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WATTBLOCK

NABERS for Apartments

Review Report

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NABERS for Apartments Review Report

Written for the NSW Department of the Environment and Energy

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Gate 2, High St, UNSW, 2052

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Executive Summary

NABERS for Apartments was announced to be part of the Australian National Energy Productivity Plan in August 2016. In addition to helping increase efficiency and lowering environmental impact, ratings systems have been shown to provide benefits to those that participate.

Wattblock's "Virtual Energy Assessments" project has shown that there is a huge potential in energy savings in Sydney city alone. NABERS for Apartments will greatly aid in the achievement of these potential savings. Even so, the main stakeholders of such a program, the tripartite (strata managers, owner-investors and tenants), have different agendas and will have to be incentivised in different ways. The strata stakeholder map by Easthope *et al.* (2016) will aid in the design of such a program.

An effort will have to be undertaken to educate strata managers about NABERS for Apartments so that they will be able to teach Owners Corporations about the program. This can be done through an education platform, which should cater to both strata and non-strata (e.g., condo owners) parties. To emulate the success of the Energy Performance Certificate in the EU, NABERS for Apartments should be implemented as a mandatory measure, but spread out in stages.

The ratings system should be designed in a way that ensures easy understanding by laypeople as well as people in industry. The ratings system may be separated into common areas and apartments. However, a rating with both areas combined may give buyers of the individual apartments a clearer picture of the efficiency of the building and apartment.

Other factors to be considered include the age and size of the residential buildings, and whether the buildings are mixed used. The size of a building greatly affects the types of amenities offered and thus the distribution of energy use. Older buildings may not have efficiency measures put in place during development, meaning that retrofits will have to be undertaken. Meanwhile, new developments will have greater incentive to improve building efficiency if NABERS for Apartments is mandatory.

High, mid and low rise buildings have different energy use distributions and may need to be accommodated separately, e.g., with separate ratings depending on the size of the building. However, before a ratings assessment is done, basic health requirements will have to be met as a baseline, e.g., ensuring all important ventilation fans are left on even if a carbon monoxide sensor is not installed.

When it comes to assessment software, NABERS should avoid giving monopoly to one particular company to ensure increased accuracy and healthy competition. A paywall to access of NABERS for Apartment ratings will defeat the purpose of the program being a public instrument to increase awareness about building sustainability. Thus, the ratings should be freely available to the public.

Currently, there are few examples of distributed or decentralised energy generation (e.g., solar PV for apartments) in strata buildings due to the complexity of implementation. Including distributed generation in the ratings may help incentivise uptake of such technologies.

NABERS only targets the day-to-day operation of stratas and does not encourage sustainability over the lifetime of a building. However, a life cycle approach to assessment, e.g., the SWITCH-Asia China project, will encourage a holistic approach to building design and promote the use of sustainable and recycled building materials.

Successful implementation of NABERS for Apartments will allow for greater opportunities to grow the green building market and establish Australia as global leader in green building standards. Therefore, it is paramount for NABERS to consult with people in the industry to ensure the success of the program.

Contents

Glossary

ABCB - Australian Building Codes Board

AEMC - Australian Energy Market Commission

AGM - Annual General Meeting

BASIX - Building and Sustainability Index

CBD - Central Business District

CSIRO - Commonwealth Scientific and Industrial Research Organisation (Australian)

DOE - Department of Energy (US government department)

DSM - Demand Side Management

EPBD - Energy Performance of Buildings Directive

EPC - Energy Performance Certificate

ESC - Energy Savings Certificate

ESCO - Energy Service Company

EU - European Union

EV - Electric Vehicle

GHG - Greenhouse Gas (emissions) (CO_2-equivalent emissions)

HEER - Home Energy Efficiency Retrofits

HERS - Home Energy Rating System

HVAC - Heating, Ventilation and Air Conditioning

IPART - Independent Pricing And Regulatory Tribunal (NSW)

LCA - Life Cycle Assessment/Analysis

MEPS - Minimum Energy Performance Standards

NABERS - National Australian Built Environment Rating System

NatHERS - The Nationwide House Energy Rating Scheme

NEPP - National Energy Productivity Plan

NMI - National Metering Identifier

NSW - New South Wales

OC – Owners Corporation

OCN - Owners Corporation Network (NSW)

PPA - Power Purchase Agreement

Solar PV - Solar Photovoltaics

ToU - Time of Use

UK - United Kingdom

US - United States of America

Metrics

kWh - kilowatt hour

Low rise - 1-3 storeys

Mid rise - 4-8 storeys

High rise - 9+ storeys

City of Sydney is the name of the Sydney local government.

1. Background

1.1 Introduction

In Australia, electricity prices have soared over the past few years due to growth in peak demand and gold-plating in network infrastructure incentivised by regulatory arrangements (Young *et al.*,2015). Buildings use 40% of the world's energy, and with high energy prices in Australia there is a growing need for buildings to become more energy efficient in an effort to reduce costs (NSW Office of Environment and Heritage, 2016a). Government action in the form of the Building and Sustainability Index (BASIX) and the National Australian Built Environment Rating System (NABERS) has arisen within the past two decades and contributed to improving the economy and people's lives through energy use reduction. High retail energy prices in Australia provide much better payback periods for energy efficient products compared to other developed countries, where energy costs are lower (Mark Intell, 2016). Figure 1 compares the increase in Australian residential electricity costs over 6 years from 2007 to 2013 to other countries around the world; illustrating how prices in Australia have increased the most.

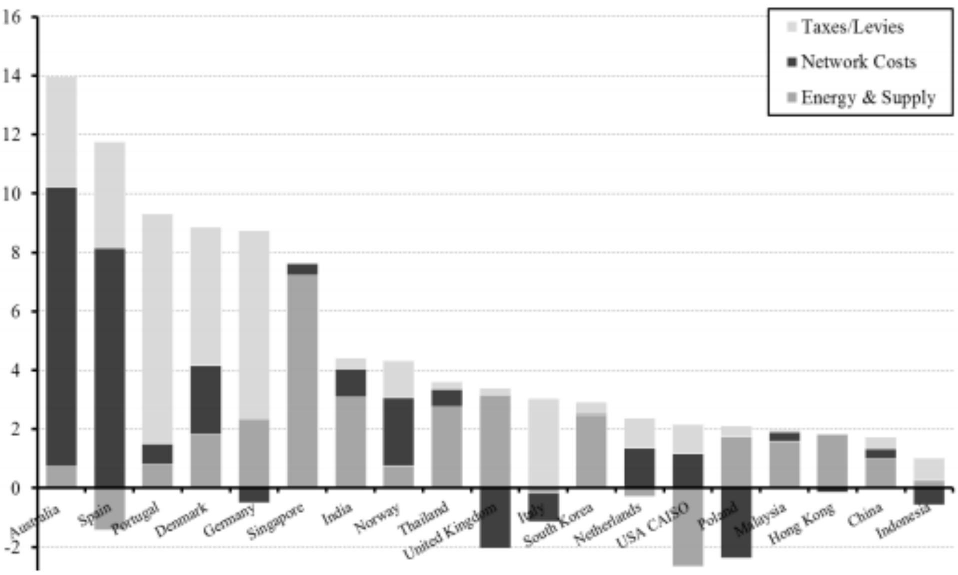

Figure 1: Residential tariff change 2007-2013 in Australian cents per kWh (Nelson, 2015)

In 2000, NABERS was founded as a building energy efficiency rating policy. Through this program, annual building energy use and carbon emissions intensity have been reduced in office buildings across Australia, while the drive for energy and water efficient buildings has increased (NSW Office of Environment and Heritage, 2016a). As shown in Figure 2 below, there are currently four NABERS rating tools that cover five types of buildings, with a sixth area of improvement for public hospitals currently in testing. Unfortunately, NABERS is yet to cover residential apartment buildings, which is the main focus of this whitepaper.

OFFICES	SHOPPING CENTRES	HOTELS	HOMES	DATA CENTRES
Energy	Energy	Energy	Energy	Energy
Water	Water	Water	Water	
Waste				
Indoor Environment				

Figure 2: The current NABERS rating tools (NSW Office of Environment and Heritage, 2016a)

NABERS for Apartments was announced to be part of the Australian National Energy Productivity Plan (NEPP) in August 2016. The NEPP has the goal of achieving a 40% productivity increase by 2030 through energy efficiency, energy market reform and climate change policy (Department of Industry, Innovation and Science, 2015). NABERS for apartments will cover both energy and water with capacity to expand to waste and the indoor environment. This helps enhance energy productivity and realisation of the City of Sydney's 100% local electricity generation and 70% emissions reduction targets by 2030 (City of Sydney, 2016a).

1.2. NABERS for Apartments Comparative Analysis

Buildings that are audited for NABERS are awarded a number of stars from 1 to 6 depending on how the building performs in the selected areas of assessment, shown in Figure 2 above. A higher star rating indicates that a given building performs better when compared to other buildings of the same class. Each building assessment uses the previous 12 months of data on the building's energy and water use and is valid for one year (NSW Office of Environment and Heritage, 2016a). NABERS was initially designed with 5 stars, which was later increased to 6. It has further room to increase to 7 stars for carbon neutral buildings and 7.5 and above for carbon negative buildings, i.e., buildings that sequester carbon emissions at a rate greater than any emissions they may produce (Bannister, 2016).

Australia has a varied climate with different climate zones and a similar variance in appliances and building styles to suit the location. For example, Melbourne buildings have more space heating compared Brisbane buildings. There are 8 climate zones across Australia outlined by the Australian Building Codes Board (ABCB) ranging from high humidity summer and warm winter (zone 1) to alpine (zone 8) as shown in Figure 3. These climate zones are used in NABERS to fairly assess the performance of a building for comparison with similar rated building types in that zone (NSW Office of Environment and Heritage, 2016a).

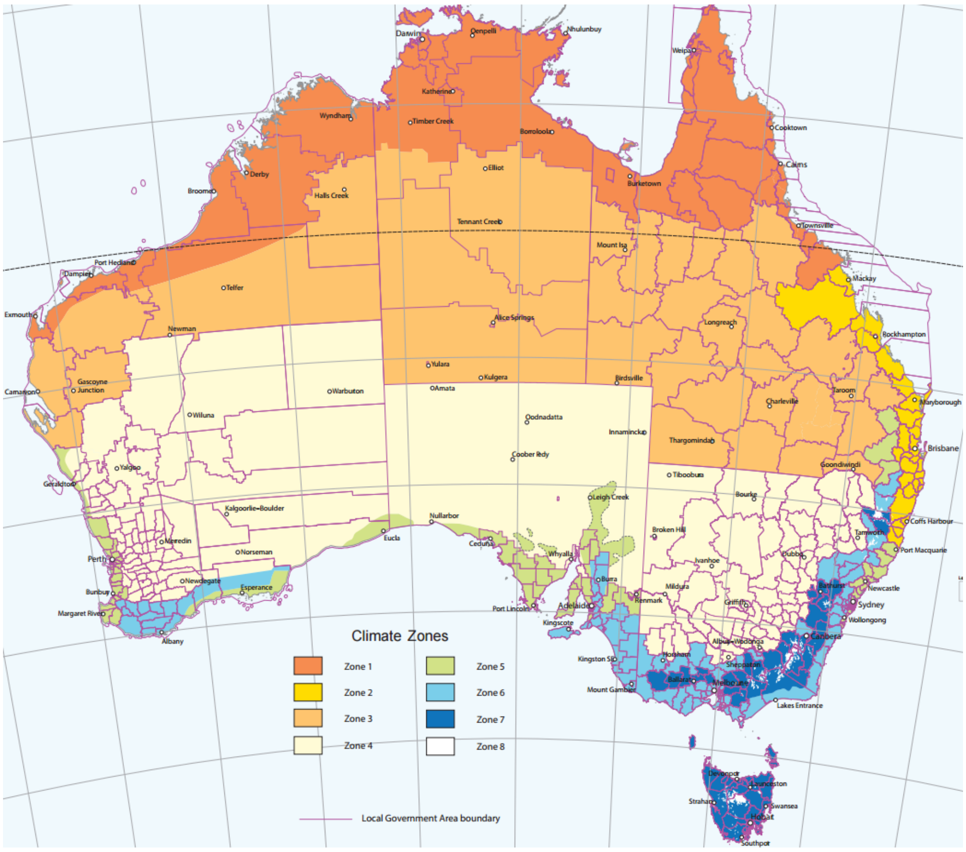

Figure 3: Climate zones Australia (Australian Building Codes Board, 2016)

1.2.1 Existing National Bodies

A summary of several existing ratings bodies are outlined in this section, which includes rating methods and some results from their programs.

1.2.1.1 BASIX and NatHERS

BASIX was introduced in the Sydney metropolitan area in 2004 as a mandatory building code, expanding until 2009 to all of New South Wales (NSW) and covers all residential building types (NSW Government, 2016a). It regulates minimum energy performance standards (MEPS) for residential buildings to improve the sustainability of Australian homes across NSW. The NSW Department of Planning and Environment wants to improve the mandatory BASIX benchmarks for new residential buildings to further reduce energy and water use (City of Sydney, 2015).

The Nationwide House Energy Rating Scheme (NatHERS) was initiated in 1993 by the federal government to rate the thermal performance of Australian homes. It is based on CSIRO modelling software that is still being continually improved (Department of the Environment and Energy, 2015). Accreditors require a cert IV in NatHERS Assessment to rate houses across Australia and can use the software to certify buildings under BASIX in NSW (Department of the Environment and Energy, 2016). NatHERS has historically focused on building materials, climate and orientation to reduce energy use and improve comfort. Recently it has been expanding its rating scheme to include energy and water assessments and indoor comfort levels (Chandra, 2016).

