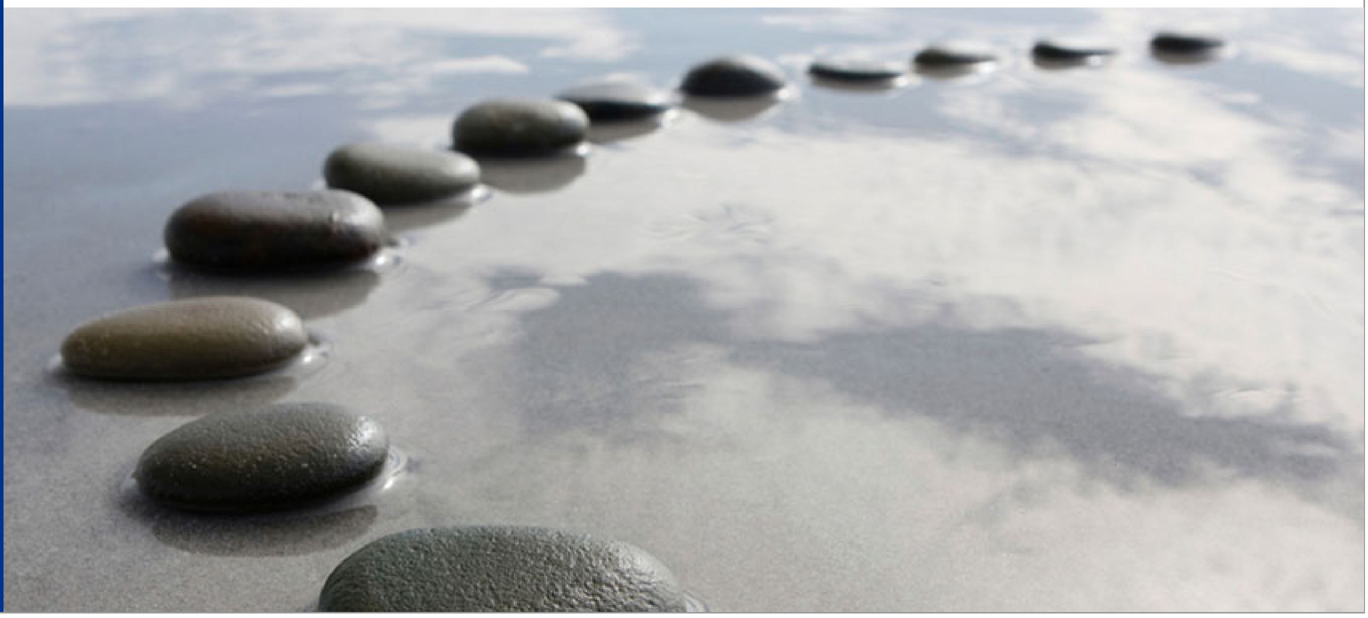
NSW Energy efficiency programs
Cost benefit analysis

Final report to the NSW Office of Environment and Heritage



JACOBS

Document title:	NSW Energy efficiency programs – Cost benefit analysis
Date:	December 12 2014
Client name:	NSW Office of Environment and Heritage

Jacobs Group (Australia) Pty Limited
ABN 37 001 024 095
Floor 11, 452 Flinders Street
Melbourne VIC 3000
PO Box 312, Flinders Lane
T +61 3 8668 3000
F +61 3 8668 3001
www.jacobs.com
Jacobs Group (Australia) Pty Limited
ABN 37 001 024 095

www.jacobs.com

Contents

Disclaimer

The sole purpose of this report and the associated services performed by Jacobs is to review the net benefit of NSW energy efficiency programs in accordance with the scope of services set out in the contract between Jacobs, and the Office of Environment and Heritage (OEH). That scope of services, as described in this report, was developed with OEH.

In preparing this report, Jacobs has relied upon, and presumed accurate, any information (or confirmation of the absence thereof) provided by OEH and/or from other sources. Except as otherwise stated in the report, Jacobs has not attempted to verify the accuracy or completeness of any such information. If the information is subsequently determined to be false, inaccurate or incomplete then it is possible that our observations and conclusions as expressed in this report may change.

Jacobs derived the data in this report from information sourced from the Client (if any) and/or available in the public domain at the time or times outlined in this report. The passage of time, manifestation of latent conditions or impacts of future events may require further examination of the project and subsequent data analysis, and re-evaluation of the data, findings, observations and conclusions expressed in this report. Jacobs has prepared this report in accordance with the usual care and thoroughness of the consulting profession, for the sole purpose described above and by reference to applicable standards, guidelines, procedures and practices at the date of issue of this report. For the reasons outlined above, however, no other warranty or guarantee, whether expressed or implied, is made as to the data, observations and findings expressed in this report, to the extent permitted by law.

This report should be read in full and no excerpts are to be taken as representative of the findings. No responsibility is accepted by Jacobs for use of any part of this report in any other context. The review has incorporated some reliance on information provided by a small number of participants.

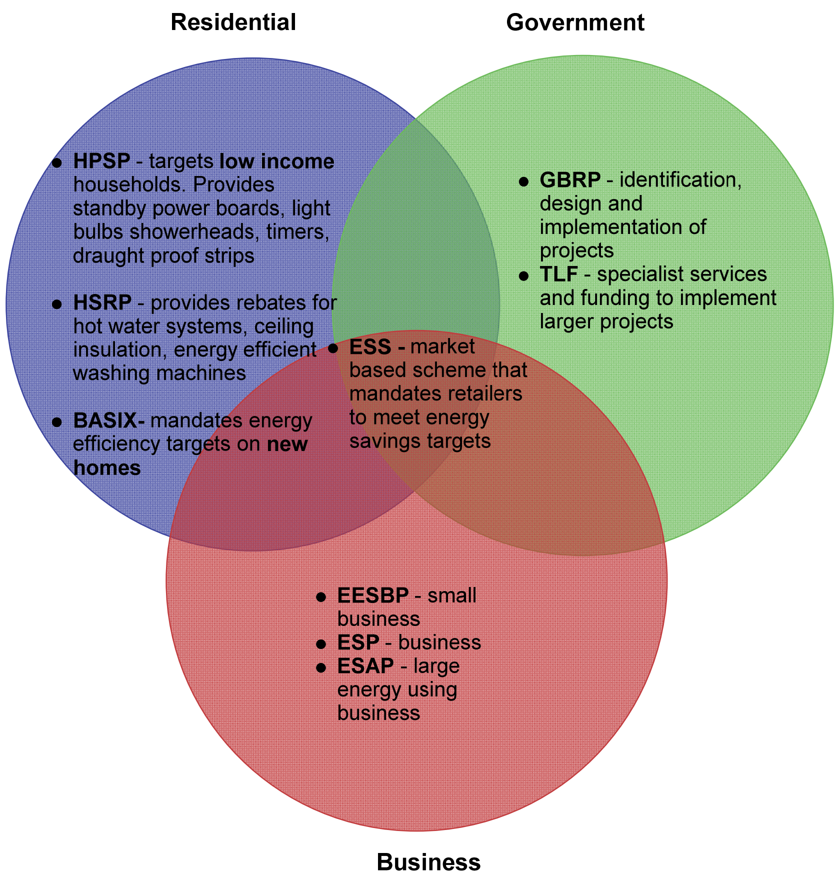
This report has been prepared on behalf of, and for the exclusive use of, OEH, and is subject to, and issued in accordance with, the provisions of the contract between Jacobs and OEH. Jacobs accepts no liability or responsibility whatsoever for, or in respect of, any use of, or reliance upon, this report by any third party.

Executive Summary

The NSW Government has implemented a number of energy efficiency programs to assist households, businesses and government agencies reduce energy consumption and energy costs. The NSW Office of Environment and Heritage (OEH) engaged Jacobs to conduct a study to analyse the cost and benefit of nine such programs. The purpose of the study is to provide an economic review of these programs and assess their collective impacts across the energy market. The review is intended to guide and inform policy development in energy efficiency programs.

The review is based on an assessment of the information available in 2013. The period of assessment includes activity undertaken between July 2007 and June 2020, with the majority of programs reaching conclusion prior to June 2013. Because the programs' impacts may have consequences for the energy market beyond these time periods, the assessment of market benefits was extended to encompass the period to 2040. Jacobs has worked with OEH and associated organisations to gather cost and energy savings data to calculate the net economic benefits.

Figure 1: Overview of programs

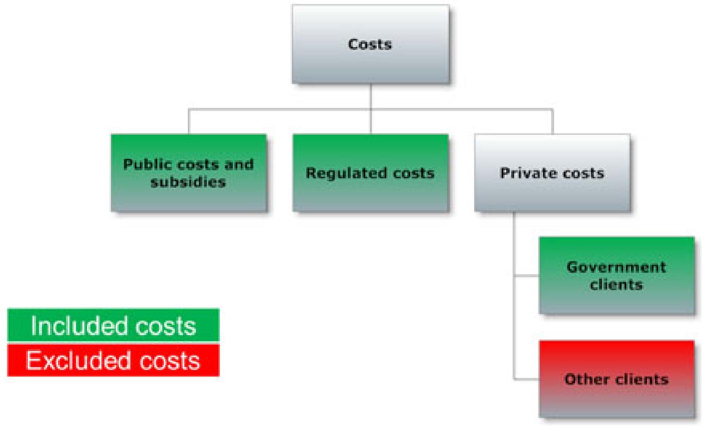


Costs and benefits

The evaluation followed protocol identified in the draft NSW Treasury CBA framework for the treatment of costs and benefits in energy efficiency programs and policies. As is normal for an economic evaluation of programs, the benefits are deducted from costs to determine the net benefit; however, the new framework provides advice on the costs and benefits that should be excluded from program evaluations. These are shown below in Figure

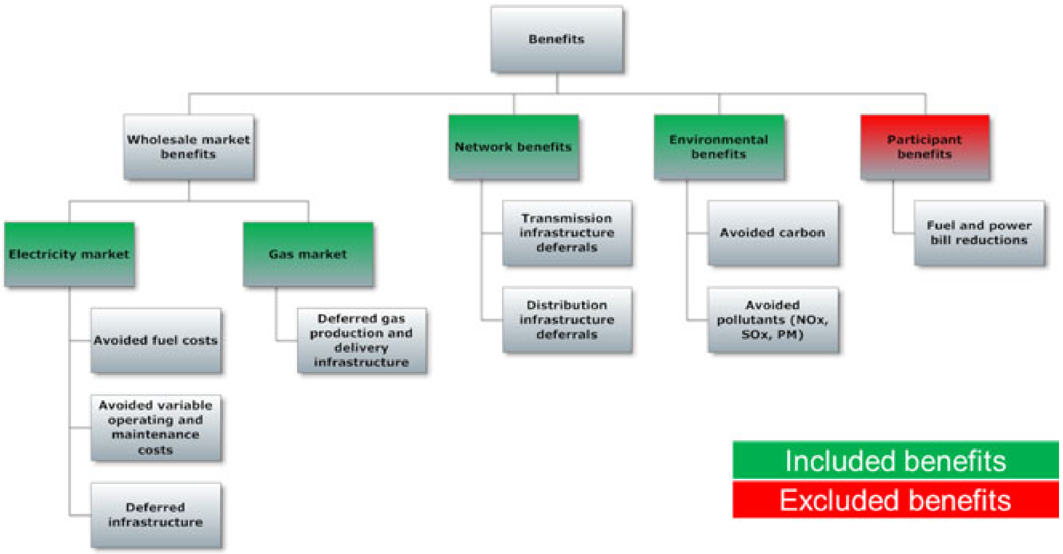
2 and Figure 3. Included costs and benefits are shaded green while excluded costs and benefits are shaded red.

Figure 2: Included costs



Source: Jacobs' interpretation of draft NSW Treasury framework

Figure 3: Included benefits



Source: Jacobs' interpretation of draft NSW Treasury framework

The main differences between the Treasury approach and past approaches (e.g. those used to evaluate a National Energy Savings Initiative) are:

- Private costs for participants are excluded except where the participant is a public entity. These costs are excluded because private costs would have undergone a separate evaluation to justify expenditure.

- Avoided pollution in the form of nitrogen oxide pollutants (nitric oxide and nitrogen dioxide), sulfur oxide pollutants (sulfur monoxide, dioxide, trioxide, various sulfur oxides and di-sulfur monoxide and dioxide) and particulate matter is now included.

A similarity between this approach and past approaches is that private participant benefits are not included in the total benefits because private benefits also include a number of market benefits such as avoided fuel benefits so inclusion would incur double counting of these benefits.

Cost efficiency

OEH also sought to understand the private costs associated with energy efficiency adoption. Private costs include private capital contributions, research effort, data collection and development of business cases, accessing funding, and validating energy savings. A better understanding of private costs is essential to the development of energy efficiency policy, as they are a key barrier to uptake in energy efficiency. These are summarised in Table 1. The lowest cost programs include the Energy Savings Action Plans (ESAP), the Energy Savings Scheme (ESS), and the Energy Saver Program (ESP). Programs facing mid-range costs include the Treasury Loan Fund Scheme (TLF), Home Power Savings Program (HPSP), Home Saver Rebates Program (HSRP), and Energy Efficiency for Small Business Program (EESBP). The highest cost programs include the Government Building Retrofit Program (GBRP) and possibly the NSW Building Sustainability Index (BASIX), both of which incorporate higher levels of capital expenditure relative to the other programs. A range of costs are presented for BASIX because it was not possible to definitively estimate costs with the information available given the wide range of possible implementations. Further explanation on possible reasons for cost differences is available in Section 2.3.

Table 1: Summary of cost efficiency by program, $June 2013 ($/MWh)

	Government costs			Regulatory	Private costs			Total in CBA
	Administration	Audit	Capital		Audit fee	Capital	Transaction	
Multi-sector programs								
ESS	0.4	–	–	12.8	–	14.3*	–	**13.2**
Business programs								
ESAP[1]	0.5	–	–	–	–	16.8*	–	**0.5**
ESP	6.8	4.9	–	–	2.3*	17.0*	–	**11.7**
EESBP	10.2	22.9	22.7	–	6.2*	30.3*	–	**55.8**
Residential programs								
HSRP	1.9	–	29.4	–	–	148.7*	–	**31.4**
HPSP	19.6	39.8	14.4	–	–	–	–	**73.8**
BASIX	1.0	–	–	6.2–139.5	–		–	**140.5****
Government programs								
TLF	8.2	2.6	40.7	–	–	–	3.4	**54.9**
GBRP	19.4	8.7	69.0	–	–	–	0.6	**97.7**

Source: Jacobs' analysis of costs and lifetime energy savings. Only costs to June 2013 considered and savings from activity to June 2013. Only savings specific to opportunities undertaken prior to June 2013 considered. Where these savings have extended beyond 2040 they have been included in the average cost calculation as this approach is more reasonable to compare programs with activities of varying lifetimes.

**Not included in totals, as these costs are viewed as a private cost and not required under NSW Treasury guidelines*

*** See Section 2.1.3. It is more appropriate to specify a range of costs rather than a single value because the BASIX program covers a wide range of potential implementations. For the purpose of undertaking the CBA the more conservative, higher value was used.*

[1] Note that there was no data available on regulatory costs for the ESAP, and therefore total program cost will be understated.

Net benefit of programs

The economic evaluation found that the programs provided a positive net benefit in all timeframes and discount rates assessed (4%, 7% and 10%) under conservative assumptions. The net benefit was also positive for NSW alone and Australia as a whole. Table 2 presents the costs and benefits for each timeframe under a 7% discount rate. The net benefit for the evaluation period was estimated to be $3.5 billion.

Table 2: Net benefit of NSW energy saving programs for activity between July 2007 and June 2020, millions, $2013 (Discount rate = 7%)

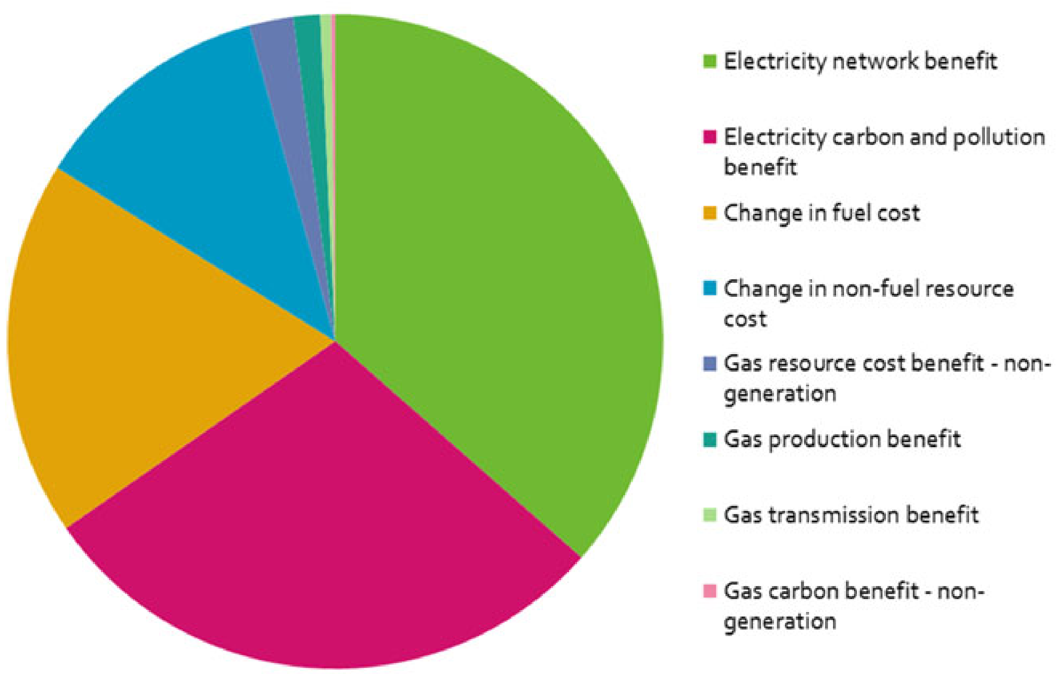
	NPV FY2008–FY2013	NPV FY2008–FY2020	NPV FY2008–FY2030	NPV FY2008–FY2040
Net benefits Australia	654	1,997	3,395	3,475
Total costs	1,946	3,679	3,680	3,680
Total benefits Australia	2,600	5,676	7,075	7,155

Source: Jacobs' analysis

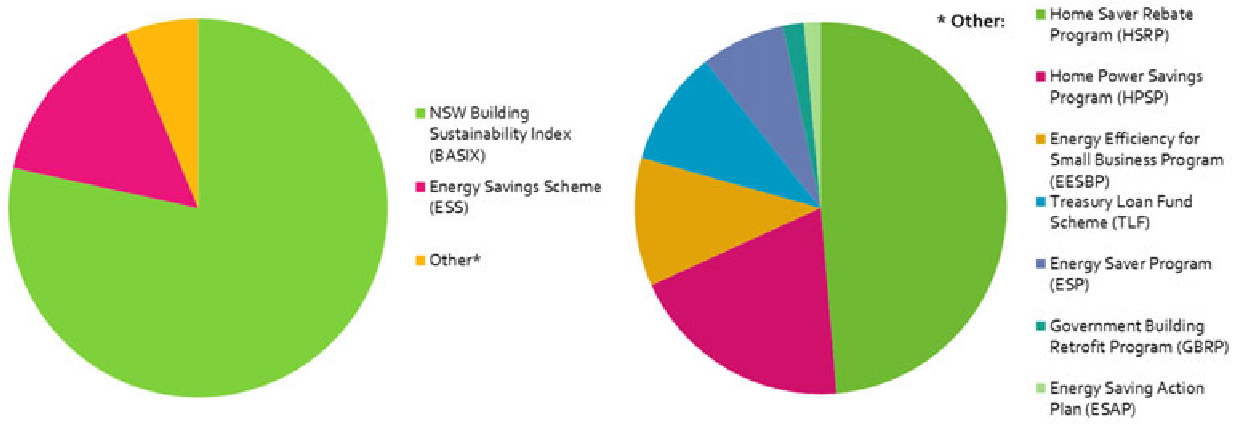
Figure 4 displays benefits and costs by type. Benefits are dominated by network benefits (approximately a third of all benefits), avoided carbon and pollution (nearly a third of all benefits), and avoided fuel and operating costs associated with generation. Costs are dominated by BASIX, which was one of the larger programs and for which costs were conservatively estimated.

Figure 4: Breakdown of benefits and costs by type and program

Benefits by type



Costs by program[2]



Source: Jacobs' analysis

** Note that the category 'other' in the left pie chart is described in further detail in the right pie chart.*

Impact on retail prices

Table 3 presents retail price impacts from implementation of the programs. The table reveals negligible historical reductions, and expectations for low to moderate reductions over the projection period.

Table 3: Retail price impacts, $2013/MWh

	FY2008–FY2013	FY2008–FY2020	FY2008–FY2030	FY2008–FY2040
Median estimate	(0.07)	(3.58)	(1.71)	(0.94)
Likely price impact	Negligible	Moderate	Low	

Source: Jacobs' analysis

[2] The costs shown are conservatively derived and include BASIX costs set to the maximum of a given range.

Conclusions

Efficiency and effectiveness

- All programs other than BASIX delivered savings under $100/MWh. For BASIX, a conservative cost estimate was incorporated in the CBA

Net economic benefit

- **Positive** in NSW and Australia
- **Positive** for 4%, 7% and 10% discount rates
- **Positive** in all time periods

Price impacts

- **Non-participants**
  - Low to Moderate ($0/MWh to $3.58/MWh) over all evaluation periods
- **Participants**
  - Low to Moderate ($0/MWh to $3.58/MWh) over all evaluation periods
  - Additional energy cost savings from reduced energy consumption

Recommendations

Recommendations were developed and categorised around program design, electricity market benefits, and undertaking future evaluations. For further detail, see Section 5.1. Our recommendations are summarised below.

Program design

- Improve the design of programs to make them more cost effective
- Continue implementing a mix of business, residential and government programs
- Consider increasing energy efficiency targets for the ESS between now and 2020, and beyond

Electricity market benefits

- Increase understanding of the relationship between network benefits and prices
- NSW Government could provide assistance to AEMO to project energy savings

Undertaking future evaluations

- Enhance data collection
- Improve evaluation methods and work toward a common, national approach

1. Introduction

The NSW Government has implemented a number of energy efficiency programs to assist households, businesses and government agencies reduce energy consumption and energy costs. The NSW Office of Environment and Heritage (OEH) engaged Jacobs to conduct a study to analyse the costs and benefits of nine such programs, the details of which are summarised in Table 4. The purpose of the study is to provide an economic review of these programs and assess their collective impacts across the energy market. The review is intended to guide and inform policy development in energy efficiency programs.

The review is based on an assessment of the information available in 2013. The period of assessment includes activity undertaken between July 2007 and June 2020, with the majority of programs reaching conclusion prior to June 2013. Because the programs' impacts may have consequences for the energy market beyond these time periods, the assessment of market benefits was extended to encompass the period to 2040. Jacobs has worked with OEH and associated organisations to gather cost and energy savings data to calculate the net economic benefits.

Table 4: Overview of programs

Energy efficiency program	Description	Evaluation period
Residential programs		
Home Power Savings Program (HPSP, residential customers only)	Home power assessments by an energy expert and energy saving kits to 220,000 low income households. Power Savings Kits include: standby power board, 4 energy efficient light bulbs, low flow showerhead, shower timer, tap aerator, draught-proof strips for around the door, door snakes, and a personal Power Savings Action Plan.	July 2007 – June 2013
Home Saver Rebates Program (HSRP, residential customers only)	A $170 million program which provided rebates to households for rainwater tanks, low emission hot water systems, ceiling insulation, dual flush toilets, hot water circulators and water efficient washing machines[3]. $105.6 million was spent on rebates for energy efficient hot water systems and insulation.	July 2007 – June 2013
NSW Building Sustainability Index (BASIX, residential customers only)	Applicable to all new homes, and some extensions / refurbishments. BASIX sets energy and water reduction targets for houses and units to ensure homes are designed to use less potable water and are responsible for fewer greenhouse gas emissions.	July 2007 – June 2020
Business programs		
Energy Efficiency for Small Business Program (EESBP, small business customers only)	On-site energy assessments, tailored advice, and up to 50% in matched funding for technology upgrades to 17,600 small businesses. The program ended on 31 December 2012, with OEH energy assistance for SMEs delivered by the Energy Saver Program from that point.	July 2007 – June 2013
Energy Saver Program (ESP, medium to large business)	Undertake energy audits and identify energy reduction projects for medium to large NSW businesses, and smaller NSW businesses from January 2013. Assist implementation with additional engineering support. Develop and disseminate best	July 2007 – June 2013

[3] While water efficient washing machines may save energy, this has not been quantified.

Energy efficiency program	Description	Evaluation period
	practice guides on technologies and for industry sectors.	
Energy Savings Action Plans (ESAP, large business and government)	High energy users in NSW were required to determine their energy use, undertake a management and technical review including an energy audit, identify measures to save power, and report on savings measures implemented.	July 2007 – June 2013
Government programs		
Government Building Retrofit Program – small sites (GBRP)	Provided advice and support to NSW Government agencies in meeting their energy efficiency obligations under the NSW Government Sustainability Policy. The GBRP fully funded the identification, design and implementation of energy efficiency opportunities.	July 2007 – June 2013
Treasury Loan Fund Scheme (TLF)	The TLF provides low interest loans to facilitate the implementation of energy efficiency opportunities for NSW Government agencies. The program provides specialist technical and procurement assistance and facilitation services and seed funding to initiate projects through the identification and design of cost effective solutions.	July 2007 – June 2013
Multi-sector programs		
Energy Savings Scheme (ESS, for purchasers of energy efficiency products and services – business and residential)	ESS sets mandatory energy savings targets for electricity retailers, rising to 5% of liable NSW electricity sales by 2014. Penalties are imposed if retailers do not meet the target. Electricity retailers are required to surrender energy savings certificates against their obligation; certificates are awarded for any electricity based energy efficiency measures that do not reduce service levels and are additional to other regulatory requirements (e.g. BASIX).	July 2007 – June 2020

OEH also sought to understand the private costs associated with energy efficiency adoption. Private costs include private capital contributions, research effort, data collection and development of business cases, obtaining funding, and validating energy savings. A better understanding of private costs is essential to the development of energy efficiency policy, as they are a barrier to uptake in energy efficiency.

To undertake these combined tasks, Jacobs:

- developed a database which collates and organises the cost and energy savings data collected
- undertook stakeholder interviews to ascertain the private transaction costs from undertaking an energy efficiency activity
- undertook desktop analysis and a literature review to fill data gaps
- used the database to aggregate energy savings and cost data to be used in our suite of energy market models and enable an appropriate evaluation of net economic benefit
- used the database to illustrate the cost effectiveness of programs.

1.1 Data development

The following provides an overview of the methodology utilised in estimating costs and benefits attributable to the selected schemes.

1) Establish study boundaries
    a) Evaluation period
    b) Program energy efficiency opportunities
    c) Program interactions
2) Compile a data request for each scheme
    a) Data review and organisation
    b) Data gap analysis
3) Estimation of transaction costs for government programs (stakeholder interviews)
4) Estimation of incremental costs (literature review)
5) Data analysis and preparation for the cost benefit analysis
6) Development of a reference case and policy based scenario representation of energy market consumption and peak demand
7) Evaluation of reference case and policy based scenarios in Jacobs' energy market modelling suite, in particular to develop a view of network and wholesale market costs under each scenario
8) Development of a cost benefit analysis comparing benefits arising from the reduction in market costs against program and other costs as prescribed by NSW Treasury guidelines

1.2 Definition of costs

The NSW Treasury has developed a draft CBA framework for the treatment of costs and benefits in energy efficiency programs and policies[4]. Costs are separated into three basic classes:

- *Public costs and subsidies* – program administration costs, subsidies to conduct home or business audits and/or assessments, and capital cost rebates or subsidies for energy efficiency equipment and/or installation
- *Regulated costs* – incurred for activities that are mandated by regulation, for instance audit, reporting and capital costs, certificate fees/costs and administration costs incurred by the regulated parties
- *Private costs (incurred by the private sector)* – residential or business contributions to audit costs, the cost of time for audits and assessment/implementation of opportunities, and capital costs related to undertaking an energy efficiency activity

Under the NSW Treasury framework, public and regulated costs are included in the CBA; however, private costs are excluded because these are separately justified from the perspective of private clients. This treatment is appropriate since private benefits are also not included in the CBA.

To enable the exclusion of private costs in the CBA, the program costs assessed under this review have been allocated to one of the categories described above (these are outlined in Table 5). Costs that are included in the CBA are shaded in pink, those that are simply reported on are shaded in green, and those that were deemed not relevant for that particular program or require further research are shaded in blue.

[4] At the time of writing the framework is in final stages of drafting.

Table 5: Allocation of costs according to NSW Treasury guidelines

	Public costs and subsidies			Regulated cost	Private costs and subsidies		
	Government admin	Audit/facilitation subsidy	Capital subsidy		Audit fee	Transaction cost	Incremental capital cost
EESBP	Program administration	Audit and implementation subsidy	Capital cost rebate		Business contribution to audit cost	Cost of time for audits, project implementation**	Incremental project capital costs
ESP	Program administration	Audit subsidy			Business contribution to audit cost	Cost of time for audits, project implementation **	Incremental project capital cost
ESAP	Program administration			Audit and reporting cost		Cost of time for audits, project implementation**	Incremental project capital cost
GBRP	Program administration	Audit cost	Incremental project capital cost			Cost of time for audits, project implementation*	
TLF	Program administration	Audit cost	Incremental project capital cost			Cost of time for audits, project implementation*	
HPSP	Program administration	Assessment cost	Kits			Cost of time taken for households to participate **	
HSRP	Program administration		HSRP rebate			Cost of time taken for households to participate**	Incremental project capital cost
BASIX	Net program administration cost***			BASIX certificate fee Incremental project capital cost			
ESS	Net program administration cost***			ESC price Electricity retailers administrative costs		Cost of time taken by participants**	Incremental project capital cost less subsidy (ESC price – ACP cost)

** Considered to be a public cost because client is in public sector; ** Not reported; ***Administration costs net of fees provided by program participants*

1.3 Energy efficiency schemes in NSW

Some of the programs being evaluated have been operating since 1998, while others have only commenced recently. In consultation with OEH, a start date for the input data was determined to be 1 July 2007. When the study commenced, most of the programs were to finish by 30 June 2013 and there were no expectations of expenditure or new energy efficiency savings beyond that date[5]; however, since BASIX and ESS are mandated

[5] Note that some programs included planned expenditure outside the set period. For consistency this planned expenditure was included in the evaluation.

by legislation to continue[6], projections of future new energy efficiency activity, savings and expenditure to 2020 were developed for these programs.

Energy efficiency will affect the entire energy supply chain from demand growth and chronological consumption patterns to electricity generation, transmission and distribution infrastructure development and gas production and transport. As many of these items have long effective life spans, it was necessary to choose an end date for the evaluation which would encompass as many of the benefits as possible while maintaining plausibility. The financial year ending June 2040 was selected as the end date to capture the future benefits of each of the programs, while recognising that past this time uncertainty of the electricity market increases and the value of the benefits decreases.

1.4 Cost benefit analysis approach

The assessed programs are treated as a single portfolio for the cost benefit analysis. The energy savings are reduced to account for interactions that may cause double counting. Details of the interactions may be found in Appendix A.

The reduction in demand arising from energy efficiency results in the following benefits:

- energy market benefits: avoided fuel, variable operation and maintenance costs, and deferral of installed generation infrastructure
- network infrastructure deferrals
- deferral of upstream gas production and delivery infrastructure.

These benefits are assessed against program administrative costs, as well as implementation costs as applied under the NSW Treasury guidelines.

The analysis also provided estimates of retail price impacts for consumers participating in the scheme as well as all consumers.

Throughout the document costs and benefits are expressed in June 2013 dollars.

1.5 Data collection

Table 6 summarises information for each program under consideration. Data has been collected from the program administrators for participant numbers, direct costs, administration costs, electricity savings, and gas savings. The quality of data varies significantly between programs. In some cases the data has been collected for individual opportunities, while in others (e.g. BASIX) only the high level savings and costs have been estimated.

Table 6: Energy saving opportunities

Energy efficiency program	Summary of energy saving opportunities	
Residential programs		
Home Power Savings Program (HPSP)	• Draught-proof strips • Door snakes • Energy efficient light bulbs • Low flow showerhead	• Shower timer • Standby power board • Tap aerator

[6] The ESS is to continue to 2020 (in November 2014, the NSW Government announced its intention to extend the ESS to 2025) and BASIX is expected to continue indefinitely with no listed end date.

