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Economic Appraisal of Wood Smoke Control Measures

Final Report

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Prepared for

Office of Environment and Heritage

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Executive Summary

This report, commissioned by the NSW Office of Environment and Heritage, examines suitable approaches to reduce particle ($PM_{2.5}$ and PM_{10}) and volatile organic compound (VOC) emissions associated with the operation of domestic wood heaters, and provides an assessment of their costs and benefits. The report also develops several potential combined approaches to controlling wood smoke to a series of case study areas.

Wood smoke is a source of air pollution in urban and semi rural settings in NSW (DECCW, 2010). While a small percentage of homes use wood heating in Sydney, smoke from wood heaters account for 48 per cent of fine (PM_{10}) and 60 per cent of very fine ($PM_{2.5}$) winter particle pollution. In colder climates, such as in Armidale, wood heaters can contribute over 85 per cent of winter particulate pollution (DECCW, 2010).

There are a range of factors that influence the choice of heating system in NSW and promote the use of wood heaters. These factors include but are not limited to:

- heating costs
- climatic factors
- availability of gas reticulation networks.

A number of assessments have been undertaken on the potential health costs associated with a range of chemicals and particulate matter in wood smoke (DITRDLG, 2010; Beer, 2002; Coffey, 2003; BDA, 2006, US EPA 2010). The range of estimates for the health costs associated with VOC and, PM_{10} were reviewed from the literature and the most relevant health cost per tonne of each substance (expressed in 2010 dollars) were included in a cost benefit analysis of the wood smoke control options.

A preliminary assessment revealed a range of potential wood smoke control options. These options were:

- ban on heater sales
- efficiency standards and emissions limits
- phase out at time of sale of house
- fuel moisture content regulation
- tax on new wood heaters
- licensing fees
- tax on wood fuel
- cash incentive phase out.

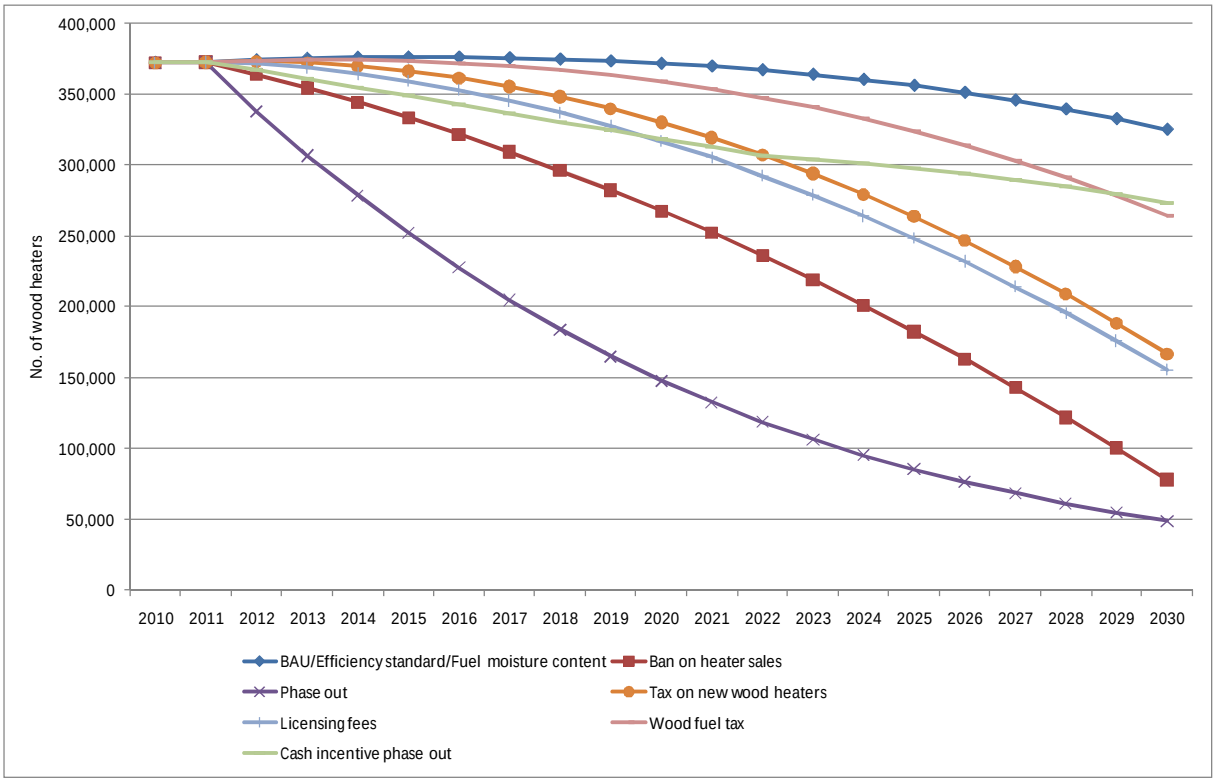
A model was developed for preparing wood heater stock forecasts and emission projections. The model took into account the stock and mix of wood heaters (slow combustion heater, open fireplace and potbelly stove) and their emission rates.

A visual comparison of these projections is shown in Figure 1. The wood heater stock under business as usual shows a small decline out to 2030. The projections of wood heater stocks for the efficiency standard/emissions limit and fuel moisture content options do not deviate from the BAU projection[1].

The most significant reduction in stock is a result of the phase out option with similar reductions in stock by 2030 under the ban on new wood heater sales. The remaining options, tax on new wood heaters, licensing fees, wood fuel tax and cash incentive phase out, have lower impacts on the projected stock of wood heaters.

[1] A comparison of the BAU and ABARE projections on domestic biomass fuel use was made. ABARE projections show a levelling off of fuel consumption to 2030 while BAU projections forecast a slight reduction in heater ownership and emission. Detail of ABARE forecasting method and assumptions were not available to allow more rigorous comparison.

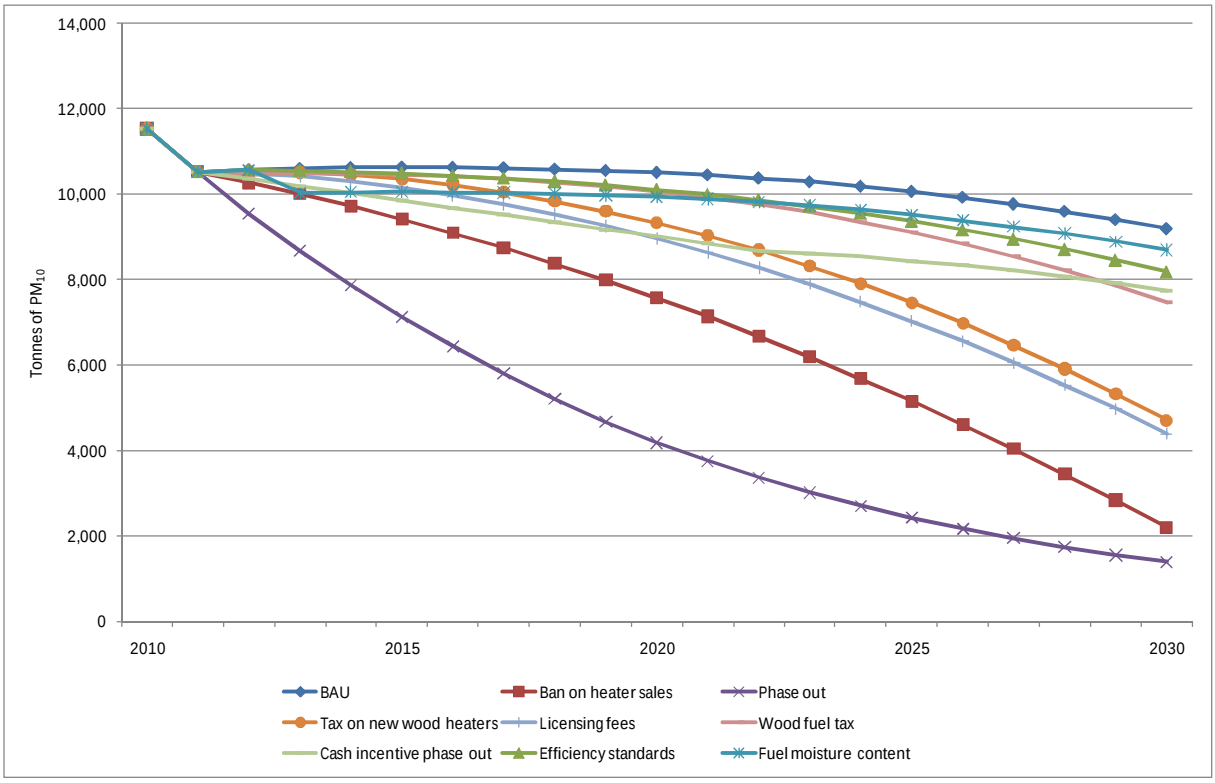
Figure 1 Stock projections for different options



Source: AECOM stock model

Reductions in the stock of wood heaters provide an indication of the effectiveness of each option to reduce wood smoke emissions however it is not a final measure since Options 3 (efficiency standard/emissions limit) and 5 (fuel moisture content regulation) also reduce the emission rate per heater. An assessment of the PM_{10} emissions associated with each option is provided in Figure 2.

Figure 2 PM_{10} emissions projects for each option



Source: AECOM stock model

VOC emissions were not projected separately but assumed to change according to PM_{10} emissions. Option 2 (state-wide ban) and option 4 (phase out) provide the most rapid overall reductions in PM_{10} while option 6 (tax on new wood heaters) and option 7 (licensing fee) are the next most successful at reducing emissions. Option 6 (wood fuel tax), option 9 (cash incentive) and option 3 (efficiency measures) provide modest reductions in emissions to BAU. Option 5 (fuel moisture content regulation) provides relatively little emissions reduction compared to BAU.

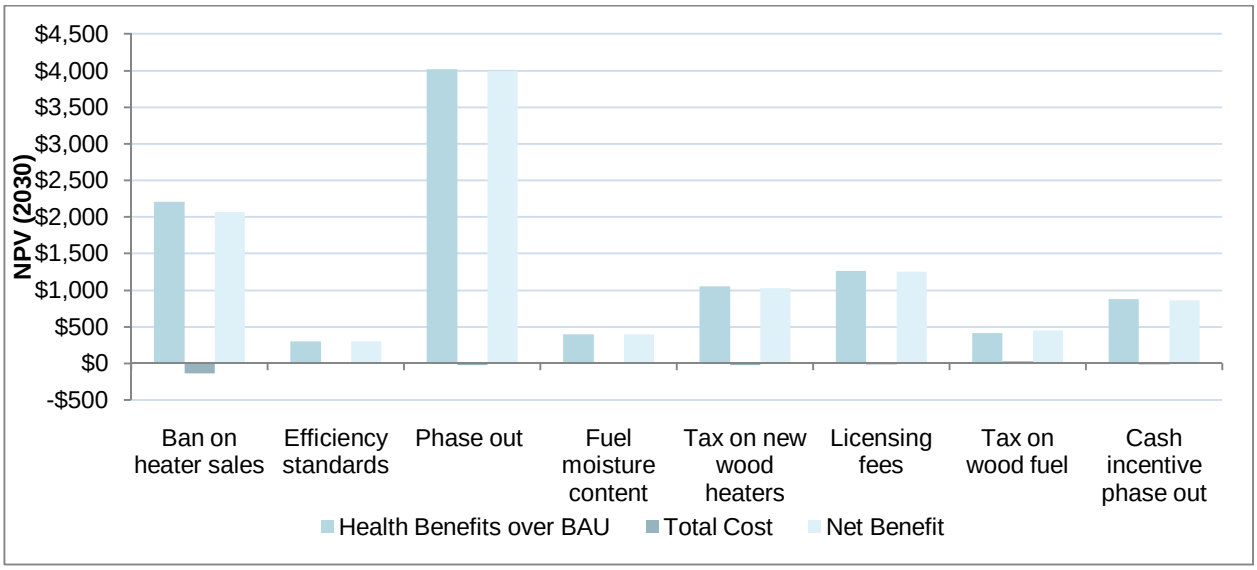
To calculate the net benefit of each option the cost benefit analysis considered:

- administration costs
- costs to consumers
- costs to industry
- health benefits.

The option with the highest net benefit is the phase out of wood heaters with over $7.1 billion out to 2030. The ban on heater sales has the second highest net benefit however this option has the highest non-health costs which are particularly high for industry.

The market based mechanisms have similar net benefits while the lowest net benefit is from the fuel moisture content regulation. The results of the cost benefit analysis are presented in Figure 3.

Figure 3 Cost benefit analysis results



The figure shows that the total non-health costs are small compared to the health benefits over BAU. This is also represented by the small difference between health benefit over BAU and net benefit. The results of the cost benefit analysis suggest that all of the primary options generate a net benefit based on the avoided health costs. There is strong justification for pursuing wood smoke control options.

Following consultation with OEH, a series of combined options were developed and shown in Table 1.

Table 1 Combined control options matrix

Option	Core Control Option	Combined Options				
		10	11	12	13	14
1	Baseline					
2	Ban	✓ (CSA)				
3	Efficiency Standards and Emissions Limits - 1		✓ (CSA)			
4	Phase Out at Sale of House or within seven years	✓ (CSA)	✓ (CSA)		✓ (CSA)	
5	Fuel moisture content regulations					✓
6	Fee on New Wood Heaters		✓ (CSA)	✓ (CSA)		
7	Licensing Fee				✓ (CSA)	
8	Excise on Fuel					✓
9	Cash Incentives	✓ (CSA)	✓ (CSA)	✓ (CSA)	✓ (CSA)	

CSA – denotes application of the option to case study areas.

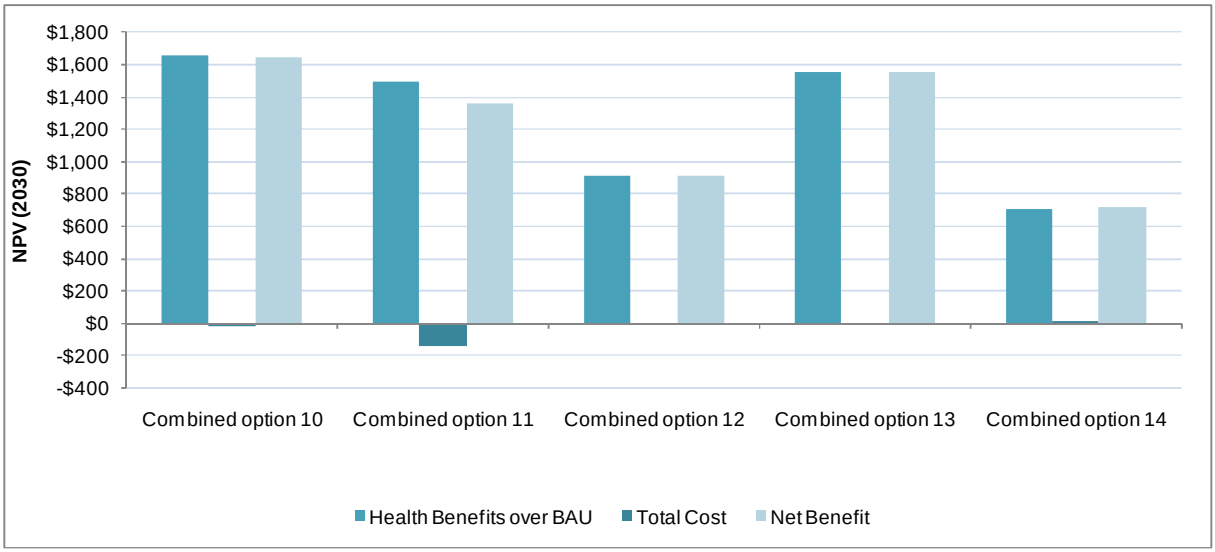
These combined options were then applied to all six case study areas that were identified based on the range of factors shown in Table 2.

Table 2 Case Study Areas

Case study area	Ownership ratio	Number of heaters	Number of dwellings	Population density (persons per sq/km)	New release area	Climate	Gas availability	% of owners in low income groups
Balmain to Strathfield	4%	4,877	124,621	4,468	No	Mild	Yes	Low
Liverpool	7%	5,408	80,438	854	Yes	Mild	Yes	High
Blacktown to Penrith	7%	10,999	158,134	216	No	Mild	Yes	Medium
Blue Mountains	28%	7,188	26,042	34	No	Cool	Yes	High
South Eastern statistical region	9%	32,786	363,616	4	No	Cold	No	High
Illawarra statistical region	14%	34,756	257,395	53	Yes	Cool	Yes	High

The results of the case study area cost benefit analysis are presented in Figure 4. The stock and emissions projections for all of the case study areas are contained in Appendix C.

Figure 4 Cost benefit analysis of combined options chart



The graph of the combined options shows the differences in net benefit between the combined options. The results of the cost benefit analysis provide a set of considerations:

- The inclusion of a mandated phase out at time of sale generates significant reductions and is common across the three most effective combined options (Combined option 10, 11 and 13).
- The introduction of a ban in the case study area is a significant source of emissions reduction.
- The introduction of fuel moisture content regulations and fuel taxes in case study areas generate relatively small emissions reductions.
- Combined options can be used to maximise health benefits while minimising the cost to consumers, industry and government.

A spatial analysis of the impacts can guide the formulation of social assistance measures that would minimise any identified inequitable distributional impacts, specifically on lower income groups i.e. similar to what is being contemplated for the national implementation of a carbon tax.

It should noted that the case study analysis understates the potential health benefits of wood smoke reduction in regional and rural areas as it uses a whole-of-LGA population density. Actual health benefits may higher where the reductions occur in the higher density settlements of the LGA.

Apart from the cash incentive program, implementation of most of the control policies will require changes to the current regulatory framework. For example:

- Amendment of existing regulatory instruments is required to set tighter heater standards unless the corresponding national review results in national standards similar to Options 3 and 11 discussed in this report .
- Local councils have used their planning powers to impose a ban on heater installation in their respective areas. However, for control policies that apply such ban on a broader area comprising several regions, they would either need to be implemented through strategic policy co-ordination and cooperation of all relevant local governments; or put into effect by Government through a regulation under the *Protection of Environment Operations* (POEO) *Act 1997* or planning laws.
- For wood smoke control options that require payment of a tax or levy, it is envisaged that a regulatory approach similar to that used for setting the waste and environment levy under the POEO Act, would be necessary, including requiring purchasers to pay a contribution; determining the levy; defining where the levy applies i.e. 'regulated area' of NSW.

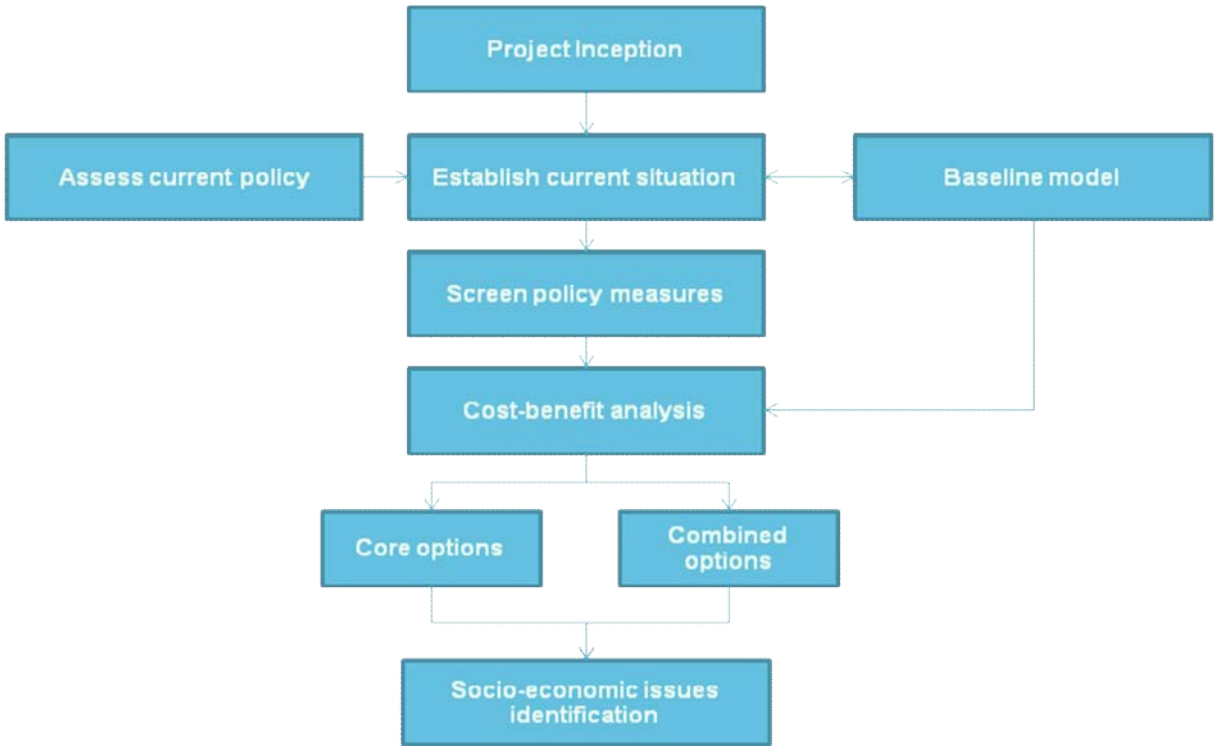
An optimum timeframe should achieve the right balance between implementing wood smoke policies as early as possible to avoid further health costs to the community and allowing adequate time for affected parties to adjust. It appears that the most suitable approach would be to implement the selected policies in a staged process with early commencement but extend their full application or coverage over several years e.g. raising efficiency standards progressively.

1.0 Introduction

The Office of Environment and Heritage (OEH) in the Department of Premier and Cabinet commissioned an assessment of measures to control wood smoke from domestic wood heaters in New South Wales (NSW). The objective of the study is to assess the costs and benefits of suitable approaches to reduce particle (PM_{10}) and volatile organic compound (VOC) emissions associated with the operation of domestic wood heaters.

Figure 5 provides a conceptual overview of AECOM's methodology for the project.

Figure 5 Study methodology



Source: AECOM

This project provides information and analysis to support policy development for the control of wood smoke in areas across NSW. In particular, this report:

- qualitatively assesses the current wood smoke control policy in NSW
- details the baseline model and a preliminary assessment of potential control measures to be included in the cost benefit analysis
- summarises the cost benefit analysis conducted on the measures identified in the preliminary assessment as well as identifying potential socio-economic impacts
- tabulates the assessment of the net public benefit of the potential options and other selected criteria.

2.0 Wood heaters in NSW

2.1.1 Wood heaters usage

Wood smoke is a source of air pollution in urban and semi rural settings in NSW (DECCW, 2010). While a small percentage of homes use wood heating in Sydney, smoke from wood heaters account for 48 per cent of fine (PM_{10}) and 60 per cent of very fine ($PM_{2.5}$) winter particle pollution. In colder climates, such as in Armidale, wood heaters can contribute over 85 per cent of winter particulate pollution (DECCW, 2010).

The Australian Bureau of Statistics (ABS) regularly collects data on heating sources within homes. The results of the latest survey are reported in Environmental Issues: Energy Use and Conservation 2008 (ABS, 2008). The percentage of NSW households using wood heaters as a source of heating is summarised in Table 3.

Table 3 Wood heater usage, NSW

Wood heater type	% of NSW households	Approx. no. of households
Combustion	12.10	323,000
Open fire	1.20	31,500
Pot-belly	0.40	10,500
Total	13.70	365,000

Source: ABS, 2008

As noted above, there are approximately 365,000 wood heaters in use in NSW. The Regulatory Impact Statement: *Proposed Protection of the Environment Operations (Clean Air) Regulation 2010* identified the current sale of wood heaters in NSW as approximately 9,600 per year (DECCW, 2010).

2.1.2 Factors influencing heating choice

There are a range of factors that influence the choice of heating system in NSW and promote the use of wood heaters. These factors include but are not limited to:

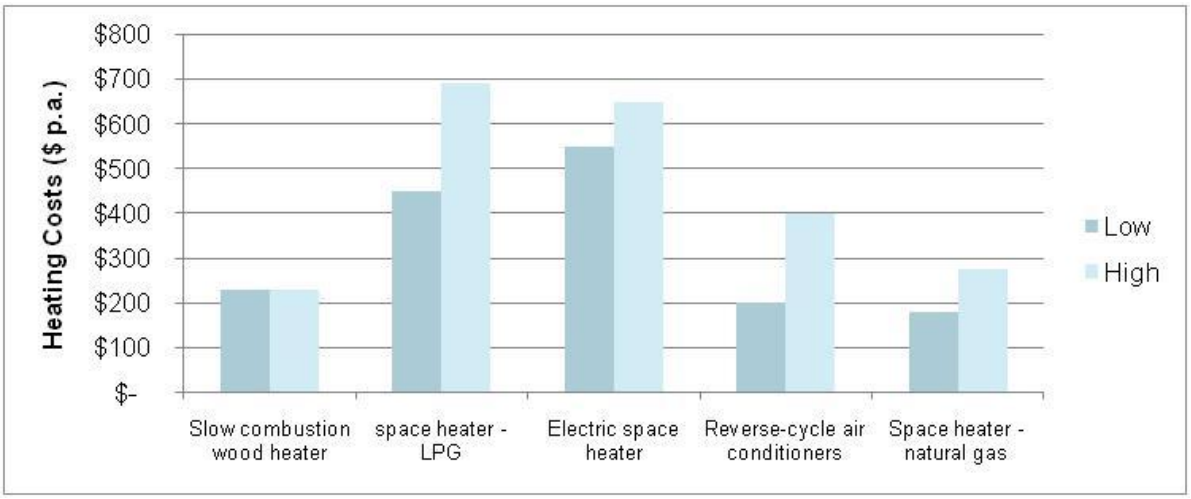
- heating costs
- climatic factors
- availability of gas reticulation networks.

Heating costs

The cost of wood heating as a source of primary heating for a home is one of the factors in the use of wood heaters. Other factors include household income; age of residence, comfort, convenience and the aesthetic value.

A detailed assessment has been undertaken on the operating costs associated with different heating systems by the Victorian Government based on a Thermal Simulation program for a typical new home with R2.5 ceiling insulation and R1.0 wall insulation. The results of this assessment are presented in Figure 6 (Sustainability Vic, 2002). The running costs are presented as high and low due to the range of variables that affect operating costs, including the size of the heater, operating temperature, hours of operation, energy efficiency and home conditioning area. The date of the assessment, 2002, means the assessment is merely indicative of the price differences between heating types.

Figure 6 Indicative Operating Costs of Heating Systems



Source: Sustainability Vic, 2002

Slow combustion wood heaters are one of the most affordable forms of heating and their operating costs are comparable to efficient reverse-cycle air conditioners and natural gas space heaters. The relatively lower cost of wood heating is particularly significant in areas of NSW without gas reticulation which removes the choice of natural gas space heaters. This lack of heating alternatives may be further exacerbated by the fact that heat pump heating (through split-system and reverse-cycle air conditioning) are an inefficient heating source in very cold climates with temperatures less than 4.4°C (US DOE, 2011). The cost difference may also be affected by the fact that a significant proportion of wood heater users source free wood fuel through scavenging. A survey for the NSW EPA in 2003 shows that the over 50 per cent of the respondent sourced fuel from friends/relatives or through local scavenging (Todd, 2003).

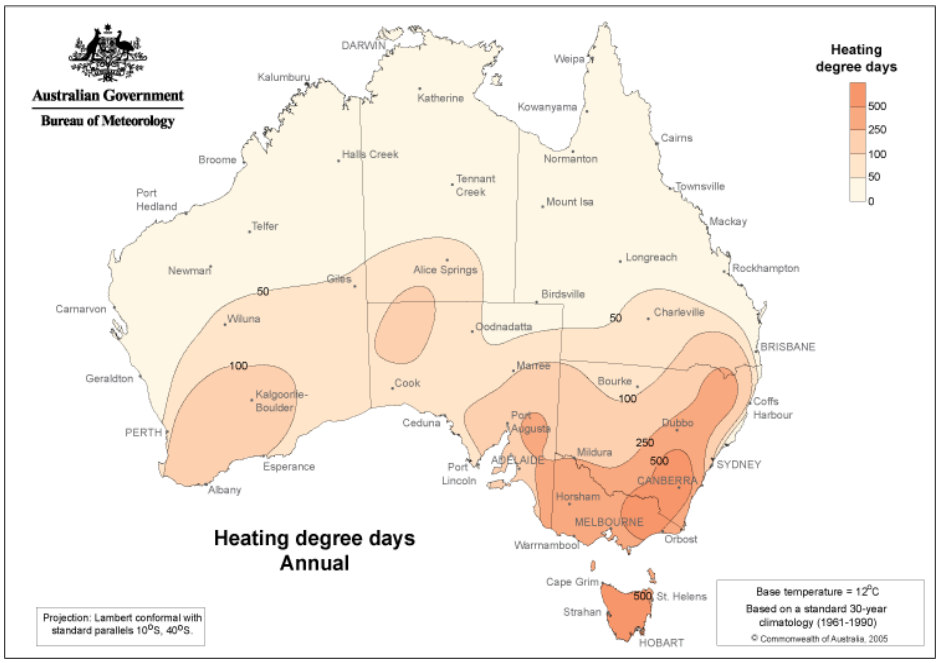
This has potential implications for low income groups who use wood heaters as an affordable primary heating source. An assessment of potential control measures that affect the cost of heating or influence the transition to alternative heating systems should include consideration of the impact on low income groups.

Climatic factors

The varying climatic regions of NSW mean that household heating use varies across the state. The Bureau of Meteorology has developed a process to record the number of heating degree days[2] in a year that households in an area would require home heating. The national map for heating degree days is presented in Figure 7.

[2] The heating degree days are determined by the difference between the average daily temperature and the comfort level temperature. For example, if heating is being considered to a temperature comfort level of 18 degrees, and the average daily temperature for a particular location was 14 degrees, then heating equivalent to 4 degrees (4 heating degree days) would be required to maintain a temperature of 18 degrees for that day. However if the average daily temperature was 20 degrees then no heating would be required, so the number of heating degree days for that day would be zero.

Figure 7 National annual heating degree days



Source: Australian Bureau of Meteorology, 2011

The heating degree day map reveals that parts of NSW, such as the South East and Riverina regions as well as parts of North East have relatively high heating requirements in comparison to areas in the North West and coastal areas.

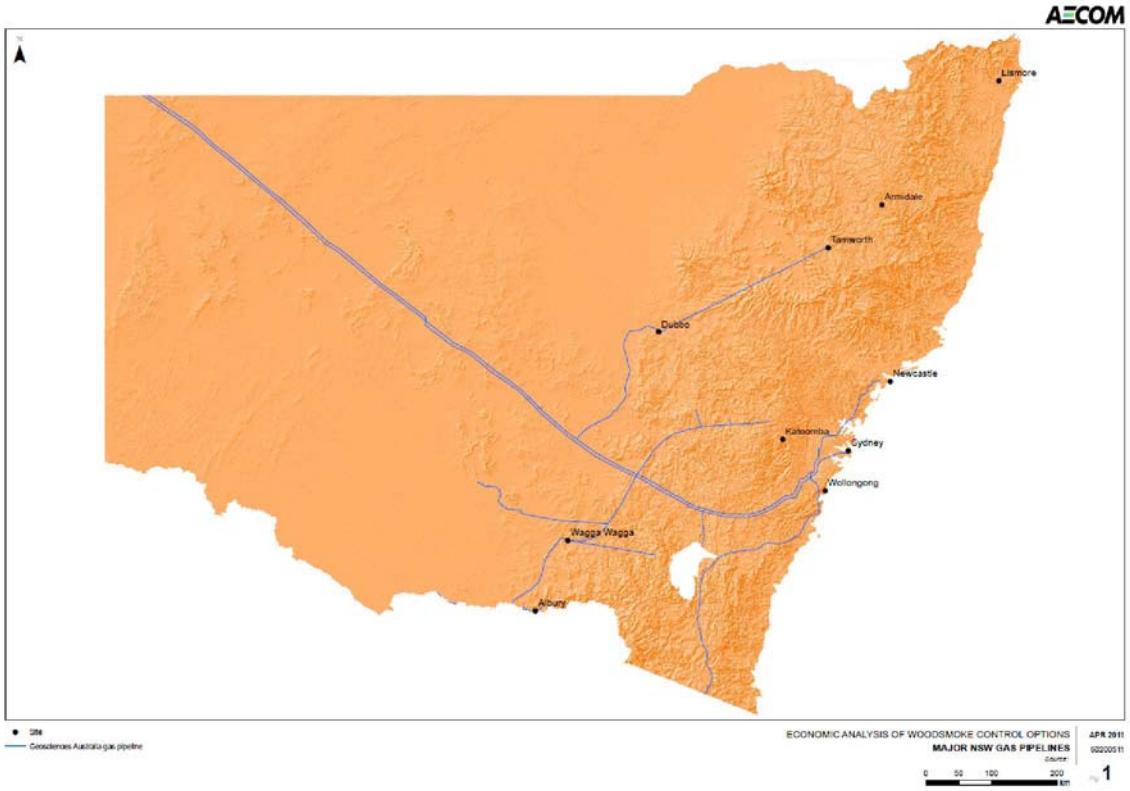
Gas reticulation network

The spatial distribution of wood heaters may also be influenced by the availability of a gas reticulation network. As noted in Figure 6, space heating using natural gas can have similar operating costs to wood heaters. The cost of alternative systems such as electrical heating is significantly higher than wood heaters.

