setting up distribution boards in a central location on each level of car parking, cabling out to chargers can be minimized. This improves the performance of chargers and reduces installation and de-installation costs for residents as they are only connecting the "last mile". Besides investment in dedicated sub-boards for EV charging on each level, the Owners Corporation could also provide cable trays down the middle of the car parking areas to further reduce the costs for residents to install and de-install car chargers.

Besides planning ahead for future EV charging demands, this sort of minimal infrastructure investment could be used to market a strata scheme as being "EV Ready". Such an investment can benefit all owners regardless of intentions around electric vehicles as it can achieve an immediate uplift in property valuation.

Setting up basic infrastructure for all residents is more cost effective that requiring individual EV owners to install their chargers without any infrastructure being provided. As a guide, across the participating strata schemes Wattblock estimates a basic infrastructure upgrade to prepare everyone for 16 Amp EV charging to be approximately $600 per apartment. For individuals setting up their own chargers one at a time this is expected to be more than $1,500. This excludes the cost of the charger unit itself and any 'user pays' commercial models.

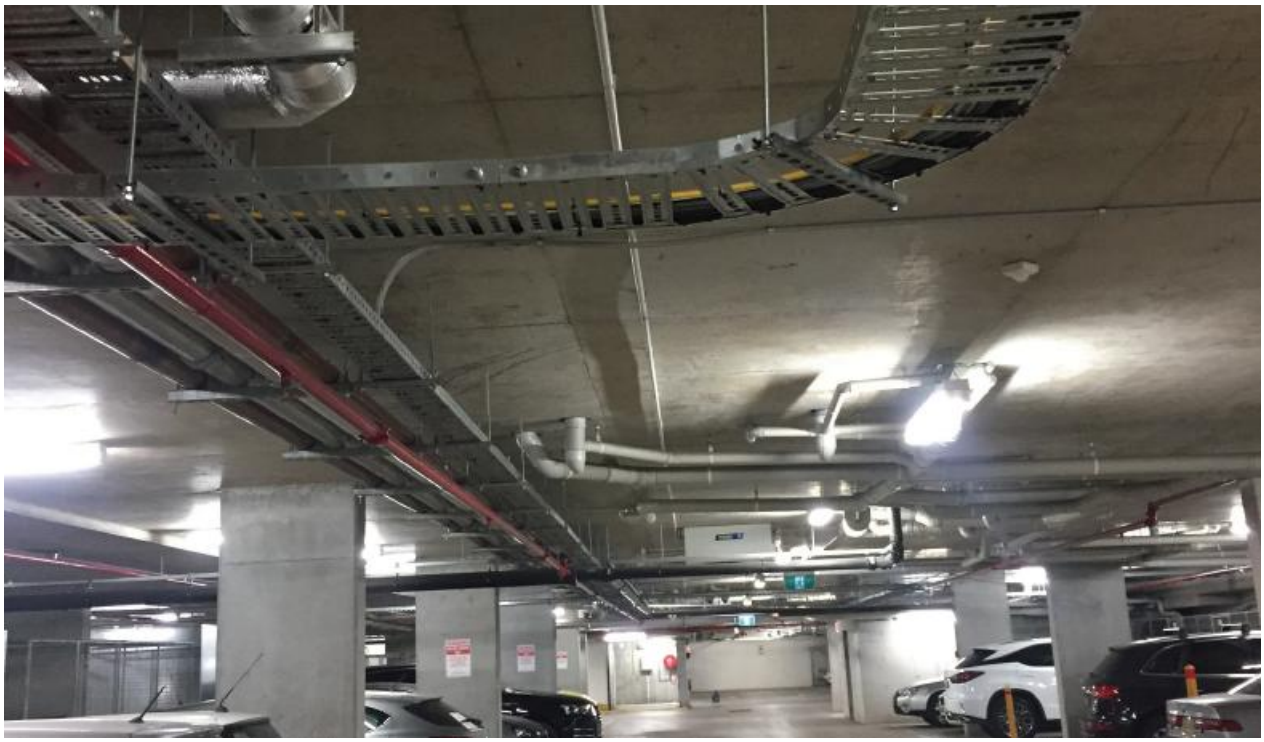


Figure 39: Sample: Cable trays installed along car park roofing

The basic infrastructure requirements vary for each strata scheme. However, assuming that the switch board itself does not require a capacity upgrade, typical itemisation may include:

- New distribution boards on each car parking level
- Physical security such as bollards
- Core holes in concrete floors and walls for cables
- Cables and junction boxes running back to the switch room
- Connection to main distribution board and fuse switches
- Fire sealing of core holes
- Meters for each charger connection point
- Cable trays throughout internal car park roofing

Basic infrastructure does not include the purchase and installation of the private charger unit itself. Basic infrastructure considered here does not include setting up metering and billing services or connection to a Building Management System either. Costs may also vary if allowing for more or less EV charger capacity than 16 Amps.

Main Switchboard Upgrade

The second type is where the main switchboard has insufficient capacity and requires an upgrade such as installing a new link from the grid. Where required this will generally be the most expensive investment to future proof a building. However, for the participating strata schemes the implementation of energy efficiency and solar projects as well as the use of power management solutions were often sufficient to avoid this worst case scenario.

Wattblock has been provided with example from the state of Queensland on multi-occupant building where "Supply upgrade" with the distributor Energex is the most expensive component ($5k-$15k). However, when it comes to electrical switch board upgrades there will be a very large range of complications and costs including such issues as checking for asbestos risks from older developments.

4.5 User Pays Commercial Models

The status quo for most of the participant buildings is that electric vehicle recharging is being supplied free of charge off the common area electricity. In most cases this is facilitated by standard 10 Amp general power outlets (GPOs) which are typically distributed around the car parking area. While these may have originally been intended to allow residents to use vacuum cleaners to clean their cars, there are often no clear rules dictating when and how these power outlets can be used.

In some cases the Owners Corporation may be OK with this in the short term, and might even consider providing more outlets. In other cases there may be pressure to put rules in place around the use of GPOs. So long as the Owners Corporations is aware of the issue they can give it proper consideration.

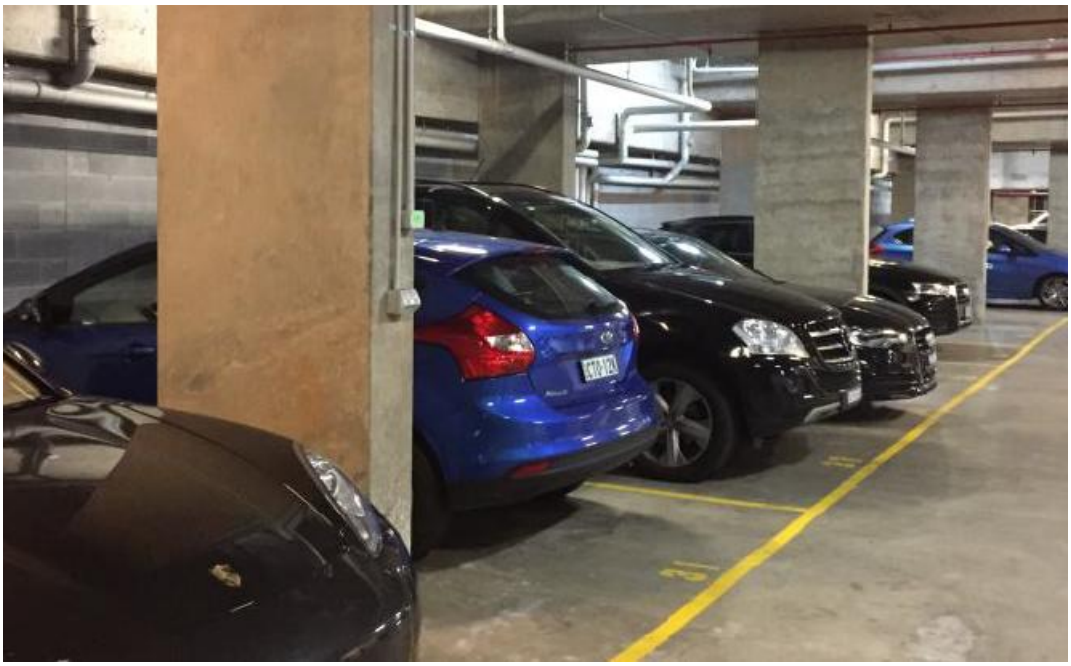


Figure 40: Basement car park showing General Power Outlets on column

The surveys show that the majority of people would like to see a user pays system put in place. Depending on the technical implementation preferred there are a number of different ways a user pays system could be implemented.

- Continue to allow free charging off 10 Amp GPOs.
- Connecting EV chargers directly to individual apartment meters will simply add usage to the apartment bill.
- Shared charger installations could use an RFID system to control charger access, monitoring and billing.
- Higher end service packages, often with power management, can include a third party billing services.

- In Canada building managers are administering billing off sub-meter readings to avoid billing service fees.
- Third party "DIY" billing platforms can assist in self management of user pays billing.
- Simplified billing could reduce administration effort, such as access fees rather than metered usage.
- The Owners Corporation may provide basic infrastructure and put by-laws in place to regulate installation and de-installation of chargers by residents.
- Buildings with Embedded Electrical Networks for apartments may be able to use existing billing service providers to include EV chargers.

The market rate for an on-going monthly billing service is currently around $30 per month. This is would typically be charged directly to EV owners together with energy usage fees. The energy usage fees would then normally be passed on to the Owners Corporation to compensate for the use of the common area electricity.

Assuming such a billing service was put in place for an average block of 238 units, the $30 service fee is equivalent to an additional cost of $85,680 per annum. For this reason we are seeing cost conscious strata schemes in Canada exploring various work-around DIY user pays solutions, often administered by building managers. Australian strata schemes should be mindful of Australian laws requiring an energy retailing license where users might be billed based on measured energy usage.

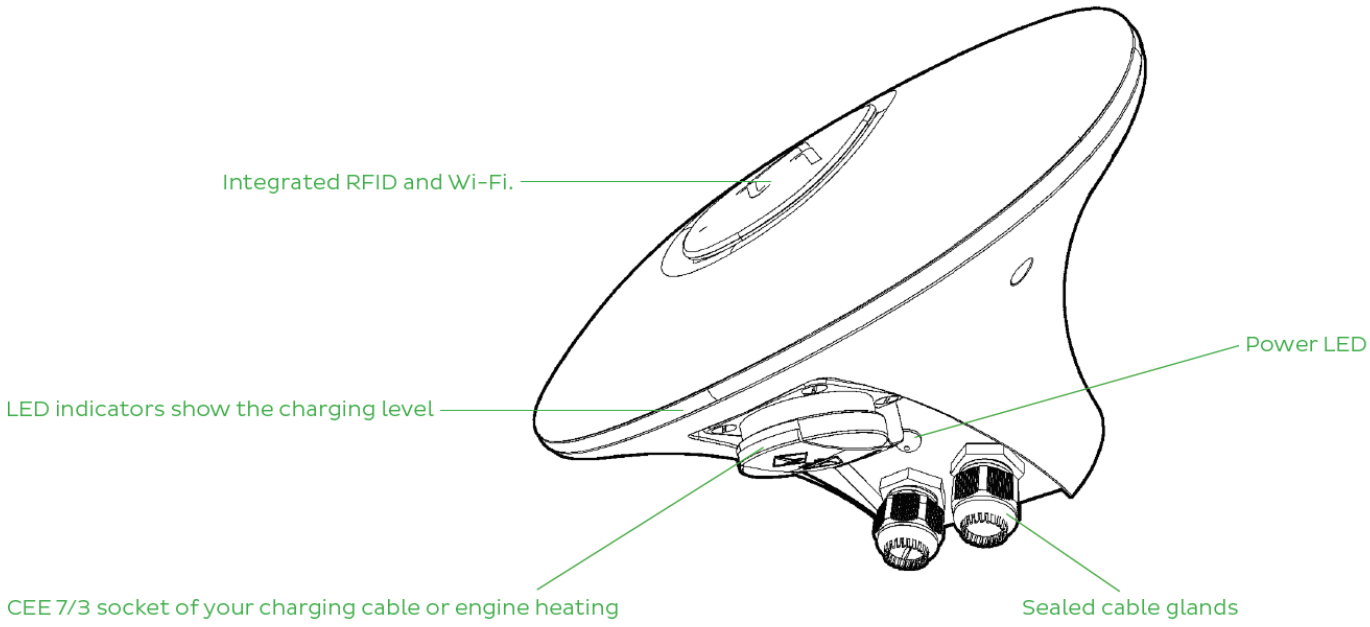


Figure 41: EV Charger RFID and Wi-Fi Access Control (Image: Charge Amps, 2017)

For shared charging bays, where a user pays system is desired, there are solutions such as RFID tag based access control. Using RFID tags provides a means of controlling access to charging facilities and for recording the usage associated with each tag. Again a third party billing service could assist for administering user pays billing. Alternatively there may be other ways to implement more basic billing such as on the basis of the number of tags and/or the number of uses per tag over a given period of time.

Embedded Electrical Network

Where strata schemes are looking at third party billing services for electric vehicle charging facilities, further though should also be given to Embedded Electrical Networks. Embedded networks involve a third party billing service for apartment energy usage. If a strata scheme already has an embedded network in place, or plans on having one, then the billing service provider may be able to accommodate billing for both the apartments and the electric vehicles.

For the sample of participant buildings, none of them already had an embedded network. Furthermore, the regulatory environment for setting up embedded networks in NSW is not favourable other than for new developments. More favourable conditions exist in Queensland where lower hurdles exist for approval of embedded network retrofits. Because of this embedded network service providers are predominantly marketing their solutions in Queensland where as strata schemes in NSW are often unaware of the opportunity (or the risks).

What is an Embedded Electrical Network?

In most strata buildings, individual residents negotiate their own electricity contract directly and receive retail energy rates. In an embedded power network, the Owners Corporation acts as an intermediary in the supply of electricity to all residents and receives discounted wholesale rates. A billing service provider would act on behalf of the Owners Corporation to charge residents for their usage with a typical billing cost of $10 per month. The service provider could potentially integrate residential electricity supply and EV charging into a single bill to lower the overall billing costs for residents. Risks around embedded networks are usually associated with the quality of the services provided and the contractual terms with the service providers, particularly with respect to the treatment of unpaid energy bills of residents.

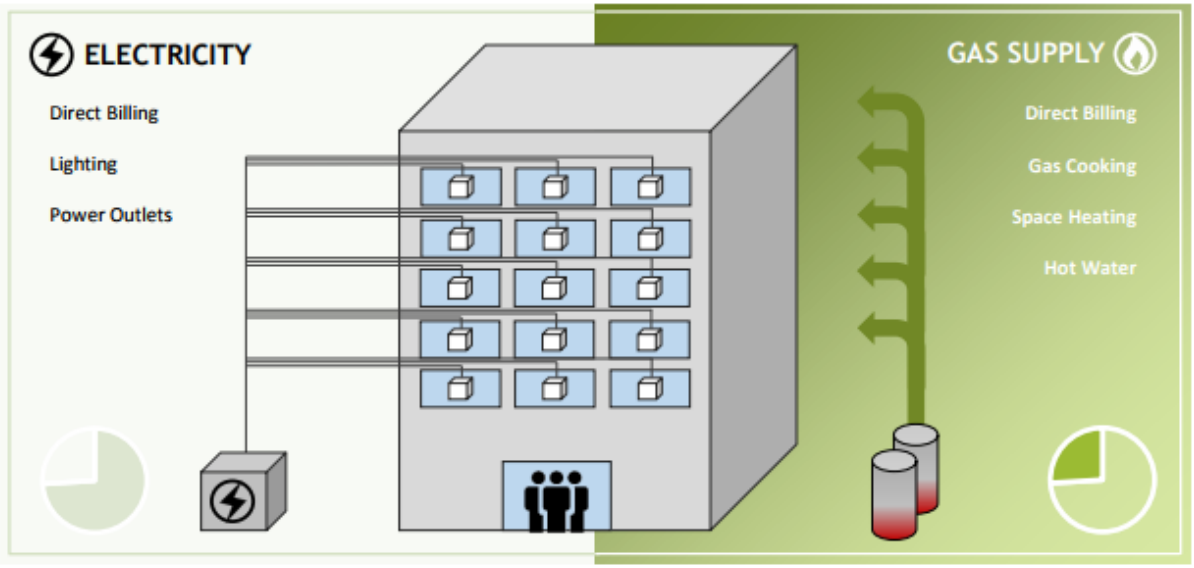


Figure 42: Embedded Networks enable bulk billing for electricity and gas services to apartments

Other Benefits of an Embedded Networks

In July 2017, Australia was ranked as number one for the highest electricity pricing in the world. Consumers living in houses can find refuge with the use of solar and battery systems. However, consumers living in residential

apartments are exposed to rising energy costs. Despite consumers having the choice to shop around for the best retail electricity pricing, an individual has a lack of bargaining power and the products offered by retailers are often confusing and misleading. Eventually consumers feel stuck and give up trying to find the best deal. These challenges can be addressed with the setup of an embedded network.

Typically an embedded network can generate savings of 20% - 40% on the total combined energy usage of the building. Depending on the Owners Corporations preferences, savings can be passed on to residents or used to offset common area energy costs. The latter treatment means the Owners Corporation can achieve direct payback on the investment. This also allows for more equitable distribution of the benefits via reduced strata levies in the medium term. The benefits of setting up an embedded electrical network are summarized below:

- 20% - 40% savings on energy costs by accessing wholesale electricity rates
- Lower strata levies and ability to offer tenants lower energy rates
- Increased property yields and valuations
- Enables future opportunities like community solar, batteries, and billing for electric vehicle recharge

4.6 Top Recommended Projects

In considering the future demands for EV charging facilities, the effective energy management of the overall electrical services of the building is drawn to attention. Wattblock utilized its data analytics and benchmarking technology to quickly determine the distribution of energy usage and to identify a range of suitable project initiatives for each of the participant strata schemes.

Across the 20 strata schemes, total projects identified have a combined cost of $2.7m with a savings of $675k per year and an average payback of 4.1 Years. With available finance options for strata schemes, these projects can generally be cash flow positive from day one. Typical projects included:

- LED lighting in basement car parks, fire escapes and common areas
- Heating, Ventilation and Air Conditioning (HVAC)
- Common hot water systems
- Power factor correction
- Embedded Electrical Networks
- Solar energy installation on the roof

While these projects are not directly related to the installation of electric vehicle charging facilities, they are indirectly adding capacity and reducing future EV infrastructure investment.

One of the simplest upgrades for increasing EV charging capacity in most strata schemes is to retrofit LED lighting in car parking levels. As noted earlier most of the participating schemes have already completed some form of LED lighting upgrade. On the other hand Wattblock was able to identify 4-5 fast payback projects for most of the participant buildings that would have an impact in freeing up further switch board capacity.

Energy efficiency might also be an eligibility consideration for future incentive programs to stimulate adoption of electric vehicle charging facilities in strata. As discussed in the conclusions the Fraser Basin Council in British Columbia has shared some learning from their incentive program. This might further be taken into consideration by the City of Sydney and other local governments to stimulate EV charging adoption in strata.