Energy efficiency program	Summary of energy saving opportunities	
Home Saver Rebates Program (HSRP)	• Ceiling insulation	• Hot water systems
NSW Building Sustainability Index (BASIX)	• Alternative energy • Clothes dryer rating • Clothes washer rating • Cooktop / oven rating • Cooling system • Dishwasher rating	• Heating system • Hot water systems • Insulation • Lighting • Refrigerator rating • Showerhead • Ventilation
Business programs		
Energy Efficiency for Small Business Program (EESBP)	• Air compressors • Air curtains • Boilers • Insulation • Kitchen equipment • Hot water system • HVAC	• Lighting • Motors • Natural lighting • Refrigeration • Ventilation • Voltage reduction units • Window tinting
Energy Saver Program (ESP)	• Air compressors • Boilers • Chillers • Computers and printers • Generation • Hot water system • HVAC	• Industrial equipment • Insulation • Lighting • Power factor correction • Refrigeration • Ventilation
Energy Savings Action Plans (ESAP)	• Air compressors • Boilers • Chillers • Computers and printers • Generation • Hot water system • HVAC	• Industrial equipment • Insulation • Lighting • Power factor correction • Refrigeration • Ventilation
Government programs		
Government Building Retrofit Program – small sites (GBRP)	• Hot water system • HVAC	• Lighting • Other
Treasury Loan Fund (TLF)	• Hot water system • HVAC	• Lighting • Other
Multi-sector programs		
Energy Savings Scheme (ESS)	• Air compressors • Building upgrade • Fans / pumps • High efficiency motors • HVAC / chiller • Lighting (CLF) • Lighting (DSF) • Lighting (PIAM)	• Multiple opportunities • Power factor correction • Power systems • Process change / control systems • Refrigeration • Refrigerator and freezer removal • Showerheads • Whitegoods

2. Cost efficiency

This section provides an overview of the programs assessed, and outlines the average and overall costs. Energy savings and costs are split into public and private costs associated with capital investment, transaction costs in undertaking an energy efficiency activity, and program administration costs.

2.1 Program costs and savings

In this section we focus on historical costs and energy savings for each program. The information collected for each program was compiled in order to:

- calculate and forecast participation by activity by year
- calculate and forecast electricity savings, peak demand reductions, and gas savings by distribution network service provider (DNSP) by activity by year. It was necessary to go to this level of detail to enable estimates of peak capacity reduction by network jurisdiction
- calculate and forecast incremental costs by customer segment by program by year
- calculate and forecast transaction costs by customer segment by program by year.

Program costs over the period were evaluated by calculating the net present value (NPV) using a discount rate of 7%. This value was escalated by 1.07^6 to bring it to current dollars. This calculation convention has been applied throughout this document to evaluate historical cost data.

Average program costs have been calculated by dividing energy savings into program costs for activity undertaken between July 2007 and June 2013. This method of calculating average cost is appropriate for comparing the cost of opportunities where the timing of savings may not match the timing of expenditure, and where some opportunities may be compared over different life cycles.

2.1.1 Home Power Savings Program

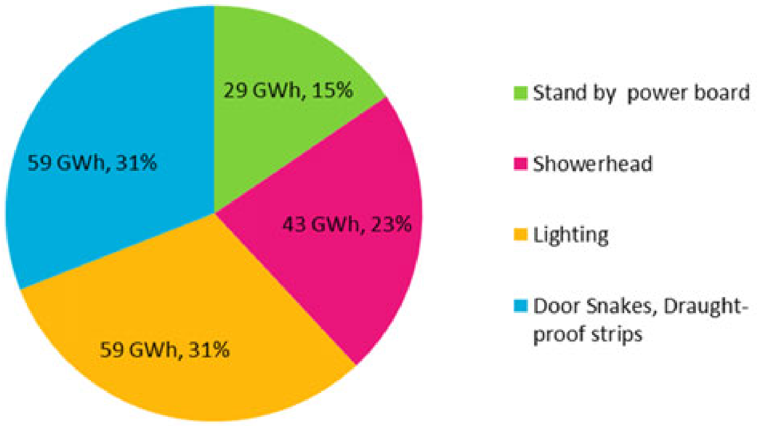
The Home Power Savings Program (HPSP) provided energy efficiency kits and home energy efficiency assessments to low income households. The energy efficiency kits included energy efficient lighting, door snakes and draught-proof strips, a standby power board, and water efficient showerheads[7].

To June 2013, approximately 200,000 household assessments were undertaken[8]. HPSP has saved an estimated 190 GWh of electricity to 2013, with potential to save a further 517 GWh beyond 2013 from activity already undertaken. The savings are larger after 2013 because existing equipment continues to provide savings over its lifetime. The largest contributor to total program energy savings comes from door snakes and draught-proofing (see Figure 5)[9].

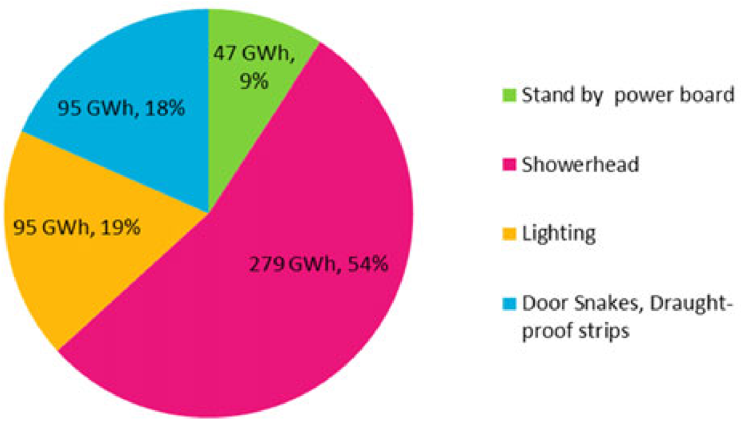
[7] Saturation for water efficient showerheads is relatively high and only around 20% of households were provided with this item.
[8] The program finished in April 2014, and met its target of helping more than 220,000 low income households reduce their energy use.
[9] Individual households that did receive a low flow showerhead saved most of their energy through the showerhead.

Figure 5: HPSP electricity savings by activity type, GWh

Historical (savings to June 2013)



Future (savings from July 2013)



Source: Jacobs' analysis

Costs included administration costs, energy assessment costs and the cost of energy efficiency kits. All costs were publicly funded. Administration costs were estimated to be $11.9 million and capital costs were estimated to be $8.7 million ($June 2013). Audit costs were estimated to be $24.1 million bringing overall costs to $44.8 million. The average levelised cost[10] of the HPSP program was estimated to be $73.8/MWh saved (assuming five year life of opportunities other than showerheads, and 10 year life of showerheads).

2.1.2 Home Saver Rebate Program

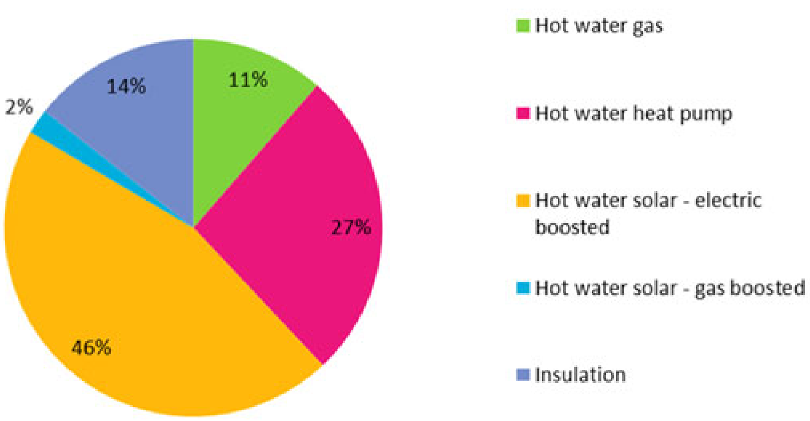
The Home Saver Rebate Program (HSRP) concluded on 30 June 2011 and provided rebates for rainwater tanks, climate-friendly hot water systems, ceiling insulation, dual flush toilets, hot water circulators and water

[10] Average cost including government administration and government subsidies on audits and capital costs

efficient washing machines. Rainwater tanks, dual flush toilets, hot water circulators and water efficient washing machines are not energy efficient activities and are excluded from this study.

Stage one estimated that 181,310 energy efficiency opportunities were implemented. These opportunities covered a range of hot water options as shown in Figure 6.

Figure 6: HSRP opportunities by type



Source: Jacobs' analysis

Administration costs were estimated to be $6.9 million and public subsidies to capital costs were estimated to be $104.7 million. Private capital costs were estimated to be $528.7 million ($June 2013). The program is estimated to have saved 1496 GWh from July 2007 to June 2013, with a further 2471 GWh expected in the future from opportunities already undertaken. The average levelised cost for the HSRP overall is estimated to be $31.4/MWh excluding private contributions.

2.1.3 NSW Building Sustainability Index

The NSW Building Sustainability Index (BASIX) sets energy and water reduction targets for houses and units to ensure homes are designed to use less potable water and produce fewer greenhouse gas emissions. The targets can be achieved from undertaking a wide range of activities including sustainable building design, more efficient appliances, insulation and less greenhouse intensive approaches to area and water heating.

Because of the wide range of activities that could possibly be undertaken to reach targets, there are in reality a wide range of prospective costs that could be applicable to this program. For example, Sustainability House conducted a study[11] that showed that residential dwellings could be redesigned to achieve greater sustainability levels (from 5 star to 6 star) at an average negative cost difference of –1.6%, for all climates and dwelling orientations. In contrast, in a survey conducted as part of the study, high volume residential builders estimated that moving from 5 to 6 stars through the traditional approach of increasing building specifications would result in a cost increase of approximately $3500. Increased education of home buyers and sales staff as well as reduced application of block layouts in residential developments would help reduce barriers to energy efficiency.

As it was desirable to conduct a conservative evaluation of the NSW programs, an upper limit for the cost of the minimum building specification increases required to achieve BASIX energy reduction targets was estimated by using a bottom up approach; see Appendix B for details. This approach was adopted to exclude costs pertinent

[11] *Identifying Cost Savings through Building Redesign for Achieving Residential Building Energy Efficiency Standards*, March 2012 www.industry.gov.au/Energy/Energy-information/Documents/identifyingcostsavingsbuildingredesignachievingenergyefficiencystandards.pdf

to water rather than energy saving opportunities, and to conservatively consider the cost savings arising from bulk purchasing of materials and other factors[12]. The estimates included insulation (floor, wall and ceiling), lighting and air conditioning improvements, and solar hot water in non-gas reticulated areas, considered sufficient for achieving BASIX energy reduction targets.

Over the period from financial year 2008 to 2013, administration costs were estimated to be $10.7 million, regulatory costs $68.2 million, and capital costs $1457 million ($June 2013).

The program is estimated to have saved 2434 GWh in electricity and 3.5 PJ in gas from July 2007 to June 2013. Beyond this time[13], electricity savings are expected to be 26,051 GWh of electricity and 18.1 PJ of gas. Based on the discussion above around the variation in program costs, average levelised costs for the BASIX program were estimated to be between $7.2/MWh and $140.5/MWh, with capital costs estimated in the range $0–133.3/MWh.

2.1.4 Energy Efficiency for Small Business Program

The Energy Efficiency for Small Business Program (EESBP) provided on-site advice and financial assistance to small businesses. As of December 2012, energy efficiency services for small businesses are being delivered under the Energy Saver Program. Opportunities included upgrading of air curtains, boilers, compressors, hot water systems, heating/ventilation and air conditioning (HVAC) systems, insulation, kitchen appliances, lighting, motors, refrigeration, ventilation, voltage reduction units, improvement of natural lighting, and window tinting.

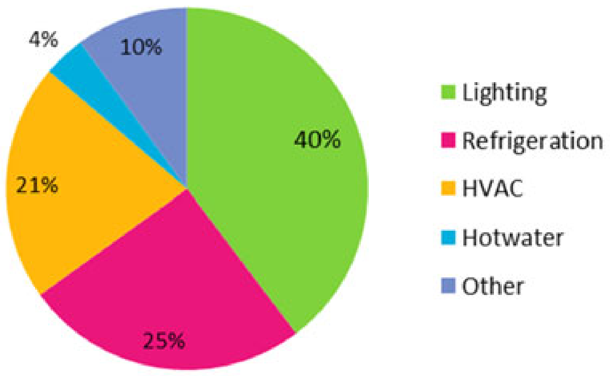
Around 17,763 implemented opportunities were undertaken. This assisted 17,600 businesses, of which more than 3000 received rebates. Additionally, over 60% of businesses implemented at least one low cost or no cost opportunity. The opportunities that dominate this sector include lighting (56%), refrigeration (27%) and HVAC (9%) (see Figure 7).

Administration costs were estimated to be $4.7 million and capital cost subsidies were estimated to be $10.5 million compared with a $14 million contribution from the participants ($June 2013). In addition, the program covered audit costs of $10.5 million in combination with private contributions of $2.9 million.

The program is estimated to have saved 111 GWh to June 2013, with a further 502 GWh expected in the future. Average costs per unit of energy saving are displayed in Figure 8, which demonstrates the range of incremental capital costs is between $40 and $136/MWh. The average levelised cost[14] for the EESBP overall is estimated to be $55.8/MWh, excluding private audit and capital cost contributions of $6.2/MWh and $30.3/MWh respectively.

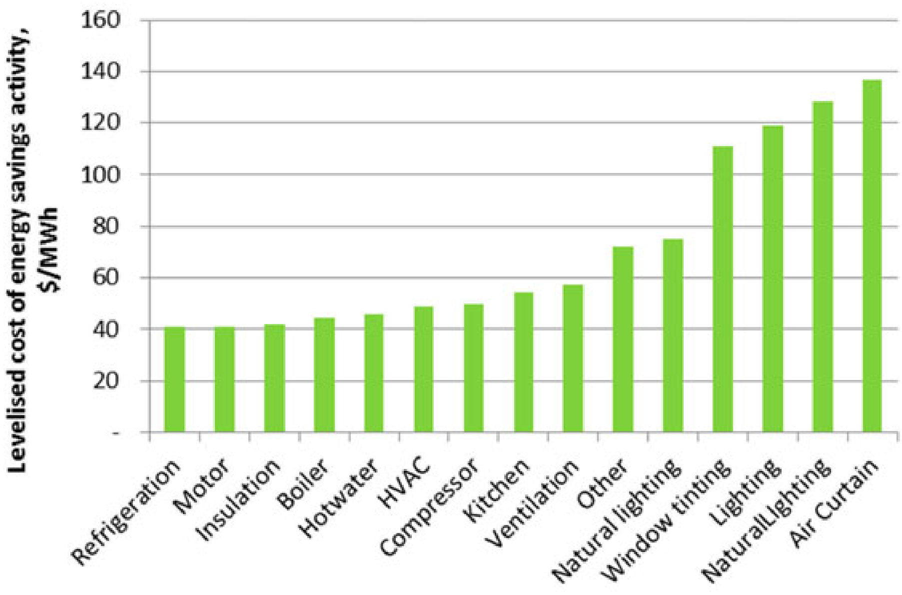
[12] See discussion on page 53 of the March 2012 Sustainability House report *Identifying cost savings through building redesign for achieving residential building energy efficiency standards*.
[13] For the purpose of calculating average costs, savings were beyond 2040 because it was important to consider longer lifetimes associated with thermal comfort measures when comparing average costs to those of other programs. This is different to the calculation of market benefits in the cost benefit calculation, which were only evaluated to 2040.
[14] These costs include government subsidies to capital and audit costs, and government administrative costs.

Figure 7: EESBP opportunities by type



Source: Jacobs' analysis of OEH data

Figure 8: Summary of EESBP average costs by activity ($June 2013)



Source: Jacobs' analysis of OEH data (costs include administration, public and private audit costs and capital costs)

2.1.5 Energy Saver Program

The Energy Saver Program (ESP) delivers energy audits to identify energy reduction projects for medium to large NSW businesses, provides technical support post-audit, and develops and disseminates best practice technology and industry sector guides[15]. Opportunities include upgrading of lighting, HVAC, industrial and

[15] After the study commenced, the program was extended for the duration of the Energy Efficiency Action Plan (EEAP) to June 2017.

commercial refrigeration and air compressors, timers and sensors, chillers, variable speed drives, industrial equipment, insulation, building management systems, cogeneration, maintenance programs, hot water systems, heat exchangers, fans, computers and printers, boilers, pumps, photovoltaic (PV) generation, laundry applications, and voltage reduction.

Four hundred and seventy-five sites were assisted to June 2013, and 1261 opportunities were reported as implemented at those sites. The opportunities that dominate this sector include lighting (29%), HVAC (15%), natural gas (8%), timers and sensors (7%), refrigeration (7%), and air compressors (6%) (see Figure 9).

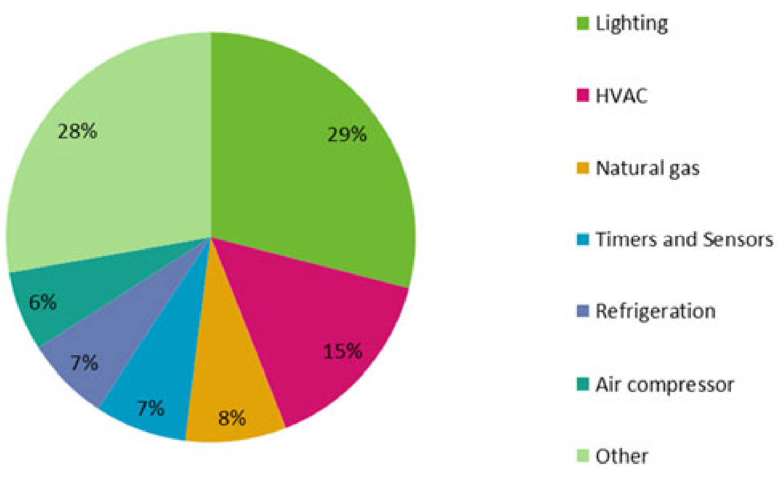
Administration costs were estimated to be $9.8 million, while public and private audit costs were $7 million and $3.3 million respectively. Participants paid $24.5 million for capital expenditure.

The program is estimated to have saved 126 GWh of electricity and 0.4 PJ of gas to June 2013. In the future it is expected to save a further 1038 GWh of electricity and 2.7 PJ of gas (to 2040).

Capital costs per unit of energy saving are displayed in Figure 10 and Figure 11. In both cases PV generation is the most expensive activity with average costs between $180 and $336/MWh; however, these numbers are historical and do not reflect costs today because PV costs have reduced substantially in recent years. Costs other than PV range from $23 to $67/MWh for larger businesses and from $30 to $75/MWh for medium sized businesses.

The average levelised cost for the ESP overall is estimated to be $11.7/MWh[16], excluding private audit and capital cost contributions of $2.3/MWh and $17/MWh respectively.

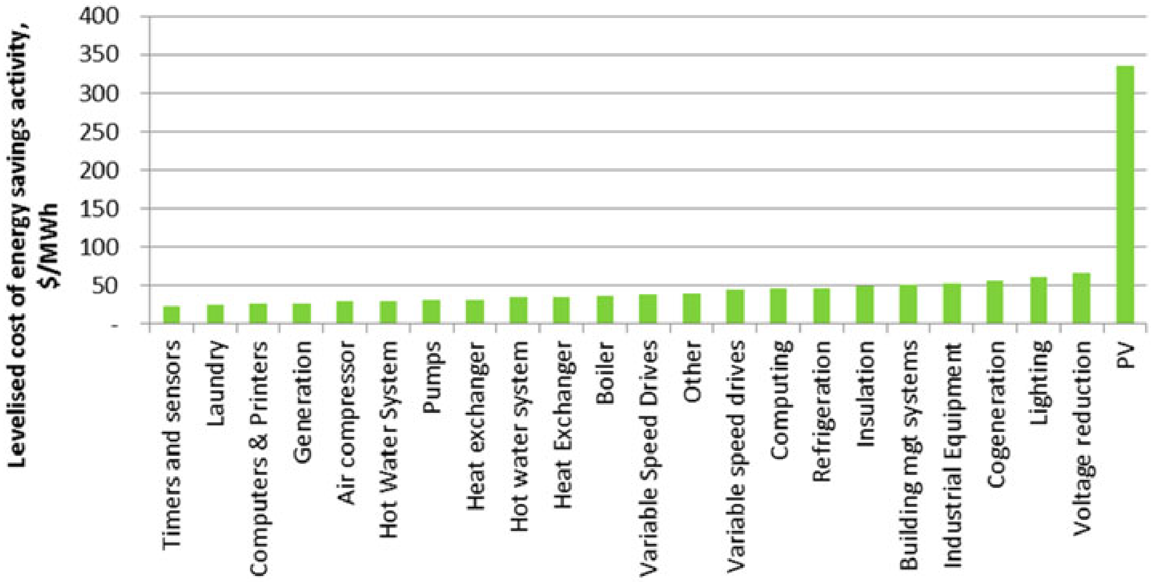
Figure 9: ESP opportunities by type



Source: Jacobs' analysis of OEH data

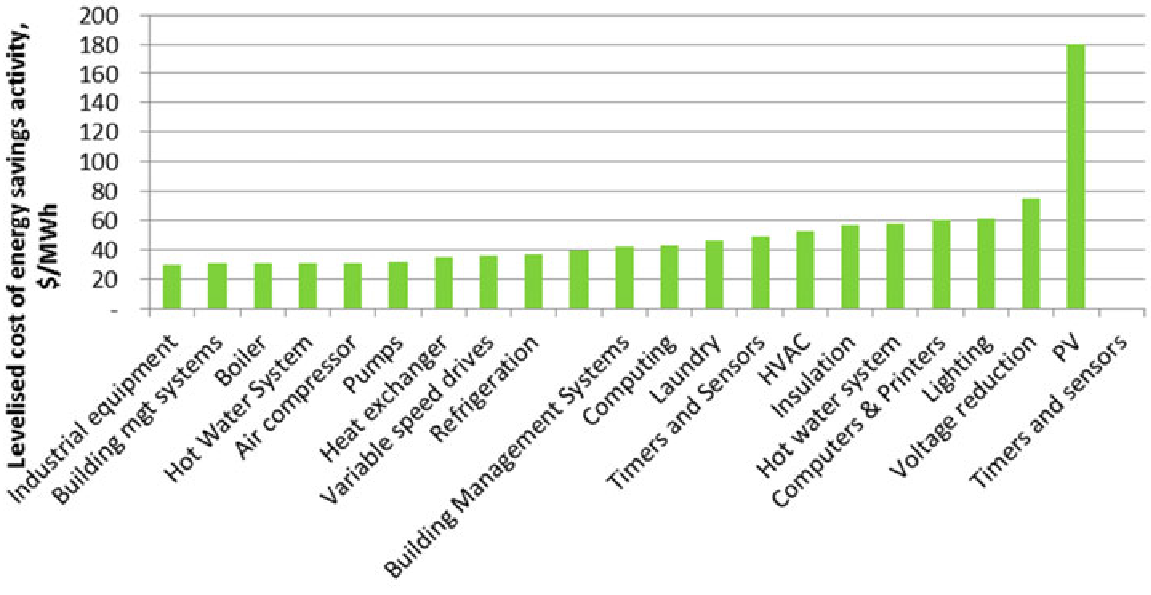
[16] Gas units were converted to an equivalent electricity unit to enable calculation of an average cost. Average costs include administration cost and the public contribution to audit costs.

Figure 10: Summary of ESP costs for larger commercial and industrial businesses by activity ($June 2013)



Source: Jacobs' analysis of OEH data

Figure 11: Summary of ESP costs for medium sized businesses by activity ($June 2013)



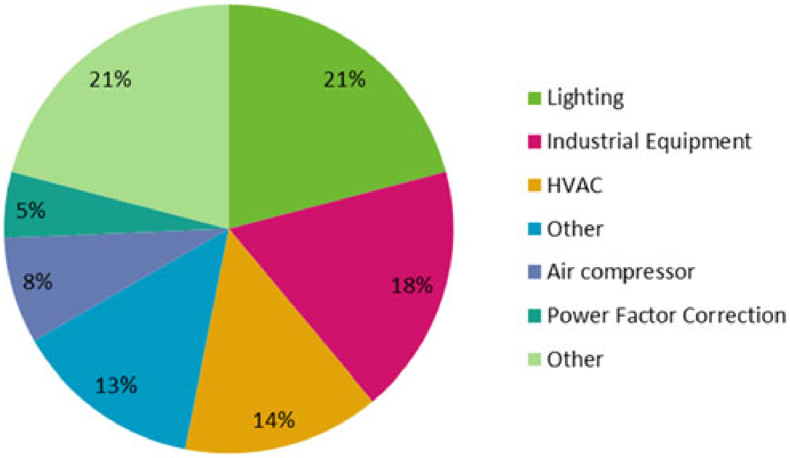
Source: Jacobs' analysis of OEH data

2.1.6 Energy Savings Action Plans

The Energy Savings Action Plans (ESAP) scheme was designed for energy users in NSW with annual consumption greater than 10 GWh and councils with a population over 50,000. These users were required to determine their current energy consumption and undertake a management and technical review of their energy use. They then had to identify measures to save energy. Implementation of measures was voluntary.

Around 267 large commercial and industrial businesses and local councils were mandated to prepare plans, with 1211 opportunities implemented as a result. The breakup of opportunities is illustrated in Figure 12. The opportunities that dominate this sector include lighting (24%), industrial equipment (18%), and HVAC (13%).

Figure 12: Breakdown of ESAP opportunities



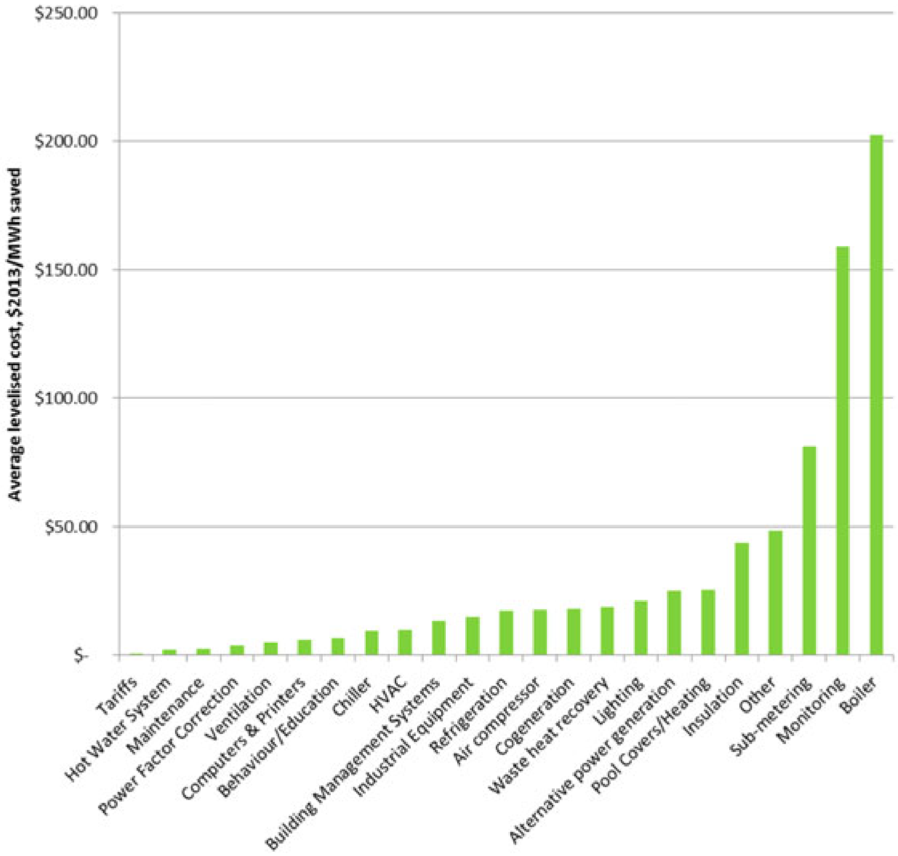
Source: Jacobs' analysis

Administration costs were estimated to be $3.3 million and capital costs were estimated to be $114.8 million ($June 2013). The program is estimated to have already saved 2020 GWh of electricity and 5.1 PJ of gas. In the future it is expected to save a further 2550 GWh of electricity and. 4.6 PJ of gas. The average cost for the ESAP overall is estimated to be $0.5/MWh[17], excluding private capital expenditure of $16.8/MWh. This also excludes the cost of the audit, which was borne by program participants. Since data on this was not collected, the overall program costs are understated in this report.

Incremental costs per unit of energy saving are displayed in Figure 13. The chart shows that there is a wide variation in cost, and the most expensive activities relate to monitoring and control, or boiler upgrades at $120 and $159/MWh respectively. The cost of the majority of activities is low, with 20 of them having costs under $50/MWh, 15 of them having costs under $20/MWh and nine of them with costs under $10/MWh.

[17] Gas units were converted to an equivalent electricity unit to enable calculation of an average cost.

Figure 13: Summary of ESAP costs by activity ($June 2013)



Source: Jacobs' analysis of OEH data

2.1.7 Government Building Retrofit Program – small sites

The Government Building Retrofit Program (GBRP) provided advice and support to help NSW Government agencies meet their energy efficiency obligations under the NSW Government Sustainability Policy. The GBRP was operational from July 2010 to June 2012 and fully funded the identification, design and implementation of energy and water saving projects in frontline service delivery facilities and iconic buildings. It provided agencies with practical, best practice information to allow them to make smart energy and water saving decisions at their other facilities. For the purposes of this study, only energy efficiency savings are included.

Around 566 energy efficiency opportunities were identified and implemented to 2013. These opportunities covered lighting (40%), hot water (10%), HVAC (4%) and other (46%) opportunities.

The program is estimated to have saved 4 GWh to June 2013, with a further 47 GWh expected in the future from implementation to date. Overall, the cost of the program was $4.1 million, comprising $0.8 million for administrative costs, $0.4 million for audit subsidies, $2.9 million for capital subsidies, and approximately $0.03 million for private transaction costs.

The average levelised cost for the GBRP overall is estimated to be $97.7/MWh. This is composed of administration costs ($19.4/MWh), audit subsidy ($8.7/MWh), capital subsidy ($69/MWh), and estimated transaction costs ($0.6/MWh).

2.1.8 Treasury Loan Fund

The Treasury Loan Fund (TLF) provides low interest loans to facilitate the implementation of energy efficiency opportunities for NSW Government agencies. The program also provides specialist technical and procurement assistance, facilitation services and seed funding to initiate projects that identify or design cost effective energy efficiency solutions. The TLF is a rolling program established in 1998. For the purposes of this study, only activity and expenditure between July 2007 and June 2013 are included.

In total 91 energy efficiency projects were implemented. These opportunities covered lighting (54%), hot water (23%), HVAC (7%) and other opportunities (14%).

The program is estimated to have saved 9.6 GWh of electricity to June 2013 with a further 635.8 GWh expected in the future from implementation to date.

The program cost $21.6 million, composed of $3.2 million for administrative costs, $1 million for audit subsidies and facilitation, $16 million for capital subsidies, and $1.3 million for private transaction costs.

The average levelised cost for the TLF is estimated to be $54.9/MWh. This is composed of administration costs of $8.2/MWh, audit and capital cost subsidies of $2.6/MWh and $40.7/MWh, respectively, and transaction costs of $3.4/MWh.

2.1.9 Energy Savings Scheme

The energy savings scheme (ESS) has set a mandatory energy savings target for electricity retailers of 5% of liable NSW electricity sales by 2014. Electricity retailers are required to surrender tradeable certificates against their obligations. Energy savings certificates (ESCs) can be created by electricity retailers or third party organisations for energy savings activities in the residential, commercial and industrial sectors. Electricity retailers who do not meet their target are required to pay a penalty rate for the shortfall, which effectively caps the cost of certificates.

To June 2013, businesses have become accredited to implement around 359 Recognised Energy Saving Activities (RESAs) through the ESS. An accreditation for a RESA allows a business to implement that type of energy efficiency project across one or more sites. At June 2013 there were 207 RESAs in the commercial sector, 112 RESAs in the industrial sector, and 40 RESAs in the residential sector. It was not possible to represent savings by household or business.

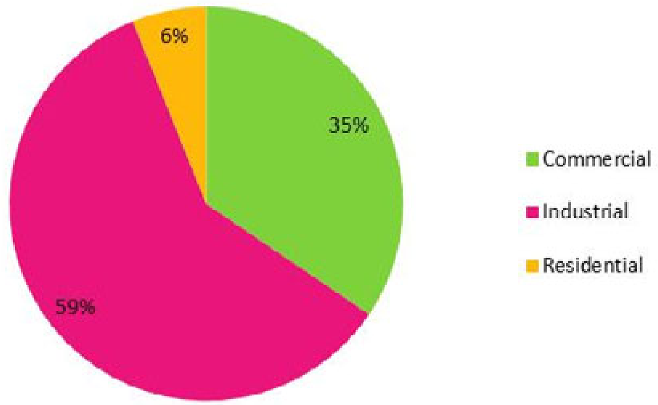
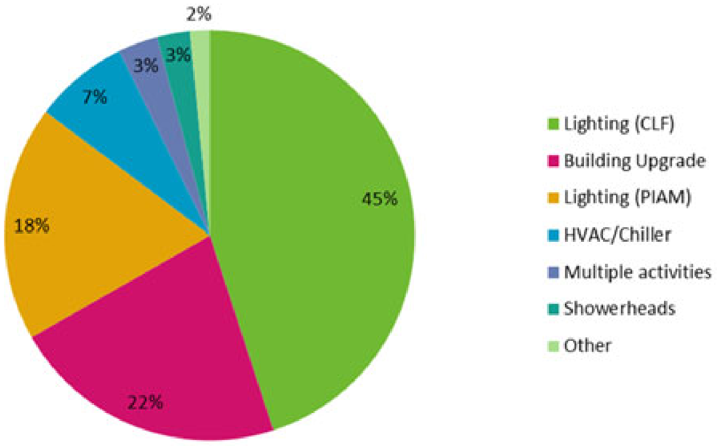
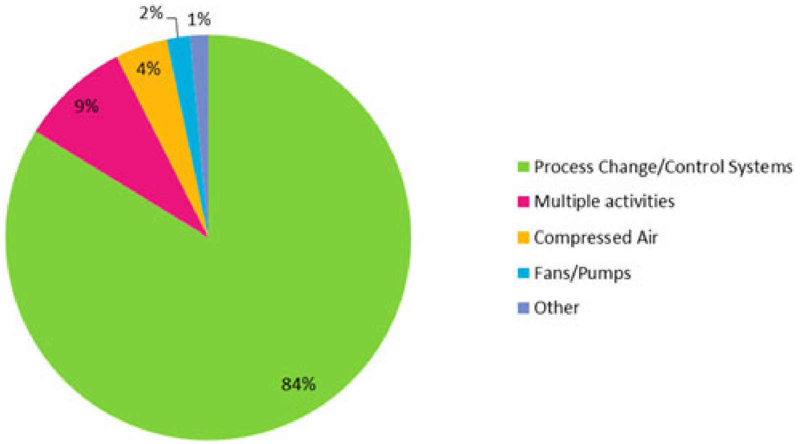
Total savings by RESA (before adjustment for interactions with other programs) are provided in Table 7. As of June 2013, the ESS has delivered around 3,214 GWh of electricity savings. This reduces to 2,716 GWh after adjustment for interactions with the ESAP, ESP and EESBP (see Appendix A for detail on these interactions). These results are also displayed by sector in Figure 14. After June 2013, the ESS is expected to deliver a further 55,332 GWh of electricity savings from activity already implemented as well as new projects implemented through to 2020.

