Fast-tracking Victoria's clean energy future to replace Hazelwood Power Station

A REPORT BY GREEN ENERGY MARKETS FOR ENVIRONMENT VICTORIA

MAY 2010

green energy markets

environment victoria

Front cover

Top:
Hazelwood power station, Environment Victoria
Waubra Windfarm, Acciona

Left to Right:
Workers preparing the foundations for a wind turbine at Waubra windfarm, Acciona
Solar roof, Mont Cenis Academy, Germany
Biogas co-generation, USA
Solar hot water installation, Sun Force Solar

Disclaimer

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The project brief

Green Energy Markets Pty Ltd has been engaged by Environment Victoria to undertake an assessment into the options and opportunities for replacing the Hazelwood Power Station by the end of 2012. This report assesses a combination of clean energy technologies to replace the generation capacity provided by Hazelwood in a way that maximise emissions reductions, whilst also maintaining energy security and minimising any increase in electricity bills.

Victoria's energy mix and Hazelwood's contribution

Victoria's energy generation mix is dominated by coal. Whilst there has been modest growth in renewables over the last decade; coal still accounts for 92 per cent of total generation. In an increasingly carbon-constrained economy, replacing the most emission intensive power stations with less carbon-intensive options will be one of the first and most effective actions. Hazelwood power station is the most emission intensive power station in Australia with sent out emissions of 1.53 tonnes of CO_2 per MWh.

Hazelwood power station comprises 8 x 200 MW units and provides 23 per cent of Victoria's electricity needs. Hazelwood contributes 1179 MW to meeting peak summer demand. In doing so however it produces over 16 million tonnes of greenhouse gas emissions and uses 27 billion litres of water each year.

Assessment of clean energy resources and projects to replace Hazelwood

We have undertaken our assessment by considering the range of clean energy options and resources that are currently available in Victoria. We have assessed the projects that could be commissioned and constructed by the end of 2012 including those with planning approvals and those awaiting approvals. We have then selected a combination of these that could replace Hazelwood's contribution to Victoria's power supplies in the short and medium-long term.

The analysis finds that Victoria is in a fortunate position to have access to a diverse range of clean energy resources, which together could replace Hazelwood's generation many times over.

In our modelling we have selected the clean energy options that not only replace the amount of electricity that Hazelwood produces over the course of a year but also replace Hazelwood's peak summer generation. In practical terms this means replacing 1179 MW of peak summer capacity and 10,301 GWh of electricity generation each year.

The scenarios and results

We have considered two scenarios for replacing Hazelwood's peak and annual contribution:

> **Scenario 1 – Supply side only option:** this scenario involves bringing forward 1180 MW of combined cycle gas turbine plant running at 65 per cent capacity factor and 1500 MW of renewable generation (predominantly wind) at 30 per cent capacity factor; and
>
> **Scenario 2 – Supply side and demand side option:** this scenario involves bringing forward 970 MW of combined cycle gas-fired generation running at 50% capacity factor initially, then declining over time, as well as 1500 MW of renewables. It also incorporates additional residential, commercial and industrial energy efficiency options that replace around 25 per cent of Hazelwood's annual generation as well as 100 MW of Demand Side Management.

As the following table demonstrates, by accelerating the implementation of gas-fired generation, renewable power generation and energy efficiency activities Hazelwood's output can be replaced in a manner that results in 13.6 to 14.5 million tonnes greenhouse gas reductions annually. This is equivalent to reducing Victoria's emissions by 11-12 per cent by 2013, and amounts to total emission reductions of more than 116 million tonnes over the eight year period from 2013 to 2020.

	Peak Summer Contribution (MW in 2020)	Annual Electricity Contribution (GWh/a in 2020)	Greenhouse Savings (mt/a in 2020)
Scenario 1 – Supply side only			
Combined cycle gas plant (1180 MW Gross)	1,133	6,450	7,555
Renewable generation (1500 MW Gross)	45	3,942	6,031
Total	**1,178**	**10,392**	**13,586**
Scenario 2 – Including energy efficiency			
Combined cycle gas plant (970 MW gross)	931	3,508	4,027
Renewable generation (1500 MW gross)	45	3,942	6,031
Residential energy efficiency		701	1,072
Business energy efficiency	169	2,365	3,382
Demand side management	100	9	11
Total	**1,245**	**10,524**	**14,524**

Policy measures to facilitate the replacement of Hazelwood with clean energy

The deferral of the Carbon Pollution Reduction Scheme (CPRS) has increased business uncertainty with particular implications for new generation investment. New generation or energy efficiency activities will be required to meet or reduce growing electricity demand, however without a price on carbon it will be more difficult to finance new clean energy projects.

To bring clean energy options forward the Victorian Government will need to implement additional policy measures that in effect work as a transition to (and complement) the eventual introduction of a price on carbon. In the short to medium term state governments have an important role to play to ensure that a policy framework exists to support new investment.