Collaborating with CSIRO and the accredited software developers involved in NatHERS would be beneficial in developing these thermal tools for other sectors covered by NABERS. Having multiple rating systems for building sustainability will confuse those involved and waste money in the process of their development and application; in the bureaucratic sector of strata schemes this would be disastrous. This would hamper the aspiration of NABERS to become an effective national and international sustainability rating tool.

1.2.3 International Bodies

<u>1.2.3.1. European Union</u>

Property listed for sale or rent within the European Union (EU) member states must disclose their Energy Performance Certificate (EPC) ratings under the Energy Performance of Buildings Directive (EPBD) (Ries *et al.*, 2009). Companies certified to perform assessments on buildings sell their services to building owners to produce these EPCs. EPCs assess the energy use of a building on a per m^2 basis and its environmental impact rating. To create an EPC, a Standard Assessment Procedure rates the energy efficiency and environmental impact of a building in bands from A to G. Figure 4 displays a UK example which divides a scale from 1 to 100 across the A-G bands, with 100 being the least energy/carbon intensive rating achievable. The EPC also displays the current and potential ratings of a building, which shows the effectiveness of a building retrofit to be more energy efficient. Other EU member countries may use different units within each band, e.g., France uses kWh and kg values instead of a scale of 100, but the lettered bands remain the same (Mudgal *et al.*, 2013).

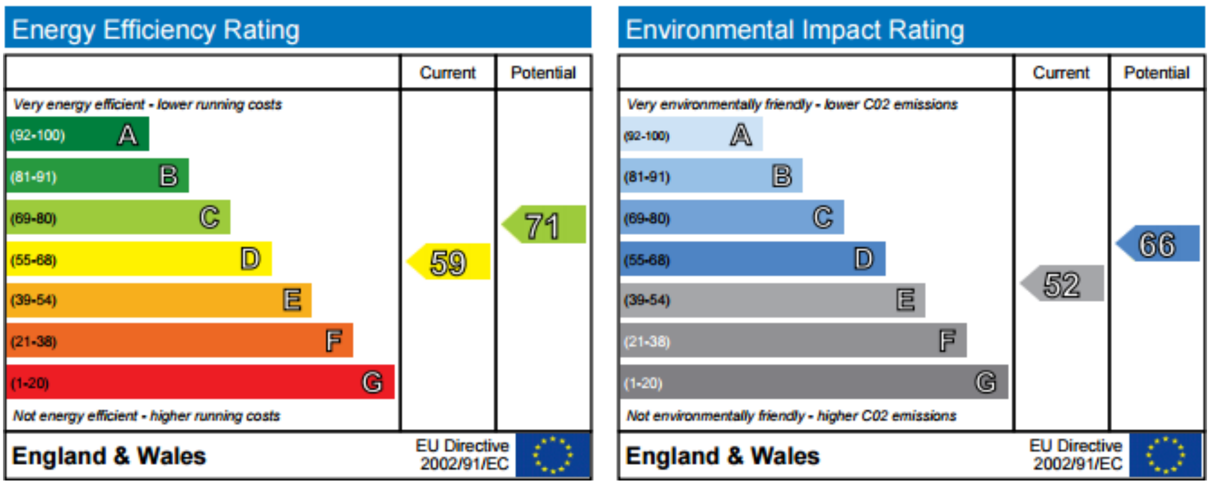

Figure 4: UK EPC example (Energy Key, 2016)

The effects of EPCs on property and rent prices across several EU countries “overwhelmingly points to energy efficiency being rewarded” through increased property value and reduced energy costs (Mudgal *et al.*, 2013). Figure 5 shows the percentage increase in property value separated into sale prices and rent rates for each assessed region. There was an overall increase in property sale and rent prices from the display of EPC ratings. This negative result for Oxford may have been caused by either the small sample size of only 236 buildings compared to the other regions or the exclusion of building age from the assessments.

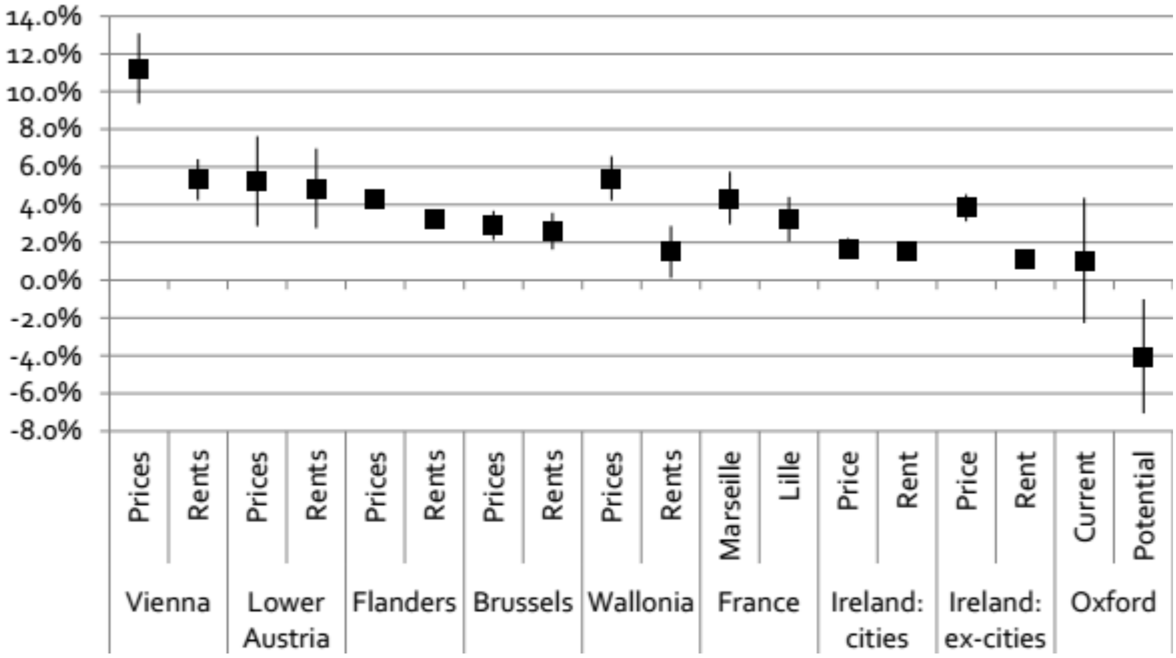

Figure 5: Effect of one-letter or equivalent improvement in EPC rating across European property markets (95% confidence interval shown) (Mudgal *et al.*, 2013)

1.2.3.2. Shenzhen and Sichuan in China

SWITCH-Asia is an EU led and funded program to improve economic development in Asia. The Low Energy Housing project trialled in Shenzhen and Sichuan by SWITCH-Asia aimed to improve the energy efficiency of new buildings. The aim of the project was to improve communication and transparency between the Chinese government and real estate developers, and educate the public about building sustainability (SWITCH-Asia, 2015). This was achieved through three means: raising minimum energy performance standards (MEPS), providing publicity and subsidies to developers for energy efficient housing construction, and advertisement of multiple benefits through a life-cycle costs concept. The program resulted in 67 PJ of energy saved, 420,000 tonnes of greenhouse gas (GHG) emissions abated and €210 million saved on energy costs. There was also an increased share of sustainable buildings in Sichuan from 4.2% to 16.6% and in Shenzhen from 22.3% to 39.5% by 2014 from a 2010 baseline. This was achieved through improved recycling of building materials and reducing GHG emissions and toxic materials used in production and construction alongside the building energy efficiency improvements. This program did not cover retrofitting however, so current buildings which make up the majority of China's built environment may follow suit later. This will likely be achieved through legislative changes by the federal or regional governments and may be a likely candidate for a rating system like NABERS.

1.2.3.3 United States of America

The Energy Star Agreement between the US and EU is an agreement for the existence of a voluntary program in the US called Energy Star. It has been operational for 20 years and is run by the Environment Protection Agency (EPA) and Department of Energy (DOE). It covers many sectors including houses, industry and residential stratas (Energy Star, 2016). The current Energy Star Agreement expires in February 2018, but it should be renewed again by the US as has been the case in the past (European Commission, 2016). The Energy Star Certified New Homes program is part of the Energy Star program and involves newly built houses that use 15-30% less energy than the MEPS, depending on state regulations. They are sold with Energy Star certified appliances installed and maximise occupant comfort through proper insulation, HVAC control and building design. It allows for Energy Efficient Mortgages which improve a buyer's purchasing power by adding energy cost savings to the borrower's income and are available to all Energy Star certified home buyers. Certification can only be done for houses, apartments and condos that have been built under the scheme. However, Energy Star offers homeowners an energy saving actions pledge which grants access to their other services. These services include a home assessment and the selling and installation of insulation and energy or water efficient appliances to homeowners and tenants (Energy Star, 2016). The Energy Star program does not currently have a rating system and is entirely voluntary, but the program has room for improvement. One such attempt at improvement by the Florida state government is the Home Energy Rating System (HERS) which works alongside the Energy Star Certified New Homes program, making all benefits available to those who volunteer (Florida Solar Energy Center, 2016). Figure 6 shows the HERS Index for an example home which rates a current house at 65 to the market standard of 100, with a rating of 0 meaning a net-zero energy use building according to grid usage.

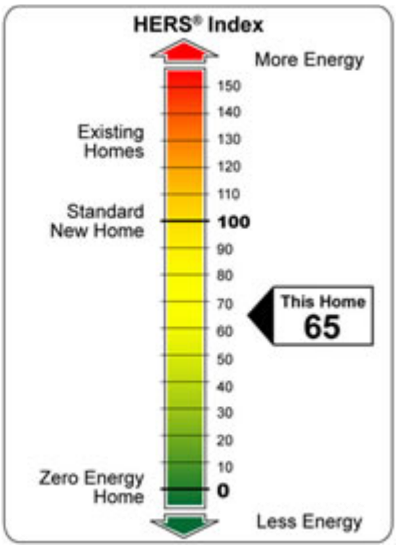

Figure 6: HERS standardised index example (Florida Solar Energy Center, 2016)

In the US, Energy Star Certified New Homes reached an average of 9.74% market penetration throughout the country in 2015, with the highest market penetration of 48.94% in Arizona and lowest in 15 states with <1% (US EPA, US DOE, 2015).

1.3 Summary

In addition to helping increase efficiency and lowering environmental impact, ratings systems have been shown to provide benefits to those that participate. These rewards include savings from increased efficiency and higher property prices for participants. It would be prudent to take into account the successes and failure of existing ratings systems when designing NABERS for Apartments.

2. Overview of The Strata Market

2.1. Stakeholder Engagement

Designing NABERS for Apartments will require engagement with the Owners Corporation Network (OCN), Strata Community Australia (SCA) (NSW) and advanced energy companies. This will greatly assist in creating a suitable way to address how NABERS for Apartments can be designed to be effectively rolled out in NSW and incentivise the uptake of energy and water efficiency in residential strata buildings. UNSW City Futures, through Easthope *et al.* (2016), has created a strata stakeholder map that can assist in choosing the stakeholders who could best assist NABERS on how to operate effectively. (https://cityfutures.be.unsw.edu.au/research/projects/strata-stakeholders/).

2.2. Virtual Energy Assessments Project

Wattblock undertook a "Virtual Energy Assessments" project in Sydney city, which was composed of 10 residential strata buildings and their energy use data to model energy savings possibilities (Wattblock, 2016a). The buildings were separated into low, mid and high rise categories and their common area use divided into its components of lighting, mechanical, HVAC, water, and leisure (further discussed in Section 6.1). The assessed ways to reduce energy use were Solar PV, energy tariff optimisation, efficiency, and microgrid billing savings which were divided into their effectiveness for the different building sizes in Figure 7. Microgrid billing for apartments reduced projected energy costs the most in mid and high rise buildings, and contributed significantly just behind energy efficiency in low rise buildings. How microgrids achieve these savings is addressed in Section 8.2.1. of this report.

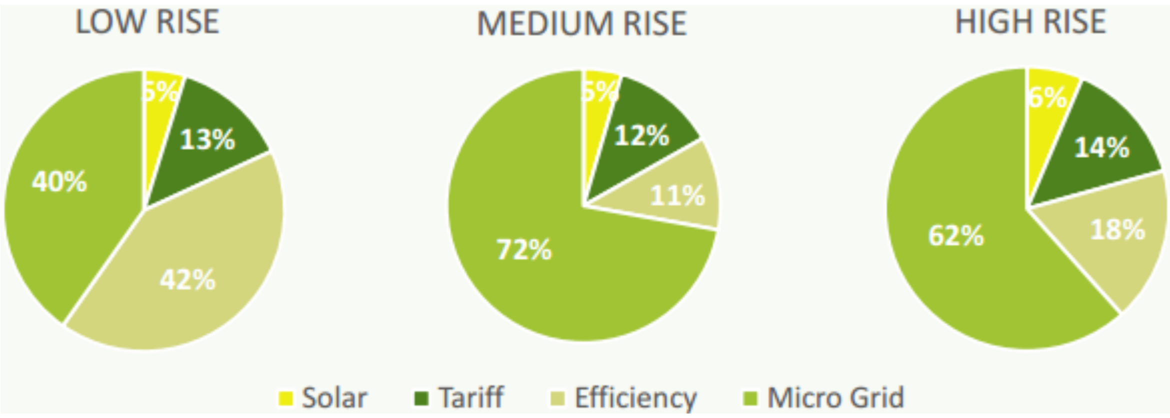

Figure 7: Energy cost reduction potential of residential strata buildings (Wattblock, 2016a)

The analysis results of the 10 buildings found an overall potential energy cost reduction of 45% with a 3.6 year simple payback and 68% GHG emissions abatement. These results were then extrapolated to reveal $25.4 million in potential energy savings and 393,000 tons of potential GHG emissions abatement annually throughout Sydney city. The emissions abatement is equivalent to removing 90,350 cars from Australian roads (Wattblock, 2016a).