4.7 Summary Participant Building Results

Based on the estimated energy usage of common area facilities across all 20 strata schemes, the existing electrical sub-boards in the car parking levels could support charging for a combined total of 290 Electric Vehicles (14.5 per strata scheme) at 32 Amps before risking the disruption of power supply within those buildings. Individual estimates for each strata scheme are provided in the following table. These results are extracted from the more detailed assessment reports which were delivered to each participant building.

Table 6: Estimated Capacity for Electric Vehicle Charging

Participants	Units	Age (Years)	Common Energy Daily Usage	EV Capacity (Vehicles)	*Energy Efficiency + Restrictions*			*Rooftop Solar Energy*			*EV Infrastructure + EN + DM*			
					Est. Cost	Payback	Extra EVs	Est. Cost	Payback	Extra EVs	Est. Cost	Payback	Best Before	Extra EVs
Waterloo	289	5	1670 kWh	16	$229,829	4 Years	22	$139,250	4.1 Years	35	$327,670	2.7 Years	2028	349
Alexandria	45	12	104 kWh	8	$78,770	4.9 Years	9	$38,209	6 Years	2	$87,600	6.8 Years	2028	54
Haymarket	646	25	8548 kWh	47	$115,982	3.1 Years	74	$107,250	12.3 Years	9	$663,080	2.2 Years	2028	779
Millers Point	83	11	1703 kWh	10	$42,853	6 Years	14	$12,150	7.4 Years	2	$132,090	3.3 Years	2028	100
Ultimo	328	19	3240 kWh	3	$54,579	2.9 Years	15	$93,250	4.7 Years	23	$351,440	2.4 Years	2024	396
Erskineville #1	197	1	612 kWh	11	$55,676	3.1 Years	13	$58,750	4.6 Years	8	$252,560	5.7 Years	2022	238
Rosebery	288	16	1334 kWh	25	$131,277	2.5 Years	30	$69,100	7.2 Years	10	$327,240	2.3 Years	2031	280
Rushcutters Bay	139	17	1303 kWh	15	$88,242	3.5 Years	22	$38,050	4.9 Years	9	$180,120	3.2 Years	2029	168
Glebe	75	12	289 kWh	12	$41,745	4.1 Years	13	$94,500	4 Years	6	$123,000	4.4 Years	2029	90
Surry Hills	54	47	235 kWh	2	$33,018	3.4 Years	3	$24,250	4.2 Years	6	$96,920	4.9 Years	2025	65
Erskineville #2	48	10	211 kWh	3	$10,913	1.6 Years	4	$69,960	5.9 Years	6	$92,040	5.3 Years	2023	58
Woolloomooloo	76	3	1100 kWh	9	$44,721	5.5 Years	10	$47,250	4.6 Years	12	$123,480	3.5 Years	2034	92
Pyrmont #1	104	9	2802 kWh	42	$30,629	2.3 Years	47	$173,750	4.1 Years	43	$134,920	2.6 Years	2032	125
Pyrmont #2	118	17	1317 kWh	7	$39,517	3.4 Years	11	$18,500	5.9 Years	4	$169,640	3.2 Years	2027	142
Sydney #1	199	21	3434 kWh	33	$211,414	5.9 Years	41	$9,850	10.3 Years	1	$254,520	2.4 Years	2021	240
Darlinghurst	86	6	1716 kWh	10	$31,966	3.3 Years	12	$20,450	6.9 Years	2	$136,280	3.3 Years	2021	104
Sydney #2	131	20	1356 kWh	13	$94,242	2.5 Years	20	$6,000	10.6 Years	1	$184,880	3.1 Years	2029	158
Sydney #3	238	18	4420 kWh	15	$147,327	2.8 Years	22	$121,225	6.8 Years	23	$287,240	2.5 Years	2025	287
Sydney #4	61	117	805 kWh	3	$62,677	4.1 Years	5	$2,400	25.5 Years	1	$105,280	3.3 Years	2025	74
Redfern	112	39	555 kWh	6	$17,026	7.7 Years	6	$35,750	3.1 Years	9	$162,760	3.7 Years	2026	135
TOTAL	3,317	117	53302 kWh	290	$1,562,402	3.5 Years	393	$1,179,894	5.1 Years	212	$4,192,760	2.9 Years	2027	3,934
Average	166	21	1838 kWh	14.5	$78,120	3.5 Years	19.7	$58,995	5.1 Years	10.6	$209,638	2.9 Years	2027	196.7

The combined energy efficiency upgrades, solar installations, and charger restrictions across the 20 strata schemes could allow an additional 605 Electric Vehicles (30.3 per strata scheme) to charge simultaneously without spending on switch board upgrades. Based on the projected EV uptake from survey responses the capacity of the switch board would not become an issue until 2027 assuming that energy efficiency and solar projects are implemented.

The recommended solution for large scale EV charging may vary for each strata scheme. In most cases the strata scheme will want to implement a user pays solution as adoption increases. The surveys further indicate that the preference will be to allow connection of individual charge stations on private car spaces.

To resolve these issues may require:

- Investment in EV charging infrastructure (distribution boards, cable trays)
- Embedded network for user pays billing integration
- Demand management solution to avoid overloading switch boards

Such an investment will cost on average $209,638 including GST and will deliver a payback of 2.9 years. In total this is estimated to increase EV charging capacity by a further 3,934 vehicles (196.7 per strata scheme). This is more than sufficient capacity for all apartment lots to have a private charging station. Payback includes estimated benefits from bulk buying electricity via the embedded network. Depending on the individual preferences of each strata scheme, the final solution could vary significantly in scope, costs and payback.

From the Owners Corporations perspective, a building with lower operating costs, and "EV ready" charging capacity, can be marketed as a premium development. There is evidence to support significant improvements to property valuation and rental income in years to come, especially as NABERS is introduced into strata. For these reasons we expect that investment in user pays EV charging infrastructure may be a high priority for some strata schemes.

Conclusions

5.0 Conclusions

According to the research, EV adoption is set to increase rapidly in the coming years and this will place strain on the buildings existing electrical services. Unchecked, most EV recharging will tend to occur in the 'after work' hours when energy usage in the building is already at its peak. It is sometimes the case that people with EVs will utilize existing common area power sockets without a user pays agreement. In this case the power would be paid for by the Owners Corporation, which is not an ideal long term solution.

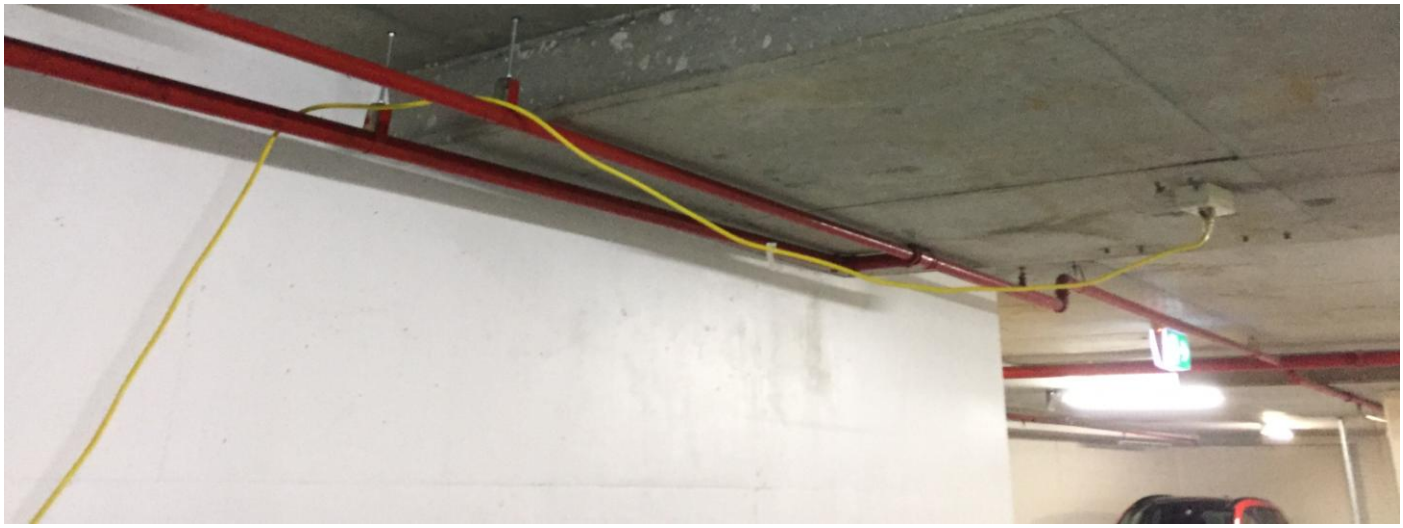


Figure 43: De-facto electric vehicle charging work arounds

Based on this research study, Wattblock provides the following recommended process for individual strata schemes to look at electric vehicle charging.

1. Conduct a resident survey to gauge EV charging intentions and attitudes
2. Engage a low cost energy assessment which covers EV charging impacts
3. Implement energy efficiency initiatives to realise savings and create more headroom for EV charging
4. Potentially conduct a more detailed assessment including site audit to determine potential site specific complications, switch board location and capacity for EV charging
5. Run a tender for install EV charging infrastructure if deemed to be needed including such things as demand management, distribution boards and switch board upgrades to increase capacity.
6. Have a plan for EV charging including bylaws, processes, and budgets.

Managed EV charging is the best long term solution for apartment buildings as discussed in Power Management Solutions. This can dramatically increase the number of vehicles that can charge and usually provides for a means of user pays based implementation. However, the market for service providers is still in the early stages and is expected to become more competitive over time. Early adopters can pay a premium to be the first, but may also benefit from valuation impacts. Case studies such as the Lumina building in California have demonstrated that early adoption of electric vehicle chargers subsequently attracted more EV owners to buy at a premium. There are also examples of buildings in Canada where the building manager administers resident billing based on readings from EV charging sub-meters.

Whether or not a given strata scheme wants to be an early adopter is a matter for the Owners Corporation to discuss. However, our analysis highlights further mitigating actions that can take the pressure off making an immediate decision. In particular, putting a by-law in force can limit the impact of individual charger installations. It is even possible to set up a simple interim user pays solution with or without individual sub-metering of EV chargers.

It has also been identified that the energy efficiency of other services in strata schemes can generally be improved. Various initiatives can be implemented to reduce overall power demands of strata schemes. Besides stand alone merits of high ROI, the projects identified would allow for more EV chargers to be installed before risking other critical services, effectively prolonging a more expensive investment in managed EV charging.

According to Wattblock's analysis and secondary research on EV adoption rates, Wattblock was able to assist the participating strata schemes in understanding when electric vehicle charging posed a risk to power supply. Furthermore we provide analysis on the specific impact that power management, by-law restriction and energy efficiency initiatives can have in extending the life of existing electrical infrastructure and to accommodate more electric vehicle charging over time.

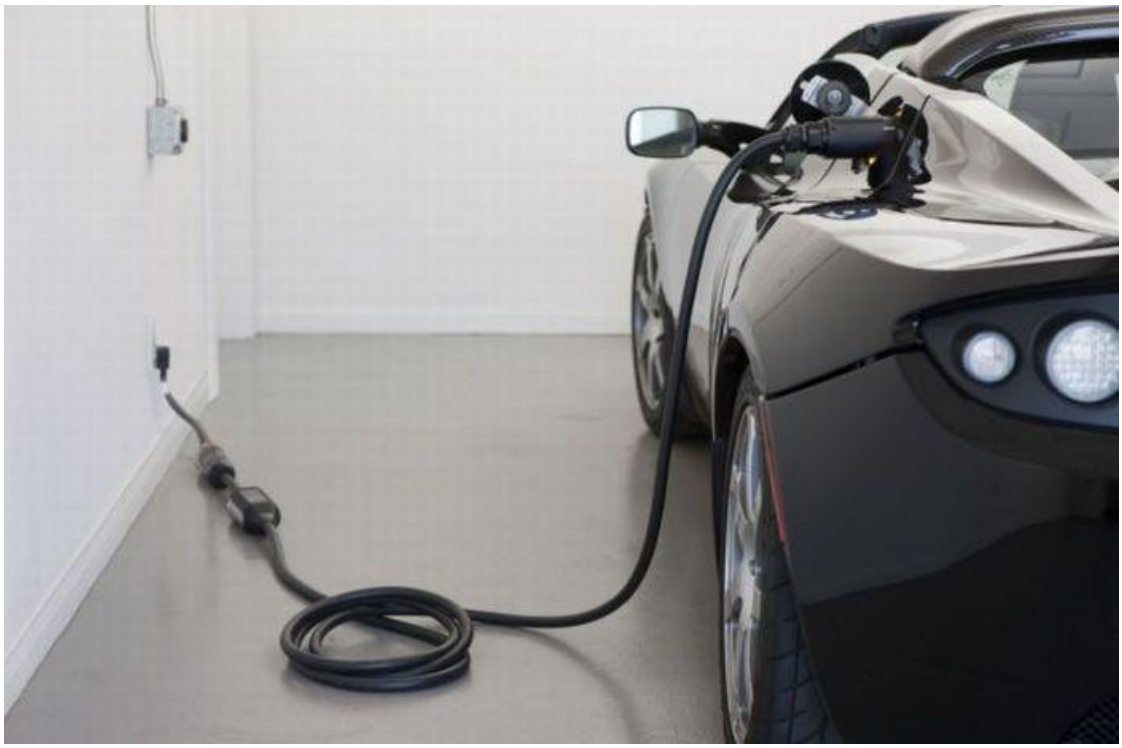


Figure 44: Electric Vehicle Using Standard 10 Amp Power Socket (2010 Dewhurst Photography)

Wattblock has developed of a number of tools to assist strata schemes in understanding the electric vehicle challenge and how to navigate the path forward. In particular we discuss the development of a simple one page EV report to be integrated in Wattblock's sustainability assessments. We also provide a high level decision tree diagram and checklists that can be further used to assist strata in working through the issues.

The following sections also include a discussion on government incentive programs, carbon emissions targets, and public charging infrastructure. In particular we cover the Plug-In BC program run by Fraser Basin Council in British Columbia, Canada. British Columbia has a similar strata model for property ownership and governance to Australia and is more advanced in the adoption of electric vehicle charging in strata buildings.

5.1 Developing Wattblock Sustainability Assessments

Wattblock's sustainability assessment service provides strata managers and owners corporations with an easy to understand and engaging review of energy and water opportunities. The reports have now been further developed to incorporate a page on electric vehicle charging. A full sample report is contained in Appendix A.15.

Wattblock sustainability assessment reports now comprise seven pages

- Page 1: Overview of opportunities with priority ranking
- Page 2: Common Area Energy Benchmarking
- Page 3: Apartment Energy Benchmarking
- Page 4: Solar and Battery Assessment
- Page 5: Water Efficiency Assessment
- Page 6: Electric Vehicle Assessment (NEW)
- Page 7: Summary of financial and environmental impacts

A sample Wattblock Sustainability Assessment is provided in the Appendix. The assessments use benchmark analytics for faster turnaround at dramatically lower cost.

Wattblock provides its sustainability reporting service to strata managers via a secure online portal that has been developed with assistance of Innovate NSW funding. Reports generated by strata managers are circulated to owners corporations to assist in the decision making process around energy and water initiatives. The report layout is designed for ease of comprehension using data visualization to generate interest and engagement.

The effectiveness of Wattblock's sustainability assessment service has previously been demonstrated in the Virtual Energy Assessments project that was completed for the City of Sydney in 2016 (McIntyre, 2016). This analytics and reporting service was awarded Innovation of the Year at the CHU Strata Community Awards in 2016. As of publication Wattblock sustainability reports have been generated for over 1,000 strata schemes across Australia.

Electric Vehicle Charging Page Development

The critical issue that the Owners Corporation needs to understand is the expected impact that electric vehicle charging will have on the power demands of their building. As covered in this report, this is affected by several contributing factors as follows.

- The expected uptake of electric vehicles over time
- The capacity limitations imposed by existing switch board infrastructure
- The impact of energy efficiency and solar power

Wattblock has determined that customers generally want a gauge on the costs of electric vehicle charging, expected uptake of EV charging, and the number of EV chargers that can be installed before disrupting other services. Two data visualizations have been developed to assist in conveying this information. The first is a meter style gauge which indicates the estimated number of electric vehicles currently in the building with red shading to show where the number starts to become a risk to other services. Intermediary shading further offers some guidance as to the impact energy efficiency and solar can provide in alleviating the problem. The second graph projects the same information over ten years with the added dimension of annual charging cost over time.

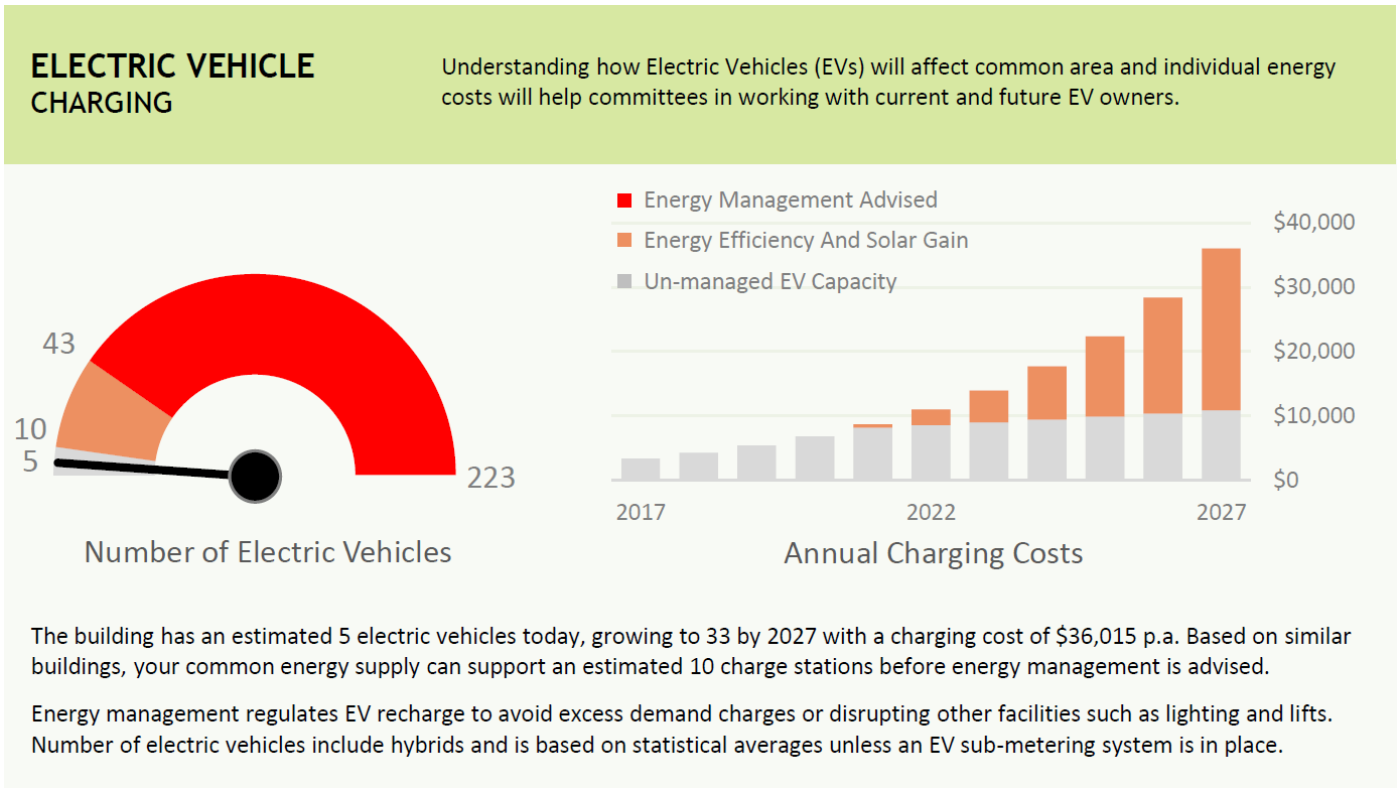


Figure 45: Electric Vehicle Projections and Capacity Assessment

This data visualization is complemented by descriptive text that further interprets the graphs for the reader. The results are calculated for the specific building based on the available data provided. Unless a survey has been conducted the electric vehicle adoption rates are based on statistical data provided by AEMO on electric vehicle adoption in Australia. This data is considerably more conservative than aggregate survey results have revealed in this research project. Capacity limits, impact of energy efficiency and solar, and costs of electric vehicle charging will generally be based on current energy billing data provided and broader sustainability analysis.

