ENERGY EFFICIENCY FOR THE CITY OF SYDNEY

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This section looks at the built form in the City and explains the methodology used to determine how energy is used by buildings in the local government area. Future scenarios show the impact of existing and new policies and programs, cost-effective and emerging technologies.

THE CITY AND ITS PEOPLE

The City of Sydney is the local government authority responsible for the city centre and more than 30 suburbs within our boundaries. The area covers 26.15 square kilometres extending from Sydney Harbour at Rushcutters Bay, to Glebe and Annandale in the west, from Sydney Park and Rosebery in the south to Centennial Park and Paddington in the east.

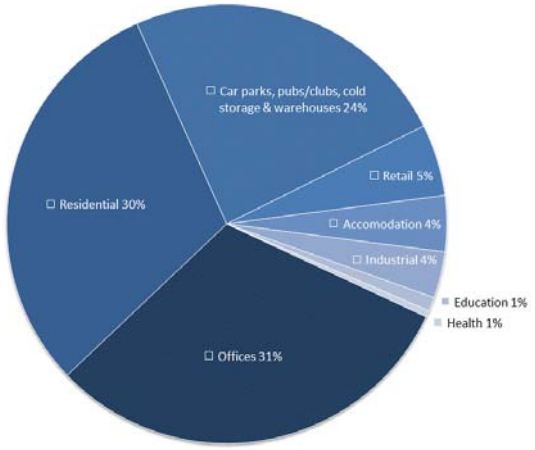
The City is the main consent authority for most new development however applications that are costed above $50 million are approved by the Central Sydney Planning Committee (of which the City is a member), and development assessment and approval and other regulatory functions in some areas come under other government authorities.

FLOOR SPACE

Every five years the City of Sydney conducts a floor space and employment survey (FES) of all buildings and businesses across the whole local area. The data informs short-term and long-term strategic planning and helps to monitor trends in land use, building characteristics, employment and parking around the local area.

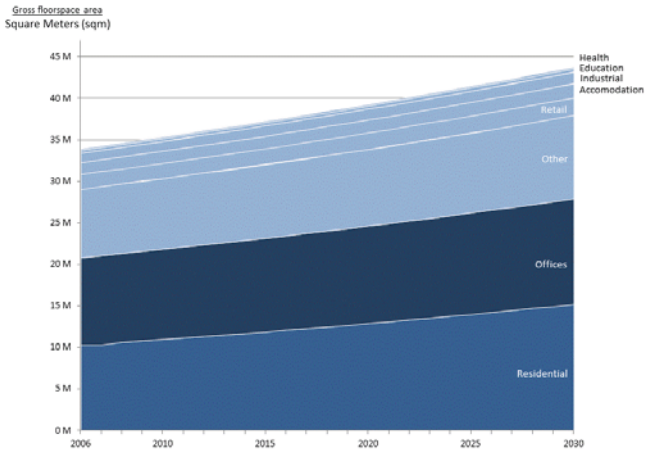
The floor space area of buildings in the City of Sydney in 2006 was 33.9 million square meters and major categories are shown in Figure 39. Mixed-use buildings with office, residential and retail spaces are commonplace and typically a building would be classified by its 'major-use'. However, due to the detailed nature of the City's floor space and employment survey we are able to separate out each component to reflect the more accurate 'space-use'.

FIGURE 39. 2006 CITY OF SYDNEY LOCAL GOVERNMENT AREA LAND-USE



Floor space in the City is forecast to grow as the population and economy grow over time. Figure 40 shows the projected growth used for this Master Plan. Total floor area in the City of Sydney local government area is projected to increase by 29 per cent to just under 10 million square meters between 2006 and 2030. The majority of growth is concentrated in multi-unit residential dwellings at 2.3 per cent per annum. The average floor area growth rate for other buildings is 0.8 per cent per annum.

FIGURE 40. CITY OF SYDNEY 2006–2030 FLOOR SPACE PROJECTION



CITY RESIDENTS

The estimated resident population at 2006 was 164,597. By 2030 it is projected to rise by more than 60 per cent, to 267,264 an additional 102,667 people. The June 2014 estimated resident population is 195,929.

The local area has one of the most ethnically diverse populations in Australia with almost half of our residents born overseas. About 30 per cent speak a language other than English and the most common language spoken at home after English is Chinese, followed by Indonesian, Korean and Greek.

Housing for a diverse population is part of our Sustainable Sydney 2030 plan. Our target is for 48,000 new dwellings and we are finding innovative ways of creating affordable housing.

At present, more than half of all city residents rent their home in the private sector, one third own or are paying off their home, and just over ten per cent are public and community housing tenants. There is also a high level of transience amongst the population which affects programs and policy options.

There are over 20,000 buildings in the local government area that contain private dwellings of which more than 1,900 are apartment buildings. Apartments, also known as multi-unit dwellings are categorised differently by the Australian Bureau of Statistics (ABS) and the NSW BASIX program. In this Master Plan we refer to the ABS definitions for low-rise (one to two storeys), medium-rise (three storeys), and the high-rise sector (four storeys or more).

Of the almost 100,000 dwellings in the City, approximately 75 per cent are accommodated in apartments, about five-times the national average. By 2030 approximately 80 per cent of residents are expected to be living in apartments, with most new residential development occurring in high-rise. Detached dwellings represent just three per cent of residential building space.

At a building level, energy consumption per person is typically higher in high-rise apartments than low-rise apartments and detached dwellings with up to 60 per cent of energy used for common areas. Energy use per person is typically high in buildings with centralised plant and equipment, and underground car parks.

There are significant opportunities for apartment owners, managers and residents to meaningfully contribute to successful implementation of this Master Plan and Sustainable Sydney 2030 targets.

BUSINESSES

The City of Sydney local government area is the most densely employed and economically active area in the country. It has over 22,000 businesses which employ over 437,000 workers, accounting for almost four per cent of Australian employment, or 20 per cent of employment across the Sydney metropolitan area.

Jobs are increasing at twice the rate of growth in metropolitan Sydney and more than $100 billion is generated each year representing over seven per cent of Australia's economy.

Around 65 per cent of our residents work in the local government area, and just like our residents, the city's workforce is relatively young, highly educated and multicultural.

The City of Sydney floor space and employment survey shows that the finance and financial services sector is the largest employment sector in the local government area with 22 per cent of all workers. In recent years greatest economic growth has occurred in the following sectors:

- Professional and business services.
- Food and drink.
- Retail and personal services.

The City's 2013 Economic Development Strategy identifies four significant and strategic industry clusters, each representing unique energy demands and engagement opportunities. These include financial and professional services, creative industries, education and knowledge, and digital industries.

Around 80 per cent of businesses in the City of Sydney local government area are small to medium enterprises. Our programs experience shows that energy efficiency gains can be improved in this sector through direct facilitation to overcome competing time and resource pressures.

Large commercial and industrial energy users are more likely to have the ability to manage their energy consumption with better metering, energy management processes, strong internal cost controls, and access to in-house skills and resources. For these sectors, price signals and reputation are considerable drivers.

There is also a significant accommodation sector within the local government area with more than 20,299 hotel rooms and 6,000 backpacker beds. There are more than 4,500 serviced apartments in the area and these sectors are growing.

THE STOCK MODEL

In developing this Master Plan the City engaged the specialist consultancy pitt&sherry in partnership with Exergy. Using the City's detailed floor space and employment survey data, pitt&sherry created a rich stock model of energy and greenhouse gas emissions associated with buildings.

FIGURE 41. CITY OF SYDNEY FLOOR SPACE AND EMPLOYMENT CENSUS 3-D SPATIAL RESOLUTION

MODEL INPUTS

To create the model, the key steps were:

- Identify the key sectors and sub-sectors that make up built form in the City of Sydney local government area.
- Develop an energy use trajectory that took into account changes in buildings and building area, changes in the energy mix, as well as the impact of a range of existing programs and policies.
- Identify what measures are already delivering energy savings and what could be improved.
- Identify what new opportunities exist to improve the energy efficiency of the buildings in the local government area.
- Prioritise these with our stakeholders to make sure that this Master Plan sets out viable and mutually agreed actions.

For assessing the built form, floor space and employment survey provided an extremely robust basis for determining the total floor area in the 2006 base year and the distribution of floor area into sectors. These are predominately based on the Australian Bureau of Statistics (ABS) Functional Classification of Buildings however sub-sectors were added into the stock model for car parks and cold storage.

The technical and policy options for driving energy efficiency beyond the 'business as usual' trajectory were assessed including benefit/cost analysis. Economic assessment was based on assumed policy or program models and uptake rates, and takes into account market barriers and cost estimates for developing and administering programs and policies.

The modelling outcomes used in this Master Plan represent building averages. Energy savings and emissions abatement will vary for any given building however we are confident that the overall modelling provides a robust and accurate picture of the energy efficiency opportunities available in the local government area. Key stages of the process and information sources used by the pitt&sherry team are shown in Table 8.

TABLE 8. BUILDING ENERGY EFFICIENCY MODEL FOR SYDNEY (BEEMS) MODEL

Phase	Activity	Output	Data source
1. Building stock	• Categorise floor space into sectors consistent with Australian Bureau of Statistics Functional Classification of Buildings. • Estimate rate of retirements, refurbishments, retrofits & new builds for each sector.	• 2006–2030 evolution of floor area.	• FES[44] • Kinesis CCAP City tool • pitt&sherry
2. Efficiency opportunities	• Quantify energy savings measures and technical opportunities for each sector.	• Unit energy & emissions savings. • Unit investment costs.	• pitt&sherry • Exergy • Public literature • Stakeholder input
3. Take-up scenarios	• Estimate take up rates for each sector based on five scenarios: – 2006 efficiency levels (no change) – Existing policies & programs (business as usual) – New policies & programs – Cost-effective technologies – Emerging technologies	• End-use energy intensities. • Sector energy intensities. • Peak load savings by end-use.	• pitt&sherry • Exergy • Public literature • Stakeholder input
4. Total savings	• Quantify total energy & emissions savings for each scenario. • Determine the value of peak load savings. • Analysis of feasible targets.	• Total energy & emissions savings. • Benefit/cost analysis and marginal social cost of abatement.	• pitt&sherry

Table 9 shows how the sector definitions used for modelling for this Master Plan associate to Australian Bureau of Statistics (ABS) and Building Code of Australia (BCA) classifications. ABS classifications are based on primary function, whereas the City's data allows much finer allocation of building floor area into functional type.

TABLE 9. BUILDING SECTOR CLASSIFICATIONS

Sector	Building Energy Efficiency Model for Sydney (BEEMS)	Australian Bureau of Statistics (ABS)	Building Code of Australia (BCA)
Offices	• Premium/A-Grade • Other grades	• Offices (231)	• Class 5
Accommodation	• Hotels/motels • Other accommodation	• Hotels, Motels, etc. (462) • Short Term (46)	• Class 3, Class 1b • Class 3, Class 1b
Health	• Health	• Health Facilities (44)	• Class 9a
Education	• Education	• Education Buildings (411)	• Class 8, Class 9b
Residential	• Detached • Semi-detached • Multi-unit dwellings (1–2 storeys, 3 storeys, 4 or more storeys)	• Separate houses (11) • Semi-detached (12) • Flats, units, apartments (13)	• Class 1a i) • Class 1a ii) • Class 2
Retail	• Major shopping centres • Smaller shopping centres • Retail strips	• Retail and wholesale trade buildings (211)	• Class 6
Industrial	• Industrial	• Industrial (3)	• Class 8
Other Commercial	• Storage • Warehouses • Cold storage • Car parks (enclosed) • Car parks (open) • Pubs, clubs, etc.	• Warehouses (321) • Cold store (331) • Commercial Car parks (223) • Entertainment and Recreation (451)	• Class 7b • Class 7b • Class 7a • Class 6

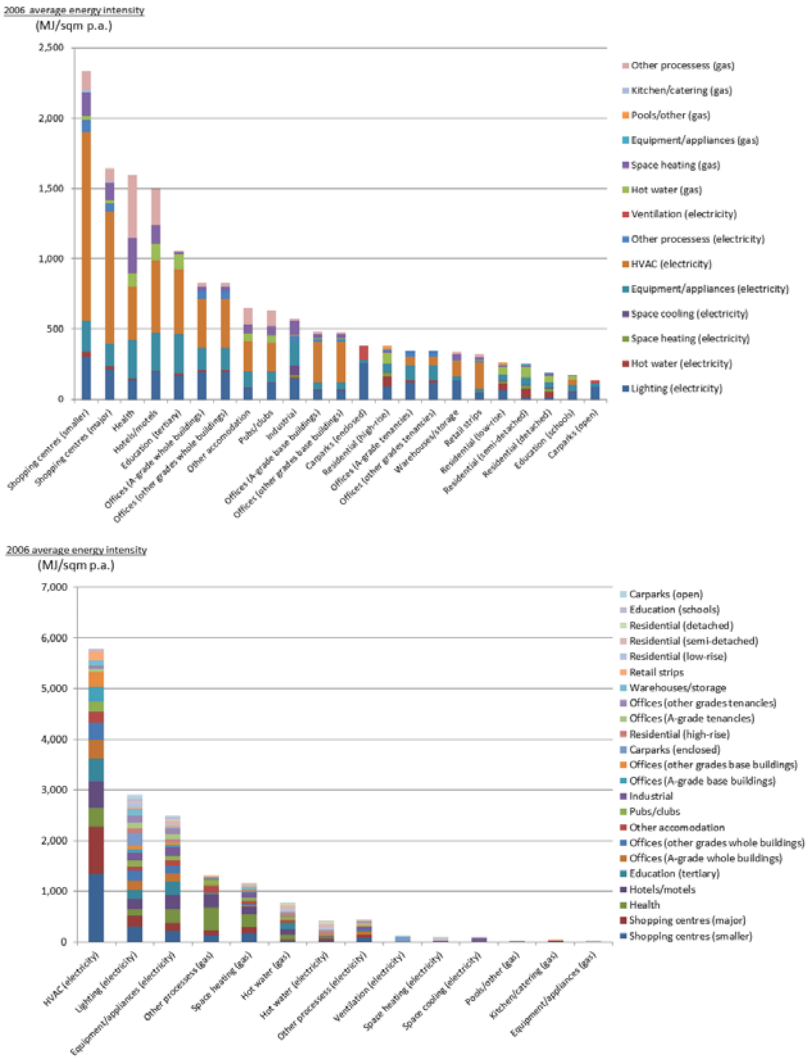
2006 ENERGY & EMISSIONS

Modelling for this Master Plan uses a 2006 baseline for consistency with Sustainable Sydney 2030 targets and the City's Trigeneration and Renewable Energy Master Plans. This section outlines the detailed 2006 energy and greenhouse gas emissions patterns used to develop future scenarios.

As with the technology shortlist, pitt&sherry quantified the average energy and emissions intensities for City of Sydney buildings based on Exergy data, other public sources, and results from 30 multi-unit dwellings assessed under the Smart Green Apartments program. Unless otherwise stated, total energy refers to both electricity and natural gas consumed by buildings converted to a common metric.

Figure 42 shows the energy intensity – the amount of energy used per unit of floor space – for each sector and major energy end-use. These are average 2006 energy intensities that apply to all building types in the local government area. Actual results for individual buildings may vary.

FIGURE 42. 2006 ENERGY INTENSITY BY SECTOR & END-USE



1. Sectors with the highest energy intensity (MJ/sqm p.a.) are cold storage, shopping centres, health, accommodation, education and non-premium grade office buildings.

2. More than three-quarters of total energy is consumed by non-premium office buildings, apartments, A-grade office buildings, accommodation and car park sectors – which are the biggest opportunities for energy savings policies and programs.

3. Heating, ventilation and air conditioning (HVAC); lighting; equipment and appliances; space heating and hot water are the major energy uses and account for around 75 per cent of total energy used by buildings.

The most energy intensive sectors respectively are:

- Shopping centres (smaller).
- Shopping centres (major).
- Health.
- Hotels.
- Education.
- Offices (whole buildings).

Cold storage is a significantly energy intensive sector, however being an insignificant proportion of total floor space in the City of Sydney it is not displayed here. The most significant energy intensive end uses respectively are:

- Heating, ventilation and air conditioning (HVAC).
- Lighting.
- Equipment & appliances.

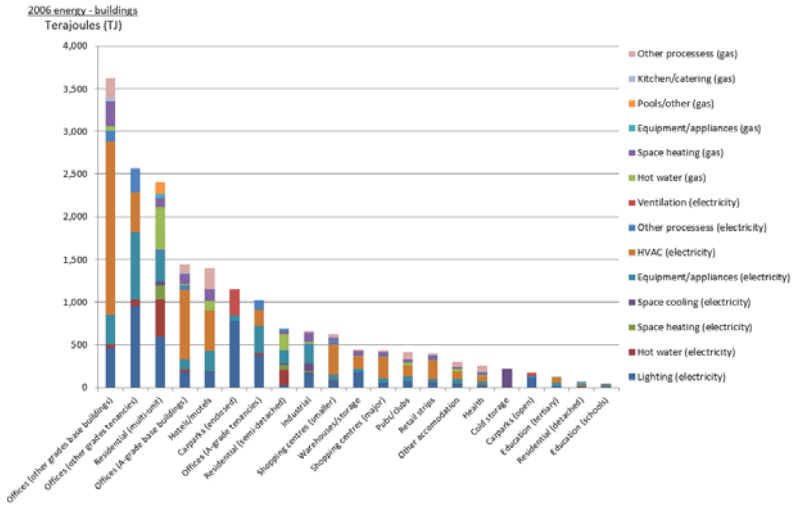
Using average energy intensities and the City's floor space and employment survey data, total energy consumption was derived as shown in Figure 43. These energy totals derived from building information and surveys (bottom-up) correlate with annual totals reported by the network utility providers (top-down data).

In terms of total energy use, there are some differences in sectors when compared to the most energy intensive sectors shown above. The greatest energy using sectors account for more than 75 per cent of total consumption and respectively include:

- Non-premium offices (base buildings).
- Non-premium offices (tenancies).
- Apartments.
- A-grade offices (base buildings).
- Hotels.
- Car parks.

There is little difference in the end-use shares between the most energy intensive end-uses and total energy usage with HVAC, lighting, equipment and appliances also representing 75 per cent of total energy. Indeed HVAC and lighting alone are greater than 50 per cent of total building energy usage and so improvements in these systems has great potential to achieve significant energy efficiency savings in the City of Sydney.

FIGURE 43. 2006 TOTAL ENERGY BY SECTOR & END-USE



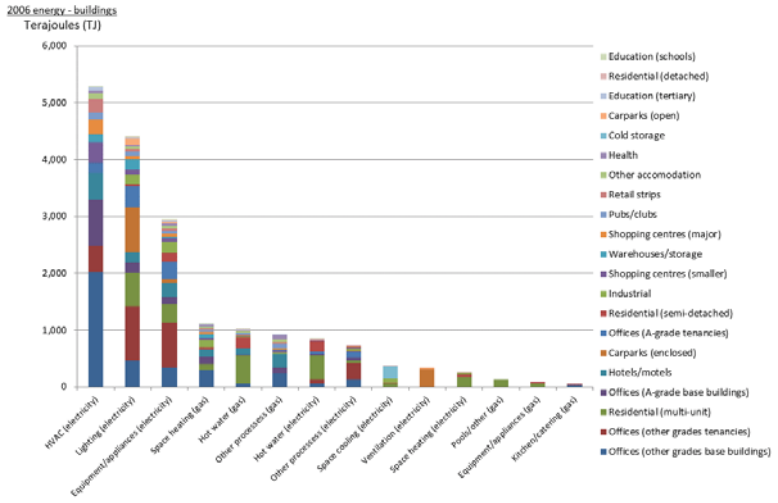


FIGURE 44. 2006 TOTAL ENERGY BY SECTOR FOR THE CITY OF SYDNEY

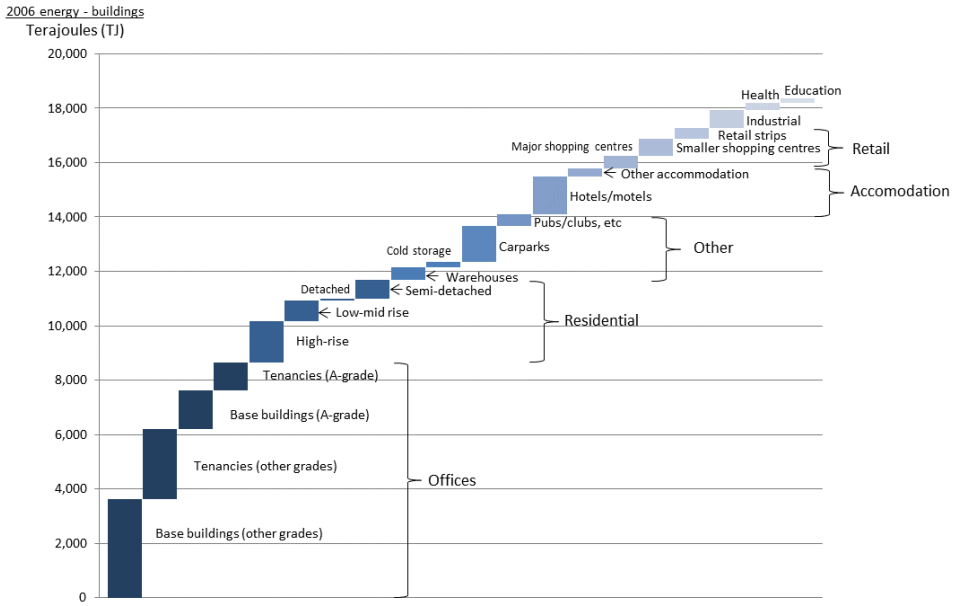


Figure 43 & Figure 44 display how much energy was used in each major sector, i.e. offices, residential, accommodation, retail and other to identify the best opportunities for sector-specific programs, as well as the total contribution from each end-use.

FIGURE 45. CITY OF SYDNEY 2006 TOTAL ENERGY CONSUMPTION BY SECTOR & END-USE

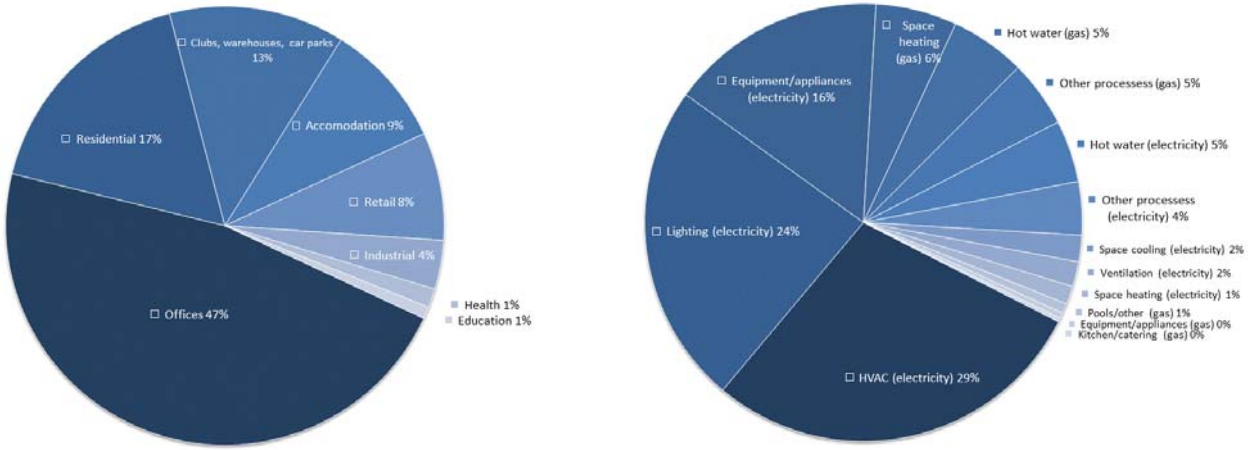
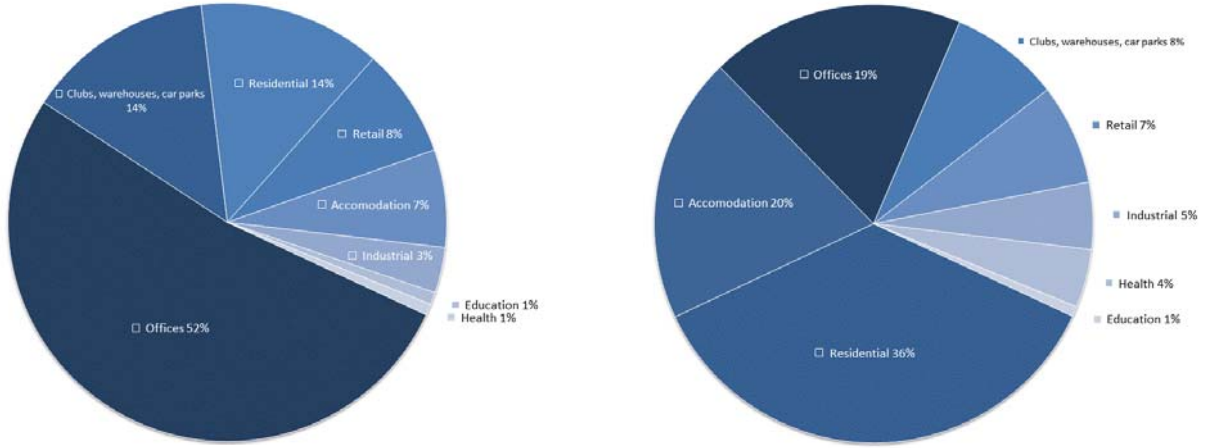
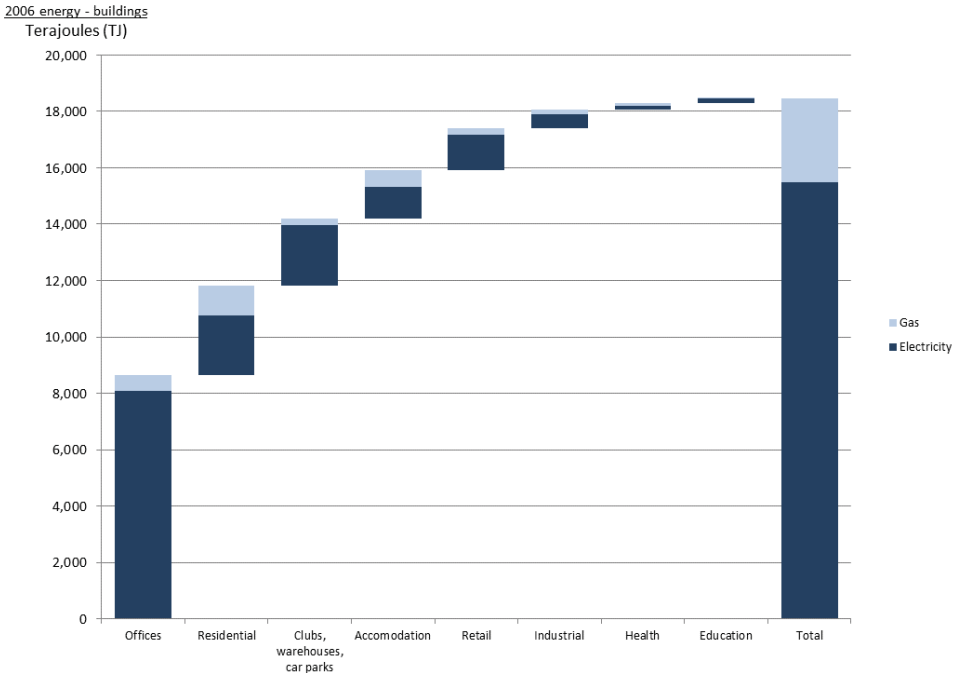


FIGURE 46. 2006 TOTAL ELECTRICITY (LEFT) AND NATURAL GAS (RIGHT) BY SECTOR



As noted, the intensity-derived energy totals correlate with annual totals reported by the network utility providers. Figure 46 shows the proportion of total electricity and natural gas used by sectors in 2006 whereas Figure 47 shows the total energy in terajoules by sector and fuel type. Electricity is the predominant fuel used by buildings.