There are a range of policy approaches that could be adopted to deliver the clean energy investment required to replace Hazelwood. These range from competitive tender processes, implementing new market based schemes, as well as expanding existing schemes such as the Victorian Energy Efficiency Target to encourage residential, commercial and industrial energy efficiency, and increasing rebates for solar water heaters where they are replacing electric storage water heaters.

Jobs and investment required

In total we expect between 1900 – 2500 construction jobs will be created in building the clean energy replacements for Hazelwood. In addition around 2300 ongoing jobs would be created across all activities under Scenario 2, mainly in energy efficiency activities. Some of these jobs would be in the Latrobe Valley but as part of the package to replace Hazelwood there will need to be investment in transitional programs for workers and in industry development in Gippsland to safeguard the region's economic future.

While developing detailed cost estimates was beyond the scope of this assignment we have considered what the cost of replacing Hazelwood might amount to. Based on public statements made by International Power we have used $20 per tonne carbon value to estimate the cost of replacing Hazelwood. Given Hazelwood's annual emissions of 16 million tonnes of CO_2 each year this amounts to a carbon value of $320 million per year. An amount of this order should be sufficient to cover both the cost of any compensation to International Power to close Hazelwood and the cost of bringing forward clean energy investment. If this cost was recovered from electricity consumers then electricity prices would rise by $6 per MWh and an average household's electricity bill would increase by around $36 per annum. This is equivalent to one fifth of the Federal Government's modelled cost impact of the CPRS under the 5 to 10 per cent emissions reductions targets by 2020.

Conclusion

Replacing Hazelwood represents a significant and comparatively low cost opportunity to reduce greenhouse emissions and begin the process of cleaning up Victoria's electricity supply.

The scenarios outlined in this report demonstrate that clean energy projects can replace both Hazelwood's peak generation and also its annual contribution by the end of 2012.

With the delay of the CPRS, there is increased attention on 'direct action' to reduce Australia's emissions. Replacing Hazelwood would reduce emissions by around 14 million tonnes per annum from 2013, which amounts to 11-12 per cent of Victoria's emissions. It would also free up 27 billion litres of water each year to be used for other purposes, and would generate substantial investment and thousands of jobs. In the absence of a price on carbon, policy intervention to facilitate the replacement of Hazelwood is more important than ever in order to deliver lower greenhouse gas emissions.

1. Project scope

Green Energy Markets Pty Ltd (GEM) has been engaged by Environment Victoria to undertake an assessment of the options and opportunities for replacing the generation capacity provided by the Hazelwood Power Station by 2012. A combination of clean energy technologies are to be considered that maximise emissions reductions, whilst also maintaining energy security and minimising any increase in electricity bills.

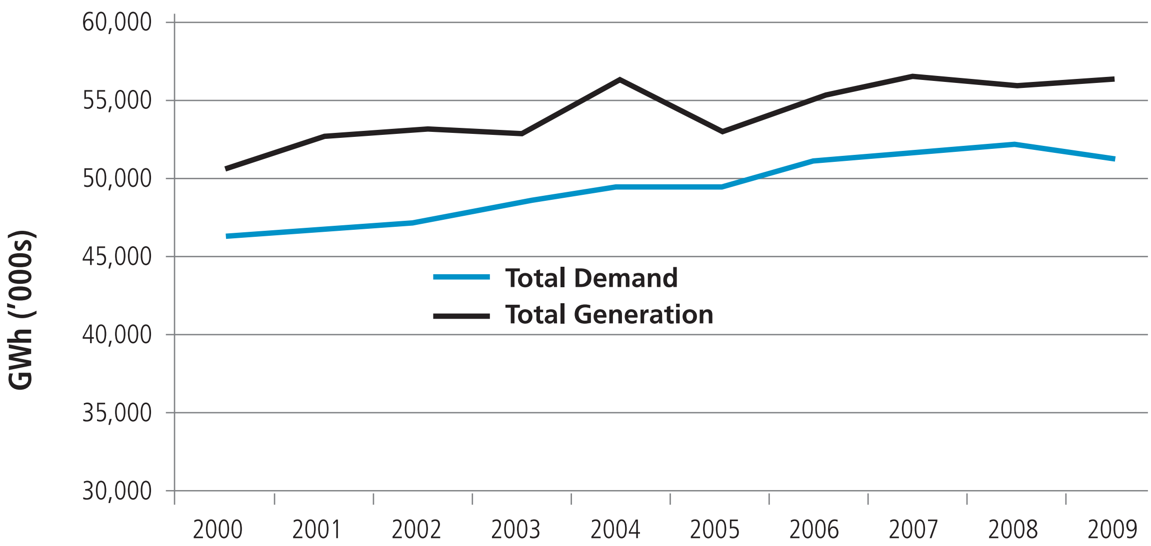
Specifically GEM is to provide:

- An assessment of Victoria's current energy mix and resultant greenhouse emissions;
- An overview of Hazelwood's operation in the National Electricity Market and its contribution to the State's emissions profile;
- An outline of approaches to replacing Hazelwood that lower Victoria's emissions without compromising the State's energy security and minimizing increase to electricity bills;
- Analysis of the employment impacts and costs of replacing Hazelwood;
- Analysis of ready-to-go clean energy projects that could be fast-tracked to replace Hazelwood, including an assessment of whether the State has sufficient gas and renewable projects under development with sufficient resource reserves to sustain electricity generation;
- Assess options for expanding energy efficiency and other demand management measures across the state; and
- Analysis of policy options to facilitate the replacement of Hazelwood power station by the end of 2012.

2. Assessment of Victoria's energy mix

Victoria's annual electricity demand has grown steadily over the last 10 years (although dipped slightly last year), and currently amounts to around 23 per cent of total electricity demand in Australia. Victoria has traditionally produced more electricity than it consumes and has been a net exporter of electricity to other states (refer to Figure 1). Typically Victoria exports electricity during off-peak times and imports during peak periods.

Figure 1 – Energy demand vs energy generation in Victoria



Source: National Electricity Market – Scheduled Generation and Demand

Victoria's electricity generation has historically been dominated by coal-fired generation and whilst renewable generation has made important inroads over the last few years, it only accounted for 5 per cent of Victoria's generation in 2009, the same share of generation as in 2000 (refer to Table 1).

While coal-fired generation has slightly reduced its overall market share of generation over the last 10 years, it still dominates electricity generation accounting for 92 per cent of total generation. In absolute terms, Victoria's reliance on coal has increased over the past decade with 51,697GWh of electricity generated from coal in 2009, up by 9 per cent on 2000 levels.

Reflecting the dominant position that coal holds in Victoria's generation mix, greenhouse emissions from electricity have increased by 10 per cent over the 10 years to 2009 – a total of 6 million tonnes (refer to Table 2). Coal-fired generation accounts for 98 per cent of emissions from electricity.

The fact that Victoria's energy mix has changed little over the past decade despite efforts to encourage renewable energy and energy efficiency highlights that unless one of the four large coal generators is replaced with clean energy generation it will be very difficult to either substantially change the State's energy mix or reduce greenhouse emissions from electricity generation.

Table 1 – Generation summary ('000 MWh)

Year	Coal Fired Generation	Gas Fired Generation	Renewable Generation	Total Generation	Coal Market Share
2000	47,242	1,150	2,258	50,649	93.3%
2001	48,776	1,241	2,694	52,711	92.5%
2002	49,765	802	2,592	53,159	93.6%
2003	49,768	437	2,794	52,999	93.9%
2004	51,739	1,601	3,143	56,483	91.6%
2005	50,108	553	2,382	53,043	94.5%
2006	51,445	821	2,944	55,210	93.2%
2007	50,137	3,545	2,968	56,650	88.5%
2008	51,386	2,242	2,431	56,059	91.7%
2009	51,697	1,688	3,091	56,476	91.5%
Total over 10 years	**502,065**	**14,078**	**27,296**	**543,439**	**92.4%**
Increase over 10 years	**9.4%**	**46.8%**	**36.9%**	**11.5%**	

Table 2 – Victorian emissions from generation ('000s tonnes)

Year	Coal Fired Generation	Gas Fired Generation	Renewable Generation	Total Generation	Coal Market Share
2000	57,373	737	0	58,111	98.7%
2001	59,395	745	0	60,139	98.8%
2002	60,682	497	0	61,179	99.2%
2003	60,670	284	0	60,954	99.5%
2004	62,856	1,004	0	63,860	98.4%
2005	60,892	336	0	61,227	99.5%
2006	62,464	507	0	62,971	99.2%
2007	60,899	2,324	0	63,223	96.3%
2008	62,441	1,468	0	63,909	97.7%
2009	62,897	1,090	0	63,987	98.3%
Total over 10 years	**610,569**	**8,991**	**0**	**619,560**	**98.5%**
Increase over 10 years	**9.6%**	**47.8%**		**10.1%**	

3. Hazelwood's operation in the National Electricity Market (NEM)

Hazelwood Power Station was commissioned between 1964 – 1971 and is one of the oldest power stations still operating in Australia. It is the least efficient of the coal generators currently operating in Australia and has the highest level of greenhouse gas emissions per MWh of generation (Refer to Table 3).

The power station was built as part of the generation assets of the State Electricity Commission. The Kennett Government sold the power station in 1996 for $2.4 billion as part of its electricity industry privatisation program. International Power which owns Hazelwood has since stated that they have invested a further $400 million.