Geoscience Australia maintains a map of the reticulated gas network in NSW (Geoscience Australia, 2010) replicated in Figure 8. The map shows that the gas network is located in eastern NSW and concentrated around Sydney and Canberra. The northern and a large proportion of southern NSW have no gas network reticulation and rely on LPG deliveries.

The combination of high heating requirements and lack of access to low cost gas heating may create greater incentives for meeting heating requirements through wood heaters. These areas may also have higher wood heater use and subsequently higher levels of wood smoke than other areas.

Figure 8 Major Natural Gas Pipeline Map



2.1.3 Health impacts of wood smoke emission

The contribution of wood smoke to annual pollutant emissions is highlighted in Table 4. The table shows the percentage contribution of wood smoke to total air pollution in the NSW Greater Metropolitan Region (GMR) and the Sydney region (DECCW, 2010).

Table 4 Contribution of wood smoke to annual pollutant emissions

Air pollutant	NSW GMR (%)	Sydney region (%)
Carbon monoxide (CO)	3	5
Nitrogen oxide	0.16	0.39
Particulate Matter		
Particulate matter ≤ 10 microns (PM_{10})	7	19
Particulate matter ≤ 2.5 microns ($PM_{2.5}$)	13	29
VOCs (air toxics)		
1,3-butadiene	6	8
Benzene	17	18
Formaldehyde	36	36
Isomers of xylene	1	1
Polycyclic aromatic hydrocarbons (PAHs)	17	19
Toluene	2	2

Source: DECCW, 2010

Wood smoke contains particulate matter (PM_{10} and $PM_{2.5}$), toxic volatile organic compounds (VOCs), carbon monoxide and nitrogen oxides. A number of studies have been conducted on the correlation (relationship) between morbidity and mortality, and exposure to these substances.

Particulates

Particulates are a broad class of chemically and physically diverse substances and are derived from natural sources (dusts from soil, pollens and fungi, sea salt, forest fires) as well as anthropogenic sources (combustion of fossil fuels from both stationary and mobile sources, biomass burning and industry) (Coffey, 2003). A summary of these studies is provided by the Australian Government which states that fine and ultrafine particles appear to affect health outcomes such as mortality and respiratory and cardiovascular morbidity and appear to do so independently of each other (DEH, 2004)

In particular, the health effects of PM_{10} and $PM_{2.5}$ include:

- increased mortality, particularly respiratory and cardiovascular diseases
- inflammation of lungs
- increased respiratory illness (e.g., bronchitis, asthma) and symptoms (e.g., cough)
- adverse effects on cardiovascular system
- increased medication use and hospitalisation.

While the number of people susceptible to hospitalisation due to acute PM exposure is probably also small, the number of people susceptible to less serious health effects such as increased respiratory symptoms, decreased lung function, or other physiologic changes may be large (Pope, 2000).

Volatile Organic Compounds

Wood smoke also contains a range of VOCs that can be hazardous for human health. VOCs such as Benzene, Formaldehyde and Polycyclic Aromatic Hydrocarbons (PAHs) can be released into the air from the combustion of wood. Some of these VOCs such as Benzene have been classified by the US EPA as a known human carcinogen (cancer causing) and the PAHs as a probable human carcinogen (US EPA IRIS, 2011).

Carbon Monoxide

Carbon Monoxide (CO) is a clear, odourless gas that reduces the blood's capacity to carry oxygen to tissues in the body. CO impairs perception and judgment at low levels, with effects increasing to include drowsiness or headaches and general discomfort as levels rise, leading ultimately to convulsions and coma at high concentrations (Coffey, 2003).

2.1.4 Health cost of wood smoke

A number of assessments have been undertaken on the potential health costs associated with a range of chemicals and particulate matter (DITRDLG, 2010; Beer, 2002; Coffey, 2003; BDA, 2006). The range of estimates for the health costs associated with VOCs, and PM_{10} have been reviewed with the aim of employing the most relevant health cost per tonne of each substance (expressed in 2011 dollars) in the cost benefit analysis.

3.0 Current NSW policy

New South Wales and its local governments have implemented regulatory measures, local planning controls, financial incentive programs and education programs for wood heaters and wood smoke (DECCW, 2010).

These policies, programs and regulations include:

- preventing the sale of new wood heaters that are not certified under the *Australian Standard, AS/NZS 4013:1999 – Domestic solid fuel burning appliances (AS/NZS 1999)*
- the use of local government planning instruments such as development control plans (DCPs) or local policies to ban the installation of new wood heaters or mandate stricter emissions standards on new wood heaters
- promoting the correct use of wood heaters achieved through advertising and providing information to the community (including targeted education of households)
- periodic wood heater replacement programs
- the use of smoke abatement notices under the *Protection of Environment Operations* (POEO) *Act 1997,* which are issued by local councils that require households to undertake smoke mitigation measures
- the inclusion of wood heaters in the *Building Sustainability Index* (BASIX).

Each of these policies, programs and regulations are discussed below.

3.1.1 Emissions standards

The *Protection of the Environment Operations (Clean Air) Regulation* 2010 requires that a wood heater cannot be sold (wholesale or retail) in NSW unless the heater is certified under AS/NZS 4013. AS/NZS 4013 certifies that the wood heater does not exceed the maximum emissions allowed of 4.0 grams of particulate matter for each kilogram of wood burnt.

The Clean Air Regulation also states that a person may not alter the structure, exhaust system or inlet air system of any heater of a model that has been certified under AS/NZS 4013.

The Regulatory Impact Statement conducted on the wood heater provisions in the Clean Air Regulation state that the net quantifiable benefit of the provisions is estimated at between $3.55 million and $35.80 million per year, depending on the region where the new, more efficient wood heaters are installed (DECCW, 2010) . This benefit is accrued through the avoided health costs from reduced particulate matter.

This control measure does not impact existing wood heaters but continues to reduce the average emissions of wood heaters in NSW.

Further, an agreement between the states and territories is required to ensure emission standards on new wood heaters in NSW are not subverted by interstate products. This is due to NSW's status as a signatory of the Mutual Recognition Agreement (MRA) and associated *Marginal Recognition Act 1992*. The MRA creates a national market for goods and services, and establishes a regulatory environment to encourage enterprise across states and territories. The effect of the MRA is that goods which are legally saleable in one jurisdiction are able to be sold throughout the country.

3.1.2 Local government planning controls

Under Section 68(1) of the *Local Government Act 1993*, wood heaters cannot be installed without the approval of the local council however councils can declare installation of a wood heater compliant or exempt development. A small group of local governments in NSW are using DCPs to place controls on wood heaters including outright bans on installation of new wood heaters. Other local government policies have also been introduced such as stricter emissions standards for installed wood heaters.

The most stringent DCPs for wood heaters have been applied in rezoned precincts in the Growth Centres of the GMR. DCPs for Oran Park and Turner Road in the South-West Growth Centre (Camden Council), and North Kellyville in the North-West Growth Centre (The Hills Shire Council) prohibit all open fireplaces and slow combustion stoves. These developments are proposed to provide approximately 16,240 new dwellings (DP, 2011).

These precincts with wood heater bans comprise a relatively small proportion of new land releases in NSW and an even smaller proportion of NSW. The Growth Centres of the GMR plan to provide up to 110,000 new dwellings

(DP, 2011) over next 25 to 30 years. Based on the percentage of NSW households with wood heaters (13.7%) in Table 3, approximately 15,000 new dwellings are forecast to install a wood heater. The DCPs in place mean approximately 2,500 new dwellings will be potentially prevented from installing a new wood heater however the Growth Centres could still see the installation of approximately 12,500 new wood heaters.

In 2010, Armidale Dumaresq Council passed *POL134 – Policy for Sustainable Domestic Energy Use and Local Air Quality* to enable consistent and clear assessment of Applications to Council for the approval to install solid fuel (including wood fuel) heating appliances. From 1 March 2011, all applications for solid fuel heaters proposed to be installed in the Armidale Dumaresq Council area will be required to emit less than 3.0 grams of particulate matter for each kilogram of wood burnt with a stricter emissions standard of 2.5 grams per kilogram in particular areas.

DCPs and local policies have an advantage as the measures can be used by local councils to target priority areas for wood heater regulation however the actual application of the DCP is at the discretion of the council as currently there is no state-wide framework to apply such controls consistently.

The application of DCPs for controlling wood smoke differs across the state. As there is no framework to guide council's application of planning controls, wood smoke emissions may be ineffectively addressed in many affected areas.

3.1.3 Periodic replacement programs

The NSW Government has periodically provided cash incentives to replace older solid-fuel heaters with cleaner heating alternatives. From 2002-2004, the NSW Wood Smoke Reduction Program included a cash rebate of $500 to residents ($700 for eligible pensioners or health-care card holders) to replace wood heaters with cleaner alternative heating sources.

An assessment of the contribution of the Launceston Woodheater Replacement Program, from 2001 to 2005, indicated that the program improved regional air quality by accelerating the existing downward trend in the number of wood heaters in Launceston (CSIRO, 2005) as well as providing incentives for the installation of more efficient wood heaters.

Economic theory suggests that wood heater owners who are already preparing to replace or remove their wood heaters would be the first group to take up a financial incentive as the value of the wood heater would be less than the value of the cash rebate. The effect of this uptake would be that the cash incentive may not lead to the majority of owners accessing the cash rebate and replacing/removing their wood heaters. The cash rebate may only assist existing wood heater owners who were already considering replacing or removing their wood heaters.

A cost benefit analysis conducted on the expansion of a wood heater replacement program to cover the Perth metropolitan area concluded that the program was labour intensive and the costs of the program would outweigh the forecast health benefits (Todd, 2006). The cost benefit analysis assumed that the program would encourage 1,500 wood heaters but the author expressed concern that the incentives were simply passing to the 9,000 households already moving to alternative forms of heating.

3.1.4 Education and information

The NSW Government has implemented a range of programs to educate local councils and the broader community about the health impacts of wood smoke and the need for proper wood heater installation and maintenance.

The NSW Wood Smoke Reduction Program has been the primary program for delivering information to the community and empowering local councils to undertake community awareness programs, chimney surveys and Smoke Abatement Notice training.

The *'Don't Light Tonight – Unless Your Heater's Right'* campaign alerts the public via mass media on nights when poor wood smoke dispersion is expected due to cold, still weather and encourages the use of alternative heating.

Education and information is considered a low cost program for influencing consumers' heating choice and assisting councils in identifying and addressing particularly smoky wood heaters.

Education and information are supporting measures that work well with regulatory and enforcement measures. Community education as a stand-alone project may not deliver significant wood smoke emission reductions. It is often difficult to assess the effectiveness of education and training in reducing wood smoke and influencing consumers' heating choices.

Lack of information on the characteristics of wood heater owners and detailed inventory of wood heaters in operation reduces the ability to target information and education to key groups such as regular wood heater users.

3.1.5 Smoke abatement notices

The NSW POEO Act provides regulatory powers for local councils to issue Smoke Abatement Notice (SANs). A SAN is issued where a household has been given information on correct wood heater operation but undertakes little or no effort to prevent excessive emissions of wood smoke. SAN provisions were created primarily as a deterrent to poor wood heater operation. The penalty notice imposes a fine of $200 for individuals and $400 for corporations with the maximum penalty that may be imposed on individuals or corporations at $3,300 by a court.

To date, only a small number of SANs have been issued and there is not sufficient data to assess the overall effectiveness of this measure.

3.1.6 BASIX

The Building Sustainability Index (BASIX) was introduced by the NSW Government to ensure that new and renovated homes are designed to use less potable water and be responsible for fewer greenhouse gas emissions by setting energy and water reduction targets. BASIX assesses the characteristics and key appliances of a house to assess the water and energy efficiency and thermal comfort against the minimum sustainability benchmarks for a local climate zone.

As BASIX focuses on energy and water efficiency, wood heaters are included as a heating/cooling option and are given an energy efficiency rating similar to a 4 star gas heater due to its low energy requirements (BASIX, 2011)[3]. Since the determination of this rating fails to account for the air pollution of wood smoke and associated public health costs, it provides a perverse incentive for installation of wood heaters. Consideration should be to given to correct the current anomaly and potentially use BASIX as a mechanism to discourage the choice of wood heaters for space heating in new dwellings.

3.1.7 Impact of price on carbon and electricity price

The Australian Government's proposed carbon price is not a measure for controlling wood smoke; however, it may impact the use of wood heaters in NSW.

A carbon price, if legislated by the Australian Government, would increase the cost of fossil fuel based energy including electricity and gas, and possibly petrol. Despite their greenhouse gas emissions, wood and biomass fuels are unlikely to be taxed, and due to the rise in other energy sources, may have a greater cost advantage. This would create a perverse incentive for households to choose (or retain) wood heaters as the preferred heating type.

Similarly, electricity prices are projected to rise in NSW (around 40% by 2013/14). This would increase the cost advantage of wood fuels and favour the selection (or at least, retention) of wood as the preferred heating choice by some consumers. Discretionary control measures may need to be considered to manage the undesirable outcomes, for example, a tax on wood fuel.

3.2 Qualitative assessment of current wood smoke policy

The review of the current policies and supporting programs for reducing wood smoke in NSW indicates that:

- The Clean Air Regulation prohibits the sale of wood heaters emitting more than 4 grams per kilogram of fuel. This is the primary regulatory mechanism for controlling wood smoke in NSW. A national review, to which NSW is represented, has been examining the introduction of heater emission and energy efficiency standards for all states and territories. There is presently no target date for completion of this initiative.
- Wood smoke control programs implemented by State and Local Governments to date have been effective in some areas (such as banning wood heaters in new precincts and replacing older wood heaters in targeted areas). However, wood smoke remains a major source of winter particle pollution and more measures are required.
- The inclusion of wood heaters as relatively energy efficient heating appliances in BASIX creates a perverse incentive for home owners and developers to install wood heaters rather than alternative heating systems with lower air pollution contributions.

[3] BASIX requires wood heaters be installed in accordance with state and council regulations.

- Information and education remain a key component of wood smoke reduction efforts in NSW. This measure is complementary to a range of other wood smoke reduction measures and any additional control measures would be supported by information and education material.

4.0 Potential Policy Measures for Wood Smoke Control

In conjunction with the identification of the measures currently implemented in NSW to reduce wood smoke from residential wood heaters, a review of Australian and international literature was undertaken to identify potential strategies, policies and programs that may be developed for controlling wood smoke. This includes the measures considered in the report 'Strategies for Reducing Residential Wood Smoke' by the U.S. Environmental Protection Agency (US EPA, 2009).

Generally, potential wood smoke control measures can be classified into four categories: regulatory measures, market mechanisms, incentive programs, and information and education.

4.1.1 Regulatory measures

Regulatory policy measures often involve a regulatory approach that mandates a particular action or set of actions that are supported by enforcement using auditing and penalties. Regulatory measures for wood smoke control include imposing a ban on installation of new wood heaters, efficiency standards and emissions limits for wood heaters permitted for sale, mandated phase out provisions or the introduction of mandated fuel moisture content levels.

These measures have been implemented in a number of locations including:

- NSW: total ban in Waverly Council, ban in new land releases in Camden Council and The Hills Shire Council, and lower emissions wood heaters mandated in Armidale Dumaresq Council
- ACT: ban on wood heaters as primary heat source in one council area
- Tasmania: emission standards
- Lincoln County, MT and Sacramento, CA; USA: ban on wood heaters
- Christchurch, New Zealand: emission standards
- Mammoth, CA, Washoe County, NV; and Oregon, USA: phase out at sale of house
- Western Australia: maximum wood fuel moisture content regulation of 20%.

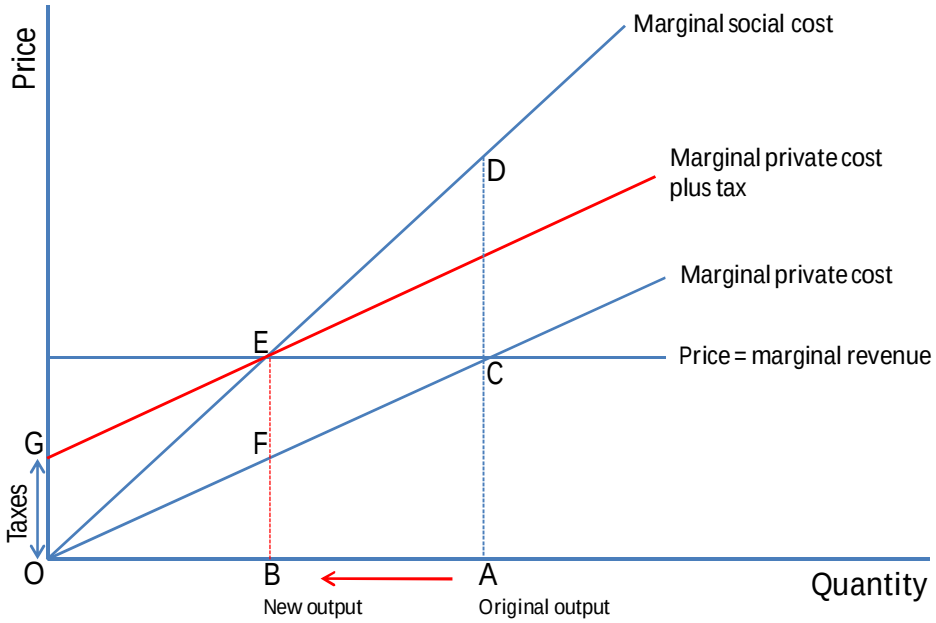
Regulatory measures require greater government intervention and administrative resources to introduce and operate as the onus is on the government to enforce the measures.

4.1.2 Market mechanisms

Market mechanisms can be introduced to ensure polluters (wood heater users) contribute to the costs of negative externalities (health costs borne by the community) and, reduce the extent of pollution through appropriate pricing signals.

A preliminary assessment of international and domestic regulations reveal there are currently no market mechanisms currently in place. For example, a tax/excise could be placed on the sale price of wood heaters to discourage their purchase/ownership. In economic theory, a Pigouvian tax is optimally set at the cost of the externality to transfer it to the polluter. Revenue collected from the tax can be used to fund the health costs incurred by the community. A Pigouvian tax on wood heaters is described in the text box below.

Figure 9 Workings of Pigouvian tax



Source: AECOM

- The marginal revenue curve is the demand curve which is assumed to be perfectly elastic. The marginal private cost is the supply curve which shows the quantity of output from producers at different price levels. The marginal social costs curve is the supply curve when all costs including those of externalities, in this case the health cost of wood smoke, are taken into account.
- A tax shifts the marginal private cost curve up by the amount of the tax i.e. the new supply curve now is the marginal private cost plus tax. As a consequence of this cost increase, producers (have the incentive to) reduce their output to a lower level, from A to B.
- New output at level B represents the socially optimum level for reducing the health costs of wood smoke externality i.e. depicted by reduction of area size from ODC to OEF, and equating the new marginal externality cost to the marginal tax levied i.e. reduced from CD to EF.
- The total tax revenue, which may or may not be used to mitigate the effect of the negative externality, is equal to the size of the tax times the new output (area OGEF).

Aside from efficiency, Pigouvian taxes may increase the fairness of how costs of negative externalities are borne. For example, even if a tax on wood heaters is not at the perfect level to achieve optimal efficiency, it transfers the cost associated with wood smoke from the public to the wood heater user.

Other market mechanisms that seek to push the externality to the polluter include a tax on fuel, pricing emissions and licensing fees for wood heater owners.

A drawback of the market mechanism approach is that, to justify government intervention in the markets, it assumes full knowledge of the externalities. In reality, it may be difficult to precisely estimate the costs that wood smoke imposes on the community. Further, to gain support of the measure from the community, they need to be assured that the tax revenue collected would be applied to appropriate purposes.

4.1.3 Incentive programs

Incentive programs provide a financial or economic incentive for a particular action. In this case, a cash incentive may be provided to current wood heater owners who purchase a new, more efficient wood heater or an alternative heating system. Voluntary incentives are relatively easy to implement and operate however the high costs of these programs tend to limit the possible extent of government actions.

A major shortcoming of programs providing cash incentives for heater replacement is that a large proportion of subsidy applicants are those who would replace their heaters anyway, with or without the cash incentive. It can also be difficult to calculate a correct amount of incentive that is required to achieve the intended outcome. For instance, lower income groups may require larger cash incentives to change heating systems than other groups.

These measures have been implemented in a number of locations including a cash incentive phase out in NSW (Wood Smoke Reduction Program); WA and ACT (Wood heater Replacement Programs).

4.1.4 Education and information

Education and information are considered a complementary measure to support the successful introduction and operation of other control measures. It is anticipated that any extension of wood smoke control in NSW would involve a supporting education and information program. It is worth noting that measuring the effectiveness of broad education and information programs is difficult.

4.2 Potential measures

Based on the assessment of the current NSW policies and the literature review of potential measures, a number of wood smoke control measures ("measures") have been identified for assessment for NSW. Table 5 lists the identified measures. Table 5 Control Measures

Control measure	Description
Business as usual (Base case)	*Protection of the Environment Operations (Clean Air) Regulation* 2010 requires that a wood heater cannot be sold (wholesale or retail) in NSW unless the heater is certified under the AS/NZS 4013.
Regulatory	
Ban	A ban on the sale of new wood heaters.
Efficiency and emissions standards	A state-wide regulation that specifies the efficiency of new wood heaters (e.g. all new wood heaters sold in NSW will have a heating efficiency of at least 65% and an emissions limit of 3.0g/kg).
Phase out	Owners of wood heaters are required to remove their wood heater or render it inoperable at the time of sale or within a specified period of time.
Fuel moisture content regulations	A regulation on a maximum moisture content for wood fuel sold in NSW.
Market Mechanisms	
Sales tax on new wood heaters	A sales tax (or excise) on new wood heaters recognising the social (health) costs of wood smoke.
Licensing fees	An annual licensing fee (and possible license test) for wood heater owners.
Levying an excise/tax on biomass fuels	A sales tax/excise on wood heater fuel recognising the social (health) costs of wood smoke.
Voluntary incentive programs	
Cash incentive phase out	A buy-back program to phase out wood heaters or incentives to purchase more efficient wood heaters.

Source: AECOM

The above measures were selected for their potential capacity to produce significant reductions in wood smoke emission, as identified in the literature. Measures can be combined to form packages of measures ("options") to be effective, cost efficient and gain stakeholder support.

The options for improving control of wood smoke have been selected through a screening assessment of the above measures. A full evaluation of the potential options has been be undertaken as a part of the cost benefit analysis component of the project (Section 6).

Support measures such as education, information briefings and the use of SANs are not evaluated as separate options in this assessment since they can be provided alongside (or in absence of) any of the identified measures. Due to the lack of data, the evaluation will only include a qualitative assessment of the costs and benefits of these support measures.

5.0 Preliminary Assessment of Options

The objective of the preliminary assessment is to identify potential options that meet the stated policy objectives and can be included in the final evaluation. The assessment is largely qualitative, though it is assisted by the use of agreed screening criteria and a metric designed to give an approximate measure of the likely effects of the options.

5.1 Criteria

The selection of the criteria for the preliminary assessment of the different options was guided by the assessment of the effectiveness of the current policy arrangement and the 'Checklist for Assessing Regulatory Quality' shown in Appendix A.

The selected criteria identify the broad policy effectiveness of potential measures. The selected set of criteria is outlined below.

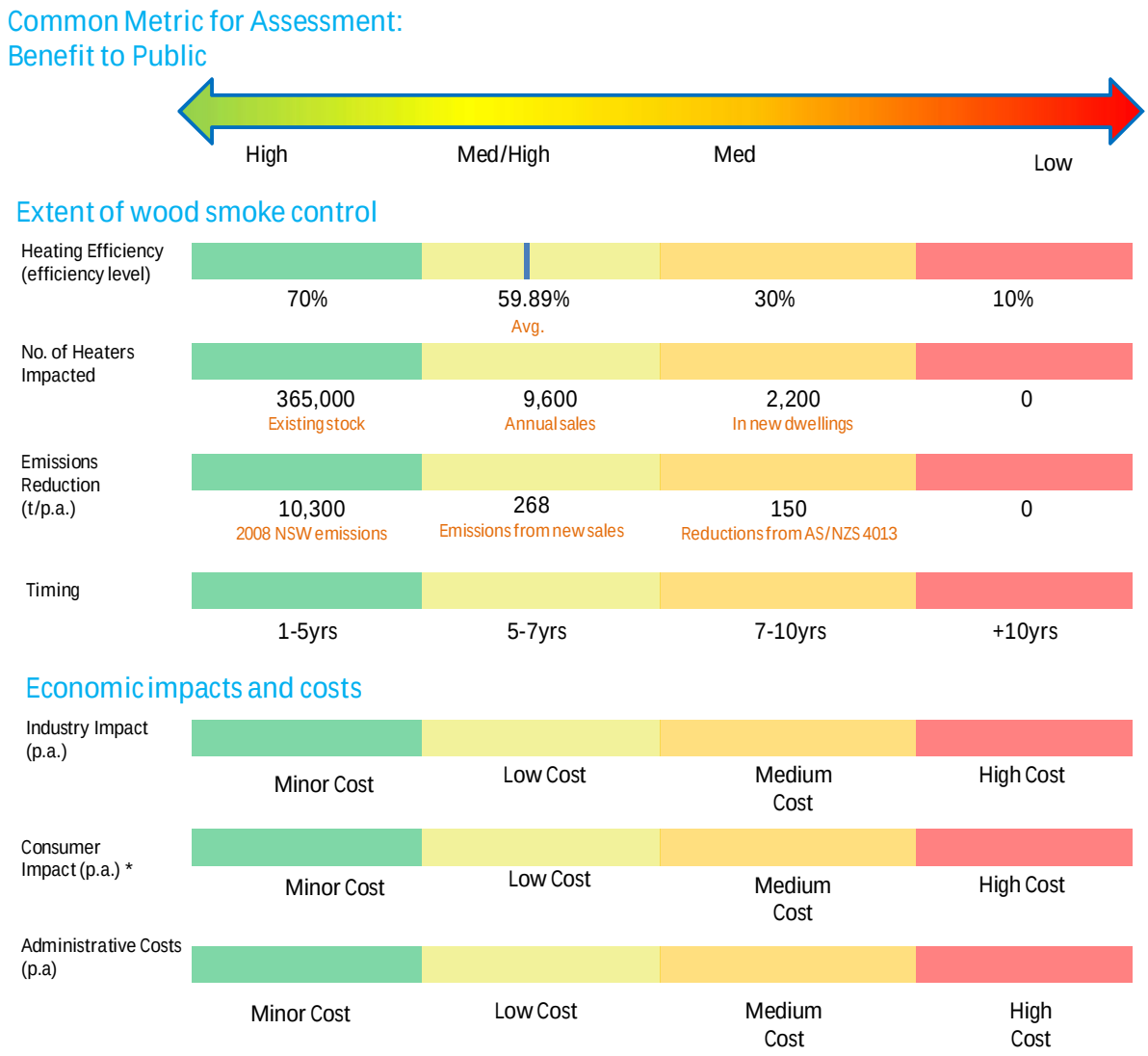
1) Extent of wood smoke control
    a) heating efficiency improvements
    b) number of heaters impacted
    c) emissions reductions (health benefits)
    d) timing of reductions
2) Economic impacts and costs
    a) impact on industry
    b) impact on consumer
    c) administrative costs
3) Distribution effects and spatial impacts
4) State-wide uniformity and consistency
5) Consistency with national approach
6) Practicality.

5.1.1 Benefit to Public Metric

The first two criteria, extent of wood smoke control, and economic impacts and costs, of each measure are qualitatively assessed by its benefit to the public.

The benefit to the public is a result of the extent to which the measure can control wood smoke and the economic costs incurred as a result of the measure. Each criteria has been evaluated using different metrics, for example, heating efficiency 70%, 60%, 30% and 10%. The measure's contribution to the net public benefit is also assessed using the common metric of Benefit to Public (High, Med/High, Med and Low) with the associated colour for the metric at top of the figure.

Figure 10 Public benefit contribution criteria



Source: AECOM and various sources

5.1.2 Extent of wood smoke control

The key element of policy effectiveness is the extent to which an option has the potential to control wood smoke. While a detailed assessment is presented in Chapter 6.0, a brief assessment has been undertaken on the extent of wood smoke control for each measure. The extent to which a measure can control wood smoke in NSW is assessed using the following indicators:

Heating efficiency and emissions limits

Heating efficiency is one of the key factors in the amount of wood smoke emissions that a wood heater produces. The efficiency is the percentage of fuel that is converted to heat.

Well-designed slow combustion stoves are approximately 70% efficient while open fireplaces are approximately 10% efficient (DEH, 2003). The average efficiency of wood heaters has been calculated using results of a survey undertaken on the wood heater industry (DEWHA, 2009). The survey recorded the heating efficiency of the range of wood heaters currently being sold across Australia. Based on this survey, the average heating efficiency of the wood heaters sold in Australia is 59.89%.

An assessment of the relationship between heating efficiency and emissions concludes that it is uncertain that burns with high combustion (heating) efficiency tend to have low mass emissions and burns with low combustion

efficiency have high mass emissions (EA, 2002). To ensure that emissions from wood heaters are reduced, a heating efficiency measure should be paired with a limit on emissions.

Number of heaters impacted

There are approximately 365,000 wood heaters in operation in NSW with approximately 9,600 heaters sold as replacement or new installations each year (DECCW, 2010). As shown in Section 3.1.2, approximately 2,500 new wood heaters may be installed in the 110,000 new dwellings to be built in the GMR growth centres (DP, 2011) . The number of wood heaters that the measure will impact is a factor in the extent to which it can contribute to a reduction in wood smoke in NSW.

Emission reductions (health benefits)

The emissions reduction criterion is an approximation of both the emission reductions, and associated health benefits, from the measure. In 2008, approximately 10,300 tonnes of PM_{10} was emitted from wood heaters in NSW. The Clean Air Regulation estimated that wood smoke emissions in NSW would decrease by between 67 and 153 tonnes per year (DECCW, 2010).

Emission reductions are be the basis for the quantitative assessment of the health benefits from each measure in the detailed cost benefit analysis. It is also important to recognise the fact that health costs differ across NSW depending on population density. The preliminary assessment is unable to attribute the impact of the measures to particular areas and so emissions reductions are used as a proxy.

A detailed assessment of the health benefits associated with each measure is included in the cost benefit analysis.