FIGURE 47. 2006 TOTAL ENERGY BY SECTOR & FUEL TYPE



The following figures show greenhouse gas emissions resulting from energy used by each sector. The differences observed between the energy and emissions charts are due to electricity in NSW having higher greenhouse gas emissions than natural gas.

Sectors with highest greenhouse gas emissions are similar to the major energy using sectors, respectively:

- Non-premium offices (base buildings).
- Non-premium offices (tenancies).
- Apartments.
- A-grade offices (base buildings).
- Car parks.
- A-grade offices (tenancies).

FIGURE 48. 2006 EMISSIONS BY SECTOR & END-USE

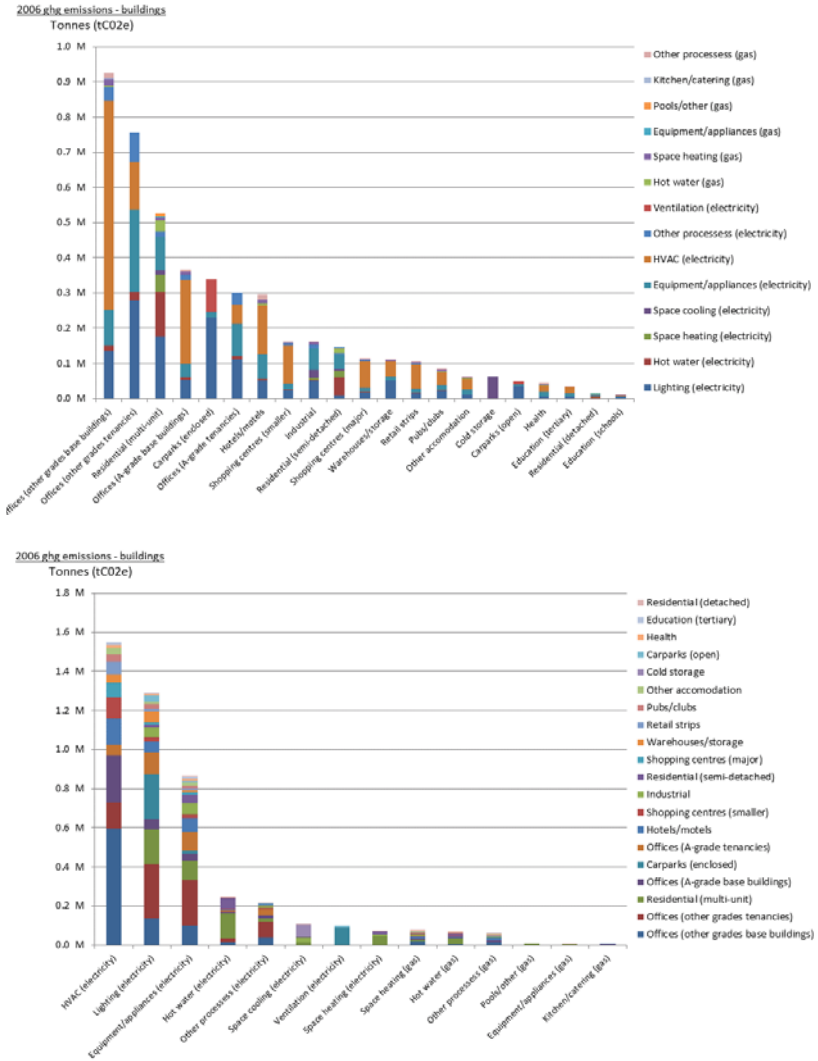


FIGURE 49. CITY OF SYDNEY 2006 EMISSIONS BY SECTOR

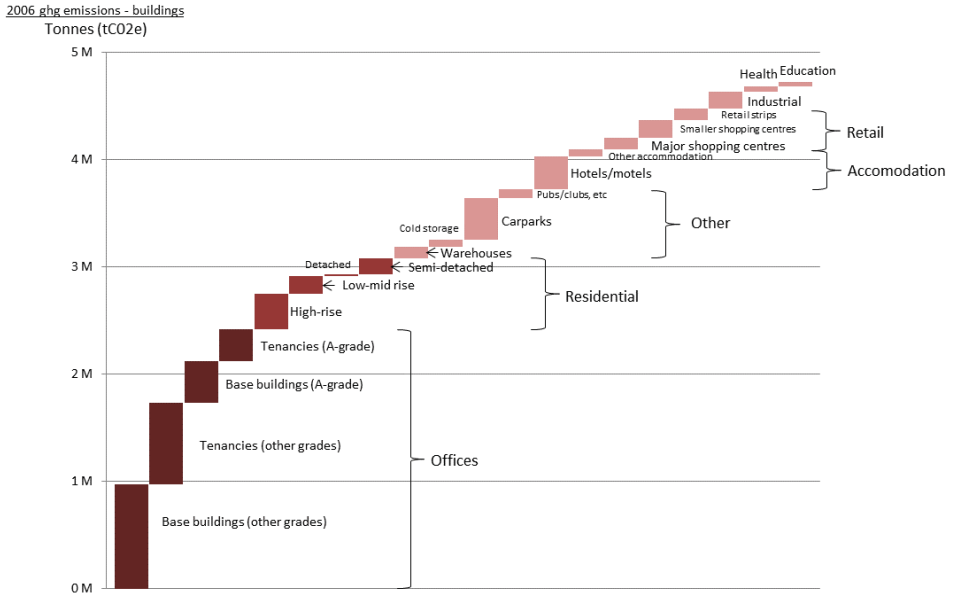


Figure 49 shows that emissions in 2006 are dominated by offices which have 31 per cent share of the floor area, relatively high energy intensity, and also high electricity share in total energy use. By contrast, emissions are lower for residential buildings, which have lower energy intensity and higher gas share of total energy consumed.

A notable result is the high share of non A-grade buildings in total emissions. These buildings make up over 24 per cent of the floor area in the city and operate at a range of energy intensities. While cool stores are extremely energy intensive, total floor space and therefore total emissions for this sector is modest. By contrast, enclosed car parks have modest energy intensity, predominantly using electricity, but because they occupy a significant proportion of floor space, this sector is a significant source of emissions.

Heating, ventilation and air conditioning (HVAC) and lighting – being electrically powered – represents a slightly larger proportion of total emissions than total energy. Space heating is mostly running on natural gas and so despite being one of the major end-uses for energy it makes a relatively smaller contribution to total emissions. Figure 51 shows that the majority of greenhouse gas emissions in 2006 were due to electricity.

FIGURE 50. 2006 EMISSIONS BY SECTOR & END-USE

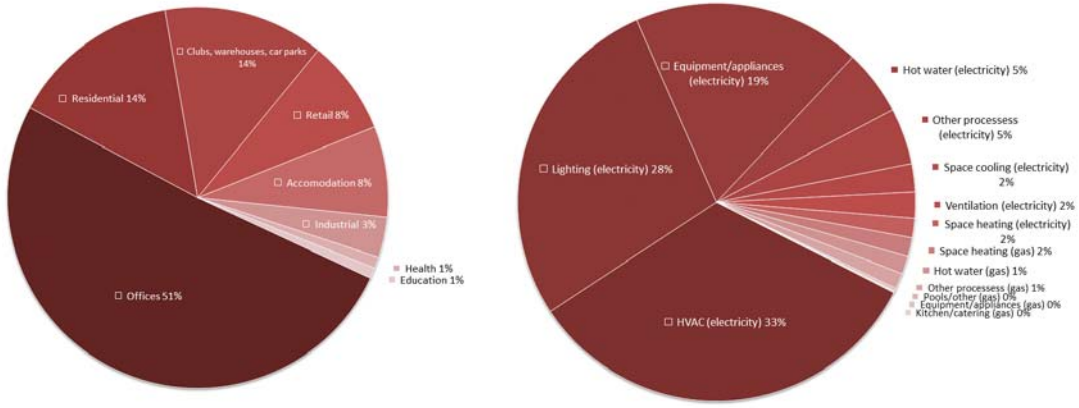
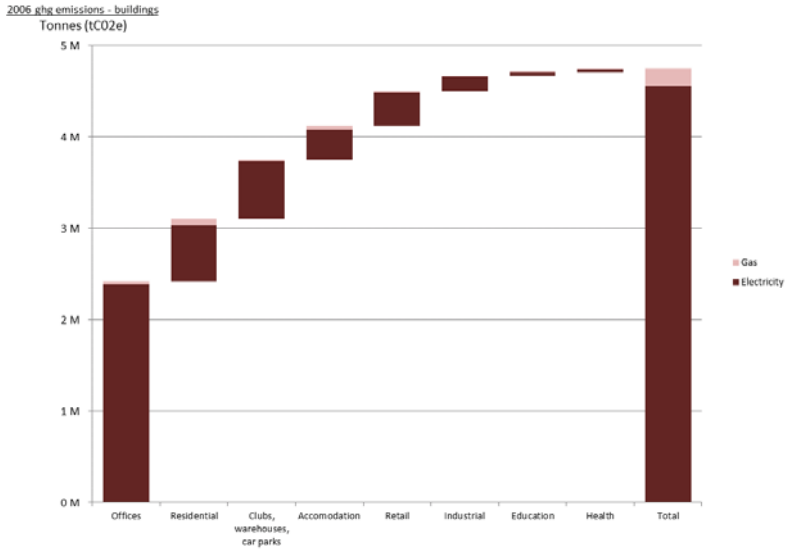


FIGURE 51. CITY OF SYDNEY 2006 EMISSIONS BY SECTOR & FUEL TYPE



FUTURE SCENARIOS

Accurately modelling a future with multiple complex interactions, assumptions and uncertainties is challenging. In developing this Master Plan, pitt&sherry applied a rigorous and evidence based approach to forecast a range of energy efficiency scenarios.

These scenarios were developed in consultation with stakeholders from government, the building sector, energy sector and community groups to ensure a detailed and practical understanding of current energy performance and to ground truth the modelling.

Figure 52 and Figure 53 depict the scenarios. Each scenario shows a substantial decline in both energy and greenhouse gas emissions by 2030, despite a 29 per cent increase in floor space. This continuing decline in energy consumption, due in large part to energy efficiency, seems very likely; the question is, to what extent?

FIGURE 52: 2006–2030 ENERGY SCENARIOS FOR THE CITY OF SYDNEY

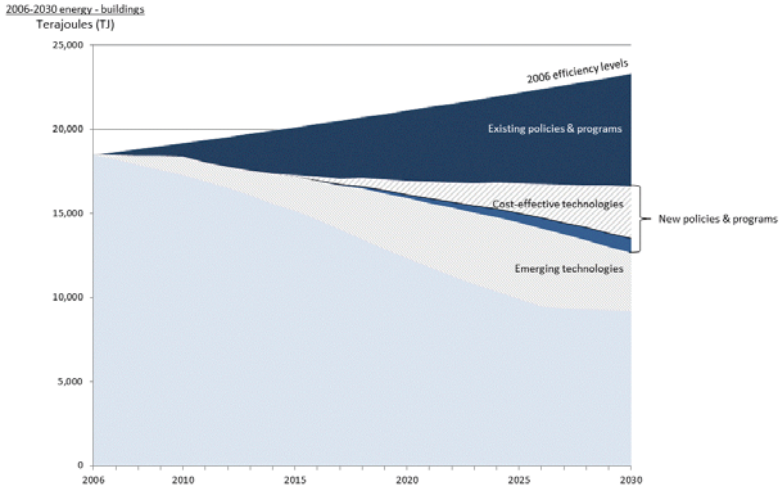
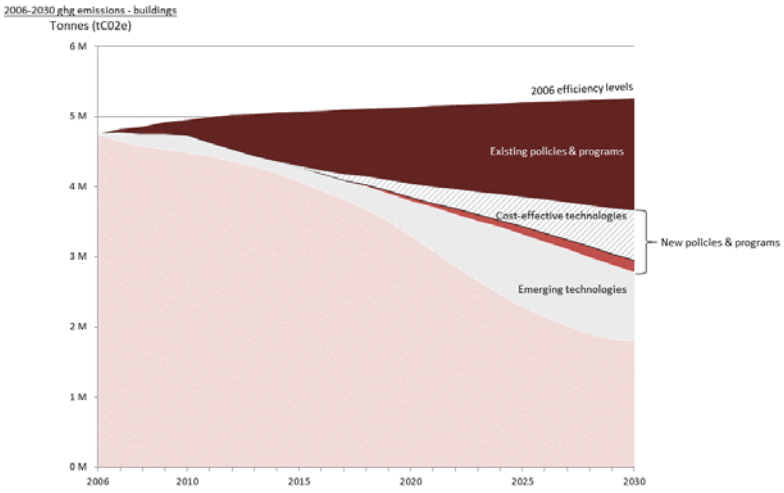


FIGURE 53: 2006–2030 EMISSIONS SCENARIOS



SCENARIO 1.
2006 EFFICIENCY LEVELS

This scenario is the reference case; it assumes that 2006 efficiency levels remain unchanged in the period modelled to 2030. In this scenario, total energy and greenhouse gas emissions growth is accordingly linked to projected growth in floor space.

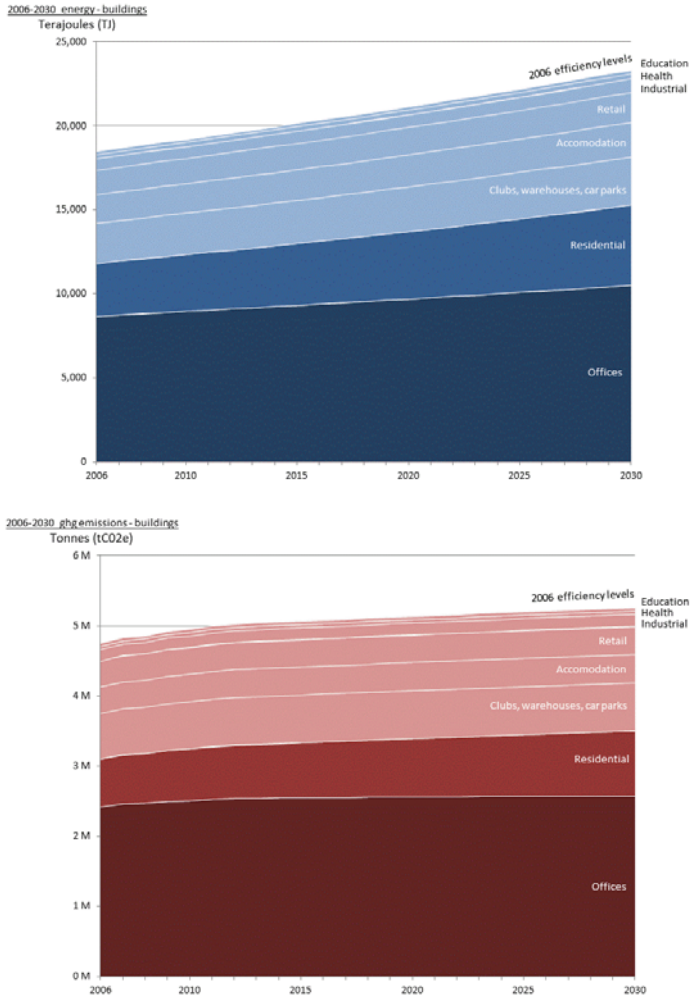
It is a highly improbable scenario given that building codes and other programs mean that most new buildings are inherently more efficient than older building stock. As outlined, total energy has decreased since 2006 despite growth in floor space.

If there were no improvements in energy efficiency over the 2006 to 2030 period, energy consumption in buildings in the City of Sydney local government area would be expected to increase by some 26 per cent or 4,800 terajoules based on 2006 levels.

Building-related greenhouse gas emissions, however, would be expected to grow more slowly, by just under 11 per cent or 0.5 million tonnes CO2e, due to an expected decline in the greenhouse gas intensity of the NSW electricity supply and a greater share of energy comes from renewable sources.

This scenario is referred to as 'frozen-efficiency' in the pitt&sherry work and sets the basis against which other scenarios are set.

FIGURE 54: 2006–2030 TOTAL ENERGY AND EMISSIONS BY SECTOR (2006 EFFICIENCY LEVELS SCENARIO)



1. Existing policies such as building codes and energy standards can save one million tonnes of $CO_{2\text{-}e}$ each year by 2030.
2. Largest energy and emissions savings are attributable to mandatory efficiency measures.
3. Keeping existing energy efficiency policies and programs is critical for continued energy and emissions savings.

SCENARIO 2.
EXISTING POLICIES & PROGRAMS

The modelling developed by pitt&sherry for this Master Plan shows that existing policies and programs significantly improve the energy efficiency of buildings with time. The key measures[38] modelled include:

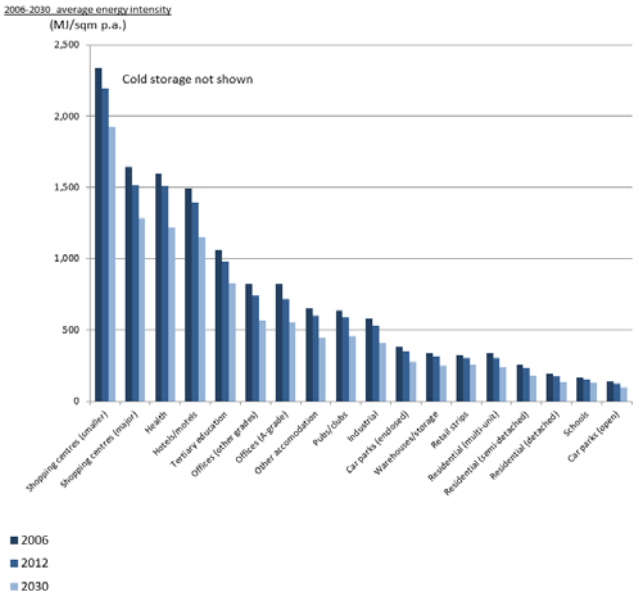
- Better Buildings Partnership (BBP).
- CitySwitch Green Office.
- Commercial Building Disclosure (CBD).
- Green Star.
- Minimum Energy Performance Standards (MEPS).
- National Australian Built Environment Rating Scheme (NABERS).
- National Construction Code (NCC).
- NSW Building Sustainability Index (BASIX).
- NSW Energy Savings Scheme (ESS).
- Smart Green Business.

Without unforeseen changes to these policies and programs – or new initiatives – this scenario indicates what a probable 'business-as-usual' future looks like and is based on assumptions for churn and new development rates, and that buildings are performing at least as efficiently as design intended.

However, the extent to which existing policies and programs may reduce future energy demand is testament to the importance of maintaining these provisions at current or higher standards. Future savings shown by this scenario would continue the decline in energy consumption observed since 2006.

The effect of these policies and programs is that the inherent design, equipment used, and operation of buildings is more efficient and requires less energy than an equivalent building from 2006. Figure 55 shows the improvement in energy intensity for each sector over time due to existing policies and programs (these are averages for all buildings and do not reflect the energy intensity of individual new buildings – which are higher).

FIGURE 55. 2006–2030 AVERAGE ENERGY INTENSITY BY SECTOR (EXISTING POLICIES & PROGRAMS SCENARIO) FOR THE CITY OF SYDNEY



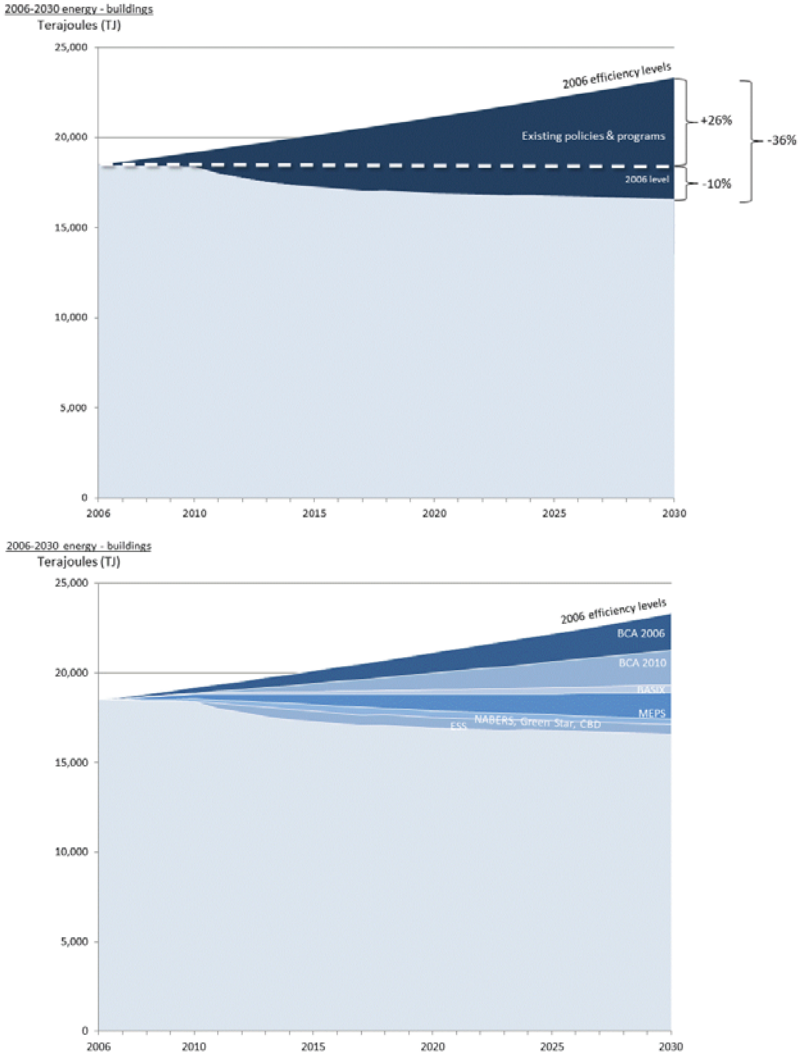
The contribution of each of the key policies and programs to total energy savings is shown in Figure 56. The savings attributable to each measure is shown as a 'wedge' of savings relative to 2006 consumption levels.

While numerous energy efficiency policy measures contribute to the energy savings, it appears that the largest savings are attributable to mandatory efficiency measures. The greatest contribution is made by the National Construction Code (NCC).

This is depicted as BCA2010 in the chart to show the time effect of changes to the code in these years. Further significant savings come from Minimum Energy Performance Standards (MEPS), the NSW Building and Sustainability Index (BASIX), the NSW Energy Savings Scheme (ESS), the National Australian Built Environment Rating System (NABERS), Green Star and Commercial Building Disclosure (CBD).

The energy savings from existing programs are expected to diminish in relative terms through time as buildings become more efficient and energy savings opportunities diminish.

FIGURE 56: 2006–2030 TOTAL ENERGY (EXISTING POLICIES & PROGRAMS SCENARIO)



Assuming no changes to these existing policies and programs, and without new measures, energy consumption in buildings in the City of Sydney local government area would be expected to decrease by ten per cent, or 1,888 terajoules based on 2006 levels. This is a net saving which accounts for the substantial growth which would otherwise occur in the absence of improved energy efficiency. Electricity consumption would fall by around 14 per cent, while gas consumption would be expected to rise by nine per cent, reflecting greater efficiency gains in electrical end uses and some fuel switching towards gas.

Figure 57 shows how energy intensities would improve and total energy savings projected from existing policies and programs may apply to specific sectors. It also shows that new buildings constructed between 2015 and 2030 would contribute around 26 per cent of the total energy savings projected. Figure 58 provides an update for 2030 energy use by sector (compared with 2006 levels as shown in Figure 44).

FIGURE 57: 2006–2030 ENERGY INTENSITY AND TOTAL ENERGY BY SECTOR & NEW BUILD (EXISTING POLICIES & PROGRAMS SCENARIO)

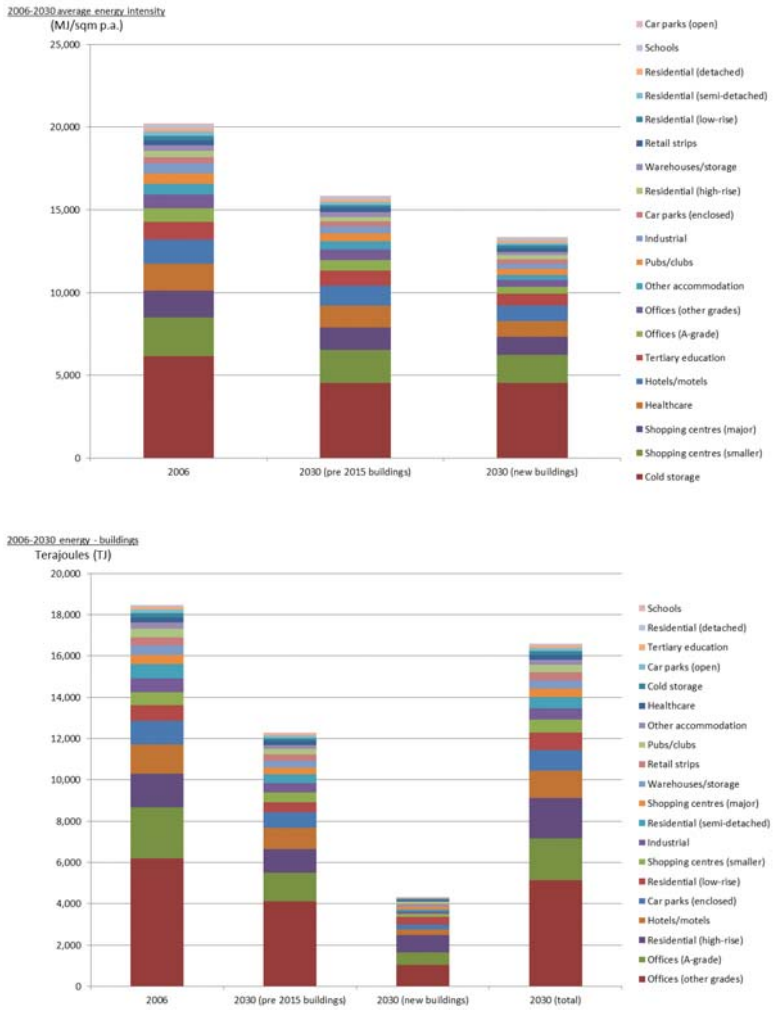
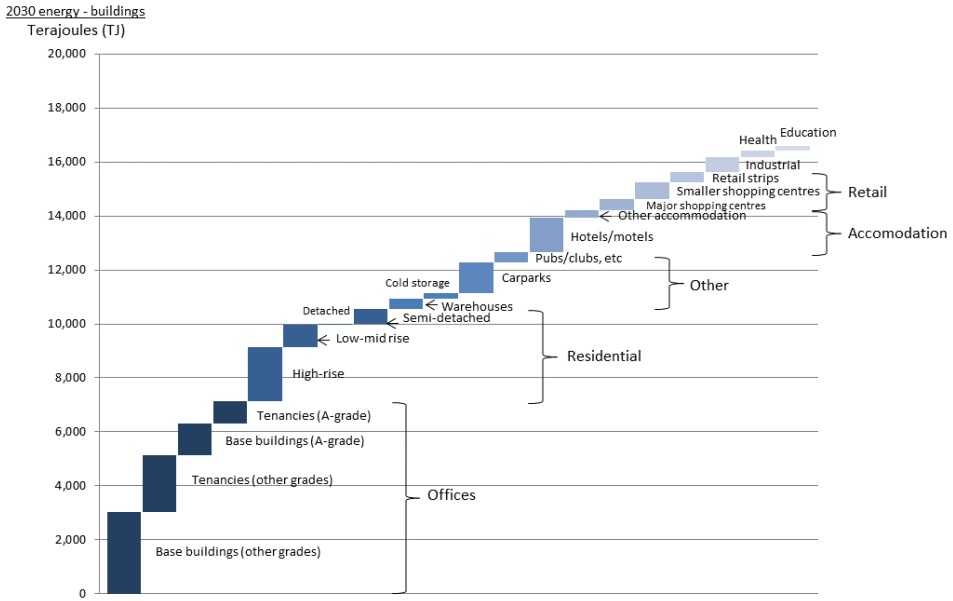


FIGURE 58. 2030 TOTAL ENERGY BY SECTOR (EXISTING POLICIES & PROGRAMS SCENARIO)



The reduction in energy consumption from existing programs and policies translates into reductions in building-related greenhouse gas emissions, by around 23 per cent, or one million tonnes of CO2e by 2030 below 2006 levels.