In 2005, the Hazelwood Power Station was granted a mine extension by the Victorian Government that released sufficient coal reserves to enable it to operate until around 2031. Before the power station was privatised in 1996 it had been scheduled to close in 2005. When the final turbine was commissioned in 1971 the SEC stated that "By the end of the century, the massive Hazelwood Power Station will probably no longer be functioning"[1].

Due to its high greenhouse gas emissions it is widely considered that the introduction of a carbon price in Australia (like the CPRS) would see Hazelwood at risk and it would be one of the first power stations to close in Australia. International Power in its submission to the Australian Government signalled that it is prepared to negotiate an early closure of the power station stating that: "the Government (could) target the largest emitters and agree with the owners an emissions reduction production profile based on a phased withdrawal over a fixed number of years, in return for a tariff derived from the pre-CPRS market value"[2].

Table 3 – Brown Coal Generators in Victoria

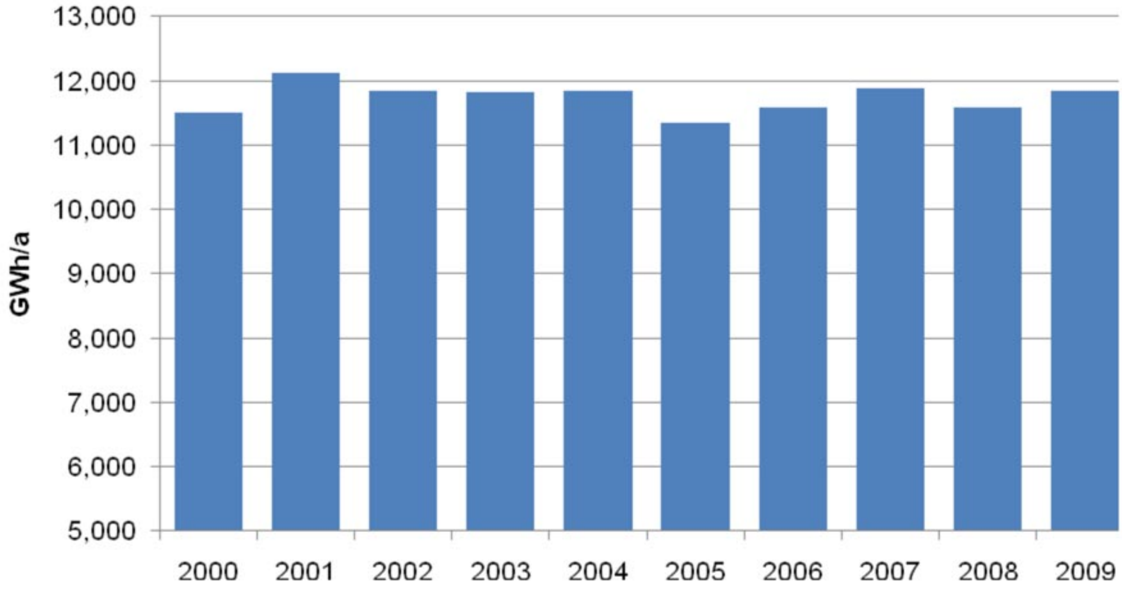
Station Name	Configuration	Capacity (MW)	Auxiliaries (own use)	Thermal Efficiency (sent out)	Emissions t/MWh (sent out)
Anglesea	1x150 MW	150	10.0%	27.2%	1.21
Energy Brix	1x90,1x30,1x75MW	195	15.0%	24.0%	1.49
Hazelwood	8x200 MW	1600	10.0%	22.0%	1.53
Loy Yang A	2x500,2x560	2120	9.0%	27.2%	1.22
Loy Yang B	2x500	1000	7.5%	26.6%	1.24
Yallourn	2x360,2x380	1480	8.9%	23.5%	1.42

Source: ACIL Tasman, Fuel resource, new entry and generation costs in the NEM, April 2009

Hazelwood currently supplies around 23 per cent of Victoria's electricity. In 2008 and 2009 it averaged 11,770 GWh of power generated per year. However it is also extremely carbon intensive and in 2008 and 2009 it produced on average more than 16 million tonnes of CO_2e each year. In addition the power station is also responsible for emitting over 57 million kilograms of other pollutants per annum such as nitrogen oxides and sulphur dioxide (refer to Attachment 1). As well as a large emissions footprint, Hazelwood also uses around 27 billion litres of water a year[3]. Hazelwood power station and mine directly employ 500 people with an additional 300 contractors also employed.