Timing

An important consideration for the effectiveness of each measure is the timeframe of the emission reductions. Measures that reduce emissions and provide health benefits at later stages have a lower value, due to the time value of money, than measures that reduce the same amount of emissions in a shorter timeframe. For example, national legislation on wood heaters standards may take longer to achieve as it requires mutual agreement of all Australian jurisdictions.

5.1.3 Economic impacts and costs

The attractiveness of a measure can be reduced if its introduction and operation causes major negative economic impacts and costs. The possible impacts of wood smoke control policies on various sectors are listed below.

Industry impact

A ban on the sale of new wood heaters in NSW would have a high impact on industry while a change in standards may have a low or minor impact on industry. The potential impact of each option on the wood heating industry will be evaluated.

The assessment of the impact at this stage focuses solely on the reduction of heater sales. In the final cost benefit analysis, more robust indicators that include loss of sales values, employment, cost of industry and profitability may be used. Use of the former indicators is usually not justified given that resources reallocate themselves to the productive sectors within the economy. The latter indicator of profitability is commonly used in economic impact assessment. The impact on producer surplus is a potential indicator for the industry impact however it does not enable an effective assessment given sales into other jurisdictions and an unknown price elasticity of supply.

Consumer impact

An element of the public benefit assessment is the impact of the control measures on the consumer surplus. Consumer surplus is the difference between a customer's willingness-to-pay for a good or service and the price they actually pay. In the case of wood heaters, banning of new sales or other measures that affect the quantity and price of wood heaters would reduce consumer surplus.

A preliminary assessment is conducted at the preliminary evaluation stage to assess the potential impact as low, medium or high. Detailed assessment of the impact on consumer surplus is provided in the cost benefit analysis.

Administrative costs

The cost of administrating the measure is included in the assessment of effectiveness of a potential measure. Administrative costs are assessed as being high, medium, low or none.

5.1.3.1 Distribution effects and spatial impacts

Measures are assessed on their ability to account for the use of wood heater among low income groups in NSW and the relatively higher operating costs of alternative heating systems. There is also a need to understand the ability to provide compensation, where appropriate, to low income groups. The consideration of other potentially vulnerable groups, including elderly, has not been included in this assessment.

The spatial impact criterion examines the potential coverage issues of the measure. For instance, the introduction of a measure may have different impacts depending on, for example, regional climates or access to reticulated gas networks.

5.1.4 State-wide uniformity and consistency

As discussed in the assessment of NSW's current wood smoke control regime, there are a range of policies, programs and measures implemented across the state that vary in some council areas. Potential control measures should seek to generate a consistent framework across the state for ease of implementation and monitoring. The preliminary evaluation also assesses whether the measure builds upon current NSW regulatory instruments, incentive programs and education.

5.1.5 Consistent with national approach

Wood smoke is currently being considered at a national level, principally in the context of uniform emission standards for wood heaters across Australia. It is anticipated that this will result in measures that ensure a minimum standard for wood heater emissions across all states and territories. It is important that any NSW specific measures are consistent with the national approach.

5.1.6 Practicality

The final criterion is the practical nature of the measure. It provides an assessment of the potential practical issues associated with the introduction of a measure. An example of a practical issue that may reduce the effectiveness of a measure is the prevalence of scavenging instead of purchasing wood.

5.2 Business as usual

Business as usual is the current wood smoke control measures in NSW. Business as usual should be used as the base case for comparing the effect of new wood smoke control measures. The measures in the business as usual include:

- requiring the sale of new wood heaters that are certified under *AS/NZS 199*
- use of local government planning instruments such as development control plans (DCPs) or local policies to ban the installation of new wood heaters or require stricter emissions standards on new wood heaters
- promoting the correct use of wood heaters achieved through advertising and providing information to the community, including targeted education of households
- periodic wood heater replacement programs
- use of smoke abatement notices under the *Protection of Environment Operations* (POEO) *Act 1997*, which are issued by local councils that require households to undertake smoke mitigation measures.

The business as usual measure will form the base case in the detailed cost benefit analysis.

5.3 Ban on new wood heaters

A ban on new wood heaters could be applied through the regulation of the sale or installation of wood heaters across NSW. There are also potential priority areas across NSW that may benefit from a localised ban enforced by the NSW Government to support the local government assessment programs.

5.3.1 Extent of Wood Smoke Control

A ban on the sale or installation of new wood heaters in NSW will avoid the emissions from all wood heaters to be sold in NSW as replacements for old heaters and for new installations. The emission reduction potential per year, based on the average emissions information provided by DECCW, is approximately 268 tonnes of PM_{10} from the 9,600 wood heaters sold each year in NSW (DECCW, 2010). The ban could be implemented in a relatively short period and begin reducing wood smoke emissions in NSW.

5.3.2 Socio-economic impacts

A ban on the sale of new wood heaters in NSW will impact on the wood heater industry and future consumers of wood heaters. A state-wide ban would halt the sale of approximately 9,600 wood heaters per year (DECCW, 2010). The consumer impact would be significant as there would be no wood heaters for sale in NSW.

Table 6 Ban on new wood heaters assessment

	Extent of wood smoke control				Economic impacts and costs		
	Efficiency	Heaters Impacted	Emissions Reduction	Timing	Industry	Consumers	Administrative Costs
Contribution to Public Benefit	Med/High	Med/High	Med/High	High	High cost	High cost	Medium cost

(1) Colour assessment of benefit to public using common metric for assessment in Figure 10.

5.3.3 Distribution effects and spatial impacts

A state-wide ban on the sale or installation of wood heaters would address wood smoke across NSW however there is the ability to target priority areas. Low income groups who depend on wood heaters as a cheap source of heating will be significantly affected, particularly in areas where there is no natural gas reticulation network.

5.3.4 State-wide uniformity and consistency

A state-wide ban will generate consistency across the state for the treatment of wood heaters compared to the current use of DCPs to ban the installation of wood heaters in particular areas.

5.3.5 Consistency with national approach

A ban on all new wood heaters in NSW would significantly exceed the intended action of the current and proposed national approach.

5.3.6 Summary

There is scope for bans of new installations in priority areas in the next stage of the project. A priority areas ban could be combined, where possible, with cash incentives or other support measures to assist low income owners to easily transition to an alternative heating system.

5.4 Efficiency standard and emission limits

An efficiency standard is the rating of the wood heaters ability to convert fuel to heat. An efficiency standard should also be paired with a lower emission standard to ensure reduced emissions. The current emission limit in NSW, effective under the Clean Air Regulation, is 4.0 grams per kilogram of fuel consumed (DECCW, 2010). A possible control measure is the introduction of a new regulation requiring that all new wood heaters should have an efficiency of at least 65% and an emission rating of 3.0 grams per kilogram of fuel.

It is important for modelling purposes to note that there is an in-service adjustment figure to calculate actual emissions of an efficiency and emission standard. Tests conducted for the Australian Department of Environment and Heritage concluded that the increase in the emission factor when in-service was approximately 2.5 times the certified level of grams per kilogram of fuel (EA, 2002). This figure accounts for the operation of wood heaters outside testing parameters and the fact that wood heater owners do not generally operate the wood heater in an optimal manner.

5.4.1 Extent of Wood Smoke Control

A mandatory efficiency standard and lower emission limit for all new wood heaters would only affect new sales of 9,600 per year. The efficiency and emission standards would reduce the emissions from all new wood heaters assuming all other factors are equal. The efficiency standard would not affect existing wood heaters. There is also a lag in the appearance of appreciable emission reductions due the time to implement the measure.

5.4.2 Socio-economic impacts

The industry impact would be less than a total ban on new sales with a small impact due to increased compliance costs. These compliance costs, if passed onto the consumer, will increase the price of wood heaters resulting in a

loss of consumer surplus. The implementation and auditing of a new efficiency standard may have relatively low administrative costs.

Table 7 Efficiency standard public benefit assessment

	Extent of wood smoke control				Economic impacts and costs		
	Efficiency	Heaters Impacted	Potential Emissions Reduction	Timing	Industry	Consumers	Administrative Costs
Contribution to Public Benefit	High	Med/High	Medium	Med/High	Low cost	Low cost	Low cost

(1) Colour assessment of benefit to public using common metric for assessment in Figure 10.

5.4.3 Distribution effects and spatial impacts

There is a need to assess the potential for an efficiency standard and emission limits to disproportionately affect low income groups as the standard may increase price of wood heaters. This impact is further explored in the detailed cost-benefit analysis. An efficiency standard and emission limit could be introduced in priority areas or in areas where significant number of wood heaters potentially may be installed such as new land releases.

5.4.4 State-wide uniformity and consistency

A state-wide heating efficiency standard and emission limit would create consistency across the state compared to the current situation where local governments (such as Armidale Dumaresq Council) implement efficiency standards for particular areas in their jurisdiction.

5.4.5 Consistency with national approach

This measure may pre-empt a national heating efficiency standard and emission limit however there is also the possibility of advocating a particular standard if it appears to be effective in NSW. There is already a national emission limit of 4.0g/kg.

5.4.6 Practicality

Under the MRA, wood heaters that can be sold in other jurisdictions would be able to be sold in NSW. NSW will have to apply for an exemption under the MRA to enforce a state efficiency standard or lower emission limit at the point of sale or introduce a new regulatory requirement that controls the installation of wood heaters. As noted in Chapter 2, several councils, including Armidale City Council, have implemented DCPs that mandate a minimum efficiency level of installed wood heaters so the measures can be adopted in priority areas.

5.4.7 Summary

An efficiency standard with an improved emission standard will be assessed in the detailed cost-benefit analysis.

5.5 Phase out

The phase out of wood heaters at sale of house has been introduced in a number of US counties to accelerate the turn-over of wood heaters to more efficient models or alternative heating system (US EPA, 2009). Wood heaters generally last 17 years while the average house in Australia is sold every 7 years (Bell, 1996). Under a phase out measure, a regulatory instrument would be introduced to require that any wood heaters on the premises should be removed or rendered inoperable when a house is sold.

This means that wood heaters would only be in service for an average of 7 years and then removed or rendered inoperable due to the sale conditions. New owners of the house would then have the choice to install a new, more efficient wood heater or an alternative heating system.

A related phase out measure may be the introduction of a sunset date for wood heaters in NSW or priority areas. This measure would mandate that all wood heaters would have to be removed by a certain date (i.e. ten years from now). The impact of the sunset clause is dependent on the time period. A short time period will affect new wood heater sales as consumers would have a limited period of use while a long period would have little effect on sales.

5.5.1 Extent of Wood Smoke Control

The inclusion of a provision that all wood heaters should be rendered inoperable or removed would target the existing wood heaters and reduce their numbers faster than natural turn-over. Once implemented, the regulation can begin reducing the number of existing wood heaters immediately with the associated emission reductions.

The emission reduction potential may be greater than the annual emissions from new sales assuming that the number of houses with wood heaters sold each year, and therefore removed or rendered inoperable, is larger than annual sales. The emission reduction potential could also be greater even if the number of houses with wood heaters sold each year is less than annual sales. This is because the existing wood heaters may be more polluting than new heaters.

5.5.2 Socio-economic impacts

The industry impact is potentially minor as there will be no restrictions on sales. There will be an increase in administrative costs due to increased auditing and monitoring of house sales to ensure that the provision is adhered to. A detailed examination of industry impacts will be undertaken in the cost benefit analysis.

Consumers may also be impacted as potential wood heaters owners who plan to sell their house will not purchase a wood heater as it will have to be removed in the near future.

Table 8 Phase at time of sale assessment

	Extent of wood smoke control				Economic impacts and costs		
	Efficiency	Heaters Impacted	Emissions Reduction	Timing	Industry	Consumers	Administrative Costs
Contribution to Public Benefit	Med/High	High	Med/High	Med/High	Minor cost	Low cost	Medium cost

(1) Colour assessment of benefit to public using common metric for assessment in Figure 10.

5.5.3 Distribution effects and spatial impacts

There is limited information to determine whether low income groups move at the average period of seven years (Bell, 1996) and whether these groups may be unduly affected by the phase out. There may be also differences in average years of household across different regions in NSW. For instance, rural properties may be sold at a lower rate than urban properties.

5.5.4 State-wide uniformity and consistency

A state-wide policy for wood heaters to be removed or rendered inoperable at the time of house sale would provide a consistent policy across NSW for control of wood smoke emissions. There is also the potential to implement the policy in priority areas.

5.5.5 Consistency with national approach

This measure would be complementary to the proposed national approach of an efficiency standard and auditing.

5.5.6 Practicality

There is the potential to introduce the phase out with other polices (such as bans or efficiency standards) that will increase the emission reductions but may impact industry and consumers. This measure may also have significant impact on wood heaters, such as open fireplaces, that are installed for aesthetic reasons which are used less and have lower associated health costs.

5.5.7 Summary

This measure will be assessed in the detailed cost benefit analysis. The ability for this measure to reduce emissions would be improved if combined with other measures including bans or efficiency standards.

5.6 Wood fuel moisture content regulations

Wood fuel moisture content regulations require particular fuel moisture content. In Western Australia, wood fuel moisture content for domestic heating must be less than 20 per cent. There may be a price rise in the cost of wood fuel due to the higher compliance regime. Wood fuel generally needs to be dried for up to 12 months to attain the required moisture content of less than 20% (BDA, 2006).

5.6.1 Extent of Wood Smoke Control

The extent to which a wood fuel moisture regulation on purchased wood fuel can control wood smoke is dependent on the impact that fuel moisture has on emissions and the amount of wood heaters that use purchased wood fuel.

There have been a number of tests conducted on the impact of fuel moisture on emissions from wood heaters. An assessment undertaken in 2002 by Environment Australia stated that there was data to suggest that emissions increase with increasing fuel moisture, although the increased emissions at moisture contents less than 15 per cent clearly have other contributing factors (EA, 2002). This assessment reveals that there is a general relationship however other factors also affect wood smoke at low fuel moisture content levels.

A survey for the NSW EPA in 2003 shows that over 50 per cent of the respondents sourced fuel from friends/relative or local scavenging (Todd, 2003). The large percentage of scavenged wood further reduces the potential effectiveness of wood fuel moisture content regulations given that the regulation would only apply to sales.

These factors reduce the potential emissions reduction and improvement in efficiency associated with the measure.

5.6.2 Socio-economic impacts

Given the evidence suggests that most available fuel is close to the potential mandated limit of 20 per cent and the prevalence of scavenging fuel, there appears to be limited impact on the consumers and industry. The administration of a new standard for fuel may be costly.

Table 9 Fuel moisture content assessment

	Extent of wood smoke control				Economic impacts and costs		
	Efficiency	Heaters Impacted	Emissions Reduction	Timing	Industry	Consumers	Administrative Costs
Contribution to Public Benefit	Med/High	Med/High	Low	High	Low cost	Low cost	Medium cost

(1) Colour assessment of benefit to public using common metric for assessment in Figure 10.

5.6.3 Distribution effects and spatial impacts

The fuel moisture content measure would cover all of the NSW.

5.6.4 State-wide uniformity and consistency

A fuel moisture content regulation would be uniform across the state and provide consistency in regulation.

5.6.5 Consistency with national approach

This measure would not conflict with the proposed national approach as the Western Australian Government currently operates a fuel moisture content standard.

5.6.6 Practicality

This measure may be impractical given the prevalence of wood scavenging.

5.6.7 Summary

Accepting that the evidence that suggests that most wood fuel is around 20% moisture content, it is still proposed that this measure be assessed in the detailed cost benefit analysis.

5.7 Tax on new wood heaters

A tax on new wood heaters would be applied at the sale of wood heaters to increase the price in recognition of the social (health) costs associated with wood smoke. The tax would be modelled on a Pigouvian tax outlined in Section 4.1.2.

The tax increases the price of wood heaters and reduces the number of wood heaters purchased. The size of the tax is based on two considerations – the health costs associated with an individual wood heater and the cost of alternative heating systems. The tax would be lower value of the calculated health costs per wood heater or the difference between a wood heater and an alternative heating system that does not emit wood smoke plus an increment to support purchase choice.

It is also possible to apply a tax on inefficient wood heaters where these wood heaters are lower priced than efficient models.

5.7.1 Extent of Wood Smoke Control

The introduction of a sales tax on new wood heaters would increase the price of wood heaters. The increased price would reduce the number of wood heaters sold each year of approximately 9,600 (DECCW, 2010). The emissions reductions would be less than the ban of all new wood heaters but potentially more than the reductions currently being achieved by the regulations in the Clean Air Regulation (67-153 tonnes per annum).

5.7.2 Socio-economic impacts

The sales tax could be introduced and begin to reduce emissions in a relatively short period. The industry impact will be less than the ban on all new sales but the increased price will reduce wood heater sales. The consumer impact will also be less than the ban but will occur due to the increased price. Market mechanisms are generally less costly to administer than regulation as administration can be funded by the tax.

Table 10 Sales tax on new wood heaters assessment

	Extent of wood smoke control				Economic impacts and costs		
	Efficiency	Heaters Impacted	Emissions Reduction	Timing	Industry	Consumers	Administrative Costs
Contribution to Public Benefit	Medium	Med/High	Medium	Med/High	Low cost	Low cost	Low cost

(1) Colour assessment of benefit to public using common metric for assessment in Figure 10.

5.7.3 Distribution effects and spatial impacts

Revenue from the tax may be used to support low income groups who may be disproportionately affected by the tax.

5.7.4 State-wide uniformity and consistency

A state-wide tax would create consistency across NSW. The impacts of the tax would be greater in areas that had greater wood heater sales which may coincide with priority areas for wood smoke reduction.

5.7.5 Consistency with national approach

This option may conflict with the proposed national approach of efficiency standards and auditing as it would mean that industry had higher compliance costs but reduced sales as a result of the tax.

5.7.6 Practicality

The introduction of a sales tax on wood heaters to recognise the social (health) costs of wood smoke may be politically difficult and adversely affect low income groups who depend on the low cost of wood heaters for primary heating. There is also the potential for consumers to purchase wood heaters interstate and install them in NSW.

5.7.7 Summary

This measure is assessed in the detailed cost benefit analysis.

5.8 Licensing fees

Wood heater owners would pay a license fee to operate a wood heater for a specific period. The fee could also include training and education on appropriate wood heater operation. The licensing scheme would develop a list of licensed wood heater owners.

5.8.1 Extent of Wood Smoke Control

The introduction of a licensing fee for wood heater owners would target the existing wood heater owners (approx. 365,000 in 2008). The fee would increase the overall cost of wood heating to all wood heater owners which may provide incentives for some wood heater owners to purchase alternative heating systems. The licensing fee could be introduced in the short term however emission reductions will be less than a ban on all wood heaters.

5.8.2 Socio-economic impacts

The introduction of a licensing fee will increase the overall cost of wood heating and may reduce the amount of wood heaters in operation. The administration costs may be higher than a sales tax due to the larger group of 365,000 wood heater owners. The revenue from the fees may be used to offset this cost.

Table 11 Licensing fee assessment

	Extent of wood smoke control				Economic impacts and costs		
	Efficiency	Heaters Impacted	Emissions Reduction	Timing	Industry	Consumers	Administrative Costs
Contribution to Public Benefit	Med/High	High	Med/High	Med/High	Minor cost	Low cost	Medium Cost

(1) Colour assessment of benefit to public using common metric for assessment in Figure 10.

5.8.3 Distribution effects and spatial impacts

A licensing fee would increase the cost of operating wood heaters which will mean that low income groups have to pay more to heat their house. The revenue from the licensing fee could be used to support low income groups who will be proportionally more affected.

A licensing scheme could also be introduced in priority areas to provide incentives for existing wood heater owners to purchase new heating systems.

5.8.4 State-wide uniformity and consistency

A state-wide licensing fee would create consistency across the state. The licensing fee program would generate a list of licensed users which may assist local governments to target education and information while also enable effective monitoring and use of SANs.

5.8.5 Consistency with national approach

A licensing regime would complement the proposed national approach as licensing fees would enable more effective auditing and enforcement.

5.8.6 Practicality

It may be difficult to introduce a licensing fee on existing wood heater owners as these owners already own and operate a wood heater. There needs to be a clear linkage between the licensing fee and the emission reductions to justify the cost on existing wood heater owners.

This measure will be assessed in the detailed cost benefit analysis.

5.9 Tax on fuels

A tax on fuels would be levied on fuel retailers to increase the price of fuel. This price increase would be reflective of the health costs associated with wood smoke. As noted in the wood fuel moisture assessment, about 50per cent of fuel used in NSW is not purchased. The tax would not affect the wood heater owners who do not purchase their fuel.

5.9.1 Extent of Wood Smoke Control

A tax on wood fuel would increase the cost of fuel and potentially reduce how often a household uses their wood heater. The measure would impact on wood heater owners who purchase their firewood however the potential emission reduction will be reduced significantly due to the amount of fuel that is scavenged in NSW. A survey for the NSW EPA in 2003 shows that the over 50 per cent of the respondent sourced fuel from friends/relatives or through local scavenging (Todd, 2003)

5.9.2 Socio-economic impacts

The fuel excise could be implemented quickly with relatively lower administration costs as market mechanisms are generally less costly to administer than regulations. Revenue from the excise could also be used to cover the administration costs. There will be some impact to wood heater sales due to the higher operating costs and some loss of consumer surplus.

Table 12 Tax on fuel assessment

	Extent of wood smoke control				Economic impacts and costs		
	Efficiency	**Heaters Impacted**	**Emissions Reduction**	**Timing**	**Industry**	**Consumers**	**Administrative Costs**
Contribution to Public Benefit	Med/High	Medium	Medium	High	Low cost	Low cost	Low cost

(1) Assessment of Benefit to Public using Common Metric for Assessment in Figure 10.

5.9.3 Distribution effects and spatial impacts

A fuel tax would increase the cost of operating wood heaters which will mean that low income groups would have to pay more to heat their house. The revenue from the tax could also be used to support low income groups who will be proportionally more affected.

5.9.4 State-wide uniformity and consistency

A state-wide tax on fuel would be consistent across the state. The impacts of the tax would be greater in areas that had greater fuel sales which may coincide with priority areas for wood smoke reduction.

5.9.5 Consistency with national approach

A tax on wood fuel would not conflict with the proposed national approach.

5.9.6 Practicality

A tax on fuel may create an incentive for more wood heaters owners to scavenge fuel instead of paying higher prices to purchase fuel.

This measure is assessed in the detailed cost benefit analysis.

5.10 Cash incentive phase out

A cash incentive is a rebate or other financial instrument to provide incentive for current wood heater owners to change over their existing wood heater to a more efficient model or alternative heating system. As noted in Chapter 3, wood heater rebates have been between $500 and $700 per system in NSW.

5.10.1 Extent of Wood Smoke Control

A cash incentive would be provided when a wood heater owner replaced an inefficient wood heater or removed the wood heater entirely. The phase out would result in emission reductions above the current regulatory regime but less than the total emissions of wood heaters as some owners may not take up the incentive.

5.10.2 Socio-economic impacts

A cash incentive program can be easily implemented and has minimal impact on industry and consumers. The administrative costs are comparably high due to the cash incentive costs being incurred by the Government.

Table 13 Cash incentive assessment

	Extent of wood smoke control				Economic impacts and costs		
	Efficiency	**Heaters Impacted**	**Emissions Reduction**	**Timing**	**Industry**	**Consumers**	**Administrative Costs**
Contribution to Public Benefit	Med/High	High	Med/High	High	Minor cost	Minor cost	High cost

(1) Assessment of Benefit to Public using Common Metric for Assessment in Figure 10.

5.10.3 Distribution effects and spatial impacts

The cash incentive program could also target low income groups to assist these groups in replacing their existing heaters with cleaner heating systems. The incentive could also be targeted in priority areas with a subsequent ability to provide large rebates for a smaller group of wood heater owners. This may increase the proportion of wood heater owners who access the incentive.

5.10.4 State-wide uniformity and consistency

A state-wide cash incentive would be a consistent policy but the costs of providing sufficient cash incentives may be prohibitive.

5.10.5 Consistency with national approach

A cash incentive measure would complement the proposed national approach as the incentive would persuade a greater number of wood heater owners to purchase wood heaters certified under the new efficiency standard.

5.10.6 Practicality

The potential cost of state-wide cash incentives for wood heaters to replace or remove their wood heaters would be significant. For instance, a $10M budget would only provide $500 cash incentives to 20,000 households in NSW. There may be a benefit in providing cash incentives for priority areas affected by wood smoke and support this measure with a ban of new wood heaters in the priority areas. A priority area cash incentive may generate greater wood smoke reductions in areas where wood smoke is a significant issue.

This measure is assessed in the detailed cost benefit analysis.

5.11 Summary of screening assessment

The screening assessment found that all of the control measures considered are feasible and should proceed to further development and evaluation. The screening does not assess the health benefits associated with each measure as health benefits differ across regions in NSW. The omission of a direct health benefit consideration does not detract from the analysis and no measures have been excluded on the basis of their potential health benefits.

Other key findings include:

- Some measures affect new wood heaters that are newly installed or replace old wood heaters while other measures affect existing wood heaters. The scope of coverage has implications for the success of a single measure but also supports the creation of packages of measures that impact both new and existing wood heaters. There is also an ability to maximise the health benefits of the measures by targeting priority areas with sets of measures.
- Potential packages of options will be assessed following the completion of the cost benefit analysis and may include:
  - a ban on new installations of wood heaters with a phase out at sale of house or mandated phase out
  - increased efficiency and emission standards with a phase out to turn over existing wood heater stock and a fee on new wood heaters
  - phase out of existing wood heaters at time of sale and a licensing fee
  - fuel moisture content regulation supported by a state-wide excise on fuel
- Certain control measures may have a proportionally higher impact on low income groups. Control policies could be designed to address potential impacts including the provision of rebates and cash incentives.
- Separate NSW regulation of efficiency standards for the sale of new wood heaters would be hard to enforce due to the MRA, however efficiency standards may be introduced on installation.
- There is also need to assess the types of policy and regulatory instruments that could be used to implement each of the measures.

Table 14 Contribution to public benefit

Option	Extent of wood smoke control				Economic impacts and costs		
	Efficiency	Heaters Impacted	Emissions Reduction	Timing	Industry	Consumers	Admin Costs
Ban on new wood heaters	Med/High	Med/High	Med/High	High	High cost	High cost	Medium cost
Efficiency standards	High	Med/High	Medium	Med/High	Low cost	Low cost	Low cost
Phase out at sale of house	Med/High	High	Med/High	Med/High	Minor cost	Low cost	Medium cost
Fuel moisture content	Med/High	Med/High	Low	High	Low cost	Low cost	Medium cost
Tax on new wood heaters	Medium	Med/High	Medium	Med/High	Low cost	Low cost	Low cost
Licensing fees	Med/High	High	Med/High	Med/High	Minor cost	Low cost	Medium Cost
Tax on fuels	Med/High	Medium	Medium	High	Low cost	Low cost	Low cost
Cash incentive phase out	Med/High	High	Med/High	High	Minor cost	Minor cost	High cost

(1) Assessment of Benefit to Public using Common Metric for Assessment in Figure 10.

The contribution to public benefit assessment shows the qualitatively assessed impacts of each option in each criterion. The assessment indicates that the ability for an option to control wood smoke is a combination of different impacts and no option was qualitatively assessed to have more than two 'high' contributions to public benefit and, as yet, no clearly preferable option based on wood smoke control potential. In the economic impacts and costs, the cash incentive phase out had high cost, and therefore low contribution to public benefit, for industry

and consumers but this may be balanced by the high costs of administering and funding the incentives. The ban on new wood heaters had cumulatively the highest apparent costs to industry, consumers and the government.

5.12 Control options for further development/evaluation

The feasible measures will now be included in a detailed cost benefit analysis. The assessment also revealed that there are a number of sub-options within each measure. The feasible measures for controlling wood smoke in NSW identified by the screening process include:

- ban on new wood heaters;
- new efficiency and emissions standards requiring 3g/kg and 60% efficiency or 1.5g/kg and 65% efficiency;
- phase out at sale of house or a sunset date for wood heaters;
- fuel moisture content;
- a tax on new wood heaters;
- licensing fees set a range of fee rates;
- a tax on wood fuel; and
- phase outs prompted by cash incentives.

These wood smoke control options could also be applied in case study areas or implemented as a package of control measures.

6.0 Cost Benefit Analysis of Core Options

The initial CBA assesses eight main control options as well as the BAU case. Additional options have been developed following the initial assessment so as to enhance their effectiveness and value for money. They have been evaluated generally as a variant or a combination of the main control options.

Option 1. Business as usual

Option 2. State-wide ban on sales

Option 3. Efficiency standards/emissions limit

Option 4. Phase out at sale of house or within a mandated time frame

Option 5. Fuel moisture content

Option 6. Sales tax on all new wood heaters

Option 7. Licensing fees

Option 8. Tax on fuels

Option 9. Cash incentive phase out

6.1 Projections

6.1.1 Stock and emission projection model

A model was developed for preparing wood heater stock forecasts and emission projections. The model took into account the stock and mix of wood heaters (slow combustion heater, open fireplace and potbelly stove) and their emission rates (estimates for 2008 are shown in Table 15). The proportions of open fireplace and potbelly stove heaters have steadily declined and are expected to continue to decline.

Table 15: Wood heater stock mix and emission rates in 2008

Heater type (years)	Average age (years)	Number of heaters	Average wood consumption (tonne/heater/year)	Emission factor PM_{10} (kg/tonne)	Emission factor VOC (kg/tonne)
Slow combustion heater with compliance plate	12	323,739	2.9	9.8	6
Slow combustion heater without compliance plate	17	98,454	2.9	15.3	26.5
An open fireplace	22	29,966	2	11.8	9.45
Potbelly stove	14	10,702	2.3	15.3	26.5
Total		364,407			
Average	17		2.8	10.1	17.1

Source: US EPA, 2006

Data used to calculate the average emission were collected from a single fireplace and are not representative of the general source population.

Due to limited availability of data, wood heater stock and sales projections were derived based on the heater ownership estimates and assumed retirement patterns as follows:

- The number of wood heaters as a ratio of total dwellings was estimated at 13.7 percent in 2008 (ABS 2008) and was projected to reduce to 10.7 percent by 2036 in the BAU case based on recent trends of declining ownership.
- The existing heater stock would retire gradually and totally in a 20 years period; while newly purchased heaters would be operational in the first 10 years following purchase (i.e. minimum life of 10 years);

thereafter, would retire gradually and totally in the succeeding 20 years period. Detailed projections for the BAU are shown in Appendix B.

- Heater sales comprise both new demand (from both new and existing dwellings) and replacement of (a percentage of) retiring heaters. An average growth rate of 3 percent per annum was derived for heater sales so that wood heater ownership (comprising mainly those installed post-2011) falls to 10.7 percent by 2036 in the BAU scenario. This fall in ownership is based on falling total ownership of wood heaters as retired wood heaters are not replaced and the forecast installation of new wood heaters does not fully compensate for this reduction.

The control options were examined to determine whether they had one or more of the following options. The model then used this information to prepare projections for the control options.

Table 16 Impact and possible wood smoke control measures

Impact	Possible wood smoke control measure
Replacement of wood heaters with other forms of space heating	- Cash incentives - Phase out - Licensing fees - Tax on fuels - Tax on new wood heaters
Reduction of heater sales	- State-wide ban on heater sales - Tax on new wood heaters
Reduction of existing stock	- Cash incentive - Licensing fee - Tax on fuels - Phase out
Impact on heating efficiency	- Efficiency standards/emission limits - Fuel moisture content regulation
Impact on emissions standards	- Efficiency standards/emissions limit
Price impact on fuel use	- Tax on fuels

The following assumptions were also used in the modelling analysis.

- Average price per wood heater of $1,000[4].
- A discount of 7.0% was applied as advised by the NSW Treasury (2007) with sensitivity analysis conducted using 4% and 10%.
- Without adequate data for statistical analysis, the elasticity of wood heater demand with respect to price was assumed to be 0.5. This is slightly higher than the average price elasticity of 0.37 for household appliances (Dale et al, 2008) assuming that purchasers of wood heaters also consider other heating options.