2.3. Urban Distribution and Density

Australian cities are moving towards dense urban living, with the development and construction of residential high rise buildings increasing annually. For instance, 90% of all new dwellings built between 2011 and 2030 in the city of Sydney are projected to be high rise (City of Sydney, 2015). Figure 8 shows a 1km^2 grid of population density around Sydney and Melbourne in 2011 as a demonstration of how populations tend to cluster in cities. It can be assumed that high density living will continue to grow in Australian cities, continuing the trend of growing residential high rise building construction. This only emphasises the need for NABERS for Apartments to be successful in reducing energy and water use to reduce the strain on the environment and electricity networks. As population density increases in urban areas, the human-induced effects on the natural environment and electricity networks become more unsustainable and severe.

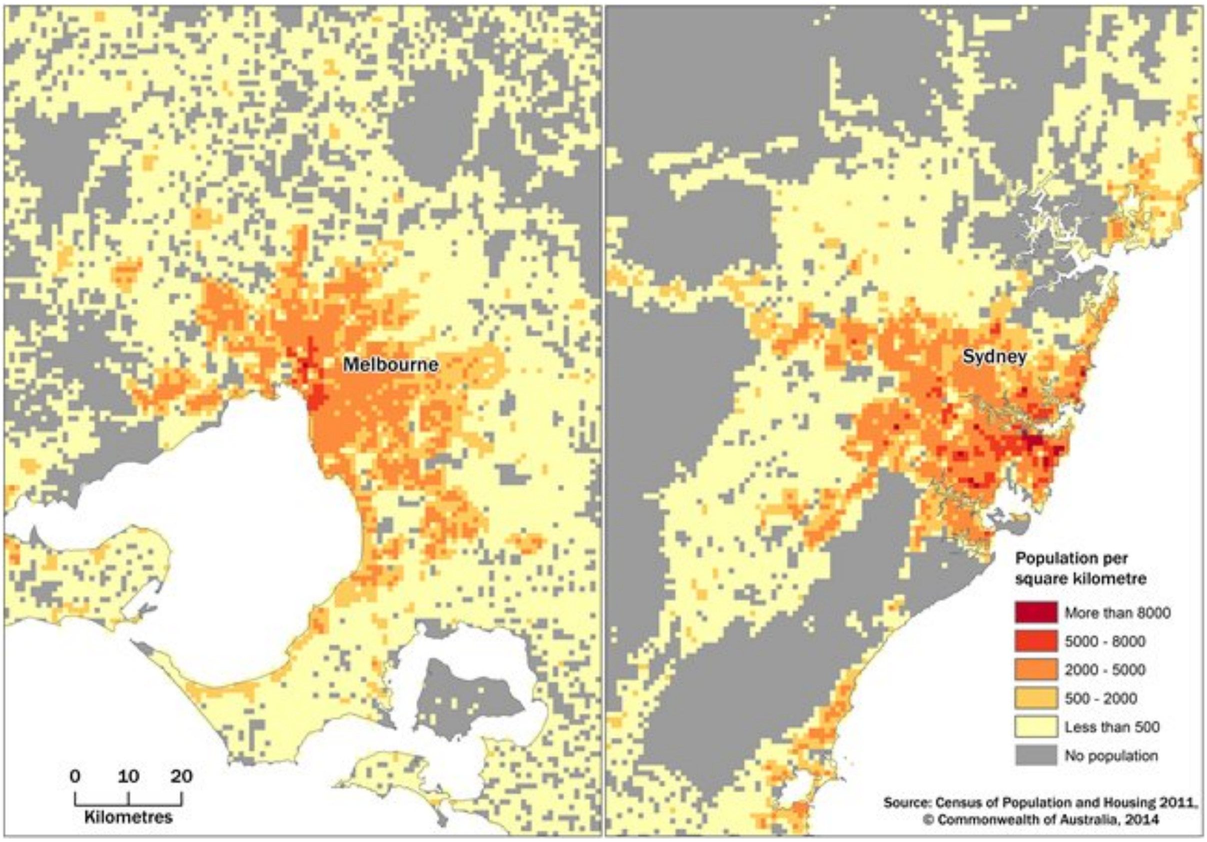

Figure 8: Population Density 1km² Grid August 2011 - Melbourne and Sydney (Australian Bureau of Statistics, 2014)

Australian urban areas tend to have low population density compared to other developed nations and unusually high city population density for the larger cities in comparison to their urban areas (Spencer *et al.*, 2015). This is reflected in the increasing rate of construction of high rise buildings and rising house prices within Australian capital cities. Figure 9 shows that Brisbane, Melbourne and Sydney have 98% to 79% of the population below 60 people per hectare respectively; while Vancouver, Montreal and London have 66% to 31% of the population of the same density. This means Australia will have to roll NABERS for Apartments out with specific regard to areas of low population density, allowing time for the energy and water building retrofit market to reach there. Sydney has both the highest population and percentage of total population in areas where population density is 400+ people per hectare (displayed as 'pph' in Figure 9). Melbourne has less than half London's population yet has thousands more people living in extremely high density areas. The extremely high density areas with high development rates would be the best places to test NABERS for Apartments as a mandatory rating.

Density range	Brisbane		Melbourne		Sydney		Vancouver		Montreal		London	
pph	Pop'n	%	Pop'n	%	Pop'n	%	Pop'n	%	Pop'n	%	Pop'n	%
0 – 4	236,503		201,433		190,019		114,942		252,097		34,293	
4 – 30	1,367,200	75%	2,103,287	55%	1,593,636	38%	637,334	29%	1,046,611	29%	731,761	9%
30 – 60	423,223	23%	1,468,669	39%	1,724,258	41%	821,987	37%	1,152,793	32%	1,758,539	22%
60 – 100	29,361	2%	161,652	4%	442,269	11%	400,469	18%	530,177	15%	2,332,275	29%
100 - 200	7,230	0%	37,692	1%	343,992	8%	238,322	11%	672,124	19%	2,836,892	35%
200 - 400	2,707	0%	18,339	0%	70,587	2%	84,854	4%	149,776	4%	473,224	6%
400+	436	0%	9,243	0%	26,453	1%	15,420	1%	20,643	1%	6,957	0%
TOTAL (>4 pph)	1,830,157		3,798,882		4,201,195		2,198,386		3,572,124		8,139,648	

Note: in some instances % totals do not add to 100% due to rounding.

Figure 9: Population by density thresholds (Coffee, Lange, & Baker, 2016)

2.3.1. Urban Heat Island Effect

A major issue in cities and urban areas is the urban heat island effect. It is caused by a high concentration of heat-absorbing surfaces such as roads and concrete as well as heat emissions from transport and air conditioners. These can increase average temperatures by 1-3°C and cause evening temperatures to be up to 12°C higher compared to less developed areas. The warmer temperatures increase community energy use by 5-10% due to increased cooling needs which can be greatly exacerbated by heatwaves. The urban heat island effect affects the environment outside developed areas by increasing the rain runoff temperature that reaches rivers and oceans. In addition to this, increased air pollutants and greenhouse gas emissions through higher energy use negatively affect many ecosystems and human health (US Environmental Protection Agency, 2016). The effects of high temperatures on power demand for a high rise apartment complex are demonstrated in Figure 10. The red top line shows a large peak in the afternoon is when people return home from work and turn their air conditioners on during a 37°C day. Comparatively, the blue bottom line shows a milder 23°C day which does not have the same afternoon peak resulting from air-conditioner use. This is mirrored in most other mid and high rise buildings, adding to the need for the high network capacity which has driven Australian electricity prices up.

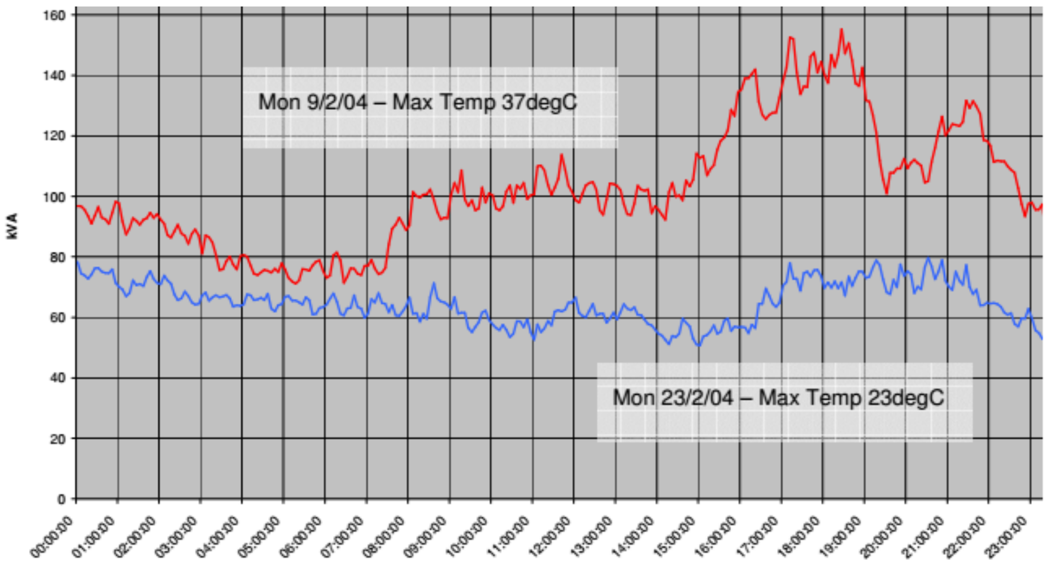

Figure 10: Daily peak demand vs maximum ambient temperature (Myors et al., 2005)

There are two immediate methods for reducing the heat island effect. The first is by using materials that reflect heat and sunlight to improve water evaporation on roofs and paved areas, while the second is by increasing vegetation coverage in developed areas. The benefits of increasing vegetation coverage in developed areas include reduced temperatures through evapotranspiration and shading, improved air quality and population wellbeing, and the ability to grow food locally (US Environmental Protection Agency, 2016). The NSW government has aims to increase tree canopy coverage in exposed suburbs and regional towns, and the Lord Mayor of Sydney has pushed for a 50% increase in canopy coverage throughout Sydney city (NSW Office of Environment and Heritage, 2016b; City of Sydney, 2016b).

The Living Buildings Challenge, run by the International Living Future Institute, is one such initiative for sustainable living that includes 'biophilic design' for buildings to become more sustainable with the use of plants. Biophilic design offers an array of psychological benefits such as stress reduction, improved cognitive performance, and more positive moods (Sturgeon, 2016). There are already buildings in cities that have 'biophilic design' in the form of external gardens; a prominent Australian example is Sydney's own One Central Park. One Central Park uses recycled water for irrigation and other household activities that do not involve ingestion, and has a trigeneration plant that uses natural gas to supply heating, cooling and electricity to the building (One Central Park, 2016). To make Sydney and other cities more sustainable, vegetation on and around buildings should be incentivised. Plants should be watered in the early hours of the morning to minimise wasted water through evaporation and wasted energy to compensate for having to pump more water. The water used should be rainwater, greywater or both to achieve a high NABERS for Apartments water rating.

Gardens are currently an externality that can be counted as a carbon offset through their macro benefits to the surrounding environment. These macro benefits should be reflected in one of the NABERS ratings in order to incentivise their uptake. The benefits are very difficult to quantify so adding a half-star to the energy rating for sustainable rooftop and other external gardens was suggested by Phelan (2016), an ex-NABERS assessor. NABERS energy ratings are based on CO_2 output per square metre, which external gardens will reduce when designed sustainably (Bannister, 2016; NSW Office of Environment and Heritage, 2016a).

2.4. Strata Portfolio Assessment

A strata portfolio comprises all the strata buildings and their data under the management of a strata manager. NABERS for Apartments will add value to portfolios by including water and energy efficiency data in the ratings for each building. Portfolios can consist of hundreds of buildings with a total cost of energy in the tens of millions of dollars. The average potential energy cost savings for residential strata buildings in Sydney is 40% for common areas and apartments combined, showing that there's $9 million in potential savings readily available in some strata portfolios across Australia (Wattblock, 2016b).

2.5. Potential Impact Assessment

2.5.1. Market Behaviour

Theoretically, typical market behaviour will trend towards the point of least-cost as depicted by the graph in Figure 11, which shows the combined cost (thick blue line) of loan repayments (thin blue line) and energy costs (thin red line) as energy efficiency is improved towards the right of the graph. The more the energy performance of a building is improved, the larger the loan will have to be to cover capital costs. This rate of increase in the capital cost is faster than the savings from reduced energy use increase with the upgrades, resulting in a point of minimum cost pointed out by the blue arrow in Figure 11. This, however, is not the case for most strata schemes in Australia which experience market failure in this area.

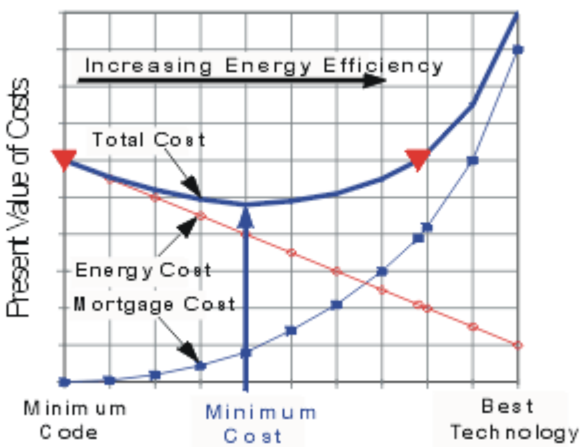

Figure 11: Florida home mortgage-energy cost curve (Florida Solar Energy Center, 2016)

In the property development market there is little drive for water or energy efficiency due to a lack of transparency and understanding. Property developers tend to build a strata scheme at the minimum BASIX (or equivalent) requirements to minimise development costs as much as possible. The developers then sell the property at whatever the going market rate is, which tends to be independent of the building's energy and water performance (Easthope, 2016). NABERS for Apartments should aim to improve the transparency of current property development practices and educate potential property buyers about the costs associated with the energy performance of buildings. The rating system should improve transparency, affecting the market for property developers through property valuations. This, alongside BASIX improvements, should address the market failure in property development as NABERS is implemented, just as similar systems have done in Shenzhen and Sichuan and across Europe (SWITCH-Asia, 2015; Mudgal *et al.*, 2013).