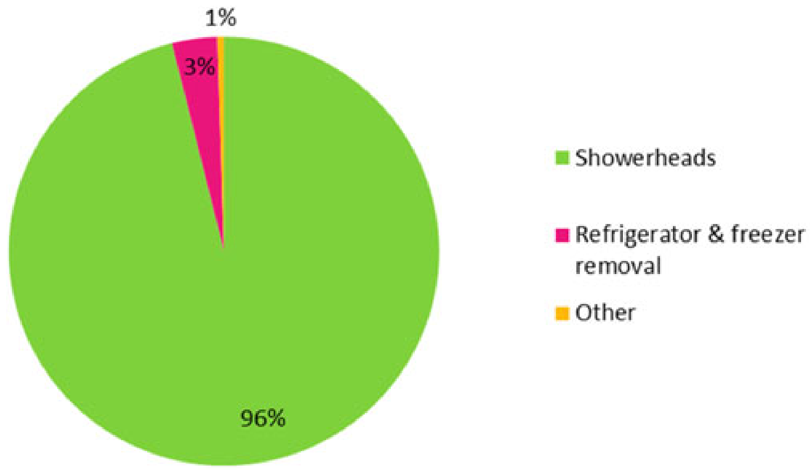
Table 7: ESS savings by RESA type, MWh (achieved by year)

Calendar year	2010	2011	2012	2013	Total
Commercial					
Building upgrade	10,606	35,095	75,288	120,225	241,214
Fans /pumps	46	68	68	68	251
HVAC / chiller	2,577	12,616	26,950	40,692	82,836
Lighting (CLF)	3,699	29,768	142,734	322,361	498,562
Lighting (DSF)	49	113	128	128	418
Lighting (PIAM)	38,084	47,649	56,571	63,038	205,342
Multiple activities	998	3,215	10,156	20,413	34,782
Power factor correction	-	-	-	-	-
Process change / control systems	2,082	4,164	4,645	5,608	16,498
Refrigeration	-	-	-	-	-
Showerheads	2,303	7,103	9,602	9,602	28,610
Commercial total	**60,443**	**139,792**	**326,143**	**582,136**	***1,108,513***
Industrial					
Compressed air	5,513	14,057	24,461	35,728	79,759
Fans / pumps	4,510	7,919	10,505	12,446	35,380
High efficiency motors	-	-	-	-	-
HVAC / chiller	702	1,404	1,565	1,886	5,557
Lighting (CLF)	574	1,523	2,496	3,345	7,939
Lighting (PIAM)	-	-	-	-	-
Power factor correction	-	11	22	22	54
Power systems	-	-	-	-	-
Process change / control systems	163,118	299,231	466,574	5 671,119	1,600,042
Refrigeration	316	2,537	5,022	6,182	14,057
Multiple activities	12,431	23,650	47,323	83,714	167,117
Industrial total	**187,164**	**350,332**	**557,967**	**814,441**	***1,909,904***
Residential					
HVAC / chiller	3	3	3	3	11
Lighting (DSF)	-	119	237	237	593
Refrigerator & freezer removal	-	-	1,660	4,981	6,641
Showerheads	21,223	49,016	59,080	59,080	188,399
Whitegoods	78	92	99	109	379
Residential total	21,304	49,230	61,079	64,410	***196,023***
Grand Total	**268,911**	**539,354**	**945,189**	**1,460,986**	***3,214,440***

Source: Jacobs' analysis of OEH data

Figure 14: Breakdown of ESS energy savings by sector

<table>
<tr><th>Sector</th><th>Pictorial overview of savings split to June 2013</th></tr>
<tr><td>All sectors</td><td>
</td></tr>
<tr><td>Commercial</td><td>
</td></tr>
<tr><td>Industrial</td><td>
</td></tr>
</table>

Sector	Pictorial overview of savings split to June 2013
Residential	

Source: Jacobs' analysis of OEH data

Energy savings delivered so far are dominated by the commercial and industrial sectors. In particular, process change and control systems dominate uptake in the industrial sector, comprising around half of the actual savings achieved in all sectors. The next largest RESAs include lighting activity in the commercial sector, with the two categories of lighting shown contributing around a quarter of the savings achieved in all sectors. The activity dominating savings in the residential sector is low flow showerheads.

The program cost $181.4 million, composed of $5.6 million government administrative costs, and $175.9 million regulated costs (including certificate costs and retailer administrative costs). Private capital costs were evaluated at $196.8 million[18].

Based on uptake to June 2013, the average cost for the ESS program overall is estimated to be $13.2/MWh, excluding private costs. The components of this amount include IPART scheme administration costs of $0.4/MWh, and regulatory costs evaluated at $12.8/MWh[19]. Private capital costs were estimated at $14.3/MWh.

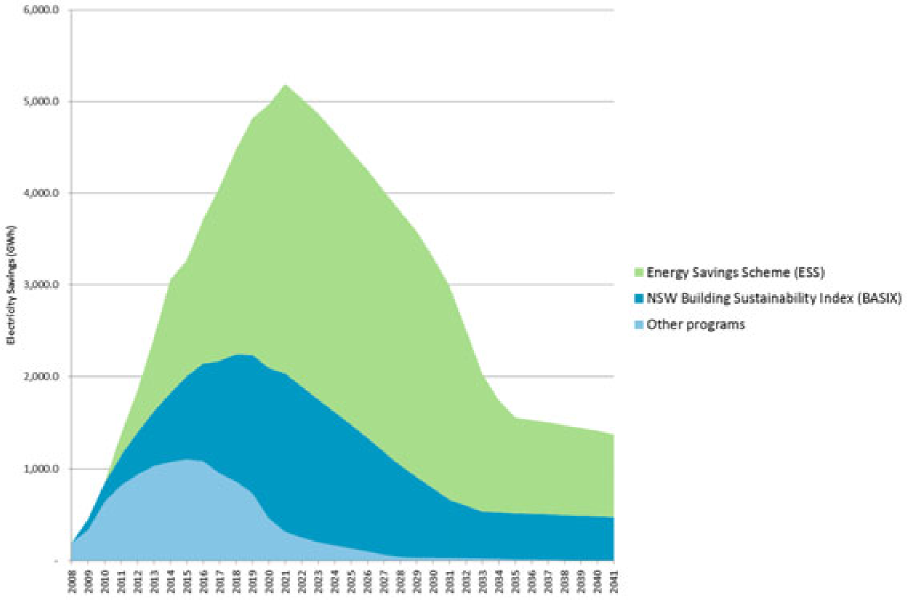
2.2 Overall energy and peak demand savings

The electricity and gas savings delivered by the programs are displayed in Figure 15, Figure 16 and Figure 17. Only savings from BASIX and ESS were allowed to accumulate from opportunities undertaken to 2020. The savings from these schemes drop away post 2020 because the appliances of the earliest adopters reach their maximum life[20]. As there is no new activity to encourage replacement of high-efficiency appliances, the energy efficiency option is removed. Savings from the other programs were based on opportunities undertaken to 2013.

The gas savings shown in Figure 17 indicate that savings trend to nil by around 2030, and then the savings turn to increased energy use post-2030 under the BASIX program. This is because the program is expected to cause some fuel switching during its operation. Gas savings from government programs are also quite low and barely noticeable next to the larger savings from BASIX, ESAP and ESP.

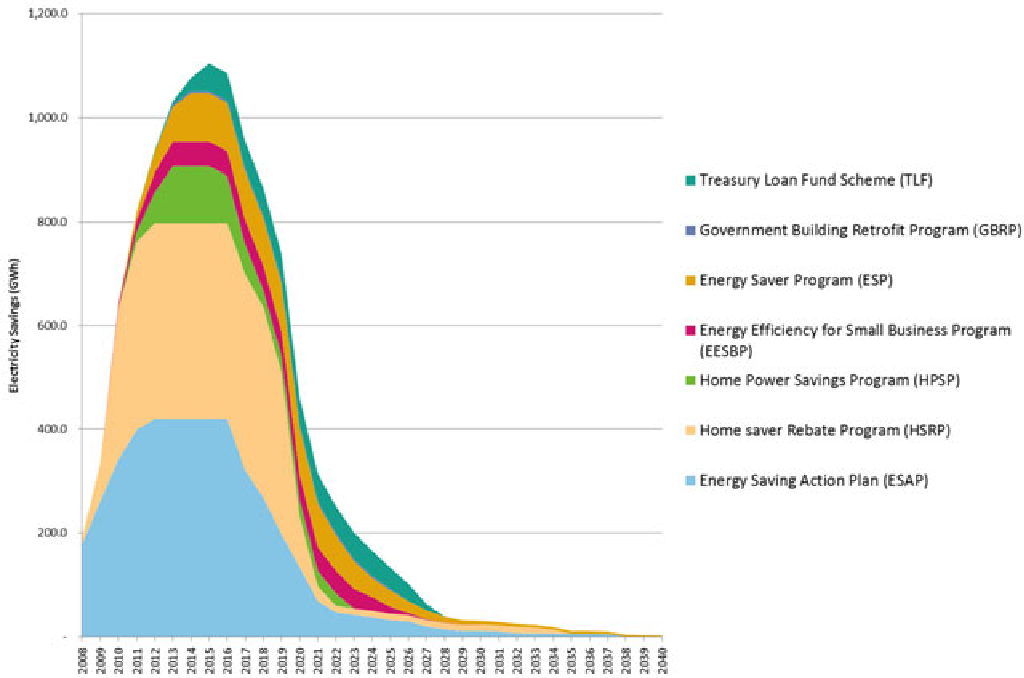
[18] Private costs were estimated from ESAP, ESP and EESBP data, redistributed according to activities undertaken under the ESS. Public subsidies (estimated as certificate prices less accredited service provider costs) were subtracted from these costs.
[19] Regulatory costs are based on longer lifetime of equipment assumptions than assumed under ESS deeming provisions.
[20] In November 2014 the NSW Government announced its intention to extend the ESS to 2025.

Figure 15: Electricity savings by program



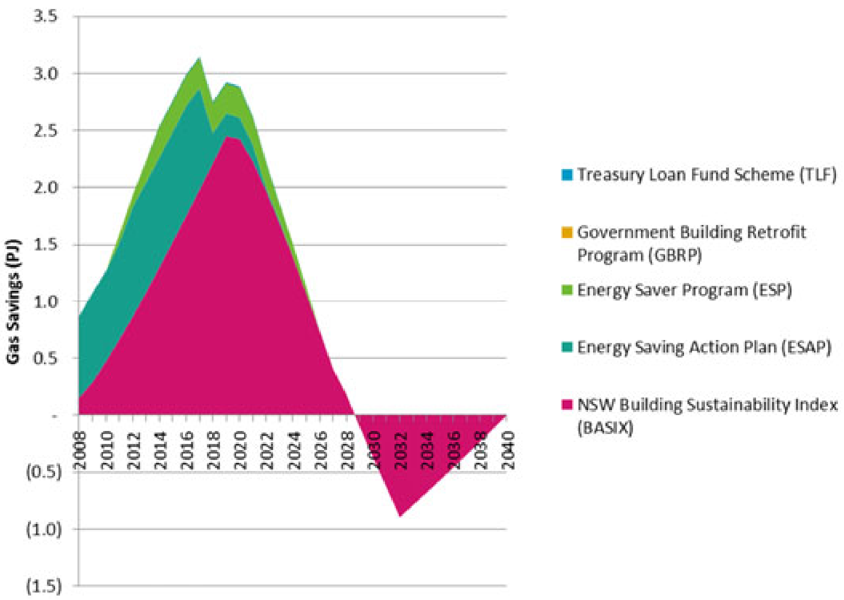
Source: Jacobs' analysis

Figure 16: Electricity savings by program



Source: Jacobs' analysis

Figure 17: Gas savings by program

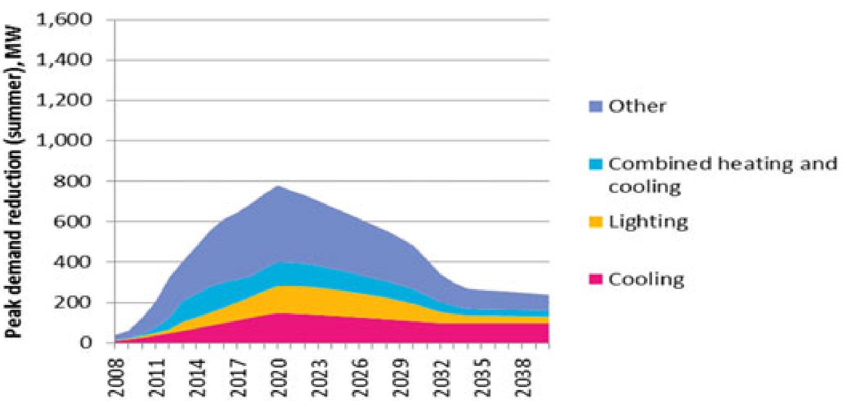


Source: Jacobs' analysis

Figure 18 and Figure 19 also display the estimated savings in peak demand by activity type. Some of the savings in peak demand will be seasonal in nature (e.g. heating and cooling) and therefore only impact peak demand during either summer or winter months. Some activities are classified as 'combined heating and cooling'. Examples of these include insulation which reduces energy use in both heating and cooling applications, and certain types of air conditioning which provide both heating and cooling services. These activities are assumed to reduce both winter and summer demand.

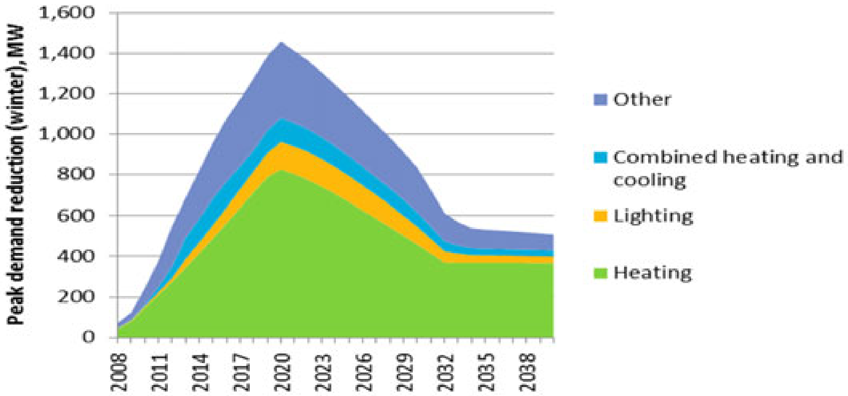
Even though there is significant reduction in peak demand, the amount of reduction is much larger in winter than in summer, when it may be of lesser value for deferral of network infrastructure. Winter peak reduction is larger than summer peak reduction because energy use is more consistent and therefore higher in winter than in summer.

Figure 18: Electricity summer peak demand savings by end use



Source: Jacobs' analysis

Figure 19: Electricity winter peak demand savings by end use



Source: Jacobs' analysis

2.3 Comparison of program costs

An important element of the study was to determine the level of each type of cost in relation to other implementation costs. Estimates of various program costs are summarised in Table 8. The table can be used to understand which cost elements of programs could be targeted and improved with regard to availability of information, efficiency of administrative process, or accreditation of suppliers.

Table 8 shows that the lowest cost programs include ESAP, ESS, and ESP. The ESS is designed to be low cost because it employs a market instrument that targets lowest cost activity. ESAP and ESP target business consumers with significant energy use and the lower cost of these programs likely reflects the economies of scale obtainable by these larger energy users. Additionally, these customers tend to understand their own energy requirements and costs.

Programs facing mid-range costs include TLF, HPSP, HSRP, and EESBP. The higher audit cost is a common element for EESBP and HPSP, likely reflecting the cost disadvantage inherent in conducting audits at small sites.

The higher administration and audit costs of EESBP relative to ESP is an indication that the larger businesses targeted by ESP are able to achieve greater economies of scale than the small businesses targeted by EESBP. Smaller businesses are less likely to have specialist staff with in-depth understanding of energy management, which may have contributed to the difference.

The audit costs of HPSP are relatively higher because energy savings were limited to the items in the kit and some behavioural change. The low income group targeted by the program is least likely to voluntarily make the capital investment for larger items that would deliver greater energy savings. HPSP may also have had higher administration costs because reaching vulnerable households required significant investment in stakeholder engagement.

HSRP is a mid-range program, and it is worth noting that the relatively modest public capital subsidy triggered a substantial private investment into energy efficiency.

The higher capital cost of TLF may reflect the complexity of the projects undertaken. Many government agencies have specialised requirements for equipment to be installed.

The highest cost programs include the GBRP and BASIX, both of which incorporate dominant levels of capital expenditure relative to the other programs. The higher capital cost of GBRP relative to TLF may reflect economies of scale obtainable at the larger TLF sites. This appears consistent with the business programs, where capital costs for EESBP are higher than for ESP. The administration cost for GBRP is also relatively high, likely reflecting the turnkey service provided by OEH to the agencies. Capital costs for BASIX are the highest within this group. This may reflect the conservative approach taken to estimating the cost of constructing a BASIX compliant dwelling. It is possible that with better data the total program cost might reduce.[21]

Table 8: Summary of average program costs, $June 2013 ($/MWh)

	Government costs			Regulatory	Private costs			Total in CBA
	Administration	Audit	Capital		Audit fee	Capital	Transaction	
Multi-sector programs								
ESS	0.4	–	–	12.8	–	14.3*	–	**13.2**
Business programs								
ESAP[22]	0.5	–	–	–	–	16.8*	–	**0.5**
ESP	6.8	4.9	–	–	2.3*	17.0*	–	**11.7**
EESBP	10.2	22.9	22.7	–	6.2*	30.3*	–	**55.8**
Residential programs								
HSRP	1.9	–	29.4	–	–	148.7*	–	**31.4**
HPSP	19.6	39.8	14.4	–	–	–	–	**73.8**
BASIX	1.0	–	–	6.2–139.5**	–		–	**140.5****
Government programs								
TLF	8.2	2.6	40.7	–	–	–	3.4	**54.9**
GBRP	19.4	8.7	69.0	–	–	–	0.6	**97.7**

Source: Jacobs' analysis of costs and lifetime energy savings. Only costs to June 2013 considered. Only savings specific to opportunities undertaken prior to June 2013 considered. Where these savings have extended beyond 2040 they have been included in the average cost calculation as this approach is more reasonable to compare programs with activities of varying lifetimes.

**Not included in totals, as these costs are viewed as a private cost and not required under NSW Treasury guidelines*

*** See Section 2.1.3 – it is more appropriate to specify a range of costs rather than a single value because the BASIX program covers a wide range of potential implementations. For the purpose of undertaking the CBA the more conservative, higher value was used.*

[21] For instance, energy efficiency can be achieved at zero or negative cost through building design decisions. See Sustainability House, 2012, *Identifying Cost Savings through Building Redesign for Achieving Residential Building Energy Efficiency Standards*, prepared for the Commonwealth Department of Industry for further information. The cost estimates are based on cost data available for retrofits; while some allowance has been made for the cost difference between new-builds and retrofits, this is was done conservatively.

[22] There was no data available on regulatory costs for the ESAP, and therefore total program cost will be understated.

3. Cost benefit analysis

The cost benefit analysis provides an estimate of net benefit from implementing the nine NSW energy efficiency programs. The net benefit is calculated by deducting costs of program implementation from estimated energy market benefits.

The costs of program implementation were calculated according to NSW Treasury guidelines. Projections of these costs were developed for the ESS and BASIX programs post 2013.

Energy market benefits are the avoided costs of energy supply as overall load is reduced through the adoption of energy efficient practices.

Energy market benefits that are evaluated include the following:

- ***Savings in wholesale electricity generation market costs***, including fuel and carbon costs, deferred capital costs, and operating costs. These items were estimated using Jacobs's energy market models, adapted for each scenario. The models consider impacts of the Renewable Energy Target (RET) scheme, energy market dispatch mechanisms, and temporal impacts of the supply and demand balance. They simulate generation and market price behaviour to provide realistic projections of fuel use, generation, emissions, wholesale electricity prices, and consequently retail electricity prices. A more detailed explanation of the wholesale electricity market models may be found in Appendix E.
- ***Deferral of transmission network infrastructure***. Two approaches were used. For interregional interconnectors, the savings in upgrade costs were determined as part of the electricity market modelling. The market models choose between generation and transmission upgrades to meet load growth and reliability criteria. Data on upgrade costs for interconnectors were obtained from the transmission planning statements published by the jurisdictional transmission planners. Second, deferments of intraregional upgrades were based on reductions in peak demand resulting from the programs. Data on upgrade costs was sourced from documents published during regulatory tariff approvals for the transmission network service providers and in-house knowledge of Jacobs' technical staff.
- ***Deferral of distribution network infrastructure.*** Jacobs has developed a methodology based on regulatory tariff reviews for each of the distribution network service providers. For further information see Appendix F.
- ***Savings in gas production and transmission costs***. The gas market models consider competitive behaviour, sources of supply, transmission networks and production capability, and demand for gas. They provide realistic projections of gas prices and gas production and transmission infrastructure impacts.
- ***Savings in gas resource costs (non-generation).*** The avoided cost of gas savings not used for generation. Jacobs values this non-purchased gas at the wholesale market rate at the time the consumption is reduced.

In a competitive market, these benefits and costs are passed on to consumers. The impacts of these changes in retail energy prices on consumers are not included in the benefit/cost analysis, because they represent a wealth transfer and their inclusion would result in double counting; however, it is possible to derive the impacts on energy users' prices (and consequently bills) from the results of the modelling, and this is done in Section 4.

3.1 Scenarios

A cost benefit analysis is conducted by comparing the outcome of a primary scenario against a reference case. Energy demand assumptions were developed for the following scenarios:

- **Reference case** – reflects a world in which no energy efficiency programs exist. This is based on a demand series where the demand that occurred historically is adjusted to reinstate energy savings from the energy efficiency programs
- **Primary case** – this energy demand scenario reflects what has actually happened and reasonably reflects what is likely to happen[23].

3.2 Net benefit

The net benefit of the energy efficiency programs is detailed in Table 9, assuming a discount rate of 7%. The analysis also assumes program costs up to 2020[24] and program benefits up to 2040[25]. The programs have a long-term net benefit of $3.5 billion, with net benefits of $647 million already achieved by June 2013. The largest benefits are derived from avoided capital network deferrals, followed by avoided carbon and pollution costs of emissions, avoided fuel costs and non-fuel resource costs (mostly operating costs of power stations). This situation is different to recent findings in Victoria where it was determined that network peak demand deferrals would not be significant[26]; however, the NSW program savings have accrued over a larger set of programs over a longer period of time, and the growth in peak demand is higher in NSW than in Victoria. Deferrals are also less than annual growth in demand as projected by the 2014 NEFR, implying that further energy savings could continue to defer network upgrades.

Table 9: Net benefit of NSW energy saving programs for activity between July 2007 and June 2020, $ millions, $2013 (Discount rate = 7%)

		NPV FY2008–FY2013	NPV FY2008–FY2020	NPV FY2008–FY2030	NPV FY2008–FY2040
Net benefits		654	1,997	3,395	3,475
Total costs		1,946	3,679	3,680	3,680
Total benefits		2,600	5,676	7,075	7,155
1	*Change in non-fuel resource cost*	210	614	952	850
2	*Change in fuel cost*	352	961	1,296	1,328
3	*Electricity network benefit*	1,548	2,610	2,610	2,610
4	*Gas production benefit*	61	165	154	95
5	*Gas transmission benefit*	22	55	56	38
6	*Gas resource cost benefit - non-generation*	47	129	162	155
7	*Gas carbon benefit - non-generation*	5	12	16	15
8	*Electricity carbon benefit*	139	399	625	716
9	*Electricity avoided pollution benefit*	216	729	1,204	1,349

Source: Jacobs' analysis

Figure 20 displays the net benefits over time. The chart indicates the timing of benefits, providing insights on when network and wholesale market deferrals may be provided and when avoided wholesale market fuel and

[23] The assumption that the demand projections include energy savings could be considered contentious, because national energy market forecasters may not use the same methodology and detail that is used by Jacobs in this project; however, the aim of the cost benefit analysis is to deduct the net costs of delivering energy in a 'without programs' world from the net costs of delivering energy in a 'with programs' world.

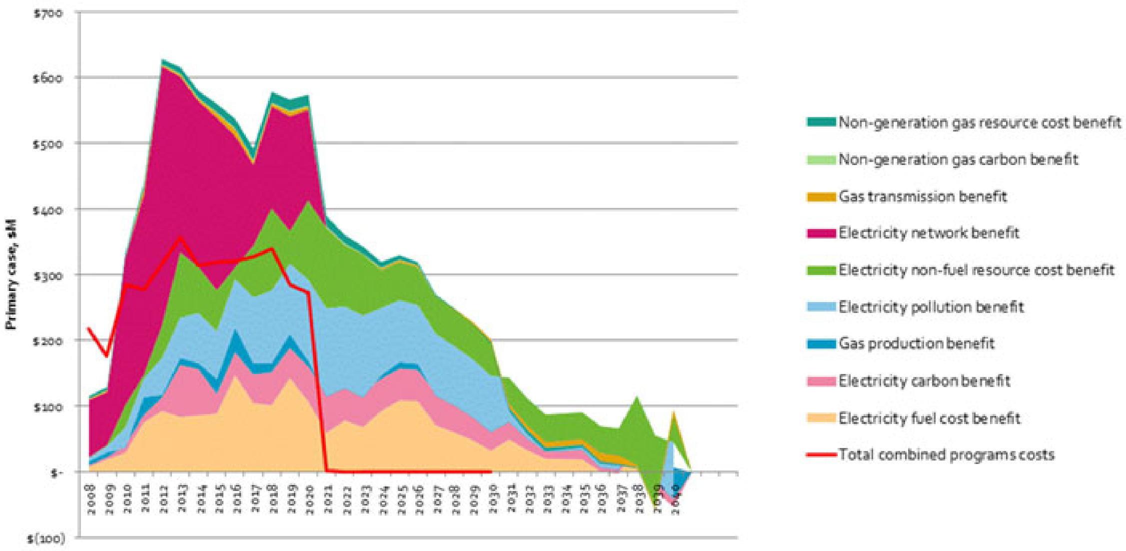
[24] A small amount of activity and expenditure occurs in 2021 as the ESS program winds up.

[25] Benefits beyond the program end dates should be considered as the benefits of energy efficient activity is expected to coincide with the life of installed equipment.

[26] 'Analysis of the impact of the Victorian Energy Efficiency Target scheme on energy consumption and Victorian energy markets', Dec 2013, Oakley Greenwood

carbon costs may be realised. The largest benefits relate to network market as well as fuel, pollution and carbon benefits.

Figure 20: Net benefit of NSW energy saving programs, $ millions, $2013



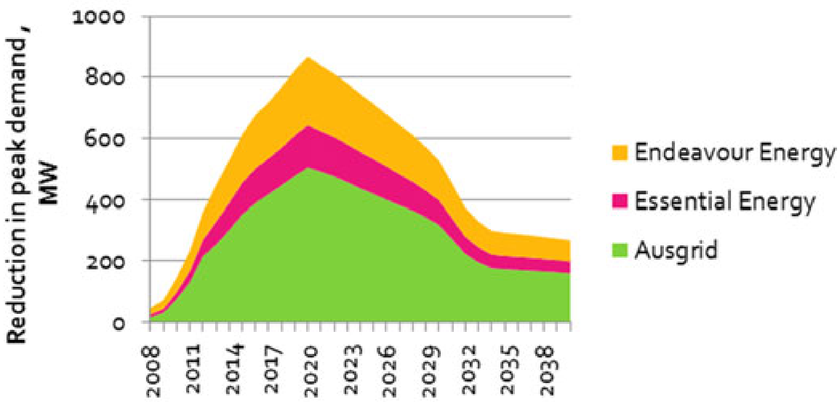
Source: Jacobs' analysis

3.2.1 Demand

Figure 20 also shows that avoided network benefits only exist until around 2020. This occurs because the peak demand savings stop growing, and without further reductions in peak demand there are no avoided expenditures on infrastructure. This is demonstrated in Figure 21 and Figure 22, which respectively show the change in peak demand resulting from energy efficiency programs, and the growth in peak demand change (i.e. deferred peak demand).

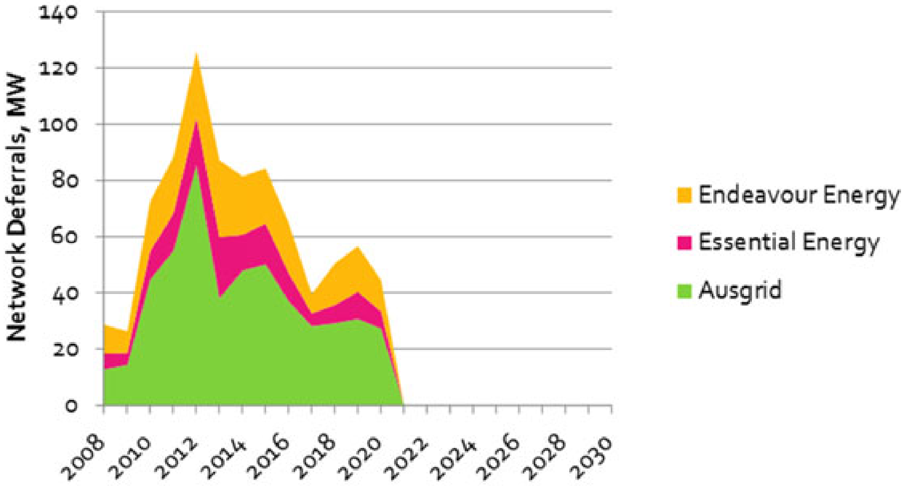
Generation deferrals occur only after 2030, because there is an oversupply in the market resulting from recent downturn in demand and growth in renewable generation as a result of the RET.

Figure 21: Reduction in peak demand by network jurisdiction



Source: Jacobs' analysis

Figure 22: Deferred peak demand by network jurisdiction[27]

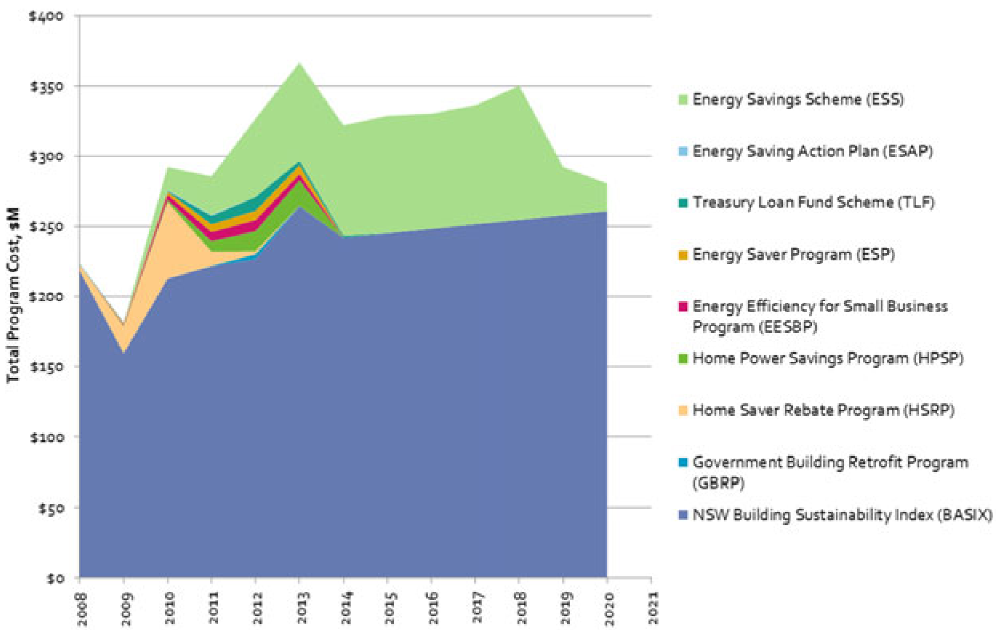


Source: Jacobs' analysis

3.2.2 Program costs

Figure 23 indicates the level of program costs over time. The largest costs are attributable to BASIX and the ESS, which both extend to 2020, while the other programs are finished by 2013.

