Appendix 12

This report was prepared by *Regulatory Impact Solutions Pty Ltd* for the Department of Environment, Land, Water and Planning.

Methodology and assumptions for cost benefit analysis

The following table sets out the costs and benefits that were quantified as part of the CBA.

Table 26: Description of quantified costs and benefits

Costs	Benefits
Cost of certificates – represents the incremental cost to the community (via energy companies and reflecting the business costs of APs etc) of achieving the efficiency improvement	Reduction in GHG due to reduced energy demand, which has a benefit to the environment
Retailer administrative costs – the administrative costs to retailers of buying certificates, interacting with ESC (surrender and reporting), compliance	Reduction in other pollutants from reduced energy generation – improved air quality
Costs to government (ESC costs of administering the scheme)	Avoided industry costs (energy generation and transmission)
Costs to large energy users who opt out of the scheme	

Shortfall penalty costs were not specifically modelled. The shortfall penalty is set in the Victorian Energy Efficiency Target Regulations 2018 at $50 in 2018, and then increased each year by CPI.

At the time of making the 2018 Regulations, it was noted that the shortfall penalty rate would be revisited upon the setting of the program targets for 2021-2025.

It is understood that the purpose of the shortfall penalty rate is to act as an incentive for retailers to meet their actual liability for surrendering certificates, rather than be an alternative compliance path. As such, the shortfall penalty rate should be set well above the range of certificate prices expected to be needed in order to meet the target each year.

These are not required to be incurred, as it is expected (so long as the penalty amount is set sufficiently high) that as far as possible retailers will meet their liabilities by purchasing and surrendering the required number of certificates. In practice, there may be a small shortfall occurring from time to time, although this is expected to be infrequent and small in the context of the scheme.

Therefore, for the purposes of this CBA, it is assumed that all retailer obligations to surrender certificates are met in full each year and no shortfall penalty is required to be paid.

Cost of certificates

The primary cost of the program is the products, appliances, equipment and business costs of the APs that are required in order to create the certificates. These costs are reflected in the number of certificates created and the average price that certificates are sold to retailers.

The number of certificates is assumed to be the same as the program target each year. This reflects the obligation created under the Act, notwithstanding that there may be excess certificates created and carried over. Allowing certificates to be carried over helps the industry manage its annual obligations.

The average price of certificates under each option is taken from modelling undertaken by various consultants, see the section on the Impact Assessment for more information.

The certificate prices were estimated in real dollars (i.e., as valued in 2019).

As the certificate prices were based on market appetite to create certificates at various prices, the certificates prices from those models implicitly includes the $1 fee paid to ESC. For the purposes of the CBA, the ESC fee is removed from the total cost of certificate creation as the costs to ESC are counted separately.

It is assumed that the price of certificates includes all of the APs business costs, including the costs of accreditation as an AP, other regulatory and reporting costs, costs of product approval, etc. According to consultation to inform the target setting in 2015, stakeholders maintained that these costs are incorporated into the price of certificates; and therefore, should not be separately costed (as this would be double counting of costs).

The modelled certificate prices also implicitly include an amount that would be profit to the APs. To the extent that this profit is an ordinary return on investment, the profit represents part of the cost of participation in the scheme. However, if there is profitability over and above the normal return on investment ('abnormal profits'), these are not true costs of the scheme, but represent only a transfer between different groups. The Department has no available data on the levels of profitability but does not believe that abnormal profits would be significant, if anything at all across the sector, given the level of competition and ability for new APs to enter.

Retailer administration costs

There are administrative costs to retailers associated with purchasing and retiring certificates and reporting under the program. All retailers should have adequate systems in place and there are no new data requirements for retailers.

Retailers' VEU administrative costs have been based on *Analysis of Compliance Costs for a National Energy Savings Initiative* — a report prepared by NERA Consulting and Oakley Greenwood for the Department of Climate Change and Energy Efficiency in 2012. This report includes information on costs that was obtained through interviews with a subset of retailers with obligations under VEU including the largest retailers. The report found that the average ongoing compliance cost per certificate for retailers in Victoria is $0.60 (in 2012 dollars, equivalent to $0.72 for 2020). The report also modelled a range of potential costs from 2 per cent of certificate costs to 7 per cent of certificate costs. In 2011, labour costs accounted for 82 per cent of compliance costs incurred by retailers in Victoria. The remainder of the costs were mostly related to external legal and other additional costs.