Secondarily the EV charging page in the Wattblock sustainability report provides high level information about different solutions available for charging facilities. This is divided into three broad categories of solution as follows.

- Unmetered Users
- Managed Charging
- Private Connection

Importantly the first option is actually the de-facto current state for most apartment buildings. The image of a standard three prong 10 Amp power socket is displayed to drive home this key message to the reader. Many residents in apartment buildings are unaware that existing common area power sockets are potentially already being used by electric vehicle owners. The combination of prior statistics showing an estimated existing vehicle adoption and image of a standard power socket helps to make it clear that action is required. In some buildings the use of standard power outlets may actually be a preferred solution for a variety of reasons. However, it should be a conscious and considered approach with buy in and agreement, rather than occurring without any awareness.

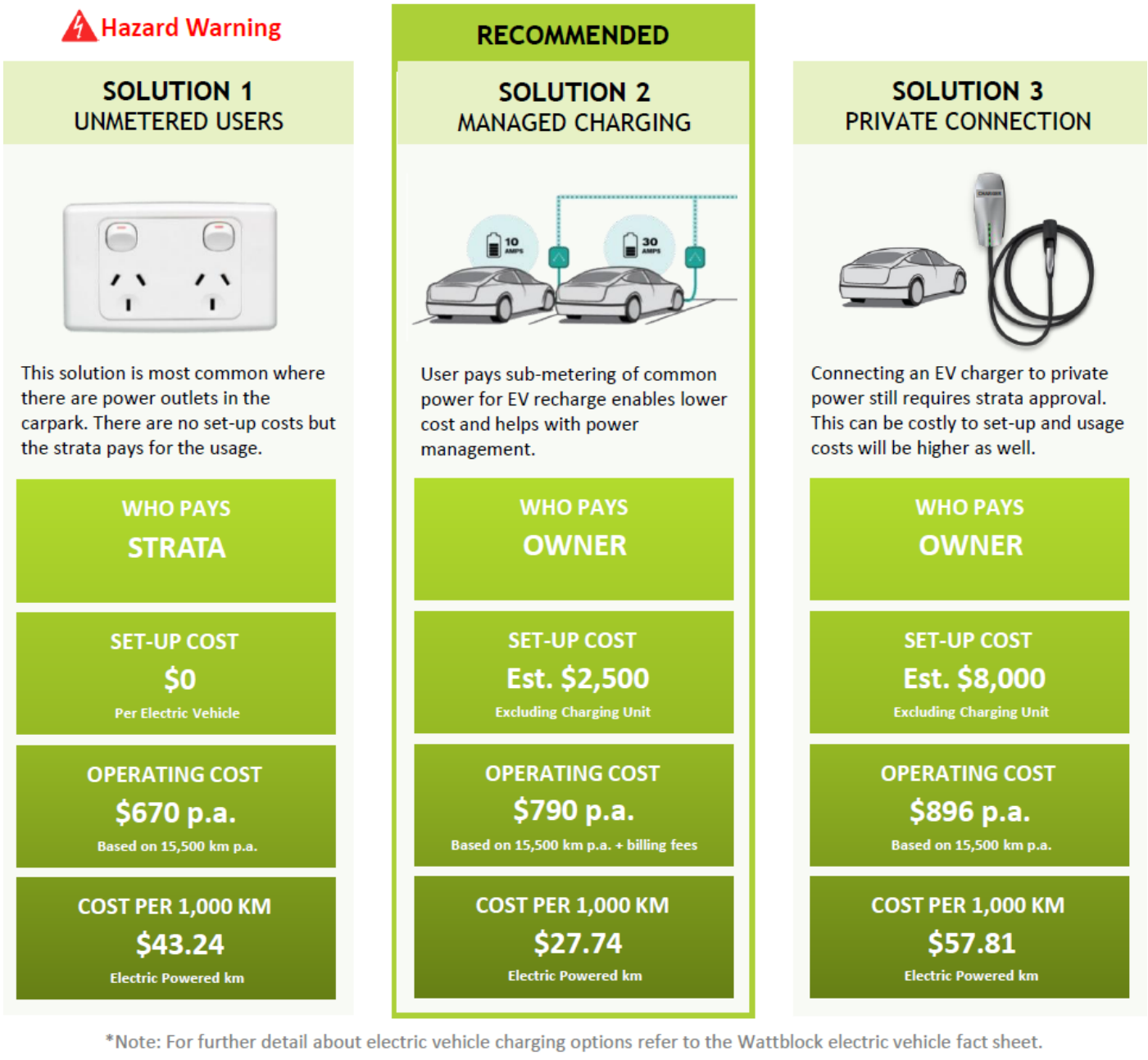


Figure 46: Electric Vehicle Charging Options Overview

The additional two options covered in the table cover the broad considerations of whether or not chargers should be installed on private power meters of the apartments, or on common areas with some form of power management and user pays system in place. In practice the strata most likely will not directly adopt one system or the other, instead following a gradual path to minimise the impact in the short term. High level figures are provided to give a sense of the ultimate cost differences involved. The Owners Corporation wants to be aware of the issues, how much it could be costing, and how long a decision can be pushed out.

5.2 Decision Tree for Electric Vehicle Charging in Strata

Wattblock has developed the following decision tree to assist strata schemes in thinking through the issues. Appendices A.6 and A.7 include a further summary and checklist for setting up EV charging in strata.

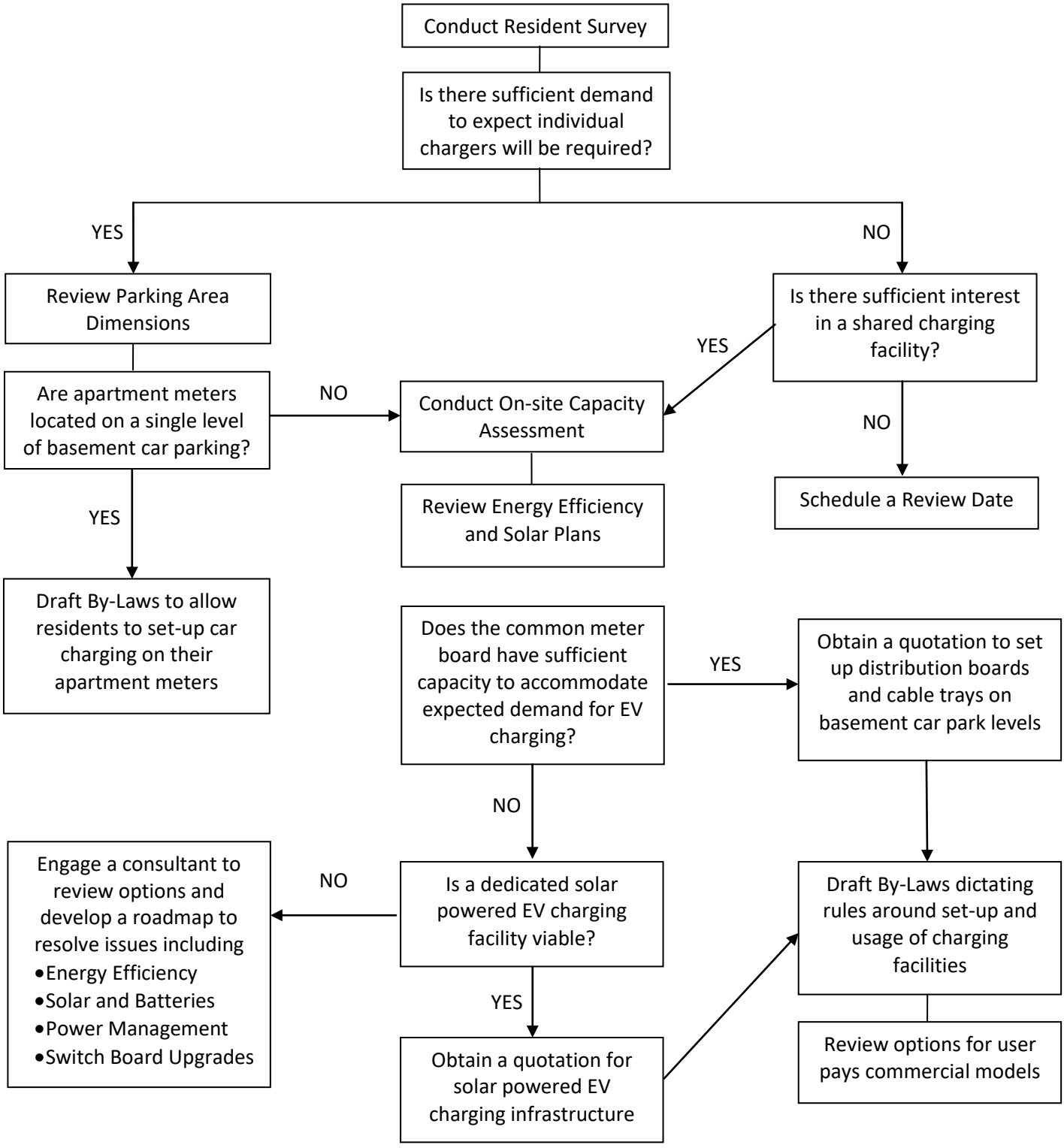


Figure 47: Decision Tree for Electric Vehicle Charging in Strata

5.3 Government Incentive Programs

At present there is no specific incentive program in place within the City of Sydney. However, the City of Sydney and other local governments may consider the implementation of incentive programs in the future to assist in the uptake of Electric Vehicle Charging Stations (EVCS) in strata buildings. Furthermore, incentive programs could be aligned to assist utilities in managing energy infrastructure impacts (Myers, 2017 and Mikaelsson, 2017). This includes the potential impact of EV clustering in causing localised power outages from overloaded transformers.

Wattblock has reached out to the Fraser Basin Council in British Columbia to obtain information about the incentive programs on offer in British Columbia. Wattblock connected with Charlotte Argue, Program Manager, and Julia Bronson, Program Coordinator, of the Climate Change & Air Quality Program, Fraser Basin Council BC CA.

Figure 48: Plug-In BC (www.pluginbc.ca)

The program, called the MURB Charging Program, was open to individuals anywhere in the province that reside in an eligible multi-unit residential building, or to parties authorized to make decisions regarding the building, such as building managers or owners, and strata councils. This was part of a broader "Plug In BC" program. MURB stands for Multi Unit Residential Building.

Approved applicants would be eligible to receive a rebate of up to 75 per cent of the total, before-tax cost of installing a Level 2 charging station, to a maximum of $4,500.

The program was hosted by the Fraser Basin Council. It was first opened in 2016 and is currently closed as of the date of publication. Wattblock was advised that the Fraser Basin Council would publish a report in January 2018 discussing the outcomes of the program. Further information is contained in Appendix A.5.

Potential considerations and learnings from the MURB Charging Program include the following:

- MURB residents have additional barriers to installing EV charging that detached homes do not have such as getting strata approval.
- Older buildings often do not have existing bylaws requiring EV charging as part of the construction process.
- Program requirements included applicants installing over-sized conduit so future stations can use the extra space as need arises.
- Applicants had to install conduit that had the capacity for a minimum of 6 stations charging at 40amps each. This would be enough to charge most EVs in 4-6 hours.
- Installation costs from electrical contractors were not improved over time with experience or through economies of scale for larger installations.
- Observed rapid uptake with a high number of strata and building owner applicants, not just residents.
- The incentive from the government helped to legitimize EV charging and bylaws with strata managers.
- Council provided resources to applicants such as available EV charging stations and how to navigate strata.
- Led to production of a 'revenue grade meter guide' to assist electricians.
- Led to development of templates for stratas to use with regard to allocation of capital funds for charging stations and recovery costs through metering/billing.
- Led to development of a charging time calculator built into the PBC site.

The final results and paper will be published on www.Pluginbc.com once ready. Further information about the MURB Charging Program is available online at http://pluginbc.ca/charging-program/murb/

Based on anecdotal evidence it is likely that the installation of electric vehicle charging facilities in strata buildings will be a catalyst for the adoption of electric vehicles. With respect to government objectives around carbon reduction targets, it may make sense to provide incentives for the installation of EVCS conditional upon the use of "green power" options or in combination with the installation of solar energy systems and/or energy efficiency initiatives.

Figure 49: Some strata schemes have car sharing

5.4 Public EV Charging Stations

Private chargers are convenient for residents. However, public charging stations are also important for the increase of EV uptake in the future. Public charging stations have the following benefits for residents:

- Top up electric vehicles, but not necessarily fully charging them
- Emergency back-up and relieving range anxiety of EV drivers

The public charging stations available to each strata scheme were provided with the survey results showing the position of the strata and nearby charging stations. Additional information on the charging stations such as how many are available, detailed location inside the building, and whether it is a free charging service or user pays can be found on www.plugshare.com.

Most of the public charging stations within the City of Sydney are located inside private car parks with payable parking fees. Some charging locations such as the Bondi Junction Westfield car park, offer free parking for 3 hours. There are also two solar powered charging stations operated by City of Sydney. More third party metered charging facilities are coming such as in the Royal Botanical Gardens.

Figure 50: Goulburn Street Car Park

Figure 51: Royal Botanical Gardens

5.5 Environmental Impact of Electric Vehicles

The environmental impact of electric vehicles is dependent on the measurable "carbon emissions" from vehicle manufacturing, power station combustion, upstream fuel production and grid losses. Shrink That Footprint, an independent research group devoted to helping people concerned about climate change understand, calculate and reduce their carbon footprints, released a study in 2013 around carbon emissions of electric cars around the globe.

Carbon Emissions in Australia

The study surprisingly shows that driving Electric Vehicles in Australia is more carbon intensive in comparison with a gasoline vehicle (Shrink That Footprint, 2013). This is because the energy generation sector in Australia is heavily dominated by coal. Despite air quality in local suburbs being improved through driving EV, more pollution will be emitted in rural areas where coal plants are based. In contrast, the study shows that European countries such as Iceland and Norway with high penetration of renewable power, the carbon intensity of driving EV is about 3 times lower in comparison with a gasoline vehicle.

Australia's 2020 Emission Reduction Target

The Australian Government has a 5% target to reduce emissions by 2020. However, the deployment of EVs can have a negative impact on carbon emissions in the transport sector.

In order to align with the government's emission reduction target, the strata scheme may want to investigate solar and batteries. This means the Electric Vehicles can be charged from a renewable energy supply bringing down the carbon emissions of the building, potentially achieving fossil fuel neutrality.

However, some apartment buildings do not have sufficient roof space for the installation of a solar system and using a battery for charging of EVs might be an expensive option. The building may want to investigate switching to "greenpower" on the common area meter to have a positive impact on carbon emissions and the environment. Greenpower is electricity sourced from the grid which is certified to come from renewable sources such as hydropower, wind or solar. Greenpower can be used to further the objective of eliminating carbon emissions generated by the building and by vehicles as the number of Electric Vehicle owners increases.

In addition, the more Electric Vehicles that are in a basement car park, the less carbon monoxide emissions will be emitted. Over a period of time as the number of Electric Vehicles increases, this will reduce the carbon monoxide levels in the basement car park. If your strata plan has carbon monoxide extraction fans triggered by carbon monoxide sensors, this will reduce the operating costs of the carbon monoxide extraction fan.

Marketability of Green Credentials

Energy efficiency and renewable energy initiatives can directly impact the operating costs of apartment buildings increasing future cash flow yields for property owners. Based on discounted cash flow modeling, this adds value to properties. However, the counter argument is that it is not easily realized where the market is indifferent.

Figure 52: Flagship "Green" developments (Images: LandCorp, Breathe Architecture, DKO Architecture)

There are a number of flagship developments in Australia that are specifically targeting the environmentally conscious segment. There is a broader appeal than just operating cost efficiency that enables marketers to promote developments as premium developments. This is expected to pick further momentum with the introduction of the NABERS for Apartment Buildings rating system in 2018.

We are now also beginning to see evidence of developers marketing their buildings as being "electric vehicle ready". At the time of publication Sasco developments in Sydney was already promoting their Genesis development as being ready for electric vehicle charging. This is included in addition to solar PV being integrated in the development as well. In California developments like Lumina have proven a market demand for electric vehicle charging does attract additional demand and supports premium property valuations. For further details see Appendix.

5.6 Recommendations

This study has demonstrated a high level of interest and engagement from the residential strata market in electric vehicle charging. Furthermore electric vehicle charging is expected to have a very high impact on electrical energy demands and carbon abatement targets.

Wattblock has developed a number of tools and services that can assist in fast tracking awareness and planning around electric vehicle charging in residential strata. Following are suggested next steps the City of Sydney could investigate to assist the residential strata marketing in preparing for electric vehicle charging. Other than the City of Sydney it may be appropriate that electricity utility providers, regulators and other organizations should play a role in educating and guiding the residential strata market. Relevant organizations could include Strata Communities Australia, Owners Corporation Network, the Property Council, NABERS and Green Building Council of Australia.

1. EV Charging in Strata web page on the City of Sydney website

A web page dedicated to providing information and assistance on EV charging in strata schemes would be a very useful in engaging the City of Sydney LGA. A website could be used to publish useful tools such as the recommended process, Decision Tree, Checklists, information on By-laws, and "How To" guides. This and other reports could be made available on the site. Any future incentive programs could be promoted on the site.

2. Extend Resident Survey

Extended roll out of the Resident Survey tool and Survey Reports to stimulate Owners Corporation thinking and planning. The survey and reports having been automated and can be scaled at very low cost. The City of Sydney should consider offering the resident survey as a free service to strata schemes within its LGA. Such a program could be promoted on the City of Sydney website and other marketing channels for engaging the strata industry.

Data from extending the resident survey may also be useful for council planning activities. This could include the location of new public charging facilities and planning of future energy infrastructure to support the growing energy demands of residential strata buildings.

3. Subsidised EV Charging Assessments

Residential strata schemes in the City of Sydney LGA could be provided a subsidy for obtaining an EV charging impact assessment for their strata scheme. This could be considered under existing programs for energy assessment subsidies or extended as a separate program. Alternatively existing energy assessment incentive programs could be expanded in scope to require consideration of future EV charging impacts.