Figure 23: Program costs, $2013



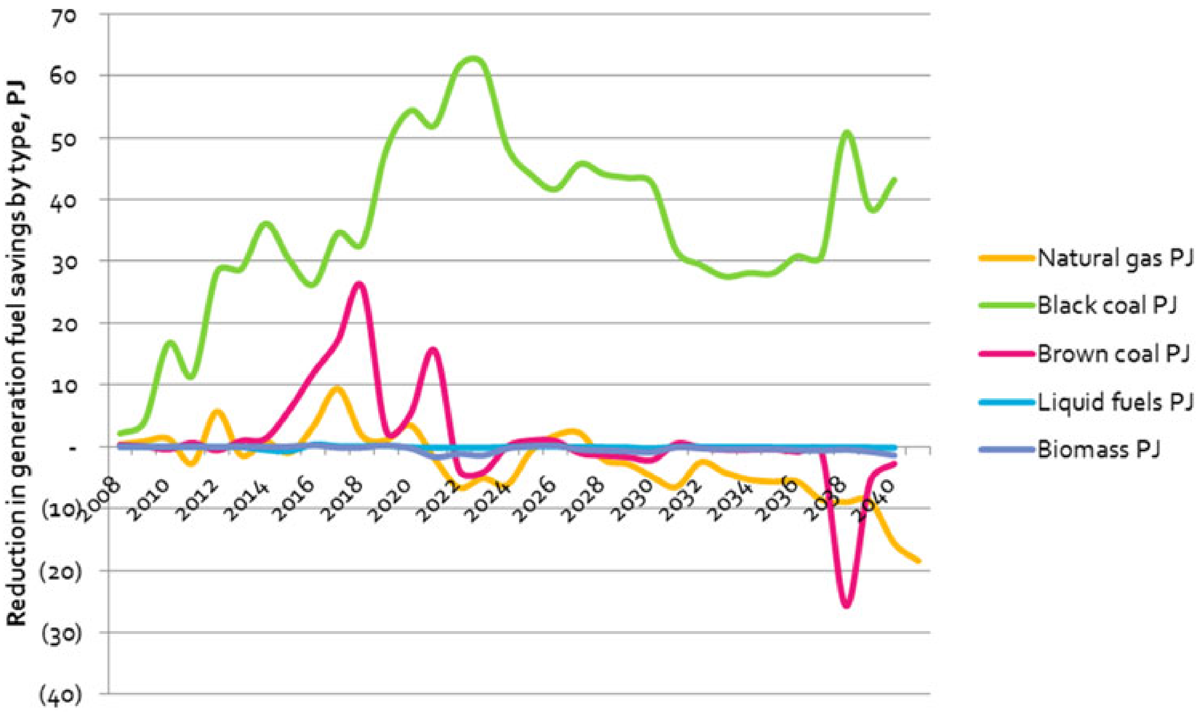
Source: Jacobs' analysis

[27] Deferred peak demand is equivalent to the year on year change in the reduction in peak demand.

3.2.3 Fuel savings

Figure 24 provides fuel savings by fuel type from the nine NSW energy efficiency programs. The majority of avoided fuel is black coal, reflecting one retirement of a NSW black coal unit and increased mothballing of black coal in response to low market prices. In the 2030s some gas plants were brought forward to balance supply and demand. The increase in black coal emissions savings after 2035 arises because it is partially displaced by gas plants brought forward around this time (following retirement of a coal unit in the 2020s).

Figure 24: Fuel savings from the NSW energy saving programs

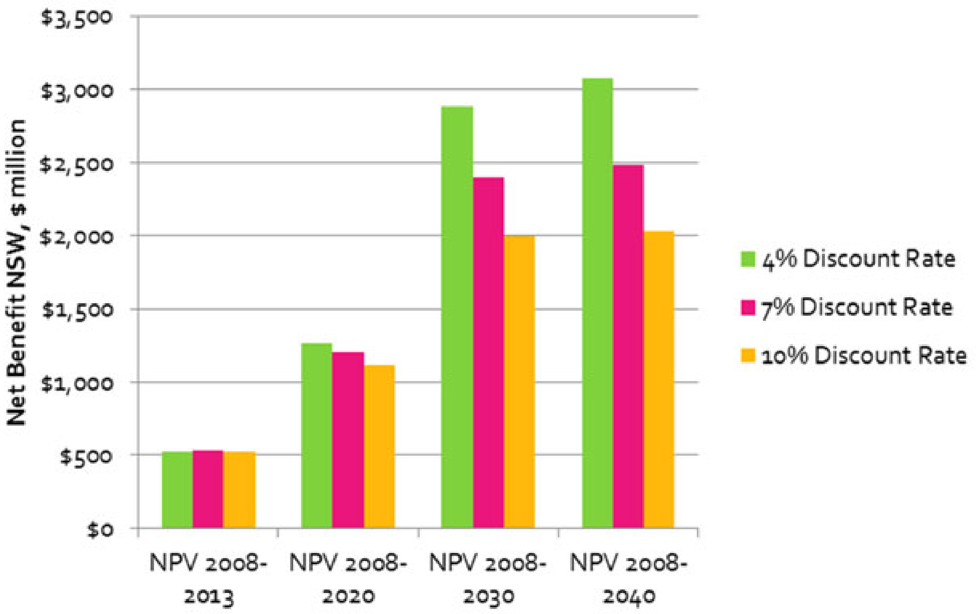


Source: Jacobs' analysis

3.2.4 Sensitivity to discount rates

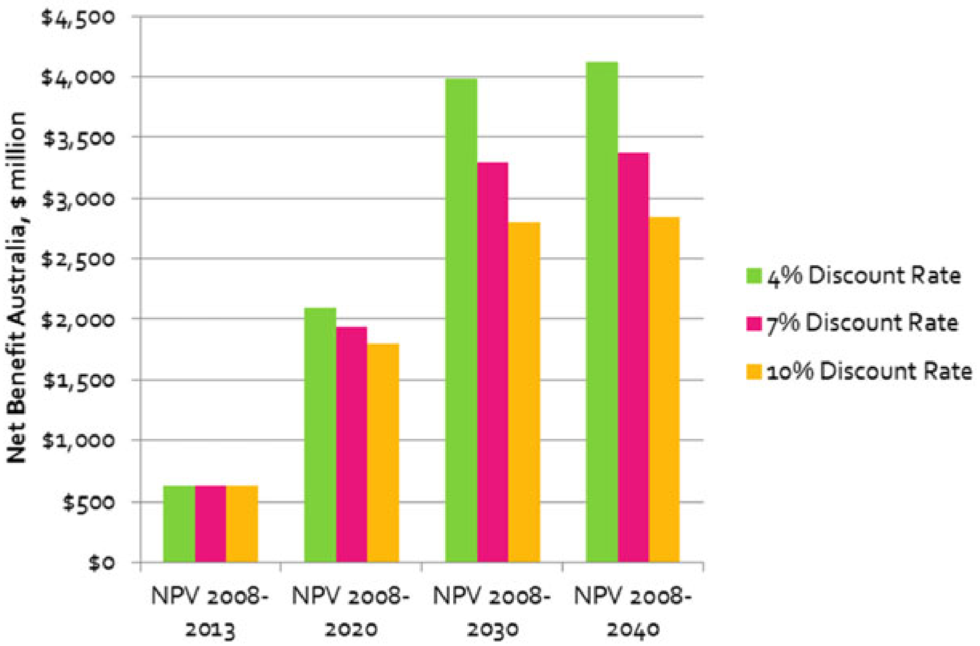
Figure 25 and Figure 26 test the programs' net benefit in NSW and Australia respectively at discount rates of 4, 7, and 10 per cent. Both sets of figures indicate that the programs provide a positive net benefit from the short term (to 2013) through to the longer term (to 2040) to NSW and Australia at the three discount rates tested.

Figure 25: Net benefit for NSW at discount rates of 4%, 7%, and 10%



Source: Jacobs' analysis

Figure 26: Net benefit for Australia at discount rates of 4%, 7%, and 10%



Source: Jacobs' analysis

3.3 Environmental impacts

The nine programs have saved around 8578 kt CO_2-e between July 2007 and June 2013. To June 2040, the programs are expected to save an additional 97,803 kt CO_2-e.

The nine programs have also saved around 21.2 kt NO_x, 0.4 kt particulate matter (PM) and 30.9 kt SO_x between July 2007 and June 2013. Further expectations to June 2040 include savings of 259.1 kt NO_x, 5.4 kt PM and 377.9 kt SO_x.

4. Retail electricity price impacts

Retail electricity price impacts of the energy efficiency schemes are developed by assessing the impacts of the programs on each of the following price components:

- wholesale prices (including the impact of carbon schemes in years in which this is applicable)
- network prices
- energy efficiency program pass-through costs (where the cost of running a given program is passed through to retailers, such as in the case of the ESS where retailers are required to surrender a specified number of energy saving certificates each year).

The retail price impact is displayed in Table 10. The energy efficiency programs are likely to reduce prices in all markets and network areas in the medium term. The price reduction is negligible in the historical period from 2007 to 2013, with a median value of $0.07/MWh, but as the period under consideration expands to 2020, grows to a median value of $3.58/MWh. During the latter period the wholesale market is expected to be in oversupply with continuing downward price pressure from the Renewable Energy Target (RET) policy, leading to low wholesale prices. The additional reduction in demand from the nine NSW energy efficiency programs increases this pressure leading to greater reductions in wholesale price. The wholesale price reduction is large enough to offset any increases in network charges.

As the period of evaluation expands to the 2020s and 2030s, the average price reduction begins to dissipate, with median price reductions of $1.71/MWh and $0.94/MWh; however, the variability in prices during this period is large enough to reduce confidence that any price change will occur in these decades.

The prices discussed so far are those that impact on all electricity consumers in NSW. Any program participants will also see energy cost reductions resulting from the energy efficiency activity undertaken and these are likely to be more substantial than the price changes shown.

Table 10: Retail price impacts, $2013/MWh

Network	Market segment	FY2008–FY2013	FY2008–FY2020	FY2008–FY2030	FY2008–FY2040
AusGrid	Residential	0.13	(3.19)	0.22	0.90
	SMEs	0.40	(3.60)	(1.89)	(1.28)
	Low voltage	(0.25)	(3.95)	(1.10)	(0.30)
	High voltage	0.09	(3.59)	(1.65)	(0.92)
Endeavour Energy	Residential	(0.00)	(3.27)	(0.23)	0.42
	SMEs	0.39	(3.51)	(1.85)	(1.25)
	Low voltage	(0.15)	(4.02)	(1.74)	(0.96)
	High voltage	0.06	(3.52)	(1.75)	(1.12)
Essential Energy	Residential	0.13	(2.77)	0.56	1.01
	SMEs	0.39	(3.56)	(1.88)	(1.27)
	Low voltage	(0.53)	(6.01)	(1.81)	(0.64)
	High voltage	(0.25)	(3.66)	(1.68)	(1.02)
Median		(0.07)	(3.58)	(1.71)	(0.94)
Likely price impact		Negligible	Moderate	Low	

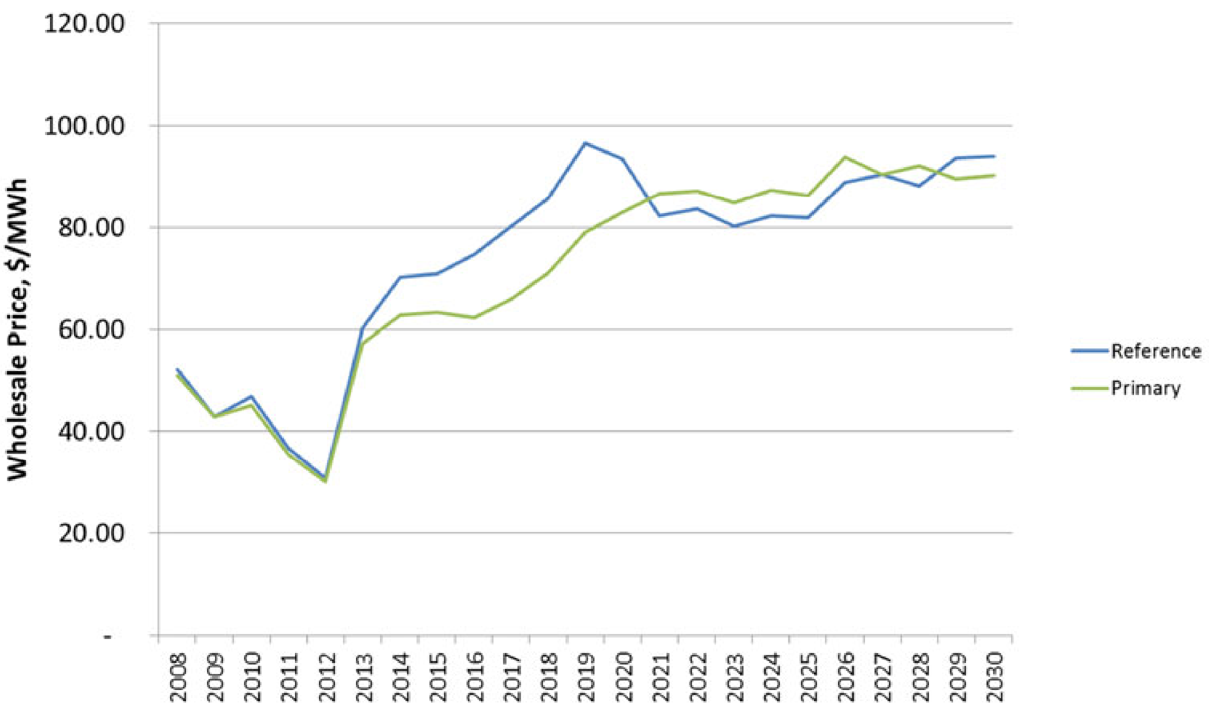
Source: Jacobs' analysis

4.1 Wholesale price impacts

For the majority of the time period, network impacts make up the largest component of price change; however, between 2014 and 2020, the largest impact on retail price reduction comes from the wholesale market. Low prices in the medium term are expected to occur as a result of a sustained gap in supply and demand, combined with the presence of an increasing renewable energy target. In the periods before 2014 and after 2020, incumbents are more easily able to adjust maintenance and bidding strategies to maintain revenue streams. Between 2014 and 2020, however, this becomes more difficult and even with increased levels of mothballing from reduced energy demand, prices are expected to remain low.

Figure 27 displays wholesale price impacts in NSW for both the reference and primary scenarios. The chart displays negligible price impacts to 2013, followed by larger price reductions to 2020. After 2020 average prices under the primary case are higher than under the reference case; however, the variation in both price series is high enough to doubt the significance of this difference.

Figure 27: Wholesale price impacts for NSW, $2013



Source: Jacobs' analysis

4.2 Network price impacts

Network price impacts are calculated by estimating the following:

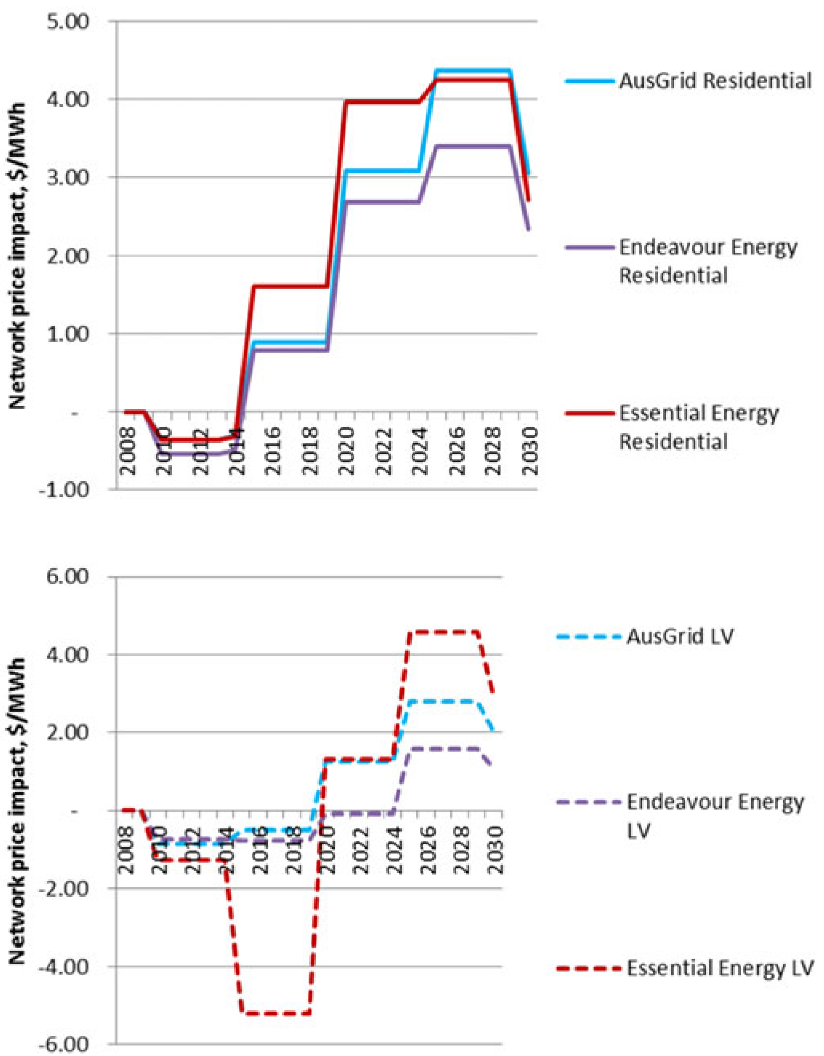
- increases in tariffs to maintain network revenue requirements in the face of reduced energy volumes
- value of network infrastructure deferrals that may result from reduced peak demand.

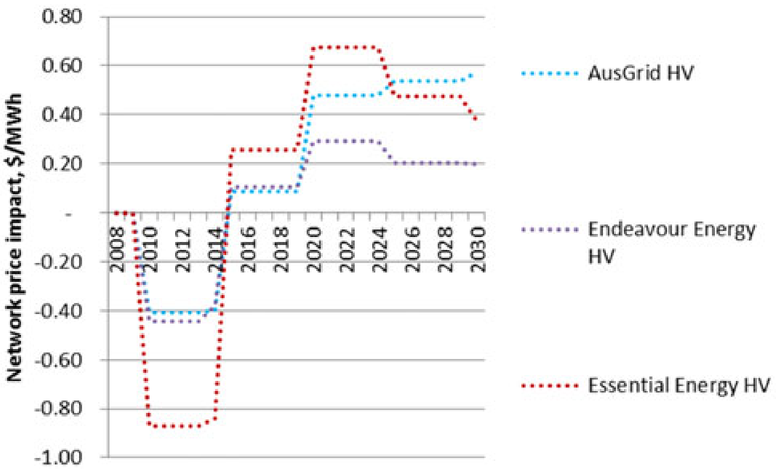
These impacts counteract each other, as reduced energy requirements are likely to increase network standing charges to compensate for reduced energy throughput, while reductions in peak demand may delay grid expansions and reduce the requirement to increase network prices.

Figure 28 displays network price impacts in NSW after consideration of both of these impacts, over three charts displaying residential, business low voltage (mostly commercial and some industrial sector) and business high voltage (mainly industrial sector) impacts respectively. The analysis assumes that networks were able to estimate around 70% of the peak impact of the programs before price changes were submitted for the 2010 price review. The analysis also assumes that price impacts remain fixed for five yearly intervals consistent with existing regulatory policy, and this is why network price changes appear as step changes rather than a smooth curve. Increases in prices beyond 2015 reflect the increasing need for networks to secure a revenue stream large enough to support existing assets with volumes that are lower than under the reference case.

The results demonstrate that most customers may have already experienced modest network price reductions as a result of the energy efficiency programs. For most customers, this modest reduction becomes an increase after 2015 as networks increase prices to recover lost revenues from reduced energy throughput.

Figure 28: Network price impacts by area and selected markets





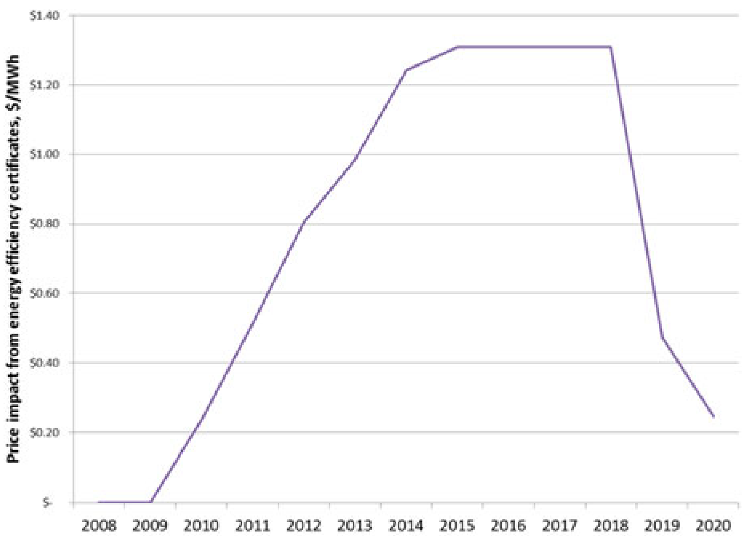
Source: Jacobs' analysis

4.3 Direct energy efficiency program price impacts

Figure 29 displays price impacts from the Energy Savings Scheme (ESS), showing an initial increase in the cost of procuring energy saving certificates (ESC) that retailers must recover. Average historical certificate prices have ranged from $19.8 in 2010, increasing to $26.88, $30.40, and $28.63 in 2011, 2012 and 2013 respectively.

The chart shows a drop in ESC prices towards the end of the scheme in 2020. It is expected that energy savings will reach the target by this time and that a level target will be maintained, resulting in a lower incentive required to maintain target requirements.

Figure 29: Energy Savings Scheme price impacts



Source: Jacobs' analysis

5. Conclusions and recommendations

Table 11 provides a summary of the economic analysis of the nine NSW energy efficiency programs. Overall, the analysis demonstrates that under conservative assumptions, the benefits of the programs exceed the costs.

Table 11: Summary of economic analysis

Energy efficiency program	Average $/MWh savings	Total cost[28] (FY2008–FY2020), $M	Total electricity savings, GWh	Total gas savings, PJ	Net benefit 2008–2040 (NPV based on 7% discount rate, $M)
Multi-sector programs					
Energy Savings Scheme (ESS)	13.2	563	58,048	–	Not available on a program by program basis
Residential programs					
Home Saver Rebates Program (HSRP)	31.4	112	3,968	–	Not available on a program by program basis
Home Power Savings Program (HPSP)	73.8	45	706	–	
NSW Building Sustainability Index (BASIX)	7.2 – 140.5[29]	2,886	28,485	21.6	
Business programs					
Energy Saver Program (ESP)	11.7	17	1,164	3.0	Not available on a program by program basis
Energy Savings Action Plans (ESAP)[30]	0.5	3	4,570	9.7	
Energy Efficiency for Small Business Program (EESBP)	55.8	26	613	–	
Government programs					
Treasury Loan Fund Scheme (TLF)	54.9	22	645	–0.1	Not available on a program by program basis
Government Building Retrofit Program – small sites (GBRP)	97.7	4	51	0.0[31]	
TOTAL		3,679	98,251	34.4	3,475

Source: Jacobs' analysis

[28] Excludes private costs for non- mandatory programs.
[29] It was found that there was wide variation in cost. For the purposes of the CBA, the highest cost was used.
[30] There was no data available on regulatory costs for the ESAP, and therefore total program cost will be understated.
[31] Value less than 0.1

The programs vary in terms of cost efficiency. There was a positive correlation between overall cost and inclusion of dominant levels of public capital expenditure. A government policy or program can be more efficient if it can overcome the barriers to energy efficiency in a way that triggers private contributions to capital costs. Where government pays for part of the capital costs or where there is a regulatory requirement to pay for capital costs, it may be possible for government to incorporate better guidance on lower cost alternatives where programs provide choices to consumers.

5.1 Recommendations

5.1.1 Observations about program design

1: Improve the design of programs to make them more cost effective

The analysis suggested that government policies or programs can be more efficient if they can overcome the barriers to energy efficiency in a way that triggers private contributions to capital costs. A key focus of the 2013 NSW Energy Efficiency Action Plan is to increase market delivery of energy efficiency activities by refocusing programs on reducing the transaction costs of participating in the NSW Energy Savings Scheme. It would also be useful to undertake an informal review to understand the breakdown of administrative costs in different programs and differences between them. We suggest that a short internal review be undertaken to assess whether the variability of costs is appropriate and justifiable based on the services offered. Lessons learned should be extrapolated and disseminated to managers of currently operating programs.

Where government pays for part of the capital costs or where there is a regulatory requirement to pay for capital costs, it would be useful to review the information available to program participants on equipment choices, so consumers can choose lower cost options where they exist. This is especially relevant to BASIX.

2: Continue implementing a mix of business, residential and government programs

The programs cover a wide variety of market sectors which reduces costs, maximises energy savings and ensures equity. Of the programs covered in this study, only ESS, ESP and TLF still continue; however, the 2013 NSW Energy Efficiency Action Plan contains actions to broaden access to energy efficiency for low income households, small businesses, government and regional customers. Because the ESS is a multi-sectoral program it can be argued that the NSW Government is still implementing a good mix of programs; however what is not clear is to what extent the ESS is accessed by low income households, small business or government, each of which face high hurdles to uptake because of lack of access to finance, knowledge, and other issues. The ESS rule change of May 2014 included new data collection on energy efficiency projects that may enable this analysis in the future.

3: Consider increasing energy efficiency targets for the ESS between now and 2020, and beyond

The aim of energy efficiency programs is to increase the productivity of the electricity market. The modelling indicates that the current program has improved productivity through reduced resource use and deferred capital expenditure on infrastructure. The resulting reduction in demand due to uptake of energy efficient appliances and processes is also likely to have reduced wholesale price.

The expansion and extension of programs such as the ESS could continue to improve productivity. It is worth considering an increase in the target to see if further economic and social benefits could be attained. The magnitude of the increase would need to be considered carefully to ensure that costs are aligned with benefits.

The study found that program participants will likely have received significant reductions to their energy bills; however, the impact on bills for non-participants is estimated to have been small. There is a need to consider the impact on non-participant energy bills of expanding the ESS.

The NSW government should also develop clear and reasonable program timeframes of at least three years to provide the appropriate market signals.

Jacobs understands that expansion of the ESS is being considered. In August 2013, the NSW Government committed to review the ESS to see how it could be enhanced as part of the NSW Energy Efficiency Action Plan. In November 2014 the NSW Government announced its intention to enhance the scheme by expanding it to provide incentives for gas savings, and extending the scheme to 2025. The NSW Government also announced that it will consult on targets in 2015.

5.1.2 Observations about electricity system benefits

4: Increase understanding of the relationship between network benefits and prices

Perhaps the most contentious area is the evaluation of network deferral benefits and their application to prices. This is because peak times can vary across distribution networks and networks may be unable to interpret the changes to supply and demand from policy. Our approach has also assumed that networks will increase prices if throughput drops, so around five to seven years after the beginning of the evaluation period network prices begin to ramp up and overtake any benefit from peak demand reduction.

The NSW Government may like to consider further research on the likely impact of changing demand and energy use profiles on network systems and network prices.

5: NSW Government could provide assistance to AEMO to project energy savings

Network deferral benefits were found to be the largest benefit in this evaluation. While our estimates could be considered conservative, these benefits may not be realised if they cannot be adequately projected. The NSW Government could provide assistance to a body such as the Australian Energy Market Operator (AEMO) to develop and project energy savings from energy efficiency programs for the benefit of the entire market.

5.1.3 Recommendations about future evaluations

6: Enhance data collection

Jacobs recommends that greater levels of data collection be undertaken as programs start up and progress. For example, the ESS program administered by IPART does not incorporate any data on cost and number of activities being undertaken, making evaluation of the program challenging.[32]

Similarly it would be useful if some additional data were collected for BASIX, specifically on the types of activities applied to meet efficiency targets, the cost of those activities and actual and relative energy savings applicable to those activities. Additionally, it would be beneficial to review how existing data could be better utilised for evaluation purposes.

As specific cost categories have been determined by the NSW Treasury, it is also recommended that cost data be kept consistent with these definitions, especially differentiation between private and public expenditure. It may also be better to stratify program data (e.g. medium sized vs large consumers, or low/no-cost opportunities compared with other opportunities), and this should be flagged early on to accommodate consistent data collection processes.

The NSW Government could collect more data on private costs, including transaction and capital costs. This would help ascertain whether certain sectors are being disadvantaged by the design of the program relative to the level of public subsidies applied. Any cost data collected should be associated with a time stamp to easily

[32] The NSW Government introduced new data collection requirements into the ESS Rule in May 2014 under a new clause 6.8. This new data collection requirement may enable more detailed and comprehensive analysis in line with this recommendation.

enable nominal versus real dollar calculations. If possible, cost data should be identified as incremental or full project costs. If it is only possible to collect full costs for a given program, an approach should be developed to convert these to incremental costs.

In some programs data collection around gas savings was sparse and inconsistent with activities set out to save electricity. If gas savings are associated with a given activity these should also be documented.

Administrative costs should consistently be provided net of income from program participation fees, and separated from participation fees.

7: Improve evaluation methods and work toward a common, national approach

The evolution of energy efficiency programs has been ongoing within Australia and internationally. The US for example, has developed a recommended standard practice manual[33].

Evaluation of energy efficiency programs is a detailed and complex task, and verification of whether the process has been undertaken correctly is complicated by lack of comparability of approaches in different jurisdictions. For example, the approaches adopted in Victoria, South Australia and the ACT can vary due to:

- presence of externalities such as avoided carbon or pollution emissions within the benefits calculation. The current report is the first evaluation to incorporate pollution benefits in the evaluation, and this needs to be considered before undertaking a comparison with any other evaluation work from other jurisdictions
- presence of network benefits, and how this has been calculated. There are a myriad of ways to evaluate avoided peak demand and deferred capacity. In particular, allocation of avoided peak demand needs to consider whether a region is summer or winter peaking as well as networks' ability to incorporate benefits in their demand forecasts. Some modellers choose not to incorporate network benefits because the uncertainties are viewed as too large and because of lack of growth in demand
- use of price projections to estimate benefits, rather than separately estimating benefits to the wholesale and network markets. Using retail prices is inadequate to determine benefits because prices are inflated by retailer margins and reflect the average change in fuel and operating costs rather than the marginal change affected by energy efficiency activity. Marginal impacts are an important consideration in an electricity market which incorporates a dispatch process based on marginal bidding
- inclusion of private as well as public costs. This report follows the draft NSW Treasury CBA framework that excludes private costs from the evaluation. This is similar to the Administrator Cost Test used in the Californian Public Utility Commission's Standard Practice Manual. This approach more accurately separates the costs and benefits of private consumers from the public costs and benefits of the programs. Previous approaches may be biased against new energy efficiency programs because costs were overstated if private costs were included
- consideration of additionality/interactions. The analysis in this report has applied interaction factors where more than one program may have caused the same energy efficiency benefit. This approach could be built upon in future work
- consideration of incremental energy efficiency costs. Frequently incremental costs are unavailable and modellers are provided full costs to base evaluations on. If the incremental cost of energy efficiency activity is not considered, costs will be overstated and programs will appear to be ineffective. In the current analysis incremental cost percentages based on research were applied to measure the cost of programs.

The NSW Government should consider working with other jurisdictions to develop a common framework for evaluation.

[33] www.cpuc.ca.gov/NR/rdonlyres/004ABF9D-027C-4BE1-9AE1-CE56ADF8DADC/0/CPUC_STANDARD_PRACTICE_MANUAL.pdf

Appendix A. Program interactions

The energy efficiency programs considered in this study are generally designed to target different energy users and sectors, and thus provide a broad suite of energy efficiency incentives. Nonetheless, there is the potential for some of the NSW energy efficiency programs to interact with one another, which may cause savings to be double counted in the cost benefit analysis if a correction is not made. For example, the ESS and the EESBP are both applicable to small to medium enterprises (SME), and it is feasible that some of the projects in the EESBP may have created energy savings certificates, so it would be important to understand where any overlap may exist that could cause double counting. The interactions between the programs scoped within this study have been considered and where overlaps occur, overlap percentages were applied in consultation with OEH.

Table 12 has been developed by Jacobs and OEH to summarise interactions between the programs being assessed.