Breakdown of on-going costs incurred by retailers to comply with the program in 2011	
Auditing	26.8%
Record keeping	7.4%
Reporting	19.8%
Legal	2.5%
Searching for energy savings to purchase	0.5%
Negotiations with energy service companies/brokers	10.6%

Other costs	11.9%

In the absence of any new data on the estimated administrative costs to retailers, it is reasonable to use the figures from the 2012 report. Hence, retailer compliance costs have been estimated at 72 cents per certificate. For sensitivity analysis, retailer compliance costs were also modelled at 2 per cent of certificate prices and 7 per cent of certificate prices.

Costs to government

There are also costs to government associated with the creation and surrender of certificates. These costs fall on the ESC as the regulator of the program.

The costs are difficult to estimate for each of the options considered in this RIS, as a large share of ESC costs do not vary directly with the size of the program. Some costs will be incurred regardless of the program size, while other costs are dependent on other drivers that may change under the options but not in a clearly predictable way (e.g., the number of AP accreditations, product registrations, take-up of PBAs, etc.). There are also costs that may change in the future based on changes to the risk profile of program participants and activities (e.g., different target options may have indirect impacts on the level of audit and compliance activity required to maintain the integrity of the scheme).

For the purpose of this RIS, it is assumed that ESC costs involve a base level of $6 million per year that does not change (directly) as a result of the options considered in this RIS, and a further component that ranges between $650,000 and $2,250,000 per year depending on the program target each year. It is noted that this is indicative only for the purpose of undertaking the CBA and the actual costs to ESC each year will depend on other factors. It is also noted that the ESC costs in total are small compared to the other impacts of the program, and a more detailed approach to estimating future ESC costs would not assist in the consideration of options in this RIS.

ESC costs are (mostly) recovered through fees charged for the registration of certificates and accreditation of APs.

Large energy users

Under options 1 and 2, large energy users (LEU) are exempt from the program. That is, their energy consumption is not counted when determining the liabilities of energy retailers under the program. Accordingly, certificates cannot be created via activities at those premises. However, exempt large energy users can ‘opt in’ to the program via notification. The number of exempt users that have opted in to the scheme since 2009 has been small.[127] For options 1 and 2, it is assumed that any exempt large energy users that opt into the program will be similarly small, and that these users have no material impact on the overall costs and benefits of the program.

Under options 3 and 4, large energy users are not exempt from the program unless they elect to opt out, which is conditional on their completion of ISO50001 certification. From 2021, there will be 83 large energy users that could choose to opt out the program. Whether a large energy user elects to opt out affects the overall costs and benefits in the following ways:

	Network benefits	GHG abatement	Cost of certificates	Other costs
LEU stays in scheme			Allows lower certificate prices by having more opportunities to	-

[127] 12 large energy using sites have opted in to the VEU program (a further 46 smaller energy users who were also exempt, for example a small shop in shopping centre, have also opted in).

	These (as measured in this CBA) are unaffected by whether a LEU stays in or opts out of the scheme.	undertake activities that create certificates	
LEU opts out of scheme	LEUs that opt out may make decisions to reduce energy consumption outside the scheme	A higher price as there are fewer opportunities to undertake activities that create certificates	Costs of ISO50001 certification

For this CBA, it is assumed that up to 55 LEUs may opt out of the program under option 3 and up to 62 under option 4. This is based on an estimate of the costs of energy they may save by opting out exceeding the cost of undertaking ISO50001. (While the LEU may save on energy prices by opting out, those costs need to be recovered from other customers, and so is not a net saving overall).

It is assumed the cost of undertaking ISO certification is $75,000 per LEU. This would only occur once in the period 2021-2025. This is a conservative (higher) estimate, as some LEUs may already have most of the processes and plans in place to achieve certification easily.