Estimated percentage reductions in fuel use and emission for different emission and heating efficiency standards were provided by BDA (BDA, 2006).

- Table 18 shows the projected impacts on emissions from the introduction of emission limits and heating efficiency standards.
- Price elasticity of 0.2 for wood consumption given that wood heating has significant fuel cost advantage over other heating types, and a proportion of 50 percent for wood fuel being purchased (with the remainder obtained from free sources).

Sensitivity analysis has not been conducted on these assumptions as the assumptions are used consistently across the options for comparison purposes.

[4] A discussion with the Australian Home Heating Association reveals that there is a range of wood heaters at a wide range of prices.

6.1.2 BAU projections

The stock model of wood heaters in NSW tracks the volume of existing and new wood heater stock including the removal of old wood heaters and the installation of new wood heaters.

Table 17 shows projections for BAU scenario where current policies, programs and education are not supplemented with new wood smoke control measures. The projection shows a decrease in wood heater stock by 13% and a reduction of 20% in PM_{10} emission (due to increasing share of combustion heaters which have lower emission rate per heater) during the period 2010- 2030.

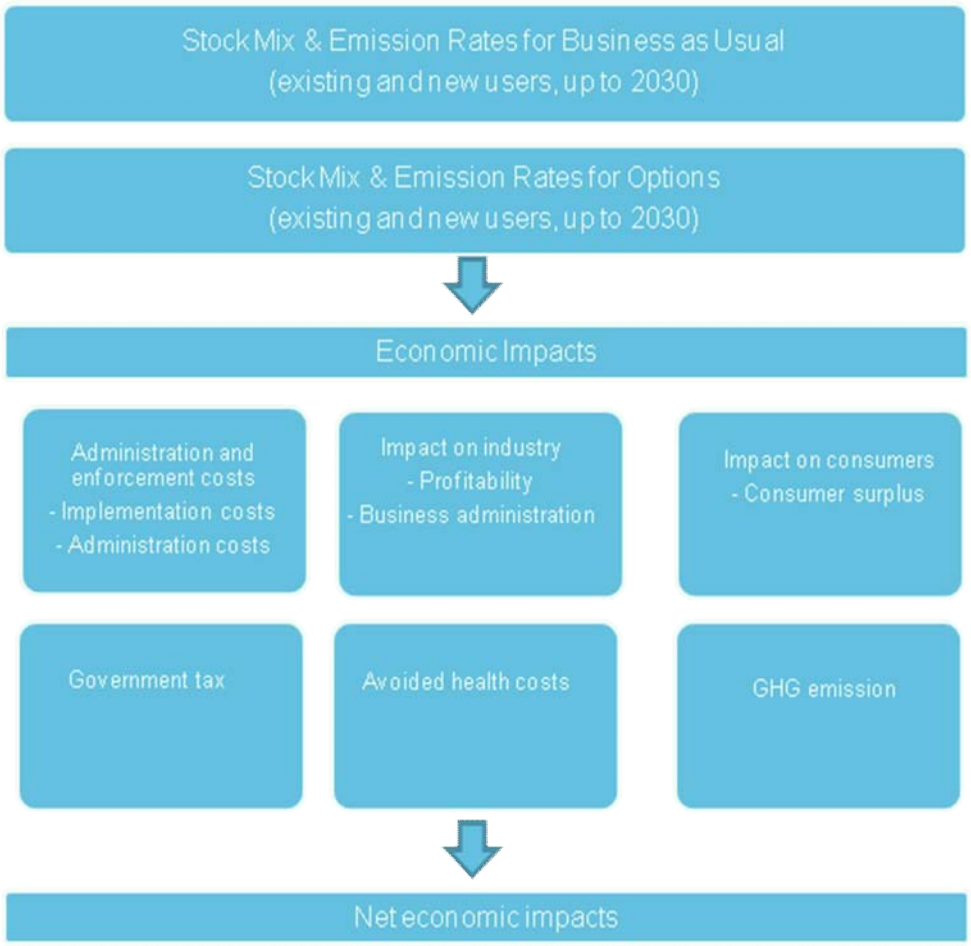
Table 17: Projections of wood heater stock and PM_{10} emissions under BAU

	2010	2015	2020	2025	2030
Stock					
Stock Installed Pre-2010	372,203	323,349	257,747	173,535	70,712
Stock Installed Post-2010	0	52,590	113,735	182,249	254,191
Total Stock	372,203	375,940	371,482	355,784	324,903
Change from 2010		1%	0%	-4%	-13%
Emission PM_{10} (tonnes/year))					
Emission from Stock Pre-2010	11,530	9,137	7,282	4,899	1,986
Emission from Stock Post-2010	0	1,489	3,221	5,164	7,207
Total Stock	11,530	10,626	10,503	10,063	9,193
Change from 2010		-8%	-9%	-13%	-20%

6.1.3 Assessment of impacts under control options

The assessment of the impacts under the control options is based on the methodology shown in Figure 11

Figure 11 Economic impact assessment methodology



Source: AECOM

The methodology includes a range of benefits and costs with the majority of the impacts to the community (health costs, consumers and industry) to result from changes to sales and emissions. The impact of the control options on heater sales and emissions is shown in
Table 18.

Table 18: Impact on industry sales

Control Option	Control factors	Impact on sales/stocks[3]	Reduction in emission per heater
2. State-wide ban on heater sales	Effectiveness of ban due to MRA?	All new sales banned; existing stock decline via natural retirement	There is no change to wood use under this option
3. Efficiency standards/emissions limit[1]	Emission limit at a. 3g/kg b. 2g/kg c. 1.5 g/kg d. 1g/kg	None [2]	 -10.0% -22.9% -28.6% -34.3%
	Heating efficiency at 60%	None [2]	Total wood use reduces by 5.6% by 2021
	Heating efficiency at 65%		Total wood use reduces by 8.8% by

Control Option	Control factors	Impact on sales/stocks[3]	Reduction in emission per heater
			2021
4. Phase out at sale of house	Decline at rate of house ownership turnover. Effect is geometric with declining ownership ratio.	Assumed to be 10% of housing stock per year as well as 10% of sales [4]	There is no change to wood use under this option
5. Fuel moisture content		No impact on sales of wood heaters	(See description below)
6. Tax on new wood heaters	Excise of $200 per heater	-10.0%[5]	There is no change to wood use under this option
7. Licensing fees	Annual licensing fee of $20	-10%[5]	There is no change to wood use under this option
8. Tax on fuels	Excise of $20 per tonne of wood fuel	-2.6%[5]	Total wood use reduces by 1.5% based on elasticity of demand[6]
9. Cash incentive phase out	Program budget of $10 million to fund phasing out of 7,000 heaters in 10 years	Only 1/3 of number of rebates is actual "induced" phasing out of stock (around 230 heaters per annum or 2%). New sales also reduce by 2% in 10 years period.	There is no change to wood use under this option

(1) Based on BDA Report, Section 7.1.4

(2) Adoption of tighter limits may cause a price increase which is not known.

(3) The impacts on sales were calculated based on:

a. policy specifications, price elasticity and the stock model

b. declining stock (i.e. reduced replacement) due to changing community attitudes to wood heater ownership.

(4) The phase out of sale of house will be approximately 10% of existing stock each year. At the same time, 10% of potential new wood heater owners will be selling their house and therefore choose not to install a wood heaters as they will have to be removed and not be used by the new owner.

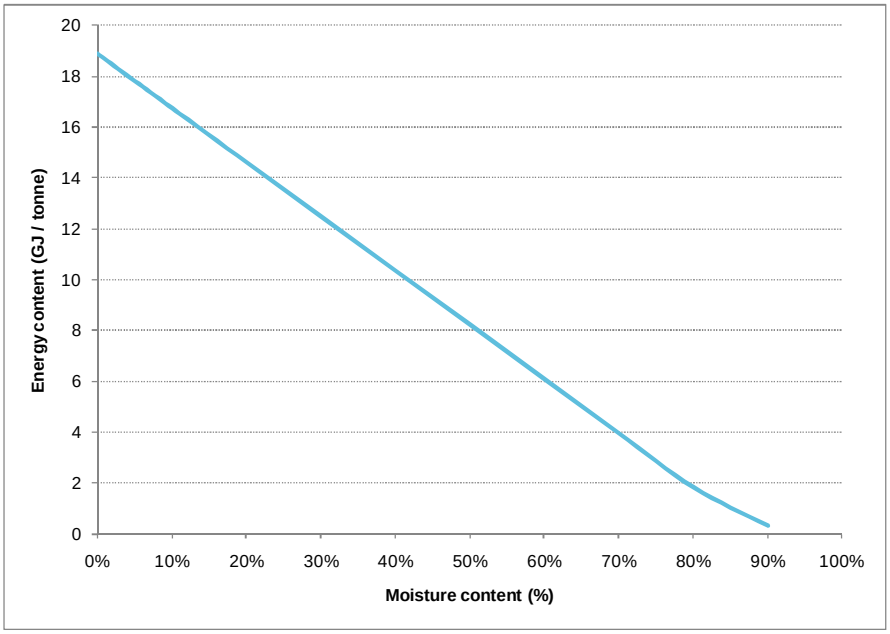
(5) The impact on sales is based on the cost of the wood heater (or wood fuel) and the assumed price elasticity of demand, which was assumed to be -0.5 e.g. A licence fee of $20 per year is equivalent to around $200 additional cost upfront. This would be similar to a 20 percent increase on wood heater price, so sales would reduce by 10 percent.

(6) The change in wood use as a result of the price increase on wood fuels is a function of the price elasticity of demand and the cost of wood fuel. This reduction also accounts for the level of scavenging for wood fuel in NSW.

For Option 5 (fuel moisture content regulation), the effect on emission reduction was derived by:.

- This study determined the relationship between fuel moisture content and energy content from EECABusiness (2011) as shown in Figure 12.

Figure 12 Moisture content and energy content relationship



Source: EECABusiness, 2011

- Figure 12 depicts the relationship between moisture content and energy content. Wood fuel with moisture content of 55% has approximately half the energy content as wood fuel with a moisture content of 20%. The lower energy content means a greater amount of fuel is required for the same total energy.
- The control would only impact on wood fuels put on sale (38% of total) and not those obtained from free sources. Report by J Todd (2003) (section 2.2.4) indicated that moisture content is already less than 20 percent for the bulk of firewood on sale, so the control would impact only on a small percentage of sale, assumed to be 20 percent or equivalent to 7.6 percent of total wood use.
- As this high moisture fuel needs be deferred for a period to achieve compliance (say by 6 months), its price may increase. At an annual discount rate of 10%, the cost of wood fuel would increase by 5% as result of the delay. The weighted average fuel cost would increase by only 0.4 percent as the bulk of wood fuel for sale is already below the wood fuel moisture content regulation and the price of only a small proportion of wood fuel would rise. Since the price effect was found to be insignificant, it was not included in the calculation.

6.1.4 Projections for control options considered

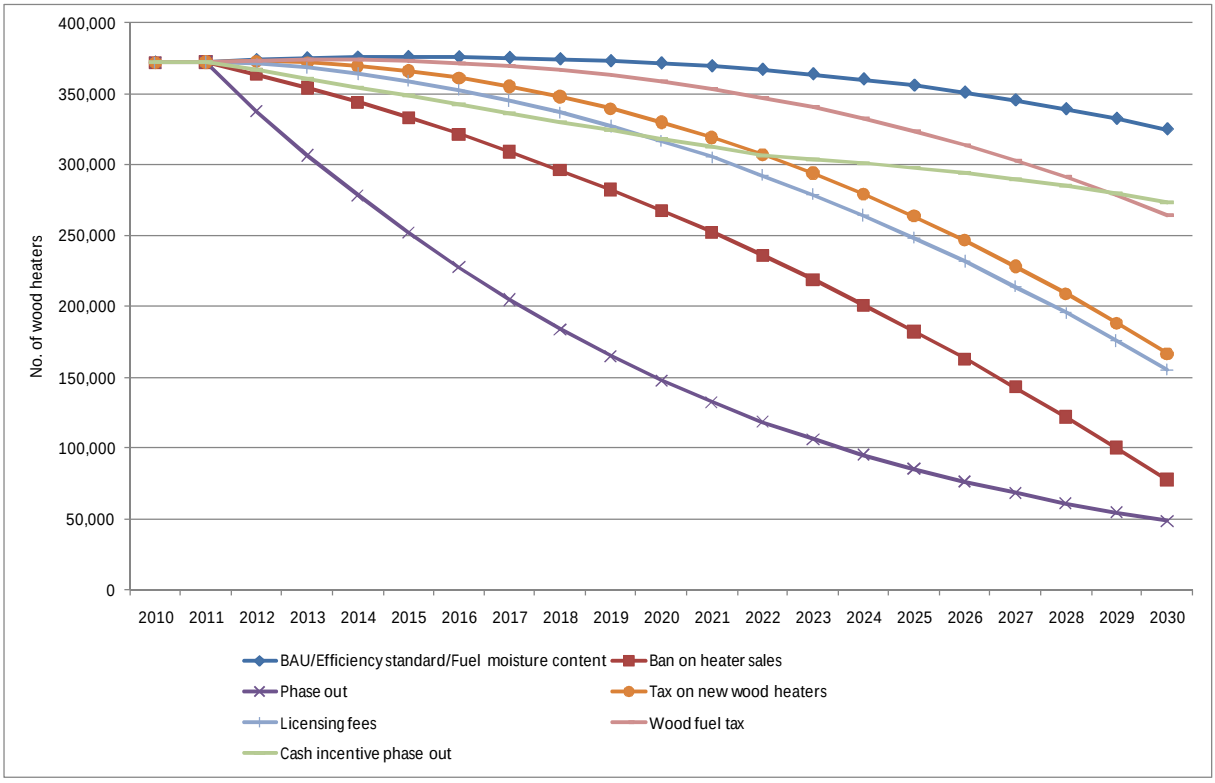
The stock model developed for existing and future wood heater ownership in NSW was used to generate projections of wood heater ownership under each option.

A visual comparison of these projections is shown in Figure 13. The figure shows that the forecast BAU stock shows a small decline out to 2030. The projection of wood heater stocks for the efficiency standard/emissions limit and fuel moisture content options do not deviate from the BAU projection[5].

[5] A comparison of the BAU and ABARE projections on domestic biomass fuel use was made. ABARE projections show a levelling off of fuel consumption to 2030 while BAU projections forecast a slight reduction in heater ownership and emission. Detail of ABARE forecasting method and assumptions were not available to allow more rigorous comparison.

The most significant reduction in stock is a result of the phase out option with similar reductions in stock by 2030 under the ban on new wood heater sales. The remaining options, tax on new wood heaters, licensing fees, wood fuel tax and cash incentive phase out, have lower impacts on the projected stock of wood heaters.

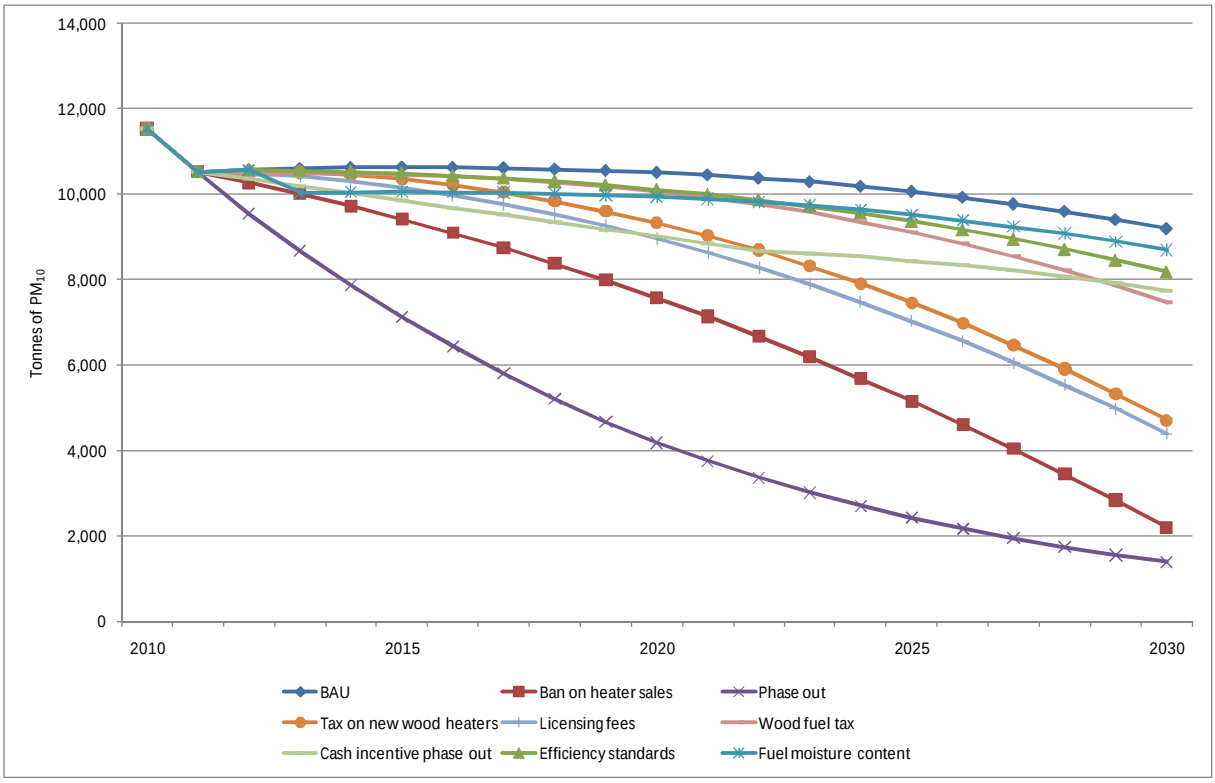
Figure 13 Stock projections for different options



Source: AECOM stock model

Reductions in the stock of wood heaters provide an indication of the effectiveness of each option to reduce wood smoke emissions. However, it is not a final measure since options 3 (efficiency standard/emissions limit) and 5 (fuel moisture content regulation) also reduce the emission rate per heater. An assessment of the PM_{10} emissions associated with each option is provided in Figure 14.

Figure 14 PM_{10} emissions projections for each option



Source: AECOM stock model

$PM_{2.5}$ and VOC emissions were not projected separately but assumed to change according to PM_{10} emissions. Option 2 (state-wide ban) and option 4 (phase out) provide the most rapid reductions in PM_{10} while option 6 (tax on new wood heaters) and option 7 (licensing fee) are the next most successful at reducing emissions. Option 6 (wood fuel tax), option 9 (cash incentive) and option 3 (efficiency measures) provide modest emission reductions compared to BAU. Option 5 (fuel moisture content regulation) provides a relatively small emission reductions when compared to the BAU.

The following tables depict the stock and emissions associated with each option at certain time points. The commencement date of the core options is 2012.

6.1.5 Ban on heater sales

The ban on all heater sales in NSW has significant impact on the total stock and total emissions to 2030. There a limited number of wood heaters sold between 2010 and the introduction of the ban in 2012.

	2010	2015	2020	2025	2030
Stock					
Stock Installed Pre-2010	372,203	323,349	257,747	173,535	70,712
Stock Installed Post-2010	0	9,894	9,894	8,885	7,240
Total Stock	372,203	333,243	267,641	182,419	77,952
Change from 2010		-10%	-28%	-51%	-79%
Emission PM_{10} (tonnes/year)					
Emission from Stock Pre-2010	11,530	9,137	7,282	4,899	1,986

	2010	2015	2020	2025	2030
Emission from Stock Post-2010	0	280	280	252	205
Total Stock	11,530	9,417	7,563	5,151	2,191
Change from 2010		-18%	-34%	-55%	-81%

1) The ban would not being until 2012 which means that a small number of wood heaters will have been purchased between 2010 and 2012.

6.1.6 Efficiency standards and emissions limits

The modelled efficiency standard and emissions limit is 60% and 3.0g/kg respectively. Further modelling can be undertaken on different efficiency standards and emissions limits during detailed policy development.

	2010	2015	2020	2025	2030
Stock					
Stock Installed Pre-2010	372,203	323,349	257,747	173,535	70,712
Stock Installed Post-2010	0	52,590	113,735	182,249	254,191
Total Stock	372,203	375,940	371,482	355,784	324,903
Change from 2010		1%	0%	-4%	-13%
Emission PM_{10} (tonnes/year)					
Emission from Stock Pre-2010	11,530	9,137	7,282	4,899	1,986
Emission from Stock Post-2010	0	1,348	2,820	4,463	6,185
Total Stock	11,530	10,485	10,102	9,362	8,171
Change from 2010		-9%	-12%	-19%	-29%

6.1.7 Phase out

The phase out of wood heaters affects the pre-2010 installed stock which are removed when the house is sold and the general attractiveness of purchasing/replacing a wood heater.

	2010	2015	2020	2025	2030
Stock					
Stock Installed Pre-2010	372,203	212,150	99,857	39,699	9,552
Stock Installed Post-2010	0	40,027	47,893	45,749	39,149
Total Stock	372,203	252,176	147,749	85,448	48,701
Change from 2010		-32%	-60%	-77%	-87%
Emission PM_{10} (tonnes/year)					
Emission from Stock Pre-2010	11,530	5,995	2,821	1,121	268
Emission from Stock Post-2010	0	1,133	1,356	1,296	1,110

	2010	2015	2020	2025	2030
Total Stock	11,530	7,128	4,178	2,417	1,378
Change from 2010		-38%	-64%	-79%	-88%

6.1.8 Fuel moisture content

The fuel moisture content regulation does not reduce sales or reduce number of pre-2010 wood heaters however the reduced moisture content of the wood fuel does reduce overall emissions compared to BAU.

	2010	2015	2020	2025	2030
Stock					
Stock Installed Pre-2010	372,203	323,349	257,747	173,535	70,712
Stock Installed Post-2010	0	52,590	113,735	182,249	254,191
Total Stock	372,203	375,940	371,482	355,784	324,903
Change from 2010		1%	0%	-4%	-13%
Emission PM_{10} (tonnes/year))					
Emission from Stock Pre-2010	11,530	8,613	6,864	4,618	1,872
Emission from Stock Post-2010	0	1,436	3,069	4,898	6,818
Total Stock	11,530	10,048	9,933	9,515	8,690
Change from 2010		-13%	-14%	-17%	-25%

6.1.9 Tax on new wood heaters

The tax on new wood heaters reduces new sales of wood heaters with an associated reduction on emissions.

	2010	2015	2020	2025	2030
Stock					
Stock Installed Pre-2010	372,203	323,349	257,747	173,535	70,712
Stock Installed Post-2010	0	42,801	72,185	90,034	95,928
Total Stock	372,203	366,150	329,932	263,569	166,641
Change from 2010		-2%	-11%	-29%	-55%
Emission PM_{10} (tonnes/year)					
Emission from Stock Pre-2010	11,530	9,137	7,282	4,899	1,986
Emission from Stock Post-2010	0	1,211	2,044	2,551	2,720
Total Stock	11,530	10,349	9,327	7,450	4,706
Change from 2010		-10%	-19%	-35%	-59%

6.1.10 Licensing fees

The licensing fees reduces the usage of existing wood heaters as well as reducing the number of wood heaters sold due to higher overall costs.

	2010	2015	2020	2025	2030
Stock					
Stock Installed Pre-2010	372,203	316,931	246,378	161,774	64,289
Stock Installed Post-2010	0	42,281	70,364	86,706	91,271
Total Stock	372,203	359,212	316,742	248,480	155,560
Change from 2010		-3%	-15%	-33%	-58%
Emission PM_{10} (tonnes/year)					
Emission from Stock Pre-2010	11,530	8,956	6,961	4,567	1,806
Emission from Stock Post-2010	0	1,197	1,993	2,457	2,588
Total Stock	11,530	10,152	8,954	7,024	4,393
Change from 2010		-12%	-22%	-39%	-62%

6.1.11 Tax on wood fuel

The tax on wood fuel reduces the overall wood heater usage with a corresponding reduction in emissions.

	2010	2015	2020	2025	2030
Stock					
Stock Installed Pre-2010	372,203	323,349	257,747	173,535	70,712
Stock Installed Post-2010	0	49,886	100,830	150,344	193,565
Total Stock	372,203	373,236	358,577	323,879	264,278
Change from 2010		0%	-4%	-13%	-29%
Emission PM_{10} (tonnes/year)					
Emission from Stock Pre-2010	11,530	9,046	7,210	4,850	1,966
Emission from Stock Post-2010	0	1,412	2,856	4,260	5,488
Total Stock	11,530	10,458	10,065	9,110	7,454
Change from 2010		-9%	-13%	-21%	-35%

6.1.12 Cash incentive phase out

The cash incentive phase out reduces the number of existing wood heaters with a corresponding reduction in emissions.

	2010	2015	2020	2025	2030
Stock					
Stock Installed Pre-2010	372,203	298,247	214,896	138,955	56,622

	2010	2015	2020	2025	2030
Stock Installed Post-2010	0	50,467	103,505	159,067	216,526
Total Stock	372,203	348,714	318,401	298,022	273,148
Change from 2010		-6%	-14%	-20%	-27%
Emission PM_{10} (tonnes/year)					
Emission from Stock Pre-2010	11,530	8,428	6,072	3,923	1,590
Emission from Stock Post-2010	0	1,428	2,931	4,507	6,139
Total Stock	11,530	9,856	9,003	8,430	7,729
Change from 2010		-15%	-22%	-27%	-33%

6.2 Administration and enforcement costs

Similar administration and enforcement costs are required in regulatory and market mechanism options. Two types of cost are considered: implementation cost and administrative cost.

6.2.1 Implementation cost

Implementation cost is incurred only once when establishing the policy, regulation or program. For Options 2-8, introduction of a regulation will be necessary as well as the establishment of relevant standards, registration procedures and/or compliance process. These costs are assumed to be around $50,000 for Option 2, since it requires minimum supporting arrangements and $100,000 for Options 3-9 due to the levels of their complexity.

6.2.2 Administrative cost

Administrative cost includes the ongoing cost to government to manage and enforce the policy, regulation or program. The RIS 2010 estimated the cost of OEH administration of the wood heater provisions at $6,200 per annum[6] (DECCW, 2010). This estimate is considered to be low because the proposed options have significantly wider scope and tighter controls than what have been in place to date. More significant resource would therefore be required for on-going promotion and awareness activities, updating of policy/regulatory information, and compliance audit. Option 9 requires less resources for assessment of rebate eligibility, assumed to be 2 hours at $40 per hour plus 30% on-cost for each rebate. Estimates of these costs are summarised in Table 19.

Table 19: Administrative costs

Cost Item	Estimated cost per annum ($)	Applicable to:
Ongoing promotion and awareness, updating information materials, use of website etc	$30,000	Options 2-9
Development of technical standards	$30,000	Option 3 only
Regulatory, compliance and enforcement activities - monitoring, inspections, investigations etc; and renewal of regulatory instrument every five years	$40,000	Options 2-8
Assessment of rebate eligibility	$104 per rebate	Option 9 only

The administration costs associated with state-based levies may be more significant than the administration cost for other control options. In 2010, the Department of Environment, Climate Change and Water received approximately $290M in waste-related levies and fees (DECCW, 2010). The costs of administering a state-wide levy represent a fraction of the levy revenue, for which detailed information was not available to AECOM at this stage. Since the wood smoke levy may not involve assessing the tax base (required for the waste levy as to weight and waste category) its administration cost may be lower.

[6] . based on 0.06 EFT at an annual salary of $79,992 plus 30% on-costs

6.2.3 Public and consumer education

For control options designed to curtail significantly the purchase of new or replacement wood heaters or ownership levels, a substantial on-going public and consumer education program is likely to be required.

Each of the options includes an education program to inform the public. The size and cost of the program would have to be assessed in detail for each option however, in this analysis, a standard education program comprises of:

- developing education program scope at a cost of $20,000;
- developing an online calculator at a cost of $20,000; and
- disseminating and/or advertising control policy or regulation at a cost $30,000.

The state-wide standard education program costs $70,000 in total per year and needs to be updated every five years.

6.3 Cost to industry

The wood smoke control options will have the following impacts on the wood heater industry. The impact on producer surplus is a potential indicator for the industry impact however it does not enable an effective assessment given sales into other jurisdictions and an unknown price elasticity of supply.

6.3.1 Impact on profitability

Impact on sales by various control options can range from minimal to severe. Options 3 (efficiency standards) and 5 (fuel moisture content) have minimal impact. Option 2 (state-wide ban on sales) would significantly affect the wood heater industry in NSW. Options 4 (phase out) and 6-9 (licensing fees, tax on fuels and cash incentive) are likely to have significant impact on sale levels.

Industry impacts can be assessed in terms of number of employees affected or loss of profitability for the industry. Use of the former indicators would tend to exaggerate the impacts because the industry and its employees are expected to shift their resources to other productive sectors. This evaluation used loss of profit as the measurement of impact, assuming that current utilisation of capital and labour resources achieves higher margin and productivity respectively in the industry than they would if required to move to other sectors. Table 20 shows the impact to industry of each option.

Table 20: Impact on industry sales

Control Option	Loss of profitability NPV ($M)[4]
2) State-wide ban on heater sales	-30.5
3) Efficiency standards/ emissions limit	0.0[5]
4) Phase out	-3.1
5) Fuel moisture content regulations	0.0
6) Sales tax/excise on new wood heaters - $200 per heater[1]	-3.1
7) Licensing fees - Annual fee of $20	-3.2
8) Levying an excise/tax on biomass fuels	-0.8
9) Cash incentive phase out [3]	-0.6

(1) A variant is an excise only on low efficiency heaters i.e. > 1.5g emission / 65% heating

(2) Based on input-output multiplier of 2.2 employees per $1 million output (ABS, 2001)

(3) Program budget of $4.1 million to fund “induced” phasing out of 7,000 heaters in 10 years

(4) Profitability based on 30% of gross turnover[7]

(5) Adoption of efficiency standards and emissions limits may cause a price increase for wood heaters which is not known.

6.3.2 Business administration cost

Manufacturers or suppliers of wood heaters and wood fuel will have responsibility for compliance with wood heater control regulations. The following business compliance costs will be incurred with most control options, but not with options 2 (ban), 4 (phase out) and 9 (cash incentive).

The costs of compliance were identified as follows:

- staff education – involves maintaining awareness of legislation and regulations, and the costs of keeping abreast of changes to regulatory details

[7] ‘Margins by Sector’ using Value Line database, of 5928 firms by A Damodaran (January 2011)

- permission (Option 3 only) – involves applying for and maintaining permission for registration to conduct an activity, usually prior to commencing that activity
- record keeping – involves keeping statutory documents up-to-date.

Table 21 shows the inputs used and the estimated cost per model and total industry cost based on 275 wood heater models available in the market in Australia (BDA, 2006).

Table 21 Business Compliance Cost

Category	Task	Cost Inputs	Cost per model per annum	Industry cost per annum
Education	Train staff	Keep up-to-date 2 hours per year per model with regulations or control programs	$104	$28,600
Permission (Option 3 only)	Complete registration of efficiency standards	4 hours per year per model supplied	$208	$57,200
Record Keeping	Maintain documents as required	2 hours per year per model	$104	$28,600
Total				$114,400

Notes : labour cost charged at $40 per hour plus 30% on-cost

6.3.3 Testing costs under Option 2 (Efficiency Standards)

The BDA report (BDA, 2006) estimated that about 275 wood heater models on the market were certified as compliant with AS4013. With compliance testing required to be renewed every five years, on average, 55 wood heater models would require compliance testing and certification each year. Manufacture and design costs to meet AS4013 were not expected to be significant and have not been estimated.

The average cost of AS4013 compliance testing and certification is $10,700 per wood heater model (BDA 2006). For the estimated 55 wood heater models compliance tested in Australia, the annual cost to industry would be $588,500. Based on the State's proportion of 39 percent of wood heater ownership, the industry cost for compliance testing under Option 3 (emissions standards and efficiency limits) in NSW was estimated at around $230,000 per year in 2006.

For the purpose of the cost benefit analysis, it is assumed that industry will pass the business compliance and/or testing costs on to customers[8] although this cost is not considered to be significant.