Table 12: Program interactions

Energy Savings Action Plans (ESAP)	**Energy Savings Action Plans (ESAP)**								
Home Power Saver Program (HPSP)	No interaction (mutually exclusive eligibility criteria)	**Home Power Saver Program (HPSP)**							
Energy Saver Program (ESP)	No interaction (mutually exclusive eligibility criteria)	No interaction (mutually exclusive eligibility criteria)	**Energy Saver Program (ES)**						
Energy Efficiency for Small Business Program (EESBP)	No interaction (mutually exclusive eligibility criteria)	No interaction (mutually exclusive eligibility criteria)	No interaction (mutually exclusive eligibility criteria)	**Energy Efficiency for Small Business Program (EESBP)**					
Government Building Retrofit Program (GBRP)	No interaction (mutually exclusive eligibility criteria)	No interaction (mutually exclusive eligibility criteria)	There is no evidence of ES audits that have supported GBRP applications. 0% overlap.	No interaction (mutually exclusive eligibility criteria)	**Government Building Retrofit Program (GBRP)**				
Treasury Loan Fund (TLF)	Overlap of just one opportunity of 964 MWh (2006–07), which is 2% of total ESAP savings.	No interaction (mutually exclusive eligibility criteria)	There is no evidence of ES audits that have supported TLF applications. 0% overlap.	No interaction (mutually exclusive eligibility criteria)	Sites either funded by GBRP or TLF. 0% overlap.	**Treasury Loan Fund (TLF)**			
Energy Savings Scheme (ESS)	Some ESAP sites have created ESCs (14% of all ESCs). This does not necessarily mean these are the same opportunities as reported under ESAP, assume only 50% were ESAP actions. **Action:** 7% of ESS savings for 2009–2013 are also ESAP savings.	Savings haven't been used to create ESCs and are unlikely to before program ends. **Action:** 0% overlap.	Projects may be used to create ESCs, but OEH estimates this has been limited to around 5% of savings. **Action:** 5% of ES savings are also ESS.	Projects may be used to create ESCs, but OEH estimates this has been limited to around 2–5% of savings. **Action:** 3.5% of EESBP savings are also ESS.	Projects may be used to create ESCs, but are not known to have done so to date. **Action:** 0% of GBRP savings are also ESS	Projects may be used to create ESCs, but are not known to have done so to date. **Action:** 0% of TLF savings are also ESS	**Energy Savings Scheme (ESS)**		
Building Sustainability Index (BASIX)	No interaction (mutually exclusive eligibility criteria).	No significant interaction. HPSP unlikely to service any homes built since 2004 and HPSP implements opportunities additional to BASIX. **Action:** 0% overlap	No interaction (mutually exclusive eligibility criteria).	No interaction (mutually exclusive eligibility criteria).	No interaction (mutually exclusive eligibility criteria).	No interaction (mutually exclusive eligibility criteria).	No interaction. ESS does not provide any incentive for new residential buildings.	**Building Sustainability Index (BASIX)**	
Home Saver Rebates (HSRP)	No interaction (mutually exclusive eligibility criteria).	Each target different households and opportunities. Only possible interaction is if HPSP encouraged take-up of a residential rebate. Home Saver Rebates finished on 30 June 2011. **Action:** 0% overlap	No interaction (mutually exclusive eligibility criteria).	No interaction (mutually exclusive eligibility criteria).	No interaction (mutually exclusive eligibility criteria).	No interaction (mutually exclusive eligibility criteria).	ESCs were not created for any HSRP opportunities. **Action:** 0% overlap	HSRP unlikely to target new homes with new equipment built under BASIX. **Action:** 0% overlap	

Appendix B. Data collation and analysis of individual programs

The following sections provide an outline of how energy savings and cost data were collated, reviewed and analysed. Transaction costs were not collected for most programs except those where there was a requirement for participants to spend time reviewing energy efficiency options, and those where the participant was also part of the public sector. These transaction costs were required for the CBA under NSW Treasury cost benefit evaluation guidelines.

B.1 Home Power Savings Program (HPSP)

The HPSP aimed to help 220,000 low-income householders reduce their power use and bills. The program finished in April 2014, having successfully met its target; during the evaluation period of this study to June 2013, approximately 200,000 household assessments were undertaken.

The HPSP program provided the following free of charge to participants:

- a home power assessment
- a tailored action plan showing free and low cost energy efficiency opportunities, and
- an energy saving kit including as appropriate: standby saver power board, energy efficient light bulbs, tap aerator, shower timer, draught-proof strips, or door snakes. Some kits also included a low flow showerhead.

B.1.1 Estimation of energy savings

Data on the number of assessments completed and annual MWh electricity savings were sourced directly from OEH. The program data provided to Jacobs has been recorded based on estimated savings of the kit items installed during the assessment (specified to householders in their action plans and recorded in the assessment plans). These calculations have been refined with the results of measurement and verification billing data analysis[34]. Gas savings were not provided by OEH and were not included in the analysis.

The savings associated with the energy saving kit have been split into four different end uses. The majority of kits provided to participants did not include a low flow showerhead, so the non-showerhead kit is treated as the base case. Kits are split into three sub opportunities, which represent three different end uses. Additionally, savings from showerheads are associated with residential water heating. The activity splits are presented in Table 13.

Table 13 : HPSP energy saving opportunities

Activity	Sub activity (end use split)	Sub activity split	End use
Showerhead	Showerhead	100%	Residential water heating
Non showerhead	Lighting	40%	Residential lighting
Non showerhead	Door snakes, draught-proof strips	40%	Residential heating
Non showerhead	Standby saver power board	20%	Residential electricity

B.1.2 Estimation of private costs

[34] As described in *2012 Evaluation of NSW Energy Efficiency Programs* (ARTD Consultants 2012)

The program targets low income households such as those on a pension, income benefit or otherwise unemployed and it is not anticipated that participation in the scheme would impact upon personal or business income. Time spent by householders would also be minimal. Therefore private costs have not been deemed significant for the purpose of this analysis.

B.2 Home Saver Rebate Program (HSRP)

The HSRP was established to help people make their homes more water and energy efficient. It provided rebates for rainwater tanks, climate-friendly hot water systems, ceiling insulation, dual flush toilets, hot water circulators and water efficient washing machines. The program ended on 30 June 2011, as scheduled, with more than 330,000 households having received rebates. Energy savings arising from hot water systems and ceiling insulation are included in this study.

B.2.1 Estimation of private costs and energy savings

The capital costs and energy savings for each year, provided by OEH, have been collated and used to calculate incremental capital costs, cumulative energy savings, peak reduction and participant rebates.

B.3 Building Sustainability Index (BASIX)

BASIX applies to all new homes and some extensions / refurbishments to homes, setting energy and water reduction targets for houses and units to ensure homes are designed to use less potable water and be responsible for fewer greenhouse gas emissions.

Due to the nature of the program and the data held, a standalone analysis process was required to provide the data required for the purposes of the study. This is summarised below.

B.3.1 Data sources

The program data provided to Jacobs for BASIX includes government and certification costs, as well as compliance requirements for dwellings; however, the data does not include the direct recording of costs and energy savings per activity, and therefore significant analysis has been required. The methodology including key assumptions has been drawn primarily from information provided by the BASIX program managers.[35]

B.3.2 Methodology overview

Estimating the net costs and benefits attributable to BASIX comprised:

1) Establish dwellings profiles and typical compliance pathways, including proportion of dwellings not connected to main gas

2) Establish potential energy savings (kWh) per dwelling type based on typical compliance pathways

3) Define network impacts from savings in energy consumption based on assumed end uses and allocated Distributed Network Service Provider (DNSP)

4) Calculate costs of the BASIX scheme including government costs and estimates for developer compliance costs (construction and administration).

B.3.3 Typical compliance pathways and dwelling profiles

The methodology for estimating energy consumption from the BASIX scheme draws on the case studies and typical compliance pathways provided by NERA Economic Consulting. Typical compliance pathways are provided for various dwelling types, with and without gas connections. These cover single dwellings in Sydney,

[35] Specifically *BASIX Post Implementation Cost-Benefit Analysis, An Economic Evaluation of the State Environmental Planning Policy – Building Sustainability Index (BASIX)*, NERA Economic Consulting (2010)

regional NSW, Southern Highlands and Northern NSW as well as attached, low rise and high rise multi dwellings.

BASIX certificate annual totals were provided by the Department of Planning and Infrastructure for new detached dwellings and multi-unit dwellings (see Table 14). It was necessary to establish a dwellings profile in line with the typical compliance pathways. The estimated BASIX compliance profiles; composition of Sydney single dwellings (average, large and affordable); and the proportion of dwellings not connected to a gas main were sourced from NERA Economic Consulting (2010). In addition, Jacobs estimated the proportion of total new BASIX certificates per year by dwelling type based on the data sources above. The derived profile has been adjusted to reflect the proportion of single and multi-unit dwellings provided by the Department of Planning and Infrastructure.

Table 14 : New BASIX certificates per year

Number	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13
New detached dwellings	18,378	16,389	21,329	21,960	22,392	23,749
Multi unit dwellings	1,519	1,372	1,997	2,490	2,735	3,216

B.3.4 Estimate potential energy savings

In establishing the potential energy savings attributable to the BASIX scheme, the following steps were undertaken.

1) Establish business as usual energy (electricity and gas) consumption per year for typical compliance pathways.

2) Compare business as usual consumption to consumption under BASIX for each case study. BASIX consumption was estimated by assuming that:

a. appliances such as fridges, dishwashers and clothes washers would save no more than 5% of baseline energy (based on review of the NSW Government energy efficiency opportunities list)

b. remaining household savings were split among lighting, area and water heating/cooling activity

c. for area heating, some of the savings come from more efficient equipment and some come from building shell improvements. Each will be affected by different lifetimes, since building shell improvements would last as long as the respective residence is in use. Once an estimate of savings is developed, savings from appliances corresponded with coefficients of performance for a three and a half star (relative to one star for BAU) and building shell savings were calculated as the difference between overall savings and appliance savings

d. calculate savings per year for both electricity (kWh) and gas (MJ).

B.3.5 Estimate costs of the BASIX scheme

Table 15 provides a summary of the methodology outlined above.

Table 15 : Costs of BASIX compliance

Description	Methodology	Source
Incremental capital / construction cost of compliance for developers	Jacobs has assumed that minimum cost to achieve a savings target of around 40% is sufficient to describe the cost of the BASIX program. To estimate this, Jacobs used the NSW energy efficiency opportunity model and estimated the cost of including insulation and efficient water heating (either solar or heat pump) and lighting in a residence	NSW energy efficiency opportunity model, unpublished, 2014
BASIX certificates fees	Jacobs MMA have estimated BASIX certificate application fees per dwelling type, based on the 'BASIX off-line fee calculator'. These fees apply from 2011 onwards.	NSW Department of Planning and Infrastructure
Cost to prepare BASIX certificate	Transaction costs are assumed as representative of the time taken to prepare BASIX certification. Jacobs MMA has obtained two estimates from consultants Deneb Design for the cost of preparing full documentation ($385) versus preparation of a certificate only ($150). Jacobs MMA has opted to use the higher estimate as a conservative measure of the full developer transaction costs.	Deneb Design (2013) www.denebdesign.com.au/basix%20certificate.html
Government administration costs	Government administration costs have been provided by the NSW Department of Planning and Infrastructure, and include both scheme development costs and administration costs. Scheme development costs are estimated at $0.75 million per year. Administration costs are estimated at $0.75 million per year to July 2011.	NSW Department of Planning and Infrastructure

B.4 Energy Efficiency for Small Business Program (EESBP)

The EESBP targeted small and medium sized businesses (that use electricity up to about $20,000 per year or 160 megawatt-hours; or have up to 10 full time staff).

The EESBP provided a participating business with:

- a subsidised energy assessment that identifies where electricity is being used
- a tailored action plan with electricity and cost saving recommendations and the information needed to claim rebates
- four hours of free support to assist with the installation of new equipment, and
- subsidised matched funding (50%) capped at $5000 for lighting, HVAC, motors, air compressors, commercial refrigeration, boilers, hot water systems or insulation (where the payback period is greater than two years).

The EESBP was originally due to be completed in June 2011 but additional funding extended the scheme to December 2012. It reached a large number of businesses and the program was updated (such as the introduction of implementation support, subsidies and assessors with supplier relationships) to increase the conversion rate of opportunities to realised energy savings.

B.4.1 Estimation of private costs and energy savings

The capital costs and energy savings for each year, provided by OEH, have been collated and used to calculate incremental capital costs, cumulative energy savings and peak reduction. Average audit costs were provided by OEH. Before 2010, businesses paid $150 (<$5000 annual energy cost) or $250 (>$5000 annual energy cost) to participate in the program; the fees were fully refundable once opportunities identified by the energy assessment were implemented. From 2010 (inclusive), the fees were reduced to $75 and $150 respectively; these fees were not refundable.

B.5 Energy Saver Program

The ESP targets medium and large sites using between 160 MWh and 10 GWh per annum in electricity. The program was extended to June 2017 for the duration of the Energy Efficiency Action Plan (EEAP); however, for the purposes of this study, activity to June 2013 has been included.

The ESP provides:

- a subsidised energy audit to identify energy saving opportunities with cost and payback calculations
- preparation of business cases for investment in energy efficiency including implementation steps, quotes, funding opportunities including Energy Savings Scheme funding and measurement and verification plans
- implementation support (up to 30 hours) to assist businesses to act on the recommendations.

B.5.1 Estimation of private costs and energy savings

The capital costs and energy savings for each year, provided by OEH, have been collated and used to calculate incremental capital costs, cumulative energy savings and peak reduction. Average audit costs have been provided by OEH. Of these, OEH provides a 50% subsidy for L3 audits, 70% for L2 audits and 80% for L1 audits. In addition, a $500 program fee has been assigned to each participant.

B.6 Energy Savings Action Plan (ESAP)

The NSW Government introduced legislation in May 2005 requiring high energy users and local councils in NSW to prepare Energy Savings Action Plans. Specifically this applied to businesses and government agencies in NSW using more than 10 GWh per year at a site, and all local councils in NSW with populations of more than 50,000 people. In December 2012, the NSW Premier announced that the ESAP program was to end.

ESAPs provided a comprehensive analysis of an organisation's energy use and management strategies. Plans involved determining current energy use, undertaking a management review, undertaking a detailed technical review and assessing and identifying savings measures. It was mandatory for sites to identify opportunities in their plan but there was no mandatory implementation.

B.6.1 Estimation of private costs and energy savings

The capital costs and energy savings for each year, provided by OEH, have been collated and used to calculate incremental capital costs, cumulative energy savings and peak reduction.

B.7 NSW Government Sustainability Policy (NGSP)

The programs investigated under NGSP are:

- Treasury Loan Fund (TLF)
- Government Buildings Retrofit Program (GBRP).

The TLF has been designed to help agencies to meet the up-front costs of implementing energy efficiency measures. It provides government agencies access to funding to implement cost effective energy and water efficiency upgrades with borrowings from the fund repaid with the savings generated. Eligible agencies are budget dependent agencies with building upgrade projects totalling $10,000–$500,000 ($1,000,000 for NSW Health).

OEH provides technical assistance to agencies to identify cost effective actions, audits and business case development. OEH organises workshops and one-on-one assistance to agencies. A contractor was also engaged in 2009 to make the application form easier to follow[36].

The Government Building Retrofit Program (GBRP) provided advice and support to NSW Government agencies in meeting their energy efficiency obligations under the NSW Government Sustainability Policy. The GBRP was operational from July 2010 to June 2012 and fully funded the identification, design and implementation of energy and water saving projects in frontline service delivery facilities and iconic buildings. It also provided agencies with practical, best practice information to allow them to make smart energy and water saving decisions at their other facilities. For the purposes of this study, only energy savings are included.

B.7.1 Estimation of costs (including transaction costs) and energy savings

The capital costs and energy savings for each year, provided by OEH, have been collated and used to calculate incremental capital costs, cumulative energy savings and peak reduction. Transaction cost in hours for GBRP was estimated from a survey to the OEH program manager and for the TLF through a telephone survey to three sites implementing five projects. The hourly labour costs are based on NSW adult ordinary full time earnings, assuming 45 working weeks per year, a 41 hour working week and a 17.6% adjustment for holidays and on-costs, as guided by NSW Treasury guidelines for determining value of time. Overhead adjustments were excluded from the estimation of costs because only incremental costs need to be considered for this evaluation, and overhead costs would remain regardless of whether energy efficiency activities were being undertaken.

B.8 Energy Savings Scheme (ESS)

The ESS is established under NSW legislation. Its main objective is to assist households and businesses to reduce electricity consumption and electricity costs. When businesses invest in reducing their energy use, energy savings certificates are created by the voluntary scheme participants that have helped to implement those energy savings opportunities. Electricity retailers, who are mandatory scheme participants, then buy the energy savings certificates to meet their own legislated targets, as required by law[37].

B.8.1 Data sources

Data on the number of certificates by participant, with information on project type and sector, was sourced from OEH. Certificate numbers were provided per calendar year and were converted to financial years by Jacobs.

B.8.2 Estimation of energy savings

Certificates are un-deemed according to the calculation type and then divided by 1.06 to determine MWh saved per year (at the end-user level). The un-deeming factor for each of the calculation types is presented in Table 16 below.

Table 16 : Deeming factors for ESS

Calculation method	Un-deeming factor
Deemed energy savings method – commercial lighting formula	10

[36] 2012 evaluation of NSW energy efficiency programs, NERA 2012
[37] www.ess.nsw.gov.au/Overview_of_the_scheme, accessed 07.02.13

Deemed energy savings method – default savings factors	10
Deemed energy savings method – high efficiency motor formula	10
Deemed energy savings method – power factor correction energy savings formula	10
Metered baseline method – baseline per unit of output	1
Metered baseline method – baseline unaffected by output	1
Metered baseline method – normalised baseline	1
Project impact assessment method	2.4

Note: un-deeming factor is typically equivalent to the assumed lifetime of the appliance

In the absence of more detailed data, it is necessary to assume that the distribution of savings across DNSPs is the same as the distribution of customers. The energy savings are therefore split into DNSPs based on customer numbers[38] in 2013 as per Table 17 below.

Table 17: ESS energy savings

	Residential	Commercial	Industrial
Endeavour	26%	15%	15%
Ausgrid	49%	80%	80%
Essential	26%	5%	5%

B.8.3 Estimation of program costs

Program costs are categorised according to the NSW Treasury framework in Section 1.2. Private costs are estimated by subtracting the government subsidy from the incremental capital cost, where the government subsidy is calculated by subtracting the accredited service provider (ACP) cost from the certificate price. Historical certificate prices, ACP costs and retailer costs are shown in Table 18.

The incremental capital cost used in the private cost calculation is based on using the cost per MWh saved for each activity derived from other OEH programs, and applying this quantity to energy savings by activity under the ESS. This is a conservative estimate because it would be expected that the ESS activities would be of lower cost than the other programs; however, cost data is not collected in the operation of the ESS so there are few alternative sources to be found.

Table 18: Program cost data ($/ESC)

Financial year ending	2009	2010	2011	2012	2013
Electricity retailer cost	$5.14	$1.25	$0.31	$0.31	$0.31
ESC price	$19.80	$26.88	$30.40	$28.63	$0.00
ACP cost	$4.83	$7.64	$5.78	$5.78	$5.78
Public subsidy/ESC:	$14.97	$18.55	$26.57	$30.09	$28.32

Source: IPART cost effectiveness survey, Databuild

B.8.4 Estimation of administration costs

[38] Source: AER, 2013

Administration costs of the program are sourced from published IPART reports for 2010 and 2011 financial years. The calculated cost per certificate in 2011 is $2.50. The total administration cost for 2012 and 2013 is estimated. Administration costs are net of fee collections of the order of $0.70 per ESC. Historical administration costs are shown in Table 19.

Table 19: Historical administration costs

Financial year ending	2010	2011	2012	2013
Gross admin. cost	1,653,543	2,100,000	2,362,500	2,657,813
IPART revenue – ESC fee $0.70	461,394	645,365	1,213,513	1,671,365
Net admin. cost	1,192,149	1,454,635	1,148,987	986,448
ESCs created	659,135	921,950	1,733,590	2,387,664
Cost/ESC	1.81	1.58	0.66	0.41

Source: IPART cost effectiveness survey, Databuild, ESS registry data

Appendix C. Incremental capital costs

Determining the proportion of capital expenditure attributable to energy efficiency schemes requires the calculation of the *incremental cost* of energy efficiency rather than total capital expenditure. Incremental cost (also referred to as *differential* or *marginal cost)* refers to the difference in cost per additional unit purchased. This report evaluates the additional capital cost for an efficient technology type, over and above the baseline capital cost of a standard technology. For example, if a standard home refrigerator was to cost $100 and an energy efficient refrigerator was to cost $150, the calculated incremental cost would be $50. In this way, incremental cost is measuring the additional cost of energy efficiency, rather than the full cost of equipment replacement.

There are many nuances associated with any given technology (as well as its cost) that must be addressed. For example, should the cost of installation be included in the incremental cost of energy efficiency? In some cases, if the product were nearing the end of its commercial life then installation cost should not be included in the incremental cost calculation because it would have needed to be replaced anyway. In other cases the installation cost cannot be removed from incremental calculation because it is considered *inherent* in the capital outlay (e.g. insulation costs conventionally include installation). Furthermore, in some cases the incremental cost of an energy efficient technology is considered equal to the whole cost. This occurs in the instance where an energy efficient product is not replacing, substituting, or enhancing an existing similar technology (e.g. a shower timer).

The list below shows our lifetime assumptions for different installation situations:

1) Installation of new technology – incremental cost assumption is equal to full capital cost spread over new product lifetime
2) Replacement of technology – incremental capital and operating cost proportion (incremental to standard technology) is spread over new product lifetime
3) Modification of technology – incremental cost proportion is equal to remaining product lifetime (existing product).

C.1 Literature review and product cost determination

The literature review evaluated each of the efficiency programs to determine the types of technologies being implemented, likely cost profiles, and variances between implementation costs/impacts. Jacobs then analysed the cost data provided by OEH for these programs and classified costs by end use. For each end use or technology subtype (e.g. lighting) a comprehensive review of available products was conducted. The literature review establishes what is considered a standard technology and what is considered a high efficiency technology, taking into account current specifications or requirements such as the *Building Code of Australia* (BCA).

While the costs of energy efficient technologies undertaken by program participants have been provided by OEH, standard costs or what the program participants might have paid for the less efficient technology needed to be established. To ensure that the most realistic and applicable product cost was determined for standard technologies, a variety of sources were considered. Jacobs utilised the *Rawlinson's Australian Construction Handbook*, 3rd edition, 2012 in order to obtain current detailed pricing and unit information for standardised mechanical, electrical and other technological applications. Next, Jacobs conducted a desktop review evaluating a wide variety of available products under each end use technology specific to the program being considered.

C.2 Incremental costs by program and end use

For each program, Jacobs calculated the incremental costs by end use technology. These incremental cost percentages are applied to capital expenditure estimates provided by OEH to determine the incremental capital cost of an initiative. The incremental costs have been calculated conservatively as they apply only to capital expenditure and do not capture reduced operational cost and maintenance savings over time.

Since some technologies may be represented in more than one program and market sector, it was necessary to calculate the incremental costs for each appliance separately for each program. This is largely due to the variations in application, size, and consumption. For example, the heating and cooling needs for a small business are not comparable to heating and cooling needs of a large industrial complex. While the technology end use is the same, the incremental cost is not applicable across the two businesses and market sectors. Furthermore, in some cases the energy efficiency option may be to replace one part of the end use technology rather than the whole system. There are also refurbishments or upgrade options to improve efficiency rather than total replacement.

Where these characteristics were present in the opportunities undertaken by the energy efficiency program participants, Jacobs has estimated an incremental cost range, and then taken a simple average of the lower and upper cost range to determine the relevant incremental cost percentage value. The ranges provided reflect the differences in efficiency upgrade cost dependent on existing system/product specifications. For example, an efficiency upgrade to cogeneration may require the installation of new generators (~50% of the capital cost may be attributed to this expenditure) or it may require a new cooling plant and more efficient generators as well (which could be as much as ~80% of the total capital cost). The incremental costs ranges were developed by Jacobs' in-house specialist engineers. Jacobs's building services engineers and energy efficiency consultants advised on the upper and lower bounds for energy efficiency cost, as compared to the baseline. In calculating the incremental cost of an energy efficiency technology, the proportion will be selected based on the end use and activity description. Not all discrete opportunities within a program or end use will have the same associated incremental cost (this will be dependent on product lifetime, installation scenario, scale, etc.); for this reason a range has been provided.

Subsequent to the estimates provided by Jacobs, OEH have analysed Energy Saver Program data, and used the actual project descriptions to estimate incremental costs (published 13.05.13). The methodology is described as follows:

- The incremental costs have been estimated based on thorough analysis of the Energy Saver Program data. Initiatives have firstly been categorised by the type of project (i.e. replacement, new equipment, retrofit, optimisation, or upgrade). The default percentage incremental cost for replacement and new equipment has been assumed at 10% and for retrofit, optimisation and upgrade at 100%. Lighting replacement has been assumed at 80% and generation technologies like cogeneration and PV at 100%.
- For other initiatives, where the cost per lifetime MWh (based on incremental costs) was more than $80/MWh (the value considered to be cost efficient for business energy efficiency investment), the percentage implementation cost has been adjusted down for the cost per MWh to come down to $80/MWh.
- High capital cost initiatives (>$200,000) have been individually reviewed to apply the most appropriate percentage incremental cost.

C.3 Limitations

Cost estimation for any product relies on numerous variables which can significantly alter the outcome. To provide the most precise estimation of incremental cost, specific technology purchases should ideally be considered on a discrete basis; however, due to the volume of opportunities undertaken by participants in each energy efficiency program, discrete incremental cost estimation was not appropriate. Instead, a more broad approach is undertaken which utilises comprehensive research, internal industry knowledge, and previous studies conducted on incremental costs of energy efficiency products. Some of the important variables impacting on cost estimation (of both standard and energy efficiency technologies) are provided in Table 20. The variables have been categorised to highlight a few issues of concern but the table should not be considered exhaustive.

Table 20: Factors to consider for incremental cost estimation

Location	Calibration	Quality	Degree of implementation
• Product costs vary by region • Access to technology infrastructure (i.e. gas reticulation) • Location/outlay of facilities within a business	• The size of a facility • The degree of heating/cooling/water flow, etc. necessary at the facility level • Necessity for the technology to link with additional system requirements	• Variations in aesthetics • Product life and assurance • User friendliness • Compatibility with other systems	• Component purchase • Holistic implementation • Economies of scale

Appendix D. Energy savings from the Energy Savings Scheme

The NEEM model (National Energy Efficiency Model) was used to project energy savings in the Energy Savings Scheme (ESS) beyond June 2013[39]. A review of historical NEEM savings estimates against calculated estimates was made to ascertain whether this approach would adequately describe savings estimates going forward. The estimates were developed from a comprehensive[40] set developed during analysis of a National Energy Savings Initiative (NESI), using the capital costs contained in that study.

Use of NESI assumptions in the NEEM for projecting ESS energy savings is a useful technique but has its limitations. These include the following:

1) At present, uptake under the ESS is assisted by the presence of other programs, including the presence of education and training programs. These are not accounted for in the NEEM.
2) The NEEM contains a number of conservative assumptions limiting uptake. These include upper limits on uptake, use of a sigmoidal uptake curve mimicking the market adoption lifecycle, and other assumptions around market size. Given the level of effort placed by the NSW and Federal governments in regard to putting in place other programs, some of these assumptions may prove to be overly conservative.
3) The NESI assumptions underlying use of the NEEM were designed to model future energy savings (post 2015) which would come at greater cost and possibly produce lower savings per activity. For example, baseline energy use estimates for the lighting market may previously have been based on use of incandescent light bulbs rather than the compact fluorescent bulbs more commonly in use today. As a result the NEEM could understate historical and current energy savings when compared to stage one estimates.
4) Baseline estimates in the NEEM are based on future projections of energy use, which may be lower than estimates of energy use in 2007, the first year of the study.

Based on the above, it was decided to use the NEEM results and scale them up to match historical values where this was found to be justified, recognising that there may be significant differences.

It was assumed that no gas activities would be introduced to the ESS, although some activities might have the windfall effect of saving gas (e.g. draught-proofing). Jacobs conducted a review of the economic uptake of each activity in the database and activities which demonstrated consistently high uptake for the period from 2014 through to 2020 were excluded as these were perceived to be likely to occur without a scheme in place. These are listed in Table 21.

[39] The ESS Rule was updated in May 2014. Because the impact of this Rule change on the certificate market is not yet known, these changes are not taken into account in this study; nor are any potential future changes to the electricity retailer savings target.

[40] Jacobs made use of a comprehensive set of activities in our energy efficiency database. The database includes over 1000 activities which cover residential, small to medium enterprises, large commercial and industrial customers.

Table 21: List of excluded activities

Activity	Reason for exclusion	Sector
Majority of behaviour change and maintenance practices	These do not exist in the NEEM as it is difficult to estimate savings and costs in advance in a generalised fashion	Industrial
Incandescent to compact fluorescent lighting	It is assumed that this activity would be exhausted prior to 2014, since incandescent lighting is no longer sold	Commercial
Majority of process controls and measurements	Demonstrated consistently high uptake, implying these would occur without a scheme in place	Industrial
Desktop computer + monitor to laptop in large offices and hospital		Commercial
Equipment upgrade – HVAC		Industrial
Equipment upgrade – lighting		Industrial
Equipment upgrade – ventilation		Industrial
HVAC controls		Commercial
Reflectors/de-lamping		Commercial
Upgrade fan motor		Commercial
Water heating control system		Commercial
Window treatment		Commercial

Source: Jacobs' analysis

The modelled results were developed to meet a 4% annual savings target from 2014 through to 2020, consistent with current market prices, which range between $19 and $30 per certificate. The certificate price projections were obtained and combined with actual historical data to develop a series of certificate costs for determining estimates of private and public capital costs and government subsidies, etc.

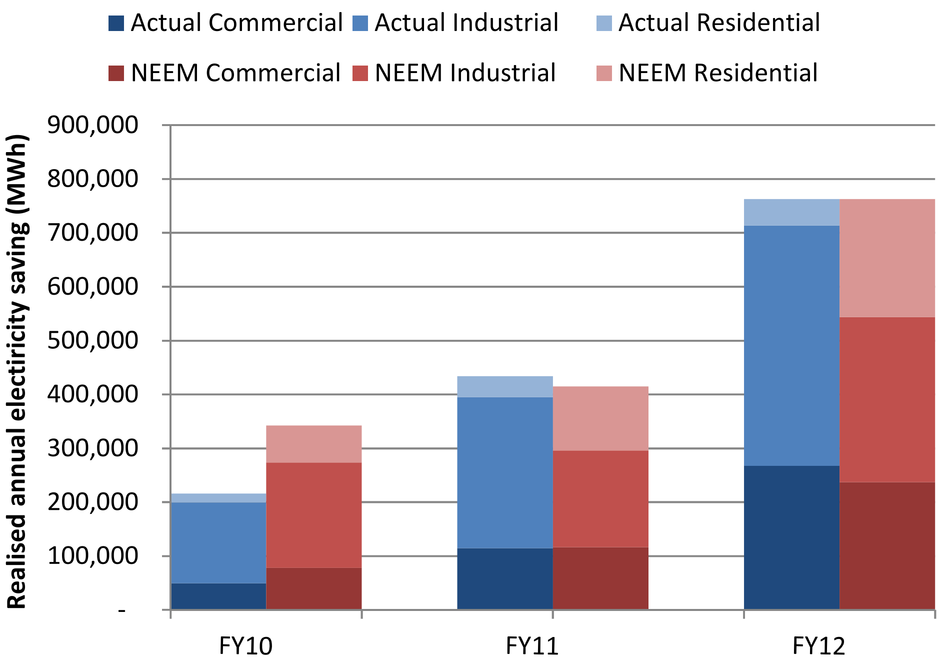
In all results presented the actuals were converted from calendar year data to financial year (using an averaging process) to ensure comparability with the NEEM outputs, as the energy market modelling tools used in the cost benefit analyses are all based on financial year data.

D.1 Historical comparison

Figure 30 shows the comparison between historical and measured electricity savings[41] against historical electricity savings estimated using the NEEM, by market (residential, commercial and industrial). These values have been obtained using historical ESC prices.

[41] Actual data has been averaged to approximate financial years, required for the energy market modelling

Figure 30: ESS savings – NEEM and historical[42]



Source: Jacobs' analysis

The NEEM model does not include showerheads, which make up 98–99% of historical residential sector savings. Therefore the NEEM results were adjusted to include the OEH estimates of this activity. The OEH savings estimates were adjusted down for interactions with other programs, to avoid double counting when these program savings are added to those from other programs[43]. Similarly, it was necessary to increase the NEEM results by 37%, as it was found that the NEEM understated savings relative to OEH historical savings estimates.

The ESS is a certificate based program with a savings target. Jacobs found that the ability to meet the target was constrained until 2018, requiring the certificate price to be lifted to the penalty rate[44]. The price was then reduced to $12.50 and $6.50 in 2019 and 2020 respectively as the market had developed or adapted sufficiently to increase uptake. Figure 31 shows the annual deemed savings achieved as a percentage of the annual target. The proportion of savings in each market is also shown, indicating that the savings are realistically spread out among the different markets, with the large commercial sector having the largest proportional savings followed by industrial and residential and small to medium enterprises. The gap between the savings and the target in 2014 and 2015 is filled by banked certificates from previous years.

The breakdown of percentage savings achieved in each market are shown in Figure 31. This shows the level of achieved savings as a percentage of the baseline energy use.