Reduction in GHG emissions

Generation of energy through fuel combustion causes greenhouse gas (GHG) emissions. Reductions in GHG benefit the community by avoiding or reducing the adverse impacts of climate change.

The volume of CO2 emissions abated each year is taken from the modelled profile of emissions abatement over time from each year’s certificates and the likely activities that are used to create the certificates.

The volume of emissions reflected in the target each year corresponds to the number of certificates to be surrendered, but the number of certificates from a given activity reflect the reduction in emissions over time, not solely in the year the certificate is created. This equivalence is managed through the prescribed formula in the VEET Regulations 2018, which takes account of assumptions for actual abatement in the long term (e.g., allowing for business as usual innovation and normal appliance replacement rate that would reduce emissions anyway).

There are several approaches available to estimate the economic cost of carbon emissions, all of which have associated advantages and disadvantages. The approaches include:

- the Social Cost of Carbon – an assessment of the difference in global economic output between a future scenario with and without additional carbon emissions
- the marginal cost of abatement – an assessment of the cost to implement measures that avoid or sequester carbon emissions
- market price of carbon permits – using a price signal set by an emission trading scheme. Market prices are only useful if the scheme is designed to reduce emissions to a level consistent with mitigating all impacts of climate change over the long term. No such market does this.

There is currently no generally accepted methodology for valuing emissions reductions.

In other recent analysis, the social cost of carbon was estimated using the following:

- as used by EY in *Modelling of the Victorian renewable energy target scheme scenarios* in September 2017[128], the value of GHG abatement was taken as $10/tonne in 2020, rising to $30/tonne by 2030. (see Figure 32, page 42)
- as used by Jacobs in *Modelling illustrative electricity sector emissions reduction policies* prepared for the Climate Change Authority in September 2016[129], a value of $69/tonne in 2020, rising to around $115/tonne by 2030 and $275/tonne by 2050 (see Figure 364, page 287).

Most other credible sources on the value of GHG abatement fall within this range. See for example, the Social Cost of Carbon for Regulatory Impact Analysis published by the US EPA.[130]

The true value of GHG abatement is likely to be at the higher end of these estimates as a number of assumed carbon values are only suitable to near-term targets (e.g., 2020) or are only designed to achieve carbon reductions of particular levels that are unlikely to fully mitigate the impacts of climate change.

Victoria is delivering its share of global action to achieve the Paris Agreement goal through the *Climate Change Act 2017*. This includes establishing a long-term target of net zero greenhouse gas emissions in Victoria by 2050 and a process to develop emission reduction policies (sector pledges). The VEU will form an important component of these sector pledges.

On this basis, the value of carbon abatement used in this RIS is based on scenarios in the Intergovernmental Panel on Climate Change's (IPCC's) Fifth Assessment Report (2014) that would provide a likely chance of limiting global temperature increases to below 2°C above pre-industrial levels. This has been selected because it is the trajectory most consistent with the Paris Agreement, agreed by the international community in 2015, to "hold the increase in global average temperature to well below 2°C and to pursue efforts to limit the temperature increase to 1.5°C."

This IPCC trajectory assumes global action is taken to keep global temperature rise to below 2°C and is maintained out to 2050. It is derived from the median of values that have been assessed by the IPCC as providing a greater than 66 per cent chance of keeping global temperature increases to below two degrees by 2100 – consistent with atmospheric concentrations of carbon dioxide equivalent to 430–480 ppm. The IPCC trajectory was developed before the Paris Agreement was established, and so looks at pathways consistent with probabilities of keeping global temperature rise to "below" rather than "well below" 2°C. As the IPCC trajectory has a 66 per cent or greater chance of limiting global temperature rise to below 2°C, it follows that it would have a less than 66 per cent chance of limiting global temperature rise to well below 2°C.

The carbon values were converted into Australian dollars for the relevant year using an average annual exchange rate and then escalated to 2019 values using an Australian GDP deflator. A straight line was used to connect each data point and calculate a value for each year.