2.5.2. Investment Costs

Figure 12 shows that insulation, lighting, HVAC and appliance retrofits are a positive net investment both in retrofitting and new buildings, meaning they effectively save more money than they cost. New building energy efficiency improvements over minimum standards also have positive investment returns. This shows that the financial case of energy efficiency is not a barrier to investment and implementation in the residential strata sector. Figure 12 is a European cost curve for GHG emissions reduction, so some parts may be slightly different to Australia, e.g., the lighting savings. The MEPS in Australia were modified to phase out incandescent lighting in place of fluorescent lighting, making GHG emissions abatement for lighting lower in Australia than in Europe.

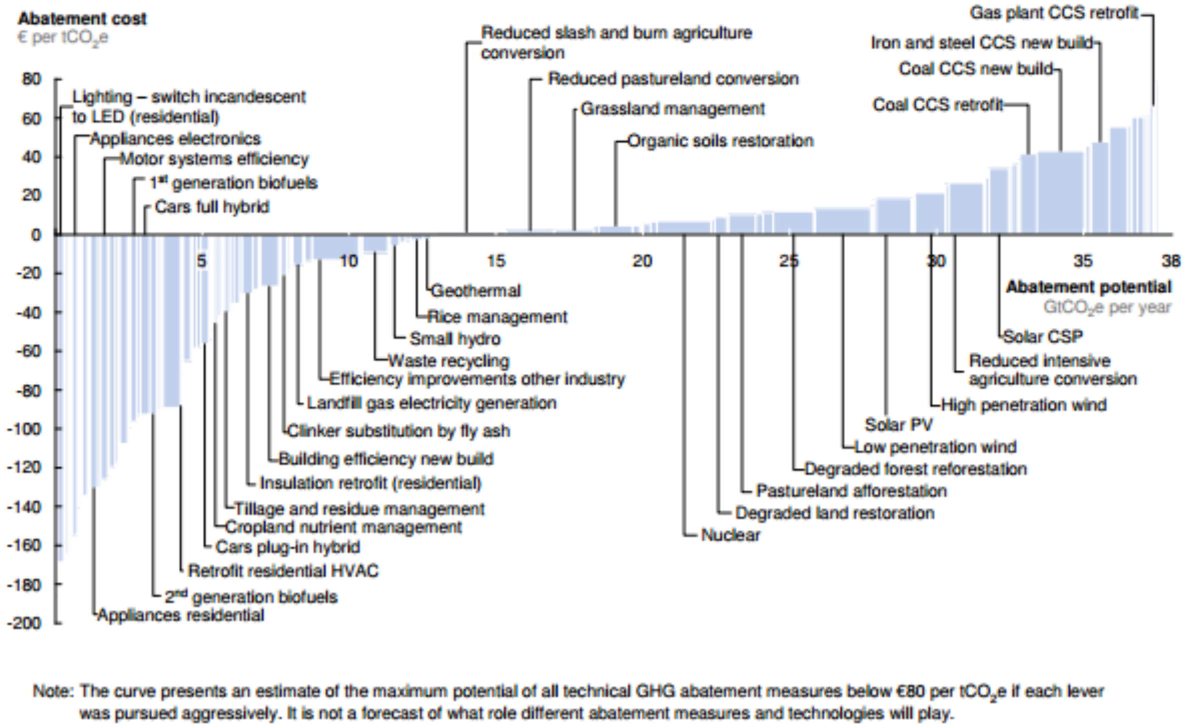

Figure 12: Global GHG Abatement Cost Curve 2030 v2.1. (Enkvist *et al.*, 2010)

From the analysis done by Myors *et al.* (2005), simple payback for energy efficiency retrofitting in residential apartment buildings is well under half the economic lifetime of a strata building's 10-year capital works fund plan (NSW Government, 2016b). This is shown in Figure 13, where building retrofits are economically viable for Owners Corporations (OCs). This also reinforces the fact that smaller buildings can have their common areas retrofitted for a low cost with a short payback. High rise retrofits and new development are more expensive, ranging from $1150 to $2150 per apartment, but have simple paybacks within 5 years. This concludes that the cost of retrofits and energy efficiency changes to new development are not a barrier in this case; this should reflect average real-world operations and costs.

		New buildings		Building retrofits		
		Mid-rise	High-rise	Low-rise	Mid-rise	High-rise
# of storeys		5	20	3	5	20
# of apartments		24	127	12	24	127
Area per apartment	m^2	136	141	136	136	141
Total floor area	m^2	3264	17907	1632	3264	17907
Costs	$	$50,000	$273,000	$2,000	$7,000	$147,000
Electricity savings	MWh/yr	48	265	5	17	218
Gas savings	GJ/yr	86	469	0	6	109
Energy bill savings	$/yr	$11,000	$61,000	$1,000	$4,000	$46,000
Simple payback	**yr**	**4.5**	**4.5**	**2.0**	**1.8**	**3.1**
NPV	**$**	**$25,476**	**$145,270**	**$4,695**	**$19,714**	**$168,304**
IRR	**% p.a.**	**18%**	**18%**	**49%**	**56%**	**30%**

Figure 13: Energy efficiency projects in residential strata buildings (Clark, 2015)

2.6 Summary and Recommendations

The main stakeholders of a program like NABERS for Apartments will be the strata market. The strata stakeholder map by Easthope *et al.* (2016) will aid in the design of such a program. Through Wattblock's "Virtual Energy Assessments" project, it was found that there is a huge potential in energy savings in Sydney city alone. This will be aided greatly by NABERS for Apartments, which should also aim to improve the transparency of current property development practices and educate potential property buyers about the associated costs of building energy performance. Strata managers may also benefit from NABERS for Apartments by including water and energy efficiency data in their portfolios.

3. Engaging with Residential Apartment Complexes

Residential apartment units may be run by strata or be condominiums that are non-strata. There are several ways to engage with both and incentivise uptake of NABERS for Apartments, which will greatly aid in the success of the program.

3.1. Current Challenges Facing Strata

In order to engage with residential apartment complexes, it is important to understand the current challenges faced by strata. This includes the compliance burden for strata managers, cost of implementation to strata management, and existing communication issues within strata.

3.1.1. Compliance Burden for Strata Managers

Strata managers have a lot of regulations for each building in their portfolio, ranging from mandatory child safety locks on windows to addressing smoking complaints and debt collection. The NSW government has brought in major legislative changes as of the 1st of December 2016 (NSW Government, 2015a), causing a lot of worry for NSW strata managers. 70% of NSW and half that for Western Australian strata businesses state that legislation is their biggest issue in the future, compared to less than 27% in Victoria and Queensland (Macquarie Bank, 2016). Strata managers have to adapt each property in their portfolio whenever there is a change in legislation. This could use up more time than some strata managers can manage. For example, 350 process changes were made in 2017 (NSW Government, 2015a, 2015b, 2016b). NABERS for Apartments will become yet another compliance burden for strata managers, putting yet more stress on strata management businesses. This could be a crippling issue for less profitable strata management businesses which are already under a lot of pressure to keep up with the market (Macquarie Bank, 2016).

3.1.2. NABERS Cost to Strata Management Companies

Strata management businesses are digitising their accumulated data from strata buildings in an effort to compete with other businesses and prepare for the future. This is an expensive endeavour and lower profit businesses behind the technology curve are investing much more than their high profit competitors, shown below in Figure 14. High profit companies are those with greater than 30% profit margins and lower profit companies have profit margins which are below 30% (Macquarie Bank, 2016). NABERS may exacerbate the problem by increasing the need for more data storage and management systems with no compensation for the extra resources used in the upgrades. Despite the costs, strata management companies are improving their ability to store and manage data effectively meaning this digitisation should reduce the investment required when NABERS for Apartments is introduced.

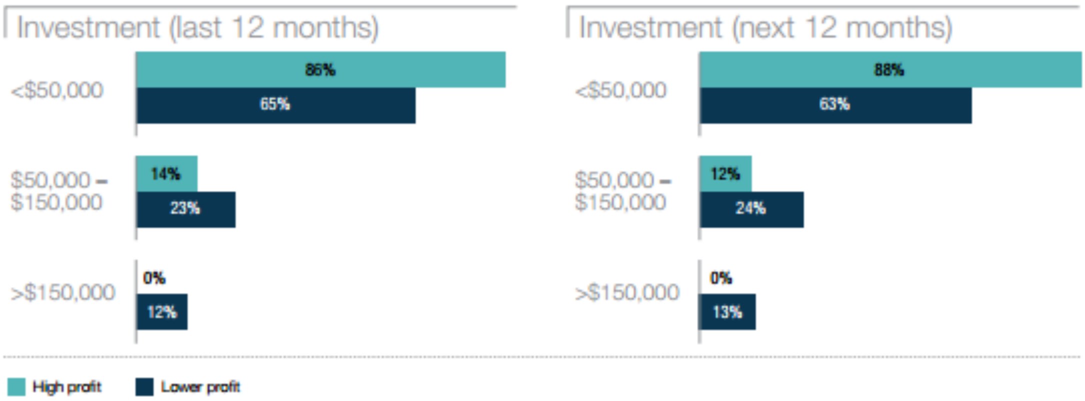

Figure 14: Lower profit firms invest for growth (Macquarie Bank, 2016)

3.1.3. Communication Challenges

Communication in a residential strata building between the strata manager, strata committee and (OC) Corporation can take months and be mired in regulation, especially in the case of large projects. Changes to the strata scheme management act were made by the NSW Government (2015a, 2015b, 2016b) to help with the issue of delay in implementing large projects and the modifying or replacement of existing developments entirely. Demolishing or structurally upgrading buildings now only requires 75% owner compliance, down from a unanimous vote, and strata committee members can vote from afar via email, exempting AGM issues. Strata committees and OCs can be quite diverse, making communication inherently difficult between members at times. Reducing this and the regulatory burden through changes to the Strata Schemes Management Act should continue to occur as they already have been.

Strata managers strongly believe that responding quickly to client requests is critical for success(Macquarie Bank, 2016). Strata managers tend to be overworked however and may not be able to respond quickly to communication from strata committees and other parties. The introduction of NABERS for Apartments may worsen the issue if its compliance burdens are too great and if audits require any form of rapid response from strata committees.

3.2. Opportunities for Strata and Managers

Streamlining NABERS for Apartments into other processes can improve its effectiveness and ease of uptake by strata managers. NABERS assessments must be re-done annually to keep ratings up to date, which could be included in the process of bulk buying of electricity to reduce the administrative load on strata managers. Strata managers will benefit from digitising their past and present utility bills, making it easier to manage and submit them to NABERS assessors. In doing this, data is kept in corporate memory in an easy-to-access manner in case a strata building changes strata managers and/or management companies. This will reduce the extra workload put on strata managers by NABERS and enable operational efficiencies to be realised.

NABERS for Apartments will also bring greater incentive for OCs to take action on energy and water efficiency projects that have been delayed over other matters, or only made it to the investigation phase. Having the common areas in a building assessed and rated for their energy and water performance will bring energy and water efficiency into strata committee meetings. Appropriate online tools for involved parties will further enable the strata committee to take action to reduce their common area bills and improve their NABERS rating. Bringing the discussion of energy and water efficiency into the strata committee's agenda will also raise awareness of the issue for other apartment buildings and households through word of mouth.

3.3. Non-Strata Residential Apartment Buildings

Non-strata residential apartment buildings, better known as condos, are becoming more prevalent in Sydney. This is due to it becoming easier and less costly for developers to own an entire building and rent it out rather than sell individual units to investors (Easthope, 2016). Incentivising energy and water efficiency is easier in condos than in stratas because there is no OC or strata manager to operate through, only the building owner. The method of incentivising condo owners is the same as stratas, i.e., make energy and water efficiency projects easier to do, make them cost efficient and make NABERS ratings mandatory on posting of apartments for rent.

3.4. Incentives for the Tripartite

The agendas of strata managers, owner-investors and tenants are quite different from one another. Tenants rent housing from owner-investors and want lower ongoing costs but don't have direct authority to modify their residence. Owner-investors own but do not live in apartments; they want lower strata levies and fewer complaints but have little interest in energy use and sometimes water use. This disinterest occurs when the tenant pays the bills for energy or water use, removing the burden from the owner-investor. Strata managers assist in managing the legal legwork for stratas and want minimal work while keeping customers happy. Other involved parties are building managers and owner occupiers,. Building managers want to keep the building operating with minimal costs, while owner occupiers have the interests of tenants and owner investors combined. Tenants will have the highest incentive for a highNABERS rating due to the benefits that they receive, such as lower ongoing costs and better comfort.