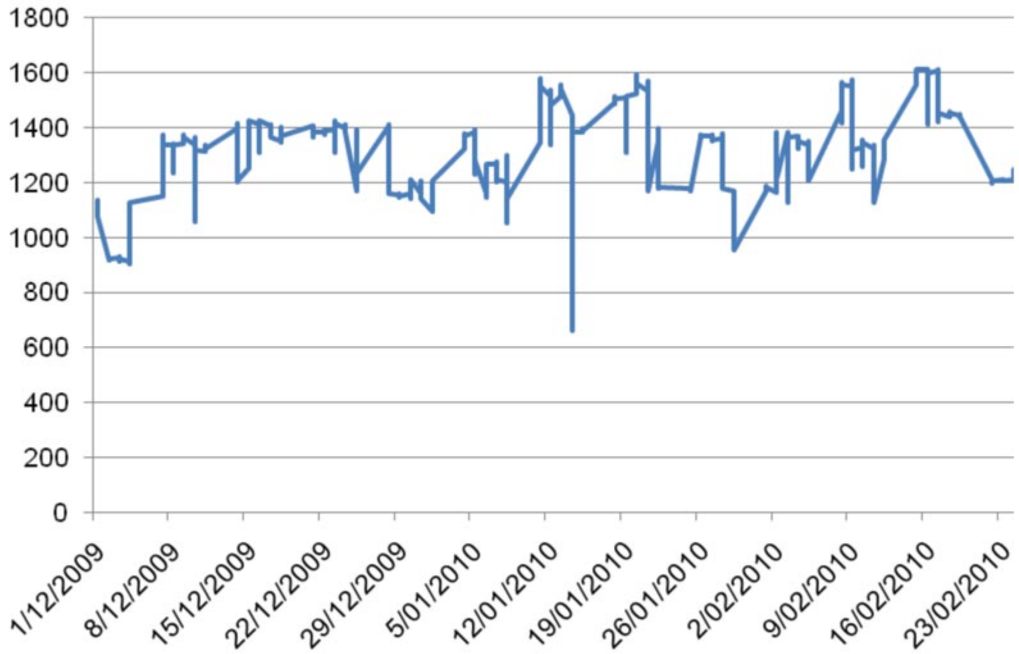
Using NEM data we have analysed Hazelwood's electricity generation in recent years and whilst generation levels have fluctuated somewhat due to changes in demand and maintenance requirements, its annual output has been relatively stable at between 11,500 to 12,100 GWh per annum over the last 10 years (refer to Figure 2).

Figure 2 – Hazelwood's electricity generation over the last 10 years



Victoria's peak power demands occur in summer and are driven by air-conditioning needs. Over the last two summer periods Hazelwood tended to operate at around 1350 MW. Hazelwood's output over the peak 2009/10 summer period has varied from less than 1000 MW to 1600 MW (refer to Figure 3).

Figure 3 – Hazelwood's generation (MW) over 2009/10 Summer (peak hours)



Hazelwood's power contribution to the NEM can therefore be summarised as follows:

- Total generation – 11,770 GWh on a gross basis (effective capacity factor of 84 per cent). This needs to be reduced by the extent of its auxiliary electricity consumption (10 per cent) and its transmission loss factor (3 per cent). This means that 10,240 GWh per annum of generation needs to be replaced.
- Contribution to meeting peak summer demand of 1350 MW on gross basis with 1175 MW after auxiliary power use and transmission losses.
- Emissions intensity 1.37 tonnes/MWh on a gross basis (1.53 on a sent out basis after adjusting for auxiliary power use).

Hazelwood has very high auxiliary power use (at 10%). This is the amount of electricity that is used by the power station itself to process coal and run the power station (pumps, fans etc). This means that only 90 per cent of the power that is produced is sent out to the transmission system and then a further 3 per cent of electricity is lost in the form of transmission losses.

4. Approach to replacing Hazelwood

Hazelwood power station plays an important role in Victoria's generation mix and at 23% of total generation plays a key role in ensuring that electricity is reliably supplied to Victorian households and businesses. In considering how to replace Hazelwood, we have considered a mix of clean energy technologies that could provide the required level of reliability to ensure that the "lights stay on" and then we have sought to deliver these in a way that results in the greatest reduction in greenhouse emissions whilst not imposing onerous costs on Victorian electricity consumers.

For the purpose of this analysis we have not considered the impact of an emissions trading scheme, if and when it is introduced. We have considered and evaluated the following clean energy technologies:

- Gas-fired generation (both open and closed cycle)
- Renewable energy
- Energy efficiency (both commercial and residential); and
- Load shedding for peak summer management (demand side management)

The options and approaches we have considered are influenced by the 2012 timeframe for Hazelwood's replacement that has been prescribed. As a result we have excluded a range of possible technologies and activities that we could not be confident could be delivered in this time frame. This does not mean that these should not be developed and supported as they can play an important ongoing role in meeting Victoria's power needs. For example large scale solar thermal and geothermal projects could provide considerable amounts of generation both over the year and at the peaks, however they are not likely to be operating in the next 3 years as there are not as yet projects with planning approvals in Victoria.

In many cases, the activities that we are targeting are merely bringing forward the early implementation of clean energy technologies that would otherwise have been built some time in the future.