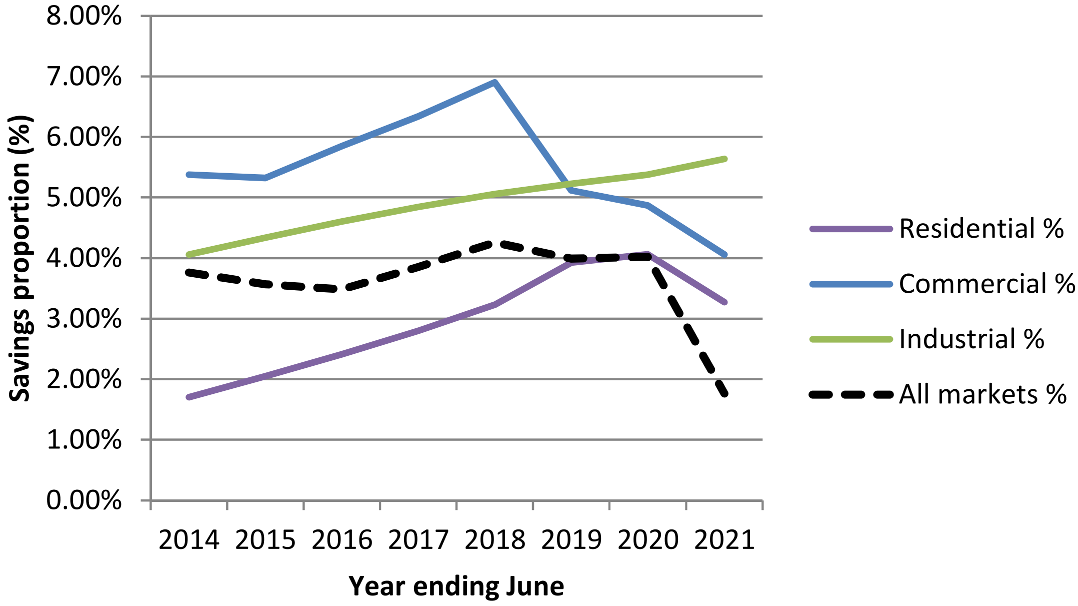
---

[42] The NEEM model does not include showerheads, which make up 98–99% of historical residential sector savings. Therefore the NEEM results were adjusted to include the OEH estimates of this activity.

[43] The presence of uptake programs increases energy savings under the NEEM and therefore a fair comparison can only be made after adjustment for other programs.

[44] When calculating the target, the energy savings as well as the baseline were scaled, to reflect the fact that the historical baseline is likely to be larger than the forecast baseline.

Figure 31: Lifetime electricity savings proportion by market

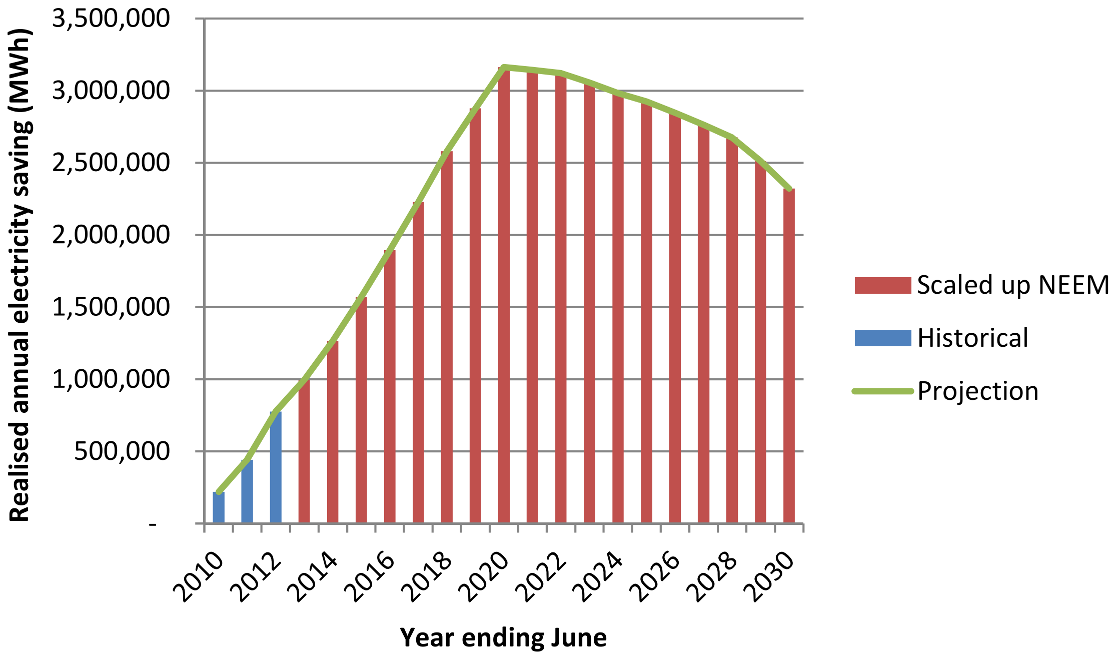


Source: Jacobs' analysis

D.2 Energy savings projections

The annual realised electricity savings from the ESS for the period 2009 to 2030 are shown in Figure 32. The figures for the period 2009 to 2012 are equal to the historical figures obtained from Stage 1. Post 2020, the projections assume 50% permanence from participants who have taken up activities under the scheme, and do not include additional uptake from other consumers even though it is plausible that the scheme would improve uptake through market transformation (achieved through reduced costs and increased public awareness).

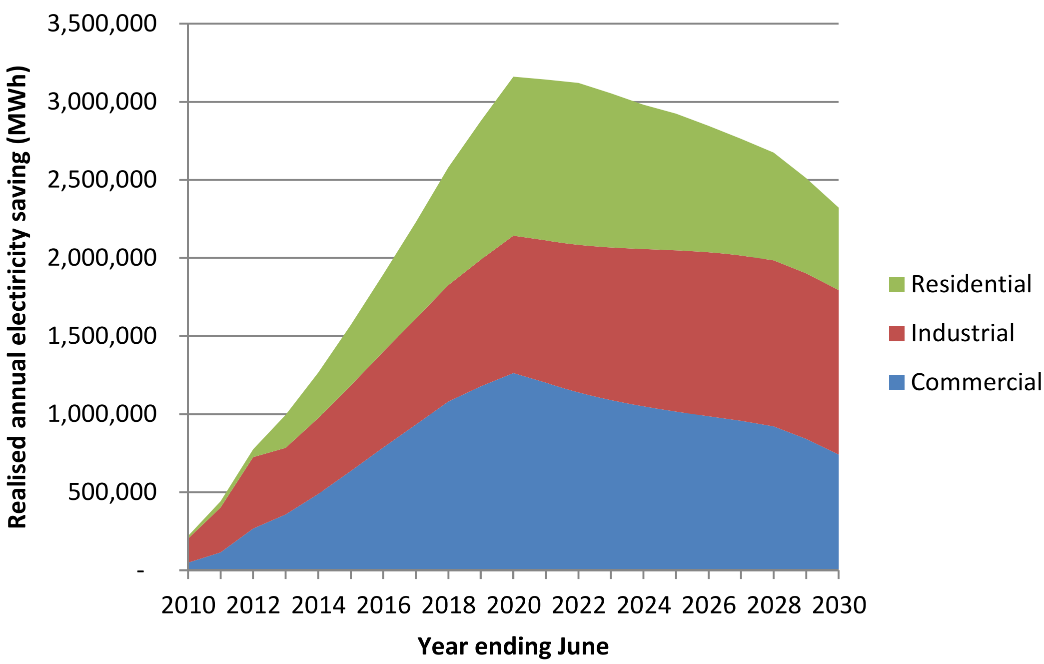
Figure 32: ESS savings 2009 to 2030 (financial years, actual savings)



Source: Jacobs' analysis

The sector breakdown of the projections is shown in Figure 33. The chart illustrates a good cross section of savings by market, consistent with policy objectives to include a wide and even coverage of the scheme. Any growth in market data beyond 2020 has occurred because of perceived growth in baseline energy use at the time the modelling was undertaken.

Figure 33: ESS savings 2009 to 2030 by sector (actual)



Source: Jacobs' analysis

Appendix E. Energy market modelling

E.1 Overview

This section provides a brief overview of the electricity market modelling concepts. Jacobs' market models are designed to create predictions of wholesale electricity price and generation driven by the supply and demand balance, with long-term prices capped near the cost of the cheapest new market entrant (based on the premise that prices above this level provide economic signals for new generation to enter the market). Price drivers include carbon prices, fuel costs, unit efficiencies and capital costs of new plant.

These models have been developed over more than 20 years, and include an energy market database that is regularly populated with as much publicly available information as possible and a suite of market modelling tools covering the electricity and gas industries as well as renewable and emissions abatement markets.

The primary tool used for modelling the wholesale electricity market is Strategist, proprietary software licensed from Ventyx that is used extensively internationally for electricity supply planning and analysis of market dynamics. Strategist simulates the most economically efficient unit dispatch in each market while accounting for physical constraints that apply to the running of each generating unit, the interconnection system and fuel sources. Strategist incorporates chronological hourly loads (including demand side programs such as interruptible loads and energy efficiency programs) and market reflective dispatch of electricity from thermal, renewable, hydro and pumped storage resources.

Strategist also accounts for inter-regional trading, scheduled and forced outage characteristics of thermal plant (using a probabilistic mechanism), and the implementation of government policies such as the Clean Energy Futures program and the expanded Renewable Energy Target (RET) schemes.

Timing of new generation is determined by a generation expansion plan that defines the additional generation capacity that is needed to meet future load or plant retirements. As such by comparing a reference case to a test case, we can quantify any deferred generation benefits. The expansion plan has a sustainable wholesale market price path, applying market power where it is evident, a consistent set of renewable and thermal new entry plant and must meet reserve constraints in each region. Every expansion plan for the reference and policy scenarios in this study is checked and reviewed to ensure that these criteria are met.

E.2 Market modelling assumptions

- Demand projections are based on AEMO National Electricity Forecasting Report (NEFR)[45] 2014 data. The model utilises medium demand growth projections with annual demand shapes consistent with the relative growth in summer and winter peak demand. The demand profile does not assume any storage and battery uptake for inter-temporal load management.
- No carbon price is assumed.
- Generators behave rationally, with uneconomic capacity withdrawn from the market and bidding strategies limited by the cost of new entry.
- Infrequently used peaking resources are bid near market price cap (MPC) or removed from the simulation to represent strategic bidding of these resources when demand is moderate or low. Torrens Island A capacity is an example when some plant is never required for median peak demand.
- The expanded RET scheme incorporated MRET and the previous VRET. The target as adjusted is for 41,000 GWh of large-scale renewable generation by 2020. The SRES is modelled as an uncapped take-up assuming a fixed price of $43/certificate in 2011 (real 2012 dollar terms), decreasing at 2.5% per annum in real terms.

[45] AEMO (2012), *National Electricity Forecasting Report for the National Electricity Market*, June, Melbourne

- Additional renewable energy is included for expected Greenpower and desalination purposes, amounting to around 4000 GWh by 2030.
- It was assumed that the Queensland gas fired generation target of 15% by 2020 was replaced by the CPM.
- The assessed demand side management (DSM) for emissions abatement or otherwise economic responses throughout the NEM is assumed to be included in the NEM demand forecast.
- Nuclear generation is not included in the study period.
- The development of the 400 MW integrated drying gasification combined cycle (IDGCC) plant by HRL in the Latrobe Valley has been shrouded in uncertainty due to a lack of investors. This project, which has a four year construction lead time, still seeks financial support and has recently been frozen by HRL because of a legal ruling that it cannot be built until an existing brown coal-fired power station has been shut down. Given the delays and uncertainty surrounding the project, we will not be considering it in this study.
- The retirement of the 2 x 300 MW Munmorah units at the end of September 2014.
- The retirement of Redbank in October 2014.
- The retirement of the Swanbank B units, as planned by CS Energy in 2011 and 2012.
- The early retirement of Snuggery unit 3 is no longer expected. We have closed the three gas turbines by June 2020.
- Playford is retired in June 2012. It is possible for Playford to run longer as it has a high emission rate and may be required to meet reliability during extreme summer conditions.

E.3 Modelling historical outcomes

The back casting process involves replicating historical outcomes to enable an analysis on what may have happened if certain policy measures were not introduced.

For the reference case, historical outcomes are simulated to enable an analysis on what may have happened if energy efficiency programs were not introduced. Jacobs uses its electricity and gas market models together with OEH data and energy savings data to estimate the costs and benefits of the schemes in terms of economic gains. Energy savings data is added back to historical demand data to obtain an estimate of baseline demand without the energy efficiency programs.

For the base program case, historical outcomes are replicated and this scenario represents what is observed in the real world with the programs already under implementation. Focus is put on replicating this world as accurately as possible in the energy market database, for example through changes in bid prices that affect dispatch.

A proprietary market modelling software Strategist is used in the back casting for both cases. The modelling is not exact due to the actual bidding and dispatch process being more refined than the Strategist modelling process. Tasmania is only displayed post Basslink commencing operations (i.e. 2006 onwards). Overall the back casting provided a pricing outcome within +/– 5 % of the historical annual prices over the period 2002 to 2012 and this was considered to be representative of the historical prices. The back castings for the base program case and peaking program case are then used to compare the impact of the energy efficiency schemes.

E.4 Simulation of future impacts

Jacobs has used its market simulation model of the Australian gas and electricity markets to estimate the future impacts on the electricity markets because of the energy efficiency schemes. The model projects electricity market impacts for expected levels of generation for each generating unit in the system. The level of utilisation depends on plant availability, their cost structure relative to other plant in the system and bidding strategies of the generators. Bids are typically formulated as multiples of marginal cost and are varied above unity to represent the impact of contract positions and price support provided by dominant market participants; however, for this study we propose to use short run marginal cost bidding as the main bidding driver to simplify the analysis.

New plant, whether to meet load growth or to replace uneconomic plant, are chosen on two criteria:

- to ensure electricity supply requirements are met under most contingencies. The parameters for quality of supply are determined in the model through the loss of load, energy not served and reserve margin. We have used a maximum energy not served of 0.002%, which is in line with planning criteria used by system operators
- revenues earned by the new plant/energy efficiency program equal or exceed the long run average cost of the new generator.

E.5 Supply

E.5.1 Marginal costs

The short run marginal costs of thermal generators consist of the variable costs of fuel supply, including fuel transport, plus the variable component of operations and maintenance costs. The indicative variable costs for various types of existing thermal plants are shown in Table 22. We also include the net present value of changes in future capital expenditure that would be driven by fuel consumption for open cut mines that are owned by the generator. This applies to coal in Victoria and South Australia.

Table 22: Indicative average variable costs for existing thermal plant in 2012 (June 2012)

Technology	Variable cost /MWh	Technology	Variable cost /MWh
Brown coal – Victoria	3–10	Brown coal – SA	24–31
Gas – Victoria	46–64	Black coal – NSW	20–23
Gas – SA	37–111	Black coal – Qld	9–31
Oil – SA	250–315	Gas – Queensland	25–56
Gas peak – SA	100–164	Oil – Queensland	241–287

Assumptions used to develop long run marginal cost (LRMC) estimates are provided in Table 23. The trend in annualised capital recovery costs is shown in Table 23. The pre-tax real equity return was 17% and the CPI applied to the nominal interest rate of 9% was 2.5%. The capital costs are generally assumed to de-escalate 1% per annum until they reach the long-term trend. New technologies have higher initial costs and greater rates of real cost decline up to –1.56% per annum for IGCC. The debt/equity proportion is assumed to be 60%/40%. This gives a real pre-tax WACC of 10.60 % pa. It is assumed that the higher risks emerging in the electricity generation sector from CPM will require these higher equity returns.

The capacity factors in Table 23 are deliberately high to allow modellers to approximate a time-weighted new entry price in each state that can rapidly be compared to the time-weighted price forecasts to determine whether or not new entry would be encouraged to enter the market.

These capacity factors do not necessarily reflect the levels of duty that we would expect from the units. The unit's true LRMC measured in /MWh is higher than this level. For example, we would expect to find a new CCGT operating in Victoria with a capacity factor of around 60% to 70% rather than the 90% as indicated in the table. Ideally, in determining the timing of new entry of such a plant we would compare the new entry cost of a CCGT operating at this level against the time-weighted prices forecast in the top 60% to 70% of hours.

Table 23: New entry cost and financial assumptions ($2013) for 2014/15

	Type of plant	Capital cost, $/kW	Available capacity factor	Fuel cost , $/GJ*	Weighted cost of capital, %	LRMC $/MWh (d)	+ CO_2, $/MWh
SA	CCGT (a)	1,304	90%	6.50	10.60%	77.59	89.58
Vic	CCGT (a)	1,183	90%	5.68	10.60%	66.13	77.03
NSW	CCGT (c)	1,183	90%	6.23	10.60%	68.90	79.76
NSW	Black coal (b)	2,698	91%	1.81	13.60%	75.55	96.66
Qld	CCGT (c)	1,183	90%	7.99	10.60%	75.08	85.03
Qld	Black coal (Tarong) (b)	2,698	91%	1.35	13.60%	69.80	89.73
Qld	Black coal (Central) (b)	2,698	91%	1.49	13.60%	70.92	93.06

*Notes: * Fuel cost shown as indicative only; gas prices vary according to the city gate prices. (a) extension to existing site; (b) not regarded as a viable option due to carbon emission risk; (c) at a green field site; (d) excluding abatement costs or revenues*

E.5.2 Fuel costs

Gas price projections for incumbent and new entrant plant are detailed in Appendix I.

World coal price projections under a medium price scenario have been derived from a number of credible forecasters, including those of BREE[46] (formerly part of ABARE), the IEA[47] and Standard Chartered Bank[48]. The medium price scenario was chosen as the median price of all relevant scenarios presented in the above sources. This price path is treated as an index which will be applied to all coal-fired power stations in the NEM, except those located at the mine mouth. The index defines price increases approximately twice that of 2011 levels by 2040 in real terms. The exceptions to this were the Victorian brown coal fired power stations, and the mine mouth black coal power stations including Millmerran, Tarong, Tarong North and Kogan Creek. It has also been assumed that by 2020 the mine mouth black coal power stations would also begin tracking the world coal price.

E.5.3 Plant performance and production costs

Thermal power plants are modelled with planned and forced outages with overall availability consistent with indications of current performance. Coal plants have available capacity factors between 86% and 95% and gas fired plants have available capacity factors between 87% and 95%.

E.5.4 Closures and new plant assumptions

The ESOO 2014 and previous publications have been consulted to determine plant closures and new plant assumptions.

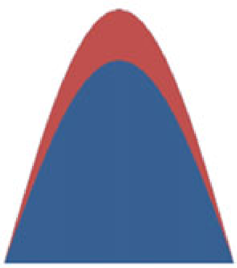
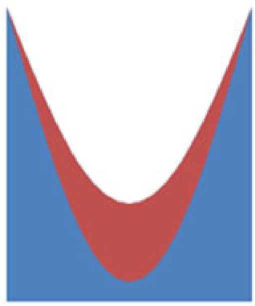
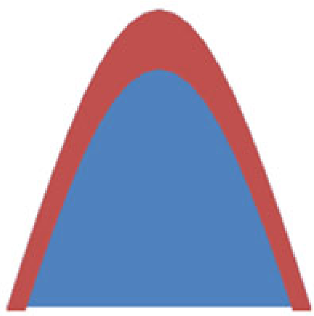
E.6 Modelling energy demand reductions

The NEEM model does not directly build a projection of energy use, but builds a projection of energy savings using a bottom-up approach. The projection of energy savings is deducted from the reference case total to achieve a final estimate of scenario demand.

46 Bureau of Resources and Energy Economics, *Australian energy projections to 2034–35*, Dec 2011
47 International Energy Agency, *World energy outlook 2011*, 2011
48 Standard Chartered, *Super Cycle: A resource challenge*, Jan 2011

The electricity market modelling also deducts energy savings from an underlying demand forecast, using one of three load shaving methods in the software (Strategist). Two of the methods – peak and off-peak shaving – require a peak input and an energy input. Under peak shaving, load above median demand is shaved in proportion to the load shape so the shaved load is consistent with the peak and energy values input by the user. Off-peak shaving works in a similar way, where load below median demand is shaved in proportion to the load shape so the shaved load is consistent with the peak and energy values input by the user. Flat shaving requires either a peak input or an energy input, and will reduce the load by a fixed quantity evenly over the profile, adjusting it so that the load never becomes negative. These methods are illustrated in Figure 34.

Figure 34: Load adjustment examples

Peak shave	***Off-peak shave***	***Flat shave***
Used for residential area heating and cooling, electronics, commercial lighting and space conditioning	*Used for residential water heating*	*Used for residential and commercial refrigeration, industrial applications*
		

For the electricity market modelling component of this work, the software deducts the energy efficiency savings from the total as appropriate for each activity. For example, space conditioning demand is most likely to occur in peak periods, so peak shaving was employed for this demand reduction. By contrast, industrial load exhibits relatively little variation, and therefore, the software made a flat deduction over all time periods. This approach allowed modellers to realistically assess impacts on the electricity market, accounting for the fact that reductions to peak demand are likely to be more economically efficient for the generation industry.

Because the demand reduction for space heating in particular is most likely to occur in winter months, some seasonal parameters were employed to ensure the benefits were being realised at the appropriate time of year. These parameters were derived using degree days (heating and cooling) for applying savings to the various months for heating and cooling activities respectively.

Appendix F. Electricity network impacts

Jacobs have assessed electricity network impacts as part of this study. Our approach recognises that most costs incurred by DNSPs are not based on throughput energy but on obligations to supply capacity. The method is focused on estimating the benefit that energy efficiency programs have in reducing peak demand for each DNSP, as well as consideration of uncertainty around each network's ability to recover revenue and the possible impact on tariff determinations. As an overview, the approach runs as follows:

- Estimate peak reduction by network service area. This is done by converting the categorised energy savings to peak demand reductions using a conservation load factor[49] (CLF).
- Convert peak demand reductions to an estimate of network capacity deferral, by calculating the year on year incremental growth.
- Apply a distribution (specific to each distributor) and transmission deferral benefit factor to the estimates of network capacity deferral.

The impact on network tariffs is complicated by a number of factors. Reduced energy throughput without a corresponding increase to the tariff may lead to a lower network revenue recovery for the DNSP. The reduced peak network demand may not always lead to a capacity deferral benefit so our approach has separated out the cost of network augmentations to meet load growth rather than including expenditure to meet reliability or other factors.

This approach is described in greater detail in the following sections.

F.1 Deferred transmission benefits

A value of deferred transmission expenditure has been estimated by ISF and Energetics[50], and has estimated a deferral benefit of $950/kW. These values are based on five year proposed system augmentation capital expenditure estimates for a large range of transmission network service providers. The report also qualifies that the NSW estimate is based on 'growth related' rather than augmentation expenditure, and hence may be somewhat less conservative than the reported estimates from the other states.

Jacobs has assumed a uniform transmission deferral benefit of $500/kW. This value is based on in-house advice and has been chosen because it conservatively reflects the uncertainty associated with network deferrals, and because the value of transmission deferrals is usually not material.

F.2 Deferred distribution benefits

The modelling approach has considered energy savings and issues at the regional distribution network service provider (DNSP) level rather than the state level to better correlate energy savings with the characteristics and costs relevant to each DNSP.

To appropriately consider issues at the DNSP level, the modelling work requires an adequate description of the likely uptake of energy efficiency in each region combined with the probable financial benefit (or financial disadvantage as the case may be) that corresponds to the change in load shape and the reduction in load.

The methodology for capturing the value of energy efficiency measures that reduce the peak demand and energy consumption relies on establishing a range of estimates for the cost of network augmentation related to load growth. At a state or DNSP level, the average capital expenditure per kW is equal to the total capital

[49] A conservation load factor (CLF) is a concept similar to the concept of load factor used in industry to relate energy use to peak demand. The CLF is slightly different, however, in that the focus of the demand saving is related to network or wholesale system peaks rather than a customer's peak. The result of this is that the CLF will usually be higher or more conservative than a simple load factor would be, reflecting the uncertainty in estimating impacts on peak demand for parts of the network.

[50] industry.gov.au/Energy/EnergyEfficiency/Documents/04_2013/building_our_savings.pdf

expenditure to meet forecast load growth (excluding customer connections) divided by forecast change in demand. The results represent the actual capital expenditure that will be saved, not the deferral value, which is the saving that will arise from deferring the expenditure. The capital expenditure programs for the DNSPs cover a wide range of potential causes including:

- aging asset replacement
- specific major project investments
- new customer connections
- augmentations to reduce constraints
- investment to meet reliability standards and compliance, and
- developments to meet existing customer load growth.

The state average $/kW is equal to the total capital expenditure spent by all of the DNSPs within that state divided by the forecast of state demand growth. The Australian Energy Regulator's Annual State of the Energy Market report provides a state based summary of the final regulatory determinations for NSW, Victoria, Queensland and South Australia. These figures have been established as a broad level guide for the more detailed distribution area data. In overall figures published by the AER in the regulatory determination summaries for each state the capital expenditure has not been explicitly separated between growth-related expenditure and that for new customer connections. As an indicator, Jacobs has assumed that in the order of 50% of the capital spend has been related to meeting demand growth. Ernst and Young (EY) in their report for the AEMC's Power of Choice Review provided greater detail on breakdown of capital expenditure related to demand growth. The data in that report is used later in this report to establish factors for the service area of each distributor. The Australian average for the system average capex (distribution) is $1341/kW as shown in Table 24.

Table 24: State based average distribution network cost $/kW associated with delayed peak demand (real 2010/11 dollars)

System average capex (/kW)	NSW	VIC	QLD	SA	WA	Australian Average[51]
Distribution	1,934	890	1,852	1,274	757	1,341

Source: AER regulatory determinations for each state.

Resolving this high level state based data down further for individual distributors' service areas is more difficult. Every five years each DNSP must submit, to the AER, a regulatory proposal that describes their services, expenditure and operation for the next five regulatory years. Once reviewed, potentially adjusted, and approved by the AER, this provides a guide to future capital projects and expenditure; however, projects greater than $5 million must still undergo a regulatory investment test prior to commencement.

Table 25 presents information from the Ernst and Young report for the AEMC's Power of Choice Review on the potential benefits of increased demand side participation in managing the growth of peak demand and network expansion and the AER's State of the Energy Market report for 2011. Ernst and Young extracted the growth related capital expenditure for all of the DNSPs operating in the NEM and reported, amongst other things, the capital expenditure related to demand growth for all of the DNSPs in the NEM. The information summarised in Table 25 does not replicate all of the data provided by Ernst and Young in the report, only that which is important to this study.

The figures in Table 25 highlight that each DNSP has a unique set of circumstances that drive its development approaches. As an example, some of the distributors have more widely separated customers across rural areas where overhead lines are acceptable compared to some city areas where undergrounding is expected. Alternative equipment standards, line technologies and the cost of land for easements will also vary.

[51] This is a simple arithmetic average of the state figures.

It would be difficult to directly compare the cost per kW between DNSP regions primarily because of the significant difference in the sizes of service areas for each distributor and their relative customer density. Without a specific area measurement that would facilitate the calculation of a customer per line density type figure, a more simplistic 'consumers per circuit kilometre' is a reasonable approximation.

The study also applies a discount factor of 0.7[52] to distribution benefits to allow for the uncertainty involved in networks actually being able to recoup the benefits from the programs.

Table 25: Average NSW network cost /kW associated with delayed peak demand for each DNSP (real 2010/11 dollars)

Network	Number of customers	Line length	Regulatory period	Total capital expenditure (EY report m)	Demand driven capital expenditure %	Demand growth expenditure (EY report m)	Asset replacement expenditure (EY report m)
AusGrid	1,605,640	49,440	1/7/2009 to 30/6/2014	7,438	36%	2,710	
Endeavour Energy	866,720	33,820	1/7/2009 to 30/6/2014	2,885	40%	1,160	
Essential Energy	801,910	190,840	1/7/2009 to 30/6/2014	4,270	36%	1,535	874

Network	New customer connections expenditure (EY report m)	Network reliability expenditure (EY report m)	Change in demand[53] (MW)	Demand growth $/kW	Non-growth related $/kW	Customers per circuit km
AusGrid		3,232	657	4,120	7,200	32.48
Endeavour Energy		1,278	360	3,220	4,790	25.63
Essential Energy		974	356	4,310	7,680	4.20

[52] Based on assumptions used in the Department of Climate Change and Energy Efficiency evaluation of a National Energy Saving Initiative
[53] It is not clear from the EY report or AER reports if this figure is exclusive or inclusive of new customer connections.

Appendix G. Impact on retail charges

The uptake of energy efficiency in each region will vary according to the mix of customers, the energy prices being paid and loads and potential for energy efficiency (as affected by non-financial barriers). The mix of customers are estimated for the state using customer numbers and energy loads, defined by geographical level customer data as already described. This section describes in more detail the approach to vary, as appropriate, baseline energy values and retail energy prices by distribution service area, gas penetration by region as these would all impact on uptake of activities in ways that might vary across the state.

G.1.1 Retail charges

Retail energy cost savings are the primary benefit for any potential consumer of engaging in a higher efficiency activity. Retail energy cost savings are estimated in the NEEM using a build-up of avoided network, wholesale and other market costs. The AEMC has summarised how these components impact the typical residential bill (see Table 26). While the makeup and growth in costs will vary significantly by state, it is evident that transmission and distribution charges are a non-trivial component of costs, making up around half the typical residential bill combined in 2009, and projected to grow around 35% by 2013.

Table 26: Composition of retail tariffs

Component of retail tariff	Estimated proportion of residential retail cost, nationally	Estimated change to cost between 2010 and 2013, nationally
Wholesale electricity costs	35–40%	19%
Transmission network charges	8%	8%
Distribution network charges	36–45%	41%
Retail costs, including margins	8–16%	14%
Renewable Energy Target (RET) costs	2–4%	11%
Feed in tariff scheme costs	0.12–2.4%	3%
Other costs relating to state and territory government programs and policies	1–7%	3%

Source: www.aemc.gov.au/Media/docs/CoAG%20Retail%20Pricing%20Final%20Report%20-%20Publication%20Version%2010%20June%202011-5fa4f4b8-8098-420c-a014-fa70808bb2e4-1.PDF

G.1.2 Network charges

Network charges are the summation of distribution and transmission charges, and are subject to regulation.

The financial impact on distribution and transmission network service providers will however largely depend on the following factors:

- the impact of the programs on load shape, such that reductions in peak demand will defer investment in capital expenditure; however, uncertainty in the new load shape increases reliability risks for the NSP
- the ability of networks to adequately predict ‘out of forecast’ changes in energy and peak demand, which can materially impact projected assessments of necessary capital investment and subsequent revenue requirement, and/or reliability

- timing of network revenue and tariff determinations. Tariffs are fixed for five year intervals as determined by the Regulatory proposal / reset periods. Without 're-openers' there is no scope for modification of the tariff components for changing loads and load profiles[54], and finally
- structural tariff considerations, such as recent trends to increase capacity charges for networks rather than energy consumption charges, to minimise risk related to energy uncertainty reducing revenue recovery.

The financial value of the Regulated Asset Base for each of the network service providers is already established. A reduction in energy consumption as a result of the programs will not change the amount of money to be recovered from consumers, rather it will increase the cost per kW consumed to deliver the same level of regulated revenue until the level of consumption matches the original levels.

Increases in network charges have been most evident in NSW and Queensland, where considerable growth in the use of air conditioning has increased demand on the networks driving augmentations to maintain service levels.

The projected increase in network tariffs is likely to drive consumers to take up energy efficient options, especially in those regions where the tariffs are likely to increase the most. Current network tariffs were collected for each distribution area, and representative tariffs were chosen for each of the residential, small to medium enterprise (businesses with fewer than 200 employees, also known as SMEs), low voltage (LV) and high voltage (HV) customers. Representative tariffs were chosen on the basis that they serve the majority of customers who would be the target market for the program.

For the modelling, all network tariffs were converted to a representative standing or supply charge, a demand charge and a variable energy use charge. Supply charges are not considered in the calculation of energy cost savings because they do not contribute to the avoidable energy costs that would count as energy savings benefits in a cost benefit calculation.

In most cases residential and SME tariffs consisted simply of a supply charge and a simple or inclining block tariff rate, and did not include a demand charge. Where inclining block tariffs apply, only the price of the first block was taken, on the basis that some customers would not have large enough loads to meet higher blocks. This will result in a conservative estimate of price as the first block is always cheapest, although this could be offset to some extent by understated estimates of revenue loss.

Low voltage (LV) and high voltage (HV) customer tariffs are more complex, and consist of a supply charge, a demand charge, and an energy charge typically split into peak, shoulder and off-peak time periods. The demand charge is applied to the estimate of peak demand reduction for each distributor. The variable energy charge, if on a time-of-use basis, is converted to a single figure based on an assumed typical usage pattern. The pattern of usage chosen was 33% energy in each of the peak, shoulder and off-peak time periods, which is consistent with a demand profile displayed in the chart below.

The assumed network tariff, for each distribution service area is shown in Table 27[55]. Revenue changes for network service providers from energy efficiency initiatives have been allocated uniformly to distribution and transmission entities on the basis of their contribution to the retail cost of energy to customers. There are limitations with this method, as it assumes that impacts are uniform for both transmission and distribution entities and in all areas, which may not be the case in reality. It is however a reasonable assumption for this analysis, and while the majority of revenues for the NSPs are collected from an energy based charge.