Figure 59 shows the contributions that existing policies and programs make to overall greenhouse gas emissions savings based on energy savings shown above. The contribution of each sector toward total reductions in greenhouse gas emissions from existing policies and programs is shown in Figure 60 and Figure 61.

The energy and emissions savings from existing policies and programs are significant, however these savings could be at risk due to weakening of policy settings, higher than predicted increases in temperatures (increasing demand for air conditioning), poor compliance with codes and standards, income growth (greater use of energy consuming equipment), or unanticipated new energy demand. These issues will require a watching brief.

FIGURE 59: 2006–2030 TOTAL EMISSIONS (EXISTING POLICIES & PROGRAMS SCENARIO)

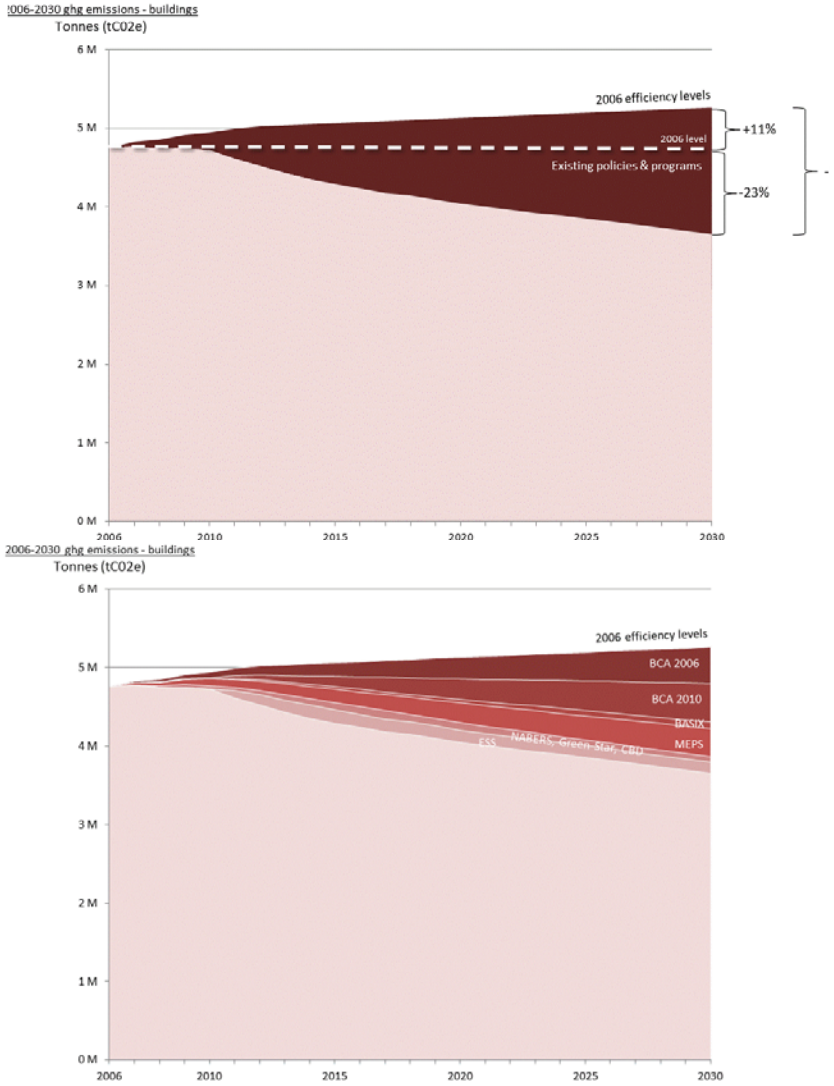


FIGURE 60: 2006–2030 TOTAL EMISSIONS BY SECTOR (EXISTING POLICIES & PROGRAMS SCENARIO)

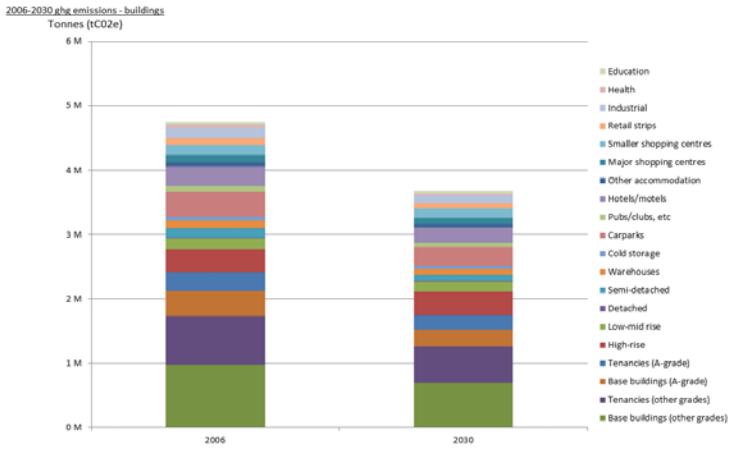
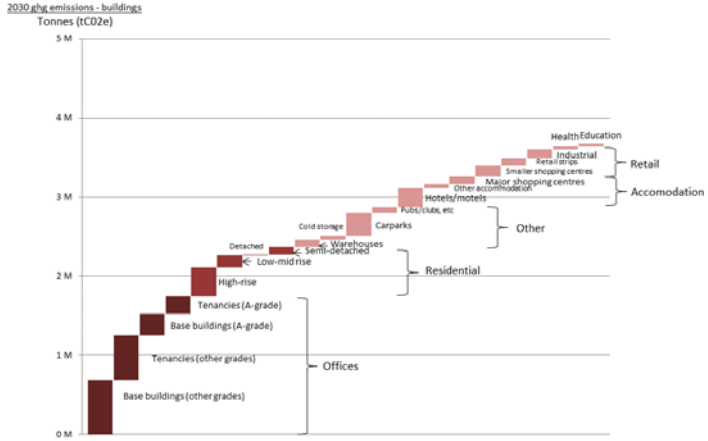


FIGURE 61. 2030 TOTAL PROJECTED CITY OF SYDNEY EMISSIONS BY SECTOR (EXISTING POLICIES & PROGRAMS SCENARIO)



SCENARIO 3. NEW POLICIES & PROGRAMS

This scenario explores new policies and program opportunities to improve energy efficiency beyond existing measures outlined by Scenario 2, to contribute to the Master Plan. Analysis by pitt&sherry shows there are significant cost-effective energy savings opportunities are available beyond existing programs and policies.

The key measures modelled[38] were based on Exergy energy audits and the Smart Green Apartments program data and include:

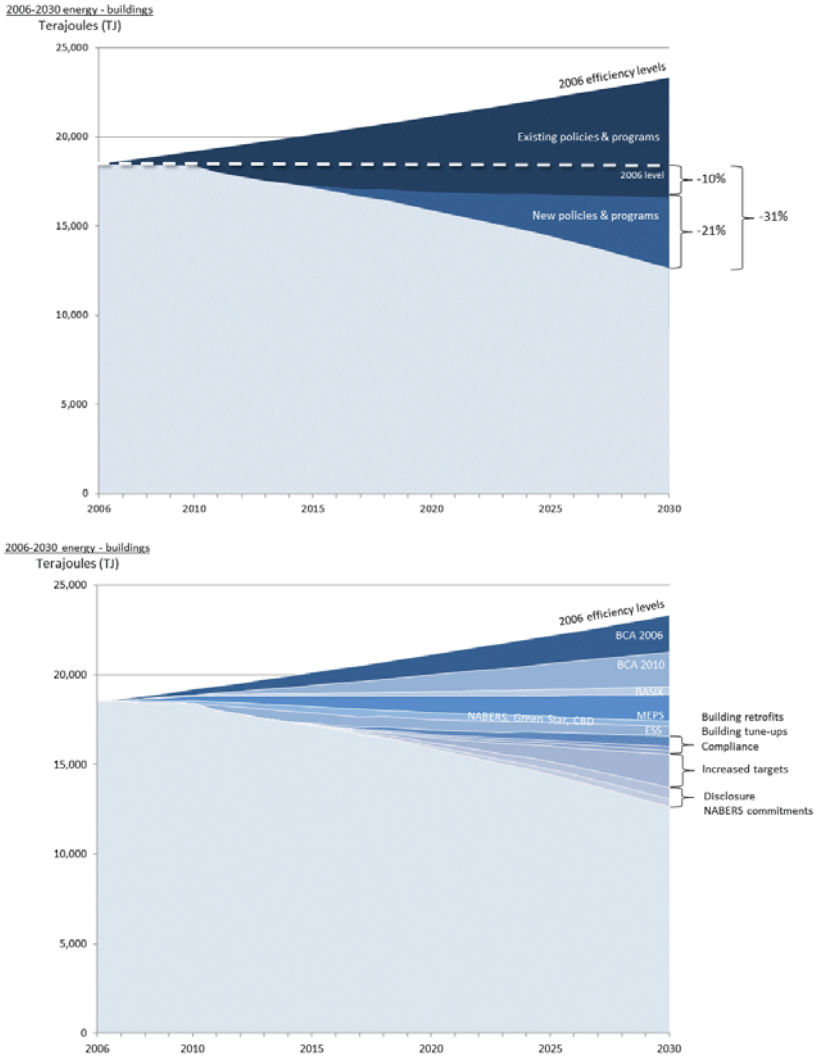
- Building retrofits.
- Building tune-ups.
- Compliance.
- Increased targets.
- Disclosure.
- NABERS commitments.

This is by no means an exhaustive list of new policy and program opportunities, however it provides a robust scenario based on improving existing measures that are well established and understood by the market.

Modelling by pitt&sherry included medium and rapid uptake scenarios which affected the extent of savings achievable by 2030. Given the high cost-effectiveness of initiatives proposed, this Master Plan adopts the rapid uptake scenario.

Energy savings modelled under this scenario and including existing policies and programs are around 5,300 terajoules below 2006 levels by 2030, equivalent to a 29 per cent reduction as shown in Figure 62. This assumes all new measures are taken up – however levels of take-up would be highly influenced by the program design, respective roles of local, state and Australian Governments, economic conditions and market trends.

FIGURE 62: 2006–2030 TOTAL ENERGY (NEW POLICIES & PROGRAMS SCENARIO)



The energy savings from new policies and programs leads to a steady reduction in the average energy intensity of all building types over the period to 2030. The rate of change varies by building type depending upon the number and stringency of energy efficiency measures that affect each particular sector, the rate of stock turnover or take-up of measures.

Figure 63 shows the improvement in energy intensities and total energy savings from new policies and programs (in addition to existing measures shown in the previous section). Total energy savings are higher and the role of new buildings constructed between 2015 and 2030 would contribute more, at around 29 per cent of the total energy savings projected.

Reductions in greenhouse gas emissions follow a similar trend to the energy savings modelled for new policies and programs with a saving of 1.9 million tonnes of $CO_{2\text{-}e}$ possible by 2030, equivalent to 41.5 per cent below 2006 levels.

FIGURE 63: 2006–2030 ENERGY INTENSITY AND TOTAL ENERGY BY SECTOR & NEW BUILD (EXISTING AND NEW POLICIES & PROGRAMS SCENARIO)

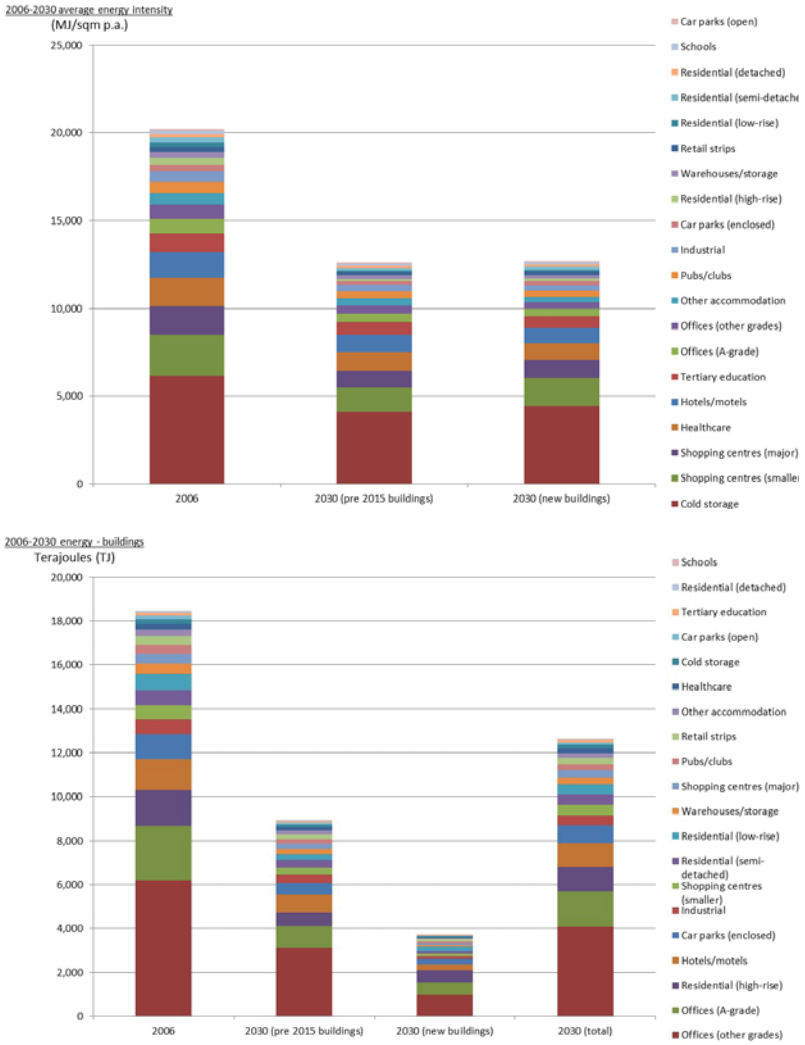
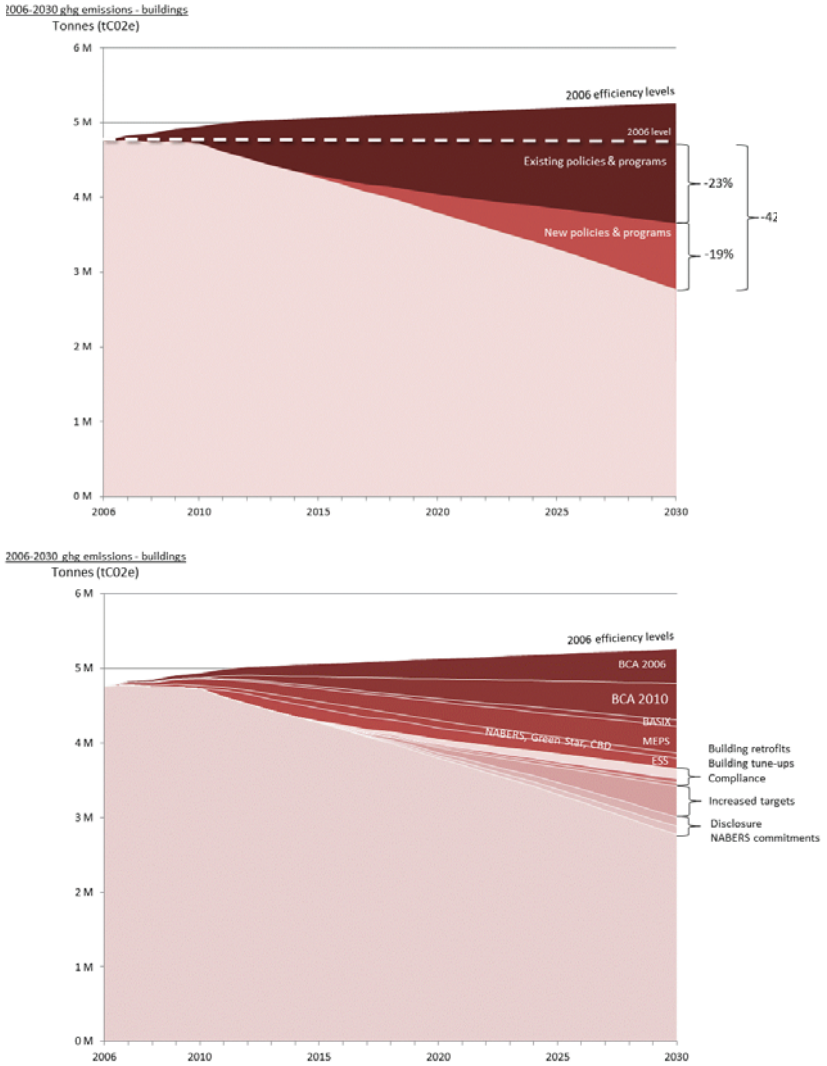


FIGURE 64: 2006–2030 TOTAL EMISSIONS (NEW POLICIES & PROGRAMS SCENARIO)



Of the new policies and programs modelled, the greatest reduction in energy and greenhouse gas emissions would come from increasing performance targets for new buildings and refurbishments, which could be achieved by increasing the stringency of energy efficiency provisions in the National Construction Code and BASIX. A short description of each new measure is provided below.

BUILDING RETROFITS

Building retrofits refer to major plant upgrades and replacement to improve the energy performance of buildings. These are typically costly to implement, however also result in substantial energy and cost-savings.

The modelling for this Master Plan is based on implementing a building retrofit program that works with building owners, conducting detailed energy audits to provide a business case for energy performance improvements.

The challenge with such programs is encouraging uptake, considering that most energy efficiency retrofit opportunities are highly cost-effective and should already have been implemented. In reality, many cost-effective energy efficiency opportunities are not taken up for various, non-economic reasons.

The assumptions made for this Master Plan for each building type are listed in the table below. Average audit costs were $5,000 for low-medium rise apartments, and $10,000 for high-rise apartments and non-residential buildings. Energy savings and incremental costs were compiled as the averages of all the retrofit options, for all building classes.

Assumptions	Non-residential	High-rise residential	Mid-low rise residential	Detached residential	Semi-detached residential
Average life of investment (years)	7	10	10	10	10
2014 take up	25%	5%	5%	5%	5%
Maximum take up (share of eligible stock)	75%	75%	75%	75%	75%
Additional take up annually	0.9%	1.9%	1.9%	1.9%	1.9%
Learning rate (real cost deflation)	1.0%	0.5%	0.5%	0.5%	0.5%

BUILDING TUNE-UPS

Building tune-ups are typically smaller and less capital intensive opportunities than retrofits to improve the energy performance of existing buildings and equipment. Typically the capital costs are lower, and substantial energy and cost savings are possible.

Program designs vary, but generally commence with an initial walk-through audit by an accredited service provider to determine whether the building is suitable and eligible for the program. This is followed by a thorough, Level 3 audit[45] to identify and establish the business case for efficiency measures. Most of the investments are likely to focus on base buildings; however some tenanted areas could be included.

Energy efficiency measures usually include tuning building management systems, HVAC control upgrades and tuning, HVAC retro-commissioning, lighting controls, de-lamping, fans, sensors and controls, and additional switching amongst others. A building owner commits to a specific investment program. Subsidies may be available to cover service provider costs, audits, and sometimes a percentage of the capital investment cost.

Between 2008 and 2011 the Australian Government Green Tune-Up Fund was an effective and popular scheme to improve energy efficiency and reduce greenhouse gas emissions. Building tune-up programs are widely used in the United States and Europe due to their cost-effectiveness. In the US many schemes are funded by levies collected by electricity users through 'demand-side' programs as least-cost options to meet energy needs.

The assumptions made for this Master Plan for each building type are listed in the table below. A$5,000 audit cost per building was assumed plus an allowance for program staff and administration costs. The measure is voluntary and only applied to existing buildings as new buildings are assumed to benefit less from tuning.

Assumptions	Non-residential	High-rise residential
Average life of investment (years)	7	10
2014 take up	5%	5%
Maximum take up (share of eligible stock)	75%	75%
Additional take up annually	1.9%	1.9%
Learning rate (real cost deflation)	0.0%	0.5%

COMPLIANCE

This measure aims to lift the energy performance standards of retrofitted buildings, by ensuring existing energy efficiency requirements under the National Construction Code and BASIX are being delivered. As discussed earlier, there is doubt about the extent to which existing requirements are being met particularly in residential and non-premium commercial buildings.

The cumulative effect of under-compliance could be very large in terms of missed savings opportunities. This measure was modelled as equivalent to a 'tune-up' program for the entire building stock, triggered when a building (or part building) undergoes a major refurbishment.

The assumptions made for this Master Plan for each building type are listed in the table below. No audit costs are assumed as the onus would be on the building owner to demonstrate that all applicable energy efficiency standards have been complied with. Allowance for program staff and administration costs is included.

Assumptions	High-rise residential	Mid-low rise residential
Average life of investment (years)	15	15
2014 take up	5%	5%
Maximum take up (share of eligible stock)	75%	75%
Additional take up annually	1.9%	1.9%
Learning rate (real cost deflation)	0.5%	0.5%

INCREASED TARGETS

This measure is mostly based on increasing targets for new residential buildings in the City of Sydney local government area. Further savings could be achieved by increasing the requirements for non-residential buildings under the National Construction Code.

Increasing minimum performance requirements of buildings by making energy efficiency requirements more stringent in the National Construction Code and BASIX (for residential buildings in NSW) can make substantial savings and bring Australian buildings on par with world leading performance.

The modelling for multi-unit dwellings is based on separate analysis by pitt&sherry for the City of Sydney which identified feasible targets to increase BASIX targets beyond current levels using cost-effective technologies and options It showed that a BASIX Energy target of at least 55 per cent (i.e. designed to deliver a 55 per cent reduction in residential per capita greenhouse gas emissions against the NSW state benchmark) is feasible for all residential building types in Sydney and suggests a strong *prima facie* case for lifting these targets.

Legislation currently requires new detached and semi-detached houses to achieve a BASIX Energy target of 40 – that is, a 40 per cent saving against the baseline average level of consumption. For high-rise apartment buildings the target is 20. The NSW Government is reviewing the BASIX target and has proposed an increase to 50 for detached and semi-detached houses and 25 for high-rise apartments. Uplifting this target to 55 instead of 25 would result in significant energy savings.

In NSW, local government is prevented from making residential energy efficiency criteria mandatory beyond the level specified under BASIX. The opportunity to set a higher BASIX target lies with the NSW Government. It is currently possible for the consent authority (Council) and the development proponent to make a voluntary planning agreement with higher criteria, but this is an ad-hoc process and will not deliver consistent outcomes at scale across most new residential development.

For detached and semi-detached dwellings the modelling calls on Sustainability House research[46] which shows up to one additional NatHERS star may be gained by zero cost design opportunities including window size and positioning, orientation, internal zoning, shading and minor wall changes.

Assumptions	High-rise residential	Mid-low rise residential	Detached residential	Semi-detached residential
Average life of investment (years)	10	10	10	10
2014 take up	0%	0%	0%	0%
Maximum take up (share of eligible stock)	100%	100%	100%	100%
Additional take up annually	3.15%	3.15%	3.15%	3.15%
Learning rate (real cost deflation)	1%	1%	1%	1%

DISCLOSURE

This measure assumes that a suitable ratings tool, such as the National Australian Built Environment Rating Scheme (NABERS) or equivalent, is developed for all classes of buildings and marketed to building owners and developers as an opportunity to differentiate their products and attract market premiums. Offices, hotels and shopping centres are excluded from the analysis, as they are already covered by NABERS tools.

Developing an effective rating and disclosure scheme that addresses broader building categories would need to consider and overcome some of the market barriers, for example within strata-title situations.

Initially, this measure was modelled on all other building types. However, feedback from stakeholders in developing this Master Plan suggests there would be significant challenges to develop disclosure schemes for sectors which are either institutional, for example hospitals and tertiary education and/or rarely tenanted buildings such as car parks and warehouses.

Two scenarios were modelled based on a voluntary or mandatory scheme being developed for the residential and retail sectors with disclosure at point of sale or lease (similar to the Commercial Building Disclosure Scheme). Take-up rates are assumed to be low for a voluntary scheme due to barriers such as strata-related issues and limited drivers for non-commercial entities to participate.

The modelling used in this Master Plan assumed a mandatory disclosure scenario where take-up rates are much higher. For example, many apartment buildings would have units available for lease at most times which would effectively amount to a continuous disclosure cycle.

Compared with a voluntary scheme the costs are higher, but so is the magnitude of savings. Due to the high take-up rate, savings are assumed to diminish with time, as the best and most cost-effective savings measures are likely to be taken up first.

For rated buildings, energy savings are based on nine per cent savings reported under the existing NABERS program for buildings rated more than once[47]. Incremental costs are calculated as an average from Exergy audits and the Smart Green Apartments data set, as it is not possible to know which technical measures would result from this policy measure.

Average rating costs of $5,000 for high rise buildings and $3,000 for other building types were used. Financial modelling includes program development costs and two full-time positions to administer the program – however this is discounted as it is considered this program would be run nationally or at the state level, thereby sharing the administrative overheads.

Assumptions	Non-residential	High-rise residential	Mid-low rise residential
Average life of investment (years)	10	10	10
2014 take up	0%	0%	0%
Learning rate (real cost deflation)	1%	1%	1%
Maximum take up (share of eligible stock)	100%	80%	80%
Additional take up annually	6.3%	5.0%	5.0%

NABERS COMMITMENTS

The National Australian Built Environment Rating System (NABERS) is a voluntary rating tool used to measure the energy performance of buildings. In some jurisdictions in Australia NABERS is used as a regulatory planning tool by requiring a NABERS Energy commitment agreement to be submitted as part of a development application.