3.4.1. Strata Managers

Strata managers will be against having more administrative issues brought forth by NABERS if there is no revenue stream to make up for it. Following the footsteps of insurance companies, which pay a direct commission to strata managers, NABERS should allow for strata managers to receive a commission on ratings and/or retrofits to incentivise energy and water efficiency. The strata manager commissions scheme should follow similar rules to the strata insurance companies. This includes allowing strata committees to outsource NABERS assessments and retrofits to strata managers or deal with advanced energy companies directly. It should also allow strata committees to deny the receipt of commissions to the strata manager in place of fee-for-service work (CHU, 2015). AGM reports for strata buildings are mandatory and mostly address the issue of transparency. There are strata companies that will rebate the commissions they receive onto the OCs as they do with insurance commissions, so an hourly rate for service would work in place of a commission. The majority of strata managers would rather charge for their time rather than using a commission (Easthope, 2016), but a diversity of payment options may assist in garnering support from the strata management community.

3.4.2. Owner-investors

Owner-investors would be incentivised by more market competition through regulation to advertise the NABERS rating of apartments for rent, as outlined by NSW Office of Environment and Heritage (2016c). For this to be more effective, the NABERS rating should be displayed at the time of posting as discussed in Section 4.7., similar to the EU laws on property sales. This is because the rating-on-sale system in place is flawed due to the lack of transparency in what the tenant is renting (Ries *et al.*,, 2009).

Disincentives for owner-investors are caused by them having to organise and pay for apartment upgrades and there being a very fluid renter market in some areas. This means that it may be easier to replace tenants instead of enacting apartment upgrades. Small business contracts to manage projects of varying scale and easing the financial burden with government rebates will reduce the burden of capital costs. There are rebate options such as Energy Savings Certificates (ESCs), Victorian Energy Efficiency Target (VEET) scheme and South Australia's Retailer Energy Efficiency Scheme (REES). However, these government schemes may require improvements like expanding the REES to residential buildings or including other appliances in the 5-year ESCs model that lighting receives in NSW (IPART NSW, 2016). ESCs are currently more difficult to obtain than local government grants for smaller residential properties. This must be fixed if the NSW government wishes to use ESCs as an effective incentive. Covering insulation in the Home Energy Efficiency Retrofits (HEER) and similar schemes which are lacking should further incentivise energy efficiency for owner investors (NSW Office of Environment and Heritage, 2016d).

Regulatory requirements are another major barrier to entry for retrofit projects, and changing regulations is not always an option for state and local governments. In this case it would be best to create template forms that can be made available for a small fee to streamline the process of working through regulations. One such example is the regulations around installing Solar PV and battery storage on common strata that is available to apartments. This was an issue for the Stucco student cooperative that took more than a year to resolve when trying to install a system in the cooperative building (Hoh, 2016). Reducing the regulatory burden would significantly improve uptake of large-scale energy and water projects in residential strata buildings.

3.4.3. Funding Options

Large projects take a long time to make it through the strata management tree due to the cost and number of people involved in the process. The capital works fund is normally the first source of funding that is considered for major projects in common areas. The fund can be a barrier if other recent large investments were made from it or if the strata committee are conservative with their funds. Working through an advanced energy company can assist in pitching and organising large energy projects for the strata committee and open doors to other methods of funding that may be acceptable.

Energy Performance Contracting is another alternative to the capital works fund that operates by paying a company for what they install through a percentage of any energy cost savings made. This removes a lot of risk from the funding for the strata committee and assigns it to the contracted company.

An Environmental Upgrade Agreement (EUA) is a tripartite funding agreement between the OC, a finance provider and the local government in the case of residential strata buildings. The finance provider advances funds for an efficiency project to the OCand the resulting savings cover a new charge that the local council puts on the land. EUAs can assist in overcoming the split incentive between property developers and buyers for new multi-dwelling buildings by distributing the cost of energy efficiency to future owners. Property developers do not view energy efficiency as added value for properties so they adhere to the minimum efficiency standards This means that many buildings require costly retrofitting in the future. Buyers will receive long-term savings from energy efficiency so the extra costs from an EUA will be cancelled out (Clark, 2015). EUAs are not useful for retrofits as they are effectively the same as the strata committee putting a special levy on the property.

Community Solar is a project that allows a group of individuals to invest in a solar photovoltaics (Solar PV) installation without the need for a capital works fund. This method can be used by both tenants and OCs to install most types of generation in a strata building. Financing is done with the help of an organisational company through the use of a power purchase agreement (PPA) or a lease. The NSW government plans to encourage these community installations and ease regulations around connecting to the grid to encourage uptake (NSW Office of Environment and Heritage, 2016b). The first case study of a successful community solar installation is the Stucco student cooperative housing, which managed to install 30kW of Solar PV and 43.2kWh of battery storage (Hoh, 2016). They received a $80,000 grant from the City of Sydney to help pay for the $130,000 project, $97,000 of which was purely the physical system costs. The Solar PV system supplies 80% of the cooperative's daily electrical energy needs and saves each of the 40 occupants $35 a month on electricity bills. This is accomplished by allowing each apartment to collectively buy cheaper electricity from the system rather than from energy retailers, but the option to swap back is still available.

Government rebates can be used to recoup project costs via federal, state or local government policies depending on what the project is and where the strata building is situated. The way the rebates are given differ depending on the policy they are from. For example, in NSW there is an Energy Savings Scheme (ESS) in operation where ESCs can be generated through energy efficiency upgrades and then sold through an energy company to a broker (IPART NSW, 2016). In the ESC case, lighting can receive 5 years worth of rebates as a single lump payment, as mentioned in Section 4.4.2., but other sources such as pool heating can only generate ESCs to be sold to a broker on an annual basis.

3.5. Education on the NABERS Rating

Strata managers need to be educated about how NABERS for Apartments will work and must be able to teach OCs about NABERS and what can be done to improve their rating. Free online teaching tools for individual occupants and paid, more advanced tools for strata managers and strata committees would illuminate and encourage improvements to their building's sustainability. A pay wall for tools for tenants and owners would serve as a disincentive for some and may inhibit the success of NABERS for Apartments.. If there is any disinterest in tenants or owners on the subject of energy and water efficiency, a pay wall will be a big barrier to entry. This is not the case with everyone however: "Retrofitting multi-tenant buildings for energy efficiency" is a recent 45 minute self-paced online course for $60 that attracted 65 architects over a 6 month period. Paid access to legal documents and more advanced services should not be a barrier for strata committees and strata managers as it would be written off as an expense to their capital works fund or company respectively.

Smart Blocks is one such website that has free and paid tools for tenants, apartment owners, strata committees and strata managers to learn how to engage strata committees on the subject of energy and water efficiency projects (Smart Blocks, 2016). It should be improved to explain what NABERS means to the involved parties with links to the official NABERS website. Smart Blocks should also be advertised to strata stakeholders via forums such as Flat-Chat and LookUpStrata and through Inside Strata magazine. Smart Blocks is currently out to tender to a private company as 'an independent profit-for-purpose business, not-for-profit or social enterprise'. This will bring it out of direct government control but still keep it open to government influence through suggestions or policy (Smart Blocks, 2016). The *Smart Blocks Final Evaluation* has many suggestions to improve Smart Blocks, some of which have already been implemented. It outlines some key issues that can be addressed in the form of a training and information platform that is frequently updated and provides better communication between councils, strata managers, OCs and third parties (Crosbie, 2015).

There may be a need for an education platform specifically for condo owners which leaves out all the issues unique to stratas.This platform must be easy to find and use. As mentioned before, condos do not have an OC or strata manager, so communication issues are less prevalent. A possibility for a teaching platform could be to include an easily visible and accessible section in Smart Blocks for condo owners and their tenants.

3.5.1. Understanding NABERS Ratings

Mudgal *et al.* (2013) stated that despite awareness and market penetration, understanding of the EPCs by the layman was still in question in the EU There is a disconnect between energy savings, capital costs and the ratings seen on the EPC form, and it is difficult for them to calculate the future energy savings. It is imperative that NABERS for Apartments ratings are designed purely with the layman in mind rather than energy experts and government officials. Simple labelling has already been achieved with the NABERS star rating, however linking that to the benefits may be more difficult for the layman. It should make sense that higher star ratings mean lower levies in common areas and lower bills in apartments but it is difficult to attach values to them when the rating is the only information available. Providing real world examples and dollar values to people would allow them to be able to understand the link between the number of stars and the direct benefits to themselves (Easthope, 2016). These examples should be explained on a building size and per person basis for common areas and apartments. The goal of NABERS is to improve energy and water efficiency in buildings, so it is important for building occupants to be educated about the benefits.

Introducing NABERS for Apartments for common areas only would omit half the information for an apartment from potential apartment buyers and would be useless to renters. It is difficult for the public to adjust to major changes such as including apartment ratings at a later date, and would delay the impact of NABERS. This would reduce the effectiveness of NABERS for Apartments in meeting energy efficiency and productivity goals of Australian governments. Common area NABERS ratings would be more of a “feel good” measure for stratas without the inclusion of individual apartment ratings.

The separation of NABERS ratings for common areas and apartments is required to avoid any misunderstandings, e.g., common areas being very efficient while apartments are not. Furthermore, having a rating for the entire building will ignore the differences in energy performance between apartments and instead show the average performance of all apartments. This is especially important when, for example, a single apartment for sale has undergone retrofitting to improve its energy performance substantially but its rating includes other more energy intensive apartments. This blanket NABERS rating would reduce the value of the apartment and provide incorrect information to potential buyers. What NABERS for Apartments must convey to the public is accurate information on energy bills, levies and apartment valuation. This can be achieved by assigning a rating to each apartment and advertising the individual apartment rating with the common areas rating at time of posting for rent or sale. Ratings for apartments will only need to be done when there is the need for a change of ownership or tenancy. However, common areas will require annual updates in case any apartments do advertise for rent or sale in this period.

Having separate ratings for common areas and apartments creates the potentially confusing situation of there being too many ratings for a building. NABERS for Apartments will encompass energy and water, with potential for waste and indoor environment ratings. A compromise must be made between showing 8 separate ratings and a single rating. Having a combined or common area-only rating for the building to display as an accomplishment will allow for competitive comparison between buildings. This rating must not be used in advertisement of apartments for sale or rent however as discussed above. Buildings that have few or no apartment ratings will not be able to display an average apartment NABERS star rating so the combined whole building rating may not be a good option. For ratings displayed with individual apartments for sale or rent, it would be best to combine the individual apartment rating and common area rating into one overall rating. A breakdown of its constituents next to the combined rating, as demonstrated in Figure 15, should be provided on a form along with the property details at posting for sale or rent. It is important that the form with the rating details be made available as part of the apartment advertisement to improve market transparency. A survey must be done across a statistically significant number of people to assist in finding the most effective layout and design of this form. It is imperative that the NABERS for Apartments ratings are understandable for the layman, not just those involved in the industry, so it is better to involve those who have little exposure to this kind of information as a majority in the survey.

Overall NABERS Rating		Energy	Water	Waste	Indoor Environment	Energy Generation
3 stars	Apartment	4 stars	3 stars	2.5 stars	3 stars	0 stars
	Common Property	3.5 stars	3 stars	2.5 stars	3.5 stars	0 stars

Figure 15: Realtor-advertised NABERS for Apartments rating breakdown form

3.6. Strata Manager "Know The Customer Better"

NABERS for Apartments can be used by strata managers to display the true value of a building for owners and tenants. They can increase the value of their strata portfolio value through improved understanding of operating costs and implementable methods. The NABERS metadata on these buildings can be used by strata managers to improve their portfolios by recording factors on strata buildings' annual energy and water performance. This data would assist strata managers in improving their worth as a manager and enable them to better show potential customers how their portfolio compares with others. For example, a strata manager may be able to advertise that 60% of schemes under their management are at 4.5 Stars and above.

Better knowledge of strata buildings will also enable strata managers to give advice to strata committees on what can be done to reduce ongoing costs, how to finance building retrofits and why building retrofits should be done at all. Achieving better knowledge can be done through online courses such as *Retrofitting multi-tenant buildings for energy efficiency* provided by eClassroom. Over 65 architects and planners have taken this course in 2016 to improve their knowledge in this space.

3.7. Mandatory Disclosure

NABERS for Apartments will not be effective as a voluntary measure due to the communication and regulation issues that frequently affect OCs. NABERS for Apartments must be introduced through mandatory disclosure to achieve any significant market penetration (Mudgal *et al.,* 2013). There are three size categories for buildings: Low rise, which covers buildings with 1-3 storeys; mid or medium rise which are 4-8 storeys high; and high rise, which covers buildings with 9 storeys and above. Mandatory disclosure should first apply to high rise buildings and then continue to be introduced in a delayed fashion to mid-rise and low-rise buildings. Low rise apartment buildings accounted for 10.3% of the NSW population in 2001 and are less concentrated in areas of high population density such as Sydney city (Myors *et al.,* 2005; City of Sydney, 2015).

Allowing some time for the industry to develop and expand into less populated areas before making it mandatory for mid and low rise buildings will reduce the cost of assessments in these areas (Chandra, 2016). In juxtaposition to this, high rise buildings accounted for only 2% of the NSW population in 2001 (Myors *et al.,* 2005).

Sydney, as Australia's own international trading hub, has access to an established market for energy efficiency , with room to expand rapidly in response to market forces or government policy. Sydney is also predicted to have 80% of residents living in apartment buildings by 2030 with 90% of new residential development being high rise (City of Sydney, 2015). This makes Sydney high rise buildings a prime candidate for mandatory disclosure of ratings to test NABERS for Apartments.

NABERS and BASIX can then be adjusted as necessary before expanding to all buildings and should be designed to affect actions on new development as soon as possible. It would be possible to test it in Sydney only and then expand to other high population density areas along the NSW coast such as Newcastle and Wollongong. These urban centres are developed enough to be exposed to mandatory ratings with smaller economic impacts than more remote towns and areas, which in turn should be exposed to the mandatory ratings last.