Any incentive programs for EV charging impact assessments should be considered in the context of other programs including NABERS for Apartment Buildings. Given that basic assessments can be delivered at very low cost (eg $500-$1000) it makes sense to favour volume of subsidy grants rather than amount per subsidy. This will have a greater impact on awareness to get strata schemes moving.

4. Funding Public Charging Stations

The survey results show that the majority of residents are opposed to provision of public charging stations on their strata schemes. However, in some circumstances certain strata scheme may be open to the idea. In particular, there may be interest where car parking is available outside secure areas such as adjacent public streets. Where

strata schemes are looking to invest in Solar PV, such integrated public charging could further be marketed as "Solar Powered" EV Charging. Such an opportunity may best be approached via an initial case study project.

5. Engage Utilities to Pilot Remote EV Charging Management

The City of Sydney may consider talking with local utility providers about grid stability initiatives. Wattblock suggests piloting alternative solutions that enable the utility provider to remotely manage the timing of EV charging equipment. Residential strata buildings with a high level of EV charging uptake might be good candidates for such a pilot program. High EV charging uptake in strata has the potential to cause 'EV clustering' that can damage localized electricity transformers. Where such a strata scheme is considering investment in EV charging infrastructure, they might be persuaded by incentives to participate in such a pilot program as a test case.

Various "behind the meter" charging solutions have already been trialed in Norway. The Norwegian market is a world leader in EV adoption. In particular 80% of condominiums (equivalent of residential strata) in the city of Oslo have EV charging infrastructure. For further reading to support such a pilot program try "UK-Norwegian Plugin Vehicle Power Grid Roundtable Summary Report" compiled by Mikael Mikaelsson of UK Science & Innovation Network on June 21-22nd 2017. The SEPA report "Utilities and Electric Vehicles, The Case for Managed Charging" (Myers, 2017) also outlines a strong case for utility involvement. A pilot program of this nature would assist in informing potential future policies and regulations.

6. Subsidies for Implementing EV Charging Demand Management in Strata

Following the lead of other councils such as Fraser Basin Council in British Columbia, consideration could be given to subsidies to guide EV implementations in strata. The City of Sydney could provide subsidies for various components including individual EV chargers and installation of public chargers. However, Wattblock suggests particular consideration should be given to EV charging Demand Management systems.

As discussed in this report EV charging Demand Management systems can have a dramatic impact on overall power management within strata. This can increase the total EV charging capacity within the strata building while at the same time reducing load impacts on the electricity grid. This offers an alternative solution to the threat of localized power outages posed by 'EV Clustering' without the complication of remote management by utility companies. Potentially a combination of incentives together with policies and regulations may be most effective.

7. NABERS for Apartment Buildings to include EV charging consideration

In June 2018 the NABERS star rating system will be rolled out for apartment building energy assessments. According to recent guidance the initial roll out will exclude electric vehicle charging from the ratings assessment. At the time of writing EV charging demands in the participant strata schemes were present but relatively minimal. This is in comparison to cities like Oslo where EV charging infrastructure has now reached 80% of condominiums.

This City of Sydney study demonstrates that interest in electric vehicle charging is very high, it is expected to have a huge impact on energy demands, and it will most likely be integrated with common area power systems or through an embedded electrical network. Furthermore the way in which EV charging is implementing in residential strata can result in dramatically different outcomes in terms of grid stability, emissions and carbon abatement targets. For these reasons implementation of pilot studies as outlined in the prior recommendations could be used to help inform future NABERS for Apartment Buildings assessment scope.

5.7 Acknowledgements

Research Director
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Wattblock
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Scott Witheridge, Regional Manager, Wattblock
Kulima Panapa, Data Analyst
Thomas Crossman, Data Analyst
James Fisher, Data Analyst
Alec Tan, Data Analyst
Jonathan Rispler, Data Analyst
Raymond Zhang, Data Analyst
Lucy Qiu, Data Analyst
Rachel Hwang, Data Analyst
Patrick Chen, Data Analyst

City of Sydney
Lynsey McGarvey, Transport Policy Officer, City Access Unit, City of Sydney
Megan Chatterton, Sustainability Programs Co-ordinator, City of Sydney
Chris Barrett, Commercial Manager, Green Infrastructure Team, City of Sydney
Melinda Dewsnap, Sustainability Engagement Manager (Residential), City of Sydney
Jonathan Boys, Sustainability Programs Officer, City of Sydney
Peter Warrington, Manager, Transport Policy, City of Sydney

Other Contributors
Charlotte Argue, Program Manager, Climate Change & Air Quality Program, Fraser Basin Council BC CA
Julia Bronson, Program Coordinator, Climate Change & Air Quality Program, Fraser Basin Council BC CA
Kristine D'Arbelles, Senior Manager, Public Affairs, Canadian Automobile Association CA
Cara Clairman, President and CEO, Plug'n Drive CA
Alberto Quiroz, Intellimeter CA
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Kristian Handberg, Electric Vehicle Lead, AGL Energy
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Appendices

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Survey Questions
Sample Survey Results
Survey Comments and Suggestions
Wattblock Sustainability Report Sample
References

Appendices

A.1 Project Management

Project Brief

Wattblock will develop and provide a new EV recharge report for strata buildings. Wattblock will capture feedback from stakeholders – building managers, strata managers, strata committee members on the report.

- Find 20 strata buildings which want to participate.
- Engage the building/facilities managers, strata managers, strata committee members to get information on their buildings.
- Select a range of buildings based upon size and spread across the 10 village areas of the City (CBD and harbour, Chinatown, Crown & Baptist Streets, Glebe Point Rd, Green Square & City South, Harris St, King St, Macleay St & Woolloomooloo, Oxford St, Redfern St)

City of Sydney LGA

Alexandria, 2015	Dawes Point, 2000	Moore Park, 2021	St Peters, 2044
Annandale, 2038	Elizabeth Bay, 2011	Newtown, 2042	Surry Hills, 2010
Barrangaroo, 2000	Erskineville, 2043	Paddington, 2021	Sydney, 2000
Beaconsfield, 2015	Eveleigh, 2015	Potts Point, 2011	The Rocks, 2000
Camperdown, 2050	Forest Lodge, 2037	Pyrmont, 2009	Ultimo, 2007
Centennial Park, 2021	Glebe, 2037	Redfern, 2016	Waterloo, 2017
Chippendale, 2008	Haymarket, 2000	Rosebery, 2474	Woolloomooloo, 2011
Darlinghurst, 2010	Millers Point, 2000	Rushcutters Bay, 2011	Zetland, 2017
Darlington, 2008			

Wattblock will provide a report back into the City of Sydney to help their internal targets e.g. carbon abatement, public vs private recharging stations strategy. The report may assist in the further selection of building(s) for future Environmental Performance Demonstration grants e.g. up to $80k matched funding from the City council.

Project Timeframes

Project Kick-Off	1st April 2017
Customer Engagement	2nd April 2017
Participant Selection	3rd June 2017
Project Implementation	3rd June 2017
Review & Acquittal	30th Sept 2017

Customer Engagement

On-line registration page set-up
Posters / flyers with QR code link to registration page
Send email confirmation of registration within 24 hours of each registration
General guidance that there is a selection process and a timeframe
Inclusion of 5-10 follow up questions
Get a “disclosure letter” signed by an authorised member of the strata committee.

Figure 53: Poster located next to public charging facilities

Delivery of Welcome Pack

More detailed explanation of what the project is about
Outline of requirements – energy bills, site visits, contact details
For strata managers and building managers, explaining how we work with them
Guidance around timeframes
Outline of selection process
Next steps – organising a site visit with a Wattblock representative

Resident Survey Design

Critical questions:

- Are you interested in purchasing an electric vehicle? (Y/N)
- What is the timeframe of purchase? Multiple Choice with ranges (eg 6 months, 1-2 years)
- What type of electric vehicle? Drop down list

Other potential questions:

- When do you drive? Daily / Weekly / Rarely / Day time / Night time
- How many Kms do you travel in an average week?
- How many people in your apartment?
- How many cars?
- Do you already have an electric vehicle?
- How do you charge it today? Common socket / dedicated EV
- Do you know where your nearest supercharger is?

Site Visit Activities

Complete basic building meta data capture
Complete energy consumption profiling using interval data, site data, energy bills
Considered viability of clamp metering for a period of 1 week
Conduct a capacity report for the main switchboard of selected buildings

The switch board capacity assessments included the following considerations:

- What is the size of the substation that supplies the building?
- How many supply lines are there?
- What is the size of the transformer(s) leading into the building? (kVA)
- How many Switchboards are there?
- How many sub-meter boards are there in the meter room?
- How many sub-meter boards outside the meter room?
- How many metered Busbars are there?
- How many meters sit in front of metered Busbars?
- How many unmetered Busbars are there?
- How many meters sit behind unmetered Busbars?
- What types of meters are they? (eg smart meters, old analogue)
- What is the size of each Busbar? (Amps)
- What space is available on each Busbar? (slots x Amps)
- What is the total supply to the building? (Amps)
- What is the type of supply? (eg 3 phase)
- What is the overall spare capacity (metered)?
- What is the overall spare capacity (un-metered)?
- Does anything need to be upgraded to use that spare capacity? (eg fuse box, cables)
- What is the overall condition and age of the switchboards?
- Are there any hazards to consider if the switchboard is to be upgraded?
- What options are there to increase the spare capacity?
- Ballpark costs of these different options versus amount of extra capacity created?
- What is impact on arc flash rating of the existing infrastructure?

Wattblock took photographs during the site visits including:

- Maps of switchboard / power supply diagram
- Cabling coming into the switchboard
- Transformers that supply the switchboard
- Open switchboard showing Busbars and where available space is
- Cabling running out of switchboard and access points through walls/roof of the switch room
- Din rails and distribution board poles and available space
- Overall picture of all meters
- Close up of meters for common areas (in front of Busbar)
- Sub meter boards located in the switch room or sample photos if elsewhere in the building
- Comms equipment in the meter room
- Any data plates providing further info
- Any other points of interest

<u>Deliver report to participating strata schemes</u>

Develop a delver a report that addresses basic questions such as

- What are the solutions which are out there for stratas/condos for EV recharging?
- How much do the solutions cost?
- Do we need different solutions as the number of electric vehicles increase?
- Who pays for installation? Electricity? Operations? Insurance? Maintenance?
- How is it billed?
- What is the carbon abatement?

A.2 Knowledge Sharing Plan

Electric Vehicle Recharging in Strata
Individual Strata Scheme Roadmap Reports (20)
For each of the 20 participating strata schemes, the report created for their strata scheme is sent to:

- Owners from the Strata Committee
- Strata Manager
- Building Manager (if relevant)
- Other building managers from the same building management company (if relevant)
- other strata managers from the same practice group as the strata manager for the building

Electric Vehicle Recharging in Strata – Final Report (Public distribution)
The final report will also be directly shared with:

- NSW Office of Environment and Heritage – Residential housing financial incentives working group
- Smartblocks
- Greenstrata
- Property Council
- Green Building Council
- ASBEC
- BMW dealer network

Presentation of Case Study
Wattblock can present the Electric Vehicle Recharging in Strata case study to the Smart Green Apartments program leadership team. This is an opportunity for 20 building representatives from strata committees to directly ask questions on the results of the study. This will be a good reinforcement for the first Electric Vehicle Recharging presentation done for the Smart Green Apartments program in August 2016.

Media
Wattblock will draft a press release upon completion of the project. Following approval from the City of Sydney marketing team it will distribute this to:

- Fifth Estate
- Lookup Strata
- Inside Strata
- Strata Community Australia (NSW) newsletter “Around the grounds”
- Telstra’s sustainability newsletter “Sustainability matters”

Wattblock is a sponsor of Owners Corporation Network. Owners Corporation Network is a highly targeted network of engaged strata Owners. Wattblock co-ordinated the positioning of the Virtual Energy Assessments final report (under 2015 Environmental Innovation Grant) on the OCN website and will seek to do the same with this report.

Wattblock will distribute the study through its newsletter services to over 1,740 strata managers and industry associates. Wattblock will promote the research in social media and is able to co-ordinate retweets through partners such as Microsoft’s CityNext smart cities program, Telstra’s muru-D and partners in Australia’s clean energy ecosystem.

A.3 Lumina Case Study, San Francisco

LUMINA
201 Folsom Street,
San Francisco, CA 94105
Website: luminasf.com
Reference: Evercharge

Scenario

As the newest landmark condominiums in San Francisco, this property desired to be the forefront of EV adoption. While still completing construction of the 600 luxury units, the developer decided to install 25 EV stations for resident use within the garage. In **just 4 months** and 25% occupancy thirteen EV owners have moved in and are leveraging charge stations today. At this rate **over 40 EV owners** are expected to move into this building by the end of 2016.

Solution

With EverCharge the building will not be capped at 25 chargers like it would with traditional EVSE. Leveraging SmartPower **over 125 charge stations can be installed** in the garage scaling to serve the growing needs of San Francisco residents without any additional electrical capacity. With this scalability the building becomes a true enabler of EV adoption for years to come. The building expects significant increases in EV demand with the release of the Tesla Model 3 and other mid range EV options.

Figure 54: Lumina, San Francisco (Tishman Speyer)

A.4 Genesis Case Study, Shepherds Bay

Sasco Developments in Sydney are now using “Ready for electric vehicle recharging” as a selling point.
http://genesisshepherdsbay.com.au/

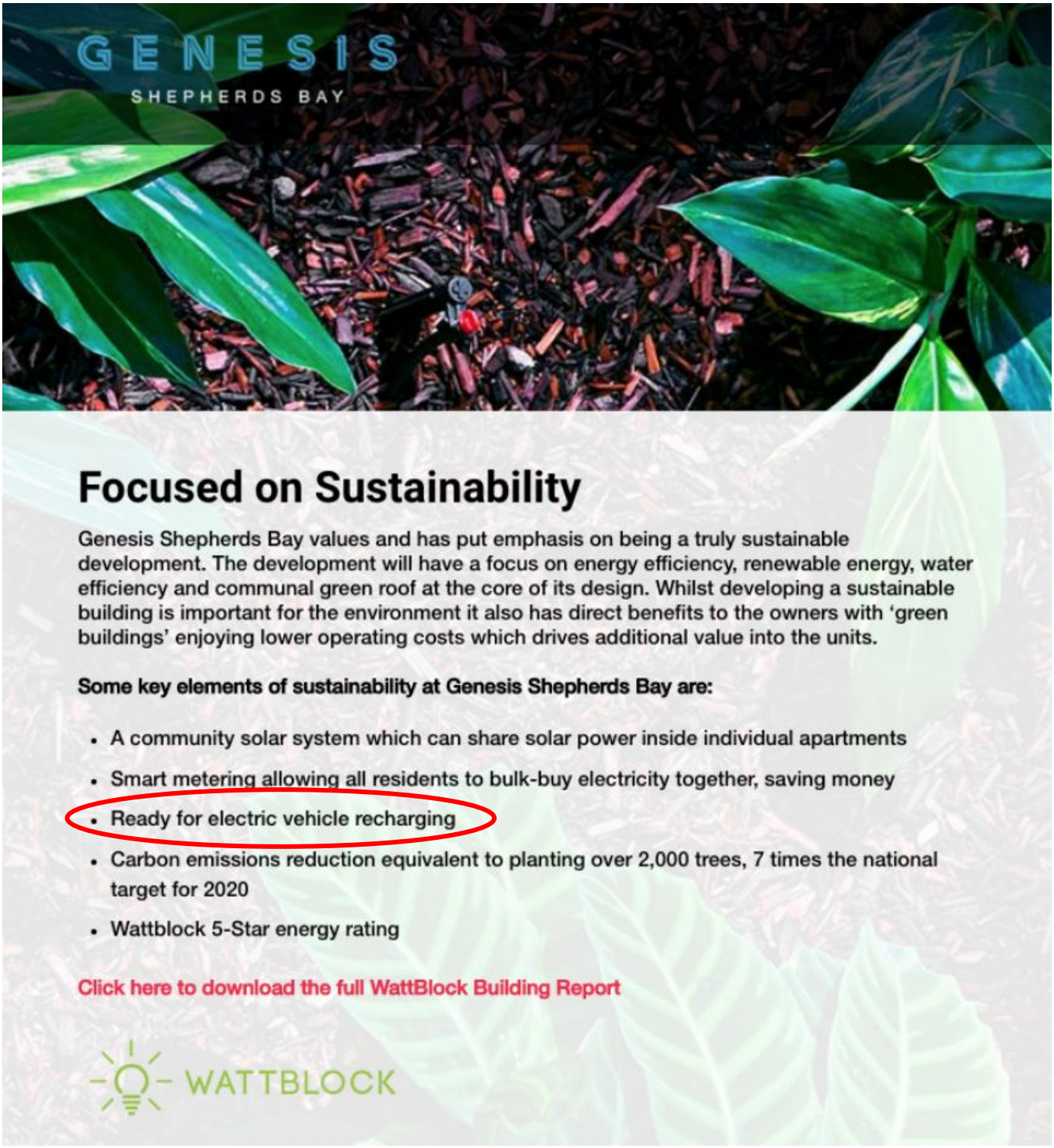

Figure 55: Genesis development promoting “Ready for electric vehicles” (Sasco Developments)

A.5 Multi Unit Residential Building Charging Program Overview

The following overview has been extracted from the *Multi Unit Residential Building Charging Program: Phase 2 Application Guide* published by Fraser Basin Council (2017).

The Multi Unit Residential Building Charging Program is part of the Clean Energy Vehicle (CEV) Charging Infrastructure Program funded by the Province of British Columbia. The purpose of this particular program is to support the purchase and installation of electric vehicle charging stations in multi unit residential buildings (MURBs) in British Columbia, and to assist in reducing the barriers for current and future electric vehicle adoption.

Eligible applicants (See Application Eligibility Requirements below) across British Columbia can apply to receive a rebate of 75% of total eligible costs up to $4,500 per Level 2 charging station, if approved for participation.

Applicants can apply for a maximum of two Level 2 charging stations, but you may only be approved for one to ensure the program funds are adequately distributed. Single port stations count as one charging station and dual port stations count as two charging stations. As such, applicants who apply for a dual port station or two Level 2 charging stations would receive a rebate of 75% of total eligible costs up to $9,000. Applicants are assessed on a first-come first-served basis. Applications will be accepted until August 15, 2017 or until funds are fully allocated.

Successful applicants will be required to provide project updates including a mandatory status report by August 15, 2017. If applicants do not provide information for this required status report they will be removed from the program, and their spot will be given to another applicant. Successful applicants will be given direction as to what information will be required for the update(s) (including, for example, have applicants received strata approval, and what work has been performed to-date).

Important resources for applicants include:

- What a revenue grade meter is and what expected costs are
- Strata bylaw and user agreement templates for EV charging on the Navigating Stratas page
- FAQ page

A.6 Checklist for Implementing EV Charging

Wattblock obtained the following checklist from British Columbia in Canada. British Columbia is a more mature market in the adoption of electric vehicles and electric vehicle charging. Furthermore, it has the very similar property ownership laws to Australia's strata schemes. This provides a general outline of steps to consider in consultation with the more detailed coverage contained in this report.