6.4 Impact on consumers

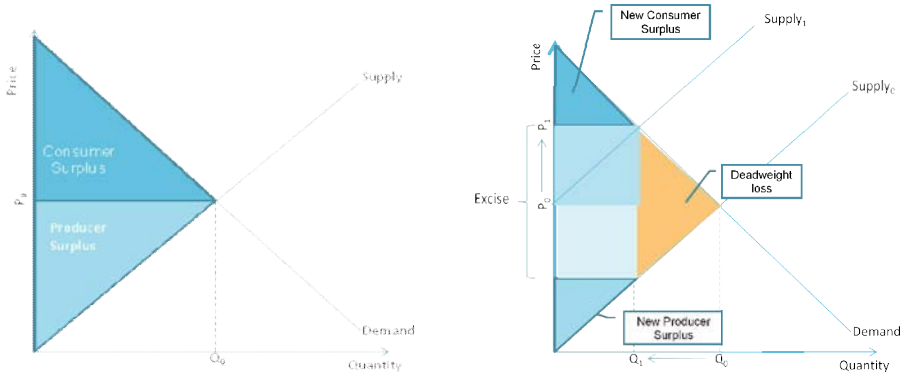
The consumer surplus for a customer in a market is the difference in the amount that a customer would be willing to pay for a good or service (i.e. new wood heater) and the price that they actually pay (ACMA, 2009). This is graphically represented as the dark blue area in the chart on the left of Figure 15.

The amount that a customer is willing to pay is that customer's 'walk-away' valuation of the good or service, that is, the price beyond which they will no longer be willing even to negotiate. Another term for 'willingness to pay' is reservation price. This value or 'price' is information privately held by the customer and not revealed to a seller. The price actually paid by a customer is equal or lower than a customer's reservation price and the larger the gap between the two, the greater the feeling the customer has of having received a 'bargain'. The size of the gap (the consumer surplus) is consequently a measure of a customer's relative 'happiness' or 'benefit' arising out of the transaction. The consumer surplus for a whole market is derived by adding the consumer surpluses of all customers.

[8] These costs only need to be accounted for once in the CBA.

The assessment of the net public benefit flowing from the control measures will include their impact on the consumer surplus. Figure 15 shows the loss of consumer surplus as a result of levying an excise on new wood heaters.

Figure 15 Consumer Impact of Excise on Wood heaters



Source: AECOM

A hypothetical increase in the price of wood heaters through the introduction of an excise will increase the price of wood heaters. This price increase from the excise reduces the quantity of wood heaters demanded and therefore reduces the consumer surplus; the area below the demand curve and above the price (P1). The amount of consumer surplus loss is dependent on the size of the excise and the responsiveness of people to price changes (elasticity of demand). There are impacts on the producer surplus and taxes collected from the excise as well as the creation of deadweight loss however the consumer does not differentiate between these costs. Consumers only experience the change in consumer surplus. The impact on industry and the resulting tax revenues are examined in other sections.

The reduction in consumer surplus generally appears as reduction in the value that people gain from the consumption of goods and services. In this case, less people would be able to purchase wood heaters and experience the private benefits of relatively cheap heating and aesthetics.

Consumer surplus will be altered with a change in price or with a change in a non-price characteristic (such as quality or delivery time) of a good or service. The differences between a change in price and a change in a non-price characteristic have implications for the process for measuring the impact on consumer surplus.

The total consumer surplus net the tax revenue loss is shown in Table 22.

Table 22 Consumer surplus impact from each option (net transfer payments)

Options	Impact on Consumer Surplus NPV ($M)
2) State-wide ban on heater sales	-$101.7
3) Efficiency standards/emissions limit	$0.0
4) Phase out	-$19.3
5) Fuel moisture content regulations	$0.0
6) Sales tax/excise on new wood heaters	-$14.9
7) Licensing fees	-$3.9
8) Levying an excise/tax on biomass fuels	$34.4
9) Cash incentive phase out	$0.0

Source: AECOM

The largest consumer impact is the state-wide ban on wood heaters. This impact was flagged in the preliminary assessment given the total restriction on wood heater sales. The impact of the phase out on consumer surplus is

a result of the change to wood heater sales from the removal and eventual phase out of wood heaters. Future wood heater consumers will factor in the phase out and make purchase decisions on this basis.

The impact of market mechanisms (taxes and licensing fees) is relatively lower than the regulatory measures except for the efficiency standards/emissions limit. The difference in the market mechanisms is that the licensing fee applies to all wood heaters while the sales tax applies only to new wood heaters and the fuel tax applies only to purchased fuel.

6.5 Transfer payment - government tax revenue

Tax revenues to government are considered as transfer payments and are not a cost or benefit. This is because government taxes are used to fund other services in the community. Only Options 6, 7 and 8 generate tax revenues, which are shown in Table 23. The government revenue is not included in the subsequent CBA and is subtracted from the consumer surplus.

Table 23 Government tax revenue

Option	Description	NPV ($M)
6	Tax on new wood heaters	4.4
7	Licensing fees	16.5
8	Wood fuel tax	39.6

Note: Calculated by multiplying forecast wood heater sales (or stock) by tax.

6.6 Benefits of avoided health costs

Air pollution released by the burning of wood in wood heaters has been shown to impact on human health. These health impacts can be converted into health costs through a willingness-to-pay (WTP) assessment or human capital assessment. These two assessments determine an economic cost for `a particular health impact which can be used to determine the cost of the health impact or benefit of avoided health cost.

A meta-analysis of cohort-based long-term United States studies by Kunzli et al in 2000 derived a series of exposure-response functions for a range of air pollutants and health outcome. An exposure-response function provides an estimate of the increase in risk of a health outcome with an incremental increase in exposure to a particular air pollutant. For example, the exposure-response function for mortality associated with PM_{10} was calculated to be a 4.3% increase in mortality for each 10μg/m3 increase in exposure to PM_{10}.

These exposure-response functions were used by the Bureau of Transport and Regional Economics (BTRE) to calculate the health cost and environmental effects of ambient concentrations of air pollution. The analysis, conducted using 2000 data, estimated the impacts attributable to air pollutants (BTRE, 2005). This study estimated, that in 2000, motor vehicle particulate pollution accounted for between 900 and 4500 morbidity cases—cardio-vascular disease, respiratory disease, and bronchitis—and for between 900 and 2000 early deaths. The range of estimates is a result of the range of exposure-response functions developed by Kunzli et al. BTRE also used a WTP economic assessment to calculate the value of human health.

A cost benefit analysis on transport fuel quality and vehicle standards conducted for the MVEC Review of Vehicle Emissions and Fuels Standards Post 2006 used exposure-response functions based on a review of Australian and international epidemiological studies to measure the health improvements associated with four vehicle emissions and fuel quality standards in Australia (Coffey, 2003). The exposure-response functions used in the cost benefit analysis by Coffey included the functions developed by Kunzli et al (2000). The cost benefit analysis adopted a range of cost estimates for health impacts, primarily relying on WTP studies from Australia and abroad.

Beer (2002) also undertook an assessment of pollutants based on published assessments of Australian health impacts from air pollutants. A separate assessment by the BDA Group (2006) used health costs per tonne based on data supplied by the Australian Department of the Environment and Heritage. The data provided health costs per tonne of PM_{10} by capital city.

The Australian Department of Infrastructure, Transport Regional Development and Local Government (DITRDLG) undertook an assessment of the health costs conducted to date including Beer (2002), BTRE (2005) and Coffey (2003). The results of the assessment were presented as health costs adjusted for 2010 in the Draft Regulatory Impact Statement for the Review of Euro 5/6 Light Vehicle Emissions Standards (DITRDLG, 2009). DITRDLG

accounted for the fact that the scale of the impact depends on the area where the air pollutant is present with greater health impacts seen in more populated centres such as capital cities.

The US EPA recently released an approximate health cost for $PM_{2.5}$ (US EPA, 2010) which has been included in this assessment. There is limited or no health costs studies relating to the cost of $PM_{2.5}$ in Australia.

The results of the range of health cost assessments are summarised in Table 24.

Table 24 Health costs by air pollutant type

Air Pollution Studies		VOCs	PM_{10}
		$/tonne	$/tonne
DITRDLG, 2010	Rural	105	55,825
	Capital City	8,830	235,260
Beer, 2002	Lower	11,700	108,300
	Best	19,331	147,429
	Upper	72,500	221,100
Coffey, 2003	Capital City	2,200	232,000
BDA, 2006	Sydney	N/A	133,543

Source: DITRDLG, 2010; Beer, 2002; BDA Group, 2006 and Coffey, 2003, US EPA 2010

The DITRDLG costs were chosen for PM_{10} and VOCs as the most relevant costs estimation for the pollution components. These health costs were then weighted by the following process. The weighting recognises that there is a significant difference between the health costs in capital cities and rural regions. It is recognised that the health costs differed on the basis of population density so population density was used to weight the health costs in regions across NSW. The calculation of weighted health costs was undertaken by the following steps

1) health costs for all urban areas were assigned the capital city health cost per tonne (i.e. Sydney) of $235,260 for PM_{10} and $8,830 for VOC

2) health costs for all other areas (regional centres and rural areas) were calculated using population density as an adjustment factor i.e. health cost $_i$ = health cost Sydney * (density for area i) / (Sydney density). These estimates are only indicative as a better evidence based scientific method for estimation is not available at this stage.

The weighting undertaken for this assessment provides health costs for the number of regions in NSW that are not rural or a capital city.

The weighted air pollution costs for the core options health cost assessment are presented in Table 25, recognising that the significant difference between population densities in regional/rural to capital cities.

Table 25 Weighted health costs

Air Pollution	$/tonne
PM_{10}	$72,114
VOC	$2,624

Source: DITRDLG, 2010, US EPA 2010 – weighted by AECOM

The calculation of the benefit of avoided health cost is centred on the valuation of the reduced emissions from each control option in relation to the BAU. The results of the health cost and avoided health cost analysis is presented in Table 26.

Table 26 Total health costs and avoided health costs from BAU (NPV $ million)

NPV ($M)	Absolute health costs			Avoided health costs		
Option	PM_{10}	VOC	Total Health Cost	PM_{10}	VOC	Avoided Health Costs
1) BAU	-$7,897	-$175	-$8,072			

NPV ($M)	Absolute health costs			Avoided health costs		
Option	PM_{10}	VOC	Total Health Cost	PM_{10}	VOC	Avoided Health Costs
2) Ban on heater sales	-$5,740	-$127	-$5,867	$2,158	$48	$2,206
3) Efficiency standards (60%, 3g/kg)	-$7,603	-$168	-$7,772	$294	$7	$301
4) Phase out at sale of house	-$3,970	-$88	-$4,058	$3,928	$87	$4,015
5) Fuel moisture content regulations	-$7,507	-$166	-$7,673	$391	$9	$399
6) Sales tax on new wood heaters	-$6,871	-$152	-$7,023	$1,026	$23	$1,049
7) Licensing fees	-$6,658	-$147	-$6,805	$1,240	$27	$1,267
8) Levying an excise/tax on biomass fuels	-$7,488	-$166	-$7,654	$410	$9	$419
9) Cash incentive phase out	-$7,038	-$156	-$7,194	$860	$19	$879

Source: AECOM

Note: The absolute health costs refer to the amount of health costs incurred across NSW as a result of the composition of the wood smoke. The total health costs are the NPV of the health costs for BAU and each option. The avoided health costs are the benefits of the each option and are the difference between the total health costs in each option and the health costs under BAU.

$$BAU\ (Total\ Health\ Costs) - Option\ X\ (Total\ Health\ Costs) = Avoided\ Health\ Costs$$

The most significant avoided health are associated with option 2 (state-wide ban) and option 4 (phase out). This is in line with them having the greatest emission reductions potential of the options. Option 9 (cash incentive), option 6 (tax on new wood heaters) and option 3 (efficiency standards/emission limits) are relatively similar in avoided health costs. The two options aimed at fuel use have the lowest impact (option 5 and 8)

The avoided health cost assessment also provides an indication of the potential size of avoided health costs from a package of options. The combination of an efficiency standard/emission limit and cash incentive phase out may generate avoided health costs that are comparable to a state-wide ban. The present values are calculated based on a 7% discount rate and the time period is 2010 to 2030.

6.7 Greenhouse gas emissions assessment

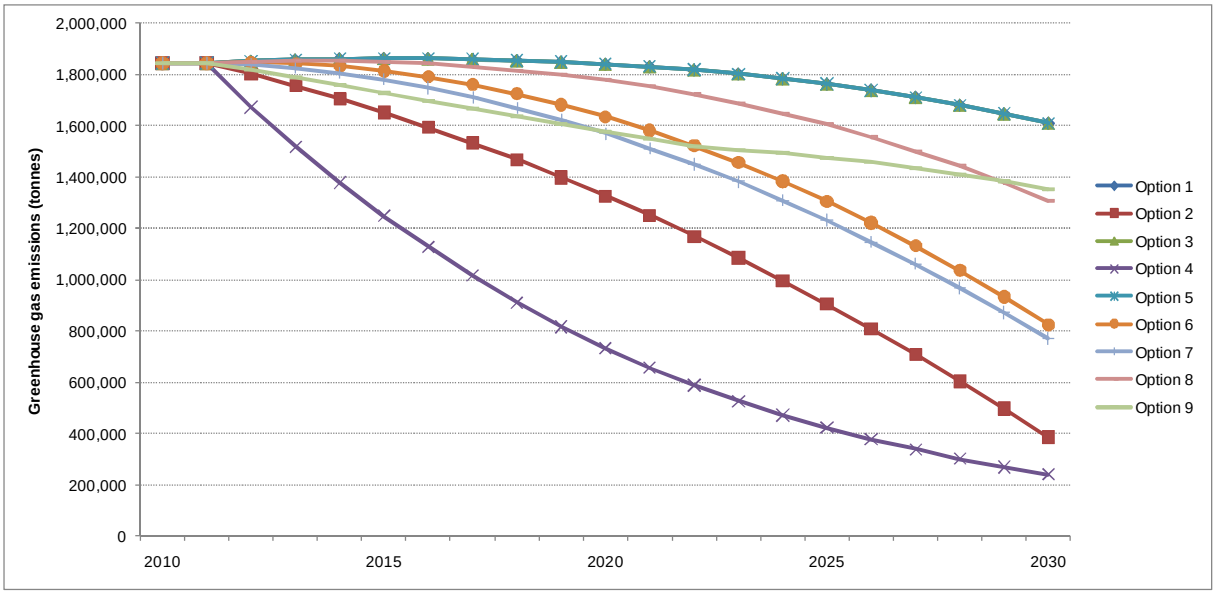
An assessment of the direct greenhouse gas emission (GHG) reductions attributable to each control options is shown in Figure 16. The assessment of GHG emissions was taken from the US EPA (2006) and includes carbon dioxide (CO_2), methane and nitrous oxide (NO_2) expressed as tonnes of carbon dioxide equivalent ($CO_{2\text{-}e}$). These factors account for the emissions associated with the combustion of the wood fuel unlike the National Greenhouse Account factors that assume the combustion of wood is a neutral greenhouse gas emission activity.

Table 27 Greenhouse gas

	Carbon Dioxide (kg/t)	Methane (kg/t)	Methane-CO_2 Equivalent Factor	NO_2 (kg/t)	NO_2-CO_2 Equivalent Factor	GHG Emissions per year (t $CO_{2\text{-}e}$ per heater)
Slow combustion heater with compliance plate	1387.7	14.20	21.00	0.15	310.00	5.03
Slow combustion heater without compliance plate	1146.1	32.00	21.00	0.15	310.00	5.40
An open fireplace	1357.8	7.20	21.00	0.15	310.00	3.13
Potbelly stove	1146.1	32.00	21.00	0.15	310.00	4.32

Source: US EPA. 2006

Figure 16 Greenhouse gas assessment of options



Source: AECOM, 2011 and DCCEE, 2011and US EPA. 2006

The GHG reduction attributable to each control option is based on the reduced wood fuel use. The GHG emissions associated with alternative heating systems has not been included as there is limited information on heating choices.

6.8 Cost benefit analysis results

The results of the cost benefit analysis are presented in Table 28. The total non-health cost is the cumulative cost accruing to the government, industry and consumers while the health benefit over the BAU is the difference in health cost for each option in comparison to the BAU health cost. The net benefit is the sum of the total non-health cost and the health benefit over BAU using a 7% discount rate as advised by the NSW Treasury cost benefit analysis guidelines (NSW Treasury, 2007). Transfer payments as a result of taxes/levies have not been included in the cost-benefit analysis.

Table 28 Cost benefit analysis results

Control Options	Total Costs[1]	Health Benefit over BAU[2]	Net Benefit[3]
BAU		$0	$0
Ban on heater sales	-$134	$2,206	$2,071
Efficiency standards	-$3	$301	$298
Phase out	-$36	$4,015	$3,978
Fuel moisture content	-$33	$399	$366
Tax on new wood heaters	-$1	$1,049	$1,048
Licensing fees	$11	$1,267	$1,278
Tax on wood fuel	$36	$419	$455
Cash incentive phase out	-$12	$879	$867

1. Total costs are the costs associated with each option excluding the health costs identified in the health assessment

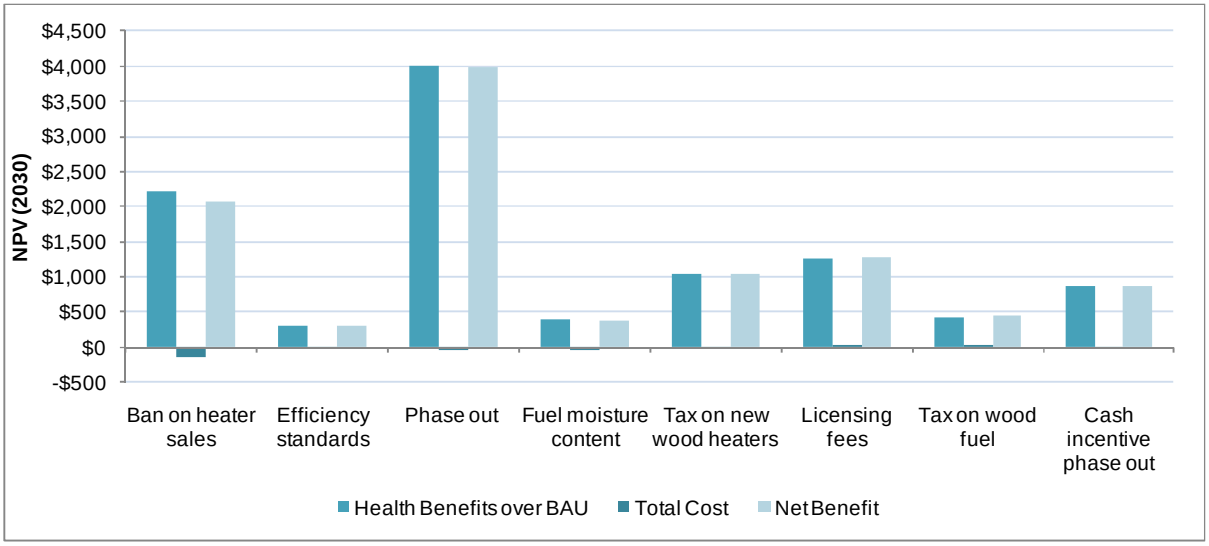
2. The benefits are the reductions in health costs that result from each control option.

3. Net benefit of each option (excluding BAU) is the health benefits over BAU minus the total costs.

The option with the highest net benefit is the phase out of wood heaters with over $3.98 billion of net benefit out to 2030. The ban on heater sales has the second highest net benefit however this option has the highest non-health costs with particularly high costs to industry.

The market based mechanisms have similar net benefits and the lowest net benefit is a result of the fuel moisture content regulation due to the relatively little health benefit over BAU. A visual representation of the results of the cost benefit analysis is presented in Figure 17.

Figure 17 Cost benefit analysis results



The figure shows that the total non-health costs are small compared to the health benefits over BAU. This is also represented by the small difference between health benefit over BAU and net benefit. The results of the cost benefit analysis suggest that all of the primary options generate a net benefit based on the avoided health costs. There is strong justification for pursuing wood smoke control options.

In particular, the introduction of a state-wide ban or phase-out of wood heaters would generate large and immediate benefits however they cause significant impacts on consumers and the industry. Consideration of

trade-offs and use of an agreed method for balancing them should be included in the development and assessment for policy option packages. Given the relatively low levels of costs associated with implementation and the huge benefit cost ratios for all options, the BCRs, if calculated explicitly, would not assist in the selection between options.

Table 29 summarises the cost benefit analysis and includes commentary on other issues including:

- acceptability of control option
- consistency with national approach
- ability to focus policy and manage socio-economic impacts.

Table 29 Summary of options assessment using selected criteria

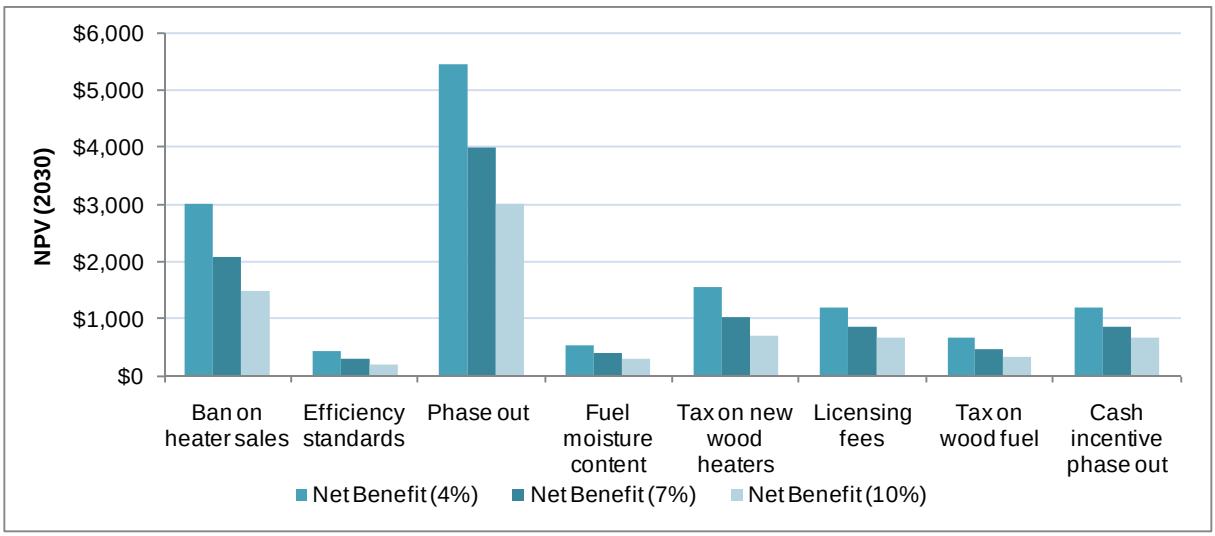
Name	Description	Net Benefit	Industry Impact	Impact on Consumers	Acceptability, Effectiveness & Ease of Implementation			Uniformity & Consistency		Ability to Focus Policy & Manage Socio-Econ Impacts
					Public Acceptability	Ease of Implementation	Timeframe	Consistency of regulatory framework	Consistent with National Approach	
Ban	A ban on the sale of new wood heaters.	- $2,071M	- -$30.5M	- -$101.7M	- Difficult to envisage broad public acceptability for ban	- Requires legislation/regulation for state-wide ban - Development control plans (DCPs) used by councils or legislative framework/regulation to target priority areas - Potential to develop new regulatory instrument for ban	- Immediate	- Total ban will have state-wide uniformity and consistency - Bans for priority areas will not be consistent based on current DCP model – may need new instrument	- May exceed the intended actions of the future national approach	- May be undertaken with cash incentive to reduce socio-economic impacts
Efficiency Standards and Emissions Limits - 1	A state-wide regulation that mandates the efficiency and emissions of new wood heaters (all new wood heaters sold in NSW will have a heating efficiency of at least 60% and 3g).	- $298M	- $0.0	- $0.0M	- Should be publicly acceptable as it will reduce fire wood consumption and reduce emissions - Availability issues	- Local policies currently used by councils to implement increased emissions standards (Armidale) - Potential to develop new regulatory instrument	- Medium term	- State-wide regulation for new standard will be consistent - Potential to develop a new regulatory framework to implement in priority areas	- National approach may improve emissions standards - May provide support for national approach for lower emissions standards	- Given little or no price rise, there appears to be little impact on lower socio-economic groups - Can be implemented in priority areas
Phase Out at Sale of House	Owners of wood heaters are mandated to remove their wood heater or render it inoperable at the time of sale and it is verified at time of sale or within a mandated period of time.	- $3,978M	- -$3.1M	- -$30.5M	- Potentially problems in communication	- Regulation required to ensure removal/render inoperable at time of sale or within the mandated period - Need to monitor and enforce	- Immediate	- Consistent if applied at state-level - Local councils generally do not have regulatory role in sale of house - New regulatory instrument required	- Would complement national approach	- May be undertaken with cash incentive to assist lower socio-economic groups
Fuel moisture content regulations	A regulation on a maximum moisture content of 20% for wood fuel sold in NSW.	- $366M	- $0.0	- -$30.5M	- Publically acceptable as it would reduce cost of heating	- Has been previously implemented in other jurisdictions (ACT, WA)	- Medium term	- Consistent if applied at state-level	- Would complement national approach	- Reduced ability to focus policy due to scavenging

Name	Description	Net Benefit	Industry Impact	Impact on Consumers	Acceptability, Effectiveness & Ease of Implementation			Uniformity & Consistency		Ability to Focus Policy & Manage Socio-Econ Impacts
					Public Acceptability	Ease of Implementation	Timeframe	Consistency of regulatory framework	Consistent with National Approach	
Fee on New Wood Heaters	An annual licensing fee (and possible license test) for wood heater owners.	- $1,048M	- -$3.1M	- $4.4M	- May be perceived as an extra tax	- Requires a good knowledge of difference between private and social costs (health costs) - Fee introduced using regulation at state-level - Fee levied at point of sale of new wood heater - Potential difficulties collecting fees at state level as opposed to GST	- Immediate	- Will be consistent across state	- Would complement national approach Potential for arbitrage between states based on price differences	- Fee revenue used to support low socio-economic groups to purchase other heating system
Licensing Fee	A licensing fee on all wood heater owners	- $1,278M	- -$3.2M	- $16.5M	- Potentially difficult given existing ownership - May be objected as an extra tax	- Potentially difficult given retrospective licensing – need to justify licensing requirements - Potentially costly to implement and enforce as currently no data on ownership	- Immediate – medium term	- Consistent if applied at state-level	- Would complement national approach	- Fee may be means tested however need for wide coverage to gain emissions reductions - Development of a licensing fee also helps identify areas of strong use
Excise on Fuel	A sales tax/excise on wood heater fuel recognising the social (health) costs of wood smoke.	- $455M	- -$0.8M	- $39.6M	- May encourage scavenging of fire wood and perceived as an extra tax	- Fee introduced using regulation at state-level - Fee levied at point of sale of wood fuel	- Immediate	- Will be consistent across state	- Would complement national approach - Potential for arbitrage between states based on price differences	- May increase scavenging
Cash Incentive Phase out	A buy-back program to phase out wood heaters or incentivise purchase of more efficient wood heaters.	- $867M	- -$0.6M	- $0.0M	- Easy to understand	- Need to choose appropriate rebate level to balance benefits to society against payment to replace/remove wood heater as well as utility of owner - Easy to implement however funding issues as replacement programs are expensive.	- Immediate	- State-wide program will be consistent - Can target priority areas	- Would complement national approach	- Able to be means tested to target lower socio-economic groups

6.9 Sensitivity analysis

Sensitivity analysis has been conducted on the net benefit of the core options (excluding the BAU), using 4%, 7% and 10% as advised by the NSW Treasury cost benefit analysis guidelines (NSW Treasury, 2007). The results are shown in Figure 18

Figure 18 Discount rate sensitivity analysis – net benefit (NPV $ million)



The size of the health benefit means that all of the options still present a net benefit using a 10% discount rate although the net benefits are significantly reduced. Higher discount rates place greater value on the initial costs of establishment and reduce the value of the health benefits in later years which decrease the NPV of the net benefits for each option.

Health benefits are the main contributor to the net benefit of the control policies. If the estimated values of health costs of the wood smoke emissions are reduced by half, all of the above control options still deliver substantial (though reduced) net social benefit. The above evaluation is therefore not sensitive to the estimate values of the health costs of emissions. However, given the possible variability of these estimates across areas i.e. capital cities, major urban centres, regional urban and rural, the evaluation may not be sufficiently precise for assessing outcomes for a particular area.

7.0 Social and Spatial Assessment

7.1 Spatial analysis

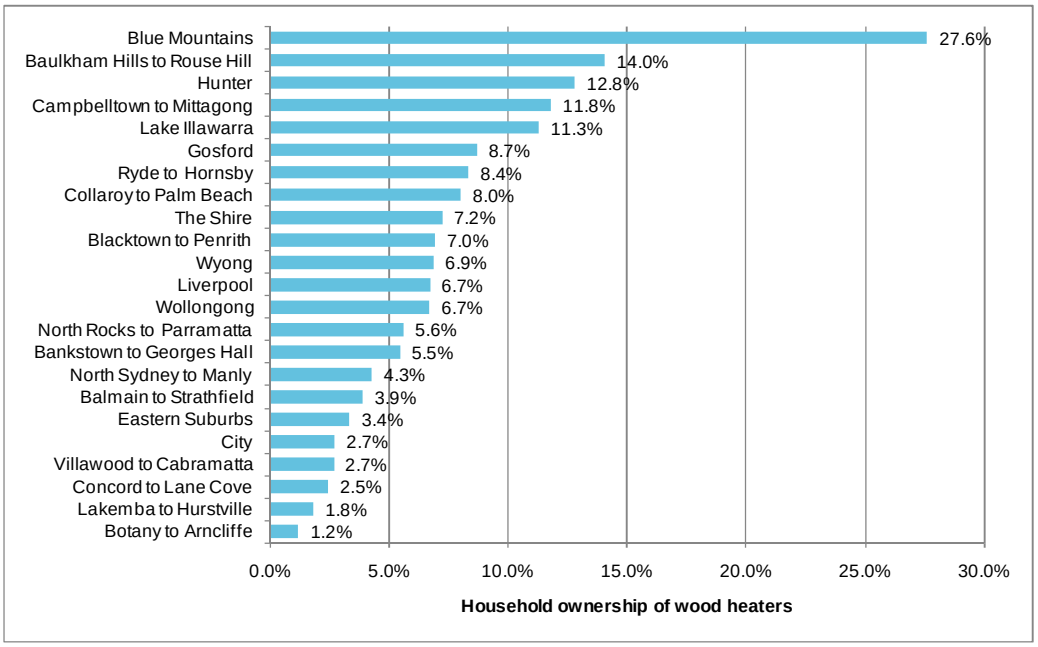
The Independent Pricing and Regulatory Tribunal of NSW (IPART) conducted water and energy surveys in recent years[9]. AECOM has obtained this data relating to wood heater ownership for:

- Sydney GMR and Illawarra in 2003, 2006 and 2010, with total sample size of 497 wood heater owners
- Hunter, Gosford and Wyong in 2008, with total sample size of 226 wood heater owners.

Raw data was available for the 2003 and 2006 surveys, however only summary data by region was available for the 2008 and 2010 surveys. To maintain consistency between the data, the results from the 2003 and 2006 surveys were aggregated to the regions defined in the 2010 survey.

Wood heater ownership for the above areas is shown in Figure 19 i.e. the proportion of respondents that identified wood/solid fuel as a form of space heating used.