There are many benefits for using NABERS commitment agreements to improve the energy efficiency of new non-residential buildings. The energy savings are significant and it may be implemented within existing regulatory frameworks and using existing rating tools. It is also considered to result in a net economic benefit to society with a negative cost of carbon abatement.

A scenario was modelled which applies mandatory minimum NABERS ratings for new developments from 2017. It applies to building types where there are existing NABERS ratings tools – including office buildings (base building and tenancies), hotels (base building only) and shopping centres (base building only).

Minimum compliance with National Construction Code energy performance requirements are estimated to result in buildings with a 4 star NABERS Energy rating, however there are uncertainties. For modelling purposes a 5 star NABERS Energy commitment was applied.

Assumptions	Offices (base buildings & tenancy)	Shopping centres (base buildings only)	Hotels (base buildings only)
Average life of investment (years)	12	12	12
2014 take up	0%	0%	0%
Learning rate (real cost deflation)	0%	0%	0%
Maximum take up (share of eligible stock)	100%	100%	100%
Additional take up annually	0%	0%	0%

SCENARIO 4. COST-EFFECTIVE TECHNOLOGIES

This scenario is based on an assessment of technologies which are deemed to be cost-effective, meaning a very short payback – typically less than three-years. The modelling is based on real-world Exergy energy audits and refurbishment projects along with the Smart Green Apartments program data from investments already undertaken for buildings in Sydney. This means there is high confidence that the modelled savings are achievable.

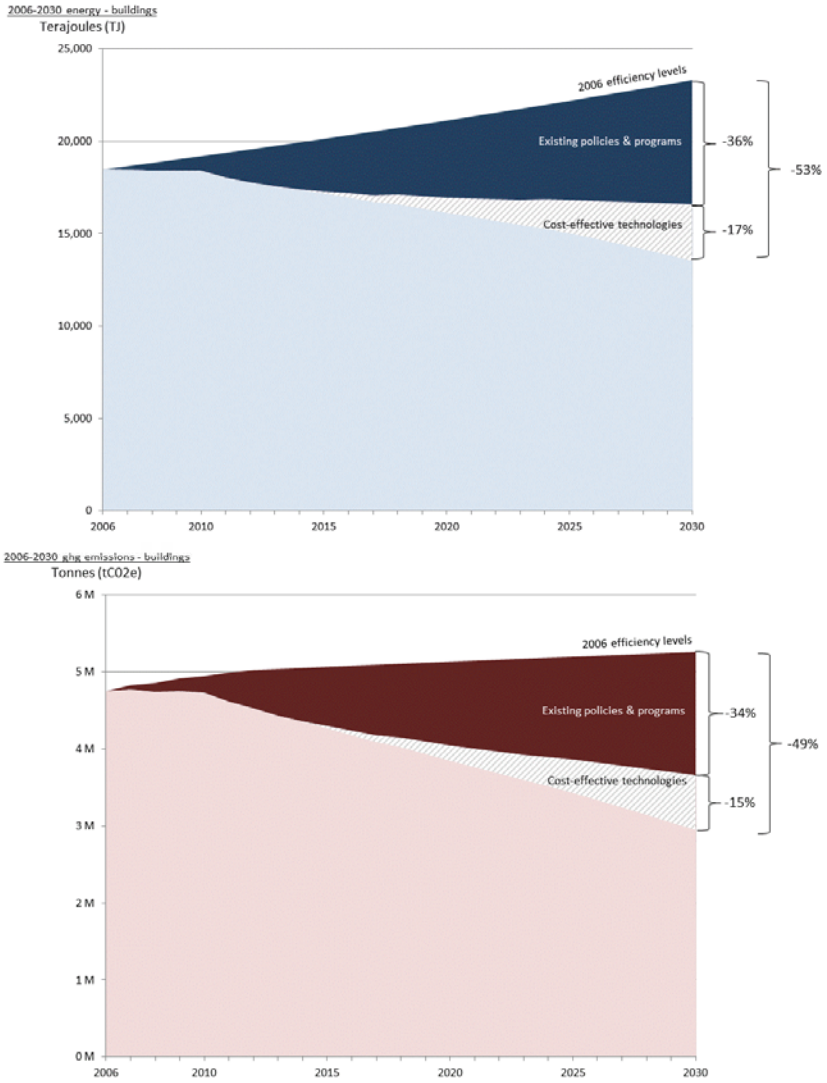
This scenario shows the scale of savings from cost-effective technologies is similar to the estimated savings from new policies and programs (which indicate that the majority of savings from new measures should be achieved through cost-effective technologies).

It is considered that this scenario is a conservative estimate of cost-effective potential, as it is based it on proven and existing opportunities. Futhermore, it is highly likely that new and improved technologies will become cost-effective between now and 2030.

Examples of the cost-effective technologies include:

- Lighting upgrades.
- HVAC upgrades.
- Hot water system improvements.

FIGURE 65: 2006–2030 TOTAL ENERGY AND EMISSIONS (COST-EFFECTIVE TECHNOLOGIES SCENARIO)



SCENARIO 5.
EMERGING TECHNOLOGIES

Similar to the previous scenario, this scenario is based upon a technology based assessment. The difference is that this scenario considered all available and emerging technologies no matter the cost. This modelling was done to show the scope of possible future opportunities and an understanding of what is to come.

Today, the costs of these measures are higher and payback periods longer. The measures would be difficult to justify on financial savings alone. However, this situation could change as new technologies and designs become proven and affordable by 2030. Future cost-effectiveness will depend on factors such as economies of scale in production, improved reliability and performance, and increasing energy prices.

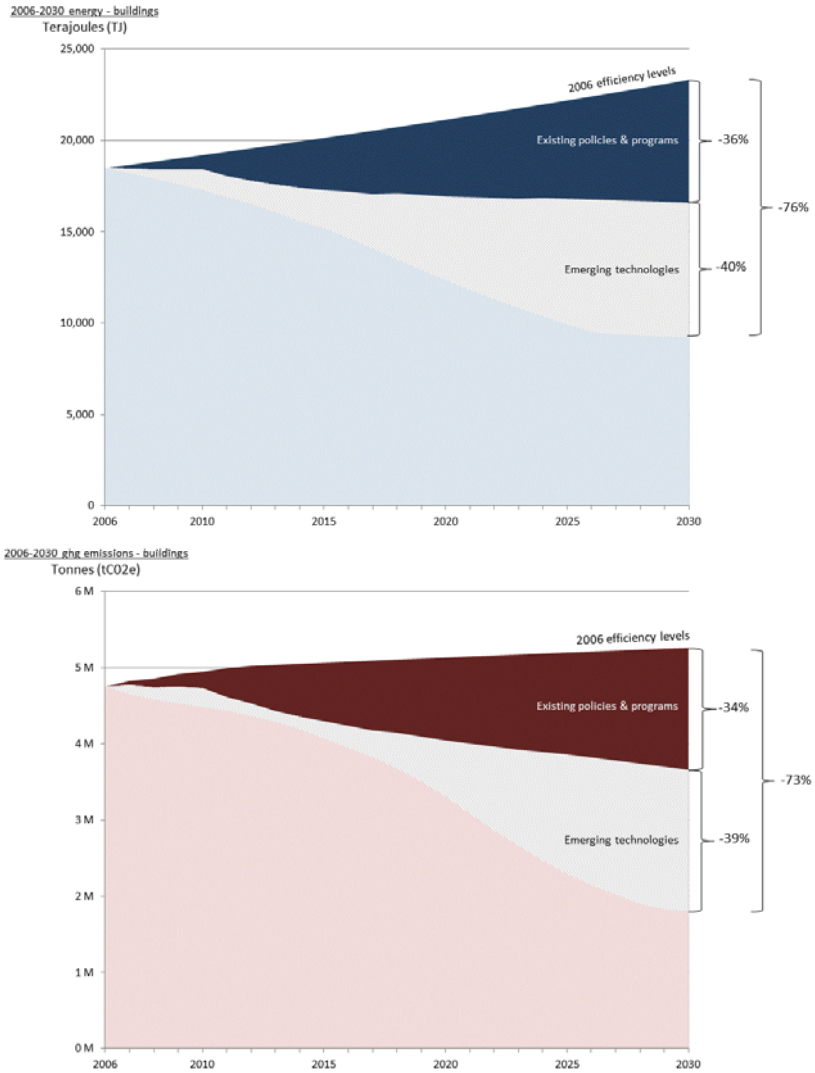
Noting these qualifications, this scenario makes it is clear that potential energy savings in buildings through emerging technologies is very high. Leading edge technologies and solutions that can deliver energy savings of 90 per cent or more are available in some applications, for example lighting or ventilation in areas with excessive air-conditioning or lighting.

For core energy using systems in many buildings – such as space conditioning, ventilation, lighting, appliances and equipment, and domestic hot water – savings potentials can reach 80 per cent compared to default solutions. Such levels are more achievable in new buildings, but may also be achieved within major retrofits.

The potential for energy savings is dependent on a building's design, the way in which components and design features are integrated into the whole building, the quality of the workmanship in construction, and the way in which the building is used by its occupants.

New technologies may well bring even higher savings potentials as we move towards 2030. It is possible that whole new classes of energy-using technologies not currently anticipated may also arise.

FIGURE 66: 2006–2030 TOTAL ENERGY AND EMISSIONS SAVINGS POTENTIAL (EMERGING TECHNOLOGIES SCENARIO)



WHAT THIS MASTER PLAN IS PROPOSING

Energy efficiency is the result of policy, standards, technologies and behaviours, amongst other influences. The scenarios developed by pitt&sherry for this Master Plan show various pathways for future energy use in the City of Sydney local government area.

It is clear that the role of existing policies and programs (Scenario 2) is paramount for constraining net energy growth to 2030, despite a significant increase in the total number of buildings, new floor space, economic growth and increased population.

The key policies and programs that absolutely must remain at current or improved levels of stringency and coverage include:

- Commercial Building Disclosure (CBD).
- Green Star.
- Minimum Energy Performance Standards (MEPS).
- National Australian Built Environment Rating Scheme (NABERS).
- National Construction Code (NCC).
- NSW Building Sustainability Index (BASIX).
- NSW Energy Savings Scheme (ESS).

Achieving 'business-as-usual' will require ongoing monitoring and work to ensure that existing programs maintain their effectiveness.

Going beyond the business-as-usual will require a mix of new policies and programs (Scenario 3), as well as new and emerging technologies (Scenarios 4 & 5). In reality, different policies and programs will call on the same pool of technologies to achieve results; for this reason the scenarios are shown as alternative possible approaches and cannot in practice be additional to each other.

The findings and enabling actions in this Master Plan focus on existing and new policies and programs (Scenarios 2 & 3). New policies and programs that may cost-effectively deliver significant savings beyond existing measures include:

- Building retrofits.
- Building tune-ups.
- Compliance.
- Increased targets.
- Disclosure.
- NABERS commitments.

PERFORMANCE MEASURES

PERFORMANCE MEASURES

This part of the Master Plan shows energy and greenhouse gas emissions savings based on both existing and new policies and programs as identified in Chapter 4. It presents a plausible future and establishes the targets against which energy efficiency opportunities will be measured.

Benefit/cost indicators and social cost of greenhouse gas abatement curves show that energy efficiency can reap many benefits for society using technologies that are economically viable today. In addition, changing technology could increase energy efficiency beyond what is shown by this Master Plan by 2030.

By 2030, local and low/zero carbon energy is also expected to be a predominant part of the energy mix which would improve the supply-side efficiency and reduce greenhouse gas emissions. However, all energy – no matter the source – should be used efficiently, and saving energy as proposed by this Master Plan is the top priority.

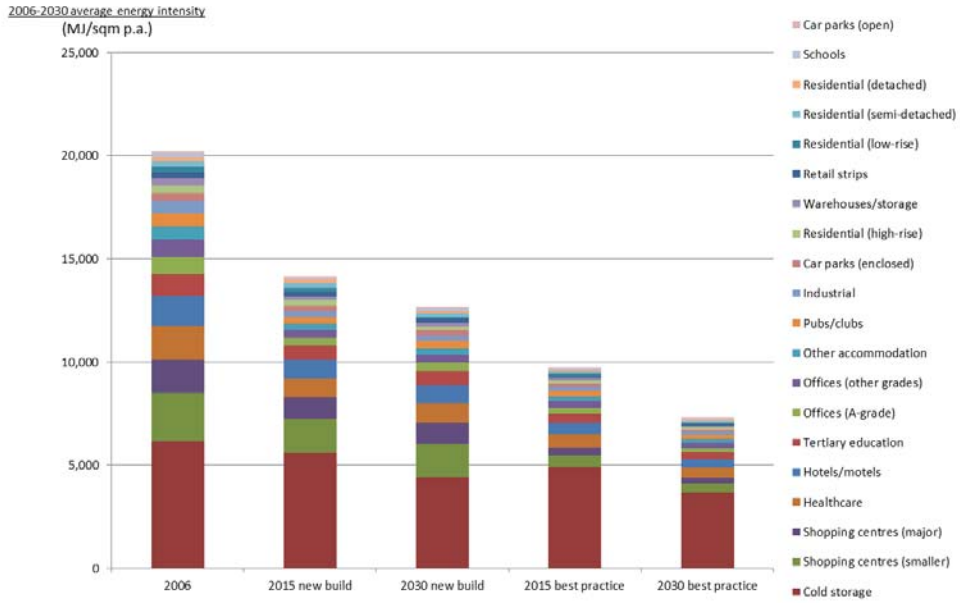
Table 10 and Figure 67 show the significant opportunities to reduce the amount of energy required per unit of floor area across building sectors within the City of Sydney local government area. Both existing and new policies and programs can make significant contributions to reducing energy intensity on par with best practice benchmarks (extrapolated from Green Star, NABERS, and other sources).

TABLE 10. ENERGY INTENSITY IMPROVEMENTS ACHIEVABLE THROUGH ENERGY EFFICIENCY MEASURES TO 2030

Sector average intensities (MJ/sqm p.a.)	2006	2015 Existing programs & policies	2030 New programs & policies	2015 Best practice	2030 Best practice
Cold storage	6,147	5,600	4,433	4,918	3,688
Shopping centres (smaller)	2,334	1,668	1,630	560	420
Shopping centres (major)	1,645	1,027	1,017	395	296
Healthcare	1,597	902	909	607	455
Hotels/motels	1,496	919	895	568	426
Tertiary education	1,059	675	676	434	326
Offices (A-grade)	825	380	386	297	223
Offices (other grades)	825	388	393	336	252
Other accommodation	650	288	297	247	185
Pubs/clubs	637	345	368	242	181
Industrial	576	276	285	190	143
Car parks (enclosed)	382	227	240	145	109
Residential (high-rise)	379	323	183	167	125
Warehouses/storage	337	164	178	128	96
Retail strips	322	197	207	77	58
Residential (low-rise)	262	216	108	115	86
Residential (semi-detached)	253	218	169	111	84
Residential (detached)	190	164	127	83	63
Schools	167	97	108	63	57
Car parks (open)	137	73	73	52	39

1. This Master Plan shows 31 per cent energy saving in buildings is feasible by 2030 with net saving to society of $208 million.
2. By 2030 total energy used in buildings may be reduced to below 13 petajoules (PJ) down from 18 PJ used today.
3. With new policies and programs, cost-effective energy efficiency can save almost two million tonnes of CO2e which is 42 per cent below 2006 buildings emissions, or 33 per cent of total LGA emissions.

FIGURE 67. ENERGY INTENSITY BENCHMARKS



This Master Plan shows how energy efficiency can reduce the total energy required by buildings in 2030 by 31 per cent below 2006 levels, despite growth in floor space during this period. This means a saving of 5,829 terajoules per year, roughly the amount of electricity used by more than 400,000 households.

The energy savings proposed by this Master Plan would reduce greenhouse gas emissions in buildings by almost two million tonnes CO2e per year which is 42 per cent below 2006 levels (or 33 per cent of total local government area emissions including emissions from transport and waste).

By 2030, existing and new energy efficiency policies and programs are expected to reduce 2006 energy levels by 31 per cent and greenhouse gas emissions by 42 per cent as shown in Table 11 and Table 12. These savings are on par with the city-wide savings that could be achieved if each sector performed at best-practice (Table 10) which would be estimated to reduce energy by 37 per cent and emissions by 46 per cent.

TABLE 11. SUMMARY OF KEY ENERGY SAVINGS IN THE BUILDING SECTOR (TJ)

2006 baseline	Terajoules (TJ)	2030 forecast	2030 saving p.a.	2006–2030 change
	FUTURE WITHOUT ENERGY EFFICIENCY			
	@ 2006 efficiency levels	23,305	–4,833	+26%
	ENERGY SAVINGS POTENTIAL UNDER DIFFERENT SCENARIOS			
	Existing policies and programs	16,585	6,720	–36%
	New policies and programs	19,364	3,941	–21%
18,473	Cost-effective technologies	20,257	3,048	–17%
	Emerging technologies	15,957	7,349	–40%
	ENERGY SAVINGS PROPOSED BY THIS MASTER PLAN			
	Existing policies & programs	16,585	6,720	–36%
	New policies & programs	19,364	3,941	–21%
	NET RESULT	**12,644**	**5,829**	**–31%**

TABLE 12. SUMMARY OF GREENHOUSE GAS EMISSIONS SAVINGS IN THE BUILDING SECTOR (T)

2006 baseline	Million tonnes ($MtCO_{2-e}$)	2030 forecast	2030 saving p.a.	2006–2030 change
	FUTURE WITHOUT ENERGY EFFICIENCY			
	@ 2006 efficiency levels	5.26	–0.51	+11%
	ENERGY SAVINGS POTENTIAL UNDER DIFFERENT SCENARIOS			
	Existing policies & programs	3.65	1.6	–34%
	New policies & programs	4.38	0.88	–19%
4.75	Cost-effective technologies	4.55	0.71	–15%
	Emerging technologies	3.41	1.84	–39%
	EMISSIONS SAVINGS PROPOSED BY THIS MASTER PLAN			
	Existing policies & programs	3.65	1.6	–34%
	New policies & programs	4.38	0.88	–19%
	NET RESULT	**2.77**	**1.98**	**–42%**

TRACKING OUR 2030 TARGET

Sustainable Sydney 2030 established a target to reduce greenhouse gas emissions across the City of Sydney local government area by 70 per cent based on 2006 levels – the level required globally to constrain warming to 2°C.

This is an absolute target and relates to the total emissions that must be prevented from entering the atmosphere. For this reason, total emissions from the local government area must not exceed a defined and absolute threshold by 2030, irrespective of growth and other changes in our city.

Since developing Sustainable Sydney 2030, waste and transport greenhouse gas emissions data quality has improved. The overall reduction target remains unchanged at 70 per cent, however the 2006 base year emissions have been adjusted marginally with a resultant change to the 2030 target emissions cap as shown by Figure 68.

FIGURE 68. UPDATED 2030 CITY OF SYDNEY EMISSIONS TARGET

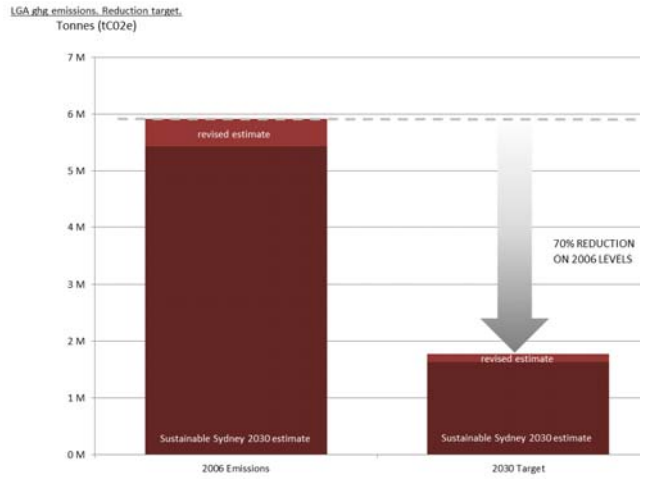
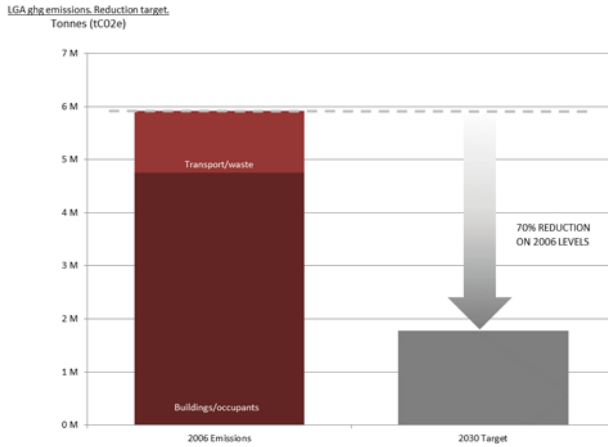


FIGURE 69. BUILDINGS CONTRIBUTION TO THE CITY OF SYDNEY 2030 EMISSIONS TARGET



In 2006, buildings and their occupants accounted for around 80 per cent of total greenhouse gas emissions for the City of Sydney local government area, predominantly due to highly polluting coal-fired electricity. The contribution from buildings toward total emissions and the reduction challenge ahead is depicted in Figure 69.

When the original Sustainable Sydney 2030 work was developed it was assumed that energy and emissions would grow each year as per historical trends. We have witnessed how this is no longer the case and Figure 70 shows a more likely business-as-usual future where greenhouse gas emissions would decrease as a result of existing energy efficiency policies and programs.

FIGURE 70. BUSINESS-AS-USUAL (BAU) 2030 EMISSIONS

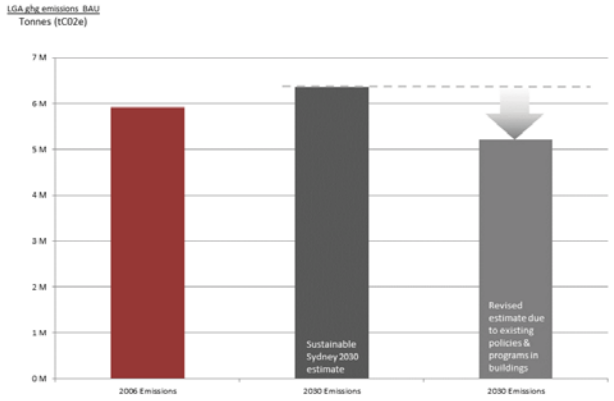


FIGURE 71. TRACKING CITY OF SYDNEY 2030 EMISSIONS TARGET

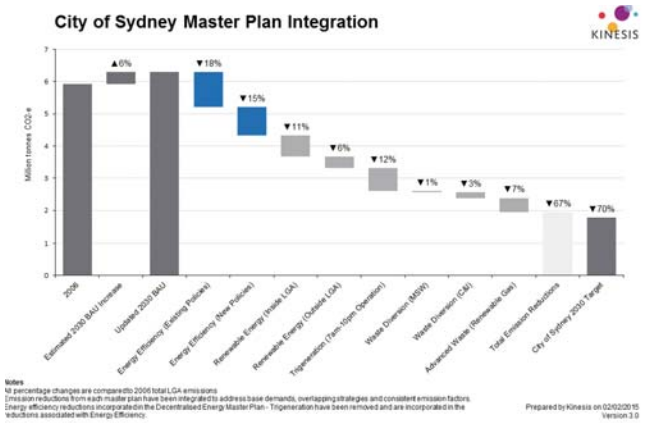


Figure 71 is an updated version of the original *waterfall* chart from Sustainable Sydney 2030 which shows identified opportunities for meeting the City's target to reduce 2006 greenhouse gas emissions by 70 per cent by 2030. It is based on detailed modelling used for this and other Master Plans developed by the City of Sydney.

This Master Plan improves our understanding about the true potential for cost-effective energy savings. Potential savings from the Trigeneration and Renewable Energy Master Plans were revisited in order to ensure each Plan is based on common scenarios and uses the same assumptions.

The significant contribution from energy efficiency is shown by the blue bars. The first bar represents the greenhouse gas emissions savings from existing policies and programs and the second bar shows the savings from new policies and programs as proposed by this Master Plan.

In 2006 greenhouse gas emissions from the City of Sydney local government area were 5.9 million tonnes $CO_{2\text{-}e}$. Our 70 per target means greenhouse gas emissions cannot exceed 1.8 million tonnes per year by 2030. Without energy efficiency, total greenhouse gas emissions are estimated to climb to 6.8 million tonnes by 2030.

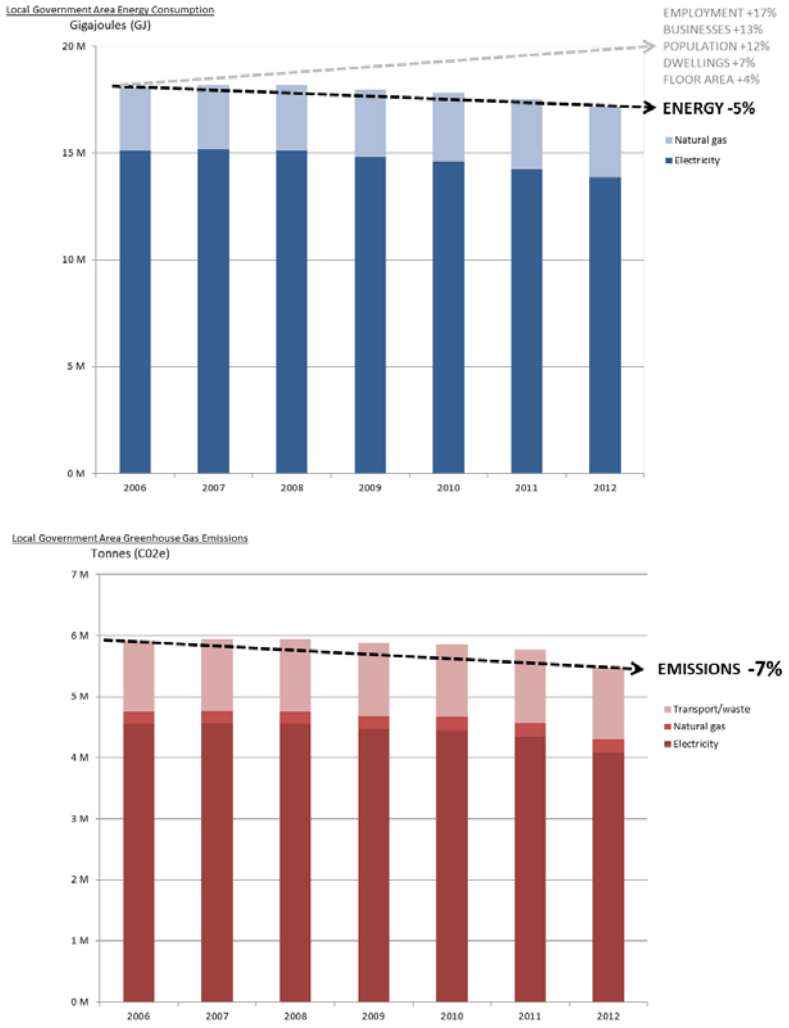
TABLE 13. 2006 BASELINE EMISSIONS & TARGET

Total emissions (Million $tCO_{2\text{-}e}$)	2006	2030 emissions cap[48]
Buildings	4.7	(1.4)
Transport	0.8	(0.3)
Waste	0.3	(0.1)
Total	5.9	1.7

Fortunately, energy efficiency is already making a difference and – based on our scenarios – will continue to do so. Chapter 2 outlined how there has been a steady decline in total energy and emissions across the local government area since 2006.