1) Identify suitable parking for charging location(s).
2) Determine the type of charging system necessary.
3) If parking re-allocation is deemed necessary, negotiate for re-assignment by special resolution or AGM.
4) Identify the cost in installation of the electric vehicle charging system accounting for any electrical or other service necessary.
5) Identify any upgrades or permits that are necessary as a result of step four.
6) Seek approval for expenses incurred by the Owners Corporation at an annual general meeting or special general meeting.
7) Establish a rule to recoup electricity costs incurred by the electric vehicle charging system.

A.7 How to Set Up EV Charging Equipment

Participating strata schemes were also provided with a summary on how residents, building management and Owners Corporations can work together to install electric vehicle charging facilities. EV owners who live in apartment buildings need to work with building management or Owners Corporation to get approval and to find the best solution for installation of the charging equipment.

- Evaluate installation options
  - Location of the charger (visitor parking vs private car parking)
  - Type of charging system (power sockets vs EV charger vs EV charger with power management)
  - Maximum charging speed of the EV charger (16 Amps vs 32 Amps or other)
  - Method to set up cabling (user pays vs strata pays for all residents)

- Evaluate payment options
  - Common power (strata pays)
  - Common power with a “flat rate annual fee” (owners pay, minimum administration)
  - Private sub-meter off common power (owners pay, requires administration for billing)
  - Residential meter (owners pay)
  - Third party billing system (owners pay, minimum administration)

- Engage a licensed electrical contractor
  - Obtain quotes for the electrical job
  - Validate the agreed solution of the Owners Corporation through a capacity assessment report. This is only recommended for setting up a large number of EV chargers. The capacity assessment report will depend on the size of the building and cost from $1,000 to $12,000.

- Include Electric Vehicle charging in the following strata documents
  - 10 Year Capital Works Plan
  - Strata By-laws

A.8 Sample Electric Vehicle Charging By-laws

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Address: Gate 2, High St
University of NSW 2052
Phone: 0414 900 515
E-Mail: brent.clark@wattblock.com.au
Web: wattblock.com

Sample Electric Vehicle Charging By-laws

Part 1 – Flat Rate Annual Convenience Fee User Agreement
This by-law allows residents to charge their electric vehicles using the existing power outlets in the common area. The residents pay for the use of electricity through an annual fee based on their typical driving distances per week. The information contained in this document is provided for general information only; it is not a substitute for legal advice.

STRATA PLAN/COMMUNITY TITLES SCHEME [Number] – [Name]

USER AGREEMENT [DATE]

WHEREAS The Owners, Strata Plan/Community Titles Scheme [_____] (the "Owners Corporation") proposes to grant to the undersigned resident(s) of Lot #___ (the "User") the right to use the electric vehicle charging equipment (the "Charging Equipment") located in common property parking stalls (the "EV Stalls"), on the terms and conditions set out in this Agreement.

For good and valuable consideration, the User agrees:

1. To pay to the Owners Corporation a user fee of $[_____] per month on the 1st day of each and every month, or such other amount as may be approved in a bylaw or in a rule that has been ratified (the "User Fee");

2. To at all times comply with the bylaws of the Owners Corporation;

3. To use the EV Stall in accordance with all applicable laws and regulations;

4. Not to do anything which may cause damage to the EV Stall;

5. To indemnify and save harmless the Owners Corporation for any cost, loss, or damage to the Charging Equipment or the EV Stalls caused by the User;

6. If the User fails to pay the User Fee in accordance with Section 1 above, the Owners Corporation will terminate this Agreement and the User will immediately cease using the EV Stalls;

7. The User will not permit any person other than the User to use the EV Stalls; and

8. This Agreement is not assignable by the User.

User: _____ (Resident)

Owners Corporation: _____ (Agent, on behalf of Strata Plan [Number])

Date: _____

Disclaimer: Advice should always be sought from a strata lawyer

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Part 2 - Electric Vehicle Charging Bylaw for Charging in Exclusive Stalls
This by-law allows residents to use and install electric vehicle charging equipment in the common area carpark. Point 5 of the by-law limits residents charging equipment to 16 Amps. The information contained in this document is provided for general information only; it is not a substitute for legal advice.

STRATA PLAN/COMMUNITY TITLE SCHEME [Number – Name]

ELECTRIC VEHICLES BY LAW

PREAMBLE: The Owners, Strata Plan/Community Title Scheme [Number] (the "Owners Corporation") proposes to amend its bylaws to allow for the use and charging of electric vehicles by owners, occupants, and tenants who own electric vehicles.

BE IT RESOLVED by a special resolution that:

1. The bylaws of the Owners Corporation be amended to add the following as Bylaw [Number]:
a. An owner (the "EV Owner") who has the exclusive use of a parking stall (the "EV Parking Stall") may request written consent from the Strata Committee to install electrical supply, distribution and an associated electrical outlet accessible to the EV Parking Stall for the purpose of charging an electric vehicle in the EV Parking Stall. In making such request, the EV Owner will provide to the Strata Committee a written description of the proposed charging equipment (the "Charging Equipment"), the proposed design and installation, and any other documents or plans requested by the Strata Committee;

b. The Strata Committee will grant consent pursuant to (a) above provided that:

i. The Strata Committee is of the opinion that its existing systems will support the Charging Equipment; and

ii. The EV Owner signs an Alteration and Indemnity Agreement on terms to be determined by the Strata Committee, including the following:

1. The EV Owner will pay for all costs related to the installation of the Charging Equipment and will pay for the cost of all future repairs, maintenance, and upgrades to the Charging Equipment;

2. The EV Owner will obtain all necessary permits;

3. The EV Owner will comply with all applicable laws;

4. The EV Owner will comply with all bylaws of the Owners Corporation;

5. The EV Owner will retain qualified contractors for the purpose of installing the Charging Equipment and instruct them to install the equipment at 16 amps; and

6. The EV Owner will indemnify and save harmless the Owners Corporation for any costs, loss or expense of whatever kind which the Owners Corporation may sustain in connection with the installation and use of the Charging Equipment;

c. Upon installation of the Charging Equipment:

i. If in the opinion of the Strata Committee the Charging Equipment can be removed with minimal damage to the common property, the EV Owner will be the owner of the Charging Equipment, and:
1. may remove the Charging Equipment at any time; and

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2. will remove the Charging Equipment upon sale of the strata lot owned by the EV Owner;
provided that the EV Owner will promptly restore any damage to the common property upon such removal of the Charging Equipment, and provided that the Owners Corporation will own the Charging Equipment if the EV Owner does not remove the Charging Equipment in accordance with 2 above;

ii. If in the opinion of the Strata Committee the Charging Equipment cannot be removed without damaging the common property, the Owners Corporation will be the owner of the Charging Equipment;

iii. Any wiring required for the purpose of the Charging Equipment will be owned and maintained by the Owners Corporation;

d. All electricity costs of the Owners Corporation with respect to the Charging Equipment will be dealt with as follows:

i. [determined by direct metering of the power consumed using internal meter available in some charging station models or a dedicated revenue grade meter]

ii. The Owners Corporation will charge to the EV Owner a user fee in the amount of $[_____] on account of the use of electricity with respect to the Charging Equipment

iii. [estimated for each EV owner based on his or her reported annual mileage and using an electricity cost estimate

2. To the extent that the installation of the Charging Equipment and use of the EV Parking Stall constitutes a significant change to the use or appearance of the common property, such change is approved in accordance with Body Corporate and Community Management Act 1997.

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Part 3 - Electric Vehicle Charging Bylaw for Charging for Common Property stalls
This by-law allows the Owners Corporation to pay for the set up costs of electric vehicle charging equipment for residents. The information contained in this document is provided for general information only; it is not a substitute for legal advice.

STRATA PLAN/COMMUNITY TITLE SCHEME [Number – Name]
ELECTRIC VEHICLES BYLAW

WHEREAS:

A. The Owners, Strata Plan [Number] (the "Owners Corporation") proposes to acquire and install electrical supply, distribution and associated electrical outlets, signage, and pavement markings (the "Charging Equipment") on common property to allow owners, tenants, and occupants to charge electric vehicles on the common property;

B. [X Number] of stalls located on common property (the "EV Charging Stalls") have been identified by the Strata Committee [through consultation with an experienced electric vehicle supply equipment (EVSE) installer] as optimal for conversion to electric vehicle charging stalls due to [insert rationale for stall selection here – for example, access by occupants, proximity to electrical panel, visibility and cost considerations].

BE IT RESOLVED by a special resolution that:
Acquisition and Installation
1. The Owners Corporation purchase the Charging Equipment and install it in the EV Charging Stalls.

2. The purchase of the Charging Equipment be approved in accordance with the Body Corporate and Community Management Act 1997.

3. The Owners Corporation apply up to [$_____] from its Capital Works Fund for the purpose of paying for the purchase and installation of the Charging Equipment.

4. The Strata Committee take all such steps as are required to retain a contractor to install the Charging Equipment, with Chairperson and Secretary authorized to sign all agreements as are required.

5. To the extent that the installation of the Charging Equipment and use of the EV Charging Stalls in accordance with this Resolution constitutes a significant change to the use or appearance of the common property, such change is approved in accordance with Body Corporate and Community Management Act 1997.

6. The bylaws of the Strata Scheme/Community Title Scheme be amended to add the following as Bylaw [Number]:
a. An owner, occupant, or tenant (the "EV User") who proposes to use a common property parking stall with electric vehicle charging capability (the "EV Stall") will apply to the Strata Council for written consent;

b. The Strata Council will grant consent to an EV User to use an EV Stall provided that:
i. The EV User signs a User Agreement on terms agreeable to the Owners Corporation;

ii. The EV User at all times complies with the bylaws of the Owners Corporation; and

iii. The EV User pays to the Owners Corporation a user fee in accordance with these bylaws;
c. The Owners Corporation will charge to each EV User a user fee in the amount of [$_____];

d. No owner, occupant or tenant will use or will permit any person to use an EV Stall except with written consent from the Strata Scheme/Community Title Scheme in accordance with these bylaws; and

e. No EV User will park a vehicle in an EV Stall for any period greater than 4 consecutive hours or 4 hours in any given 12 hour period.

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A.9 Flat Rate Fee Example

Example of a flat rate fee that could be applied to users of electric vehicle recharging facilities.

Table 7: Recommended annual flat rate fee

Weekly Driving Distances	Up to 50km	Up to 100km	Up to 200km	Up to 400km	> 400km
Annual Fee	$119	$218	$417	$814	$1,210

Recommended fix charges are calculated based on average driving distances of a standard Electric Vehicle and the electricity rates of the common area. A small administration fee for strata management is also included.

Owners charging with control equipment during off-peak hours can receive a 50% discount off the standard annual fee. Hybrid Electric Vehicle owners may also be able to negotiate for a discount.

A.10 Capital Works Plan

In a medium-large size strata it is likely that you already have one or more Plug-in Hybrid Electric Vehicles in the building. Electric Vehicles are predicted to reach 25% of new Electric Vehicle sales within the next 10 years. This means your 10 year Capital Works Plan (formerly Sinking Fund plan) should be updated now to cater for Electric Vehicle charging upgrades to common areas.

The key items to be added to the Capital Works plan are:

- Upgrade of common area meter to a smart meter (if required)
- Higher amp cabling of all basement car park areas
- Upgrade of capacity for existing electrical switchboards or to connect a new grid link into the building

A.11 Sample Survey Flyer

WATTBLOCK

strata community australia NSW member

OWNERS CORPORATION NETWORK

CITY OF SYDNEY

Sydney2030/Green/Global/Connected

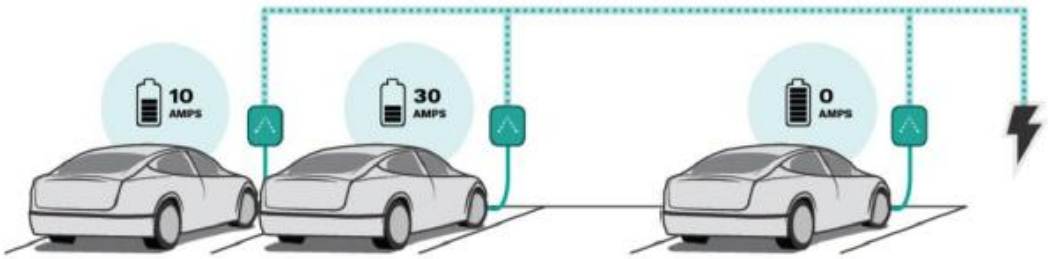
Electric Vehicle Charging for Apartments

Dear Residents,

We are looking into your future needs for electric vehicle charging facilities in this building. Have your say and assist us in planning ahead.

In order for us to plan for your future requirements we ask if you could complete a short online survey. This will assist with planning for what equipment may be required which will keep your building up to date with future demands. Your assistance is greatly appreciated.

The survey link is: **[Survey Link]**



Kind regards,

[Building Contact Name]
Phone: [Contact Number]

2030

CITY OF SYDNEY

This study is supported through a City of Sydney Environmental Grant

For further information phone **(02) 9977 1801**

A.12 Survey Questions

Are you in favour of installing electric vehicle recharge facilities in your building? *

- ○ Yes
- ○ No
- ○ Undecided

Indicate any preferences

- ☐ Free service (paid for by strata)
- ☐ User pays service
- ☐ Shared charging facility on visitor car spaces
- ☐ Chargers on individual car spaces
- ☐ Accessible to public

Household Driving Habits

Consider all vehicles, electric or otherwise

How many vehicles do you keep on your lot/unit? *

- ○ 0
- ○ 1
- ○ 2
- ○ 3 or more

What type of vehicles?

- ☐ None
- ☐ Small Motorbike (eg Moped)
- ☐ Large Motorbike
- ☐ Small Car (eg Hatchback)
- ☐ Family Car (eg Sedan)
- ☐ Large Car (eg 4WD)
- ☐ Other: _____

How many kilometers do you drive per week on average?

- ○ None
- ○ Less than 50km (About 1.5 hours)
- ○ 50 - 100km (About 1.5 - 3 hours)
- ○ 100 - 200km (About 3 - 7 hours)
- ○ 200 - 400km (About 7 - 14 hours)
- ○ More than 400km (About 14 hours)

Electric Vehicle Intentions

When are you likely to have an electric vehicle on your lot/unit? *

- ○ Already Have
- ○ 0 - 6 months
- ○ 6 months - 2 years
- ○ 2 - 5 years
- ○ 5 - 10 years
- ○ No Plans (Skip to the last question)

Which make, model or brand? (Skip if none)

Your answer

Hybrid or Fully Electric?

- ○ Hybrid (Use both petrol and electricity)
- ○ Fully Electric

If you own an electric vehicle, how do you charge it today?

- ☐ Public Charging Stations
- ☐ Common Area Power Socket at Home
- ☐ Private Electric Vehicle Charger at Home
- ☐ At Work

Do you know where the nearest public charging station is to your building?

- ○ Yes
- ○ No

Contact Details

Provide your email to receive a copy of the report (Optional)

Your answer

Comments / Suggestions (Optional)

Your answer

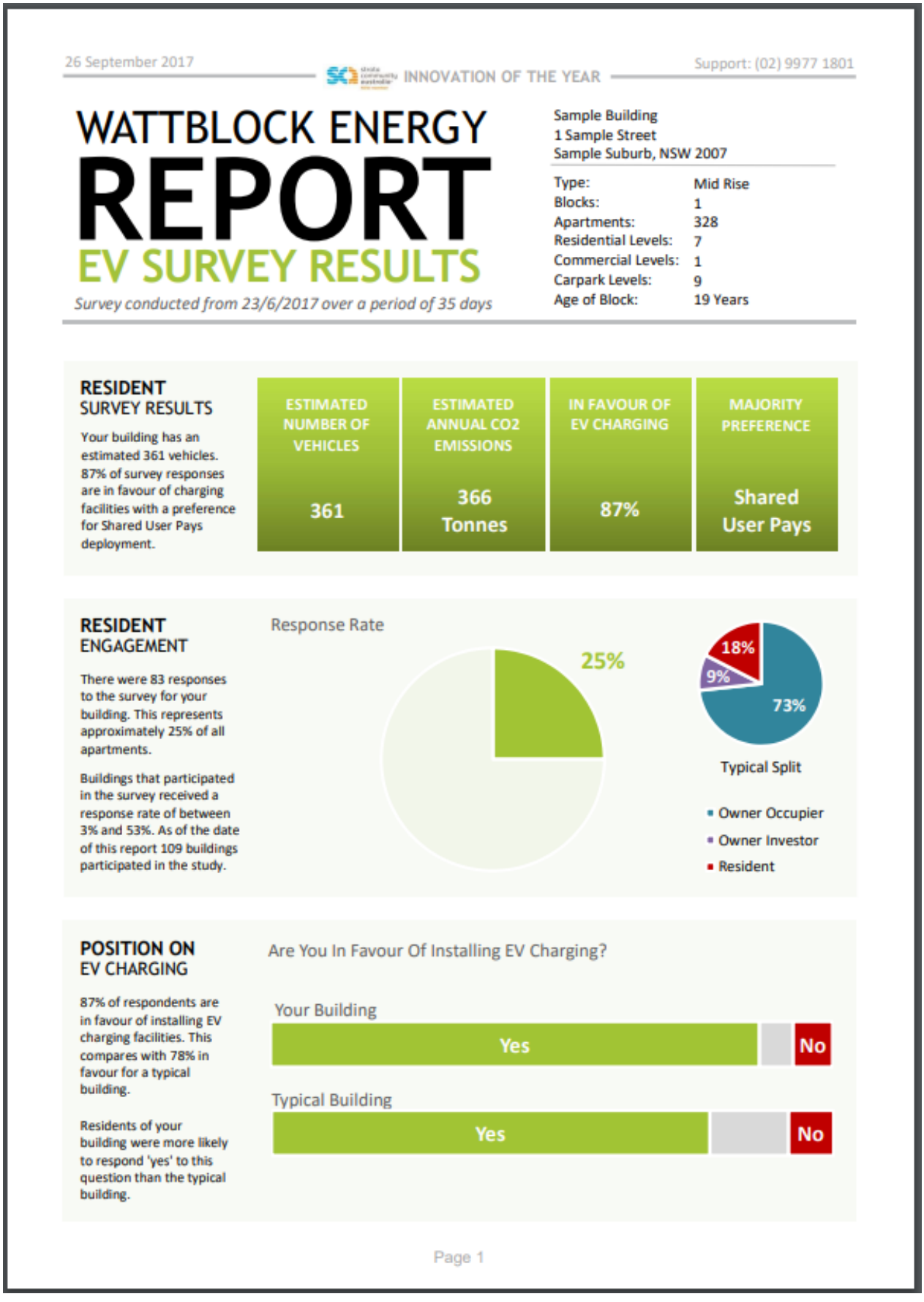
Which best describes your residence?

- ○ Owner Occupier
- ○ Owner Investor
- ○ Resident

Other buildings that may want to participate?