[54] Regulation allows DNSPs to submit annual pricing proposals. Subject to the applicable side constraints, the DNSP can change the level of charges within the various components of any tariff (e.g. reduce energy charge and increase the daily supply charge). SKM MMA does not attempt to model this re-balancing in any way.

[55] This is by no means all of the tariffs that are used by the network service providers but it is a realistic and representative sample of typical arrangements.

Table 27: Representative network charges[56] by NSW distribution area[57]

Network	Market segment	Representative tariff	Standing charge[58] (c/day)	Demand rate (c/kW/day)[59]	Energy Rate (c/kWh)
AusGrid	Residential	Residential IBT	31.057	–	11.69
	SME	Small business IBT	100.90	–	9.959
	LV	Medium business (160 – 750 MWh)	385.00	37.125	7.099
	HV	High voltage TOU	1424.37	17.096	5.388
Endeavour Energy	Residential	Domestic	34.10		11.471
	SME	General supply non TOU	47.30		9.869
	LV	LV demand TOU	1659.90	64.302	2.817
	HV	HV demand TOU	2746.70	46.464	2.229
Essential Energy	Residential	Residential LV continuous	76.16		16.240
	SME	Business LV general supply	76.16		21.185
	LV	Business LV TOU demand 3 rate	1288.5	51.334[60]	4.047
	HV	Business HV TOU demand 3 rate	1613.3	38.117[61]	3.194

Source: Jacobs' analysis of DNSP tariffs for 2011/12

G.1.3 Assessing differences in peak demand response by energy efficient activity

Energy efficient activities, depending on their nature, will affect peak demand in different ways. For example, activities affecting end uses operating continuously (e.g. some industrial processes, refrigeration) will reduce peak demand in proportion to their end-use pattern. End uses which are driven by weather conditions and occupancy cycles will have a more variable impact on peak demand. Activities affecting residential lighting may only have impact in certain hours which may not coincide with the peak demand network period. Because energy efficiency reductions can affect peak demand in different ways, it is necessary to arrive at an approach that enables appropriate conversion of energy efficiency load reductions to peak demand reductions.

To estimate the impact on peak demand the energy savings for each activity were profiled such that a conservation load factor (CLF) could be identified to represent the change in demand at the peak. The CLF is effectively the ratio between average and maximum demand associated with each end use. The formulation of the relationship between the CLF, energy savings and peak demand is:

$$\text{Peak demand impact (kW)} = \text{Average hourly energy savings (kW)} / CLF$$

where the annual energy savings are converted to average hourly savings by dividing the annual kWh by the number of hours in a year (8784 in leap years and 8760 in other years).

The CLF has been used in a number of studies on energy efficiency[62], and is similar to the load factor concept commonly used in the energy industry to describe the relationship between peak and average demand. Load factors range from zero to one. A load factor of one would represent a flat profile where the average equals the peak and results in high utilisation of all of the assets in the energy supply chain. As the load factor becomes smaller, the peak demand becomes increasingly larger with respect to the average demand or the load becomes increasingly peaky. Servicing a peaky load shape requires considerable expenditure on capacity without the benefit of sustained throughput.

56 Includes transmission use of system charges and GST
57 SAC=standard asset customers
58 Requires conversion to a c/kWh rate and requires an estimate of customer numbers to energy ratio
59 Where kVA has been quoted in the tariff this has been converted to kW using a conversion factor of 1.25 kVA = 1 kW
60 Peak demand rate is used, since the peak demand rate is what would be affected by the CLF calculation.
61 Peak demand rate used, even though the tariff has a peak, shoulder and off-peak demand rate, since the peak demand rate is what would be affected by the CLF calculation [same as above]
62 industry.gov.au/Energy/EnergyEfficiency/Documents/04_2013/building_our_savings.pdf

CLFs range from zero to infinity. The inclusion of very high CLFs in the allowable range is necessary to account for activities which provide a small impact on peak demand. For example, lighting would have a significantly smaller impact on the peak demand periods compared to off-peak demand periods[63]. For activities where the CLF is close to one, such as winter refrigeration, the load is fairly constant over the whole day and thus the average and the maximum demand from a refrigerator are almost equivalent. In contrast, activities such as summer air conditioning will have a CLF that is much lower than one, since the average load over a given summer will typically be much lower than the maximum load in the same period. The CLFs to be used in the modelling are presented in Table 29.

An alternative metric is the peak demand factor (PDF), which describes the kW savings in demand for each kWh saved. CLFs can be converted to PDFs using the following formulation:

$$PDF = kW / kWh = peak\ kW / (average\ kW \times 8760) = 1 / (CLF \times 8760)$$

Both CLFs and PDFs are therefore presented for reader convenience, in Appendix A. These are based on a combination of professional judgement and analysis of load shapes.

Most distribution regions and states of Australia peak in summer between 1pm and 6pm, with the system or state based peak occurring at around 4pm. The exceptions were Tasmania, Canberra (covered by ActewAGL) and the AusGrid region in NSW which appeared to follow winter peaks, timed around 6pm approximately. The variability around the timing of the peak and uncertainty with respect to the load shapes for each DNSP required the modellers to consider treating all regions as either summer or winter peaking, and determine the annual peak demand[64] using either the summer or winter CLF as appropriate.

Ausgrid has experienced some switching between summer and winter peaking outcomes. That is, over the last 10 years the peak season has switched several times between summer and winter. While it is not possible to predict when this will occur, it is possible to estimate the proportion of the load that is predominantly winter peaking and the proportion that is predominantly summer peaking. This was done for NSW where it is most likely to be an issue in the inland coastal zones. Jacobs used published network planning reports for the terminal substations and connection point demand and estimated the proportion of demand that was most likely to be winter or summer peaking. These ratios were used to determine a uniform capacity benefit (UCB) factor that would weight summer and winter demand, effectively apportioning the demand savings between the winter and summer seasons. These are displayed in Table 28.

Table 28: Summer and winter uniform capacity benefit factors for NSW

Area/state	Summer UCB factor	Winter UCB factor
Ausgrid	93%	7%
Essential Energy	77%	23%
Endeavour Energy	61%	39%
ActewAGL	80%	20%

Table 29: Summary of end-use load factors and conservation load factors

Residential end use	Basis/ source	Load factor		Conservation load factor	
		Summer	Winter	Summer 4pm peak	Winter 6pm peak
Building shell upgrade	Summer cooling + winter heating	48%	45%	48%	50%

63 Note that it may have a significant impact in regions which are winter peaking however, as days are shorter and the winter peak is usually later.
64 Note that seasonality in peak demand is addressed for weather sensitive activities by using cooling and heating degree days.

Residential end use	Basis/ source	Load factor		Conservation load factor	
		Summer	Winter	Summer 4pm peak	Winter 6pm peak
Residential cooling	RC AC profile	48%	–	48%	–
Residential heating	RC AC profile	–	45%	–	50%
Residential lighting	Daylight hours & household occupancy	18%	30%	264%	34%
Residential water heating	NZ HEEP study	59%	55%	149%	109%
Residential outdoor lighting	Daylight hours & household occupancy	18%	30%	264%	34%
Residential refrigeration	Adjusted cooling profile	70%	81%	70%	90%
Televisions and set top boxes	Household occupancy	59%	59%	79%	66%
Computers and laptops	Household occupancy	59%	59%	79%	66%
Other consumer electronics including mobile chargers, printers, etc.	Household occupancy	62%	62%	87%	73%
Other miscellaneous appliances including kettles, toasters, hairdryers, shavers etc.	Household occupancy	59%	59%	83%	69%
Residential pools/spas	Household occupancy, Ergon Energy profile	58%	52%	73%	84%
Commercial load – building shell upgrades, HVAC	ISF and Energetics study to DCCEE (2010)	73%	78%	74%	79%
Commercial load – lighting	Chicago study	70%		70%	109%
Commercial load – refrigeration	Adjusted cooling profile	70%	81%	70%	90%
Commercial load – other (air compressors, appliances and equipment, water heating, boilers, furnaces, ovens, pumps, lifts and travellators)	Chicago study	63%		63%	85%
Commercial load – cooling	Chicago study	52%		52%	
Industrial load	Jacobs assumption	100%	100%	100%	100%

Source: Jacobs' analysis

G.1.4 Impact of cost savings on network tariffs

In previous modelling exercises for OEH, Jacobs did not adjust network tariffs in the NEEM. In the current modelling exercise Jacobs propose to undertake two forms of adjustment:

- Estimate energy impact, i.e. the impact on total revenue under reduced energy use compared to business as usual. It would be expected that fixed revenue requirements and reduced energy use could lead to higher network charges unless the utilisation of the network also improves.
- Estimate peak impact, i.e. the impact of deferred network upgrades resulting from reduced network peak load, if any. Depending on the mix and list of energy efficient activities undertaken, it would be expected that some reduction to network peaks would be likely to occur, providing some benefit that will reduce network charges. Whether this is sufficient to counter the increases to network charges from reduced consumption is as yet unknown. This is difficult to resolve without real data. An economic analysis such as this one requires an assumption about the kW impact that actually reduces capex at various points in time,

and this is a product of the specific augmentation requirements over time and the geographic take-up of the energy efficiency. Assessing the likely financial (as opposed to economic) impact of the programs (or any network demand reduction effort) is spatial and temporal.

For each scenario modelled, it was assumed that some proportion of peak impact benefit will occur and adjustments will take place only in the years following the existing tariff review period since networks are unable to accurately forecast and assess changes to their projected revenues prior to the next tariff review. Some DNSPs can rebalance tariffs annually to try to respond to changes in forecasts of customer numbers, peak demand and consumption by tariff, reducing the efficacy of the assumption. Capital expenditure by the NSPs requires some level of regulatory test examination if only to identify the most appropriate lowest capital cost option; however, we believe this simplification is justifiable and reinforces a conservative approach to our analysis.

Reductions to network charges were applied only to the energy component of the network tariff, to replicate the existing trend for networks to reduce their risk by increasing fixed charges and reducing consumption charges.

Appendix H. Conservation load factors

This section presents the conservation load factors (CLF) that enable conversion from energy savings to peak demand reduction. For the purposes of this report the system peak is assumed to occur at 4:00pm in the summer months and 6:00pm in the winter months.

H.1 Evaluation of conservation load factors for each end use

Jacobs reviewed a set of in-house CLFs against others cited in the literature. See Table 30, which illustrates that there can be wide variation in CLFs used as a result of regional variations relating to differences in average temperatures, daylight hours and work practices. As the table also displays differences in summer and winter CLFs by EMET, it should be noted that annual peaks usually occur in the summer months in most states and regions of Australia, with some exceptions (ActewAGL and AusGrid). The CLFs that are recommended for use in the modelling were derived from analysis of a load shape, market knowledge and understanding gained through previous experience modelling the NSW Demand Management and Planning Project (DMPP). These CLFs are shown in Table 30.

The reference load shapes for each residential end use was used to estimate CLFs based on peaks occurring at 4:00pm in summer and at 6:00pm in winter; however, for individual DNSPs, the peak times can vary by up to 2–3 hours, and it is difficult to determine with the available data whether this variation is a clear trend or is part of the general variability present in peak timing.

If the peak demand of a particular end use occurs at the same time as the network system peak demand, the CLF for that end use will be equal to the end-use load factor. If the end-use peak demand does not coincide with the system peak demand, the end-use demand at the time of system peak demand will necessarily be lower than the end-use peak demand, and the CLF for that end use will be higher than the end-use load factor. The shorthand way for calculating the end-use CLF therefore is to taking the ratio of average end-use demand to end-use demand at the time of system peak.

The calculated CLFs using this method are presented in Tables 31, 32 and 33 and reveal the following:

- As expected heating activities have no impact on demand in the winter peaking areas, and similarly cooling activities have no impact on demand in the summer peaking areas.
- Lighting has negligible impact on demand in most summer peaking areas with a CLF of 200+%, but in winter peaking areas lighting has much higher impact with a CLF of 35%.
- The upward adjustment to the cooling CLF is on average 7% but can be as much as 25%.
- The upward adjustment to the refrigeration CLF is on average 13% but can be as much as 37%.
- The upward adjustment to the CLF for all other appliances ranges from 6% on average to around 40%.

Table 30: Comparison of conservation load factors

End-use	SKM (Based on DMPP analysis in NSW)	Alternative A: Summer (EMET)	Alternative B: Winter (EMET)	Alternative C: SEDA	Alternative D: US case studies	Comments
Residential aircon					3-15%	Most effective on peak demand
Reduction of thermostats	30%					
Residential space conditioning	38%	13%	79%			
Residential energy efficiency including lighting				25%		
Secondary school lighting					29%	
Residential hot water substitution				30%		
Small hotel/motel lighting					39%	
Large commercial - natural gas cooling				40%		
Office lighting					40-44%	
Commercial/Industrial efficiency, including HVAC				40%		
Large retail					44-54%	
large hotel/motel lighting					49%	
Space conditioning - commercial	45%	32%	150%			
Commercial lighting	55%	49%	61%			
Hospital lighting					71%	
Restaurant lighting					78-80%	
Industry exc mining and petroleum	55%	72%	80%			
Solar aircon	63%					
Mining and petroleum industry	65%	72%	80%			
Commercial Refrigeration	80%					
Residential refrigeration	80%	68%	105%		60-86%	
Residential consumer electronics	80%					
Supermarket lighting					89%	
Residential lighting	100%	297%	33%			
Residential water heating	150%	189%	159%			
Residential cooking		152%	21%	25%		
Residential outdoor lighting	500%					Least effective on peak demand

Source: Jacobs' analysis, Langham, E, Dunstan, C, Walgenwitz, G, Denvir, P, Lederwasch, A, and Landler, J 2010, Reduced Infrastructure Costs from Improving Building Energy Efficiency, *report prepared for the Department of Climate Change and Energy Efficiency by the Institute for Sustainable Futures, University of Technology Sydney and Energetics, Sydney.*

Table 31: List of residential CLFs and peaking factors

Residential end use	Basis/ source	Conservation load factor		Peaking factor (MW saved per GWh saved)	
		Summer 4pm peak	Winter 6pm peak	Summer 4pm peak	Winter 6pm peak
Building shell upgrade	Summer cooling + winter heating	48%	50%	0.24	0.23
Residential cooling	RC AC profile	48%	–	0.24	
Residential heating	RC AC profile	–	50%		0.23
Residential lighting	Daylight hours & household occupancy	264%	34%	0.04	0.34
Residential water heating	NZ HEEP study	149%	109%	0.08	0.10
Residential outdoor lighting	Daylight hours & household occupancy	264%	34%	0.04	0.34
Residential refrigeration	Adjusted cooling profile	70%	90%	0.16	0.13
Televisions and set top boxes	Household occupancy	79%	66%	0.14	0.17
Computers and laptops	Household occupancy	79%	66%	0.14	0.17
Other consumer electronics including mobile chargers, printers, etc.	Household occupancy	87%	73%	0.13	0.16
Other miscellaneous appliances including kettles, toasters, hairdryers, shavers, etc.	Household occupancy	83%	69%	0.14	0.17
Residential pools/spas	Household occupancy, Ergon Energy profile	73%	84%	0.16	0.14

Source: Jacobs' analysis

Table 32: Conservation load factor by residential end use and network distribution area

Residential end uses	Essential Energy	Endeavour Energy	AusGrid	ActewAGL
Building shell upgrade	50%	49%	51%	51%
Residential cooling	50%	49%		
Residential heating			51%	51%
Residential lighting	273%	269%	34%	34%
Residential water heating	154%	151%	110%	110%
Residential outdoor lighting	273%	269%	34%	34%
Residential refrigeration	72%	71%	91%	91%
Televisions and set top boxes	82%	80%	67%	67%
Computers and laptops	82%	80%	67%	67%
Other consumer electronics	90%	89%	74%	74%
Other miscellaneous appliances	86%	84%	74%	70%
Residential pools/spas	76%	75%	74%	74%

Source: Jacobs' analysis

Table 33 Commercial sector conservation load factor for each NSW distribution service area

Distribution network service provider	Commercial	Industrial
AusGrid	80%	100%
Essential Energy	76%	100%
Endeavour Energy	75%	100%
ActewAGL	80%	100%

Source: Jacobs' analysis

The AEMO analysis was limited by the absence of large customer data in the totals. This is a significant issue as it implies that it is not possible to determine, with certainty, that the state, DNSP or local peak demand and daily/annual load shape being used is what actually drives network design. Jacobs has opted to use the system or state based CLF rather than the DNSP adjusted CLF since timing of network peaks cannot conclusively be determined to be materially different from that of the system network peak. This is at least the case with areas which peak in summer; however, winter peaking within AusGrid in a state which is predominantly summer peaking may complicate the determination of network system benefits.

Table 34 summarises the timing of peak demand in each distribution network area based on analysis of 2011 DNSP load shape data available from AEMO and the corresponding CLF adjustment factors for both summer and winter. The table shows that system peaks for most distributors are between 1:00pm and 6:30pm in summer, with exceptions occurring for AusGrid, ActewAGL and Aurora Energy, who each peak in winter.

Table 34: NSW DNSPs winter and summer peak times and adjustment factors for summer 4pm peak and winter 6pm peak (peak seasons in bold)

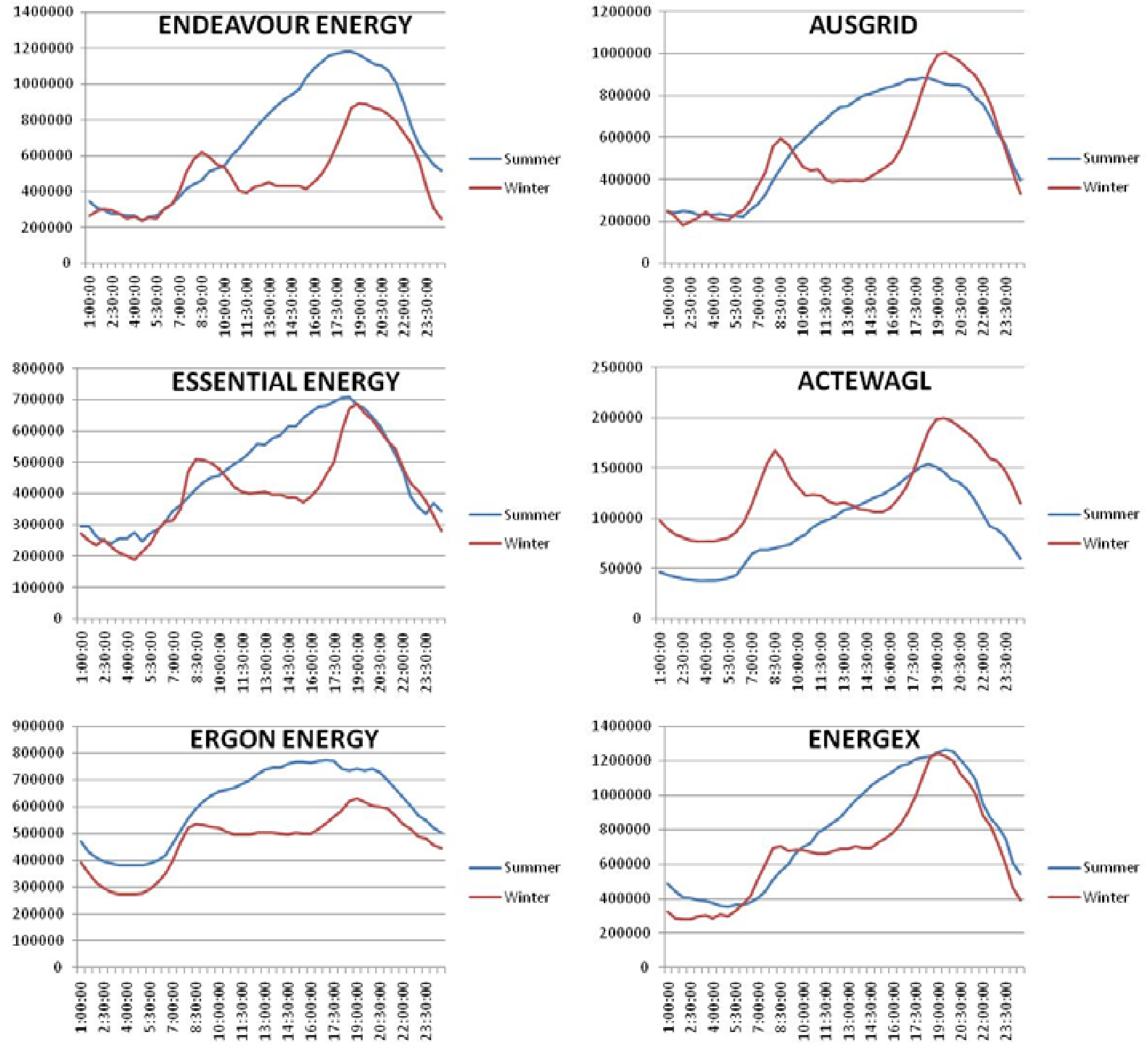
Distribution network service provider	State	Summer peak time	Summer peak day	Summer CLF adjust-ment	Winter peak time	Winter peak day	Winter CLF adjust-ment
AusGrid	NSW	18:30	Saturday	1%	**18:30**	**Tuesday**	**1%**
Essential Energy	NSW	**17:30**	**Tuesday**	**4%**	18:00	Wednesday	0%
Endeavour Energy	NSW	**17:00**	**Tuesday**	**2%**	18:00	Wednesday	0%

Figure 35 provides a summary of the peak timing for the NSW and ACT DNSPs. Load profile data was sourced from AEMO[65] for the year 2011, from the net system load profile[66].This is a noticeable shortcoming of the method used to estimate system peak since data for larger customers is often confidential and not publicly available.

The summer and winter peaks are closely aligned in some distribution networks. For example, reduction of summer peaks in the Essential Energy service area may not result in significant deferrals as the winter peak is almost the same level. That is if an activity addresses air conditioning demand alone then the summer peak may be replaced by a winter peak. This is not expected to be a significant issue.

[65] www.aemo.com.au/Electricity/Data/Metering/Load-Profiles
[66] The net system load profile is based on consumption patterns of interval metered customers, and therefore presumably is typically made up of residential and small commercial customers.

Figure 35: NSW, ACT, and QLD DNSP load profiles



Source: Jacobs' analysis of AEMO data

H.2 Derivation of CLFs

CLFs were developed for the Jacobs (formerly SKM) work undertaken to evaluate a National Energy Saving Initiative. These are presented in Table 35.

Table 35: CLFs by activity and distributor

Program	Market	Activity	Sub activity	Ausgrid LF	Essential Energy LF	Endeavour Energy LF
Residential						
HPSP	Residential	Showerhead	Showerhead	146%	140%	133%
HPSP	Residential	Non showerhead	Lighting	248%	211%	174%

Program	Market	Activity	Sub activity	Ausgrid LF	Essential Energy LF	Endeavour Energy LF
HPSP	Residential	Non showerhead	Door snakes, draught-proof strips	4%	12%	20%
HPSP	Residential	Non showerhead	Standby saver power board	50%	50%	50%
RRP	Residential	Hot water gas	Hot water gas	146%	140%	133%
RRP	Residential	Hot water heat pump	Hot water heat pump	146%	140%	133%
RRP	Residential	Hot water solar – electric boosted	Hot water solar – electric boosted	146%	140%	133%
RRP	Residential	Hot water solar – gas boosted	Hot water solar – gas boosted	146%	140%	133%
RRP	Residential	Hot water not specified	Hot water not specified	146%	140%	133%
RRP	Residential	Insulation	Insulation	48%	48%	49%
BASIX	Residential	Hot water system		146%	140%	133%
BASIX	Residential	Ventilation		45%	37%	29%
BASIX	Residential	Space cooling systems – equipment		45%	37%	29%
BASIX	Residential	Space heating systems – equipment		4%	12%	20%
BASIX	Residential	Space cooling systems – home design		45%	37%	29%
BASIX	Residential	Space heating systems – home design		4%	12%	20%
BASIX	Residential	Lighting		248%	211%	174%
BASIX	Residential	Pool & spa		74%	76%	77%
BASIX	Residential	Alternative energy source		50%	50%	50%
BASIX	Residential	Cooking		50%	50%	50%
BASIX	Residential	Appliances		50%	50%	50%
BASIX	Residential	Others (other dwelling internal uses & dwelling characteristics such as computers)		50%	50%	50%
ESS	Residential	HVAC/chiller	HVAC/chiller	48%	48%	49%
ESS	Residential	Lighting (DSF)	Lighting (DSF)	248%	211%	174%
ESS	Residential	Refrigerator & freezer removal	Refrigerator & freezer removal	71%	75%	78%
ESS	Residential	Showerheads	Showerheads	146%	140%	133%
ESS	Residential	Whitegoods	Whitegoods	50%	50%	50%

Program	Market	Activity	Sub activity	Ausgrid LF	Essential Energy LF	Endeavour Energy LF
Business						
ES	Large commercial & industrial	Lighting	Lighting	90%	90%	90%
ES	Large commercial & industrial	HVAC	HVAC	90%	90%	90%
ES	Large commercial & industrial	Refrigeration	Refrigeration	50%	50%	50%
ES	Large commercial & industrial	Air compressor	Air compressor	90%	90%	90%
ES	Large commercial & industrial	Timers & sensors	Timers & sensors	90%	90%	90%
ES	Large commercial & industrial	Chiller	Chiller	90%	90%	90%
ES	Large commercial & industrial	Variable speed drives	Variable speed drives	90%	90%	90%
ES	Large commercial & industrial	Industrial equipment	Industrial equipment	90%	90%	90%
ES	Large commercial & industrial	Insulation	Insulation	90%	90%	90%
ES	Large commercial & industrial	Building management systems	Building management systems	90%	90%	90%
ES	Large commercial & industrial	Cogeneration	Cogeneration	90%	90%	90%
ES	Large commercial & industrial	Maintenance	Maintenance	90%	90%	90%
ES	Large commercial & industrial	Hot water system	Hot water system	90%	90%	90%
ES	Large commercial & industrial	Heat exchanger	Heat exchanger	90%	90%	90%

Program	Market	Activity	Sub activity	Ausgrid LF	Essential Energy LF	Endeavour Energy LF
ES	Large commercial & industrial	Fans	Fans	90%	90%	90%
ES	Large commercial & industrial	Other	Other	90%	90%	90%
ES	Large commercial & industrial	Computers & printers	Computers & printers	90%	90%	90%
ES	Large commercial & industrial	Generation	Generation	90%	90%	90%
ES	Large commercial & industrial	Boiler	Boiler	90%	90%	90%
ES	Large commercial & industrial	Pumps	Pumps	70%	70%	70%
ES	Large commercial & industrial	PV	PV	90%	90%	90%
ES	Large commercial & industrial	Laundry/ washing machines & dryers	Laundry/ washing machines & dryers	90%	90%	90%
ES	Large commercial & industrial	Voltage reduction	Voltage reduction	90%	90%	90%
ES	Large commercial & industrial	LPG	LPG	90%	90%	90%
ES	Large commercial & industrial	Natural gas	Natural gas	90%	90%	90%
ES	SME	Lighting	Lighting	50%	50%	50%
ES	SME	HVAC	HVAC	38%	38%	38%
ES	SME	Refrigeration	Refrigeration	82%	82%	82%
ES	SME	Air compressor	Air compressor	72%	72%	72%
ES	SME	Timers & sensors	Timers & sensors	55%	55%	55%
ES	SME	Chiller	Chiller	38%	38%	38%
ES	SME	Variable speed drives	Variable speed drives	38%	38%	38%
ES	SME	Industrial equipment	Industrial equipment	55%	55%	55%
ES	SME	Insulation	Insulation	43%	43%	43%

Program	Market	Activity	Sub activity	Ausgrid LF	Essential Energy LF	Endeavour Energy LF
ES	SME	Building management systems	Building management systems	55%	55%	55%
ES	SME	Cogeneration	Cogeneration	55%	55%	55%
ES	SME	Maintenance	Maintenance	55%	55%	55%
ES	SME	Hot water system	Hot water system	72%	72%	72%
ES	SME	Heat exchanger	Heat exchanger	55%	55%	55%
ES	SME	Fans	Fans	72%	72%	72%
ES	SME	Other	Other	55%	55%	55%
ES	SME	Computers & printers	Computers & printers	55%	55%	55%
ES	SME	Generation	Generation	55%	55%	55%
ES	SME	Boiler	Boiler	72%	72%	72%
ES	SME	Pumps	Pumps	72%	72%	72%
ES	SME	PV	PV	55%	55%	55%
ES	SME	Laundry/ washing machines & dryers	Laundry/ washing machines & dryers	55%	55%	55%
ES	SME	Voltage reduction	Voltage reduction	55%	55%	55%
ES	SME	LPG	LPG	55%	55%	55%
ES	SME	Natural gas	Natural gas	55%	55%	55%
ESAP	Large commercial & industrial	Lighting	Lighting	90%	90%	90%
ESAP	Large commercial & industrial	Industrial equipment	Industrial equipment	90%	90%	90%
ESAP	Large commercial & industrial	HVAC	HVAC	90%	90%	90%
ESAP	Large commercial & industrial	Other	Other	90%	90%	90%
ESAP	Large commercial & industrial	Air compressor	Air compressor	90%	90%	90%
ESAP	Large commercial & industrial	Power factor correction	Power factor correction	90%	90%	90%
ESAP	Large commercial & industrial	Hot water system	Hot water system	90%	90%	90%

Program	Market	Activity	Sub activity	Ausgrid LF	Essential Energy LF	Endeavour Energy LF
ESAP	Large commercial & industrial	Boiler	Boiler	90%	90%	90%
ESAP	Large commercial & industrial	Building management systems	Building management systems	90%	90%	90%
ESAP	Large commercial & industrial	Sub-metering	Sub-metering	90%	90%	90%
ESAP	Large commercial & industrial	Pool covers/heating	Pool covers/heating	90%	90%	90%
ESAP	Large commercial & industrial	Chiller	Chiller	90%	90%	90%
ESAP	Large commercial & industrial	Behaviour/education	Behaviour/education	90%	90%	90%
ESAP	Large commercial & industrial	Maintenance	Maintenance	90%	90%	90%
ESAP	Large commercial & industrial	Ventilation	Ventilation	90%	90%	90%
ESAP	Large commercial & industrial	Refrigeration	Refrigeration	50%	50%	50%
ESAP	Large commercial & industrial	Insulation	Insulation	90%	90%	90%
ESAP	Large commercial & industrial	Waste heat recovery	Waste heat recovery	90%	90%	90%
ESAP	Large commercial & industrial	Cogeneration	Cogeneration	90%	90%	90%
ESAP	Large commercial & industrial	Tariffs	Tariffs	90%	90%	90%
ESAP	Large commercial & industrial	Monitoring	Monitoring	90%	90%	90%

Program	Market	Activity	Sub activity	Ausgrid LF	Essential Energy LF	Endeavour Energy LF
ESAP	Large commercial & industrial	Computers & printers	Computers & printers	90%	90%	90%
ESAP	Large commercial & industrial	Alternative power generation	Alternative power generation	90%	90%	90%
EESB	SME	Air curtain	Air curtain	55%	55%	55%
EESB	SME	Boiler	Boiler	72%	72%	72%
EESB	SME	Compressor	Compressor	72%	72%	72%
EESB	SME	Hot water	Hot water	72%	72%	72%
EESB	SME	HVAC	HVAC	38%	38%	38%
EESB	SME	Insulation	Insulation	43%	43%	43%
EESB	SME	Kitchen	Kitchen	55%	55%	55%
EESB	SME	Lighting	Lighting	50%	50%	50%
EESB	SME	Motor	Motor	55%	55%	55%
EESB	SME	Natural lighting	Natural lighting	55%	55%	55%
EESB	SME	Other	Other	55%	55%	55%
EESB	SME	Refrigeration	Refrigeration	82%	82%	82%
EESB	SME	Ventilation	Ventilation	38%	38%	38%
EESB	SME	Voltage reduction units	Voltage reduction units	55%	55%	55%
EESB	SME	Window tinting	Window tinting	43%	43%	43%
EESB	SME	Gas	Gas	55%	55%	55%
ESS	Commercial	Building upgrade	Building upgrade	43%	43%	43%
ESS	Commercial	Fans/pumps	Fans/pumps	72%	72%	72%
ESS	Commercial	HVAC/chiller	HVAC/chiller	38%	38%	38%
ESS	Commercial	Lighting (CLF)	Lighting (CLF)	50%	50%	50%
ESS	Commercial	Lighting (DSF)	Lighting (DSF)	50%	50%	50%
ESS	Commercial	Lighting (PIAM)	Lighting (PIAM)	50%	50%	50%
ESS	Commercial	Multiple activities	Multiple activities	55%	55%	55%
ESS	Commercial	Power factor correction	Power factor correction	55%	55%	55%
ESS	Commercial	Process change/control systems	Process change/control systems	55%	55%	55%
ESS	Commercial	Refrigeration	Refrigeration	82%	82%	82%
ESS	Commercial	Showerheads	Showerheads	72%	72%	72%
ESS	Industrial	Compressed air	Compressed air	90%	90%	90%
ESS	Industrial	Fans/pumps	Fans/pumps	70%	70%	70%
ESS	Industrial	High efficiency motors	High efficiency motors	90%	90%	90%

Program	Market	Activity	Sub activity	Ausgrid LF	Essential Energy LF	Endeavour Energy LF
ESS	Industrial	HVAC/chiller	HVAC/chiller	90%	90%	90%
ESS	Industrial	Lighting (CLF)	Lighting (CLF)	90%	90%	90%
ESS	Industrial	Lighting (PIAM)	Lighting (PIAM)	90%	90%	90%
ESS	Industrial	Multiple activities	Multiple activities	90%	90%	90%
ESS	Industrial	Power factor correction	Power factor correction	90%	90%	90%
ESS	Industrial	Power systems	Power systems	90%	90%	90%
ESS	Industrial	Process change/control systems	Process change/control systems	90%	90%	90%
ESS	Industrial	Refrigeration	Refrigeration	50%	50%	50%
Government						
GBRP	Government	Lighting	Lighting	50%	50%	50%
GBRP	Government	Hot water	Hot water	72%	72%	72%
GBRP	Government	HVAC	HVAC	38%	38%	38%
GBRP	Government	Other	Other	55%	55%	55%
TLF	Government	Lighting	Lighting	50%	50%	50%
TLF	Government	Hot water	Hot water	72%	72%	72%
TLF	Government	HVAC	HVAC	38%	38%	38%
TLF	Government	Other	Other	55%	55%	55%

Appendix I. Gas market modelling

The supply of gas for electricity generation is often contracted with a take-or-pay type of arrangement where a gas customer (e.g. power station) pays for a volume of gas whether or not the customer consumes it. That is, it becomes a sunk cost and when a generator is faced with an oversupply, it will choose to generate electricity in order to recover costs by selling it to the pool market. If this were to happen during a low price period, it has the potential to further lower energy pool prices. More often, generators would reduce oversupply by scheduling extra generation during high price periods to obtain optimal benefit.