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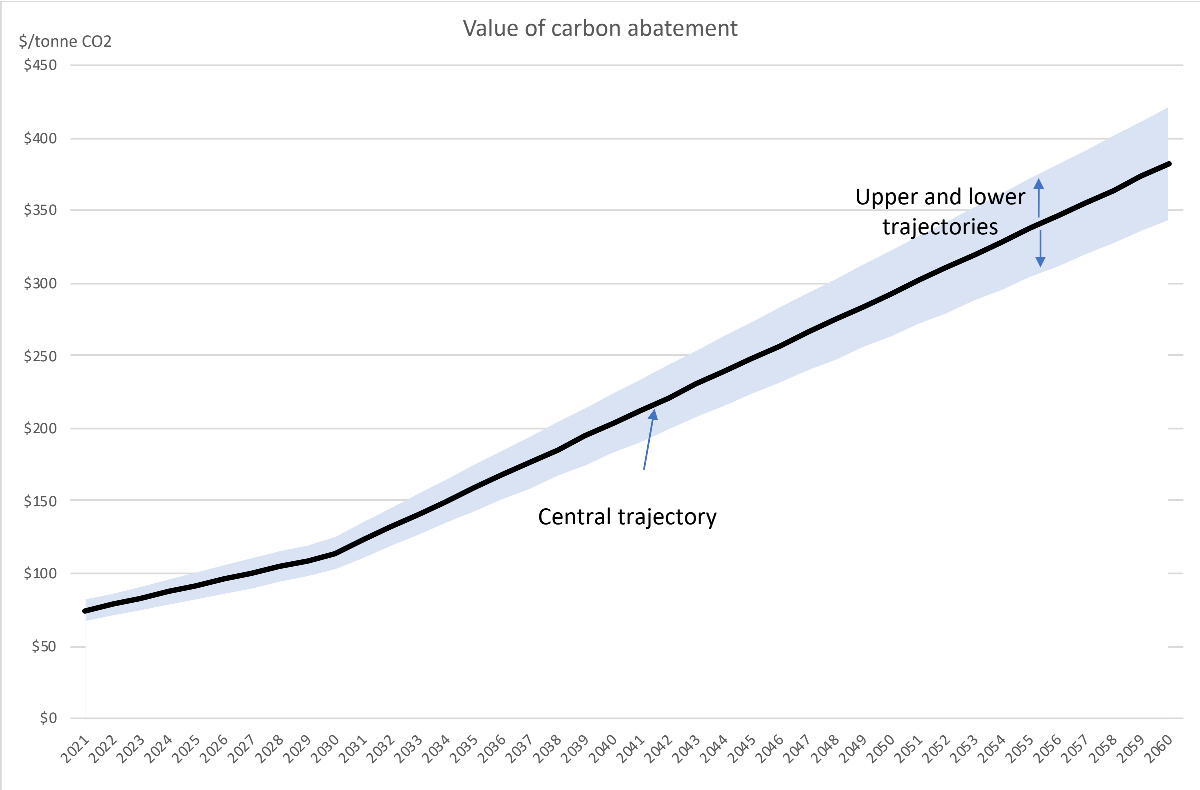
[128] https://www.energy.vic.gov.au/__data/assets/pdf_file/0021/83091/EY-modelling-report-VRET.pdf

[129] http://climatechangeauthority.gov.au/sites/prod.climatechangeauthority.gov.au/files/files/SR%20Modelling%20reports/Jacobs%20modelling%20report%20-%20electricity.pdf

[130] https://19january2017snapshot.epa.gov/climatechange/social-cost-carbon_.html



Improved air quality

A reduction in overall energy generation has incidental health benefits in terms of improved air quality.

Power stations are a significant source of air pollution in Victoria. The mining and combustion of coal for electricity generation in Australia produces air pollution containing particulate matter (measured as PM10 and PM2.5), nitrogen oxides, sulphur dioxide, as well as other emissions. These pollutants are well documented to result in adverse health consequences such as premature mortality and acute and chronic respiratory morbidity. Any reduction in these pollutants and subsequent improvements in air quality will have a positive impact on the residents of Victoria.

PM2.5 is a component of PM10 and both size fractions show clear evidence of being associated with health effects, with PM2.5 generally showing stronger associations.