The decline in electricity consumption and the switch to lower emissions natural gas has caused a five per cent decline in overall energy and nine per cent decline in greenhouse gas emissions from buildings as shown by Figure 72. This also takes into account recent (relatively small) reductions in emissions from grid electricity due to the increased proportion of grid power that comes from renewable energy sources.

FIGURE 72. RECENT ENERGY AND EMISSIONS DECLINE IN CITY OF SYDNEY LOCAL GOVERNMENT AREA



This observed decline in both energy and emissions has occurred during a period of sustained growth in the economy, population and built form and it appears to be the new business-as-usual. Figure 73 and Figure 74 show the continued trajectory for energy and emissions savings proposed by this Master Plan based on existing and new policies and programs. Should these trends continue, total energy consumption of buildings would be 20 per cent below and greenhouse gas emissions 36 per cent below 2006 levels by 2030.

This Master Plan shows cost-effective energy efficiency measures can make a substantial, and likely the most significant contribution, toward the City's emissions target. By 2030 the total energy used by buildings can be 31 per cent below 2006 levels, despite an increased number of buildings. However, trends in technology and cost reductions (mostly beyond the City of Sydney's direct control) should not be underestimated. Emerging technologies may well save energy beyond what is shown here.

FIGURE 73: 2006–2030 TOTAL ENERGY (EXISTING & NEW POLICIES & PROGRAMS SCENARIO)

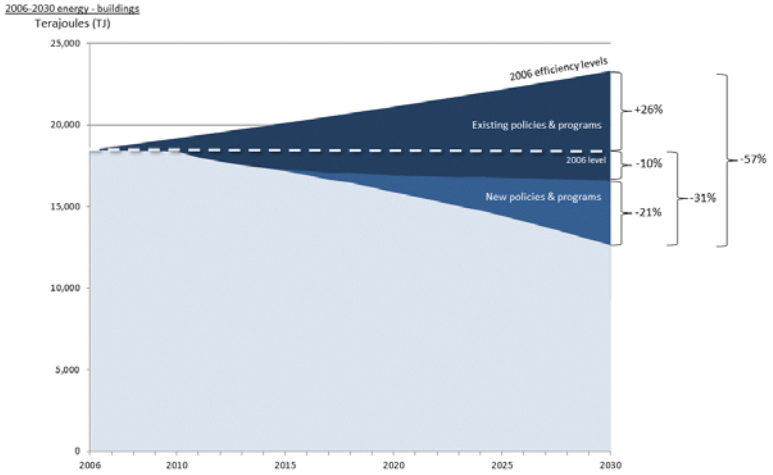
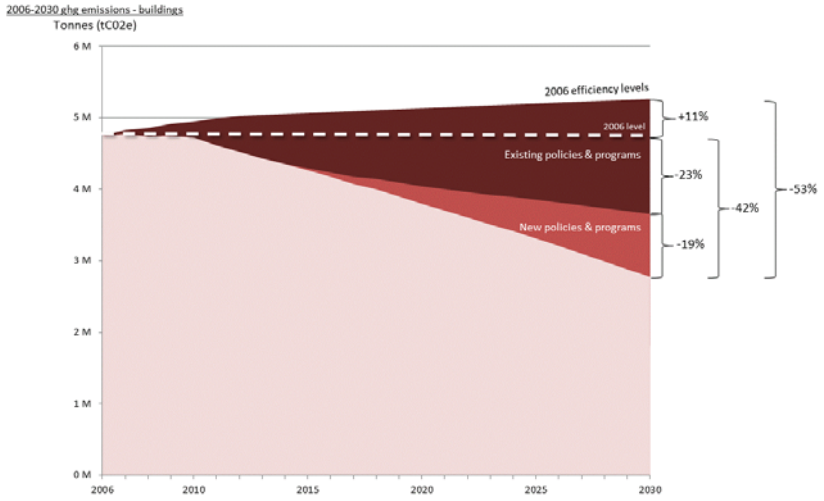


FIGURE 74: 2006–2030 TOTAL EMISSIONS (EXISTING & NEW POLICIES & PROGRAMS SCENARIO)



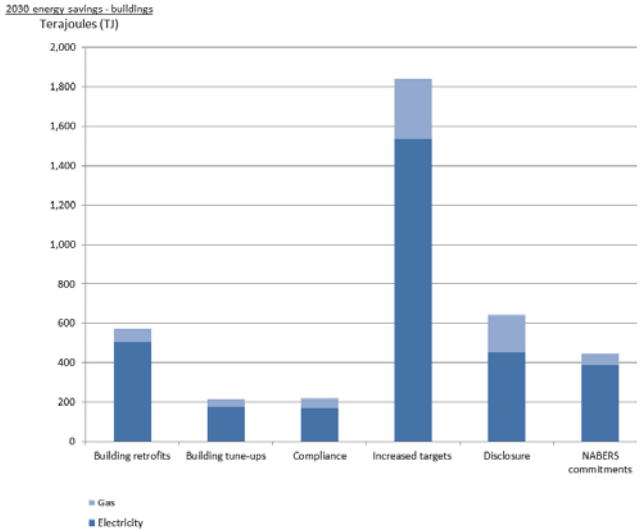
With the energy savings of the above measures taken into account, as well as the declining greenhouse gas intensity of grid electricity supply discussed, greenhouse gas emissions associated with building energy use in the City of Sydney local government area are expected to fall by 42 per cent by 2030 based on 2006 levels.

This represents a fall of almost two million tonnes CO_{2-e} from around 4.7 to 2.8 million tonnes CO2e, despite a growth in floor area of 29 per cent over the same period. This is a significant reduction and is equivalent to just under half of the City's 70 per cent emissions reduction target when taking into account non-building related emissions from transport and waste.

This Master Plan clearly shows the imperative for retaining existing policies and programs in meeting the City of Sydney's target to reduce 2006 greenhouse gas emissions by 70 per cent by 2030.

To go beyond minimum practice, new policies and programs have been modelled for this Master Plan. Figure 75 shows that lifting the targets for new buildings – predominantly higher BASIX targets for new residential developments and other mechanisms for non-residential development – have the highest energy savings potential of the new policies and programs modelled.

FIGURE 75. ENERGY SAVINGS FROM NEW POLICIES AND PROGRAMS



1. This Master Plan can double energy productivity – the economic output per unit of energy input – across the local government area by 2030.
2. Significant economic potential can be unleashed for the City of Sydney with energy efficiency.
3. Rising energy prices, climate change and the enormous productivity potential makes now the right time for energy efficiency.

FINANCIAL AND ECONOMIC VIABILITY

ENERGY PRODUCTIVITY

The City of Sydney is signatory to a joint statement by the Australian Alliance to Save Energy (A2SE) on lifting Australia's energy productivity. The aim is for a doubling of Australia's energy productivity by 2030 based on 2010 levels.

For the City of Sydney, this Master Plan shows that existing and new policies and programs could lead to a doubling of energy productivity by 2030. Deloitte Access Economics[9] estimates gross domestic product (GDP) for the City of Sydney in 2010 was $100.8 billion, increasing to $166.1 billion by 2030.

In 2010, energy demand was 17,820 terajoules (TJ) which equates to $5.66 GDP output per megajoule (MJ) of energy input. Under this Master Plan, existing and new policies and programs would reduce energy consumption to 12,644 terajoules by 2030. This equates to $13.14 GDP per megajoule, more than double the 2010 energy productivity.

This is a good indication that reducing energy demand and spend is good for economic growth and the environment. However this is an indicative result only. Further work, as outlined by Enabling Action 10 (see Chapter 5), is required to properly assess the City's 2010 energy productivity baseline and method for monitoring progress.

TABLE 14 DOUBLING ENERGY PRODUCTIVITY BY THIS MASTER PLAN

Scenario	Terajoules (TJ)	2010 $GDP/ megajoule	2030 $GDP/ megajoule	Per cent of 2010 GDP
2010 total energy	17,820	$5.66		100%
Existing policies & programs	16,585		$10.01	177%
New policies & programs	12,644		$13.14	232%
Cost-effective technologies	13,537		$12.27	217%
Emerging technologies	9,236		$17.98	318%

In addition to the GDP output per unit of energy input, Table 15 shows that there are net savings to society by implementing energy efficiency measures proposed by this Master Plan. These net savings represent 0.2 per cent of the 2010 City of Sydney GDP, which is a small but noticeable contribution. Any expenditure not used for energy can be used for other economic activity which may lead to further improvement in energy productivity.

1. The financial benefit proposed in this Master Plan is greater than the cost.
2. In addition to energy savings, this Master Plan could avoid millions of dollars' worth of network capacity.

FINANCIAL ANALYSIS

Realising the energy and emissions savings of this Master Plan would generate large benefits for Sydney's residents and businesses. Energy cost savings of up to $604 million could be realised by 2030.

Taking into account $396 million in costs, existing and new policies could deliver $208 million in net financial benefits. The financial benefit is greater than the financial cost, resulting in negative costs of abatement (that is, net financial savings for every unit of greenhouse gas abatement achieved).

Table 15 provides a summary of the financial performance of energy savings measures proposed by this Master Plan. It shows the net present value (NPV) of energy savings over the 2015 to 2030 period, associated costs, the NPV of net financial savings and benefit/cost ratio.

TABLE 15. ECONOMIC PERFORMANCE[49] OF EXISTING AND NEW POLICIES AND PROGRAMS 2015–2030

Sector	Total cost (AUD $m 2014)	Total cost saving (energy) (AUD $m 2014)	Net savings (AUD $m 2014)	% of 2010 GDP	Benefit cost ratio
Residential	$219.9	$377.5	$157.6	0.2%	1.7
Non-residential	$176.2	$226.7	$50.6	0.1%	1.3
Total	$396.1	$604.2	$208.1	0.2%	1.5

The financial modelling undertaken by pitt&sherry is based on actual project costs from Exergy audits, the Smart Green Apartments data set, and other information such as regulatory impact statements.

There is an assumption that new measures are applied between 2015 and 2030, and that savings accrue until the end of economic life of the investments or 2050, whichever is earlier. Where the end of the economic life occurs before 2030, reinvestment of capital is included.

The analysis assumes that economic performance of energy efficiency improves by typically one per cent per year, to reflect new technologies, economies of scale that reduce costs and skills improvements – also known as 'learning rate'. However, costs of labour-intensive aspects such as audits are assumed to remain constant in real terms.

A real discount rate of seven per cent is applied to bring future costs and benefits back to present value. All prices are 2014 real (inflation adjusted) dollars. Modelling does not include a carbon price. A price on carbon before 2030 would improve the benefit/cost ratios.

The net costs are inclusive of costs to comply with programs and implement upgrades (typically met by building owners) and the administration of programs (typically met by state, national or local government). Energy cost savings are typically received by building occupants through lower energy bills.

These are broad benefits and costs to society. They do not detail ways to overcome barriers about who are the winners and losers for investing into energy efficiency – a subject which is covered in the next chapter, Enabling Actions.

INFRASTRUCTURE SAVINGS

Energy savings proposed by this Master Plan have a secondary benefit of reducing network expenditure between now and 2030. With lower demand for energy, as a result of the energy efficiency measures modelled in this study, investment in electricity network and generation infrastructure could be deferred or avoided. Other things being equal, reduced expenditure on electricity infrastructure would lead to reduced electricity prices to households and businesses.

However, the degree to which efficiency measures amounts to an additional economic benefit remains to be seen. The link between network investment, energy demand and peak load is complex and difficult to forecast. It does vary through time, and patterns of energy and peak demand are changing in ways never before experienced in Australia's history.

Recent scrutiny on network investments means that historic levels of network spending may no longer be a reliable picture of what is to come. At the same time, the way that energy is being generated and used is changing, with unknown consequences for future network capacity and spending levels.

For these reasons, the economic analysis in this Master Plan does not include network cost savings. However, Table 16 provides some indication as to the level of network infrastructure costs and benefits that could result from this Master Plan over the period 2015 to 2030.

TABLE 16. ECONOMIC PERFORMANCE49 OF ENERGY AND INFRASTRUCTURE SAVINGS 2015–2030

Sector	Total cost (AUD $m 2014)	Total cost saving – energy (AUD $m 2014)	2030 capacity savings (MW)	Total cost saving – infrastructure (AUD $m 2014)	Net savings (AUD $m 2014)	% of 2010 GDP	Benefit cost ratio
Residential	$219.9	$377.5	31	$92.4	$249.9	0.2%	2.1
Non-residential	$176.2	$226.7	176	$178.6	$229.1	0.2%	2.3
Total	$396.1	$604.2	207	$270.9	$479.0	0.5%	2.2

Avoided infrastructure costs are based on conservation load factors (CLF) that relate the demand (in megawatts) for network assets to energy consumption (in megawatt hours). Each megawatt of capacity in the network has a cost, and therefore a saving if it can be avoided or reduced through energy efficiency. A value of $0.31 million/MW p.a. is assumed for the value of electricity infrastructure savings.

The conservation load factor is defined as the average annual load savings divided by the peak load savings, where both are based on measured data or the output of an hourly simulation model.

CLF = [Annual Energy Savings (kWh)/8760]/Peak Load Savings (kW)

End-uses with a relatively flat load throughout the year (such as refrigeration) will have a greater conservation load factor, for example values of 0.7 are typical. For end-uses with a relatively peaky performance throughout the year (such as residential air conditioning), the conservation load factor value is much lower, typically between 0.01 and 0.1. In this Master Plan a conservation load factor of 0.4 was applied for both residential and non-residential savings.

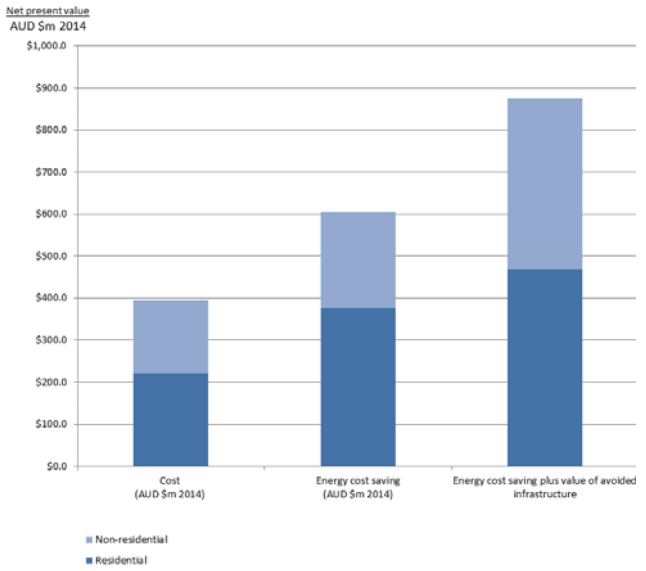
The extent to which energy efficiency may avoid or defer network investment will vary depending on the nature of the efficiency investments made. Generally, energy savings in the residential sector have a greater impact, in reducing the need for supply infrastructure, than equivalent savings in the commercial sector due to the greater 'peakiness' of residential demand – particularly space conditioning.

It is noted that avoided demand does not universally lead to a reduction in system capacity required – which is also affected by the load shape in different regions, the nature of generation technologies supplying those regions, reserve and other security requirements, load shedding capabilities and other factors. Therefore the infrastructure cost and savings estimates shown in this Master Plan should be treated as indicative only.

A similar effect as for electricity infrastructure savings could occur for gas savings, however the potential for avoiding gas network costs through efficiency measures would only occur in specific circumstances, such as when the gas network was close to fully utilised. Gas infrastructure savings have not been modelled for this Master Plan.

Given the importance of reducing energy demand and greenhouse gas emissions, regulatory systems need to evolve to enable both electricity and gas network service providers to maintain their socially valuable infrastructure services, without an explicit or implicit assumption of continual growth in energy demand.

FIGURE 76. ECONOMIC PERFORMANCE[49] OF ENERGY AND INFRASTRUCTURE SAVINGS



1. Energy efficiency is cost-effective and will make the most significant contribution – almost half – of the City's emissions target.
2. Greenhouse gas abatement is negative cost – that is for every tonne saved there is a net benefit to the community.

ECONOMIC ANALYSIS

This section of the Master Plan shows energy efficiency is a highly cost-effective way to reduce greenhouse gas emissions and its significance cannot be overlooked. Energy efficiency measures that pay for themselves require no additional cost to reduce greenhouse gas emissions. This means that there are net financial savings to be realised at the same time as emissions are reduced.

The strong growth in electricity prices in recent years has improved the value proposition for energy savings. The financial benefit/cost ratio outlined in the previous section shows how energy efficiency is inherently cost-effective – with a high return on investment. This means that for each dollar invested there is more than a dollar return.

Greenhouse gas abatement cost curves developed by pitt&sherry clearly show there are cost-effective opportunities for both existing and new policies and programs, as well as technologies. The latter is provided by way of reference as many of these technologies would be called upon under the new policies and programs scenario. The results are based on a rapid uptake scenario, meaning 100 per cent of the assessed potential is taken-up by 2030.

These are social cost of abatement curves, meaning that the costs and benefits pertain to society as a whole. They do not consider the specifics of who pays and who benefits. For example, the social cost of abatement is not changed by a decision to subsidise program costs – this merely redistributes the cost from one party to another.

The abatement cost is the present value of net annual costs in each year over this period, discounted at a seven per cent real discount rate, divided by the cumulative greenhouse gas abatement over the same period. These are *incremental costs*, or just the additional amount required to pay for the more energy efficient technology or design in question. The analysis remains balanced, because the energy savings are also measured as incremental benefits.

How to read the graphs:

Each bar represents a unique measure or opportunity. Because of this, the abatement effect of measures can be added together within a single cost curve to reveal the total abatement potential. The width of the bars indicates the volume of greenhouse gas emissions savings that accrue from 2015 to 2030. Both the height and width of each bar is affected by assumptions made about the nature of the measure undertaken, energy prices, take-up rates and many other factors. Some measures may be mutually-exclusive (such as mandatory and voluntary ratings). They should therefore be regarded as indicative only.

The vertical axis shows the social cost (typically benefit) of reducing greenhouse gas emissions. An abatement cost of $0 per tonne of abatement would indicate a measure where the benefits are equal to the cost of investment. A negative cost of abatement, shown below the line, actually depicts a *positive return* which means the investment opportunity is economically worthwhile. A positive cost of abatement, shown above the line, indicates an additional cost required to reduce greenhouse gas emissions.

These results should not be read as predicting what could be achieved in any particular building, but rather as an indicative, average result for all buildings within the City of Sydney local government area.

NON-RESIDENTIAL BUILDINGS

The social cost of abatement for non-residential buildings ranges from –$79 to –$24 per tonne of $CO_{2\text{-}e}$ abated as shown by Table 17 and Figure 77. The greatest emissions savings, more than two million tonnes over the period to 2030, would come from increasing the targets for new buildings beyond current minimum performance.

All new policies and program measures modelled for non-residential buildings are cost-effective. Each of these savings is additional to those achieved by existing policies and programs.

TABLE 17. EMISSIONS SAVINGS AND COSTS IN NON-RESIDENTIAL BUILDINGS (RAPID UPTAKE NEW POLICIES & PROGRAMS SCENARIO)

New policies & programs	Abatement cost* ($/t$CO_{2\text{-}e}$)	2015–2030 total abatement (t$CO_{2\text{-}e}$)
Building retrofits	–$21	520,438
Building tune-ups	–$51	352,106
Compliance	–$79	250,476
Increased targets	–$24	2,241,438
Disclosure	–$38	278,060
NABERS commitments	–$54	814,310

*Negative numbers denote positive return.

FIGURE 77. ABATEMENT COST CURVE FOR NON-RESIDENTIAL BUILDINGS (RAPID UPTAKE NEW POLICIES & PROGRAMS SCENARIO)

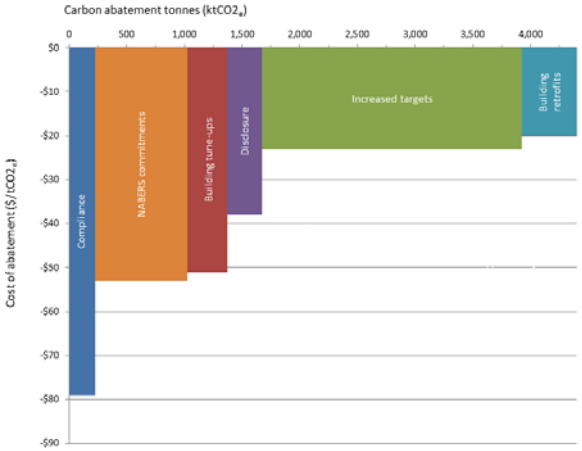


FIGURE 78. ABATEMENT COST CURVE FOR NON-RESIDENTIAL BUILDINGS (RAPID UPTAKE COST-EFFECTIVE TECHNOLOGIES SCENARIO)

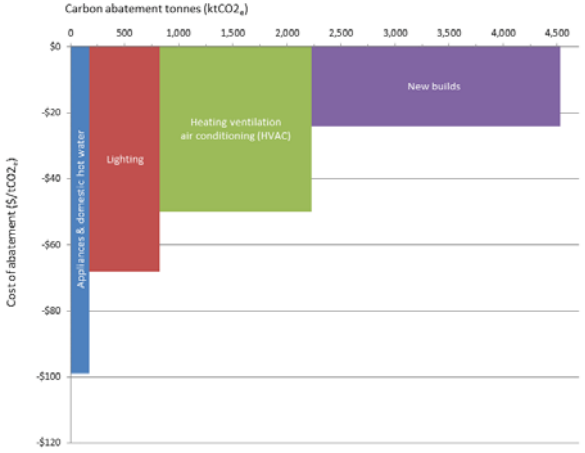


Figure 78 shows that all technologies modelled in non-residential buildings have a negative social cost of abatement, with the greatest emissions savings identified for technologies in new buildings and upgrades to heating, ventilation and air conditioning (HVAC).

HVAC often accounts for around half of total energy consumption in commercial buildings, and has large potential to reduce emissions for example through higher efficiency components, better controls and integration, and management via building management systems.

Higher efficiency new builds are an important abatement opportunity – they have higher benefit/cost ratios than retrofit of existing buildings. This is because they can use low cost design improvements and install efficient equipment and systems at marginal cost during new-build design and construction stages.

The modelling is based on detailed audit and retrofit data supplied by Exergy to represent the savings opportunities in these building segments. This data reflects commercial experience in assessing and implementing building tune-ups, retrofits, retro-commissioning and other opportunities in Sydney and elsewhere.

HIGH-RISE MULTI-UNIT DWELLINGS

Overall, there is very significant economic potential to cost-effectively reduce emissions in high rise multi-unit dwellings in the local government area. All of the measures described are cost-effective, with a negative cost of abatement. This indicates that there are net financial benefits to be realised while reducing emissions.

The largest emissions abatement opportunities for high-rise residential buildings are mandatory disclosure, building retrofits and higher efficiency standards for new buildings. Retrofits and new builds are the most cost-effective options, while mandatory disclosure is marginally cost-effective.

FIGURE 79. ABATEMENT COST CURVE FOR HIGH-RISE MULTI-UNIT DWELLINGS (RAPID UPTAKE NEW POLICIES & PROGRAMS SCENARIO)

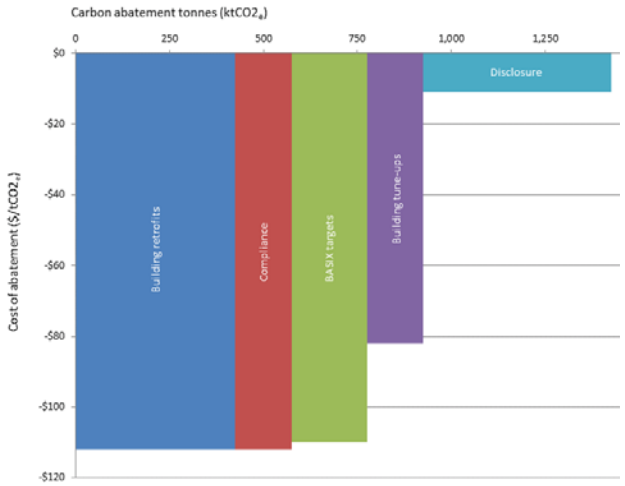


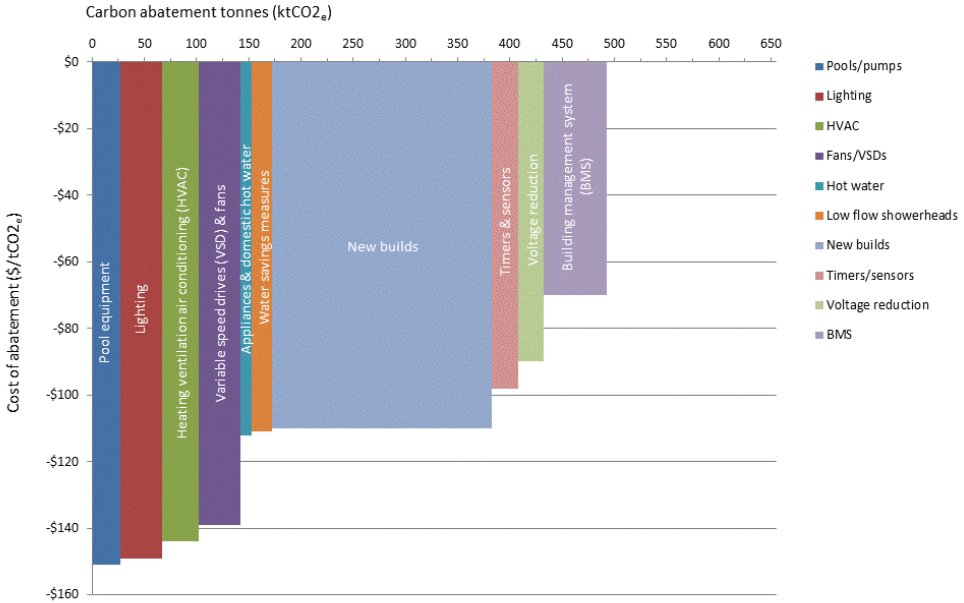
TABLE 18. EMISSIONS SAVINGS AND COSTS IN HIGH-RISE MULTI-UNIT DWELLINGS (RAPID UPTAKE NEW POLICIES & PROGRAMS SCENARIO)

New policies & programs ($/tCO2e)	Abatement cost	2015–2030 total abatement (tCO2e)
Building retrofits	–$112	434,833
Building tune-ups	–$82	129,503
Compliance	–$112	129,503
Increased targets	–$110	212,162
Disclosure	–$11	558,225

As discussed earlier, these abatement curves do not consider whether the costs are subsidised. Such decisions do not impact on the net social benefits of the initiatives but rather redistribute the costs between parties.