Your answer

A.13 Sample Survey Results



26 September 2017 — INNOVATION OF THE YEAR — Support: (02) 9977 1801

WATTBLOCK ENERGY REPORT

EV SURVEY RESULTS

Survey conducted from 23/6/2017 over a period of 35 days

Sample Building
1 Sample Street
Sample Suburb, NSW 2007

Type:	Mid Rise
Blocks:	1
Apartments:	328
Residential Levels:	7
Commercial Levels:	1
Carpark Levels:	9
Age of Block:	19 Years

RESIDENT SURVEY RESULTS

Your building has an estimated 361 vehicles. 87% of survey responses are in favour of charging facilities with a preference for Shared User Pays deployment.

ESTIMATED NUMBER OF VEHICLES	ESTIMATED ANNUAL CO2 EMISSIONS	IN FAVOUR OF EV CHARGING	MAJORITY PREFERENCE
361	366 Tonnes	87%	Shared User Pays

RESIDENT ENGAGEMENT

There were 83 responses to the survey for your building. This represents approximately 25% of all apartments.

Buildings that participated in the survey received a response rate of between 3% and 53%. As of the date of this report 109 buildings participated in the study.

Response Rate

Typical Split

- Owner Occupier
- Owner Investor
- Resident

POSITION ON EV CHARGING

87% of respondents are in favour of installing EV charging facilities. This compares with 78% in favour for a typical building.

Residents of your building were more likely to respond 'yes' to this question than the typical building.

Are You In Favour Of Installing EV Charging?

Page 1

RESIDENT DRIVER PROFILE

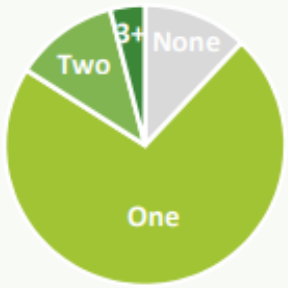
Across approximately 361 vehicles in your block, a total of 2,023,000kms are travelled each year, which requires 223,000 litres of petrol and costs $290,000 per year.

VEHICLE ACCESS

The residents of your building keep an average of approximately 1.1 vehicles, compared with 1.2 for a typical building.

This includes 12% of respondents that do not have a vehicle. This compares with 11% for a typical building.

How Many Vehicles Do You Keep On Your Lot?

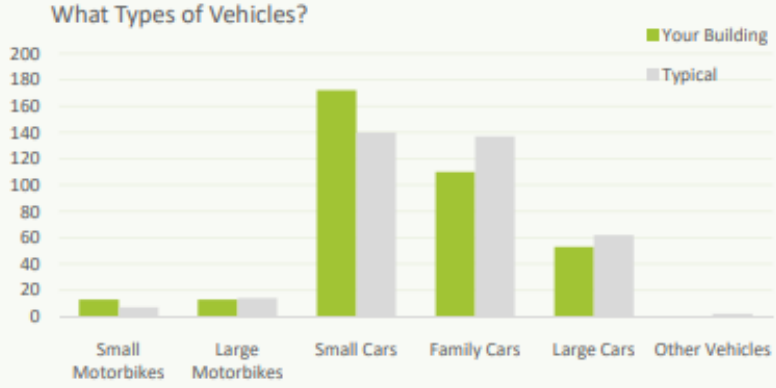


VEHICLE DISTRIBUTION

The residents of your building were most likely to drive Small Cars, estimated to be 48% of all vehicles or 172 in total.

Family Cars are the most common in typical buildings accounting for 39% of vehicles.

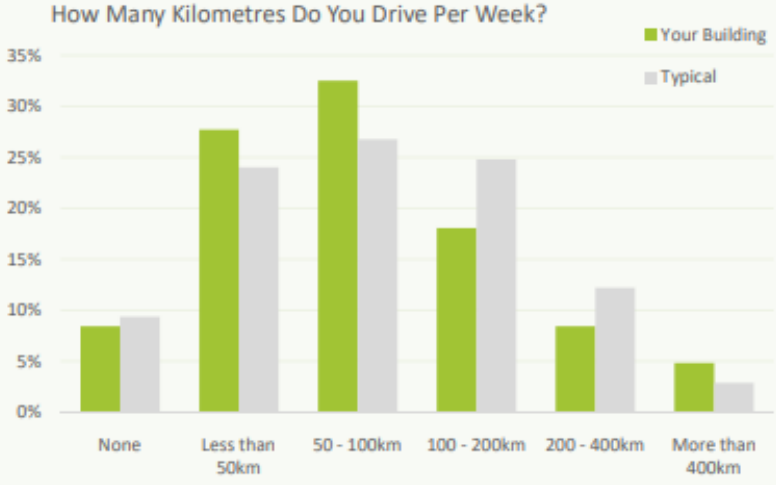
What Types of Vehicles?



DISTANCE TRAVELLED

The residents of your building drive an average of approximately 108 kms per week, compared to an average of 114 kms for a typical building.

How Many Kilometres Do You Drive Per Week?



Support: (02) 9977 1801

ELECTRIC VEHICLE BUYING INTENTIONS

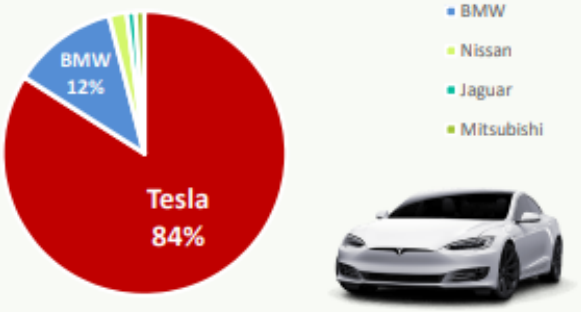
Among the 87% of respondents in your building who were in favour of EV charging, 58% either already have an electric vehicle or plan to have one in the next 10 years.

BRAND & MODEL PREFERENCES

For the typical building 84% indicated a preference for Tesla, followed by 12% for BMW.

For your building 9 of 10 responses indicated a preference for Tesla.

Which Make, Model or Brand?

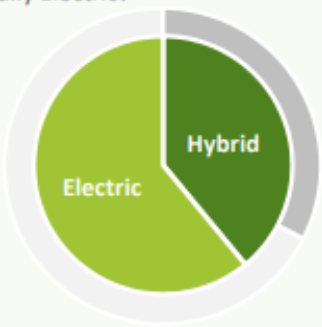


HYBRID OR PURE ELECTRIC

61% of your residents prefer fully electric vehicles to hybrid vehicles, which is 6% less than the typical building.

51% of respondents expressed no preference.

Hybrid or Fully Electric?



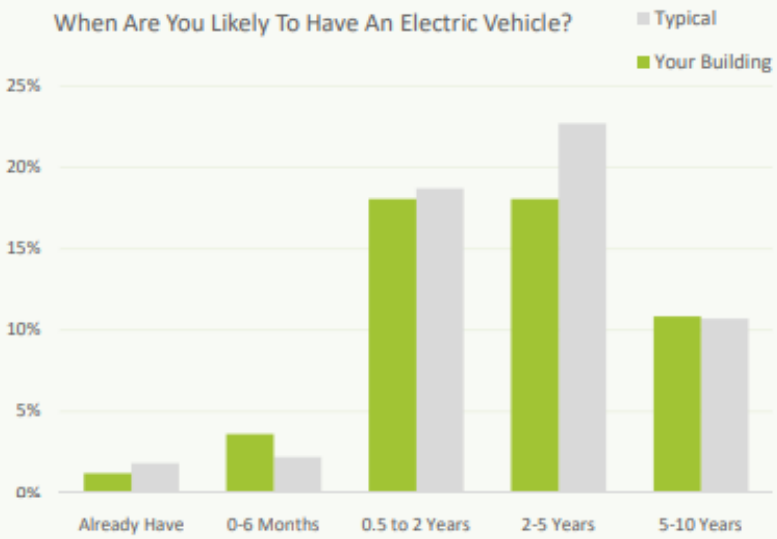
PROJECTED ELECTRIC VEHICLES

52% of respondents either have or plan to have an electric vehicle within the next 10 years versus 56% for the typical building.

Most repondents expect to have an electric vehicle within 2-5 Years.

The residents of your building were 4% less likely than a typical building to have plans.

When Are You Likely To Have An Electric Vehicle?



Page 3

EV CHARGING PREFERENCES

If your building were to proceed with Electric Vehicle charging facilities, the majority of respondents expressed a preference for User Pays and Shared chargers.

CHARGING OPTIONS

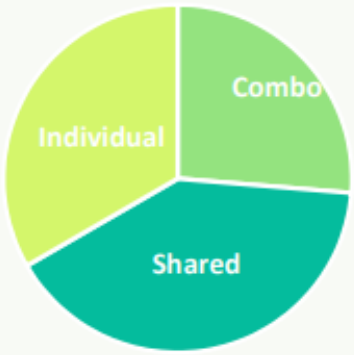
Charging systems can be set up on visitor car spaces as a shared facility or provided directly to individual car spaces. There are numerous options available.

SHARED OR INDIVIDUAL

33% of respondents indicated a preference for individual chargers while 40% prefer shared chargers and 27% want a combination.

For the typical building 61% prefer individual chargers.

Do You Prefer Shared or Individual Charging Facilities?



USERS PAYS OR FREE SERVICE

83% of respondents indicated a preference for a user pays service while 11% prefer a free service and 6% want a combination.

For the typical building 79% prefer user pays.

Do You Prefer a User Pays or Free Service (Paid For by Strata)?

PUBLIC VERSUS PRIVATE CHARGING

Residents in typical buildings showed low awareness of public charging stations and low interest in making facilities available to the public.

PUBLIC CHARGING FACILITIES

There are 3 public charging facilities near your building.

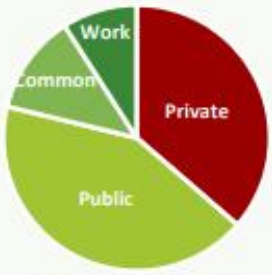
Public charging can lead to faster adoption of electric vehicles and may also alleviate the need for charging in your building.

NEAREST PUBLIC CHARGING STATION

14% of your residents knew the location of their nearest public charging station versus 11% for a typical building.

Respondents that have electric vehicles use private (36%) and public chargers (42%) with few using common area power sockets or facilities at their work.

Do You Know Where Your Nearest Public Charging Station Is?



Charging Behaviour

CREATE PUBLIC EV CHARGING

3% of your residents where in favour of your building providing a publically available charging facility. This compares with 2% for the typical building.

A public charging facility may be a source of revenue for the owners corporation.

Are You In Favour Of Making Charging Available To The Public?

COMMENTS & SUGGESTIONS

Survey respondents were invited to provide written comments and suggestions. Long responses may be truncated. You can contact Wattblock for the full transcript.

"Thanks for the survey... I am seriously interested in developments in this issue."

"we own a hybrid prius c which needs/uses no recharging "

"Probably too early - wait a few years"

'If it is proposed that strata provide the service free of cost to the electric vehicle owners, this would currently be an unfair burden on the residents and owners (as power prices rise) unless the electricity was provided by a fully renewable source such as a roof top solar system with battery backup. At present this is costly, however may be an option worth investigating as costs reduce. Having a facility for electric vehicle charging will be an asset to the building and owners/residents and add to the amenity of the facility and hopefully will be supported. "

'I love the way our we are thinking about the future of our building. Well done to the strata team."

"Installation and operational costs (electricity costs and electrical checks etc) should be paid by users and not by strata or strata levies. Perhaps a per user levy on top of strata levy to pay back costs over time?
power cables support extra capacity for charging? What about off-peak
How will users pay for power they use? Use identity card for smart billing? Use of extra levy to pay for power for charging?

Will this reduce number of visitor parking places?
How will stations be shared? What etiquette? Some stations charge by time car occupies bay (as well as electricity) to discourage long-term parking.
Is there a plan to scale out over 10 years (and electric vehicles become more common). Do electric only vehicles get priority over hybrids?"

"Support for EV car sharing services in the building would be very welcome."

"I am looking to buy a new car but holding of to get a small - medium electric car when charging stations are more available"

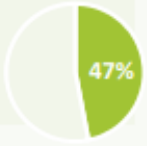
"Better to be early than late "

"Wait for electric cars to become common (if they ever do)."

"Utter waste of body corporate time. Install solar panels on roof first"

"If the provision of charging facilities may (surely 'will') AFFECT valuation/rentals, I suggest that, at the very least, one or two units be installed in the common area."

47% of respondents indicated they would like to see the report



A.14 Survey Comments and Suggestions

_____ *Strata Scheme Responses*_____

''This is an excellent idea to implement. thank you ''

''F*ck off with your plans''

''Would be interested if there are car spaces equipped with charging stations for sale.''

''I oppose non-electrical car users paying any cost for electric car owners. Electric car owners should pay costs associated with it.''

''Happy to consider depending on cost.''

"'Hi, This survey is a great initiative but it is not aimed at investor owners. I don't live in [Building Name] or park a vehicle there - I just own an apartment there. But I still think this is a great initiative, as long as the chargers are metered and bill the charge to the actual user, not the Owners Corporation.''

''How will this impact strata fees? It does not make sense to install this unless there is a justified need to have it! ''

_____ *Strata Scheme Responses*_____

''Please let me know the outcome''

"Personally. As an owner, electric cars are NOT welcome anywhere near my home. They are MUCH more toxic and polluting to the environment than modern gasoline powered vehicles and present a SERIOUS health and safety issue due to the chemicals in their power cells during high rise building (high intensity) fires. The presence of electric cars puts first responders in harm's way. Furthermore. I seriously would NOT be surprised to find ANY attempt to have STRATA funded electric power points…. Incinerated by an advocate of one of the owners to lower costs to the owners. WHY should owners subsidise other owner's or renter's travel/energy costs? This is not Soviet Russia. It is disgusting to even suggest this as a possibility at all. Electric cars should be BANNED from the building and those who contravene this by-law forcibly evicted Just my opinion of course. Which you asked for."

''We need to look at solar panels and battery storage to help reduce costs and should be part of the entire proposal''

''Strata levy has been increasing over the years for what is already high for our city apartment. However, we do support the e-vehicles for the greater good of the environment but it would be best to have the charging stations at our building at the cost of the e-vehicle users (user pay). This way, apartment visitors or even the public do not misuse the facility if free and those who have chosen not to have e-vehicles will not bear additional costs of those who do.''

_____ *Strata Scheme Responses*_____

''Our carpark is common property and has electricity through strata so some kind of meter would be good so we can assess use.''

_____ *Strata Scheme Responses*_____

''Thanks for the survey... I am seriously interested in developments in this issue.''

''we own a hybrid prius c which needs/uses no recharging ''

''Probably too early - wait a few years''

''If it is proposed that strata provide the service free of cost to the electric vehicle owners, this would currently be an unfair burden on the residents and owners (as power prices rise) unless the electricity was provided by a fully renewable source such as a roof top solar system with battery backup. At present this is costly, however may be an option worth investigating as costs reduce. Having a facility for electric vehicle charging will be an asset to [Building Name] and owners/residents and add to the amenity of the facility and hopefully will be supported. ''

''I love the way our we are thinking about the future of our building. Well done to the strata team. – [Name]''

''Installation and operational costs (electricity costs and electrical checks etc) should be paid by users and not by strata or strata levies. Perhaps a per user levy on top of strata levy to pay back costs over time? Can [Building Name] power cables support extra capacity for charging? What about off-peak charging? How will users pay for power they use? Use identity card for smart billing? Use of extra levy to pay for power for charging? Use "JET Charge"? Will this reduce number of visitor parking places? How will stations be shared? What etiquette? Some stations charge by time car occupies bay (as well as electricity) to discourage long-term parking. Is there a plan to scale out over 10 years (and electric vehicles become more common). Do electric only vehicles get priority over hybrids?''

''Support for EV car sharing services in the building would be very welcome.''

''I am looking to buy a new car but holding of to get a small - medium electric car when charging stations are more available''

''Better to be early than late ''

''Wait for electric cars to become common (if they ever do).''

''Utter waste of body corporate time. Install solar panels on roof first''

''If the provision of charging facilities may (surely 'will') AFFECT valuation/rentals, I suggest that, at the very least, one or two units be installed in the common area.''

_____ *Strata Scheme Responses*_____

''Is there an option to include a solar system for the charging of vehicles or to supply electricity to communal areas?''

_____ *Strata Scheme Responses*_____

''We should also be looking at solar capture and storage for the building''

''Thank you for this initiative''

_____ *Strata Scheme Responses*_____

''Strata owners should in no way have to pay to charge other people's car. This needs to be metered by the actual users of the power whether they are owners, renters or members of the public. ''

''should be user pays so as not to encourage driving over other forms of transport. Needs to be in visitor parking spots for practical, and progressive reasons but has to be user pays, there in particular ''

''It must be discussed and reviewed among ourselves. Too Important in the scheme of things, to not review this in connection with at least one ongoing and important other issue. And like real folk that live (pretty much in a responsible and harmonious, friendly way) together as a community facing new ideas.''

''There should probably also be charging facilities for mobility scooters - we're not getting any younger!''

_____ *Strata Scheme Responses*_____

''I would like to purchase an electric vehicle, however am unable to do so until charging stations in the basement parking are installed. Once installed I would buy an electric vehicle. I imagine there would be other residents who are also interested in EV but unable to purchase one until the infrastructure is available.''

''If subsidies exist for the provision of the infrastructure for electric cars then perhaps worthy of investigation. The cost of provision and maintenance shouldn't be a cost carried by the strata. Individuals should supply and pay for the electricity as they do in Europe. ''

_____ *Strata Scheme Responses*_____

''Preferably supplied with power from solar panels on the building roof space. ''

''We should consider solar panels and Tesla power walls''

''My answers do not indicate a "yes" for electric power, I merely would like to see what options are available and the associated cost per owner.''

''Do not want increases in strata fees as a result of providing the charging facilities, strata fees are already high.''

''I'm an apartment owner but the flat has been tenanted for 10 years.''

_____ *Strata Scheme Responses*_____

''Do recommend installation of electric vehicle charging as soon as possible.''

''While I support the implementation of electric vehicles, I think the priorities in this building should be completing the building rectification works.''

_____ *Strata Scheme Responses*_____

"[Building Name] chairman has vested interest, just like the ECC member seeking a kayak pontoon on an adjacent Strata site with no indication it will be a user pays basis. Not happy at potentially having to subsidize ''

''Residents should be permitted to install their own charging stations and battery units.''

''I think that if someone has an electric car and needs to charge it then the individual people who need the charging station should be able to put them in there own private car spaces at there own cost! with there being no addition cost for other unit owners who do not wish to have anything to do with electric cars!''

_____ *Strata Scheme Responses*_____

''I'd prefer money to be spent on solar panels''

''Believe that this is the future - would like to understand the drain on the resources such as air conditioning and lifts given our aging system. Plus the options of having meters in place to ensure the user payment. ''

''Would not like for it to be covered by strata payments from owners as it's not a common good service that everyone can use. Eg. paying for a pool, gardens and elevator maintenance is something everyone has the right to use and enjoy. Paying for a charging station only benefits those who choose to have that specific type of car. Definitely think it should be a user-pays service.''

''If residents want or have an electric vehicle they should pay for the charging of their vehicle not the other residents. They should pay for the installation of electric chargers in their own car spaces. There should be no costs to be paid for by the strata fees that all owners pay related to charging of electric vehicles - it would be like the strata paying for petrol for individual residents vehicles - doesn't make sense at all. Thanks for the opportunity to comment and participate in the survey.''