Systematic reviews and meta analyses investigating the association between PM2.5 and effects on health have mainly focused on effects on respiratory and cardiovascular systems. There is clear and strong evidence that there is an association between increases in daily PM2.5 and emergency department presentations and hospital admissions for respiratory and cardiovascular conditions and mortality.

In addition, many studies have also shown an association between exposure to PM10 and PM2.5 and reduced lung function, respiratory symptoms and physiological and sub-clinical changes, such as heart rate variability, blood markers of inflammation and coagulation.

It is generally accepted that there is a linear relationship between exposure to particulate matter PM10 and PM2.5 and health outcomes, and that there is no safe PM10 and PM2.5 level below which no effects are expected.

The table below shows the estimated average air pollutant from Victorian power stations during 2016-2017. It is based on reported pollutant quantities from the National Pollutant Inventory and annual generation figures from NEM historical data.

Power Station	Oxides of Nitrogen (kg Nox)	Oxides of Nitrogen (kg Nox/MWh)	Particulate matter 10.0 um	Particulate matter 10.0 um(kg PM/MWh)	Particulate matter 2.5um	Particulate matter 2.5um (kg PM/MWh)	Sulphur Dioxide (kgSO_2)	Sulphur Dioxide (kgSO_2/MWh)	Electricity generation in 2016-17 (MWh)
Loy Yang A	21,000,000	1.33	4,100,000	0.26	510,000	0.03	52,000,000	3.29	15,828,553
Loy Yang B	14,000,000	1.62	1,100,000	0.13	620,000	0.07	23,000,000	2.66	8,633,915
Yallourn	15,000,000	1.31	2,100,000	0.18	810,000	0.07	21,000,000	1.83	11,473,807
Weighted average		0.71		0.09		0.03		1.30	N/A
Total	50,000,000		7,300,000		1,940,000		96,000,000		35,936,275

To establish the economic impact associated with the health costs from these emissions it is possible to rely on an approach established by the Australian Academy of Science Technology and Engineering (ASTE) in its 2009 report *The Hidden Costs of Electricity: Externalities of Power Generation in Australia*. This approach takes values from the European Union and discounts the value based on the local population density. The ASTE report draws on the best available studies of externalities of power generation from the EU – the ExternE Project and its successor NEEDS (New Energy Externalities Development for Sustainability). Utilising a large body of research and analysis, ExternE produced estimates of monetary costs of greenhouse, health and other environmental impacts of power station emissions, based on full life-cycle assessments. The ultimate objective of the ATSE report was to derive a health damage cost in terms of dollars per megawatt-hour, which then provides a common basis for comparing different generating technologies.

As mentioned above, the ATSE study utilises health damage costs used in ExternE calculations and discounts the value based on the local population density (in this case based on a figure included in the ATSE report for the Latrobe Valley). The ATSE report translated the European results to Australia by making some simple approximations and assumptions:

- Most health costs arise from the three-stack emissions sulphur dioxide, the various nitrogen oxides and fine particulate matter PM10;
- The stack emissions spread in similar patterns;
- The health effects for a similar dose are similar to Europe; and
- The impacts can be proportionally scaled to adjusts for the difference in population density between Europe and the relevant regions in Victoria.

Together, these assumptions lead to a single scaling factor for converting European to Australian health damage costs.

The ATSE report calculated that the range for total health damage costs of coal fired power stations (NOx, SO2 and PM10) is between $1.60 and $52, and that the mid-range for total health damage costs is $13.20 per MWh.

The 2015 Review of the NSW Energy Savings Scheme also utilised ATSE costs, finding the ATSE values to be conservative compared to other published sources.[131] To continue this conservative approach in this CBA, a value of $15/MWh has been used (reflecting increase in value to 2019 dollars).

Avoided industry costs

The primary benefit of the VEU program is to reduce the energy needs of households and businesses for the same level of energy service provision. This has several benefits. There are lower costs of the fuel required to generate electricity and its transmission. A lower level of overall energy demand also means

[131] NSW Government 'Review of the NSW Energy Savings Scheme –Part 2: Options Paper' (2015), 131.

that investments required to expand capacity can be deferred. Essentially, these are the costs that no longer need to be incurred and paid for by Victorians to meet their equivalent energy needs.