Figure 19 Wood heater use priority areas in Sydney GMR



Source: IPART, 2003, 2006, 2010

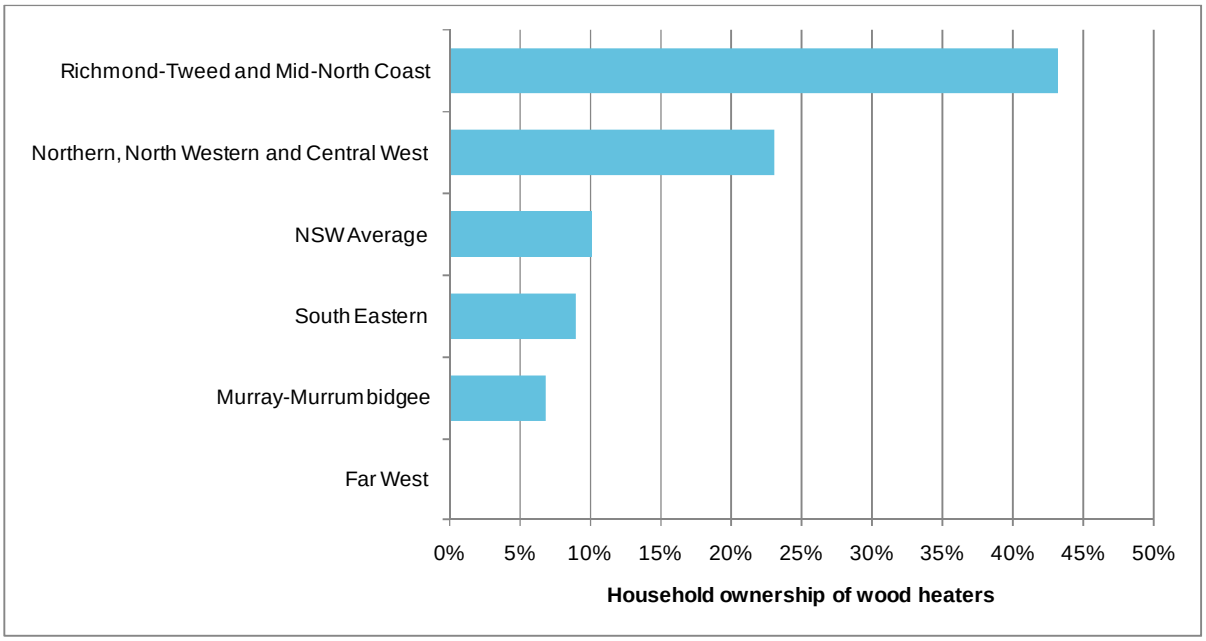
The above spatial information could be used to help identify case study areas where wood smoke control policies can be targeted to achieve more effective control and the most emission reductions. The following observations can be made on the levels of ownership of wood heaters by region.

- The Blue Mountains has the highest proportion of wood heater use with around 28%.
- The next highest areas are:
    - Baulkham Hills to Rouse Hill (14%)
    - Hunter (13%)
    - Campbelltown to Mittagong (12%) and Lake Illawarra (11%).
- Sydney areas such as the City, Balmain to Cabramatta, Eastern Suburbs and Botany to Arncliffe show low levels of wood heater usage (less than 5%).

[9] The surveys covered the areas of operation of the major water utilities Sydney Water, Hunter Water, and Gosford and Wyong Councils

Additional data sourced from the Australian Bureau of Statistics on wood heater ownership in regions across NSW is shown in Figure 20.

Figure 20 Wood heater ownership in NSW regions



Source: ABS, 2008

The ABS data shows that wood heater ownership is significantly higher in the Richmond-Tweed and Mid-North Coast along with Northern, North Western and Central West.

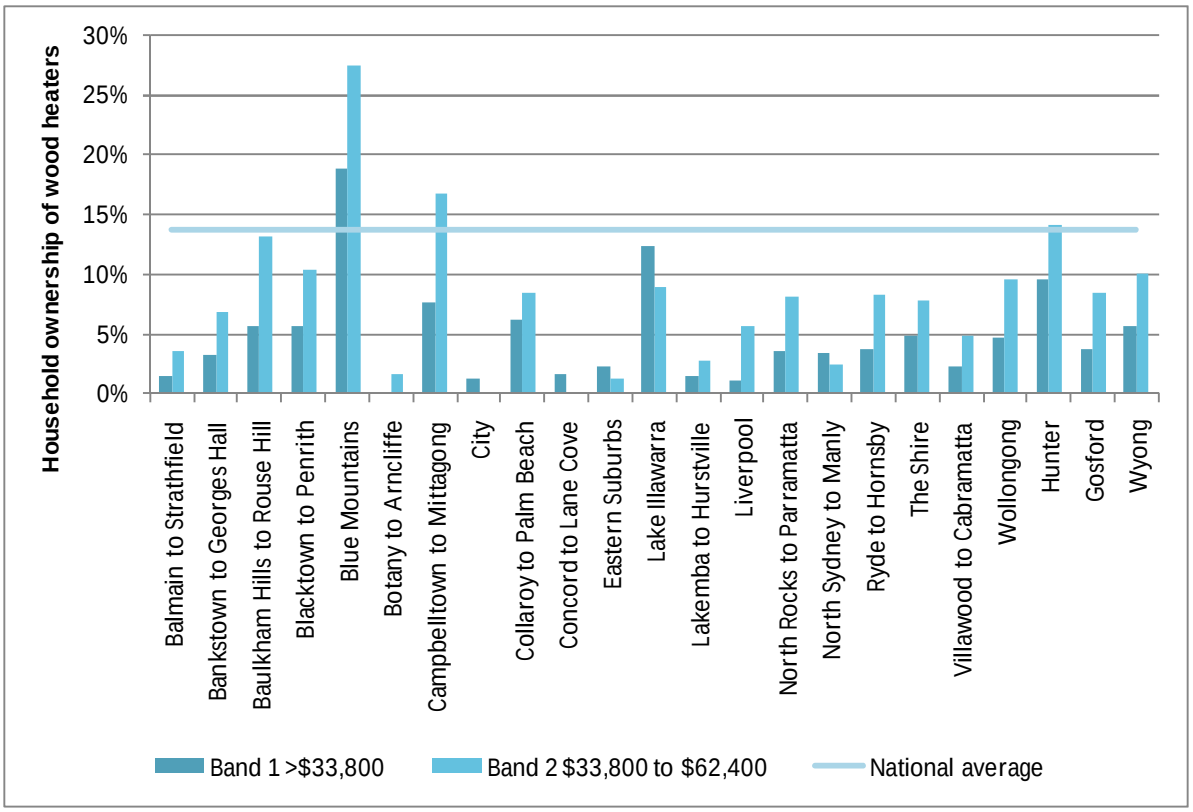
However, while the level of wood heater ownership is an important factor, there are other factors that determine the magnitude of the health impacts of wood smoke emission in a region, such as its population density, type of wood heaters, usage and projected growth and climate zone. A closer examination of these factors was made in the selection of the case study areas for introducing control policies described in Section 8..

7.2 Social analysis

The IPART data has also been used to determine areas where low and middle income groups may be more dependent on wood heaters than the national average. The IPART data was broken into income bands as per IPART assessments. The two income bands that were designated as low and middle income were Band 1 (<$33,800 p.a.) and Band 2 ($33,800 to $62,400 p.a.).

Figure 21 shows the areas of the GMR with percentage of households in Band 1 and 2 that own a wood heater compared to the national average of 13.7% (ABS, 2008).

Figure 21 Wood heater usage by low and middle income bands



Source: IPART 2003, 2006, 2010; ABS 2008

The areas of the Blue Mountains and Lake Illawarra have high percentages of wood heater ownership among the lowest income group. The Blue Mountains, Campbelltown to Mittagong and Hunter have wood heater ownership that is equal or greater than the national average in the middle income band.

The results of this assessment are that high wood heater ownership areas such as the Blue Mountains also have high levels of ownership in low and middle income groups. This information enables the inclusion of spatial and social analysis in policy development

8.0 Cost Benefit Analysis of Combined Options

8.1 Selection of combined options

Based on the assessment of the core control options above and consultation with OEH, a number of additional options were formulated as a combination of the core control options that are only applied to selected case study areas where possible (Combined Options). There are five combined options (Combined Options 10, 11, 12, 13 and 14), the composition of which is shown in Table 30.

Table 30 Combined control options matrix

Option	Core Control Option	Combined Options				
		10	11	12	13	14
1	Baseline					
2	Ban	✓ (CSA)				
3	Efficiency Standards and Emissions Limits - 1		✓ (CSA)			
4	Phase Out at Sale of House or within seven years	✓ (CSA)	✓ (CSA)		✓ (CSA)	
5	Fuel moisture content regulations					✓
6	Fee on New Wood Heaters		✓ (CSA)	✓ (CSA)		
7	Licensing Fee				✓ (CSA)	
8	Excise on Fuel					✓
9	Cash Incentives	✓ (CSA)	✓ (CSA)	✓ (CSA)	✓ (CSA)	

CSA – denotes application of the option to case study areas.

(1) A modified tax regime may involve applying an increasing tax rate, starting from heater efficiency of 1.5g (emission) and 65% (heating) scaling up to other levels. A strong rate hike would cause emission to reduce significantly more than the number of heaters. The average tax amount was the same as that used in the core control option i.e. $200 per heater.

The combined options include both state-wide and case study area options. This assessment simulates the application of these combined options by local governments in each case study area. A description of each control option is contained below.

8.1.1 Combined option 10

Option 10 combines the core options 2 (ban), 4 (phase out) and 9 (cash incentive). The ban on new sales and the phase out of wood heaters on house sales are applied to case study areas with a case study area specific cash incentive. The combined ban and phase out respectively target new sales and existing heaters to gradually reduce the stock of wood heaters in case study areas. In parallel, a cash incentive is provided to encourage the phase out of wood heaters or purchase of more efficient wood heaters as well as support low socio-economic users.

8.1.2 Combined option 11

Option 11 combines options 3 (efficiency standards), 4 (phase out) and 6 (fee on new wood heaters) with a case study area specific cash incentive. In contrast to Option 10, this option does not apply an outright ban on new sales, but instead utilises efficiency standards and limits for new wood heaters to target sales in case study areas. A fee on new wood heaters is also applied which acts as a source of revenue through which the cash incentive phase out can be funded.

8.1.3 Combined option 12

Option 12 targets new wood heater sales in case study areas through a sales tax with a targeted cash incentive program to reduce existing stock. Revenue raised through the sales tax can be used as a source of funding for the cash incentive program.

8.1.4 Combined option 13

Option 13 does not explicitly target new wood heater sales, but rather applies an annual licensing fee combined with a phase out of existing heaters in case study areas and cash incentives. The annual licensing fee provides an ongoing source of funds for the cash incentive program to encourage home owners to install more efficient heaters or potentially switch to alternative heating sources.

8.1.5 Combined option 14

In contrast to the other options, option 14 targets fuel use rather than wood heaters. A state-wide excise on fuel sales is combined with a state-wide fuel moisture content regulation. The fuel sales excise is designed to encourage people to reduce fuel use while the moisture content regulation encourages the consumption of fuel with relatively higher energy content.

8.2 Case study area selection

The selection of case study areas aims to achieve the maximum policy outcome (reduction of emission) while reducing the scope of required regulatory or planning intervention and enhancing the ability of government to manage the impact of the policies on the affected stakeholders.

Case study areas were selected based on a combination of factors:

- Wood heater ownership – areas with relatively higher ownership rates are considered to be a higher priority than other areas due to the ability for the targeted policy to have a significant impact on ownership and emissions.
- Population density – the overall health cost of emissions from wood heaters is dependent on the population density of the area. High density areas such as in capital cities will have relatively larger health costs per tonne of emissions due to higher population exposure.
- Population and dwelling growth – future health costs are related to population growth through increased exposure to emissions, and dwelling growth through increased number of emission sources.
- New release areas – policy measures to reduce the sale or installation of new heaters can be targeted towards new housing developments in new release areas which is relatively simpler to implement than in already populated areas.
- Availability of gas – discouraging the use or purchase of wood heaters is of particular importance for areas without gas reticulation as usage tends to be high since the ability for wood heater owners to use gas as an alternative heating source is not possible.
- Climate – colder areas beyond the metropolitan area tend to have higher wood heater ownership. Combined with the reduced availability of gas reticulation further away from metropolitan areas, these colder areas may be of high priority.
- Socio-economic status – as wood heating is a relatively affordable form of space heating, areas with a higher prevalence of low-income households may be unable to afford more expensive forms of heating. For these areas, the decision to implement a cash incentive program will be of particular importance.

Based on consideration of the above factors, the following areas were selected:

a) Balmain to Strathfield

b) Liverpool

c) Blacktown to Penrith

d) Blue Mountains

e) South Eastern statistical region

f) Illawarra statistical region.

The above six areas represent approximately 34.6 percent and 41.3 percent of NSW in terms of number of wood heater ownership and estimated wood smoke health impacts respectively.

Table 31 Case study area selection

Case study area	Ownership ratio	Number of heaters	Number of dwellings	Population density (persons per sq/km)	New release area	Climate	Gas availability	% of owners in low income groups
Balmain to Strathfield	4%	4,877	124,621	4,468	No	Mild	Yes	Low
Liverpool	7%	5,408	80,438	854	Yes	Mild	Yes	High
Blacktown to Penrith	7%	10,999	158,134	216	No	Mild	Yes	Medium
Blue Mountains	28%	7,188	26,042	34	No	Cool	Yes	High
South Eastern statistical region	9%	32,786	363,616	4	No	Cold	No	High
Illawarra statistical region	14%	34,756	257,395	53	Yes	Cool	Yes	High

Climate defined as (mild, cool, cold)

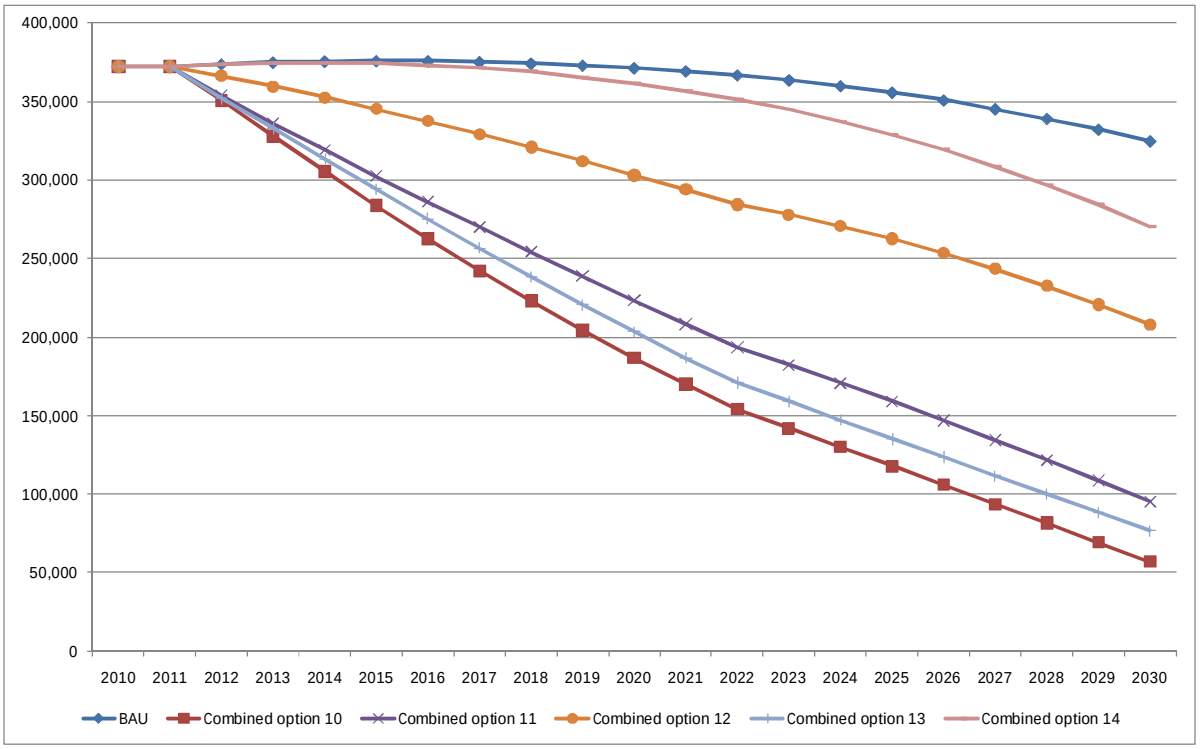
The right most column of the above table shows that a high proportion of wood heater owners are in low income groups in four of the six selected case study areas. This suggests that if these areas are targeted for implementation of control policies, there would be a strong need to have accompanying social policies to mitigate their impacts on the socially and economically disadvantaged groups.

8.3 Stock and emissions projections

The stock model developed to forecast the wood heater stock and emissions for the core control options was used to model the impact of each combined option. The combined options target the case study areas identified in Section 8.2.

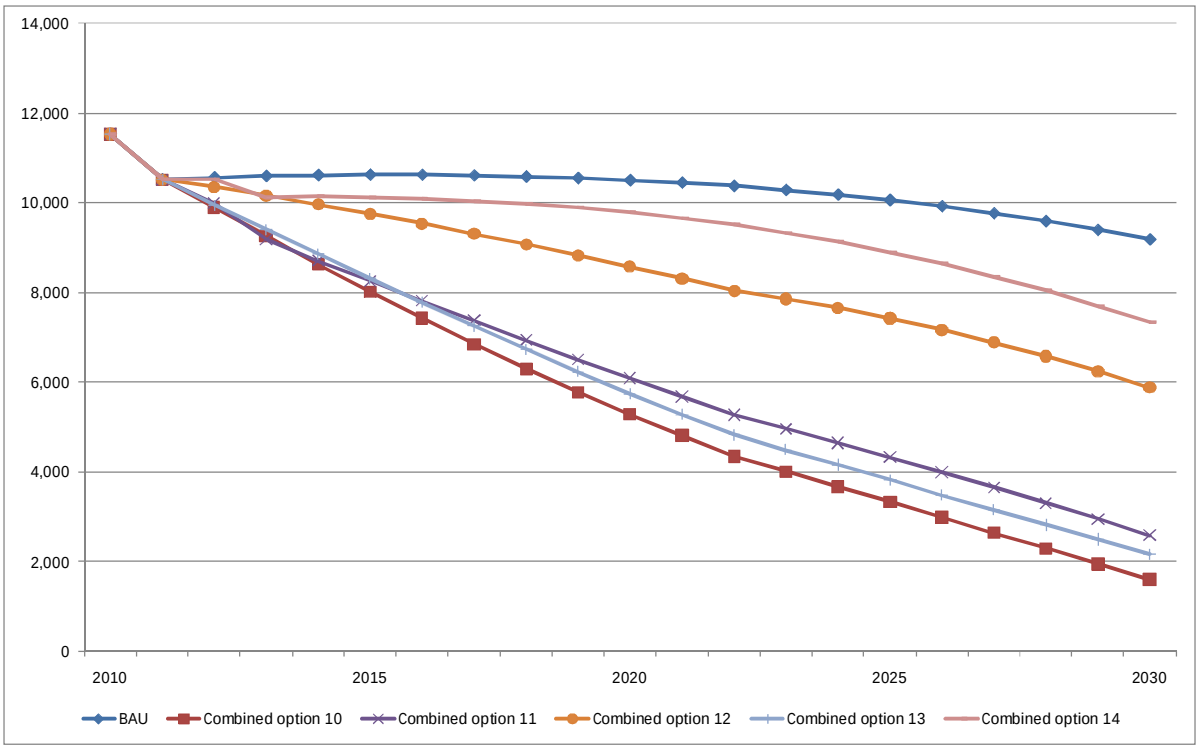
The stock and emissions projections for all of the case study areas are contained in Appendix C. The projections for each case study are pro-rata based on the proportion of wood heaters in NSW that are located in each case study area. This process for attributing wood heater stock and emissions to each case study based on ownership can then be applied to each of the costs and benefits.

Figure 22 Combined options stock projections



The emissions projections for the combined options are shown in Figure 23.

Figure 23 Combined options emissions projections



8.3.1 Combined option 10

Option 10	2010	2015	2020	2025	2030
Stock					
Stock Installed Pre-2010	128,749	89,861	55,443	32,052	12,268
Stock Installed Post-2010	0	8,255	9,182	8,702	7,373
Total Stock	128,749	98,116	64,624	40,754	19,641
Change from 2010		-24%	-50%	-68%	-85%
Emission PM10 (tonnes/year)					
Emission from Stock Pre-2010	3,988	2,539	1,566	905	345
Emission from Stock Post-2010	0	234	260	247	209
Total Stock	3,988	2,773	1,827	1,151	554
Change from 2010		-30%	-54%	-71%	-86%

8.3.2 Combined option 11

Option 11	2010	2015	2020	2025	2030
Stock					
Stock Installed Pre-2010	128,749	89,861	55,443	32,052	12,268
Stock Installed Post-2010	0	14,784	21,796	22,913	20,674
Total Stock	128,749	104,645	77,239	54,965	32,942
Change from 2010		-19%	-40%	-57%	-74%
Emission PM10 (tonnes/year)					
Emission from Stock Pre-2010	3,988	2,451	1,512	874	333
Emission from Stock Post-2010	0	406	594	624	562
Total Stock	3,988	2,858	2,107	1,497	895
Change from 2010		-28%	-47%	-62%	-78%

8.3.3 Combined option 12

Option 12	2010	2015	2020	2025	2030
Stock					
Stock Installed Pre-2010	128,749	103,167	74,335	48,066	19,586
Stock Installed Post-2010	0	16,256	30,530	42,750	52,344
Total Stock	128,749	119,422	104,865	90,816	71,930
Change from 2010		-7%	-19%	-29%	-44%
Emission PM10 (tonnes/year)					
Emission from Stock Pre-2010	3,988	2,915	2,100	1,357	550
Emission from Stock Post-2010	0	460	865	1,211	1,484
Total Stock	3,988	3,375	2,965	2,568	2,034
Change from 2010		-15%	-26%	-36%	-49%

8.3.4 Combined option 13

Option 13	2010	2015	2020	2025	2030
Stock					
Stock Installed Pre-2010	128,749	87,641	51,510	27,984	10,046
Stock Installed Post-2010	0	14,142	18,807	18,792	16,466
Total Stock	128,749	101,783	70,317	46,776	26,512
Change from 2010		-21%	-45%	-64%	-79%
Emission PM10 (tonnes/year)					
Emission from Stock Pre-2010	3,988	2,477	1,455	790	282
Emission from Stock Post-2010	0	400	533	532	467
Total Stock	3,988	2,877	1,988	1,322	749
Change from 2010		-28%	-50%	-67%	-81%

8.3.5 Combined option 14

Option 14	2010	2015	2020	2025	2030
Stock					
Stock Installed Pre-2010	128,749	111,850	89,157	60,027	24,460
Stock Installed Post-2010	0	17,676	35,909	53,647	69,145
Total Stock	128,749	129,526	125,066	113,674	93,605
Change from 2010		1%	-3%	-12%	-27%
Emission PM10 (tonnes/year)					
Emission from Stock Pre-2010	3,988	2,969	2,366	1,592	645
Emission from Stock Post-2010	0	483	970	1,443	1,856
Total Stock	3,988	3,452	3,336	3,035	2,502
Change from 2010		-13%	-16%	-24%	-37%

8.4 Administration and enforcement costs

As discussed above, administration and enforcement costs include implementation cost, administrative cost and public and consumer education cost. Costs for the combined options are shown in Table 32.

Table 32: Administration and enforcement costs for combined options

Control Option	Cost NPV ($M)
Combined Option 10	-3.1
Combined Option 11	-4.3
Combined Option 12	-2.4
Combined Option 13	-3.3
Combined Option 14	-3.4

8.5 Cost to industry

Cost to industry includes loss of profitability and business administration cost. The latter cost was not significant. Estimates of lost sales and profitability were shown for the combined control options in Table 33.

Table 33: Impact on industry profitability per annum

Control Option	Loss of profitability NPV ($M)
Combined Option 10	-$12.2
Combined Option 11	-$2.7
Combined Option 12	-$1.7
Combined Option 13	-$2.8
Combined Option 14	-$0.3

8.6 Loss of consumer surplus

An estimation of the loss of consumer surplus attributable to each combined option was undertaken using the same process as the core option assessment. The results of this assessment are presented in Table 34.

Table 34 Loss of consumer surplus for combined options

Options	Impact on Consumer Surplus NPV ($M)
Combined Option 10	-$45.9
Combined Option 11	-$16.3
Combined Option 12	-$8.6
Combined Option 13	-$14.2
Combined Option 14	$12.1

8.7 Government tax revenue

Tax revenues to government are considered as transfer payments as government taxes are used to fund other services in the community. Estimates for government revenue under each combined option are shown in Table 35 however the transfer payments are not included as a benefit or cost.

Table 35 Government revenue from combined options

Option	NPV ($M)
Combined Option 10	$0
Combined Option 11	$1
Combined Option 12	$2
Combined Option 13	$4
Combined Option 14	$14

8.8 Health benefits

The health benefits associated with each combined option have been assessed using the estimates for the health benefits of the core options. The weighted average health costs per tonne of emission for the case study areas are higher than the weighted costs of PM_{10}, $PM_{2.5}$ and VOC across NSW (population density, climate zone etc) as the case study areas have greater ownership and usage of wood heaters than other areas with the same population density.

The following formula was used calculating the weighted average health cost for a group of case study areas.

g) health costs for all urban areas were assigned the capital city health cost per tonne (i.e. Sydney) of $235,260 for PM_{10}

h) health costs for all other areas (regional centres and rural areas) were calculated using population density as an adjustment factor i.e. health cost $_i$ = health cost Sydney * (density for area i) / (Sydney density). These estimates are only indicative as a better evidence based scientific method for estimation is not available at this stage.

i) health cost for case study areas were calculated as: [Σ (number of heaters in case study area i) * (health cost for case study area i)] / number of heaters in all case study areas.

The weighting of the health costs associated with VOC was undertaken using the same process. The weighted costs are shown in Table 36.

Table 36 Weighed health costs for case study areas

Air Pollution	$/tonne [1]
PM_{10}	$74,497
VOC	$2,796

Source: DITRDLG, 2010, US EPA 2010 – weighted by AECOM

1) Estimates are only indicative given the method used for deriving health costs by area discussed above.

These health costs were applied to the case study areas and the total health costs and avoided health costs (as benefits are shown in Table 37.

Table 37 Health benefits of combined options (NPV $M)

	Absolute health costs (NPV $M)			Avoided (NPV $M)		
Option	PM_{10}	VOC	Total Health Cost	PM_{10}	VOC	Avoided Health Costs
BAU	-$3,264	-$72	-$3,336			
Combined Option 10	-$1,641	-$36	-$1,677	$1,623	$36	$1,659
Combined Option 11	-$1,798	-$40	-$1,838	$1,465	$32	$1,498
Combined Option 12	-$2,373	-$53	-$2,425	$891	$20	$911
Combined Option 13	-$1,743	-$39	-$1,781	$1,521	$34	$1,555
Combined Option 14	-$2,576	-$57	-$2,634	$687	$15	$703

Note: The absolute health costs refer to the amount of health costs incurred in the case study areas as a result of the composition of the wood smoke. The total health costs are the NPV of the health costs for BAU and each option. The avoided health costs are the benefits of the each option and are the difference between the total health costs of each option and the health costs under BAU. The formula for the calculation of avoided health costs is shown below.

$$BAU\ (Total\ Health\ Costs) - Option\ X\ (Total\ Health\ Costs) = Avoided\ Health\ Costs$$

Combined options 10, 11 and 13 generate significant avoided health costs while the remaining options have less avoided health costs.

8.9 Summary results for combined options

The summary of the non-health costs, total benefits and net benefit of each combined option is contained in Table 38.

Table 38 Summary of combined options cost benefit analysis (NPV $M)

Control Options	Total Costs[1]	Health Benefit over BAU[2]	Net Benefit[3]
Combined option 10	-$61	$1,659	$1,598
Combined option 11	-$23	$1,498	$1,475
Combined option 12	-$13	$911	$898
Combined option 13	-$20	$1,555	$1,535
Combined option 14	$8	$703	$711

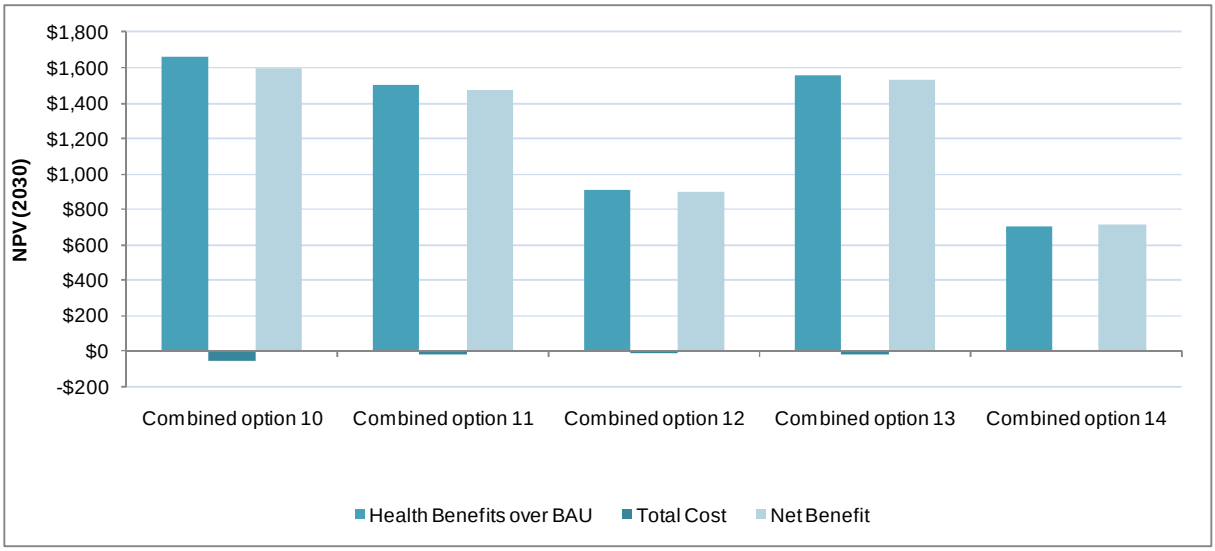
1. Total costs are the costs associated with each option excluding the health costs identified in the health assessment

2. The benefits are the reductions in health costs that result from each control option.

3. Net benefit of each option (excluding BAU) is the health benefits over BAU minus the total costs.

The CBA results for the combined options are shown in Figure 24.

Figure 24 Cost benefit analysis of combined options chart



The graph of the combined options shows the differences in net benefit between the combined options. The results of the cost benefit analysis provide a set of considerations:

- The inclusion of a mandated phase out at time of sale generates significant reductions and is common across the three most effective combined options (Combined option 10, 11 and 13).
- The introduction of a ban in the case study area is a significant source of emissions reduction.
- The introduction of fuel moisture content regulations and fuel taxes in case study areas generate relatively less emissions reductions.
- Combined options can be used to maximise health benefits will minimising the cost to consumers, industry and government.

The estimated impacts on the wood heater industry and wood heater consumers presented above provide an indication on the need to give consideration to industry adjustment. Similarly, the spatial analysis of the impacts

can guide the formulation of social assistance measures that would minimise any identified inequitable distributional impacts, specifically on lower income groups i.e. similar to what is being contemplated for the national implementation of a carbon tax.

A key consideration is that the benefits of reducing wood smoke in particular areas are heavily dependent on the population density of that area. The analysis conducted above uses whole-of-LGA population density which is suitable for urban centres where the density is fairly uniform. The whole-of-LGA population densities for regional/rural areas may be significantly lower than the actual densities in the settlements of the LGA. Therefore, health benefits associated with control options will be understated for these LGAs as the benefits and reductions will occur in the higher than average density areas of the regional and rural LGAs.

9.0 Conclusion

The foregoing economic analysis has confirmed that wood smoke control policies are worth pursuing on the basis of their net benefit. This is because most of the options considered can:

- produce substantial health benefit over the years, valued at billions of dollars;
- require relatively modest costs for implementation; and
- impacts on a small number of stakeholders that may be managed through natural economic adjustment process and/or specific targeted assistance policies.