The greatest technology-based opportunity for saving energy and reducing greenhouse gas emissions is through improving the performance of new builds. Energy efficiency opportunities modelled for new builds relate to the fixed equipment and appliances rather than the thermal shell of the building, as the BASIX tool does not allow for incremental improvements in the thermal shell to be reflected in the percentage reduction calculated (rather, it takes a pass/fail approach).

FIGURE 80. ABATEMENT COST CURVE IN HIGH-RISE MULTI-UNIT DWELLINGS (RAPID UPTAKE COST-EFFECTIVE TECHNOLOGIES SCENARIO)

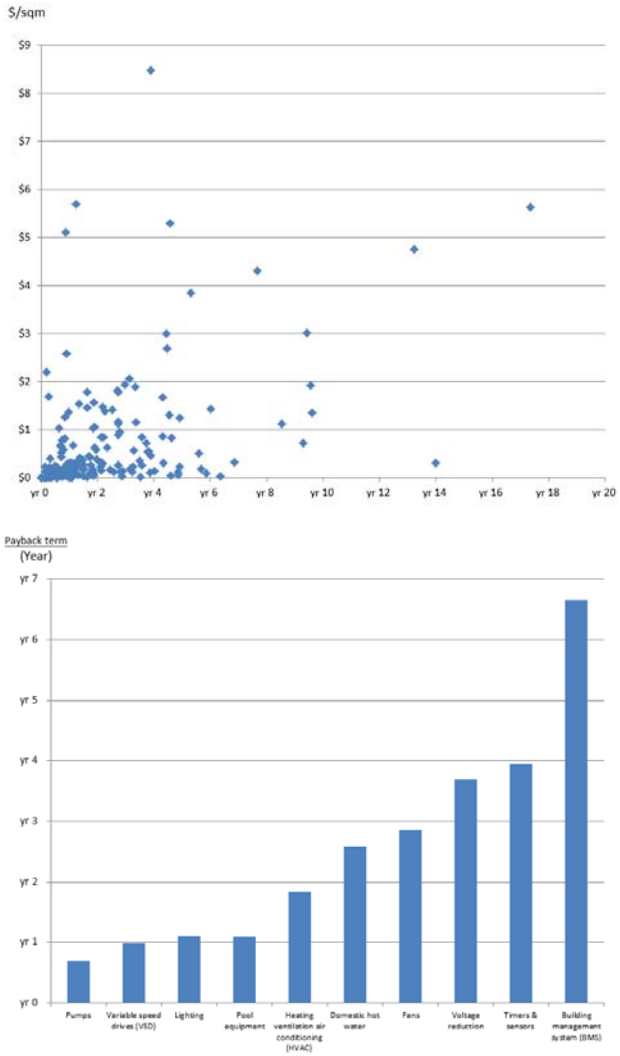


The range of incremental costs and payback periods are based on data from the Smart Green Apartments program. The vast majority of measures cost less than $2/sqm to implement with simple payback periods of less than five years. Figure 81 shows individual measures which were used for the modelling.

The modelling takes into account the starting take-up point of certain technical opportunities, for example low-flow shower heads, lighting upgrades and high-efficiency fans with variable speed drives are reasonably common due to uptake already driven by the NSW Energy Savings Scheme and other programs.

The savings opportunities for multi-unit dwellings are significantly greater than mid-low rise housing. This is because high-rise has a greater share of floor space in the local government area, is growing more rapidly, the buildings are larger, and on average use more energy because of common services, such as pools and centralised heating, ventilation and air conditioning. These factors combine to create larger opportunities for cost-effective energy savings and greenhouse gas emission abatement.

FIGURE 81. INCREMENTAL COSTS AND PAYBACK OF RETROFITS IN HIGH-RISE MULTI-UNIT DWELLINGS



MID-LOW RISE DWELLINGS

Similar to other sectors, there are cost-effective opportunities to reduce energy and emissions beyond existing policies and programs in the mid-low rise multi-unit dwelling sector. Abatement potential is lower than the high-rise sector which is reflective of the lesser floor space occupied by mid-low rise dwellings.

The measures identified for this sector range from highly to marginally cost-effective. The major opportunities are mandatory disclosure and building retrofits at –$0.50 and –$111 per tonne of $CO_{2\text{-}e}$ abated.

TABLE 19. EMISSIONS SAVINGS AND COSTS IN MID-LOW RISE DWELLINGS (RAPID UPTAKE NEW POLICIES & PROGRAMS SCENARIO)

New policies & programs	Abatement cost ($/t$CO_{2\text{-}e}$)	2015–2030 total abatement (t$CO_{2\text{-}e}$)
Building retrofits	–$113	240,698
Compliance	–$110	86,695
Increased targets	–$122	111,410
Disclosure	–$0.50	250,812

FIGURE 82. ABATEMENT COST CURVE FOR MID-LOW RISE DWELLINGS (RAPID UPTAKE NEW POLICIES & PROGRAMS SCENARIO)

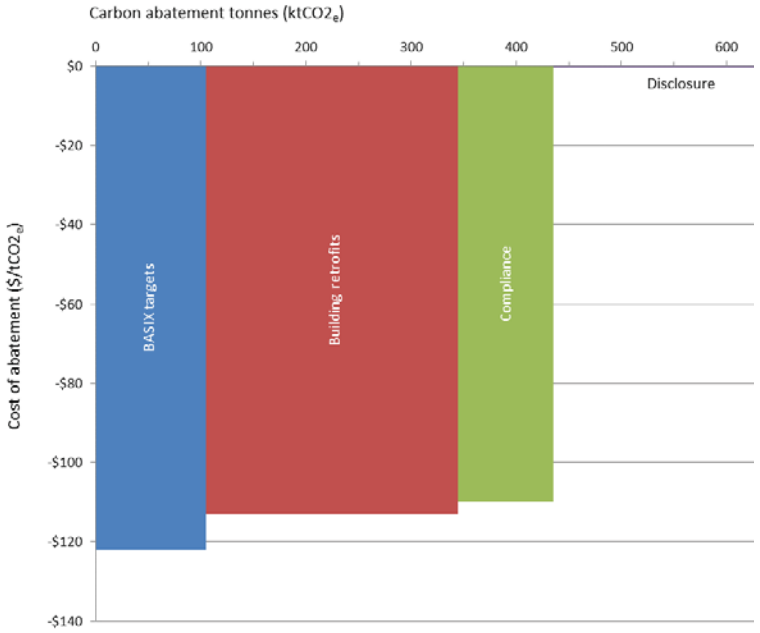
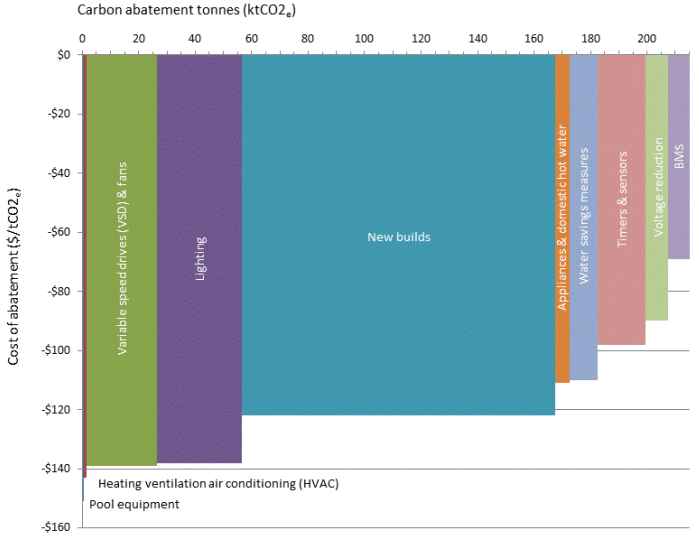


FIGURE 83. ABATEMENT COST CURVE FOR MID-LOW RISE DWELLINGS (RAPID UPTAKE COST-EFFECTIVE TECHNOLOGIES SCENARIO)



As with high-rise, the greatest technology-based opportunity for saving energy and reducing greenhouse gas emissions is through improving the performance of new builds. There are also opportunities for building management system upgrades, lighting upgrades and others initiatives within existing buildings.

Low take-ups were assumed for upgrades to swimming pools; heating, ventilation and air conditioning (HAVC); and building management systems, as these are less common in low-rise residential buildings.

DETACHED & SEMI-DETACHED DWELLINGS

There is modest potential for achieving additional greenhouse gas savings in detached residential dwellings, primarily due to their small (and declining) share of the building stock. Nevertheless, there is potential for very cost-effective savings by setting higher efficiency standards for these dwellings.

Modelling for new builds assumes techniques are incorporated during the design and build stages such as optimising orientation, internal zoning and improved management of thermal mass. The majority of savings are from upgrades to fixed appliances, such as hot water, lighting and space conditioning.

The abatement modelling for semi-detached dwellings, such as terrace houses, shows a very similar pattern to the detached dwellings however this sector represents a much larger share of floor space than fully detached dwellings in the local government area with further growth expected over the period to 2030.

With similar assumptions regarding the potential for upgrades both to new and the existing semi-detached housing stock, the abatement cost curve for this building type shows similar results to that for the detached dwelling, although the total abatement potential (width of the bar) is much greater.

Overall there is significant potential for reducing greenhouse gas emissions, beyond existing policies and programs, in semi-detached dwellings. Higher standards for new semi-detached dwellings are more cost-effective, but retrofit options offer greater abatement potential at modest net cost of abatement, on average.

TABLE 20. EMISSIONS SAVINGS AND COSTS IN DETACHED DWELLINGS (RAPID UPTAKE COST-EFFECTIVE TECHNOLOGIES SCENARIO)

Cost-effective technologies	Abatement cost ($/tCO$_{2\text{-e}}$)	2015–2030 total abatement (tCO$_{2\text{-e}}$)
Applied to new buildings	–$129	1,126
Applied to existing buildings	$13	16,043

TABLE 21. EMISSIONS SAVINGS AND COSTS IN SEMI-DETACHED DWELLINGS (RAPID UPTAKE COST-EFFECTIVE TECHNOLOGIES SCENARIO)

Cost-effective technologies	Abatement cost ($/tCO$_{2\text{-e}}$)	2015–2030 total abatement (tCO$_{2\text{-e}}$)
Applied to new buildings	–$147	15,106
Applied to existing buildings	$13	139,034

FIGURE 84. ABATEMENT COST CURVE FOR DETACHED DWELLINGS (RAPID UPTAKE COST-EFFECTIVE TECHNOLOGIES SCENARIO)

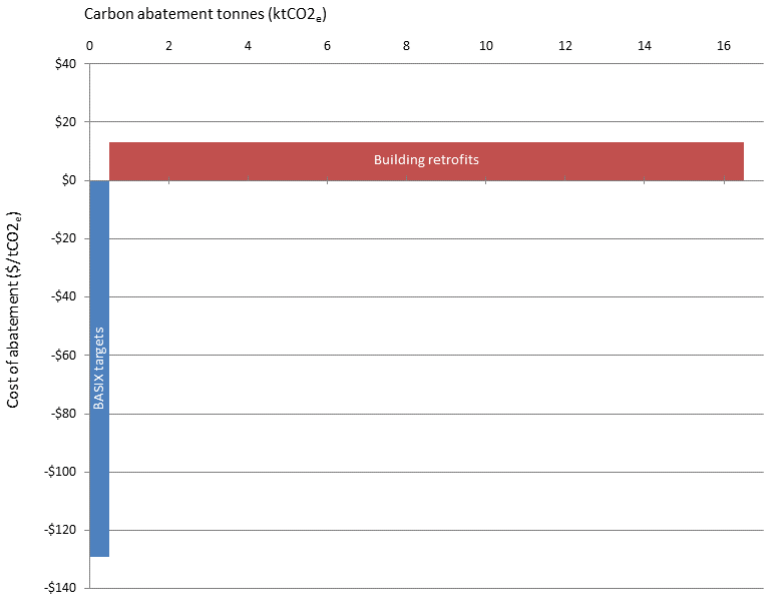
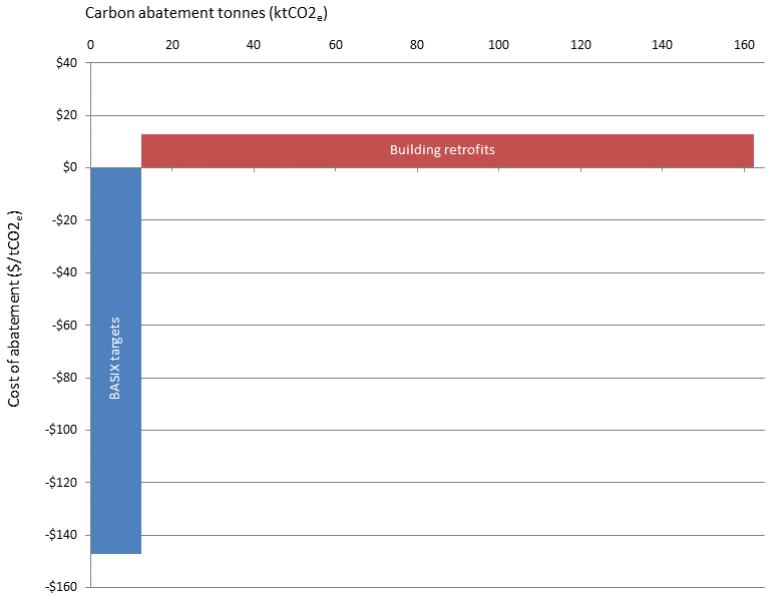


FIGURE 85. ABATEMENT COST CURVE FOR SEMI-DETACHED DWELLINGS (RAPID UPTAKE COST-EFFECTIVE TECHNOLOGIES SCENARIO)



ENABLING THE MASTER PLAN

ENABLING THE MASTER PLAN

1. It is people who make energy efficiency happen, and we need to build the skills and motivation to turn this Master Plan into actual energy savings.
2. Continuing our successful working relationship with the NSW Government and other partnerships is essential to achieving the energy savings proposed by this Master Plan

This Master Plan provides a range of energy saving solutions for buildings in the City of Sydney local government area which would reduce greenhouse gas emissions, increase productivity and save money on energy bills over the next 15 years and beyond.

The solutions are practical and can be implemented at a cost that is affordable when compared to the economic and social costs of current energy consumption levels. Taking these theoretical savings and making them real for businesses and residents is the focus of this section.

The enabling actions in this section establish a set of principles, whereby:

- New buildings meet current minimum energy performance requirements of the National Construction Code and BASIX.
- Rating tools are developed for sectors where they do not currently exist for both design and as-built stages.
- Energy performance of major energy using building types is publically reported through mandatory disclosure.
- The capacity of building owners and occupants to improve energy efficiency is improved.
- Minimum performance standards are periodically reviewed and increased in line with best practice.
- Buildings that perform beyond minimum practice are encouraged.

There is no single entity in the government or private sector that can implement the scale of energy efficiency envisioned in this Master Plan. It must be a shared responsibility implemented by all levels of government as well as businesses and residents in the City of Sydney local government area.

Energy management isn't core business for many people, but the energy and cost saving opportunities are compelling. We encourage building owners, households and tenants to act in their own economic interests and cut their energy costs through investing in energy efficiency.

BARRIERS TO ENERGY EFFICIENCY

As outlined in this Master Plan there are multiple benefits of energy efficiency, and the return on investment is typically high. However, there are a large number of factors including market failures, and existing attitudes and behaviours which impede the uptake of energy efficiency.

The recent decline in energy consumption shows that energy efficiency improvements are happening. Existing policies and programs are making a contribution and energy users are increasingly responsive to energy prices. Without further intervention, continued improvement in energy efficiency would be expected.

However, the rate and extent of energy savings can be improved by overcoming barriers to energy efficiency in both existing and new buildings. Simply waiting for the market to deliver may delay cost-effective efficiency improvements and lock energy users into higher than necessary energy costs.

This Master Plan was developed with input from multiple stakeholders and many barriers were identified, which if not addressed, may impede the uptake of energy efficiency.

The following barriers listed in this Master Plan are not unique to Sydney.

SPLIT INCENTIVE

The term *split incentive* refers to a mismatch between who bears the costs and who receives the benefits of energy efficiency upgrades. This typically occurs in a net lease commercial building where tenants pay for outgoings.

For example, the occupier of a building will generally receive the benefits from energy efficiency, through reduced energy bills and productivity improvements and yet may have a limited role in the decisions required to make energy efficiency happen.

Conversely, the costs of energy efficiency upgrades are typically borne by a building owner or developer who may find it challenging to regain their investment from energy savings such as through increased rent or property value.

Environmental Upgrade Agreements, improved returns, green leases, and innovative low cost funding mechanisms are some of the demonstrated ways to overcome the split incentive.

LIMITED INTEREST, AWARENESS OR CAPACITY

Despite growing evidence of the cost-effectiveness of energy efficiency initiatives, there are instances where this knowledge alone is not enough to prompt action. In some cases the perceived value of energy savings may be too small to capture, even if deemed to be cost-effective.

Investment in energy efficiency is more likely to occur at certain times, such as when a building or a significant part of it is being refurbished, or at point of sale or lease. Being aware of and tapping into these opportunities is important.

There may be limits to the skills, capacity or expertise required in key areas of energy efficiency, such as building optimisation. Real or perceived lack of trusted information and service providers is another barrier.

Lack of transparent energy information is a barrier. Both residential and non-residential occupants of buildings typically do not have ready access to detailed energy consumption data, especially for base building services. Access to information is necessary for making a case to improve energy efficiency.

Lack of information may also result in sub-optimal commissioning and operation of building management systems and controls once a tenant (or owner occupier) is installed in a building. This can lead to buildings using much more energy than necessary to maintain comfortable conditions.

Even when a building owner, manager or tenant is interested in energy efficiency, and has access to energy information, they may not know what steps to take. Key decision makers may not have enough information to capture energy efficiency opportunities when making purchasing decisions or selecting buildings. Governments have a role in addressing this knowledge gap.

Social factors such as overall level of wealth and attitudes towards consumption in general can also affect patterns of energy use. This is where minimum standards, technologies and behaviour change programs will make a difference.

Governments have a role to provide impartial information and to build trust through demonstration projects and technologies.

COMPLEX DECISION FRAMEWORKS

Especially in large scale energy efficiency projects there are literally hundreds of decisions that need to made, and typically many people are involved. For example, informed choices must be made throughout the whole supply chain for new buildings; from building designers, construction companies, equipment and system suppliers and installers, owners, tenants or owner-occupiers, investors, building managers, maintenance and cleaning contractors, real estate agents and many others.

Certain building title structures like strata titles add to the complexity which may delay decision-making and acting on energy efficiency opportunities. In some cases, key stakeholders such as office tenants, may have limited opportunity to participate in decision-making, and their scope to change may be affected by decisions made long ago, for example in procurement guides.

FIGURE 86 SAMPLE OF ENERGY EFFICIENCY DECISION MAKERS

COMPETING PRIORITIES

For many organisations and individuals, other priorities outweigh energy efficiency, even if it is cost-effective. Traditionally energy has only represented a fairly small percentage of total business costs or household budget, so saving energy may not be a priority for management time and focus – although this paradigm is changing with higher energy costs. Alternative strategies like investing in renewable energy may also be preferred.

Government can assist by demonstrating the business case, technologies and multiple benefits of energy efficiency and encouraging uptake through mechanisms like competition and partnerships.

LIMITED ACCESS TO FINANCE

In some cases access to finance for upfront investment can be a key barrier. Despite the often compelling case for cost-effective action on energy efficiency, other investments or spending may be seen as more pressing. Investment in energy efficiency may only happen where there is a very short return on investment, such as three-year payback or less.

Despite the business case for investing in energy efficiency, building owners and managers may not have access to the capital required. In some cases, separate departments or divisions within the same company administer capital expenditure and operational expenditure, so one would pay for energy efficiency actions whilst the other would benefit from them – a split incentive barrier within the organisation.

Government can assist by providing seed funding and connecting proponents of energy efficiency with new innovative funding mechanisms like Environmental Upgrade Agreements and Green Bonds.

COMPLIANCE UNCERTAINTY

The issue of potential non-compliance with minimum energy performance requirements of building codes has a large impact on future energy consumption. There is concern that many buildings, both commercial and residential may either not meet the standards as set out by the National Construction Code and BASIX, or may not actually perform as efficiently as intended.

Addressing the compliance of the building sector is a challenge, especially when an approval authority such as the City of Sydney does not have the capacity to enforce compliance in the existing system of private certification.

Another issue, faced not only by the City of Sydney local government area, is the extent to which refurbished buildings are being upgraded to meet current minimum requirements for energy efficiency under Section J of the National Construction Code. This is an important issue given there is a great deal of refurbishment activity that occurs each year, ranging from fit-out to complete renewal of building plant, equipment and interiors, and facade renewals.

Refurbishments and fit-outs are opportunities to upgrade the energy performance of building systems and even whole buildings, being a natural investment point in a building's life cycle. If this opportunity is not captured then the opportunity cost of lost energy savings will accumulate through time.

Newly constructed buildings (new builds) also present compliance concerns. The City of Sydney's response to the NSW Governments recent review of the BASIX scheme, noted that there is limited understanding about the actual performance of BASIX certified buildings during their operational life. This is a particularly important issue for Sydney given the increasing number of new multi-unit dwellings.

There is a role for government to develop and fund a framework for audits and compliance to quantify actual performance of buildings against the National Construction Code and BASIX targets.

ADDRESSING THE BARRIERS

Despite the often compelling case for energy efficiency, government intervention can help to overcome barriers and capture more of the benefit that energy efficiency offers. Table 22 shows that many barriers are addressed by enabling actions contained within this Master Plan.

TABLE 22. INTERFACE BETWEEN THIS MASTER PLAN AND BARRIERS TO ENERGY EFFICIENCY

	MASTER PLAN ENABLING ACTIONS										
BARRIER	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
1. Split incentive	x	x	x		x	x	x	x	x	x	x
2. Limited interest, awareness or capacity		x	x	x	x			x	x	x	x
3. Complex decision frameworks	x	x	x		x	x	x	x	x		x
4. Competing priorities		x	x		x	x	x	x	x		x
5. Limited access to finance		x	x		x	x	x	x			x
6. Compliance uncertainty	x	x	x						x	x	

NSW GOVERNMENT PARTNERSHIP

Successful programs and partnerships will be required to successfully deliver this Master Plan. A Memorandum of Understanding (MOU) between the NSW Minister for the Environment and the City of Sydney signed in November 2014 is a major opportunity for energy efficiency within the City of Sydney. The following MOU objectives have been incorporated within enabling actions of this Master Plan.

Increasing the uptake of environmental upgrades by improving financing mechanisms, by initially focusing on the following areas:

- Establishing an appropriate long term Environmental Upgrade Agreement (EUA) operating model.
- Financing mechanisms that support environmental upgrades for multi-residential strata buildings.
- Mechanisms that would create an incentive for developers to exceed minimum environmental building standards for multi-unit dwellings and other building types.

Improving environmental outcomes for new and existing multi-unit dwellings, by initially focusing on the following areas:

- Implementing higher BASIX targets that are equal across new single and multi-unit dwellings.
- Developing a rating tool to benchmark the actual performance of occupied multi-residential buildings, combined with a plan for its implementation.
- To consider the City's Residential Apartments Sector Sustainability Strategy and action plan to determine which other actions could be jointly delivered.

Another key enabler for this Master Plan is its integration with the NSW Energy Efficiency Action Plan. Table 23 shows how enabling actions from this Master Plan align with actions contained within the NSW Plan (refer to Figure 33 for more information).

The NSW Plan includes 30 actions that target household, business and government sectors, and energy efficiency in general. Many actions will strengthen opportunities and coverage under the successful NSW Energy Savings Scheme. Enabling actions of this Master Plan also make a case for retaining existing programs, increasing funding, and government leadership, amongst other initiatives.

TABLE 23. ENABLING ACTIONS AND THE NSW ENERGY EFFICIENCY ACTION PLAN

	MASTER PLAN ENABLING ACTIONS										
NSW ENERGY EFFICIENCY ACTION PLAN AUG 2013	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
STRENGTHEN THE ENERGY EFFICIENCY MARKET											
1. Review Energy Savings Scheme	x					x	x	x			x
2. Enhance Energy Savings Scheme Rule	x		x		x			x			
3. Target energy savings during peak demand		x				x	x				
4. Market mechanisms to improve gas efficiency	x							x			
5. Position NSW as Asia-Pacific centre for energy efficiency	x			x	x	x	x				
6. Monitor, evaluate and report energy efficiency programs	x	x			x	x	x		x	x	
ENERGY EFFICIENT HOMES											
7. Energy Savings Scheme led innovative behavior change	x				x	x		x			
8. Energy Savings Scheme to support home retrofits	x				x		x	x			
9. Energy Savings Scheme to support appliance retailers	x				x			x			
10. Home Power Savings Program to low-income households	x				x			x			x
11. Improve opportunities for low-income households					x						
12. Investigate voluntary ratings			x		x	x			x		
13. Improve access to finance					x	x	x	x			
14. Digital platform to share information					x	x	x		x	x	
ENERGY EFFICIENT BUSINESS											
15. Increase upfront Energy Savings Scheme incentives	x				x	x	x	x			
16. Streamline Energy Savings Scheme tools and guides	x				x						
17. Accelerate uptake in priority sectors and technologies	x	x	x		x	x	x				
18. Hands on training to site managers					x	x	x				
19. Energy efficiency training and information					x		x				
20. Standardise financial contracts					x		x	x			
21. Digital platform to share information					x	x	x		x	x	
ENERGY EFFICIENT GOVERNMENT											
22. Government Resource Efficiency Policy	x		x	x							
23. Specialist team to implement projects					x	x	x				
24. Pre-qualified tender panel						x	x				
25. Improve access to finance								x			
26. Energy efficient office leases	x	x							x		
27. Share government energy and efficiency data	x			x	x				x	x	
STRENGTHEN THE ENERGY EFFICIENCY MARKET											
28. Energy specialists in regions					x						x
29. Partnerships with regional networks					x						
30. Online resources for households and businesses.					x	x	x		x		x

IMPLEMENTING THIS MASTER PLAN

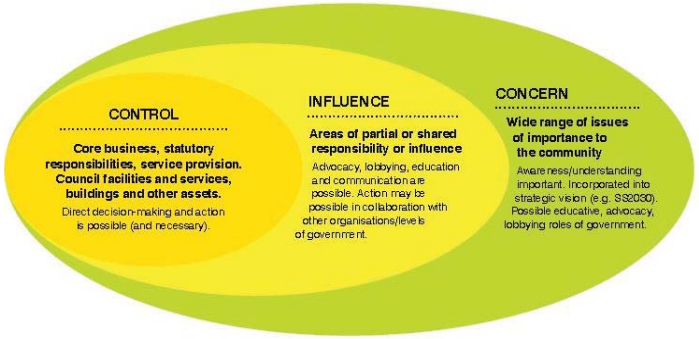
Enabling actions in this section have been developed to address the need to ensure compliance with existing regulations, raise minimum standards for new buildings, and develop programs and incentives for existing buildings.

In recent years there has been good progress in saving energy across the City of Sydney local government area, and this is despite growth in the economy, employment and new buildings. Energy efficiency has played a key part and will continue to do so.