The EPC system had mixed uptake results in different countries before it was made mandatory across the EU member states in 2013. During the voluntary period Cyprus had 10% of all property transactions (sold and rented) accompanied by an EPC while Austria accomplished 20%. France and Portugal achieved almost 100% market penetration and the UK reached 95% when EPCs were made mandatory alongside any transaction by the individual countries (Mudgal *et al.,* 2013). The Energy Star Certified New Homes program has achieved only 9.74% market penetration as a voluntary measure (US EPA, US DOE, 2015).

It is essential that the NABERS ratings are supplied at listing and not at or after the signing of the contract or lease. Not providing a rating before the contract is signed defeats the purpose of NABERS by omitting important information about the value and ongoing costs of the building. This removes the incentive for property developers and owners to improve the energy and water efficiency of their buildings above BASIX standards or equivalent MEPS. This was realised by the EU so the EPBD was recast on the 9th January 2013 to make advertising the EPC at point of posting for sale or rent mandatory (Mudgal *et al.,* 2013). The City of Sydney (2015) also concluded that mandatory ratings of buildings will contribute to 51% of possible GHG emissions abatement in high rise buildings.

3.8 Summary and Recommendations

Challenges facing strata in implementing NABERS for Apartments include existing regulatory compliance burdens, implementation costs and communication issues between all stakeholders. Even so, there are opportunities that may help mitigate these challenges, such as the opportunity for digitisation of utility bills and bringing efficiency projects into the discussion for strata committees.

The tripartite (strata managers, owner-investors and tenants) have different agendas and will need tobe incentivised in different ways. Strata managers may be incentivised with a commission system where they are given a commission on ratings and/or retrofits. Owner-investors may benefit from having more market competition through regulation to advertise the NABERS rating of apartments for rent. Moreover, tenants will be greatly incentivised by the savings achieved through choosing an apartment with a high NABERS rating.

Strata managers will have to be educated about NABERS for Apartments and must be able to teach OCs about the program. This can be done through an education program, which should be tailored to both strata and non-strata parties.

To avoid a situation where laymen do not understand the ratings system, e.g., EPC in the EU, NABERS for Apartments ratings should accommodate the layman rather than energy experts and government officials. It may be useful to include real world examples and dollar values to allow people to easily understand the link between the number of stars and direct benefits that they can derive from the ratings.

The ratings system may be separated into common areas and apartments. However, a rating with both areas combined (e.g., Figure 15) may give buyers of the individual apartments a clearer idea of the efficiency of the building and apartment.

To ensure significant market penetration, NABERS for Apartments will be more effective as a mandatory measure, implemented in stages. This kind of implementation has seen success in the EU, which had mixed uptake of EPCs before being made mandatory.

4. Physical Characteristics of Strata Buildings

4.1. Size Variations

There are three size categories for buildings: Low rise, which covers buildings with 1-3 storeys; mid or medium rise which are 4-8 storeys high; and high rise, which covers buildings with 9 storeys and above. Having a larger building means usually means there are more apartments in it, larger common areas and more energy-using appliances and equipment such as HVAC and lifts. This causes assessments to take longer and cost more in relation to smaller buildings. Larger buildings tend to have more money available in the capital works fund to cover these expenses. However, they also have larger Owners Corporations (OCs) which increases the difficulty of implementing large projects due to the high number of people involved in the process.

4.2. Mixed Use Buildings

Rating mixed use buildings will not be an issue in most cases. It is very rare for businesses in a mixed use building to be on the common area meter and have their own business meter. They are usually disconnected from most apartment or common area energy use, with exceptions like small hot water tanks or garbage area lighting. Rating the businesses separately to the residential and common area sections will normally be an effective method. In most cases a variety of NABERS assessments will cover all the categories within a building, which is what NABERS is trying to achieve as a universal building rating system.

One of the most difficult things for NABERS to rate is mixed use buildings with unmetered common area energy or water use shared with businesses. One example of this is when a cooling tower is being used by apartments and businesses for cooling needs, making it incredibly difficult to choose who to bill for operation. NABERS for Apartments will run into a similar problem if auditors try to split the cooling tower energy use between users (the issue is discussed further in Section 9.1.). Similarly, sections of underground car parks such as loading docks are not usually sub-metered by commercial and residential spaces so they are usually billed to common areas.

4.3. New Development And Retrofitting

The NABERS for Apartments scheme will need to incentivise efficiency in both energy and water, requiring different methods for new development and old stratas. New developments are stratas in planning or construction that can be designed to be energy and water efficient from the ground up. Old stratas are existing buildings which require retrofitting to attain higher NABERS ratings. New developments generally involve larger construction and engineering companies and the investors in the project are able to exercise higher degrees of control compared to old development. This makes the process fairly efficient when compared with working through an OC for retrofitting, making new development a prime target for NABERS and BASIX to address market failure.

Retrofitting for energy efficiency is a difficult process in the strata community due to the slow rate at which communication occurs between all parties. These parties could include the strata committee, strata manager, advanced energy company, suppliers, government, and the entire OC depending on the scale of the project. There is little competition and few players in the the market involving retrofitting residential strata buildings (Easthope *et al.* 2016). Introducing NABERS for Apartments will improve energy efficiency market competition through regulation and education. This will incentivise more suppliers and advanced energy companies to enter the market and some advanced energy companies will develop NABERS assessors.

Some residential buildings are retrofitted from another use such as an office or industrial building. The performance of these buildings is more difficult to predict but makes no difference in how they are rated under NABERS for Apartments, only in the resulting rating.

4.3.1. Age of Buildings

The age of a residential apartment building dictates its style and how much energy it uses pre-retrofit. Residential apartment buildings developed in the 1960's tend to have low energy use in terms of lighting in common areas and insufficient thermal performance in apartments. Buildings from the 1990's to 2000's tend to have a lot of halogen downlights and little to no insulation before BASIX was introduced and very high energy use. Current buildings are mostly designed to meet BASIX standards so there is some insulation. There is also a tendency for there to be a lot of fluorescent lighting and the inclusion of HVAC, resulting in high energy use. Retrofitting for each type of building will have very different costs, paybacks and paperwork and the initial NABERS ratings will vary widely. However, the method of NABERS assessments will not significantly change so they will continue to be effective across these building demographics.

4.4 Summary and Recommendations

There are three building size categories:

- Low rise – 1-3 storeys
- Medium rise – 4-8 storeys
- High rise – 9 storeys and above

Mixed use buildings are buildings that house both residential and commercial properties. Rating mixed use buildings will rarely be an issue. However, some mixed use buildings have unmetered common area energy or water shared between residential and commercial properties, e.g., shared cooling tower.

New developments will have a higher degree of control over efficiency projects, compared to an old development with an established strata community, where communication is slow and projects take longer to approve. NABERS for Apartments will have to be designed around these issues to maximise uptake and benefit from the program.

5. Energy and Water Consumption In Strata

NABERS for Apartments must be able to address the diverse issues in improving energy and water efficiency in residential strata buildings. Figure 16 shows how common area energy use intensity in buildings varies immensely with building size. High rise buildings have a markedly higher common area energy intensity (in blue) than mid and low rise stratas. This is usually caused by heating, ventilation and air conditioning (HVAC), car park and floor lighting and other common amenities that are less common in smaller buildings. NABERS ratings may have to compensate for different building sizes by categorising the ratings by high, mid and low rise if the energy performance of high rise buildings remains like this.

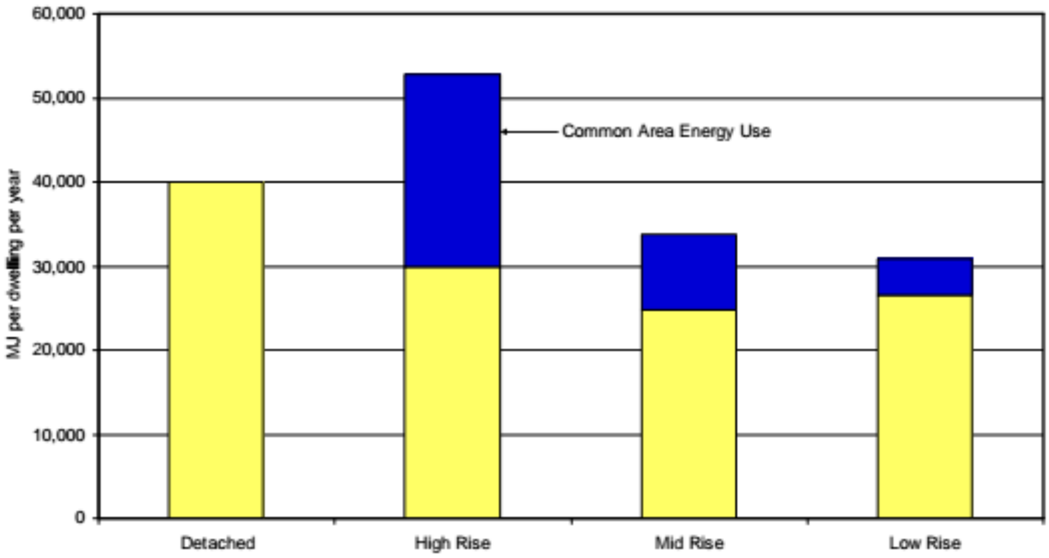

Figure 16: Total Energy Consumption (MJ/dwelling/year) vs. Housing type (Tupper)

Economically speaking, improving the energy efficiency of a building reduces the money flow of energy costs, freeing up funds for other uses. Figure 17 demonstrates how this works by setting the baseline energy use from before an upgrade from previous energy use data and/or modelling (left side). It is then compared against what the building uses post-upgrade (right side), resulting in avoided energy use (in green). This works for both old and new buildings by using modelling to fill in any unknowns, e.g., projected energy use of two different plans for the same building to calculate energy savings. The increase in available funds from the resulting smaller energy bills allows buildings to pay back any loans used for the more efficient design. Upgrades on average become more expensive capital-wise as efficiency increases. Less energy efficient appliances have a lower upfront cost due to cost cutting, which results in wasteful design and higher lifetime costs. Water savings do not operate the same way due to the exceedingly low price of water and high cost of retrofits. Regulations and a rating system should improve this market failure, but the issue will remain until water becomes more expensive.

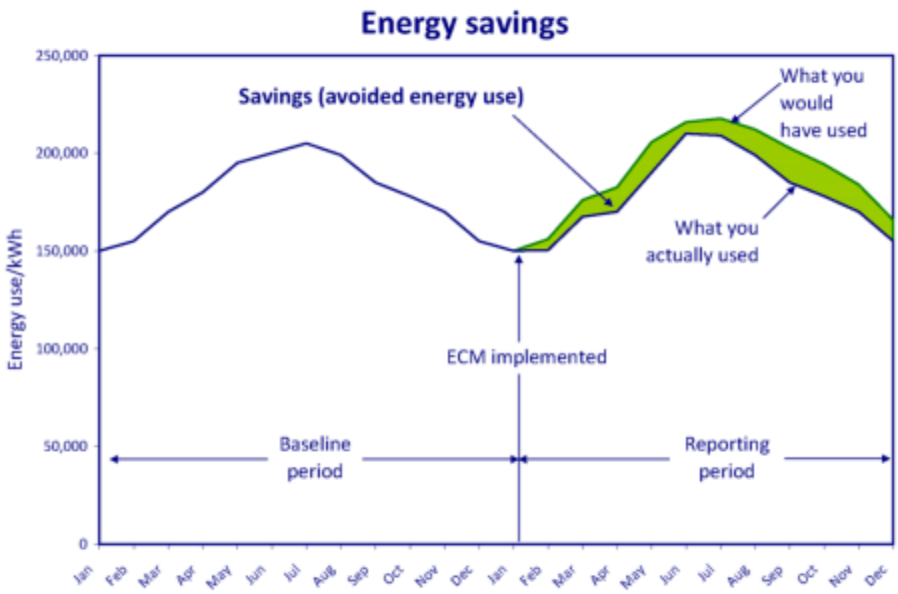

Figure 17: Energy savings example (Amber Green Sustainable Capital, 2013)

5.1. Common Types of Facilities

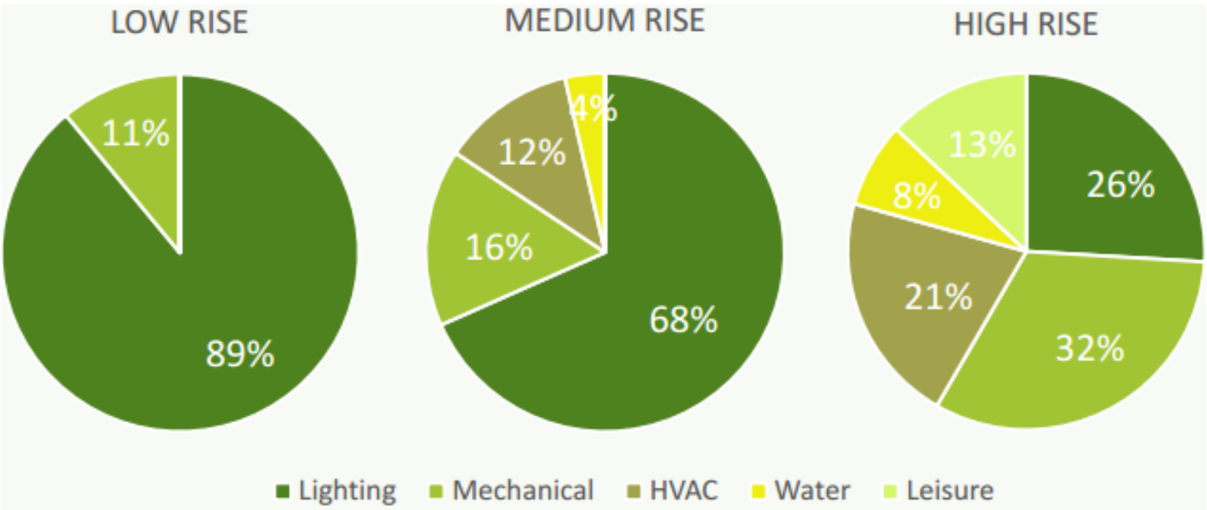

Figure 18: Common area energy use by building size then usage source (Wattblock, 2016a)

5.1.1. Lighting

As shown in Figure 18, much of the energy in strata buildings is due to lighting. LED lighting retrofits are usually relatively simple and can generate ESCs, making lighting a prime candidate for energy efficiency retrofits. Low rise buildings usually stand to gain the most from lighting retrofits, whilehigh rise will gain the least the least due to the share of the building's energy that lighting uses.