_____ *Strata Scheme Responses*_____

''I think for the building to have this facility is great as a lot of residents are aging and in need of this and I also have a relative who visits and uses a scooter.''

''Great initiative; very happy to see OT engaging with the city in this innovative way! ''

''I am elderly but still want to drive. My children as well as myself would like to have an electric vehicle, especially for me, for my comfort and most particularly my safety.''

''Great that management is preparing for the inevitable future. ''

''While I currently have no specific plans for an electric car, this is definitely a positive step for the future of cars in Australia. it would be good to have recharging facilities as more and more people become aware of the limited fossil fuel resources available. Great idea!!''

''thank you.... it will be good when we have a practical option to buy and use hybrids ...and charging stations on-site are simply a vital no-brainer in that''

''no brainer - we need to be able to plug in our cars.''

''If electric vehicle recharge facilities were available in our building we would almost certainly move to an all-electric car much sooner than otherwise.''

_____ *Strata Scheme Responses*_____

''In regard to an earlier question we don't have a visitor car park''

''excellent forward planning, the way of the future''

''Smart meters may work in order to integrate power usage bills with respective apartments. If the service were to be paid by strata, my preference would be that a green energy provider is used. ''

_____ *Strata Scheme Responses*_____

''i had made inquiries with the building management some 2 years ago when i was looking at purchasing an electric car. it is a shame it has taken this long for these issues to be addressed. i have been unable to purchase a car as was planned due to difficulties accessing / installing charging stations in carpark. ''

''Great to see some forward thinking. A charging station should be available at some stage in the future, but not necessarily for every car space - possibly a couple of 'community' spots on each floor that could be booked or only made available for the minimum charging time....''

"'Suggest a common use Tesla charger whilst there are only a few electric cars. Other types of electric vehicles can purchase adapters. Once there are scheduling problems owners should be allowed to install their own chargers,

have the Meters read once per month and reimburse the body corporation. My Tesla costs about $15 per week in electricity which even if electricity prices go up is low. I only change it up in Sydney about 6 times a year.''

''We are likely to have visitors and rental cars that need charging. ''

''I have lived in building 5 since August 2011 and I think this survey is a good idea. Surveys may be the way forward regarding any future policies although my fellow residence need to understand if they do not participate they have no right to complain on future policies and decisions.''

''While looking at electricity services/supply could consideration be given to supplying the hot water systems from separate off peak systems''

''Whether or not I would support the installation of electric recharging facilities in the [Building Name] complex depends on the plans for doing that, ie, how many stations, where would they be located, how would users pay for the electricity, how would access be regulated, what are the risks inherent in parking and charging electric/hybrid vehicles in the parking basements of the [Building Name] complex, etc. If these questions could be answered satisfactorily, I would support such a move.''

''If significant electrics work is being done in the garage, I would like to see more simple power points, reachable by each bay, to allow for the occasional battery charging and use of small appliances such as car vacuums. ''

''Pleased to see you are looking at this. We do need a coordinated approach for the whole complex. There are probably a number of buildings either in Australia, Europe or US that have already looked at this and have arrived at a workable solution for a large complex similar to [Building Name]. [Name]''

''Request my own dedicated power outlet at my parking spot to charge my vehicle overnight ''

''Facilities could presumably also be useful to allow use of "trickle chargers" for conventional cars which are not driven much.''

_____ *Strata Scheme Responses*_____

''Opportunity for the strata body to arrange a PPA with a renewables generator off-site?''

_____ *Strata Scheme Responses*_____

''Great initiative. Seriously considering an all electric vehicle for my next car.''

''Unsure of user pays vs strata pays (assume this is included in strata fees)''

''would like an electric car, but waiting for a charging station''

A.15 Wattblock Sustainability Report Sample

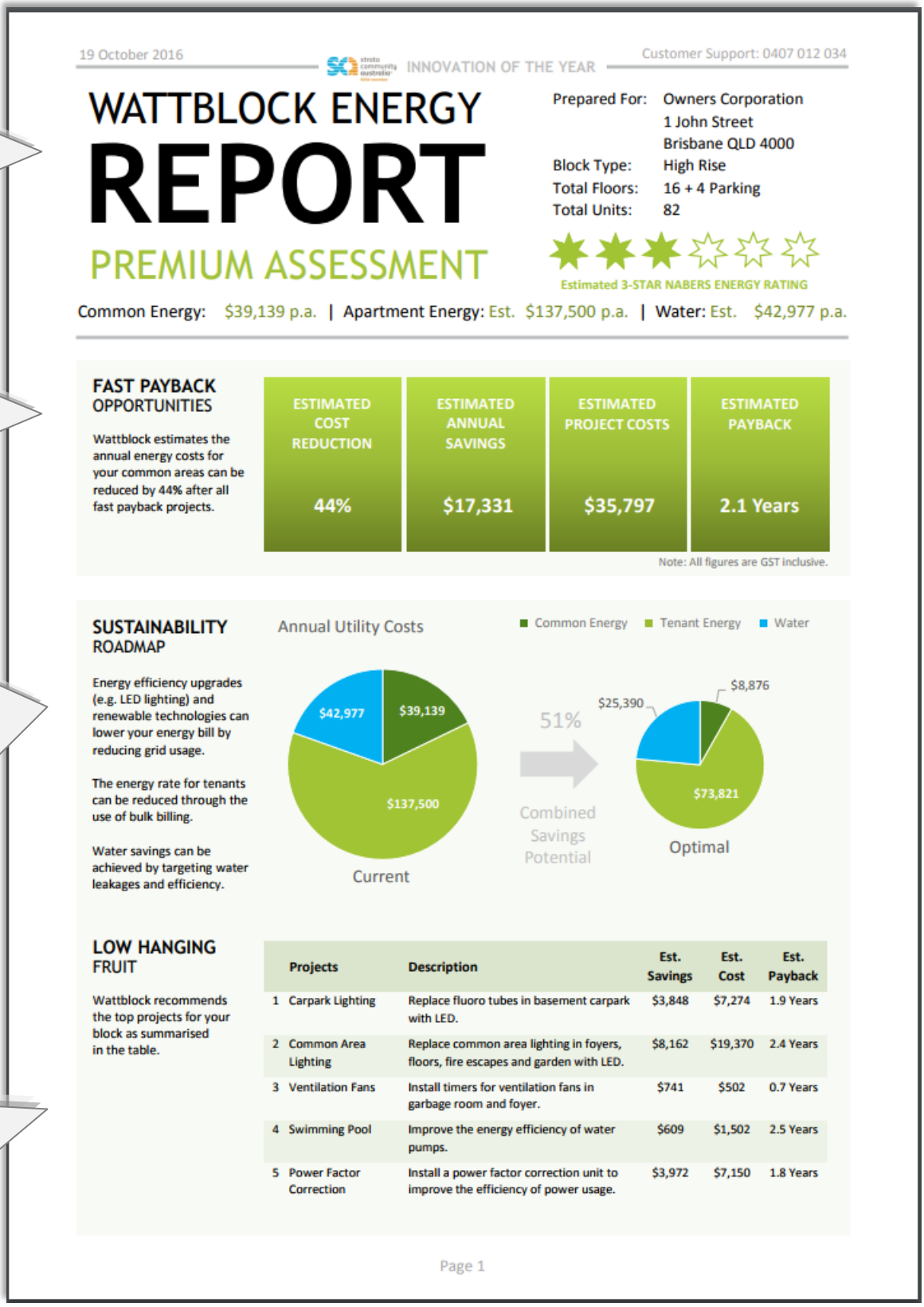
PAGE 1 – REPORT OVERVIEW

BUILDING IDENTIFICATION
Building address, category, size, and overall utility costs.

FAST PAYBACK OPPORTUNITIES
Highlights potential savings or least cost options.

SUSTAINATBILTY ROADMAP
Compares the benefits brought on by tariff savings, energy efficiency and solar separately for the common areas and for the apartments.

LOW HANGING FRUIT
Lists out the top projects in terms of payback and project complexity.



19 October 2016 — INNOVATION OF THE YEAR — Customer Support: 0407 012 034

WATTBLOCK ENERGY REPORT

PREMIUM ASSESSMENT

Prepared For: Owners Corporation
1 John Street
Brisbane QLD 4000
Block Type: High Rise
Total Floors: 16 + 4 Parking
Total Units: 82

Estimated 3-STAR NABERS ENERGY RATING

Common Energy: $39,139 p.a. | Apartment Energy: Est. $137,500 p.a. | Water: Est. $42,977 p.a.

FAST PAYBACK OPPORTUNITIES

Wattblock estimates the annual energy costs for your common areas can be reduced by 44% after all fast payback projects.

ESTIMATED COST REDUCTION	ESTIMATED ANNUAL SAVINGS	ESTIMATED PROJECT COSTS	ESTIMATED PAYBACK
44%	$17,331	$35,797	2.1 Years

Note: All figures are GST inclusive.

SUSTAINABILITY ROADMAP

Energy efficiency upgrades (e.g. LED lighting) and renewable technologies can lower your energy bill by reducing grid usage.

The energy rate for tenants can be reduced through the use of bulk billing.

Water savings can be achieved by targeting water leakages and efficiency.

Annual Utility Costs

Common Energy Tenant Energy Water

LOW HANGING FRUIT

Wattblock recommends the top projects for your block as summarised in the table.

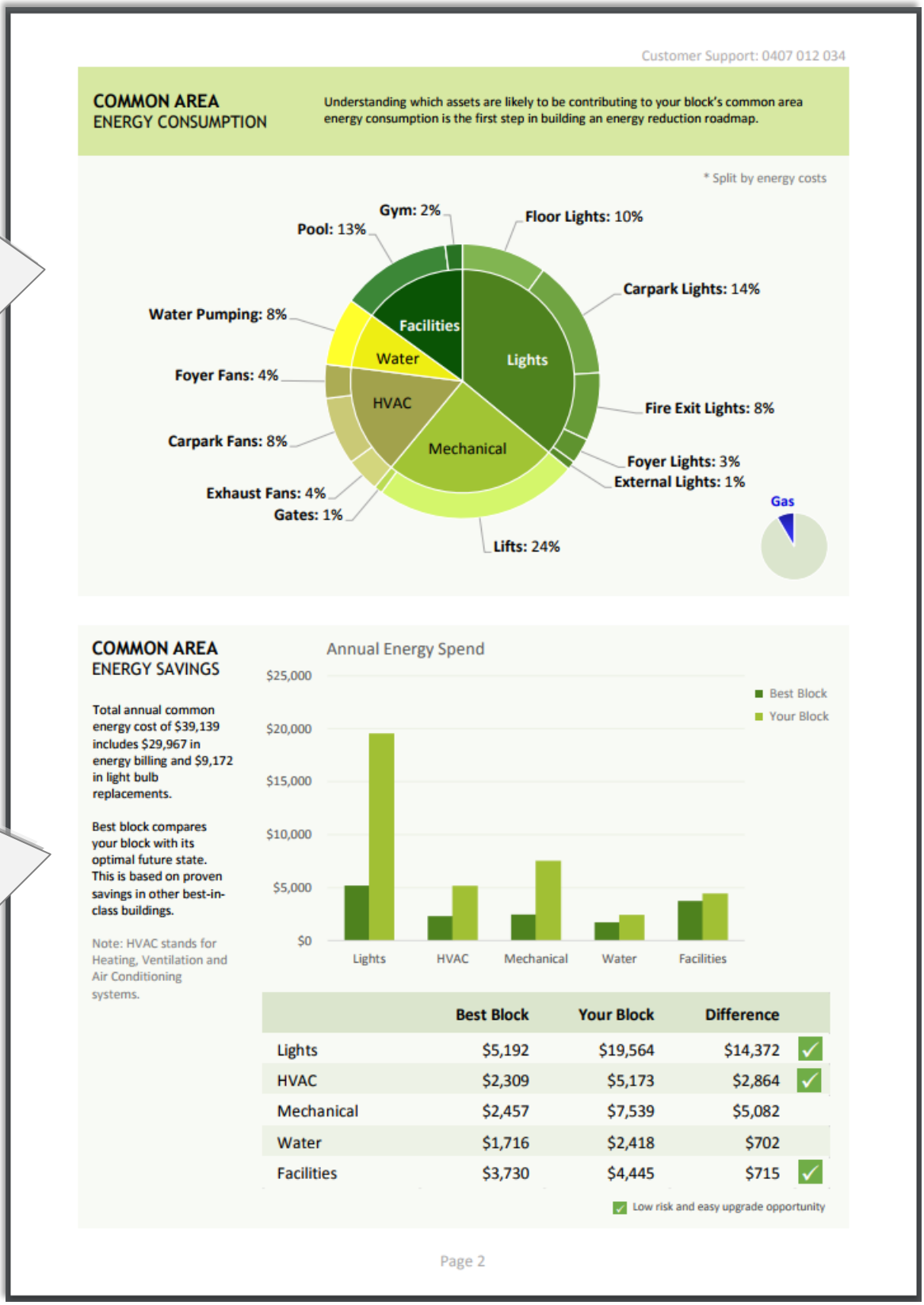
	Projects	Description	Est. Savings	Est. Cost	Est. Payback
1	Carpark Lighting	Replace fluoro tubes in basement carpark with LED.	$3,848	$7,274	1.9 Years
2	Common Area Lighting	Replace common area lighting in foyers, floors, fire escapes and garden with LED.	$8,162	$19,370	2.4 Years
3	Ventilation Fans	Install timers for ventilation fans in garbage room and foyer.	$741	$502	0.7 Years
4	Swimming Pool	Improve the energy efficiency of water pumps.	$609	$1,502	2.5 Years
5	Power Factor Correction	Install a power factor correction unit to improve the efficiency of power usage.	$3,972	$7,150	1.8 Years

Page 1

PAGE 2 – COMMON AREA CONSUMPTION

COMMON AREA ENERGY CONSUMPTION
Graphical "Energy Wheel" separated into five main categories; lighting, HVAC (heating, ventilation and air con), mechanical, water and facilities.

COMMON AREA ENERGY SAVINGS
Visually shows how much energy each category is using compared to the average best case achieved in comparable buildings.



Customer Support: 0407 012 034

COMMON AREA ENERGY CONSUMPTION

Understanding which assets are likely to be contributing to your block's common area energy consumption is the first step in building an energy reduction roadmap.

* Split by energy costs

COMMON AREA ENERGY SAVINGS

Total annual common energy cost of $39,139 includes $29,967 in energy billing and $9,172 in light bulb replacements.

Best block compares your block with its optimal future state. This is based on proven savings in other best-in-class buildings.

Note: HVAC stands for Heating, Ventilation and Air Conditioning systems.

	Best Block	Your Block	Difference	
Lights	$5,192	$19,564	$14,372	✓
HVAC	$2,309	$5,173	$2,864	✓
Mechanical	$2,457	$7,539	$5,082	
Water	$1,716	$2,418	$702	
Facilities	$3,730	$4,445	$715	✓

✓ Low risk and easy upgrade opportunity

Page 2

PAGE 3 – INDIVIDUAL APARTMENT ENERGY CONSUMPTION

ELECTRICITY VS GAS SERVICES
Listing of energy services into apartments.

INDIVIDUAL ENERGY BILLING
Provides estimated distribution of energy (electricity and gas) costs incurred by residents.

BULK BILLING ANNUAL BENEFIT
Approximate savings based on resident cost brackets.

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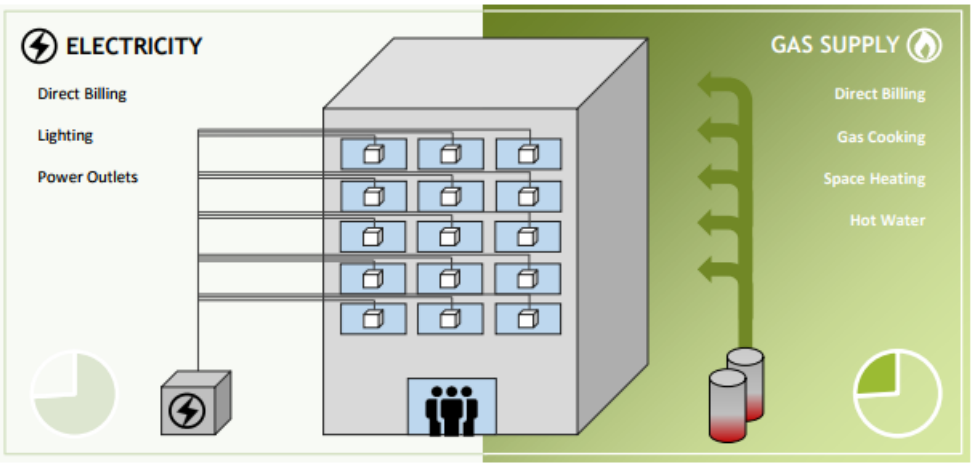
INDIVIDUAL APARTMENT ENERGY CONSUMPTION

Coordinating electricity purchases across common areas and individual apartments provides mutual benefit.



INDIVIDUAL ENERGY BILLING

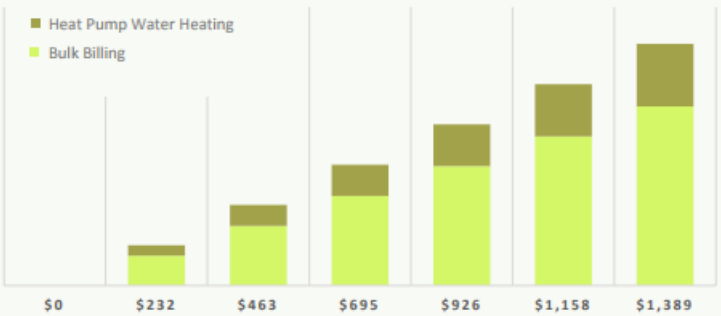
Wattblock estimates the annual energy cost for all individual units to be $137,500. This cost is distributed among 82 apartments as follows.

For example, it is estimated that there are 21 apartments which are spending about $2,000 per year on energy usage.

BULK BILLING ANNUAL BENEFIT

The Owners Corporation can secure energy for apartments at lower rates. Savings can be passed on to residents or provide additional income to the Owners Corporation.

For example, an individual unit currently spending $2,000 p.a. could reduce their bill by $926.