This Master Plan shows substantial further savings are possible through both existing and new policies and programs. It is imperative therefore that existing measures continue, and indeed expand to realise cost-effective energy and emissions savings.

The City of Sydney as an organisation recognises that there are limits to what we alone can control or even influence. However, the potential role for our residents and businesses in saving energy is significant. It is people who make the decisions and enact the behaviours to save energy in buildings.

Implementing this Master Plan will take action by all levels of government, businesses and residents within the City of Sydney. In developing this Master Plan we surveyed key staff on the first ten enabling actions to understand our ability as an organisation to implement this Master Plan in accordance with the City's governance framework, nominating three types of roles the City can play for any of the actions.



Control – *City has full control, for example within City of Sydney owned facilities and assets, core business, statutory responsibilities and service provision.*

Influence – *City has partial control, for example in areas of shared responsibility or influence.*

Concern – *City has no direct control and must advocate for others to take action.*

The survey showed a relatively even split of the enabling actions that were under the City's control, potential influence or concerns. Staff identified slightly lesser ability to directly affect outcomes for existing policies and programs. There is consensus about the (mostly) high importance of actions being proposed.

	GOVERNANCE			IMPORTANCE		
	CONTROL	INFLUENCE	CONCERN	HIGH	MEDIUM	LOW
1. SAFEGUARD ENERGY SAVINGS	35	32	33	92	8	
2. IMPROVED BUILDING COMPLIANCE	32	30	38	92	8	
3. RAISING THE BAR	12	37	51	77	23	
4. SHOW BY DOING	85	10	5	85	15	
5. EMPOWER PEOPLE	33	40	27	62	31	7
6. BUILDING TUNE-UP PROGRAM	48	35	22	62	38	
7. BUILDING RETROFIT PROGRAM	39	34	27	54	46	
8. INCENTIVES	38	31	31	54	46	
9. RATING AND DISCLOSURE	12	41	47	69	31	
10. INTERIM TARGETS AND MONITORING	80	12	8	85	15	
AVERAGE	41	30	29	73	26	1

ENABLING THE MASTER PLAN

1. SAFEGUARD ENERGY SAVINGS

This Master Plan shows the significant contribution made by existing policies and programs to achieving energy and emissions reductions by 2030. These programs are already making a difference with total net energy savings observed since 2006 despite growth in employment, population and the economy.

The City will work with all levels of government and industry representatives to advocate for regular review, monitoring and compliance checking of the key existing energy efficiency programs. These measures must be retained, at least at current or improved levels of stringency, and include:

- Building Sustainability Index (BASIX).
- Commercial Building Disclosure (CBD).
- Green Star.
- Minimum Energy Performance Standards (MEPS).
- National Australian Built Environment Rating Scheme (NABERS).
- National Construction Code (NCC).
- NSW Energy Savings Scheme (ESS).

These policies and programs are key factors that will influence the business-as-usual energy profile for our city and are crucial for this Master Plan to succeed. Our modelling shows that without these existing policies and programs energy and emissions will increase. Keeping these programs and policies in place will reverse the trend and reduce energy consumption below 2006 levels by 2030.

Key stakeholders include the Green Building Council of Australia (GBCA); the Energy Efficiency Council (EEC); the Australian Sustainable Built Environment Council (ASBEC); the Australian Institute of Refrigeration, Air conditioning and Heating (AIRAH); Better Buildings Partnership (BBP) and CitySwitch members; NSW and Australian Governments, and others.

TIME-FRAME	ACTION(S)
Now through 2030	• Provide advocacy & support for key existing energy efficiency policies and programs (listed above). • Continue to collaborate with key stakeholders and peak bodies to provide a common voice in support of key existing policies and programs.

2. IMPROVED BUILDING COMPLIANCE

Existing policies and programs are working and building codes and regulations are making a substantial contribution by improving minimum practice. The results are demonstrated by falling total energy consumption in the City of Sydney since 2006, despite increased floor space.

However, there is some uncertainty about levels of compliance with energy savings provisions of building codes – specifically whether provisions are actually being applied where triggers have been met, and whether buildings are indeed performing as intended by code. Various studies are looking into these issues.

Modelling for this Master Plan estimates the majority of future savings from buildings in Sydney will come from energy efficiency improvements required by the National Construction Code and BASIX for both new builds and major refurbishments. It is very important therefore that these design outcomes actually result in real energy savings.

Performance of buildings is the function of design, how people operate within the physical shell, decisions made in the selection of equipment, appliances and so forth. The objective of this enabling action is to ensure compliance with existing codes to at least ensure the basic components are in place for buildings to be efficient.

TIME-FRAME	ACTION(S)
Now	• Actively participate in the Cooperative Research Centre for Low Carbon Living program and follow other research assessing the performance of building codes.
By 2020	• Partner with universities and other agencies to research whether public and privately certified major refurbishments in Sydney have applied energy efficiency provisions and are performing as required by code. • Assess skills and training needs for building certifiers to increase the application of energy efficiency code provisions. • Develop mechanisms to audit and enforce improved compliance if under-compliance or under-performance of buildings is evident.

3.

RAISING THE BAR

To be a world-leading and competitive city and to improve energy productivity, we need to go beyond minimum practice and see continuous improvement.

In a submission to the NSW Government's recent review of the BASIX scheme, the City of Sydney advocates for higher BASIX targets to improve the energy performance of new dwellings and major refurbishments.

Energy efficiency provisions in Section J of the National Construction Code, while worthy, are conservative by world standards and there is scope to improve energy efficiency beyond current levels.

Modelling for this Master Plan estimates that increasing minimum requirements could reduce energy consumption in buildings by eight per cent by 2030 based on 2006 levels.

A mechanism already exists through voluntary planning agreements to facilitate higher energy efficiency standards in new buildings in exchange for additional floor space or height allowance. However, in some areas this may not be possible due to urban design or infrastructure constraints and a more consistent approach is preferable.

Some jurisdictions (Melbourne, North Sydney and Randwick) require minimum NABERS Energy rating commitments for new non-residential developments.

The purpose of this enabling action is to raise industry expectations and go beyond minimum standards of the National Construction Code and BASIX.

TIME-FRAME	ACTION(S)
Now	• Investigate options for improving the uptake of environmental ratings tools and energy efficiency for new non-residential developments. • Participate in the Australian Alliance to Save Energy roadmap to double energy productivity by 2030. • Work with developers to identify and overcome Sydney-specific barriers to increasing energy efficiency in new developments and major refurbishments. • Work with the NSW Government to consider mechanisms that would create an incentive for developers to exceed minimum environmental building standards for multi-unit dwellings and other building types. • Advocate for the NSW Government to implement higher BASIX targets for new single dwellings and multi-unit dwellings. • Continue to improve efficiency standards of the City's public domain lighting code. • Improve energy efficiency through Voluntary Planning Agreements and design competitions for major new developments.
By 2020	• Major planning reviews and site changes consider an energy efficiency target above compliance requirements. • Advocate for improved and robust energy efficiency provisions in the National Construction Code. • Develop a Sydney zero carbon buildings roadmap with energy efficiency benchmarks and pathways for major building categories.

4.

SHOW BY DOING

There is a clear role for local government to advocate for and put into practice actions for the social good. Early adoption of new and emerging technologies, raising expectations, and 'showing by doing' can all contribute to making best practice energy savings and behaviour a mainstream approach. The overall objective of this enabling action is to encourage the uptake of energy efficiency through demonstration and provision of impartial information.

TIME-FRAME	ACTION(S)
Now	• City to adopt the NSW Government Resource Efficiency Policy (GREP) and thereby achieve and maintain a NABERS Energy rating of at least 4.5 stars by June 2017 for City of Sydney owned and leased office buildings over 2,000 sqm.
By 2020	• Best practice is applied during the feasibility, design and operation of new and existing City of Sydney owned buildings with key learnings shared with the community. • City to be an early adopter of emerging energy efficiency technologies. • City owned lighting to be replaced with energy efficient LED lighting where feasible. • Case studies and lessons learned are created through existing programs and stakeholders such as the Better Buildings Partnership.

5.

EDUCATION, TRAINING AND CAPACITY-BUILDING

People are effectively the most important element for the energy efficiency of buildings – deciding how efficiently to design a building, which equipment to install, how to operate and maintain services, when to refurbish, upgrade, lease and so forth. The motivations of people are at least as important as technological and design solutions for energy efficiency.

The City of Sydney cannot implement this Master Plan alone. Improving energy efficiency practices and technologies requires action by residents and businesses. How our community embraces energy efficiency will be a major factor for its success and the delivery of this Master Plan.

There is a role for the City of Sydney to empower and enable our communities – including building owners, managers, tenants and residents – by identifying and supporting leadership, encouraging information sharing, and systematically removing barriers to action.

In most cases the economic benefits of energy efficiency are compelling. However this is not always enough of a driver to make energy efficiency happen or there may be other factors that defer uptake of economically logical actions. The main objective of this enabling action is to overcome the non-financial barriers to energy efficiency.

TIME-FRAME	ACTION(S)
Now	• Continue to engage with our communities and stakeholders like the Better Buildings Partnership through existing communications channels and programs to encourage, support and improve capacity to take action. • Collaborate with the NSW Government in the delivery of the City's Residential Apartments Sector Sustainability Plan.
By 2020	• Develop strategies and action plans for key customer sectors that identify relevant services, actions and targets that will deliver on the outcomes of Sustainable Sydney 2030 and City of Sydney Master Plans. • Identify and communicate economic development opportunities that result from energy efficiency. • Work with other governments and education sectors to address skills gaps and develop capacity in energy efficiency.

6.

BUILDING TUNE-UP PROGRAM

Few buildings operate as efficiently as they are technically capable of or designed to be. Commissioning holds the key for a building to perform to its potential.

Building tune-ups are a relatively low cost way to review services, systems and controls and make adjustments to improve the way that energy is used without affecting comfort levels. Tune-ups are identified as an immediate and relatively easy to implement opportunity and are therefore a priority for this Master Plan.

The focus is major energy uses within the major energy using sectors. For Sydney, this means heating, ventilation and air conditioning (HVAC) and lighting in office buildings and high-rise apartments. There are other energy uses and systems that can be improved during a building tune-up such as correcting power factor, optimising building management systems (BMS), and fixing leaks. Improving lighting and ventilation systems in car parks is another opportunity.

A building tune-up program would be voluntary and in addition to technical outcomes would ideally improve skills and awareness by contractors and building owners. The program would commence with an audit by a qualified professional and most improvement would focus on base building services although tenancies could be included.

TIME-FRAME	ACTION(S)
By 2020	• Engage with key stakeholders to scope a building tune-up program including the Property Council of Australia (PCA), the Australian Institute of Refrigeration, Air conditioning and Heating (AIRAH), NSW Government and the Better Buildings Partnership (BBP). • City commits to co-funding a building tune-up program with partners and cost-recovery over time. • City continues to work with key stakeholders like the Better Buildings Partnership (BBP) to encourage regular building tune-ups that reach widely into existing building stock. • Work with key stakeholders to develop performance benchmarks for commonly used equipment.

7.

BUILDING RETROFIT PROGRAM

This is similar to the previous enabling action except that building retrofits typically require a more thorough process for audits, and the costs of participation are greater with capital investment required to replace or upgrade major plant and equipment.

Unlike a tune-up which mostly relies on existing equipment, a retrofit program will usually target bigger ticket items that may need replacing in order to make significant energy efficiency gains such as replacing whole heating, ventilation and air conditioning (HVAC) systems, lighting systems and building management systems (BMS).

Power factor correction should also be incorporated into HVAC commissioning of new buildings and retrofits. HVAC upgrades and power factor correction offer significant energy efficiency gains with good payback and have a significant advantage in that the target audience for change is concentrated and largely informed.

Other opportunities include upgrading appliances and hot water systems to achieve cost-effective energy efficiency gains.

Like a tune-up program, this would be a voluntary program which would target the largest energy end-uses and sectors. Monetary or non-monetary incentives may be required to encourage higher participation rates.

TIME-FRAME	ACTION(S)
By 2020	• Engage with key stakeholders to scope a building retrofit program including the Property Council of Australia (PCA), the Australian Institute of Refrigeration, Air conditioning and Heating (AIRAH), NSW Government and the Better Buildings Partnership (BBP). • City commits to co-funding a building retrofit program with partners and cost-recovery over time. • City continues to work with key stakeholders like the Better Buildings Partnership (BBP) to encourage regular building retrofits that reach widely into existing building stock.

8.

ACCESS TO FINANCE AND INCENTIVES

This enabling action is specifically about monetary and non-monetary incentives for proponents to increase energy efficiency beyond levels which would occur without them.

There are an increasing number of energy efficiency finance options including bank loans, operating or capital leases, on-bill financing and energy services agreements, amongst others. The 2014 Energy Efficiency and Renewables Finance Guide by the NSW Office of Environment & Heritage provides more information.

Climate or energy bond instruments are an emerging mechanism to fund energy efficiency programs where upfront capital is required. Multiple projects are packaged together to form the basis for an investment grade bond which investors and institutions purchase to provide the debt capital needed to carry out energy efficiency projects.

Innovative and emerging ways of funding energy efficiency are effective ways to overcome barriers such as policy uncertainty. Access to longer term funding is necessary to implement projects with a longer payback than typical commercial terms may otherwise allow.

Seed funding is also an important opportunity. The City of Sydney provides co-funding through its grants programs to undertake initial energy ratings to help overcome inertia and improve energy efficiency. Environmental Upgrade Agreements (EUAs) are another well recognised way to reduce risk and enable low-cost financing for energy efficiency retrofits.

Improved valuation, reduced vacancy rates and higher rental returns have been observed in buildings with higher energy efficiency ratings. In many instances, this increased return quickly pays for the cost to install energy efficiency improvements. Conversely, the commercial leasing sector and property industry associations refer to a 'brown discount' that applies to poorer performing buildings.

Aggregating savings across multiple projects improves economies of scale and may increase the potential for funding through the NSW Energy Savings Scheme (ESS) or other funding opportunities. Non-financial incentives can take the form of in-kind provision of advice, information and training; or other negotiated outcomes.

TIME-FRAME	ACTION(S)
Now	• Continue to promote and administer Environmental Upgrade Agreements (EUAs). • Continue to provide seed funding for energy ratings, demonstration and innovation projects through the City's grants program.
By 2020	• Work with the NSW Government to increase the uptake of environmental upgrades by establishing an appropriate long term Environmental Upgrade Agreement (EUA) model. • Work with the NSW Government to address the need for financial mechanisms that support environmental upgrades for multi-residential strata buildings. • Identify ways for helping local businesses leverage the incentives and funding available from the NSW Energy Savings Scheme. • Play an active role linking building owners with emerging funding models to grow the energy efficiency market. • Assist project aggregators to implement large scale energy efficiency across multiple buildings. • Proactively contribute to new electricity rules that provide funding for non-network solutions including energy efficiency.

9.

RATINGS & DISCLOSURE

The premise for this enabling action is that gaps exist in the suite of rating tools for major energy using building types, and there are inconsistencies between tools that influence design outcomes versus those which assess as-built performance.

The overall objective of this enabling action is to measure as-built performance and drive change with information. This enabling action also seeks to expand the scope of existing mandatory reporting and to increase the sector coverage.

Modelling by pitt&sherry for this Master Plan shows that mandatory reporting is a cost-effective way to increase energy efficiency beyond minimum standards and overcome barriers such as complex ownership structures.

TIME-FRAME	ACTION(S)
Now	• Advocate for the Commercial Building Disclosure (CDB) scheme to continue at current or improved levels of stringency, with greater transparency of information to tenants. • Identify opportunities to extend mandatory reporting within the commercial office sector and other sectors. • Work with the NSW Government to develop a rating tool to benchmark the actual performance of occupied multi-residential buildings, and a plan for its implementation. • Advocate for consistent measures between design and as-built rating tools. • Identify and communicate preferred design and as-built rating tools for each main building class in the City of Sydney. • Apply design and as-built rating tools to all major energy using City of Sydney owned properties.

10.

SECTOR TARGETS & MONITORING

This Master Plan establishes that significant energy and emissions savings may be realised by 2030 through existing and new energy efficiency policies and programs. The City of Sydney is not able to achieve this outcome alone, and it will take support and action by businesses, residents and other levels of government.

Establishing targets for key sectors will help communicate this Master Plan and provide clarity around more immediate milestones. Planning and working with our community to implement actions is a key objective for monitoring and reporting on energy used in the local government area. There is also an obligation to communicate energy savings and progress towards implementing this Master Plan.

Monitoring energy efficiency may include regularly reporting total and sector based energy consumption (taking into account local generation), working with utilities to develop intensity or sector based targets, and using the planning system to report energy efficiency outcomes of new developments.

TIME-FRAME	ACTION(S)
Now	• Continue monitoring and analytics through the Better Buildings Partnership and CitySwitch Green Office programs.
By 2020	• Report status of actions contained in this Master Plan within annual reporting. • Establish targets and publish targeted energy and emissions information for major energy using sectors to encourage greater performance. • Work with energy network utilities to monitor, benchmark and report energy data matched with City of Sydney land-use data. • Monitor sectors with significant growth in energy consumption and develop programs accordingly. • Establish a target, methodology and baseline for measuring energy productivity. • Continue to report and communicate energy efficiency performance for City of Sydney owned buildings. • Identify and communicate simple and universal energy performance benchmarks for buildings.

11.

EQUITY

With modest investment, energy efficiency can reduce energy waste and save users significant sums of money on energy bills. However it is the lower income sectors that are most susceptible to increasing energy prices who may be less equipped to install energy efficiency measures.

TIME-FRAME	ACTION(S)
Now	• Advocate for the NSW Government and energy utilities to support energy efficiency in low-income sectors to address increasing energy costs.

CASE STUDIES

CASE STUDIES

POLICIES & PROGRAMS

C40 CITIES PROGRAMS

The C40 Cities Climate Leadership Group was established in 2005 as a network of large cities to take action and reduce greenhouse gas emissions. In 2014 the City of Sydney together with the Tokyo Metropolitan Government established the C40 Private Sector Buildings Energy Efficiency Network. The following case studies come from the new report *Urban Efficiency: A Global Survey of Building Energy Efficiency Policies in Cities.*[50]

HONG KONG – BUILDINGS ENERGY EFFICIENCY ORDINANCE

The Buildings Energy Efficiency Ordinance of Hong Kong is a legislative means to improve the energy efficiency of buildings and overcome the split incentive problem. It is a major initiative for Hong Kong towards meeting the Asia-Pacific Economic Cooperation (APEC) target for reducing 2005 energy intensity by 45 per cent by 2035.

The Ordinance came into full effect in September 2012 and covers new construction and major retrofits of existing commercial buildings. Retrofits are triggered by a services installation covering a floor area of 500 sqm or more, or the addition or replacement of a main component. There are three main elements.

- **Building Energy Code** – *Sets minimum standards for air conditioning, electrical, lift and lighting installations for new buildings and existing buildings undergoing major retrofits.*
- **Energy Audit Code** – *Requires an energy audit for each of the above installations every ten years and public display of the energy audit report.*
- **Registered Energy Assessors** – *To process certifications and energy audit works.*

The Building Energy Code covers most public and private commercial buildings including offices, hotels, government, educational and transport related buildings as well as commercial portions of industrial and residential buildings. The Energy Audit Code component focuses on commercial buildings and the commercial portion of composite buildings. There are financial and civil penalties for non-compliance.

Savings are expected to be 2.8 billion kilowatt hours (kWh) and 1.96 million tonnes $CO_{2\text{-}e}$ within the first ten years. As a regulation there is no overall budget for development or implementation.

Lead agency: The Government of the Hong Kong Special Administrative Region of the People's Republic of China

Website: www.beeo.emsd.gov.hk

HOUSTON – GREEN OFFICE CHALLENGE

The Houston Green Office Challenge is a voluntary program launched in 2010 for commercial buildings property managers, building owners and tenants to implement energy savings and other environmental outcomes. The program is based on the US EPA ENERGY STAR Portfolio Manager and ICLEI Green Business Challenge scorecard platforms. This is supplemented with free training, workshops and webinars. Participants are referred to free energy audits and financial incentives. Within the first year 28,000 megawatt hours (MWh) were saved.

Lead agency: City of Houston

Website: www.greenpsf.com/go/community/index/houston

MELBOURNE – 1200 BUILDINGS PROGRAMME

The 1200 Buildings is a voluntary program launched in 2010 with a goal of retrofits for 1200 buildings to improve energy efficiency by 38 per cent. It works by helping owners to understand their energy consumption, opportunities to improve energy efficiency, and finance options. The focus is on institutional building owners and underperforming 'mid-tier' existing buildings with office space. Since 2008 around 450 buildings have undertaken a retrofit.

Lead agency: City of Melbourne

Website: www.melbourne.vic.gov.au/1200buildings

NEW YORK – GREENER, GREATER BUILDINGS PLAN

The New York Greener, Greater Buildings Plan targets energy efficiency in existing buildings larger than 50,000 square feet (4,645 sqm) which account for almost half of the city's total floor space and energy usage. This is approximately 24,000 private buildings and 2,600 public buildings. The Plan consists of four local laws and is supplemented by training and financing opportunities.

- **Local Law 84:** *Benchmarking – Private sector buildings larger than are required to undertake annual benchmarking of energy and water use with public disclosure. A list of covered buildings is published on the NYC website. Buildings measure energy and water use using the US EPA ENERGY STAR Portfolio Manager benchmarking tool and submit the data to NYC annually or face a fine and public listing. There has been more than 84 per cent compliance to date. The high levels of compliance are attributed to enforcement, outreach and training, focus on large buildings, communications and technical support, and consultants. The reporting applies to whole buildings and building owners are encouraged to obtain aggregated tenants data from utilities.*
- **Local Law 85:** *NYC Energy Conservation Code – Similar to energy efficiency provisions of the National Construction Code in Australia, the New York State Energy Conservation Construction Code only required buildings to upgrade to current code standards during renovations where more than half of the building's systems were being replaced. The NYC Energy Conservation Code (NYCECC) was introduced to require all upgrades to meet code for any renovation or alteration project, instead of those only affecting more than 50 per cent of the building system.*
- **Local Law 87:** *Energy Audits and Retro-commissioning – This law requires large buildings to conduct an audit and retro-commissioning of base building services and to submit an Energy Efficiency Report to NYC every ten years.*
- **Local Law 88:** *Lighting and Sub-metering – Large non-residential buildings are required to upgrade lighting to meet current NYC Energy Conservation Code standards by 2025, and to install electrical sub-meters for each large non-residential tenant space, and provide monthly energy statements.*
- **NYC Energy Efficiency Corporation** *– Independent non-profit financial corporation that partners with banks, financial institutions and energy services companies to provide energy efficiency financing for private building owners.*

These laws will reduce greenhouse gas emissions by almost five per cent, have a net savings of $7 billion, and create roughly 17,800 construction-related jobs over ten years.

Lead agency: New York City

Website: www.nyc.gov/ggbp

PHILADELPHIA – BUILDING ENERGY BENCHMARKING ORDINANCE

Philadelphia has a goal to become "the greenest city in America" by 2015. The Building Energy Benchmarking Ordinance, introduced in 2012 mandates benchmarking, reporting and public disclosure of energy and water efficiency for non-residential buildings.

Philadelphia is the sixth city in the US to legislate a benchmarking law after New York, Washington, Seattle, San Francisco and Austin. Owners of covered buildings are required to submit data through the US EPA ENERGY STAR Portfolio Manager each year and this information will be publically disclosed. Owners must also disclose benchmarking data to prospective purchasers or tenants upon request.

Covered buildings include commercial buildings or mixed use buildings with internal commercial floor area larger than 50,000 square feet (4,645 sqm). The requirement falls on the building owner and the ordinance requires tenants to provide information so that the owner can fulfil the benchmarking requirement. Obtaining tenants data has so far not been a barrier for compliance as many buildings have 'master' energy and water meters.

The benchmarking relies on self-reporting by building owners and does not require appointment of registered professionals to verify data. Compliance levels are greater than 88 per cent of covered buildings. In 2012, a total of 1,762 buildings submitted benchmarking data. This program is a key tool in Philadelphia's greenhouse gas reduction strategy.

Lead agency: City of Philadelphia

Website: www.phillybuildingbenchmarking.com

SAN FRANCISCO – EXISTING COMMERCIAL BUILDINGS ENERGY PERFORMANCE ORDINANCE

San Francisco has an aim to reduce the total energy consumption in commercial and non-residential buildings by 2.5 per cent per year in line with a total reduction of 50 per cent by 2030 below 1990 levels.

The Existing Commercial Buildings Energy Performance Ordinance (Environmental Code Chapter 20) came into force in 2011 and applies to all non-residential buildings with more than 10,000 square feet (929 sqm) of conditioned space. It is likely this represents a smaller threshold to similar schemes in other US cities however it only applies to air-conditioned buildings. Non air-conditioned buildings such as warehouses are exempt.

Approximately 19,000 private sector buildings and 450 public buildings are covered. The ordinance requires benchmarking, auditing and other measures designed to complement other finance and incentive programs and to encourage retro-commissioning and building retrofits. The City of San Francisco offers free presentations, webinars, helpdesk and technical support.

Targeted buildings are required to annually disclose their total energy consumption, energy intensity, greenhouse gas emissions, and ENERGY STAR score. In addition, buildings must conduct either an energy audit or retro-commissioning of the entire building (including both tenant and common areas) at least every five years.

As with similar programs there are fines for non-compliance; however this has not been enforced to date. An important key to the success of this program is that it was designed with the input of key stakeholders, including building owners and representative bodies.

Lead agency: San Francisco Department of the Environment

Website: www.sfenvironment.org

SEATTLE – BUILDING ENERGY BENCHMARKING AND REPORTING PROGRAM

Seattle has a goal to be a carbon neutral city by 2050. The Seattle Building Energy Benchmarking and Reporting Program requires all residential and commercial buildings of 20,000 square feet (1,858 sqm) or larger to track energy performance annually, report to the City and disclose upon request this information to current and prospective tenants, buyers or lenders.

There are approximately 3,250 properties covered by the scheme. As with similar US schemes reporting is carried out through the ENERGY STAR Portfolio Manager from the US EPA. Data submitted by building owners is not required to be verified by a third party however the City of Seattle does check for inaccuracies in addition to providing free support and workshops. Non-compliant buildings are issued with fines.

A 93 per cent compliance rate has been achieved which includes 89 per cent for non-residential and 97 per cent for multifamily buildings. This rate is one of the highest recorded of US cities implementing similar benchmarking.

Lead agency: City of Seattle

Website: www.seattle.gov

SINGAPORE – EXISTING BUILDINGS LEGISLATION

Singapore has a national target for 'greening' at least 80 per cent of existing building stock and to reduce total greenhouse gas emissions by between seven and 11 per cent below business as usual levels by 2030.

There are three key elements to the existing building legislation which was passed in 2012.