In the short to medium term, increased imports of electricity (from black coal-fired generation) from NSW and Queensland could be used to replace some of Hazelwood's electricity production – but not its contribution to meeting peak power demand. Over the last three years, Victoria has exported a net 4,500 GWh per annum to other states. It is therefore arguable that not all of Hazelwood's generation needs to be replaced to ensure that Victoria's energy needs are met.

However in this analysis we have chosen to fully replace Hazelwood's generation with cleaner energy options. By doing so we maximise greenhouse emission reductions and we provide scope to ensure that local clean energy options are available to meet any growth in electricity demand.

5. Bringing forward gas-fired generation

Gas, while still a fossil fuel, is significantly cleaner than coal and when used in combined cycle mode for power generation produces only 27 per cent of the emissions of the Hazelwood Power Station. Compared to coal, gas-fired generation has a number of other advantages; it has lower capital costs, is more flexible (i.e. can be turned on and off more quickly than a coal plant), can be economically built in smaller increments, can be located closer to the load to reduce transmission and distribution losses and is quicker to build. Gas complements renewable energy plants well, as its flexibility enables it to power up or down quickly depending on the amount of renewable energy being produced at any time.

However gas is a more expensive fuel than coal, and as such it has typically operated a lower proportion of the time. Gas plants in Victoria have not run base load – though they could if provided with the appropriate price signals – such as through a price on carbon.

There are currently seven scheduled gas-fired generators operating in Victoria with a combined capacity of 1798 MW (refer to Table 4). These generators are predominantly open cycle plants and do not operate very often, hence they only contribute 3 per cent of Victoria's current electricity supply (refer to Table 2). They are used predominantly during periods of high electricity demand – particularly over summer.

Table 4 – Scheduled gas-fired generators in Victoria

Station Name	Configuration	Capacity (MW)	Output 2009 (GWh)	Capacity Factor	Auxiliaries (own use)	Thermal Efficiency (sent out)	Emissions t/MWh (sent out)
Bairnsdale	OCGT 2x47MW	94	113	14%	3.0%	34.0%	0.60
Jeeralang A	OCGT 4x51MW	204	39	2%	3.0%	22.9%	0.90
Jeeralang B	OCGT 3x76MW	228	129	6%	3.0%	22.9%	0.90
Laverton North	OCGT 2x156MW	312	125	5%	2.5%	30.4%	0.68
Newport Steam turbine	1x500MW	500	1108	25%	5.0%	33.3%	0.62
Somerton	OCGT 4x40MW	160	91	6%	2.5%	24.0%	0.86
Valley Power	OCGT 6x50MW	300	83	3%	3.0%	24.0%	0.86

Source: ACIL Tasman, Fuel resource, new entry and generation costs in the NEM, April 2009

Victoria has access to significant gas reserves and there are currently a range of gas-fired generation projects that are under development. Projects currently under development are summarised in Table 5.

Whilst gas is a mature technology, in the case of combined cycle gas plant it would typically take two years to reach project completion once commitment is given. Mortlake I is currently under construction and is expected to be operational by mid to end 2010. Origin Energy has planning approval for 1000 MW at Mortlake. Mortlake I at 550 MW is being built initially as an open cycle plant with the second stage (450 MW) to be built as a combined cycle plant once market circumstances warrant.

Table 5 – Gas-fired generation projects under development

Station	Owner	Type	Size (MW)	Emission Factor t/MWh	Construction Jobs
Mortlake II	Origin Energy	CCGT	450	0.40	280
Shaw River I – III	Santos	CCGT	1500	0.40	765
Yallourn	Truenergy	CCGT	1000	0.40	600
Tarrone I – II	AGL Energy	CCGT	850	0.40	300
Total			**3800**		

Note: Origin Energy's Mortlake 1 – the "open cycle" component is under construction. All other projects are under development and have not yet been committed

Excluding Mortlake I, there are 3800 MW of gas-fired generation projects that are at various stages of development. Of these, Mortlake 2 (450 MW) has planning approval and a number of other projects are currently going through the environmental planning process. Thus there are more than 1000 MW of gas-fired plants that could be readily implemented and be available to produce electricity by the end of 2012.

If an effective price on carbon was in place (i.e. through the CPRS) we would expect that a number of these projects would be progressively committed and brought on-line. In the absence of a carbon signal, the State or Federal government may have to provide initial funding to get these projects off the ground.

Whilst a significant number of construction jobs would result with the development of some of these projects, there would also be opportunities for ongoing operational jobs. It is expected that 30 people will be employed at the Mortlake project on an ongoing basis once stage 2 is complete. If we use this as the average for new gas projects then at least 100 ongoing jobs would be created if all the above projects proceeded. These figures exclude additional employment by contractors and other service providers to the facility that will be created directly as a result of the project proceeding.

Significant gas reserves are available to meet the gas demand required by these projects even in the event that they were all implemented and were all operating at high capacity factors.