Page 3

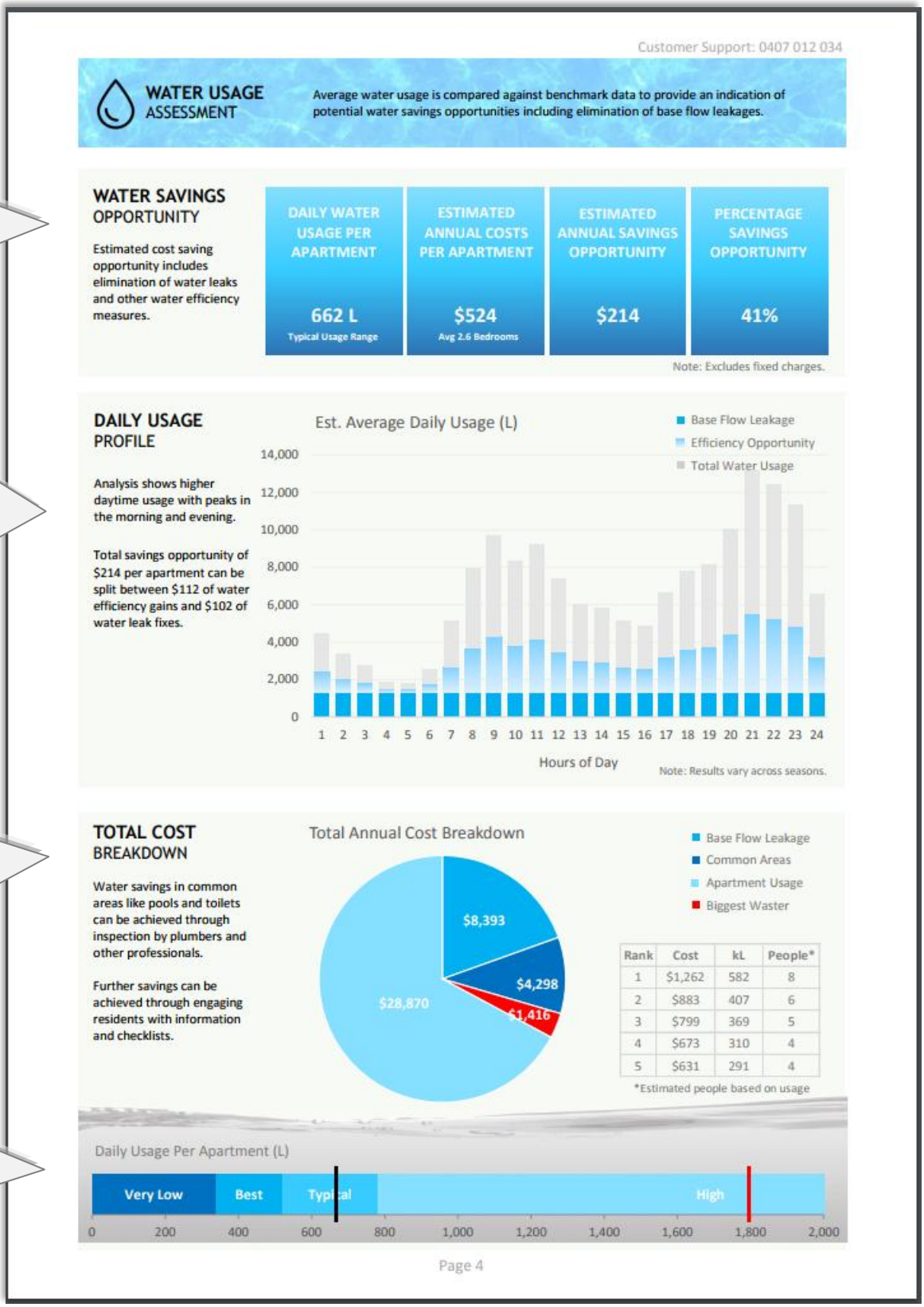
PAGE 4 – WATER USAGE ASSESSMENT

WATER SAVINGS OPPORTUNITY
Key metrics around water usage, costs and savings

DAILY USAGE PROFILE
Graphical visualization of water usage by hours of the day showing savings potential.

TOTAL COST BREAKDOWN
Pie chart shows common area usage relative to tenants and to users.

USAGE PER APARMTENT
Average and worst apartment relative to benchmarks.



PAGE 5 – SOLAR AND BATTERY IMPACT ASSESSMENT

ENERGY SAVINGS OPPORTUNITY
Highlights potential savings from solar with and without batteries.

LOAD PROFILE ASSESSMENT
Shows the average hourly energy use over a day with solar generation included.

SOLAR PAYBACK ASSESSMENT
Compares upfront purchase to finance options in terms of cashflow impact.

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SOLAR + BATTERY IMPACT ASSESSMENT

Solar energy viability depends largely on available roof space for solar panels, the electrical usage over the day and across seasons of the year. Adding batteries enables a larger solar system to be installed.

ENERGY SAVINGS OPPORTUNITY

This entire page assumes all energy efficiency projects (e.g. LED lighting) have already been completed.

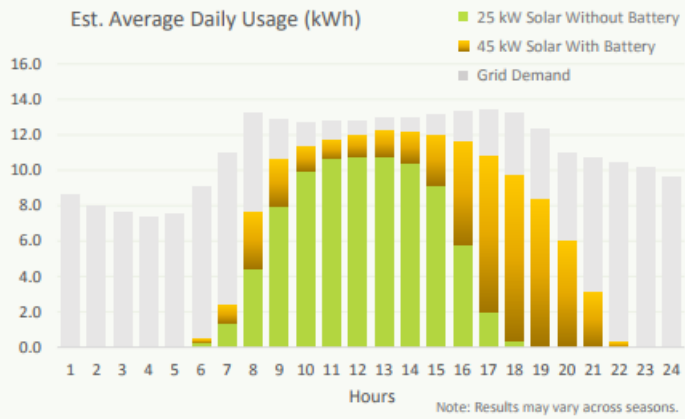
	SOLAR SYSTEM SIZE	ESTIMATED ANNUAL COST SAVINGS	ESTIMATED PROJECT COSTS	ESTIMATED PAYBACK
	25 kW (100 Solar Panels)	$3,743	$30,000	7.2 Years
Add Batteries (Based on Tesla Powerwall)	45 kW (180 Solar Panels)	$6,528	$112,913	16.3 Years

Note: Contact Wattblock for alternative system configurations.

LOAD PROFILE ASSESSMENT

Taking into account the available roof space and your common area energy usage, a 25 kW solar energy system is possible.

This can be increased to a 45 kW system with 56 kWh of batteries.



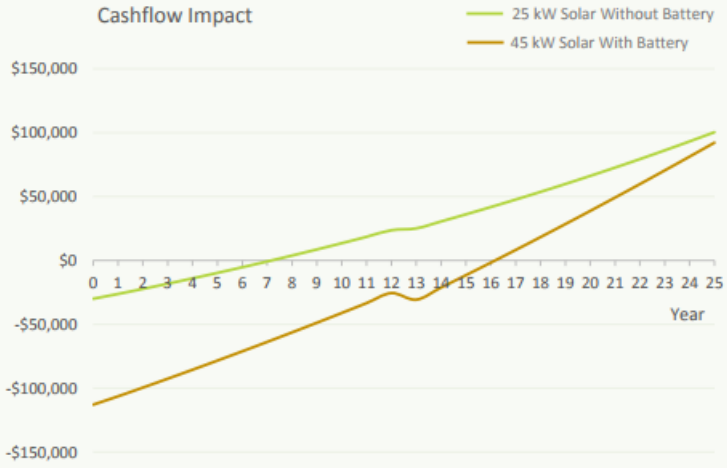
Note: Results may vary across seasons.

SOLAR PAYBACK ASSESSMENT

Upfront purchase of the 25 kW solar energy system without batteries is estimated to cost $30,000 with a 7.2 year payback.

The 45 kW system with 56 kWh of battery is estimated to cost $112,913 with a 16.3 year payback.

Solar energy suppliers may also offer a no upfront cost installation via a power purchase agreement.



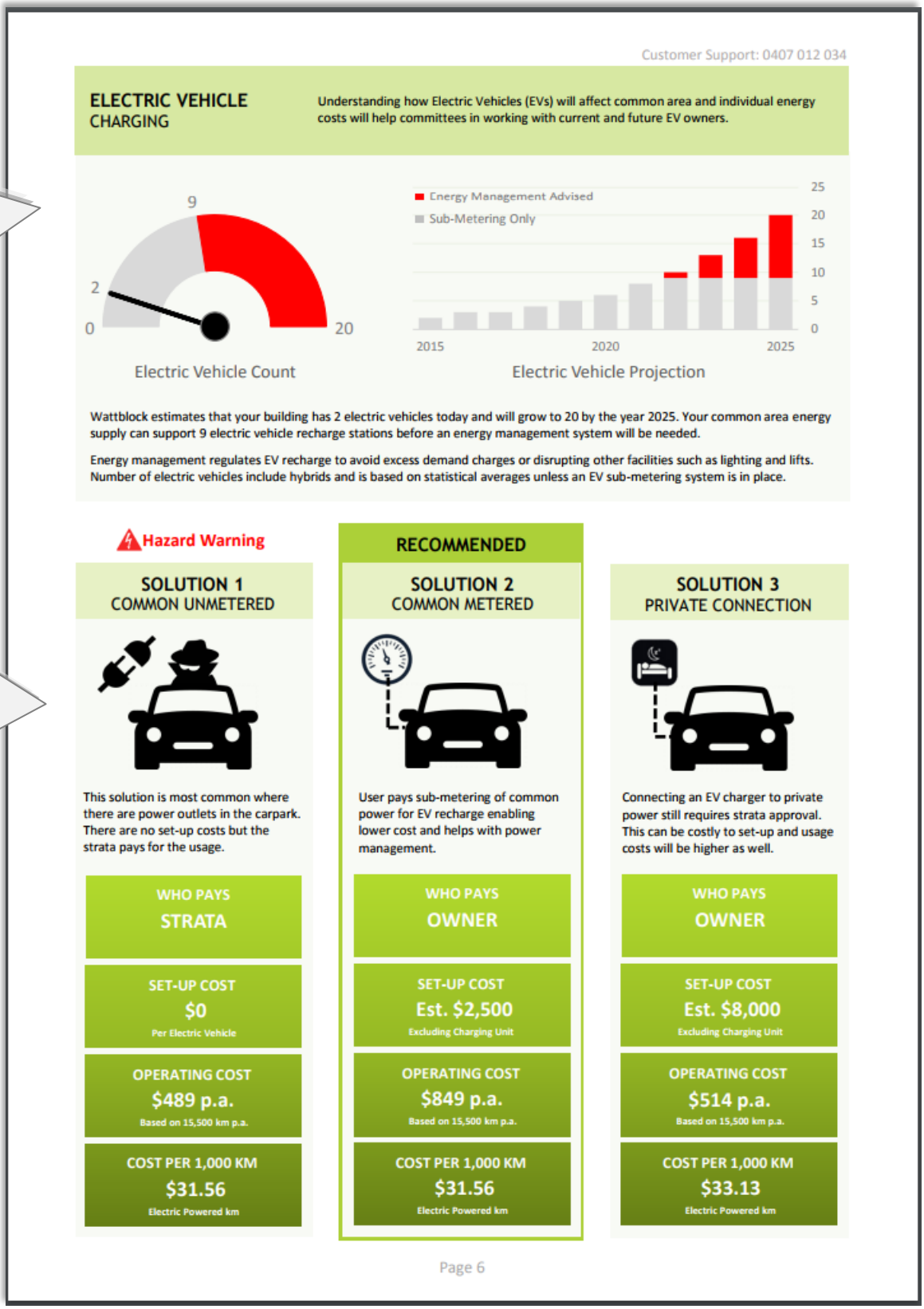
Note: Includes inverter and battery replacement in year 12.

Page 5

PAGE 6 – ELECTRIC VEHICLE CAPACITY ASSESSMENT

EV CHARGING CAPACITY
Projected electric vehicle adoption showing capacity limitations.

EV CHARGING SOLUTIONS
Three broad types of EV charging solution presented with indicative capital and operating costs.



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ELECTRIC VEHICLE CHARGING

Understanding how Electric Vehicles (EVs) will affect common area and individual energy costs will help committees in working with current and future EV owners.

Wattblock estimates that your building has 2 electric vehicles today and will grow to 20 by the year 2025. Your common area energy supply can support 9 electric vehicle recharge stations before an energy management system will be needed.

Energy management regulates EV recharge to avoid excess demand charges or disrupting other facilities such as lighting and lifts. Number of electric vehicles include hybrids and is based on statistical averages unless an EV sub-metering system is in place.

Hazard Warning

SOLUTION 1
COMMON UNMETERED

This solution is most common where there are power outlets in the carpark. There are no set-up costs but the strata pays for the usage.

WHO PAYS	STRATA
SET-UP COST	$0 Per Electric Vehicle
OPERATING COST	$489 p.a. Based on 15,500 km p.a.
COST PER 1,000 KM	$31.56 Electric Powered km

RECOMMENDED

SOLUTION 2
COMMON METERED

User pays sub-metering of common power for EV recharge enabling lower cost and helps with power management.

WHO PAYS	OWNER
SET-UP COST	Est. $2,500 Excluding Charging Unit
OPERATING COST	$849 p.a. Based on 15,500 km p.a.
COST PER 1,000 KM	$31.56 Electric Powered km

SOLUTION 3
PRIVATE CONNECTION

Connecting an EV charger to private power still requires strata approval. This can be costly to set-up and usage costs will be higher as well.

WHO PAYS	OWNER
SET-UP COST	Est. $8,000 Excluding Charging Unit
OPERATING COST	$514 p.a. Based on 15,500 km p.a.
COST PER 1,000 KM	$33.13 Electric Powered km

Page 6

PAGE 7 – PROGRESS AND ENVIRONMENTAL ACHIEVEMENT

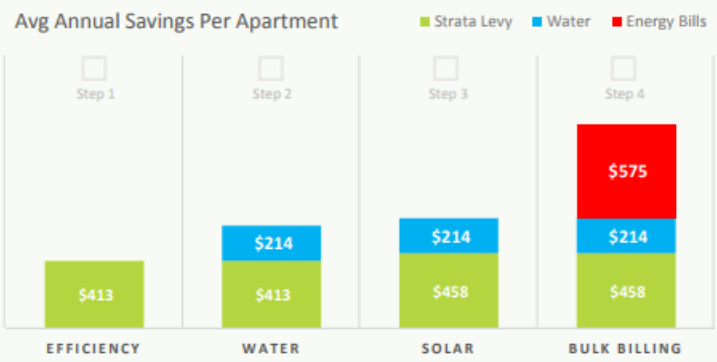
CUMULATIVE COST REDUCTION
Step by step savings opportunity from identified projects.

PROPERTY VALUE IMPACT
Translation of cost savings into property value based on cash flow multiple.

ENVIRONMENTAL ACHIEVEMENT
Impact on carbon footprint and contribution to national or local council targets.

CUMULATIVE COST REDUCTION

Individual units are estimated to save $458 p.a. on strata levies, $214 p.a. on water bills and $575 p.a. on apartment energy bills after implementation of all identified initiatives.



PROPERTY VALUATION IMPACT

A building with lower operating costs is worth more because net income to property owners is increased.

Total valuation increase represents an average of $24,961 per apartment.

Note: Valuation impact is based on 20x multiple of cash flow.

ENVIRONMENTAL ACHIEVEMENT

Following sustainability initiatives your block will exceed the national carbon reduction target of 5% set for 2020. If every block did this, we would be well on our way to exceeding the target.

PROPORTION OF POPULATION LIVING IN THIS BLOCK TYPE: 3.8%	AVERAGE OCCUPANCY RATE PER APARTMENT: 2.6	NUMBER OF BLOCK RESIDENTS: 213	ENERGY USE PER APARTMENT (MJ / YR): 26,170
CURRENT BLOCK CO_2 EMISSIONS (TONNES/YR): 632	EMISSIONS SAVINGS OPPORTUNITY (TONNES/YR): 106	EQUIVALENT NUMBER OF TREES PLANTED: 1,583	NATIONAL CO_2 REDUCTION TARGET 2020 CONTRIBUTION: 334%

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A.17 Calculation Assumptions

Discount Rates

This report does not provide Net Present Value (NPV) estimates for project costs, maintenance and savings over time. The appropriate discount rate will vary significantly between strata schemes. In some cases strata schemes have sinking funds earning less than 2% interest that could be used to finance projects. In other cases strata schemes might use strata lending facilities at interest rates greater than 9%.

Project Paybacks

The report does provide estimated project paybacks based on nominal cash flow projections. Net project costs are based on current value benchmarking against similar projects and quotations. Estimated savings are based on current electricity rates in the first year with an assumed annual inflation rate of 3% applied in future years. Where relevant, maintenance and replacement costs are included in future years in accordance with expected lifetimes published in product data sheets. The specific assumptions are noted in the relevant sections of the report.

Electricity Costs

Electricity costs for participating strata schemes are based on the actual electricity billing data provided for each common area meter. Electricity usage cost per kilowatt hour is calculated as the total variable electricity costs (excluding fixed charges such as supply and metering charges) divided by kilowatt hour usage taking into account Time Of Use (TOU) energy tariffs where relevant.

Electric Vehicles

Unless stated otherwise assumptions include operating efficiency of 0.185kWh/km, battery charging efficiency of 80%, and average driving distances based on survey results for each building or otherwise 50km/day.

Solar Energy Estimates

Estimates for solar energy production utilise Bureau of Meteorology statistical data on sunshine hours from the Mascot Sydney Airport weather station (station number 066037). This is the closest weather station for buildings in the City of Sydney having recent sunshine data. Observatory Hill weather station data is available up to 1992.

The report also includes figures and estimates from secondary research for which the sources are noted.

Who is Wattblock?

Wattblock was co-founded by Brent Clark and Ross McIntyre in 2014. They are joined by Jacky Zhong and Wilson Huang solar engineers plus a team of solar and low energy buildings specialists. For more information visit wattblock.com

What is Wattblock's mission?

The energy wasted in Australia's strata buildings has a bigger impact on carbon emissions than the cars driving on the roads. Wattblock aims to **crowdsource** the achievement of Australia's national carbon emission reduction target.

How many strata buildings has Wattblock assisted?

Wattblock has assisted approximately 1,000 strata buildings across Australia with energy reports. Wattblock has also directly project managed the upgrade of 70 buildings with LED lighting, solar, ventilation and hot water. To date it has identified over $25m of annual energy waste across townhouses to high-rise residential skyscrapers. Over 100 strata buildings have participated in electric vehicle recharging studies.

Who is partnering with Wattblock?

City of Sydney, NSW Innovate, Advance Queensland, Microsoft CityNext, Telstra's muru-D, UNSW, Griffith Uni, Queensland University of Technology, University of Queensland & the Michael Crouch Innovation Centre.

Who is covering Wattblock in the media?

SBS, North Shore Times, Foxtel, BRW, The Australian, Business Insider, Computerworld, Startup Smart, Startup Daily, Lookup Strata, SmartStrata, SSKB, Technode, Fifth Estate, One Step off the Grid and Renew Economy.

Wattblock Awards

Innovation of the Year 2016 Strata Community Australia (NSW), Best Social Change Entrepreneur 2015 (Start-up Smart), Energy Winner at 1776 Challenge Cup Sydney, CeBIT Community Support Finalist

Are Wattblock's electrician's licensed?

All electricians engaged by Wattblock have been licensed in the states in which they operate.

Is Wattblock insured?

Wattblock has professional indemnity insurance as a renewable and energy efficiency consultant ($1m), public liability insurance ($20m) and complies with workers compensation requirements in all states in which it operates.

Who is backing Wattblock?

Wattblock has received investment from muru-D as part of Telstra's startup accelerator program, Eastern Hill Investments, an Asian-based environmental engineer, a UK-based energy company consultant, a U.S.-based hi-tech investor, a NZ sustainability funds manager, a Sydney-based environmental impact investor, a Sydney-based clean tech consultant, a Sydney-based clean technology finance consultant and an innovation laboratory research director.

Where is Wattblock located?

Wattblock is based at Michael Crouch Innovation Centre at UNSW in Sydney.