Information about how energy benefit is calculated and any assumptions in relation to this can be found in Appendix 11.

Other assumptions

Assessment period

The costs and benefits quantified relate to activities that occur within the years 2021-2025, the years for which the targets are being set. However, the activities that occur in those years continue to have benefits after the period of the targets. In particular, reduced GHG emissions can continue for up to 40 years for some types of activities. Therefore, the time period to be modelled is as long as possible (that is still feasible). We would expect benefits to not go longer than normal replacement period for each type of appliance (although some may have a long effective life). This aligns with the calculations in the VEET Regulations on activities. It is noted that impacts beyond 30 years are less certain, and due to discounting add little to the overall impacts. Therefore, the ongoing benefits are quantified only to 2050.

Discount rate

Assessing impacts involves a comparison of economic flows that occur at different points in time. The discount rate is used to compare economic effects occurring at different times. Discounting converts future economic impacts into their present-day value. The discount rate is generally positive because resources invested today can, on average, be transformed into more resources later. If climate change mitigation is viewed as an investment, then the return on investment can be used to decide how much should be spent on mitigation.

Future values should be discounted by the social discount rate, to take account of the opportunity cost to the community. Discounting costs and benefits allows a consistent determination of net benefit or cost. The discount rate is a critical parameter in cost-benefit analysis whenever costs and benefits differ in their distribution over time, especially when they occur over a long time period.

Best practice uses a social discount rate equal to the long-term average market rate of return, which suggests a real discount rate of 7 per cent.[132] As with any uncertain variable, sensitivity analysis should be conducted, so in addition to the 7 per cent ‘central’ discount rate, the net present values were also calculated with real discount rates of 4 per cent[133] and 10 per cent. If the sign of the net present value changes, or the ranking of options changes due to a change in the discount rate, the sensitivity analysis reveals that the choice of discount rate is important. For the analysis of options in this CBA, it was found that varying the discount rate within this range did not affect the ranking of options nor cause any option to change from a net benefit to a net cost.

Discounting costs and benefits received in the far future involves valuing the effects of policies on future generations, raising ethical issues. For example, the current generation can adopt policies which harm future generations – not only a different group of people, but one that is not around to defend its interests. As such, some studies have advocated for a much lower discount rate (or even zero) where long-term environment impacts are involved, to better reflect intergenerational equity. The 2006 Stern Review on the Economics of Climate Change used an average discount rate for climate change damage of approximately 1.4 per cent. This was subject to some criticism. The more recent analysis of choice discount rates by the

[132] This is consistent with the Commonwealth Office of Better Practice Regulations (2016) and NSW Treasury (2007), but slightly below that recommended by Harrison (Productivity Commission 2010, Valuing the Future: the social discount rate in cost-benefit analysis, Visiting Researcher Paper, Productivity Commission, Canberra). This rate used in the Commonwealth RIS process to support the NCAA agreement for all jurisdictions to adopt the national standards.

[133] A real discount rate of 4 per cent is commonly used in Victorian RISs.

Productivity Commission concluded that a lower discount rate to account for intergenerational equity ignores the likelihood that future generations will have a greater capacity to meet future needs, and therefore overcompensates for impacts between generations.

All values in the CBA are expressed in 2019 dollars (real), with NPV values discounted to 2019.

Sensitivities of estimates

The following tables sets out the key assumptions used in the estimation of costs and benefits (drawn from above) and the 'best case' and 'worse case' ranges used to estimate the sensitivity of the costs and benefits to each parameter input.

Table 27

Parameter	Central case used	Worst case	Best case
Value of CO2 abatement	IPCC trajectory consistent with 66% chance of limiting warming to 2 degrees Celsius	values are 10% lower	values are 10% higher
Value of improved air quality (in terms of $benefit per MWh avoided generation)	$15	$10	$20
VEEC prices	As modelled (see above)	+10%	-10%
Retailers' administrative costs	72 cents per certificate	7% of VEEC price	2% of VEEC price