5.1.2. HVAC

High rise buildings always have common area HVAC in foyers, lift lobbies and other communal spaces; while medium rise buildings will sometimes have it. Underground car parks will have ventilation to remove any accumulated fumes. However it should be noted that there is a trend in medium-sized strata buildings to illegally turn-off these ventilation fans not on carbon monoxide (CO) sensors. This reduces their common area electricity bills. This can be a health hazard if the CO builds up and a fire hazard if the ventilation fans are part of the emergency smoke exhaust system. This issue can be resolved by making it a requirement for basic health measures to be met before a NABERS assessment is produced.

5.1.2.1. Insulation

Insulation is a layer of material that reduces the amount of heat that can transfer through a surface, keeping the room at a more stable temperature. Examples are the thin layer of argon that is between two panes of glass in double glazed windows or the spray-in insulation in ceilings and walls. Figure 19 shows the areas in a standalone home where heat loss or gain can occur during winter and summer respectively. This heat loss/gain applies to apartments as well with the addition of common areas and other apartments on the conjoined sides. Incentivising the improvement of insulation in apartments will save ongoing energy costs, improve indoor comfort and increase apartment valuation.

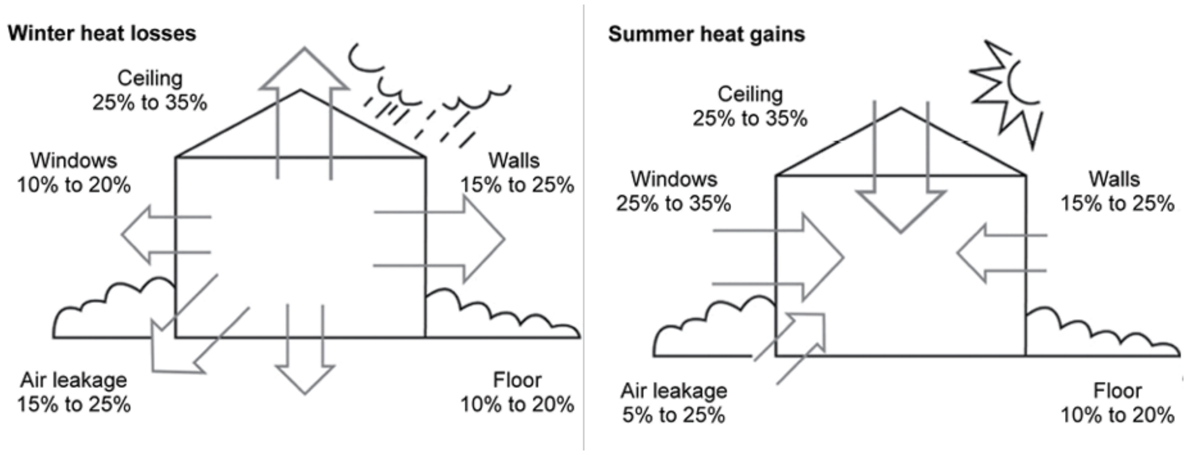

Figure 19: Typical heat losses in an Australian home (Australian Government, 2016)

Home Energy Efficiency Retrofits (HEER) is part of the Energy Savings Scheme which addresses multiple energy use issues that can earn households a minimum of four ESCs. Insulation types such as door and window glazing and drafts are covered; while floor, wall and ceiling insulation types are not (NSW Office of Environment and Heritage, 2016d).. This disparity should be addressed , e.g., by using the NatHERS tools to assess insulation. This could assist in streamlining the process rather than changing the currently available Home Energy Assessment Tool.

5.1.3. Mechanical

Mechanical covers any elevators in strata buildings. These are always found in mid and high rise buildings and sometimes in low rise depending on when the building was designed. It also includes motorised gates and garage doors.

5.1.4. Leisure

Pools, spas, saunas, gyms and any other facilities that exist for the leisure of occupants and are mostly installed in high rise buildings. Figure 18 (above) shows that pool pumps and heating tend to use a lot of energy which can be retrofitted to be more efficient.

5.1.5. Water

Energy use for water is composed of water pumps for large buildings to compensate for the lack of water pressure at higher levels, as seen in yellow in Figure 15. Smaller buildings with access to town water do not need any water pumps but buildings in more remote areas will if the water pressure is too low.

5.1.5.1. Hot Water

Centralised hot water uses a lot of common area energy; it can use more than 50% of common area energy in some buildings (Myors *et al.,* 2005). This is a large proportion which will spread across more stratas in the future as population and the demand for living space increases. Energy performance of hot water systems must be covered under NABERS for Apartments if the NSW government and the City of Sydney wish to fulfill their sustainability targets. Not doing so will result in higher evening peaks on the grid and possibly higher capacity demand charges for strata common areas. Changing to the more efficient water boiler setups could reduce hot water energy use and potentially save common areas thousands of dollars on annual energy bills.

5.2. Electric Vehicle Recharging In Strata

The NSW state government aims to double the energy productivity of the NSW vehicle fleet by increasing the uptake of low emission and electric vehicles by 2040. This will be accomplished through incentivised uptake by both businesses and individuals. This will occur by improving the availability of said vehicles and improving people's knowledge on the matter through 'real-world' information. Government incentives are also included through stamp duty and registration as outlined in the NSW Draft Climate Change Fund Strategic Plan (NSW Office of Environment and Heritage, 2016b).

Market penetration for EVs will increase in the future so it is paramount for preparations to be undertaken on the local grid. Only 0.05% of new car sales in Australia are EVs, meaning that current projections of EV market penetration are too inaccurate to use (Young *et al.*, 2015). However, market penetration effects on the grid can still be modelled and they show that demand could rise substantially at higher penetrations. This can cause demand spikes when uncontrolled charging occurs, as shown in blue in Figure 20.

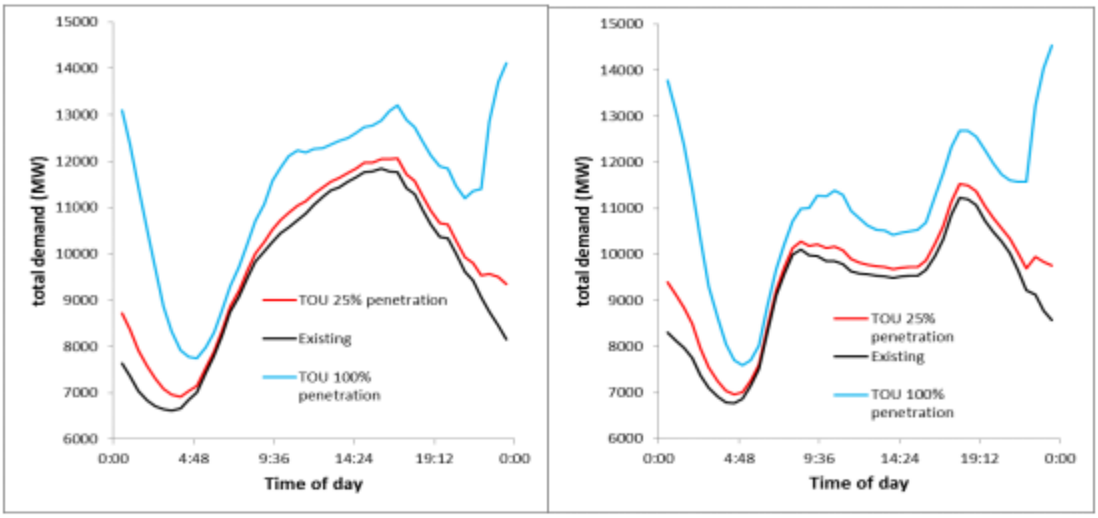

Figure 20: 'Peak summer and winter demand profiles with the application of uncontrolled ToU charging at 25% penetration of EVs and 100% penetration of EVs' (Young, Hungerford, Macgill, & Bruce, 2015)

Onsite EV charging is equivalent to refuelling a petrol car which is not part of NABERS so energy used in charging should be removed from the building's or apartment's net electricity use. This will avoid lowering the NABERS rating or skewing distributed energy generation use. Currently all EV charging stations require a separate National Metering Identifier (NMI) and metering with interval data (AEMC, 2012). This should result in the chargers being separate from common area wiring.

5.2.1. Drawing the Line - Electric Vehicles, In or Out?

Electric vehicles (EVs) do not need to be supported by the OC. However, this will create a missed opportunity to increase property value and incentivise potential EV owners to buy property in the strata building. There are two general ways to set up onsite EV charging. The first is shared parking spots which have charging stations with multiple adaptors for different EVs, labelled as 'shared charging'. The other involves parking spots legally entitled to apartments that have personal charging stations, labelled as 'personal charging'. Personal charging requires more wiring to be installed and can be quite expensive for parking spaces that are far away from the electricity meter. However, it does not require self-driving technology or special programming of cars and chargers like hands-off shared charging does.

High numbers of EV chargers in one apartment block will require thicker wiring and possibly more than one connection to the grid. This problem can be greatly mitigated or possibly circumvented entirely by intelligently controlling the recharge times and rates for all the cars. The software for scheduled charging already exists and will continue to improve as EV market penetration increases, offering charging hardware and software that works with multiple car makes and models. This charging software will expand in future to allow for EVs to export energy to the grid during peak times if set up through an energy service company (ESCO), similar to a dedicated battery bank like a Tesla Powerwall.

Batteries are heavy so the few stratas with car stackers will have to lift heavier cars and will need to know where to put EVs for automated charging if parks are randomly chosen for cars. The car stackers could be reprogrammed to use shared charging spaces rather than individual apartment parking to save on capital costs. However, this will limit EV uptake when market penetration eventually overwhelms the shared space use and will require expensive modifications to the involved software and hardware.

5.2.2. Electric Vehicle Ride Sharing

Shared charging for EVs brings forth the possibility of ride sharing in residential strata buildings. Ride sharing companies, such as GoGet and Hertz 24/7, work with local government councils to rent out public parking spaces for their cars (City of Sydney, 2016c). EV chargers are susceptible to property damage, making enclosed carparks, like those in some residential strata buildings, perfect for EV ride sharing between building occupants. Ride sharing reduces vehicle GHG emissions and using EVs instead will reduce emissions further as more renewables enter the grid. Owners Corporations or owners themselves could collaborate with ride sharing companies or set up their own for building occupants to use. One major barrier to entry for apartment EV ride sharing is regulatory requirements. This includes fire safety and the requirement for the circuit the EVs are charging on to have its own NMI, which can be costly and difficult to successfully apply for. The paperwork burden for these can be reduced through provision of templates by government or private strata websites for a fee, similar to what was discussed in Section 4.4.2.

5.2.3. Hot Water vs. Electric Vehicles

The future of EV recharging and common hot water energy use are increasingly grabbing the attention of strata managers. Common thinking is that hot water will be a larger energy user than EVs. With calculations derived from studies by Young *et al.* (2015) and Myors *et al.* (2005), on a per apartment basis, common area energy use with currently installed average gas or electric heaters will use 1.8-2.6 times more energy per apartment than a single average EV in a Sydney high rise building. Hot water energy use can be reduced significantly with currently available technologies. This simple retrofit will match or even outstrip EV energy use on a per-apartment energy use basis, assuming one EV per apartment. In this example, a heat pump hot water system with electric backup can run on backup for 28% of the time and be on par for energy use with an EV at about 2500kWh per year. This demonstrates that hot water boilers can be comparative to EV charging with current market technology. Gas backup can be run 15% of the time to match energy use but creates significantly less GHG emissions and is cheaper to operate, making it the preferred technology if the gas lines are installed. This infers that currently installed common hot water is lagging behind readily available technology so retrofits can be done to save 40-60% on hot water energy use.

5.3 Summary and Recommendations

Energy and water consumption depend on a number of factors, chiefly the size of the building. High rise buildings have higher common area energy use than mid and low rise stratas, mainly due to HVAC and other amenities that are less common in smaller buildings. NABERS may have to cater to different building sizes by categorising ratings to three categories, i.e., high, mid and low rise. Market failure occurs when it comes to water efficiency due to the cheap price of water, making water efficiency retrofits cost prohibitive.

Retrofits of the main types of energy and water consuming facilities depend on the size of the building. Based on the share of lighting energy use, low rise buildings gain the most from lighting retrofits, while high rise buildings gain the least. There is a trend for mid rise buildings to illegally turn-off ventilation fans not on CO sensors. This can be prevented by having basic health measures met before a NABERS assessment can be produced. Currently, not all insulation types are covered in the NSW ESS. This disparity should be addressed by using NatHERS tools to assess insulation. Centralised hot water systems comprise a lot of common area energy use. Thus, energy performance of hot water systems should be covered under NABERS for Apartments. Finally, as EV uptake increases, NABERS for Apartments will have to start factoring EV charging into the ratings.