Table 6 – Current gas reserves in the NEM (Peta Joules)

Region	Conventional Reserves (2P)	Coal Seam Gas Reserves (2P)	Coal Seam Gas Reserves (3P)
QLD	458	14,729	33,094
NSW	0	900	3,329
VIC	9,695	0	0
SA	871	0	0
TAS	430	0	0
Total	**11,455**	**15,629**	**36,422**

Source: ACIL Tasman, Fuel resource, new entry and generation costs in the NEM, April 2009[5]

Note: 2P = proven and probable reserves, 3P= proven, probable and possible reserves

ACIL in their assessment did not see gas-availability to be a constraining factor for gas-fired developments in the NEM. Whilst the significant coal seam gas reserves that are available in Queensland could be deployed into other states, Victoria is relatively well placed having access to significant conventional gas reserves largely in the Bass Strait fields. Total proven and probable reserves of 9,695 PJ amounts to 44 years of supply based on Victoria's current gas production of 222 PJ/a[6] . An additional 1200 MW of combined cycle gas generation projects operating at a 65 per cent capacity factor would consume around 48 PJ/a. The impact of this on gas availability would be to reduce the number of years of reserves remaining by 7 years to 37 years.

In terms of risk management and getting the required levels of replacement generation at a relatively low cost in a short time-frame, replacing Hazelwood with gas would be the most straightforward solution. Gas however would not deliver the lowest level of emissions as gas-fired generation still produces around 0.4 tonnes of greenhouse emissions per MWh of electricity generated.

In our analysis we have assumed that up to 1180 MW of combined-cycle gas projects will be brought forward and have assumed the level of auxiliary power use will be 4 per cent[7].

6. Bringing forward new renewable generation

Victoria has access to a broad range of renewable energy resources that could be deployed over time. These resources include:

- Excellent wind regime across many parts of Victoria;
- Significant potential for geothermal resources particularly in Western Victoria;
- Extensive coastline that can support wave and tidal technologies;
- Significant levels of solar radiation particularly in the north-west of the state that can support large-scale solar thermal and solar concentrator technologies; and
- Extensive agricultural industries that could support bioenergy projects with appropriate environmental protections in place.

Green Energy Markets has used its internal databases as well as ABARE data to identify the renewable energy projects that are currently under development in Victoria (refer to Table 7). We have classified these into those projects that have received planning approval, those that are currently in the planning approval process and those projects that are subject to feasibility study.

Table 7 – Renewable power generation projects under development

Under Development (MW)	Capacity(MW)	Average CapacityFactor	Cost ($mill)
Planning approval received	1,006	30%	2,473
Planning approval under way	1,375	30%	3,529
Subject to feasibility study	953	30%	2,420
Total	**3,334**		**8,422**

Note: For a full list of renewable projects under development, see Attachment 2.

There are currently more than 3,334 MW of renewable power generation projects that are under development. Of this around 30 per cent has received planning approval, the majority of which is wind. Nearly 1400 MW of projects are currently proceeding through the planning process and we would expect a reasonable number of these will be successful in getting planning approval in time to be operational by 1 January 2013 if the commercial circumstances warrant.

Many of these projects will undoubtedly come on-line over the next decade with the Australian Government's enhanced Renewable Energy Target (RET) providing an incentive to build new renewable energy projects. However bringing these projects on-line earlier than would otherwise occur, in order to assist in replacing Hazelwood's generation, will require additional policy support from the Victorian Government.

To meet the revised renewable energy target under the enhanced RET, which will exclude small residential solar technologies, around 1300 MW of new renewable generation projects will need to be commissioned each year over the next nine years.

The Macarthur wind farm at 365 MW was conditionally committed by AGL after the Commonwealth Government announced the separation of the RET. We have excluded this project from our assessment.

A further consideration with renewable energy, especially wind, is that it is typically intermittent and operates on a "non-firm" basis. For the purpose of our analysis we have allowed a very conservative estimate of 3 per cent of the capacity being available to meet peak summer demand which is consistent with the assumption that the Australian Energy Market Operator (AEMO) have used for wind generation projects[8].

In our analysis we have assumed that 1500 MW of renewable generation projects are brought forward and are commissioned by 31 December 2012. Most of the renewables projects are assumed to be wind at an average capacity factor of 30 per cent, reflecting that these renewable energy projects are the most advanced and already have planning approvals.