With respect to the last item, the main affected groups are the home heating industry and wood heater consumers. For the former group of which Australian manufacturers make up approximately 70 percent, they would require time (such as staging of policy implementation) and perhaps assistance to adjust to the shrinkage of the industry, say, by shifting resources to other comparable businesses. For consumer groups, they would need to switch to alternative forms of space heating, which result in higher heating costs, particularly for those in areas without access to gas reticulation. Control policies may need to be supplemented with the provision of financial assistance to low income groups to protect low socio-economic groups.

The preceding sections of the report have provided both a quantitative and qualitative assessment for a range of options to assist with the selection of a preferred policy approach:

- The use of a combination of control policies demonstrated that some policies are naturally complementary with one another. For example, a combination of a tax measure and a cash incentive program applied in case study areas provide both push and pull effects on heater sales and ownership as well as the financial source for funding cash incentives and social assistance.
- The selection of case study areas helps to target areas where the problems of wood smoke are most serious but policies can be implemented with manageable impacts and higher levels of public acceptance (e.g new release areas).

In summary, while the report has not made recommendations for specific control options, it has provided an analytical tool for policy makers to develop and evaluate suitable wood smoke control options. The final selection of the preferred policies would need to reflect the policy objectives and air pollution reduction targets. AECOM believes that the study has established clear evidence on the (substantial) net benefit of wood smoke control. This information forms a strong basis for seeking in-principle approval from decision makers. Similarly, it will support more effective consultation with industry and the community so that a balanced set of policies can be developed to significantly reduce the long term effects of wood smoke on public health.

It should noted that the case study analysis understates the potential health benefits of wood smoke reduction in regional and rural areas as it uses a whole-of-LGA population density. Actual health benefits may higher where the reductions occur in the higher density settlements of the LGA.

Apart from the cash incentive program, implementation of most of the above control policies will require changes to the current regulatory framework. For example:

- Amendment of existing regulations is required to set tighter heater standards unless the corresponding national review results in national standards similar to those discussed above (Options 3 and 11).
- Local councils have used planning powers to impose a ban on heater installation in their respective areas. However, for control policies that apply such ban on a broader area comprising several regions, they would either need to be implemented through strategic policy co-ordination and cooperation of all relevant local governments; or put into effect by Government through a regulation under the POEO Act or planning laws.
- For wood smoke control options that require payment of a tax or levy, it is envisaged that a regulatory approach similar to that used for setting the waste and environment levy under the POEO Act, would be necessary, including requiring purchasers to pay a contribution; determining the levy; defining where the levy applies i.e. 'regulated area' of NSW.

An optimum timeframe must achieve the right balance between implementing wood smoke policies as early as possible to avoid further health costs to the community and allowing adequate time for affected parties to adjust. It appears that the most suitable approach would be to implement the selected policies in a staged process with early commencement (say 2012) but extend their full application or coverage over several years e.g. increase number of case study areas from 1 to 6; raising efficiency standards progressively.

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Appendix A

Checklist for Assessing Regulatory Quality

Appendix A Checklist for Assessing Regulatory Quality

Regulations that conform to best-practice design standards are characterised by the following seven principles and features:

Minimum necessary to achieve objectives

- Overall benefits to the community justify costs
- Kept simple to avoid unnecessary restrictions
- Targeted at the problem to achieve the objectives
- Not imposing an unnecessary burden on those affected
- Does not restrict competition, unless demonstrated net benefit

Not unduly prescriptive

- Performance and outcomes focused
- General rather than overly specific

Accessible, transparent and accountable

- Readily available to the public
- Easy to understand
- Fairly and consistently enforced
- Flexible enough to deal with special circumstances
- Open to appeal and review

Integrated and consistent with other laws

- Addresses a problem not addressed by other regulations
- Recognises existing regulations and international obligations

Communicated effectively

- Written in 'plain language'
- Clear and concise

Mindful of the compliance burden imposed

- Proportionate to the problem
- Set at a level that avoids unnecessary costs

Enforceable

- Provides the minimum incentives needed for reasonable compliance
- Able to be monitored and policed effectively

Source: Argy and Johnson (2003).

Appendix B

Stock and emission projections (2010-2040) under BAU

Appendix B Stock and emission projections (2010-2040) under BAU

Table 39 Projections of woodheater sales and stocks for 2010-2040 in the BAU

es						2010	2011	2012	2013	2014	2015	2020	2025	2030	2035	2040
Year of		Sales		Stock												
Manufact	Sales	Heating eff	Emission eff	Emission	Fuel use											
2010	9,600	100%	100%	100.0%	100.0%	372,203	362,432	353,778	344,380	334,237	323,349	257,747	173,535	70,712	0	0
2011	9,894	100%	100%	100.0%	100.0%	0	9,894	9,894	9,894	9,894	9,894	9,894	8,885	7,240	5,100	2,466
2012	10,197	100%	100%	100.0%	100.0%	0	0	10,197	10,197	10,197	10,197	10,197	9,434	7,841	5,738	3,125
2013	10,509	100.0%	100.0%	100.0%	100.0%	0	0	0	10,509	10,509	10,509	10,509	9,988	8,451	6,389	3,801
2014	10,830	100.0%	100.0%	100.0%	100.0%	0	0	0	0	10,830	10,830	10,830	10,546	9,070	7,053	4,494
2015	11,161	100.0%	100.0%	100.0%	100.0%	0	0	0	0	0	11,161	11,161	11,161	9,696	7,729	5,204
2016	11,503	100.0%	100.0%	100.0%	100.0%	0	0	0	0	0	0	11,503	11,503	10,330	8,417	5,930
2017	11,855	100.0%	100.0%	100.0%	100.0%	0	0	0	0	0	0	11,855	11,855	10,969	9,116	6,671
2018	12,218	100.0%	100.0%	100.0%	100.0%	0	0	0	0	0	0	12,218	12,218	11,613	9,826	7,428
2019	12,592	100.0%	100.0%	100.0%	100.0%	0	0	0	0	0	0	12,592	12,592	12,261	10,545	8,200
2020	12,977	100.0%	100.0%	100.0%	100.0%	0	0	0	0	0	0	12,977	12,977	12,977	11,274	8,986
2021	13,374	100.0%	100.0%	100.0%	100.0%	0	0	0	0	0	0	0	13,374	13,374	12,010	9,786
2022	13,783	100.0%	100.0%	100.0%	100.0%	0	0	0	0	0	0	0	13,783	13,783	12,753	10,599
2023	14,205	100.0%	100.0%	100.0%	100.0%	0	0	0	0	0	0	0	14,205	14,205	13,502	11,424
2024	14,640	100.0%	100.0%	100.0%	100.0%	0	0	0	0	0	0	0	14,640	14,640	14,255	12,261
2025	15,088	100.0%	100.0%	100.0%	100.0%	0	0	0	0	0	0	0	15,088	15,088	15,088	13,107
2026	15,549	100.0%	100.0%	100.0%	100.0%	0	0	0	0	0	0	0	0	15,549	15,549	13,963
2027	16,025	100.0%	100.0%	100.0%	100.0%	0	0	0	0	0	0	0	0	16,025	16,025	14,827
2028	16,516	100.0%	100.0%	100.0%	100.0%	0	0	0	0	0	0	0	0	16,516	16,516	15,698
2029	17,021	100.0%	100.0%	100.0%	100.0%	0	0	0	0	0	0	0	0	17,021	17,021	16,574
2030	17,542	100.0%	100.0%	100.0%	100.0%	0	0	0	0	0	0	0	0	17,542	17,542	17,542
2031	18,079	100.0%	100.0%	100.0%	100.0%	0	0	0	0	0	0	0	0	0	18,079	18,079
2032	18,632	100.0%	100.0%	100.0%	100.0%	0	0	0	0	0	0	0	0	0	18,632	18,632
2033	19,202	100.0%	100.0%	100.0%	100.0%	0	0	0	0	0	0	0	0	0	19,202	19,202
2034	19,789	100.0%	100.0%	100.0%	100.0%	0	0	0	0	0	0	0	0	0	19,789	19,789
2035	20,395	100.0%	100.0%	100.0%	100.0%	0	0	0	0	0	0	0	0	0	20,395	20,395
2036	21,019	100.0%	100.0%	100.0%	100.0%	0	0	0	0	0	0	0	0	0	0	21,019
2037	21,662	100.0%	100.0%	100.0%	100.0%	0	0	0	0	0	0	0	0	0	0	21,662
2038	22,325	100.0%	100.0%	100.0%	100.0%	0	0	0	0	0	0	0	0	0	0	22,325
2039	23,008	100.0%	100.0%	100.0%	100.0%	0	0	0	0	0	0	0	0	0	0	23,008
2040	23,712	100.0%	100.0%	100.0%	100.0%	0	0	0	0	0	0	0	0	0	0	23,712

Option 1	2010	2011	2012	2013	2014	2015	2020	2025	2030	2035	2040
Stock	372,203	372,326	373,868	374,978	375,666	375,940	371,482	355,784	324,903	327,546	399,913
Legacy stock	372,203	362,432	353,778	344,380	334,237	323,349	257,747	173,535	70,712	0	0
New Stock	0	9,894	20,090	30,599	41,429	52,590	113,735	182,249	254,191	327,546	399,913
Emission PM10 (tonnes/year)											
* Emission from Existing Stock	11,530	10,241	9,996	9,731	9,445	9,137	7,282	4,899	1,986	0	0
* Emission from New Stock	0	280	568	866	1,173	1,489	3,221	5,164	7,207	9,292	11,351
* Total	**11,530**	**10,521**	**10,565**	**10,597**	**10,617**	**10,626**	**10,503**	**10,063**	**9,193**	**9,292**	**11,351**
Heater Sales	9,600	9,894	10,197	10,509	10,830	11,161	12,977	15,088	17,542	20,395	23,712
Fuel use (tonnes)	1,150,306	1,049,581	1,053,998	1,057,198	1,059,207	1,060,054	1,047,862	1,003,951	917,121	926,958	1,132,379

Table 40 Woodheater retirement pattern (survival rates by age shown)

Year	1	2	3	4	5	6	7	8	9	10
New Sales	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Stock pre-2010	97%	95%	93%	90%	87%	84%	80%	77%	73%	69%
Year	11	12	13	14	15	16	17	18	19	20
New Sales	97%	95%	93%	90%	87%	84%	80%	77%	73%	69%
Stock pre-2010	65%	61%	56%	52%	47%	41%	36%	31%	25%	19%
Year	21	22	23	24	25	26	27	28	29	30
New Sales	65%	61%	56%	52%	47%	41%	36%	31%	25%	19%
Stock pre-2010	13%	7%	0%	0%	0%	0%	0%	0%	0%	0%

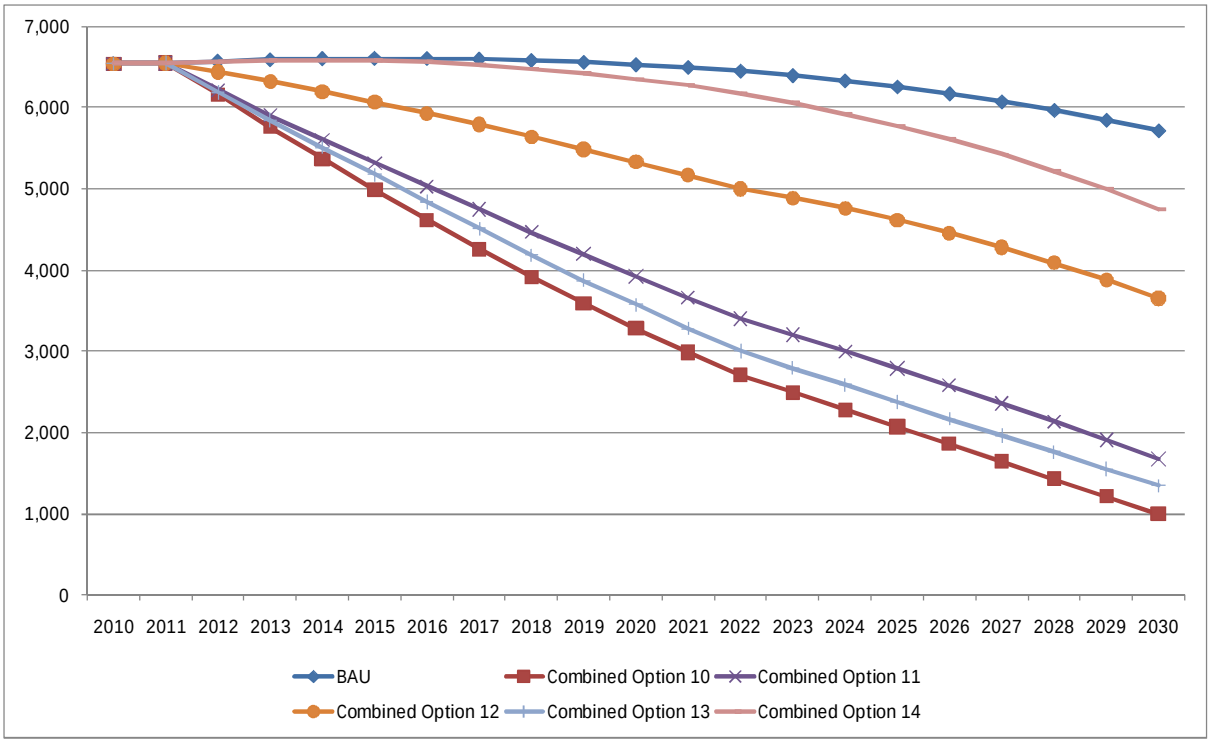
Appendix C

Case Study Area Assessment

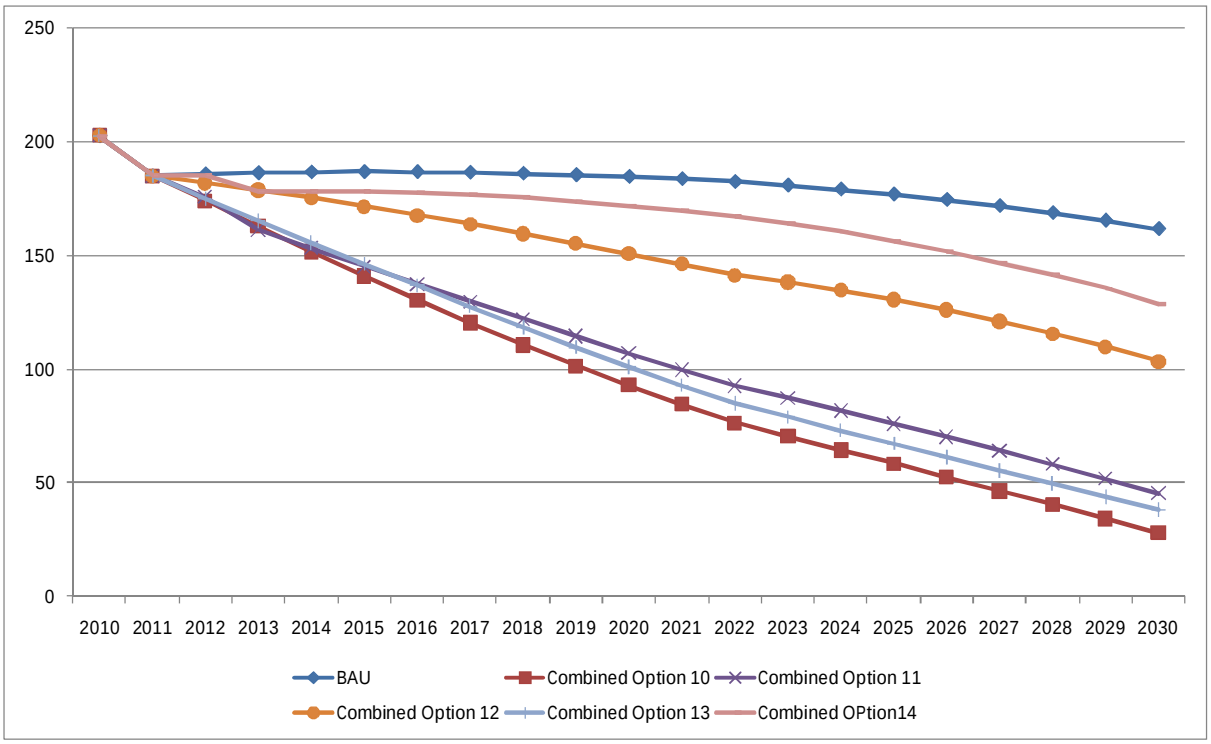
Appendix C Case Study Area Assessment

Balmain to Strathfield

Stock Projections



Emissions Projections



Cost Benefit Analysis (NPV $M)

Control Options	Total Costs[1]	Health Benefit over BAU[2]	Net Benefit[3]
Combined option 10	-$3.1	$266.1	$263.0
Combined option 11	-$1.2	$240.3	$239.1
Combined option 12	-$0.6	$146.1	$145.4
Combined option 13	-$1.0	$249.4	$248.4
Combined option 14	$0.4	$112.7	$113.1

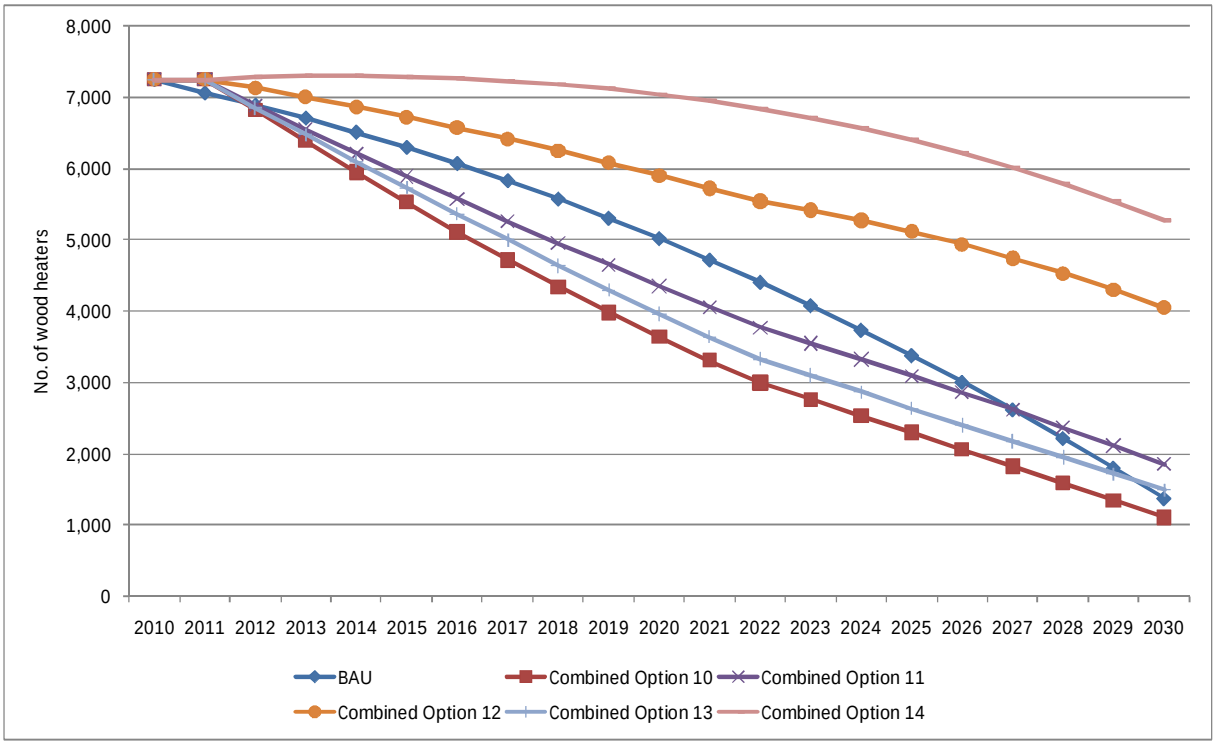
1. Total costs are the costs associated with each option excluding the health costs identified in the health assessment

2. The benefits are the reductions in health costs that result from each control option.

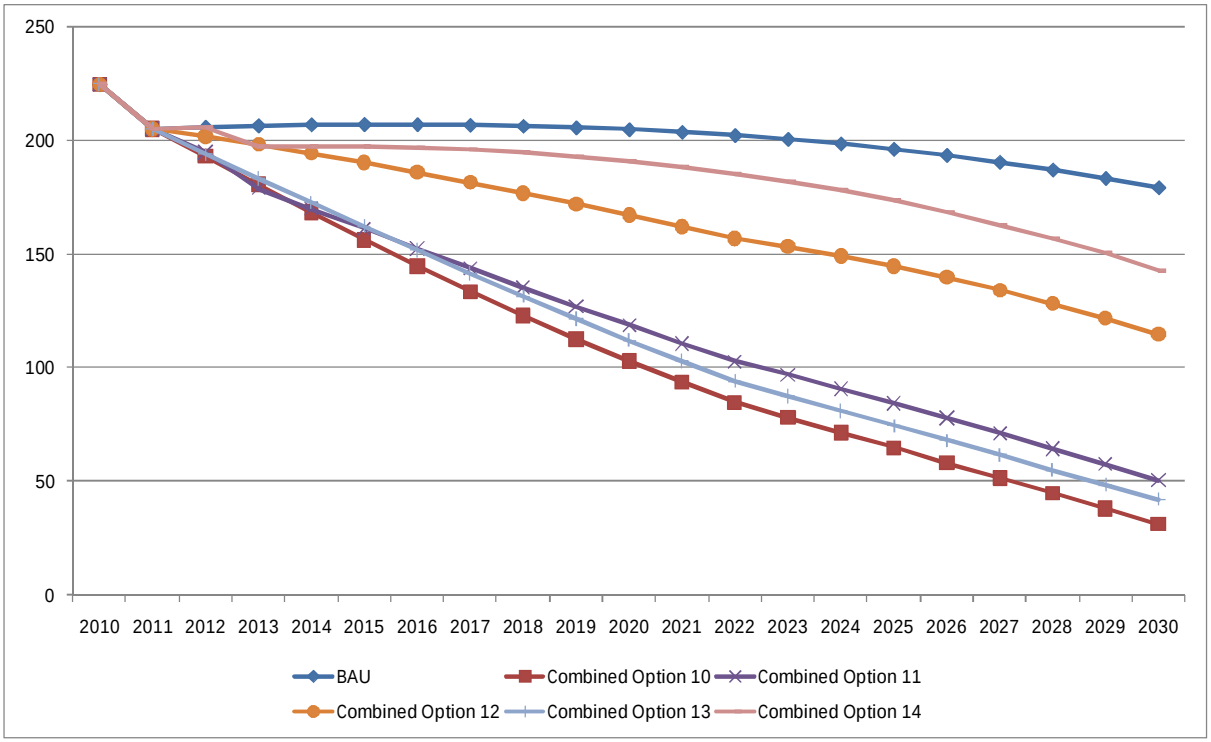
3. Net benefit of each option (excluding BAU) is the health benefits over BAU minus the total costs.

Liverpool

Stock Projections



Emissions Projections

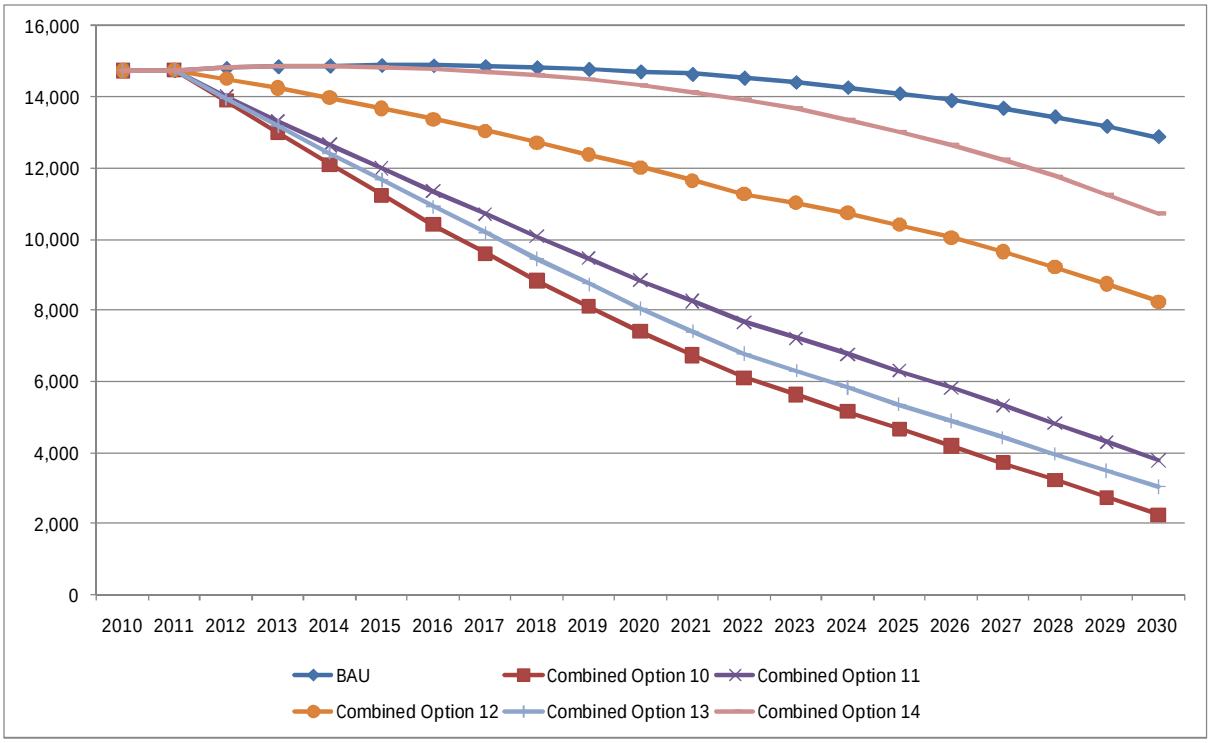


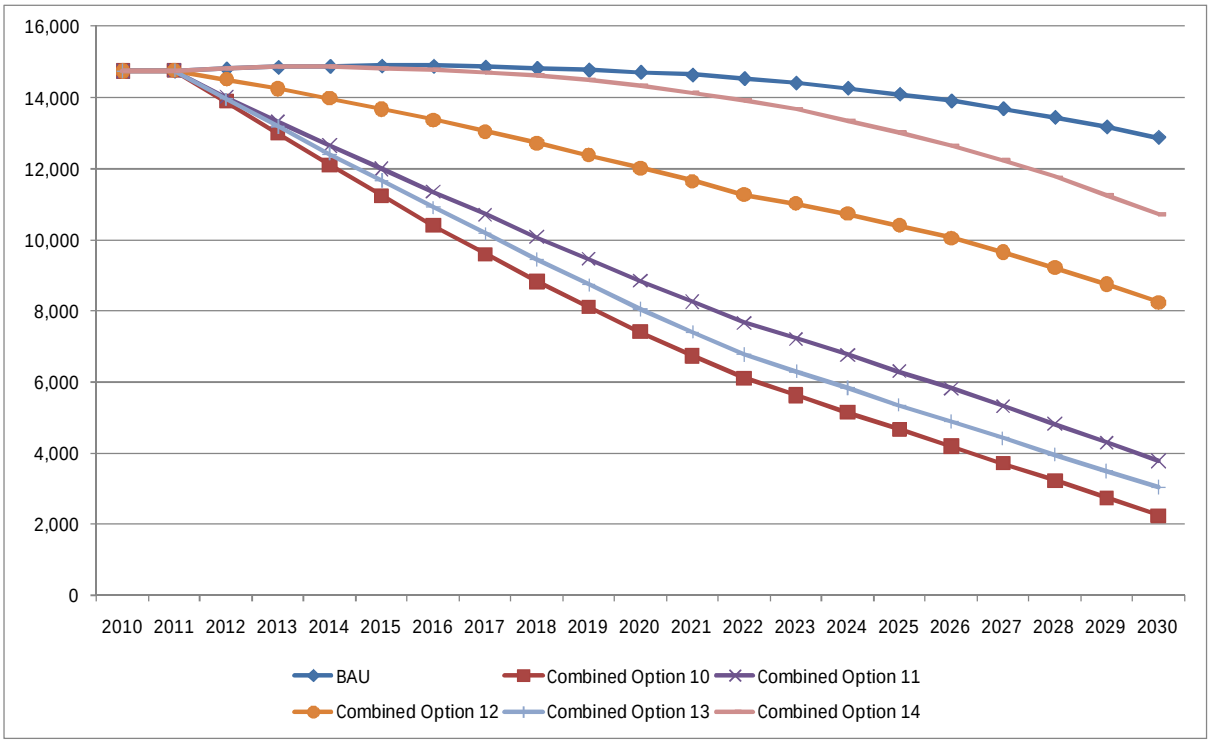
Cost Benefit Analysis (NPV $M)

Control Options	Total Costs	Health Benefit over BAU	Net Benefit
Combined option 10	-$3.4	$295	$291.6
Combined option 11	-$1.3	$266	$265.1
Combined option 12	-$0.7	$162	$161.3
Combined option 13	-$1.2	$277	$275.4
Combined option 14	$0.5	$125	$125.4