6. Renewable Energy Challenge

Distributed or decentralised generation works by being cheaper to run than importing energy from the grid to pay off the capital financing. Distributed generation is one of two categories of electrical energy generation in Australia, with the other being centralised generation. Centralised generation is the large utility-scale generation such as coal- and gas-fired power plants and wind and solar farms. These require a lot of expensive distribution infrastructure. Distributed generation involves smaller systems that are on-site in residential and commercial buildings such as solar photovoltaics (Solar PV) and trigeneration plants. Distributed generation reduces running costs for buildings by supplying cheaper energy than centralised generation on 'the grid'. A building not using the grid in this manner circumvents the power loss in the networks that occurs over long distances, especially during periods of high demand. Distributed generation can also export energy to the grid, creating macro benefits from the precinct to the district, similar to having a rooftop garden in the city. There are already residential apartment buildings within Sydney that have or plan to have trigeneration. One Central Park (2016) and buildings in Barangaroo are buildings with the ability to supply energy to other buildings. Solar PV is also becoming more common on residential apartment buildings with the already-discussed Stucco solar and battery installation standing as proof that it can be done (Hoh, 2016). Again, as discussed and remedied in Section 4.4.2., there are regulatory burdens put on residential stratas for decentralised energy generation which cannot be changed by local or state governments.

For rating with NABERS when there is no microgrid present, common area energy generation should only be assessed in the common area or 'base office building'-equivalent rating. When the building is part of a microgrid (further discussed in Section 8.2.), the split rating system discussed above should be used for common equipment that affects apartment performance. Rating of apartments on their own external tariff when not connected to a microgrid will be affected only by external factors like Greenpower or Solar Cloud.

6.1. Solar Cloud

Anyone can invest in Solar Cloud, which is the purchase of part of a large Solar PV system that is not on the property and is connected to the property solely via the grid. Solar Cloud deals can be treated similarly to Greenpower as GHG abatement through renewable energy generation but on a time-of-use (ToU) basis. However, it would be good to encourage Solar Cloud investment and construction within suburbs by applying the Solar PV generation to the NABERS score or through subsidies. This will improve local energy generation sustainability and reduce network strain.

7. Data Access

7.1. Availability / Market Assessment

In Victoria, the software tools for assessing the thermal performance in new building designs are very limited in both choices and accuracy in its current monopolistic status (Phelan, 2016). The software is quite lacking in accuracy when compared to other software packages that work but are not approved for use. NABERS may avoid this issue by assessing the viability and compatibility of third party software,potentially reducing costs on the government to run NABERS. This can be achieved through competition between external businesses by removing the need for NABERS to develop its own software if the assessment procedure of their software is not too strict. This in turn will reduce costs and improve the accuracy of NABERS assessments.

7.2. Metering and Microgrids

The method of including distributed generation into NABERS for Apartments depends on whether the strata is on a microgrid, also known as an 'embedded electrical network'. As shown in Figure 21, a microgrid in a building works by connecting the property to the grid through one main 'gate' or 'master' meter and then splitting the wiring off into individual apartments and the common areas, each with its own sub-meter attached. Grouping the entire system together brings the benefits of aggregate billing through the common areas, which is usually offered at a cheaper rate per kWh. It also allows apartments to benefit directly from any distributed generation, as discussed in Section 7.1. (Wattblock, 2016c).

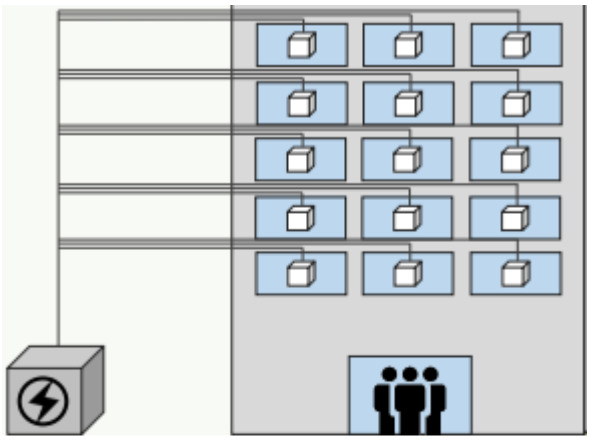

Figure 21: Microgrid in a strata building example (Wattblock, 2016c)

7.2.1. Making Money From Microgrids

Microgrids can be used to supply electricity to apartments via the common areas at a cheaper rate than would be available to them normally. The price can be set to enable extra revenue to flow to the capital works fund by reselling the electricity to apartments. By law, the microgrid energy prices must be in competition with market retail prices and apartments must be able to access the external electricity market as an alternative (AEMC, 2015). Microgrids also allow distributed energy generation such as Solar PV in common areas to be used by apartments and subsequently be billed for it in some financial agreements. This also enables distributed generation in common areas to be included in NABERS for Apartments ratings for individual apartments.

7.3. Realtime Monitoring Systems

NABERS Equipped is the proposed realtime monitoring equipment and software for water and energy use to spot leaks and uncover faulty appliances made by the NSW government (NSW Office of Environment and Heritage, 2016a). It would be best suited for building managers, enabling them to maintain the building more effectively and reduce ongoing costs from wasted water and energy. This same data logging and gathering of energy and water use in strata buildings will improve the accuracy of NABERS for future ratings and scheme changes.

NABERS Equipped can assist in future building assessments by removing the need for another physical assessment of the building. This can be achieved through the availability of NABERS Equipped, general usage data and the floor space that was previously surveyed. This would remove the need for assessments, speed up the audit process and reduce the organisational burden on strata managers. Strata managers could also assess logged water or energy use for some communal appliances such as hot water to help discover overcrowding or illegal sub-letting in a strata building. This would have the added benefit of backing up resident complaints of overcrowding and ensuring fire safety standards are met. NABERS Equipped will also be able to take advantage of the occurring digitisation across the strata management sector (discussed above in Section 4.1.2.).

NABERS Equipped is likely to be used more frequently by building managers than strata managers and could save residential strata buildings money in the future. An automated system that can identify malfunctioning appliances is a potential value added service. This can be further improved via integration]with ‘service delivery’ systems to automatically dispatch small work orders after the building manager agrees and signs them.

7.4. Summary and Recommendations

NABERS should try to avoid having a monopolistic situation for assessment software. The decision on including distributed generation in NABERS for Apartments will likely depend on whether the apartments are connected in a microgrid. Microgrids allow distributed generation of energy, e.g., solar PV, to be distributed to both the common area and apartments. This will allow inclusion of distributed generation to be included in the ratings for individual apartments.

Access to NABERS for Apartments ratings of buildings should be free and made available to the public. Having a pay wall for NABERS ratings undermines their purpose of a public instrument for improving knowledge on building sustainability.

NABERS Equipped data will only be recorded from the buildings that choose to have it installed so it should be available to them as part of the cost of hiring/running the equipment. Other parties that request the NABERS Equipped data should have to buy it as a means to recover the costs of data storage and equipment operation.

8. Recommendations8.1 Incentives for the Tripartite

Success of NABERS for Apartments will largely depend on participation and uptake from the main stakeholders of the program, i.e., strata managers, owner-investors and residents. Strata managers may be incentivised with a commission system where they are given a commission on ratings and/or retrofits. Owner-investors need to be educated about the benefits of increased market competition, while tenants will be greatly incentivised by the savings from choosing an apartment with a high NABERS rating.

8.2 Ratings System for the Laymen

Despite market penetration and awareness in the EU, there is a lack of understanding on the EPC due to the disconnect between energy savings, capital costs and the ratings seen on the EPC form. Therefore, NABERS for Apartments should be designed with the layman in mind. For example,e it may be useful to include real world examples and dollar values to the results.

8.3 Accommodating Different Building Types

High, mid and low rise buildings have different energy use distributions and may need to be accommodated separately. For example, low rise buildings benefit the most from lighting retrofits due to lighting comprising a high percentage of energy use. Meanwhile, HVAC accounts for the majority of energy use at high rise buildings. Therefore, ratings can be categorised into three separate categories, i.e., high, mid and low rise.

8.4. Unpacking Water and Energy

NABERS for Apartments should consist of the base building office assessment and home assessment with modifications to allow for shared apartment services. These would include common hot water and central cooling and heating. Ratings for common areas should involve anything that is part of the strata levies on owners. Apartment ratings should consist of anything directly billed to apartment owners or tenants by energy and water retailers. This would be consistent with what was discussed earlier in Section 4.5.1. on the separate NABERS for Apartments ratings.

8.4.1. NABERS Rating Methods

Apartments and common areas in strata buildings are very different from one another and so must have their water and energy use assessed separately. The NABERS energy and water base building office assessment with lighting included will suffice for common areas. The NABERS house assessment will work for apartments with minor tweaks. When an apartment in a residential strata building does not have a separate water meter, the water rating will have to be done through an inspection of water-using appliances. This method will be time consuming and will require a database of appliances to work from, causing the assessment process to cost more. The alternatives would be to have water sub-meters installed or find a technology that allows for in-line water metering without the need for any building modifications for those that cannot install sub-meters. In the worst case scenario it may be necessary to either model or ignore water use altogether if the alternatives are not possible.

The current method for rating offices requires pedantic measurements of floor area and energy use and generalised surveys for building managers to fill out occupancy information. This results in an imbalance between effort and accuracy on behalf of the NABERS assessor (Phelan, 2016). For apartment buildings, NABERS must develop the right assessment cost and accuracy trade-offs before expanding the program beyond mandatory high rise building assessments. One method for new development in this direction is to allow for the bulk assessment of apartments of similar design and orientation. This should free up funds for the developers to spend on energy and water efficiency improvements instead.

8.4.2. Thermal Performance

Thermal performance should be included in the NABERS energy ratings for both apartments and common areas to ensure the building is adequately insulated and draft-proofed. In some cases apartments may already have or will install air conditioners which will worsen their NABERS rating if the thermal performance of the apartment is sub-optimal. The thermal performance of common areas and apartments is linked through inner walls and doors and, in some buildings, ventilation. An assessment that ignores this will be inaccurate. The NatHERS or similar infrared imaging tools and software would be an effective means to measure how much insulation is installed. It could improve NABERS' effectiveness in analysing heat gain and loss in an apartment, and could be modified further for use in common areas.

8.5. Preparing for the Future

8.5.1. Holistic Sustainability Approach

NABERS only targets the day-to-day operation of stratas and does not encourage sustainability over the lifetime of a building. Immediate changes to BASIX to improve building materials sustainability and recycling are required. However a full life cycle approach to the NABERS rating could achieve the same outcome a different way by improving market transparency. This is similar to the life cycle assessment (LCA) approach advertised by the SWITCH-Asia China project, which is a cradle-to-grave environmental impact assessment. Chinese contracts with construction companies for sustainable building materials increased by 12.8% from 2010 to 2014 (SWITCH-Asia, 2015). This means the market and the knowledge is there to make building materials sustainable and cheaper. Locally sourced renewable materials, e.g., wood from specialised Australian plantations for building materials, are the preferred choice. They will provide Australian jobs and improve the security of supply for building materials.

8.5.2. NABERS for Distributed Generation

Introducing a rating system for distributed energy generation and storage is a good way to incentivise implementation. Carbon emissions, efficiency, size, and availability throughout the day and night will be required to fairly assess distributed generation. This would result in Solar PV alone rating worse than Solar PV with energy storage and enable trigeneration to compete. Engaging with local companies can improve the knowledge of what distributed generation and energy storage can do for the value of apartments by reducing running costs. Changes to BASIX to ready new development for solar installations would improve system size. The “solar ready” standards set out by the Title 24 Building Standards in California should be used as an example to develop the BASIX changes. This would enable stratas to install more Solar PV and assist in meeting local generation targets set out by the City of Sydney and other local governments (City of Sydney, 2015).

8.5.3. Power of Choice

Having a “Power of Choice” submission and review procedure like the AEMC will allow for public and corporate input into how NABERS will evolve to become an effective rating system.

9. Conclusion

The initial recommendations of this paper are to make NABERS for Apartments ratings mandatory and to separate apartment and common area assessments and ratings. These, alongside teaching tools, simplification of ratings and supplying a rating with property listings will make NABERS for Apartments a successful rating tool. More importantly it will become an effective driver for energy and water efficiency across both new and old strata buildings. NABERS is still in its infancy and must be effective, highly adaptable and able to be innovated at minimal cost to the taxpayer. This will enable NABERS to be able to become the universal national rating tool the NSW government wants it to become. Being lax in any area due to political reasons or otherwise will cripple its launch across NSW and Australia. This will result in the Australian public continuing to feel the effects of high energy prices and the increasing effects of climate change.

NABERS is slowly expanding to cover more aspects of building sustainability and should be designed alongside BASIX to ensure sustainable practice. This will improve development methods that allow for further population increases across Australia in a sustainable manner. Improving and enforcing the BASIX standards is the most effective way to ensure sustainable construction across the industry. If implementation of NABERS for Apartments is successful, there is substantial opportunity to grow the green building market and investments. This will also establish Australia as a global leader in green building standards.

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WATTBLOCK

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2016 Winner INNOVATION OF THE YEAR strata community australia

2015 Finalist COMMUNITY SUPPORT CeBIT

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Who is Wattblock?

Wattblock was started by Brent Clark, chair of a strata building which reduced common area energy costs by 77%. He is joined by Ross McIntyre specialising in data analytics, Scott Witheridge, environmental engineer and Morgan Warnock, environmental scientist plus a team of solar and low energy buildings specialists.

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 22 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.

Who is partnering with Wattblock?

NSW Innovate, Advance Queensland, City of Sydney local government, Microsoft CityNext, Telstra's muru-D, the University of NSW, Griffith University, University of Queensland and Queensland University of Technology.

Who is covering Wattblock in the media?

SBS, North Shore Times, Foxtel, BRW, The Australian, Business Insider, Computerworld, Startup Smart, Startup Daily, Lookup Strata, Technode, Fifth Estate.

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.

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 and at River City Labs in Brisbane.

Where can I find out more about Wattblock?

wattblock.com

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