- **Minimum Green Mark Certified standard** – *Minimum standards apply at the time of installation or replacement of centralised air conditioning systems.*
- **Three-yearly energy audit** – *Notified building owners must engage a professional mechanical engineer or auditor to ensure cooling systems comply with minimum standards.*
- **Annual mandatory reporting** – *Building owners are required to submit building and energy consumption information annually through an online portal which forms the basis for national building energy benchmarks.*

The legislation focuses on commercial buildings including offices, hotels, retail and mixed developments. The minimum Green Mark certified standards and three-yearly energy audit for building cooling system are applicable to commercial buildings with gross floor area of at least 15,000 sqm. Annual mandatory reporting is applicable to all commercial buildings regardless of size. Similar to other programs, the obligation is on the building owner. Overall compliance achieved for the first year of data collection is 99 per cent, as at 30 June 2014.

Lead agency: Singapore Government

Website: www.bca.gov.sg

TOKYO – CAP-AND-TRADE PROGRAM

The Tokyo Metropolitan Government has a target to reduce greenhouse gas emissions by 25 per cent and energy by 20 per cent below 2000 levels by 2020. As part of this target, there is an ambition to reduce greenhouse gas emissions in the commercial and industrial sectors by 17 per cent.

The Tokyo Cap-and-Trade Program began in 2010 and is the world's first urban cap-and-trade scheme. It requires covered facilities to achieve absolute emissions reductions of six to eight per cent from base-year emissions for the first compliance period, and then 15 to 17 per cent for the second. The program consists of three elements.

- **Compliance period** – *Each compliance cycle lasts five-years during which time covered facilities are required to annually report energy consumption and greenhouse gas emissions. Targets apply, and if these are not met then facility managers or owners need to purchase carbon credits and ensure further reduction measures are in place for the next compliance period.*
- **Compliance adjustment period** – *During the 18-months following a compliance period total actual energy and emissions allowances are confirmed.*
- **Mandatory implementation and orders** – *Where mandatory reductions are not achieved, an Order for Action will be issued which requires non-compliant facilities to reduce emissions by up to 1.3 times the target shortfall or face penalties and public disclosure of breech.*

Information from covered facilities is publically disclosed online. The program applies to large private and government facilities that use more than 1,500 kilolitres of crude oil equivalent (around 60 terajoules).

This translates to around 1,400 buildings including 1,100 mostly commercial office buildings and 300 industrial facilities which account for a small fraction of the total number of buildings in Tokyo and yet are around 40 per cent of total emissions from these sectors.

Five types of credits may be traded.

(1) Excess credits from other covered facilities.

(2) Credits obtained by non-covered small and medium facilities in Tokyo.

(3) Credits obtained from generation of renewable energy.

(4) Excess credits from large facilities outside of Tokyo.

(5) Credits from facilities covered by the Saitama Cap-and-Trade Program.

The owner is responsible for achieving the emissions reduction target, however the program applies to whole buildings which includes tenanted space, and therefore tenants are obliged to cooperate with building owners. Large tenants who either occupy a floor area more than 5000 sqm and/or consume in excess of six million kWh in electricity annually must also submit an annual report via the owner.

The first compliance period will finish in March 2015. Already the covered facilities have reduced emissions against the base year by 22 per cent which is more than the targets for both the first and second compliance periods meaning that most facilities are expected to fulfil emissions reduction requirements.

Lead agency: Tokyo Metropolitan Government

Website: www.metro.tokyo.jp

SYDNEY ENVIRONMENTAL UPGRADE AGREEMENTS

City of Sydney Environmental Upgrade Finance (EUF) forms part of the NSW government Environmental Upgrade Agreement (EUA) program. The Local Government Act allows local governments to enter into agreements with property owners and financial providers to enable the funding of works aimed at improving the efficiency of buildings.

This scheme allows access to capital with repayments made via a council rates charge on the property. This financing model also allows for the costs of building upgrades to be passed onto the building tenant, providing the amount does not exceed the financial saving the tenant will benefit from as a result of the upgrade.

The key feature of the scheme is that it provides an incentive for building owners to engage in energy efficiency upgrades from which their tenants may well benefit, thereby overcoming a longstanding persistent obstacle to upgrades i.e. the 'split incentives' barrier.

The Central Park development of the old brewery site at Broadway was the first Environmental Upgrade Agreement in the local government area involving the City of Sydney, developers Frasers Property and Sekisui House and financiers ANZ, Eureka Funds Management and the Clean Energy Finance Corporation.

Funding of $26.5 million was used to install a trigeneration system for heating, hot-water and cooling with the cost being repaid by a charge on the land, called the Environmental Upgrade Charge, which is levied and collected by the City of Sydney on behalf of the financiers.

In June 2014 the Anglican Church Property Trust signed and Environmental Upgrade Agreement for a $700,000 financed through the Australian Environmental Upgrade Fund which is jointly financed by the Clean Energy Finance Corporation and National Australia Bank, and managed by Eureka Funds Management.

Finance provided under the agreement will allow the building owner to undertake an energy efficiency upgrade, chiller replacement, a new building management system, and lighting upgrade. The expected outcome is a 30 per cent reduction in base energy use and annual energy bill savings of $56,000.

The success of this scheme derives from the creation of stronger incentives for building owners to engage in energy efficiency upgrades and share the costs with tenants through existing net lease provisions or by specific agreement which is not usually possible with more traditional finance arrangements. Once paid off, the tenants and building owner continue to benefit from a more efficient building and ongoing reduced energy bills.

Lead agency: City of Sydney

Website: www.cityofsydney.nsw.gov.au

CITY OF MELBOURNE PLANNING CONTROLS

In 2013 the City of Melbourne adopted Clause 22.19 – Energy, Water and Waste Efficiency controls under the Melbourne Planning Scheme which establishes minimum energy performance requirements for new buildings and refurbishments.

Office building developments greater than 2,000 sqm must be designed to achieve a minimum 5 star NABERS Energy rating or equivalent.

This is a positive example where a local government in Australia has endorsed mandatory planning controls which set standards that go beyond the minimum energy performance requirements under Section J of the National Construction Code.

Lead agency: City of Melbourne

Website: www.melbourne.vic.gov.au

UK GREEN DEAL

The Green Deal is designed to save energy in homes through a range of technologies and opportunities with flexible payment options designed to cost less than the energy saved. Examples are insulation, heating, draught-proofing, double glazing and renewable energy.

Any household with an electricity meter in England, Scotland or Wales can use the scheme. Where a building is rented, both the landlord and tenant must agree to participate.

An assessment of the property must be conducted by a Green Deal assessor, typically for a fee. The assessor will prepare a Green Deal advice report that includes an Energy Performance Certificate, occupancy assessment, and recommended improvements including estimated costs and payback.

The report is valid for ten years or until changes are made to the property. After a Green Deal advice report is received, the works can be implemented through the Green Deal provider or another installer.

Upgrades can be paid for directly or through Green Deal finance – which is a loan that is paid back through a charge added to the electricity bill. Similar to Environmental Upgrade Agreements, the annual repayments on the load should not be more than the savings on the electricity bill as a result of the upgrades.

The Green Deal stays with the property, so when moving into a property with a Green Deal, a landlord or seller must provide a copy of the Energy Performance Certificate which shows what improvements have been made and repayment amounts. The electricity supplier may be changed as long as they are participating in the Green Deal.

This is a UK Government initiative that was officially launched in 2013. By October 2013 approximately 91,000 households had conducted an assessment and four out of five had either installed or were in the process of installing a measure. More than half of the installations were through third party funding.

Lead agency: UK Government

Website: www.gov.uk

EU DIRECTIVE – ENERGY PERFOMANCE OF BUILDINGS

Directive 2010/31/EU of the European Parliament replaces the former Directive 2002/91/EC. It requires member states to adopt national or regional methodologies to calculate the energy performance of buildings and set minimum requirements for energy performance.

The methodologies must take into account takes into account certain elements, including:

- Thermal characteristics of a building.
- Heating insulation and hot water supply.
- Air-conditioning.
- Built-in lighting.
- Indoor climatic conditions.
- Other aspects such as local solar exposure, natural lighting, and electricity produced by cogeneration, and district or block heating or cooling systems.

Minimum requirements are to be reviewed every five years, and may differentiate between new and existing buildings, and cover different categories of buildings. New, replaced or upgraded technical building systems such as heating systems, hot water systems, air-conditioning systems and large ventilation systems also need to comply with energy performance requirements.

In addition, major elements that form part of the building envelope and have a significant impact on the energy performance also need to meet minimum requirements when replaced or retrofitted. Intelligent energy consumption metering systems are encouraged whenever a building is constructed or undergoes renovation.

The European Energy Performance of Buildings Directive has since 2009 required the labelling of energy performance of buildings using the A-G rating scale also used for appliances in Europe.

These Energy Performance Certificates show the energy performance of a building and must be included in all advertisements and commercial media as well as displayed at time of construction, sale and lease. The scheme applies to all new and existing buildings including apartments.

An ambitious objective of the Directive is that all new buildings shall be nearly zero-energy consumption by 2020 (or 2018 for public owned and occupied buildings).

Lead agency: European Union

Website: www.europa.eu

EFFICIENCY UPGRADES

MEDIUM SIZED BUSINESS PILOT

The Medium Energy Pilot program ran from 2011–12 as a collaborative engagement between the City of Sydney Smart Green Business program & the NSW Office of Environment and Heritage. In all, 20 medium sized businesses were involved across eight industry sectors including health, retail, pubs and clubs, creative industries, restaurants, industrial, accommodation and commercial offices. The intent was to determine the energy audit service requirements for medium sized businesses, and common energy efficiency opportunities within each of the sectors.

The program included tailored energy audits and implementation support for medium sized business. It identified the differing energy audit service requirements as well as barriers and needs of medium sized businesses. Over 2,000 megawatt hours (MWh) per annum were saved with businesses saving more than $400,000 in energy bills.

Lead agency: City of Sydney

Website: www.cityofsydney.nsw.gov.au

COLORADO BUILDING TUNE-UP

Tune-Up programs are widely used in the United States and Europe due to their cost-effectiveness. Efficiency measures targeted in building tune-up programs fall short of major plant upgrades and replacement, which are more expensive, but instead focus on tuning building management systems, lighting controls, fans, etc.

In 2010 the City of Boulder Colorado launched its Small Buildings Tune-up Program focusing on commercial buildings ranging from around 450 to 4,500 square metres. Typically these buildings do not have dedicated (full time) building managers on site and the older stock usually does not have a Building Management System. It is common that poor energy performance and wastage goes undetected, often for years.

This voluntary program provided free tune-ups to 15 commercial buildings. Specialists worked with building owners to undertake site diagnostics and manage work orders and contractors. Typical tune-up works included adjusting heating and cooling controls to better suit occupancy and external climatic conditions; cleaning or changing out coils, filters, and dampers; reset water heating thermostats and timers on hot water recirculation pumps; recalibrate lighting motion sensors; and adjust building automation systems where these exist.

Several of the buildings had payback periods of less than two years. The Boulder program led to a similar program in Fort Collins, Colorado which again found that payback periods as a result of tune up assessments were around two years or less. Other programs are taking place in Colorado with the utility partially funding site visit and implementation works.

Lead agency: City of Boulder Colorado

Website: www.bouldercolorado.gov

SYDNEY LED LIGHTING

The City of Sydney is upgrading street and park lights with light emitting diode (LED) technology. Public lighting accounts for around one-third of the City's annual electricity bill and greenhouse gas emissions. LED lights use 40 per cent less electricity than conventional bulbs.

LED produces light that appears brighter than traditional street and park lighting. Prior to installing these upgrades, the City conducted a trial of LED lighting. More than 90 per cent of people surveyed by the City said they found the new lights appealing and three-quarters said the LEDs improved visibility.

Sydney is one of the largest users of street lighting in NSW with 22,000 lights. Of these, 13,500 are owned by the public utility and 8,500 by the City of Sydney. This project is upgrading approximately 6,400 of the lights owned by the City saving nearly $800,000 a year in electricity bills and maintenance costs. The project is being installed through a joint venture of GE and UGL Limited, selected by tender. The project is $7 million with a carbon abatement cost of $17 per tonne. Simple payback is estimated within ten years.

On a lowest total cost of ownership basis it is anticipated that LED will become common practice for most public lighting applications consistent with the City's own experience and a range of international precedent. The City of Sydney LED program was recognised for leadership and innovation at the 2014 Institute of Public Works Engineering Australasia (NSW) annual awards.

Lead agency: City of Sydney

Website: www.cityofsydney.nsw.gov.au

FIGURE 87. CITY OF SYDNEY LED LIGHTING BEFORE AND AFTER

CITY OF SYDNEY ENERGY RETROFIT

The City of Sydney has completed an energy retrofit to 45 of its major energy using buildings with independent measurement and verification in line with best practice[51]. Energy and water saving equipment is being commissioned, fine-tuned and monitored to achieve savings of 6,641 megawatt hours (MWh) per year. Payback is estimated within nine years. Projects include:

- Lighting upgrades.
- Voltage reduction on lighting circuits.
- Building management control system (BMCS) upgrades and fine tuning.
- Pool circulation pump upgrades.
- Voltage power optimisation.
- Boiler and compressor optimisation.
- Computer power management.

This project has improved the National Australian Built Environment Rating System (NABERS) ratings for commercial offices and tenancies owned by the City of Sydney and lowered maintenance costs.

Lead agency: City of Sydney

Website: www.cityofsydney.nsw.gov.au

NEW YORK TIMES BUILDING

The New York Times building is a 52 storey building constructed in 2007 which is achieving energy efficiency through integrated design and technologies such as dimmable lighting, automated roller shades for windows, and underfloor air distribution. Around 40 per cent of the building energy comes from a nearby cogeneration plant.

The building has saved annual electricity use by 24 per cent and heating energy by 51 per cent compared to if the building was designed to only meet energy efficiency code. It has also reduced peak demand by 25 per cent and there is a high level of satisfaction by occupants with the building's design and features. The investment in energy efficiency technologies is estimated to yield a 12 per cent rate of return on initial investment.

These savings have been achieved through the combination of design, technology, and integrated systems throughout the construction, commissioning and operations stages. Facilities staff conducted checks during construction to ensure the building was constructed according to the design intent.

Commissioning occurred prior to opening to test that the building's systems were performing correctly. Monitoring and fine-tuning has continued since occupancy to improve performance.

The New York Times building uses significantly less energy than would otherwise be the case if built according to energy code. This success is attributed to the design team and owner purchasing high performance building equipment, and verifying the proper performance of the equipment and systems after they are installed.

Lead agency: New York Times

Website: www.newyorktimesbuilding.com

RESEARCH, MONITORING & STANDARDS

THE LOW ENERGY HIGH RISE

The Low Energy High Rise Building Research report was developed by the Warren Centre for Advanced Engineering (Sydney) in 2009 and shows that most office buildings can achieve a 4 Star National Australian Built Environment Rating System (NABERS) Energy rating of the base building through improved management practices.

The project included a survey of 127 buildings mostly greater than 7,500sqm located in Australian capital cities with extensive analysis of energy management practices and attitudes by tenants as well as building, asset and portfolio managers. This was a world-first project that used empirical data to relate operational behaviour to energy efficiency outcomes.

The report shows that major improvements in energy efficiency are possible without huge capital expenditure with greatest environmental gains achieved with little or no cost. The main findings below show the NABERS Energy improvement, (in stars) towards a maximum 6 star rating, compared with buildings that have not implemented similar measures.

- Good practice façade and services technology (1.4 stars).
- Higher level of energy efficiency knowledge (1.3 stars).
- Management at least partially in-sourced (1.3 stars).
- Building, Asset and Portfolio Manager feel able to affect efficiency (0.9 stars).
- Incremental investments in energy efficiency (0.6 stars).
- Buildings with economy cycle (0.6 stars).
- Buildings disclose NABERS performance to tenants (0.5 stars).
- Efficiency training program available (0.5 stars).
- Efficiency penalties/incentives to maintenance contractors (0.4 stars).
- Support from building owners (negligible uplift).
- Efficiency savings retained in building budget (negligible uplift).
- Building manager is conservative with new technologies (negligible uplift).

The second stage of this program is to develop information that helps building operators in implement energy efficiency strategies and behaviours. The report also provides checklists for building operators in the management of tenant fit-outs, monitoring and reporting, and technical aspects.

Lead agency: The Warren Centre for Advanced Engineering

Website: www.thewarrencentre.org.au

ADVANCED ANALYTICS

Sophisticated tools and services are available that provide fine grain data of the performance of buildings in a timely manner, normalised against temperature, humidity and operational parameters; and compared to real-time benchmarks for similar building types.

These tools provide diagnostics and alerts to enable building and facility managers to respond sooner to any anomalies in the way a building uses energy. Many such tools are available for buildings in the City of Sydney. Technologies and systems have evolved to the point where tools such as these should become increasingly common place to ensure that buildings are commissioned and operating optimally.

Some systems also optimise building controls against weather predictions. One example is the National Information and Technology Communications Centre of Australia building located in the Australian Technology Park in Sydney. This building was previously a well-tuned and high-performing building with 5.5 NABERS Energy star-rating. Applying an advanced predictive tool resulted in a further 17 per cent saving of total power.

AUSTRALIAN STANDARD AS3598.1

A framework for energy audits in buildings has existed in Australia since 2000. In 2014, a new Australian Standard AS/NZS 3598:2014 was introduced that addresses a number of shortfalls, and includes stronger guidance, end use breakdown, and accuracy requirements amongst other changes.

The code sets empirical standards that give the building owner, tenant or other stakeholder increased confidence that an audit has focused on cost-effective energy efficiency actions, with at least 80 per cent of recommendations costed. Audit types vary in cost and complexity as outlined below.

Type 1: Basic energy audit

- Initial scoping study.
- Basic evaluation of low cost opportunities.
- Site visit required.
- End use breakdown (EUB) to 20 per cent resolution.
- Indicative savings based on rules of thumb, reconciled to EUB.
- Measure focus: <two-year payback.
- 80 per cent of <two-year payback measures quantified.
- Broad level of accuracy.

Type 2: Detailed energy audit

- Standard audit type for general application.
- Identification of coherent and specific measures.
- Site visit required.
- End use breakdown (EUB) to ten per cent resolution.
- 24 hour profile of end use for each fuel for typical cases.
- Savings based on calculations reconciled to EUB.
- Medium level of accuracy.
- Measure focus: <four-year payback.
- 80 per cent of <four-year payback measures quantified.
- Half of >four-year payback measures to medium accuracy.
- Balance to broad level of accuracy.

Type 3: Precision Subsystem audit

- Detailed energy audit with additional metering.
- Identification of coherent and specific measures.
- Site visit required.
- End use breakdown (EUB) to ten per cent resolution.
- 24 hour profile of end use for each fuel for typical cases.
- Savings based on calculations reconciled to EUB.
- Costs based on built up estimates.
- Higher level of accuracy.
- Measure focus: <four-year payback.
- 80 per cent of <four-year payback measures quantified to higher accuracy.
- 50 per cent of >four-year payback measures quantified to medium accuracy.

Accuracy definitions

- Broad estimates – Based on precedent. Simple engineering estimates and rules of thumb.
- Medium level of accuracy – Site specific data. Reconciled to end use breakdown. Capex built up from cost components.
- Higher level of accuracy – Site specific data. Reconciled to end use breakdown plus additional metering. Capex built up from components and quotes.

Lead agency: Standards Australia

Website: www.standards.org.au

ENERGY EFFICIENCY CERTIFICATION SCHEME

A new Australian professional certification scheme, delivered through the Energy Efficiency Council, enables energy efficiency specialists to prove their credentials in managing comprehensive integrated building energy retrofits via Certified Energy Specialist and Certified Energy Leader qualifications.

The Scheme:

- Identifies industry leaders delivering comprehensive energy retrofits of commercial buildings.
- Provides a benchmark for aspiring energy efficiency professionals that wish to develop their skills.
- Allows commercial building owners and managers to identify industry professionals with expertise.

The Scheme is operated by the Energy Efficiency Council on behalf of the sector. It has been designed under the supervision of an independent Steering Committee made up of experts that work in industry, government and the property sector. With a policy framework, an ombudsman, a clear set of operating rules, and an appeals and complaints resolution pathway, the Scheme has rigor and probity.

The scheme recognises the breadth of energy efficiency intervention opportunities that exist including and beyond specific technical aspects such as commissioning, tuning measurement and verification activities that ensure intended building performance improvement is actually delivered into the future.

Certification covers all stages of a building energy efficiency retrofit which generally includes:

- Project scoping.
- Energy reviews or audits.
- Developing the business case.
- Verification of technical aspects and design.
- Procurement of products and services.
- Managing supply, installation and integration with existing services.
- Commissioning and tuning.
- Measurement and verification.
- Behaviour change measures.
- Ongoing maintenance.

COMMUNITY ACTION

THE 1 MILLION WOMEN POWER PROJECT

The 1 Million Women's, Women Power Project is a community energy efficiency initiative piloted with the City of Sydney and its Green Villages program in 2013. The project reduced electricity consumption of participants by an average of 20 per cent based on readings from a monitoring device and billing history.

The key objectives were to:

- Empower participants to save electricity in their own homes.
- Share the energy saving learning from the pilot with others.
- Assess the opportunities to expand the Women Power project.

The project was implemented in three stages.

1. **Look and Learn** – *Getting to know all about electricity use in the home.*
2. **Plan to Save** – *Working out the strategy for the household to save electricity.*
3. **Cut by 20 per cent** – *Reduce electricity consumption by 20 per cent compared with normal use.*

The project provided participants with their own real-time electricity use data, additional information about saving energy and support to answer questions and complete energy saving actions throughout three months.

Lead agency: 1 million women

Website: www.1millionwomen.com.au

NSW ENERGY SAVER

The following examples are of energy efficiency outcomes which have been achieved by businesses, residents and government departments located in the City of Sydney with assistance from the NSW Government Energy Saver program.

- **Australian Museum** – *A major upgrade of the air conditioning system has saved energy and positioned the Museum as the one of the premier arts venues in Australia. Operational savings are $80,000 a year.*
- **Bennelong Apartments and Opera Quays** – *This residential complex recently upgraded to new LED lighting significantly reducing running and maintenance costs by $84,000 a year.*
- **Jones Bay Wharf** – *New LED lamps at Jones Bay Wharf have reduced energy and improved night time safety and security with higher quality light. Energy savings are $150,000 per year in addition to $20,000 in avoided maintenance costs.*

Lead agency: NSW Government

Website: www.environment.nsw.gov.au

NATIONAL ENERGY EFFICIENCY NETWORK

Many small to medium sized buildings or floor areas within buildings are occupied by not-for-profit (NFP) organisations. The National Energy Efficiency Network aims to provide templates and tools to this typically time poor and resource constrained sector.

This is an Australia-wide program with a focus on practical energy efficiency measures that can be implemented by organisations with often very limited budgets.

The main components of this program include a free online calculator to identify energy efficiency measures tailored to this sector and flag irregularities based on billing data.

Cost-effective actions typically relate to management options and retrofits to lighting, heating, cooling and hot water supply. Each opportunity identified has estimates for typical energy reduction, cost savings, upfront costs, associated greenhouse gas savings and simple payback.

The tool produces a succinct report that would enable building managers and boards of management to prioritise, investigate and implement specific actions depending on available budgets.

Lead agency: National Energy Efficiency Network

Website: www.neen.org.au

GREEN STAR

The Green Building Council of Australia have develop a suite of Green Star tools to improve the sustainability of buildings including Design and As-Built, Performance, Communities, and Interiors rating tools. Noteworthy examples of buildings that have been rated within the City of Sydney are listed here.

- **1 Bligh Street, Sydney** – *Achieved a 6 star Green Star (Office Design v2) rating and a number of innovative sustainability strategies that were 'firsts' in the marketplace.*
- **Darling Quarter** – *Achieved a 6 star Green Star (Office Design v2) and 6 star Green Star (Office As-Built v3). Energy-efficient lighting and air conditioning, onsite energy production via tri-generation all helped to achieve this rating.*
- **The GPT Group** – *Fit out achieved a 6 star Green Star (Office Interiors) rating. Energy improvements have been aided by the installation of T5 lights, LED down lights and desk lamps.*
- **388 George Street, Sydney** – *Achieved a 4 star Green Star (Office As Built v2) rating. Energy consumption of the building has been reduced by 1.9 million kilowatt hours per year.*
- **101 Chalmers Street, Sydney** – *Example of a heritage building made more sustainable. This project achieved a 5 star Green Star (Office Interiors v1.1) rating.*
- **Redfern Housing redevelopment** – *This is the second public housing development in Australia to gain a Green Star rating and achieved a 5 star Green Star (Multi Unit Residential PILOT) rating.*

Lead agency: Green Building Council of Australia

Website: www.gbca.org.au

INVESTMENT MODELS

CLEAN ENERGY FINANCE CORPORATION

In Australia the Clean Energy Finance Corporation (CEFC) is a commercial lending facility established by the *Clean Energy Finance Corporation* Act 2012. The legislation requires that 50 per cent of funds be invested into energy efficiency and low emissions technology.

The purpose of the fund is to overcome barriers such as access to upfront finance and information about available technologies for achieving energy efficiency and improved productivity.

Under the Act, the CEFC has access to AUD $2 billion per year from 2013 to 2017. At the end of 2014, the CEFC portfolio has contracted investments of over AUD $900 million and is earning an average return of 7 per cent. This is double the Government five-year bond rate and these investments are expected to result in a positive net benefit to the taxpayer in the order of $2.40 per tonne $CO_{2\text{-}e}$.

The CEFC provides financial facilities tailored to meet the needs of larger corporations, as well as co-financing programs with major financial institutions such as through Environmental Upgrade Agreement financing for the property sector.

There is up to AUD$100 million in finance dedicated to commercial property upgrades through a partnership with Balmain Corporation. In addition there is another AUD$200 million available in partnership with the Commonwealth Bank Energy Efficient Loans and Efficient Loans for not-for-profits products.

The CEFC encourages investment into sustainability projects by offering lower cost of funds compared with traditional lenders. It also offers flexibility to match financing terms with the life of the assets which de-risks transactions and allows private financiers to become involved.

Lead agency: Clean Energy Finance Corporation

Website: www.cleanenergyfinancecorp.com.au

GREEN BONDS

Green Bonds and Climate Bonds are becoming increasingly common mechanisms for financing projects to improve the energy performance of buildings while providing a return to investors through savings in energy bills.

Globally, there is estimated to be more than $500 billion USD invested in green bonds and climate bonds according to the Climate Bond Initiative[52]. Buildings and industry make up around $13 billion, but this sector could grow as investors seek out responsible investment opportunities.

In November 2014 Stockland issued a EUR$300 million green bond underwritten by UBS and HSBC. The bond is a seven year issue sold predominantly into the UK and French markets. Proceeds of the bonds are to be used by Stockland for development and redevelopment of green star rated retail, commercial, residential and retirement living projects.

The National Australia Bank launched the first Australian bank green bond issued into the domestic market in December 2014. Initially anticipated to raise AUD$150 million, the bond immediately raised $300 million indicating the appetite for green bonds by investors. While the National Australia Bank bond is initially focused on renewable energy, other banks are developing bonds which may be eligible for energy efficiency projects.

FOOTNOTES

1 Net present value over period 2015–2030 discounted at seven per cent each year, rapid uptake scenario. Includes marginal investment & compliance costs, and costs to government.

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CITY OF SYDNEY

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2015–2030

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