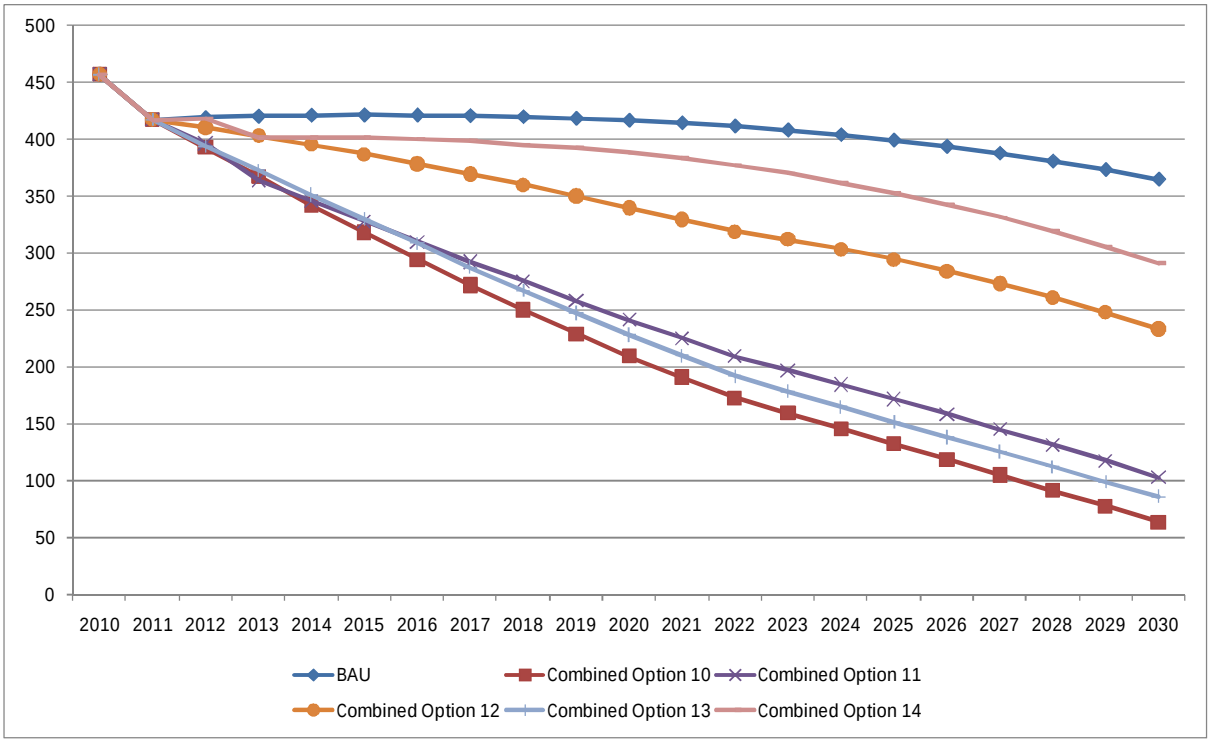
Blacktown to Penrith

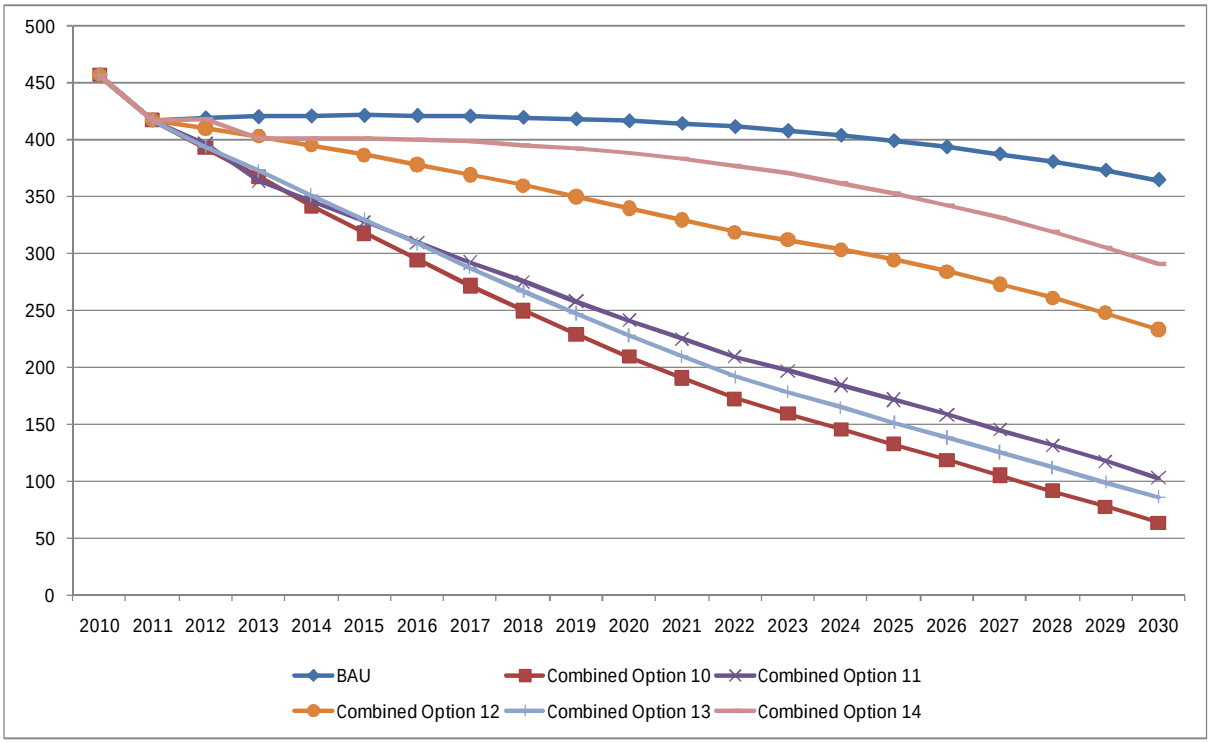
Stock Projections





Emissions Projections



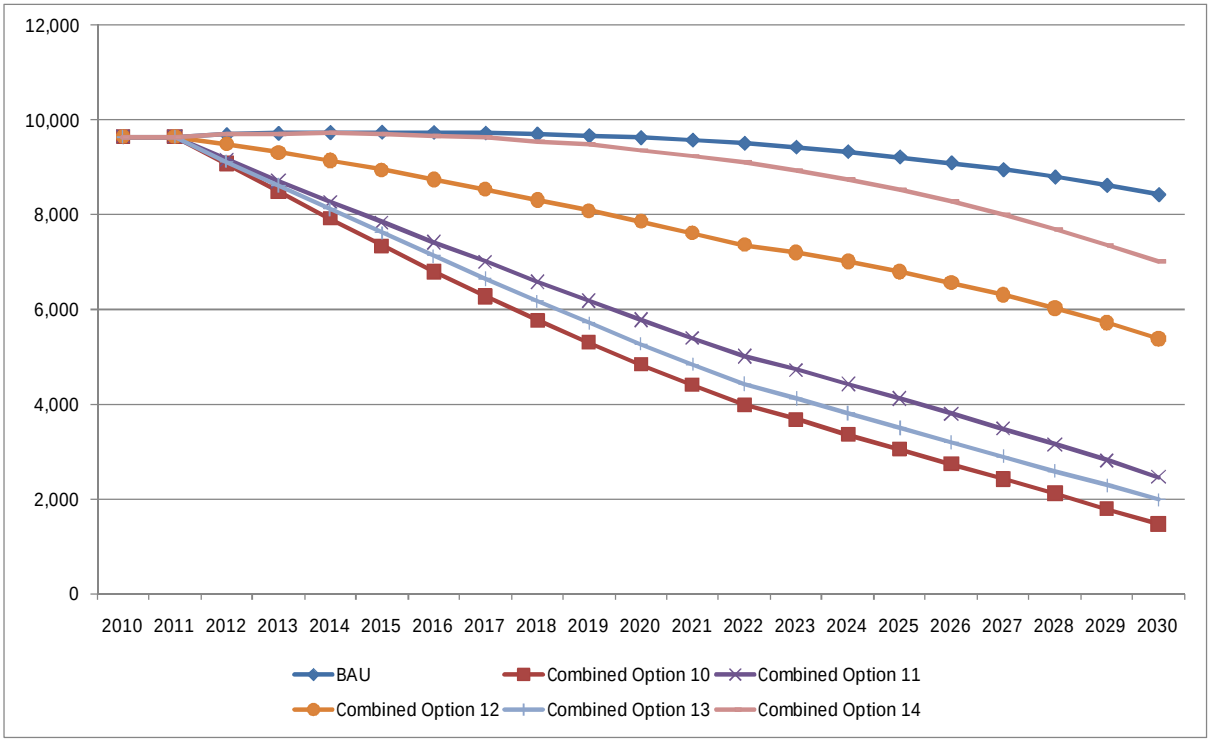


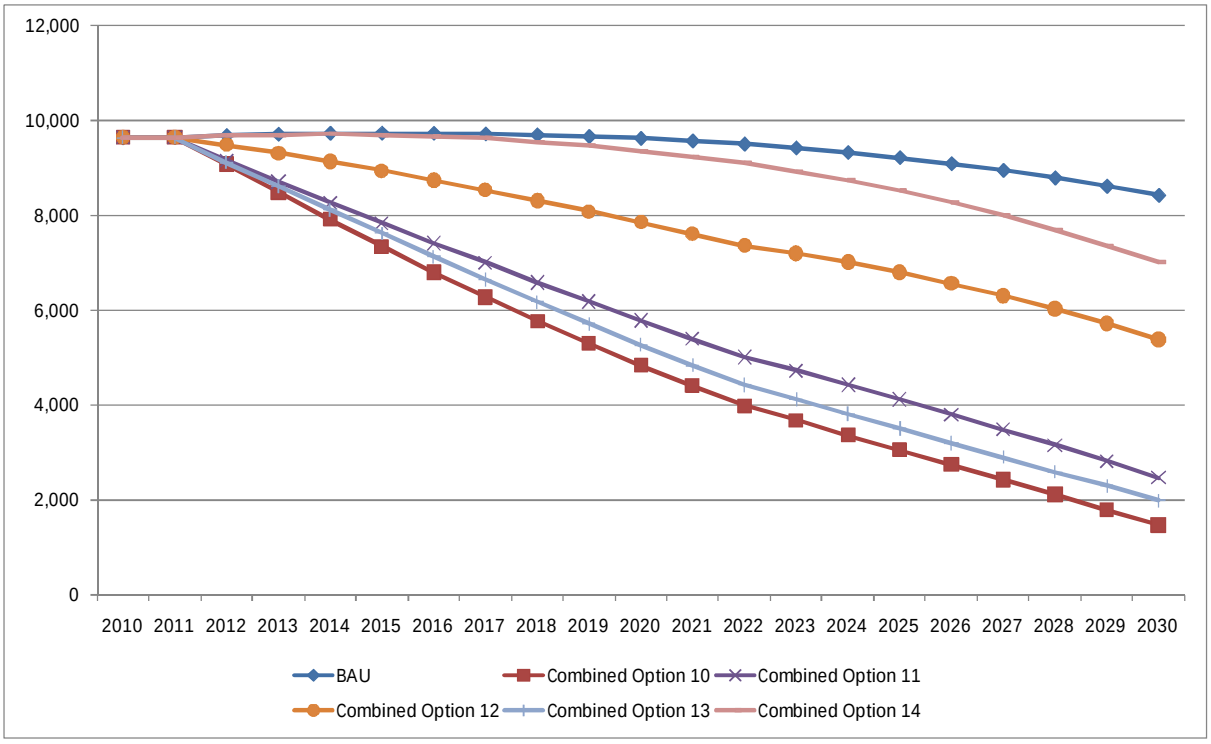
Cost Benefit Analysis (NPV $M)

Control Options	Total Costs	Health Benefit over BAU	Net Benefit
Combined option 10	-$7.0	$600	$593.1
Combined option 11	-$2.7	$542	$539.3
Combined option 12	-$1.5	$329	$328.0
Combined option 13	-$2.3	$562	$560.1
Combined option 14	$1.0	$254	$255.2

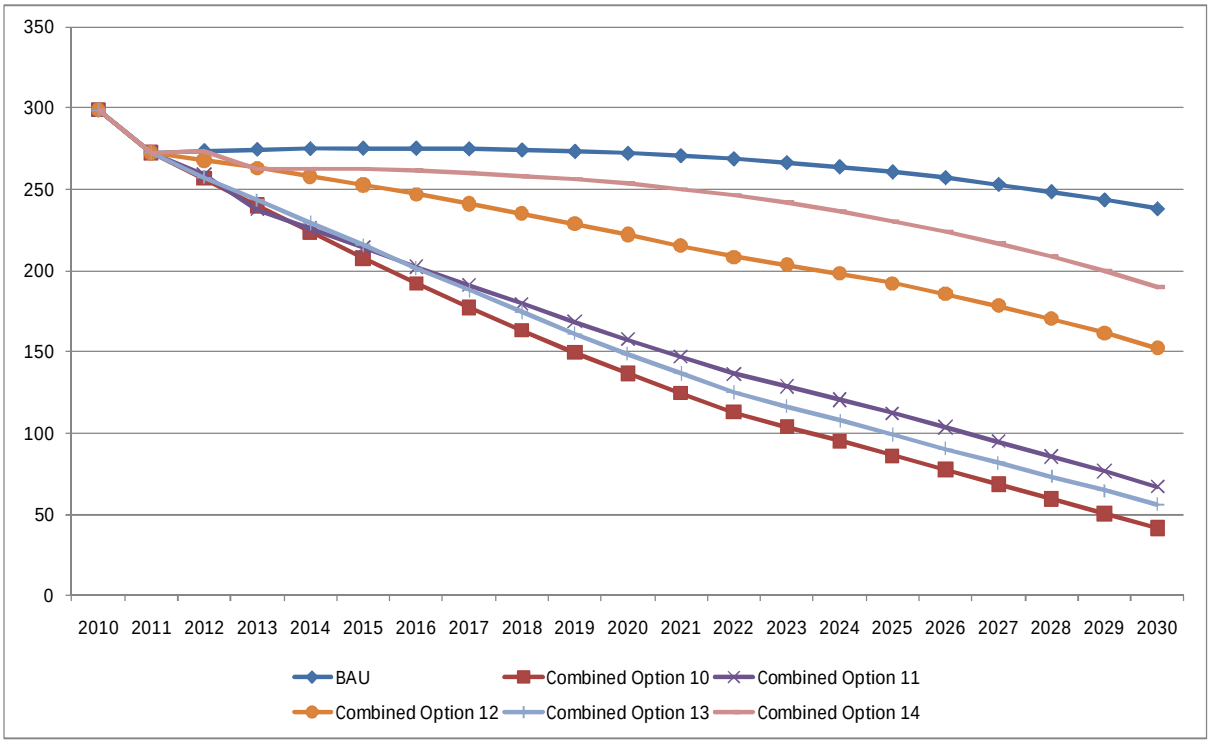
Blue Mountains

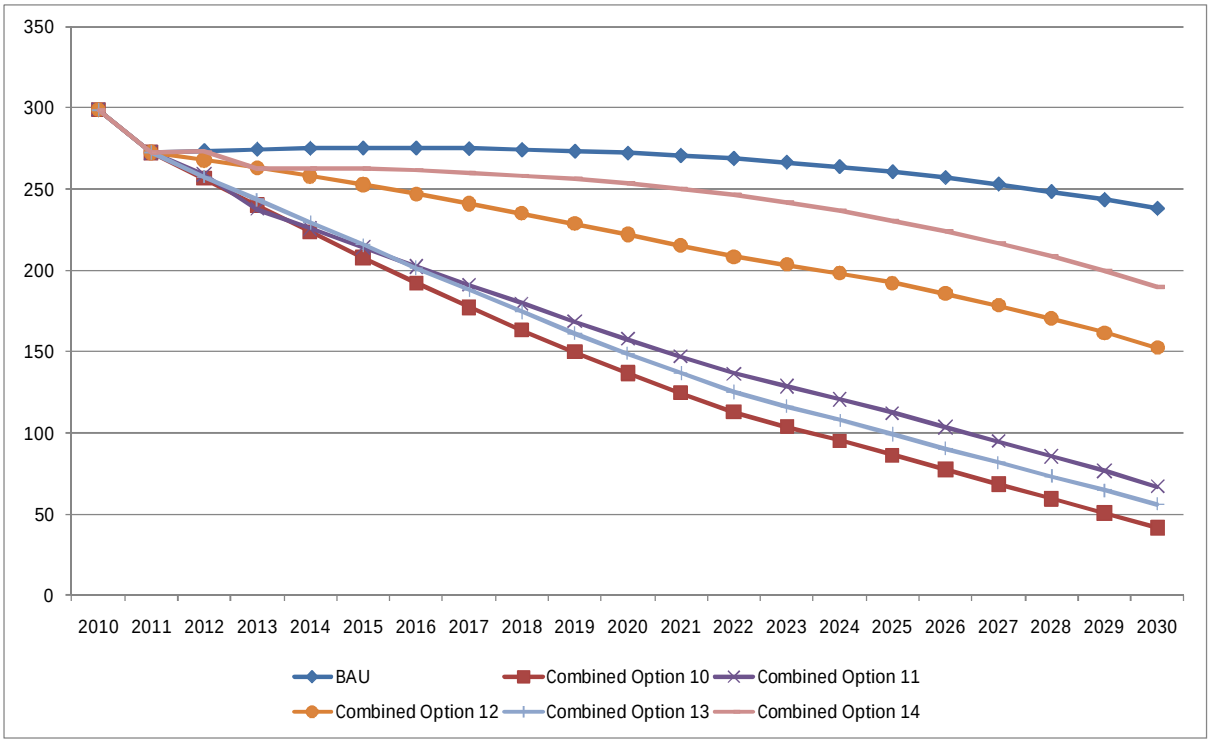
Stock Projections





Emissions Projections



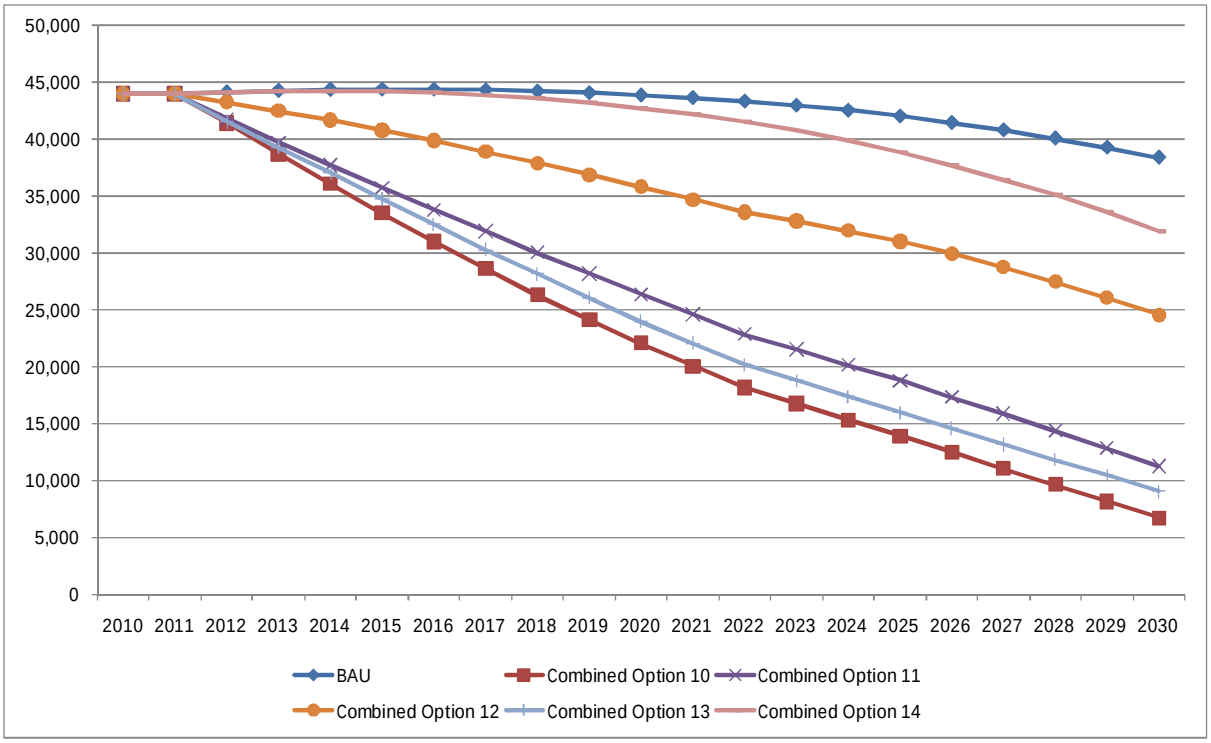


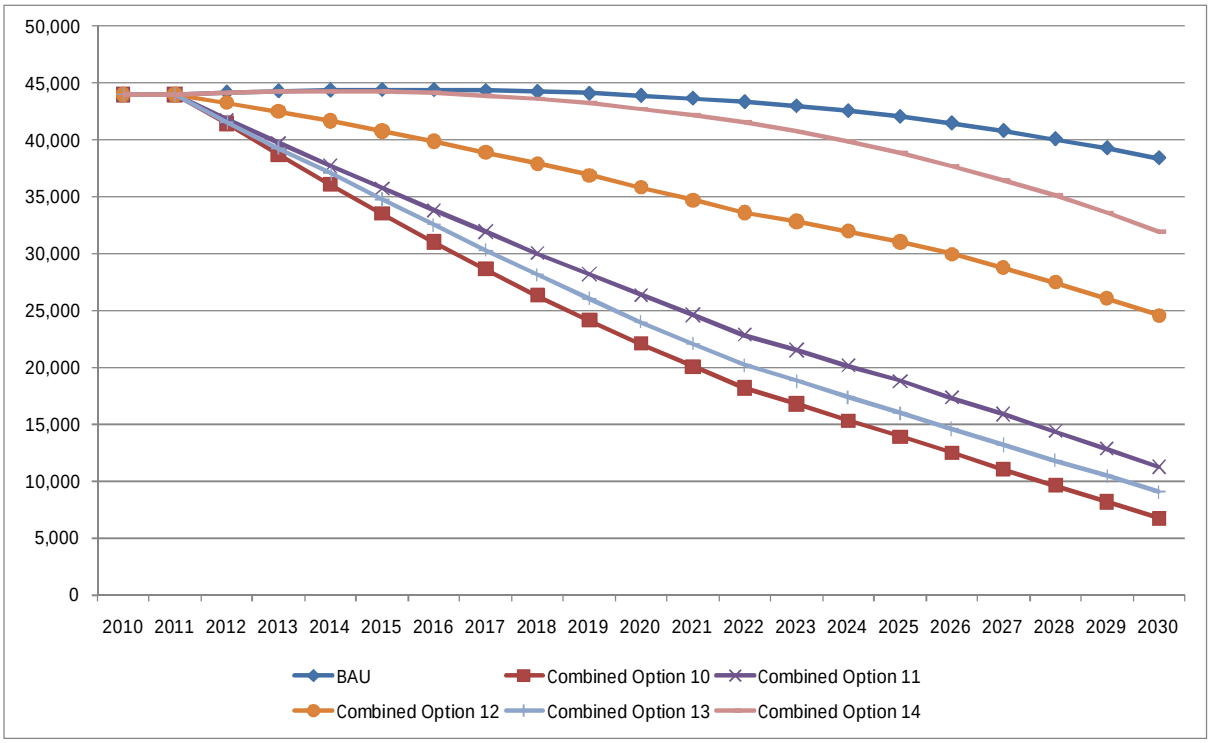
Cost Benefit Analysis – (NPV $M)

Control Options	Total Costs	Health Benefit over BAU	Net Benefit
Combined option 10	-$4.6	$6	$1.6
Combined option 11	-$1.7	$6	$3.9
Combined option 12	-$0.9	$3	$2.5
Combined option 13	-$1.5	$6	$4.3
Combined option 14	$0.6	$3	$3.3

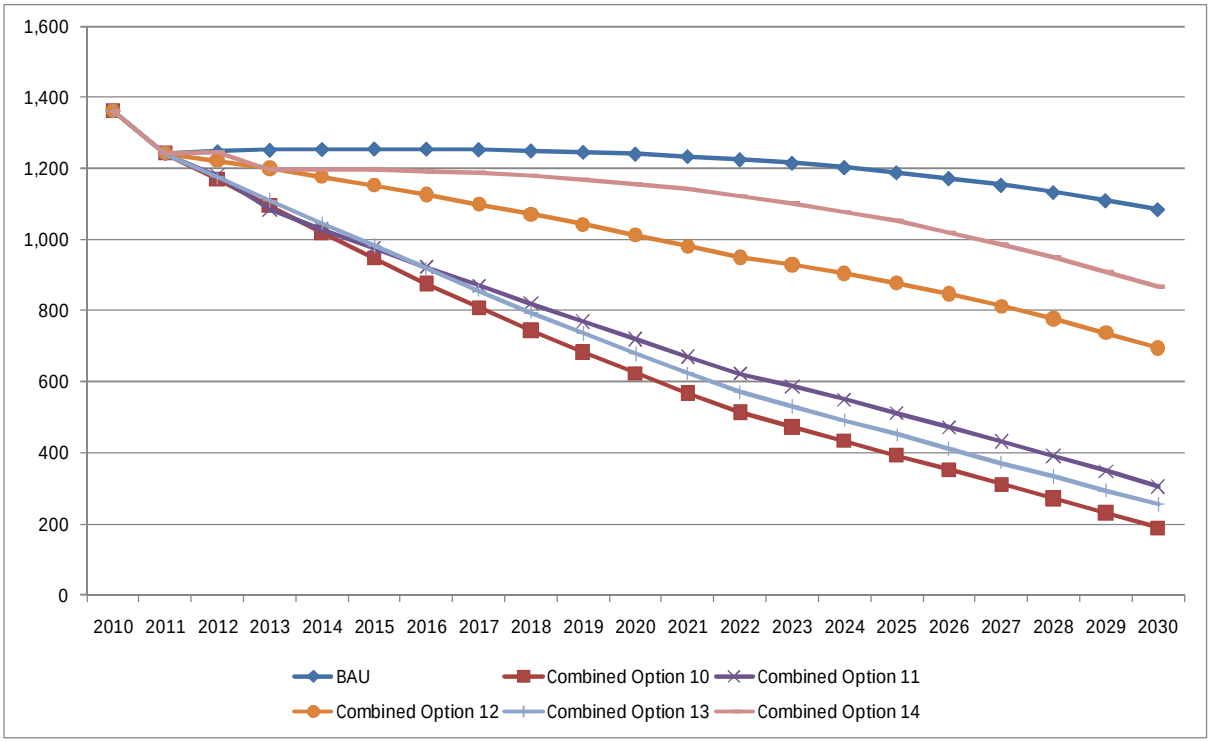
South Eastern statistical region

Stock Projections





Emissions Projections



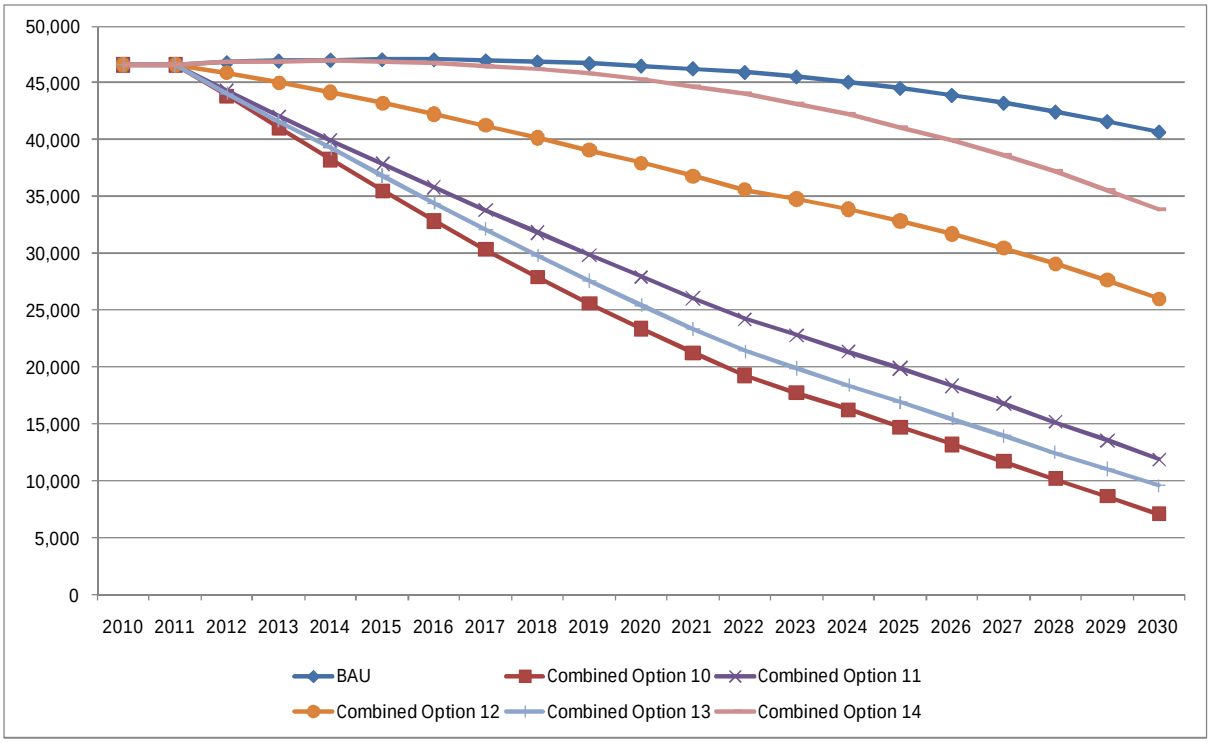
Cost Benefit Analysis (NPV $M)

Control Options	Total Costs	Health Benefit over BAU	Net Benefit[1]
Combined option 10	-$20.9	$4	-$17.3
Combined option 11	-$8.0	$3	-$4.7
Combined option 12	-$4.3	$2	-$2.3
Combined option 13	-$7.0	$3	-$3.6
Combined option 14	$2.9	$2	$4.4

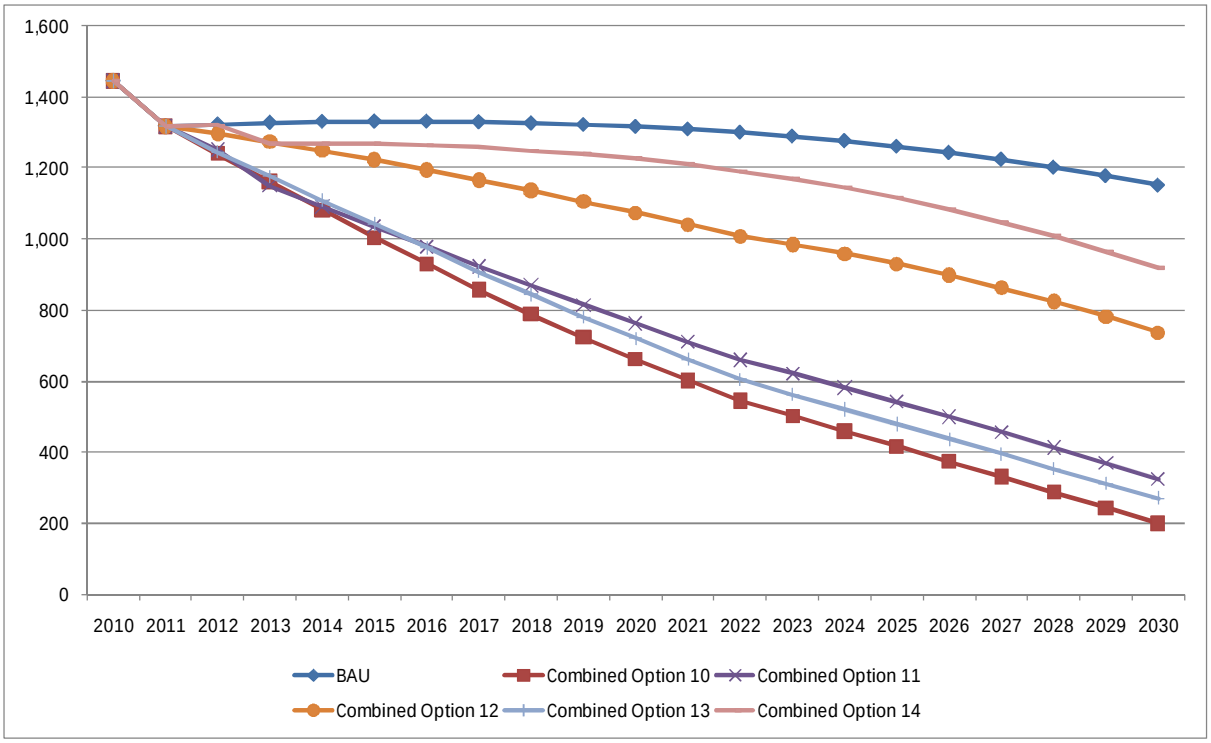
(1) Negative values indicate a net economic cost. This happens when the combined cost of implementation and the loss of consumer surplus exceeds the health benefit produced by the policy option.

Illawarra statistical region

Stock Projections



Emissions Projections



Cost Benefit Analysis (NPV $M)

Control Options	Total Costs	Health Benefit over BAU[2]	Net Benefit
Combined option 10	-$22.2	$488	$465.6
Combined option 11	-$8.4	$440	$432.0
Combined option 12	-$4.6	$268	$263.2
Combined option 13	-$7.4	$457	$449.8
Combined option 14	$3.1	$207	$209.7

Overall assessment for selected study areas

The evaluation indicated that implementing the combined options in the selected study areas would produce

a) significant net economic benefit worth several hundred million dollars in three areas:
   - Balmain to Strathfield
   - Liverpool
   - Blacktown to Penrith
   - Illawarra statistical region.

b) minor net economic benefit in Blue Mountains area; and

c) generally, a net economic cost in South Eastern statistical region.

The low benefit outcomes obtained for b) and c) would generally result when policy options are applied to rural areas with low population density, for which health impact of wood smoke i.e. $/tonne of PM_{10}, was assumed to be small, compared to capital city or regional urban areas. The current method for estimating health impacts based on regional population density, however, was approximate and imprecise. A reliable scientific method to determined location-specific health impacts of PM_{10} emission is not available. On the other hand, a number of considerations may be made to improve reliability of estimates, including:

- specifying smaller local geographic boundaries e.g. Armidale;
- taking into account population density for the specific target areas;
- taking into account existing pollution levels and spatial distribution of the air sheds e.g. western Sydney areas tend to have worse pollution with natural air movements and the surrounding mountain range.
- including heating degree days and other climate parameters in the estimation;