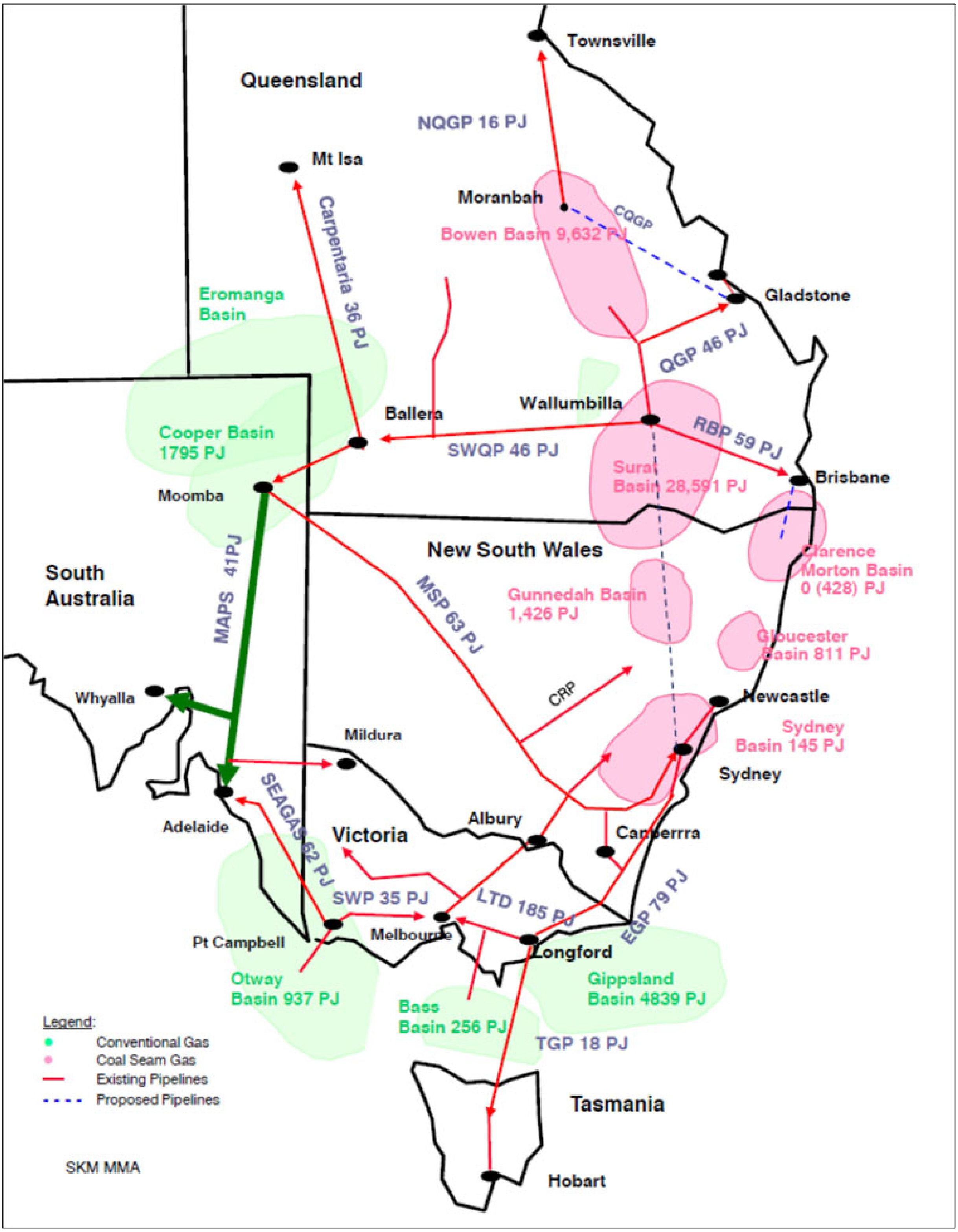
Two approaches are common for generating electricity from gas plants. Regardless of the source of the fuel, gas is used either as a peaking plant or in an intermediate capacity. Due to its fast start capability gas fired generation can be called upon at short notice to meet periods of high demand or a sudden spike in demand. Open cycle gas turbine units are used for peaking capacity and run typically around 5% of the time or less, each year. To recover their capital costs, these plants bid at very high prices. During high demand, one of the peaking units would become the marginal unit and therefore set the pool price. Since their bidding does not reflect their short run marginal costs, increases in the cost of gas supply do not have a significant impact on electricity prices. Pool prices during these periods are already high.

In the intermediate mode, combined cycle gas turbine units supplement base load capacity based on their bidding strategy, which in part will reflect their short-term costs such as fuel. Therefore, changes to the fuel costs will impact their bidding strategy and if they become the marginal plant, then the electricity prices would be directly impacted. Increasing gas prices has the potential to change the generation mix from existing power generators. Should the change be significant, it would change the merit order of plants and therefore impact on government policy options such as the carbon pricing mechanism. It is expected that under CPM, combined cycle plants would increasingly take the role of base load generation as coal options become expensive. High gas prices can prevent this merit order change, making the CPM policy ineffective.

In the long term, gas prices can also play a role in determining the number and type of new entrants. Determining the composition of renewable, combined cycle gas turbine and open cycle gas turbine new entrants is a complex process and the final mix and timing of technology has direct impact on electricity prices.

Jacobs prepares gas price forecasts based on projected demand–supply balance in Eastern Australia. The gas resources and delivery infrastructure in this region are illustrated in Figure 36. This chapter presents in detail Jacobs's gas price forecasts, along with the assumptions underlying them.

Figure 36: Gas basins and pipeline infrastructure, Eastern Australia

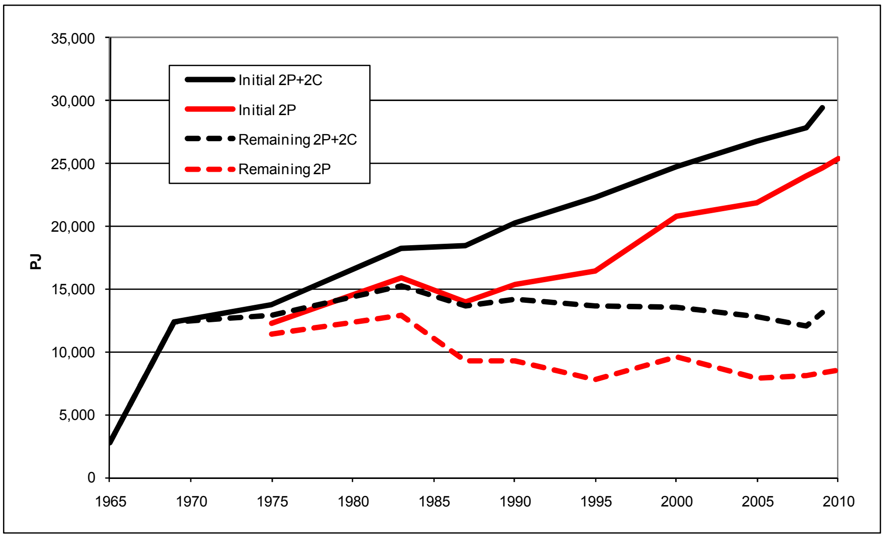


Source: Jacobs' analysis

I.1 Outlook for reserves and demand for gas

The Eastern Australian gas market has grown steadily since the late 1960s, supported by conventional gas reserves that have remained relatively static since approximately 1980 (refer to Figure 37). The past decade however has witnessed rapid growth of coal seam gas reserves (CSG), mainly in Queensland, to the extent that by 2008 it was clear that reserves could rapidly exceed domestic demand provided that an additional market could be found, otherwise the development may have stalled.

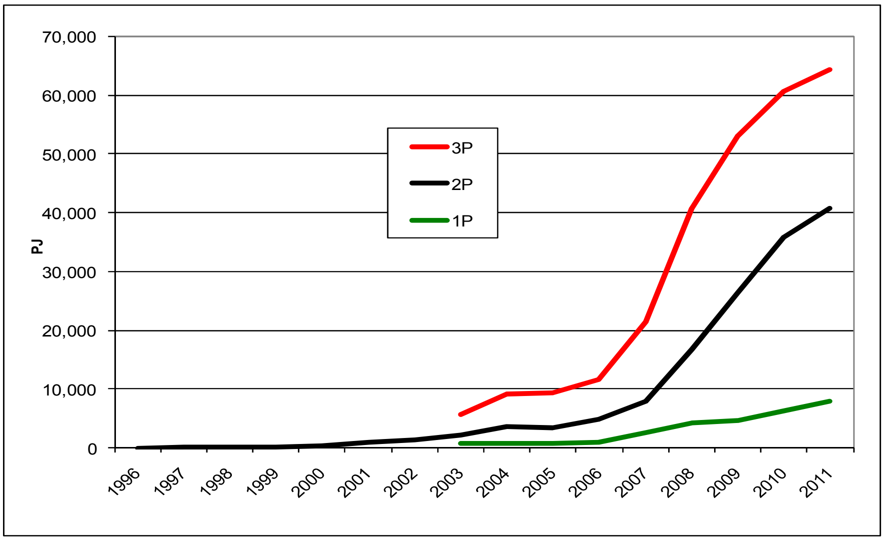
Figure 37: Aggregate conventional gas resources and reserves, Eastern Australia (PJ)



Source: Jacobs' analysis

Note: 2P = proven and probable; 2C = proven and probable but contingent on price obtained.

Figure 38: Aggregate CSG reserves, Eastern Australia (PJ)



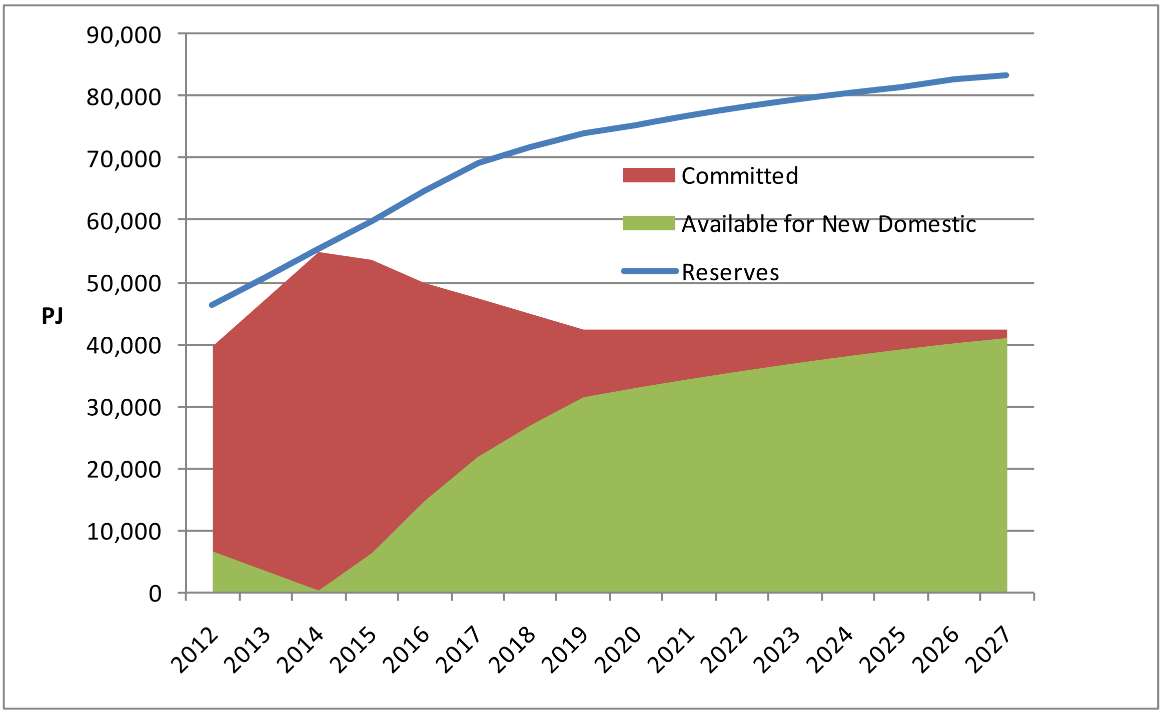
Source: Jacobs' analysis

Notes: 1P = proven; 2P = proven and probable; 3P = proven, probable and possible.

Worldwide, the preferred technology for utilising excess gas[67] is LNG production. LNG is an internationally traded commodity that saw rapid growth and high prices during the oil price surge from 2003 to 2008. Since 2007 10 proposals have been put forward to export LNG from liquefaction plants with eight proposed for the Queensland coast and one each in NSW and South Australia. Three of the large projects at Curtis Island, near Gladstone, have now passed the final investment decision and their six LNG trains, each capable of delivering about four million tonnes of LNG per year, are under construction, with first deliveries scheduled in the period 2014 to 2016.

APLNG and QCLNG have proved up sufficient reserves to meet their export requirement of two trains each. The focus for these project proponents has moved from reserve development to construction of production capacity; however, GLNG still requires reserves to meet its second train requirement despite the fact that it has purchased some third-party contracts originally intended for the domestic market. This has sustained the relative lack of reserves available to support new domestic gas contracts. Figure 39, illustrates reserves availability to meet new domestic contracts after meeting LNG commitments. This includes a safety margin which is assumed to reduce after the LNG plants start up. The shortage of reserve available for the domestic market is apparent in the near term, especially the period to 2014.

Figure 39: Reserves availability for new domestic contracts



Source: Jacobs' analysis

I.2 Methodology

To assess the future balance of gas demand and supply across Eastern Australia Jacobs has:

1) updated the 2011 GSOO medium scenario assumptions to that comparable to the 'planning' scenario used by AEMO in the 2012 GSOO. For this scenario Jacobs prepared:

    a) projections of future gas demand for the domestic sector, comprised of two sub-sectors:

[67] Excess gas is gas that cannot reach a market by pipeline. LNG is preferred to conversion technologies such as Gas-To-Liquids.

i) utility (residential and small medium business) and large industrial customers (taken from 2012 GSOO)

ii) gas for power generation including large cogeneration projects (taken from the Strategist output of the 2011 GSOO medium scenario for gas consumed by gas fired generation and adjusted to reflect contractual take-or-pay level)

b) projections of the level of LNG exports from Eastern Australia, linked to global demand and supply conditions (consistent with 2012 GSOO)

c) estimates of the timing of gas reserve commitments to long-term contracts to meet the above demand, taking into account existing reserves commitments to domestic contracts

2) reviewed gas reserves and determined potential reserves development profiles based on recent growth rates, currently known contingent and prospective resources (this has been revised down)

3) tested the ability of reserves growth to physically meet the timing requirements of new domestic and export contracts, taking into account the multi-train targets of LNG projects

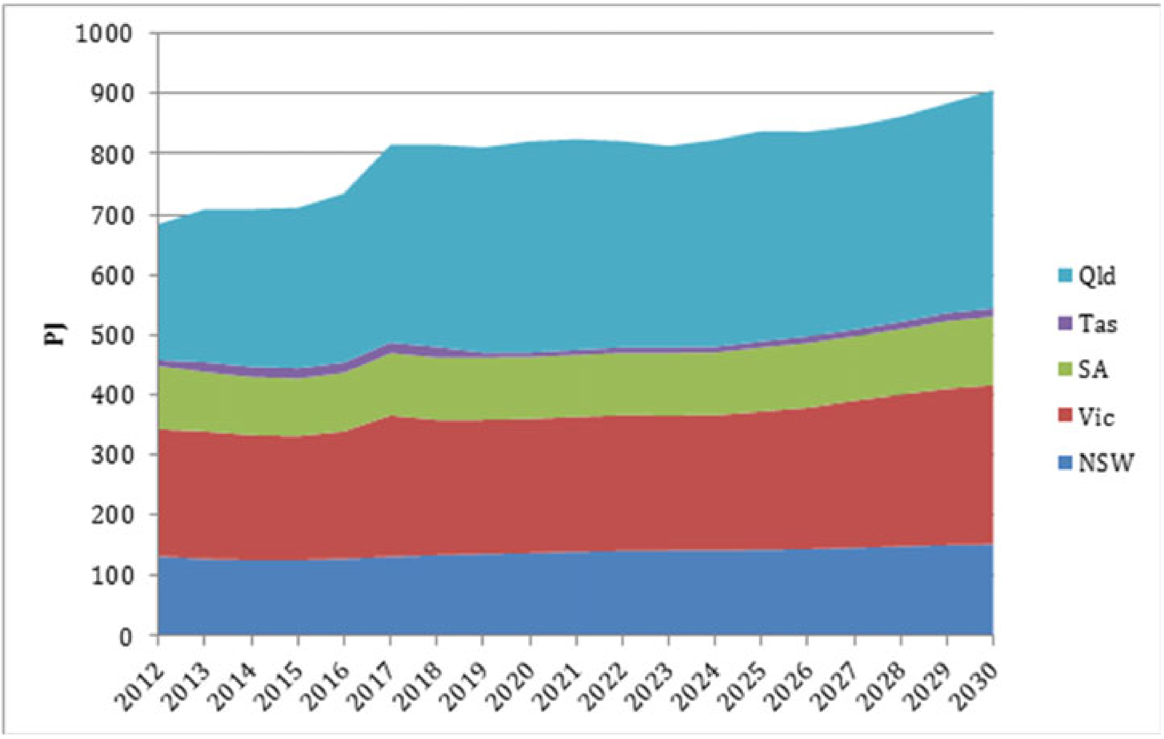
4) reviewed other aspects of gas supply including likely future production and transmission costs

5) modelled the economic balance of demand–supply and consequent price outcomes.

I.3 Physical demand–supply balance

Figure 40 illustrates the domestic demand projections.

Figure 40: Eastern Australian gas demand projections (PJ)

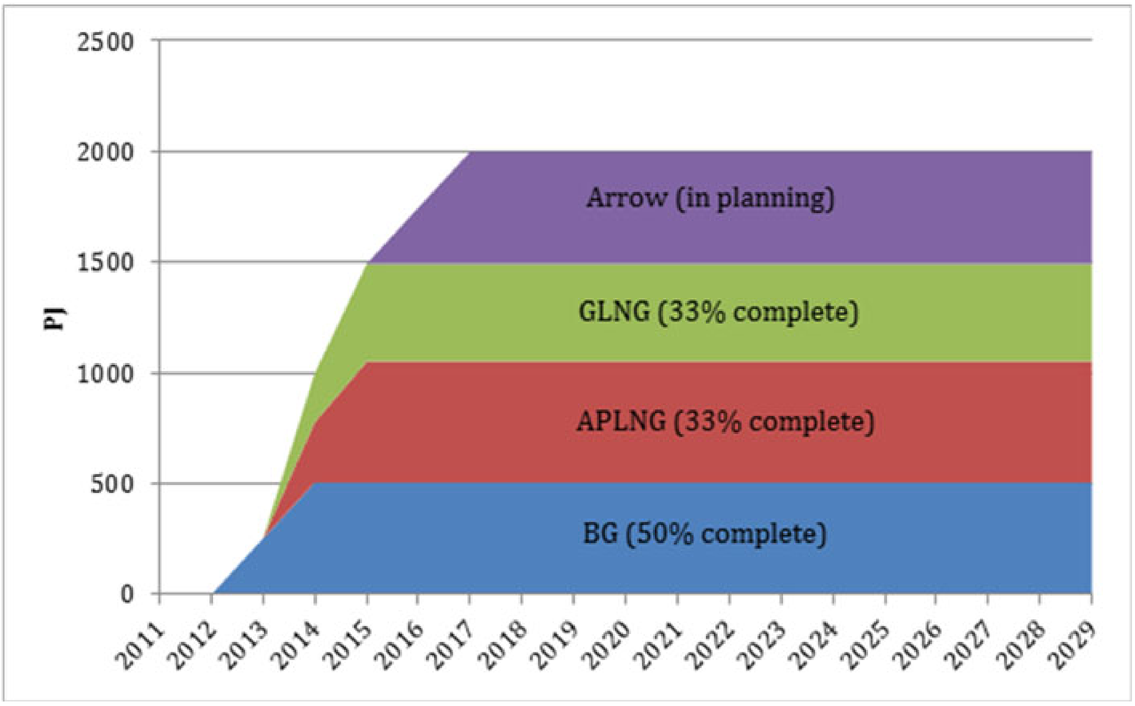


Source: Jacobs' analysis

Domestic gas demand growth is projected to be quite subdued over the next two decades. There are several causes of this: a) the general downturn in electricity demand reduces the need for additional generation capacity other than renewable capacity mandated by the RET; b) the expected increase in gas prices over the next 3–5 years due to the start up of LNG exports in Queensland makes gas generation less competitive; and c) the future of carbon pricing, which was expected to reduce coal usage, is uncertain.

Figure 41 illustrates the LNG export demand projections. This is consistent with the projections under the 'planning' scenario in 2012 GSOO prepared by AEMO.

Figure 41: LNG export demand projections (PJ)

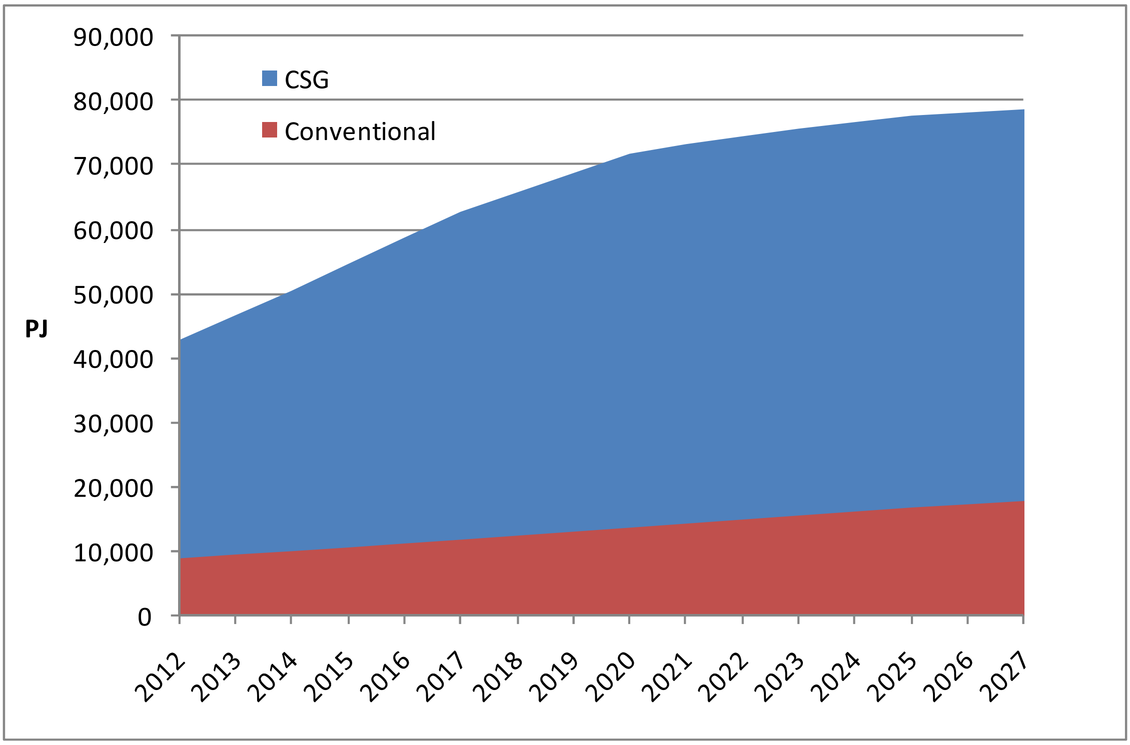


Source: Jacobs' analysis

There has been a downward revision in LNG export demand compared to the 2011 GSOO medium scenario. This is mainly due to the rising cost pressures in extracting and liquefying gas coupled with increasing competition from other LNG export projects such as those located in USA, Iran, Russia, Canada, Qatar, Papua New Guinea, Western Australia and Northern Territory.

On the supply side, there has also been a downward revision of the future growth in uncontracted 2P reserves. This is mainly driven by the requirement to prove up reserves for additional LNG export projects. The aggregate uncontracted gross (prior to production) 2P reserves growth is illustrated in Figure 42.

Figure 42: 2P uncontracted gross reserve projections (PJ)



Source: Jacobs' analysis

I.4 Economic demand–supply balance and price projections

The economic gas demand–supply balance has been determined in each scenario using Jacobs' proprietary model, MMAGas, Market Model Australia – Gas, which replicates the essential features of Australian wholesale gas markets:

- a limited number of gas producers
- dominance of long-term contracting and limited short-term trading
- a developing network of regulated and competitive transmission pipelines
- domestic market growth driven by gas-fired generation and large industrial projects.

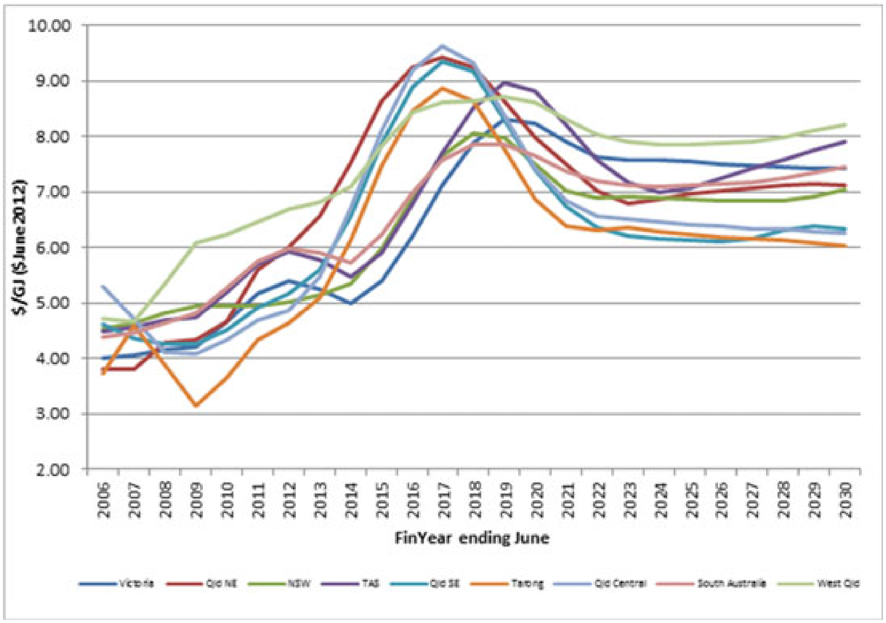
Gas price projections at the Queensland (Wallumbilla) and South Australia (Adelaide) pricing points plus eastern states aggregate are presented in Figure 43 and Figure 44. All prices are for gas delivered to zonal hubs (i.e. include transmission costs) and are expressed in real 2012 terms. Two prices are presented for each point:

- the estimated price of new 15-year gas contracts starting in a particular year
- the estimated average price over all gas contracts delivering gas in any year.

At all points new contract prices are expected to rise sharply to 2017, to levels between $2/GJ to $3/GJ higher; however after 2017 the prices fall as more reserves are available for domestic supply.

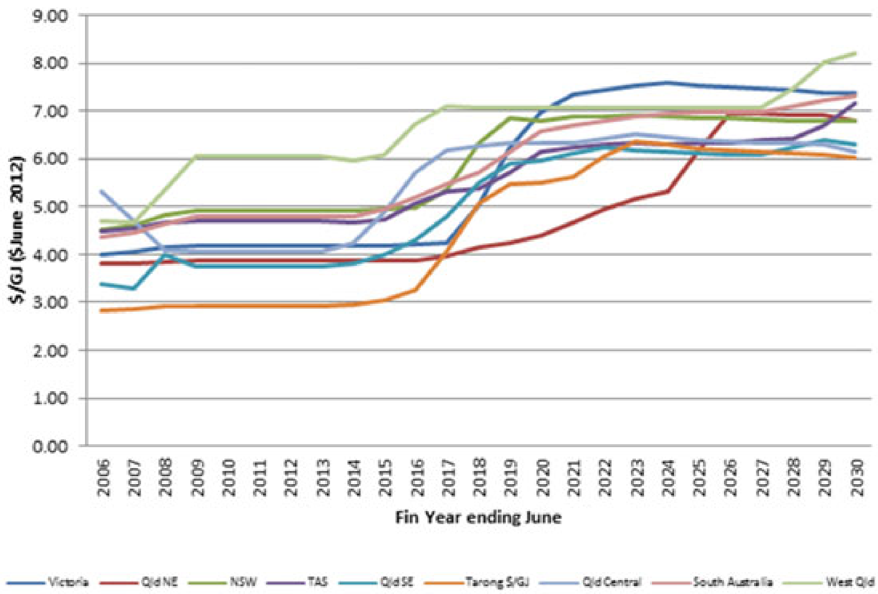
Average contract prices reflect the progressive addition of new contracts to the aggregate contract portfolio, at higher prices.

Figure 43: Projected new contract gas prices for the eastern states, June 2012



Source: Jacobs' analysis

Figure 44: Projected average contract gas prices for the eastern states, June 2012



Source: Jacobs' analysis

List of shortened forms

ABARE	Australian Bureau of Agricultural and Resource Economics (former)
ACP	accredited service provider
AEMC	Australian Energy Market Commission
AEMO	Australian Energy Market Operator
AER	Australian Energy Regulator
BASIX	NSW Building Sustainability Index
BCA	Building Code of Australia
BREE	Bureau of Resources and Energy Economics
CBA	cost benefit analysis
CCGT	combined cycle gas turbine (power plant)
CLF	commercial lighting formula (energy savings)
CLF	conservation load factor (energy consumption)
CPM	carbon pricing mechanism
CSG	coal seam gas
DCCEE	NSW Department of Climate Change and Energy Efficiency (former)
DMPP	NSW Demand Management and Planning Project
DNSP	distribution/distributed network service provider
DSF	default savings factor (energy savings)
DSM	demand side management
EEAP	NSW Energy Efficiency Action Plan
EESBP	Energy Efficiency for Small Business Program
EMET	EMET Consultants Pty Limited
ESC	energy saving certificate
ESP	Energy Saver Program
ESAP	Energy Savings Action Plans
ESOO	Electricity Statement of Opportunities (AEMO)
ESS	Energy Savings Scheme
EY	Ernst and Young
GBRP	Government Building Retrofit Program
GSOO	Gas Statement of Opportunities (AEMO)
GW, GWh	gigawatt, gigawatt hour
HPSP	Home Power Savings Program
HSRP	Home Saver Rebates Program
HVAC	heating/ventilation and air conditioning
IDGCC	integrated drying gasification combined cycle

IEA	International Energy Agency
IPART	NSW Independent Pricing and Regulatory Tribunal
LNG	liquefied natural gas
LRMC	long run marginal cost
MPC	market price cap
MRET	mandatory renewable energy target
MW, MWh	megawatt, megawatt hour
NEEM	National Energy Efficiency Model
NEM	National Electricity Market
NESI	National Energy Savings Initiative
NEFR	National Electricity Forecasting Report
NGSP	NSW Government Sustainability Policy
NPV	net present value
NSP	network service provider
OEH	NSW Office of Environment and Heritage
PDF	peak demand factor
PIAM	project impact assessment method (energy savings)
PJ	petajoule (10^{15} joules)
PM	particulate matter
PV	photovoltaic
RESA	Recognised Energy Saving Activity
RET	Renewable Energy Target
SME	small to medium enterprise
SRES	Small-scale Renewable Energy Scheme
TLF	Treasury Loan Fund
UCB	uniform capacity benefit
VRET	Victorian Renewable Energy Target
WACC	weighted average cost of capital