7. Energy efficiency options

Supporting residential and business consumers to reduce their electricity use is another way in which the generation currently provided from Hazelwood can be offset. There has been a range of studies that have sought to determine the level of energy efficiency accessible in the Australian economy and possible cost. A summary of some of these include:

- Towards a National Framework for Energy Efficiency – Issues and Challenges Discussion Paper (National Framework for Energy Efficiency), November 2003. Economic modelling indicated that a 9 per cent reduction in stationary energy use could be achieved if commercially available technologies with a four year payback were introduced;
- The Centre for International Economics published a Paper in February 2009 that estimated that there were around 40 million tonnes of greenhouse reductions that could be achieved each year by 2030 from energy efficiency in the building sector (covering residential and commercial buildings); and
- ClimateWorks published a report in March 2010[9] which developed a greenhouse gas abatement curve for the Australian economy assuming an emission reduction target of 25 per cent on 1990 levels. The ClimateWorks report listed the options for reducing greenhouse emissions from the least expense to the most expensive. We have used their work as a basis to determine the energy efficiency potential of the commercial and industrial sector in Victoria.

While significant opportunity for energy efficiency exists across the residential, business and industry sectors, this scenario has only investigated those measures that are deliverable in Victoria in the short term in order to replace Hazelwood. Further energy efficiency potential exists in Victoria, and support for this would continue to reduce overall energy demand and increase emissions reductions.

Commercial and industrial sector

The ClimateWorks report identified energy efficiency in the commercial and industrial sectors as the cheapest abatement opportunity with most of the activities having a negative cost impact. The commercial sector measures identified would result in a 28 mt/pa reduction in emissions by 2020. A brief summary of the key energy efficiency activities in the commercial sector is summarised in Table 8.

ClimateWorks' analysis of the industrial sector identified 37 million tonnes per annum of abatement with 73 per cent of the emissions reduction potential offering net savings to society. The largest opportunities were seen to be in improved energy efficiency (17 mt/pa) and cogeneration (5 mt/pa).

If we assume that the opportunities in Victoria are in proportion with Victoria's share of electricity consumption (23 per cent[10]) then the potential abatement from commercial activities would be 6.4 mt/pa and 8.5 mt/pa for industrial activities by 2020. The greenhouse abatement covers reduction in the use of gas as well as electricity. If we were to conservatively assume a 50/50 split between gas and electricity then the potential avoided electricity use would amount to 5,700 GWh per annum. This amounts to around 10 per cent of Victoria's electricity consumption and is around half of Hazelwood's current generation.

Table 8 – Abatement reduction activities in the commercial sector in Australia

	Societal Cost A$/tCO2e pa in 2020	Abatement Volume Mt/CO2e pa in 2020
Commercial energy waste reduction	–138	4.4
Commercial retrofit lighting	–97	1.8
Commercial elevators and appliances	–97	5.2
Commercial retrofit elevators and appliances	–98	1.3
Commercial retrofit electronics	–106	2.0
Commercial retrofit cooking and refrigeration	–79	0.4
Commercial new builds elevators and appliances	–89	1.6
Commercial retrofit water heating	–48	0.7
Commercial retrofit insulation	–55	2.3
Commercial retrofit HVAC	–119	3.6
Commercial new builds	–73	2.4

Source: ClimateWorks – Low Carbon Growth Plan for Australia, March 2010

In our second scenario we have conservatively assumed that 2,365 GWh of industrial and commercial energy efficiency is progressively achieved by 2020. Some of this will be in the form of gas-fired cogeneration (which involves switching from electricity to gas) which will involve some greenhouse emissions. Therefore we have assumed that average emissions of 10 tonnes per MWh will be produced from commercial and industrial energy efficiency in total.

Residential energy efficiency

The Victorian Government has implemented the Victorian Energy Efficiency Target (VEET), which has supported the roll-out of energy efficiency activities in order to reduce greenhouse emissions from the residential sector by 2.7 million tonnes per annum. To date the scheme has been very successful and has delivered greater abatement at a lower cost than was initially expected. For 2009, the installation of energy efficient light globes accounted for 80 per cent of activity with hot water accounting for 15 per cent and low flow shower heads 4 per cent .

Replacing electric water heaters has been targeted by state and federal governments as an effective means to reduce greenhouse emissions and governments have agreed to the progressive phase-out of greenhouse intensive electric water heaters. Under Stage 2, commencing in 2012, the phase-out will be extended so that greenhouse intensive electric hot water systems will no longer be able to be installed in:

- any existing detached, terraced, town house or hostel; or
- any new flats and apartments with access to piped gas, except where an exemption applies.
- for new apartments without access to reticulated gas, the phase-out of electric resistance hot water systems will occur between 2012 and 2015 depending on further investigation of the feasibility of low-emission water heating options for such buildings.

According to the most recent ABS survey[11] 587,000 homes in Victoria use electric water heaters. A typical electric resistance water heater uses around 3 kWh of electricity per annum. Replacing all of these systems with a solar hot water system would save more than 1,000 GWh per annum, equivalent to nearly 10 per cent of Hazelwood's output.

Accelerating the phase out of electric water heaters by replacing them with solar water heaters, would have most impact in regional areas of Victoria, which have the highest proportion of electric water heaters (52 per cent) compared to 19 per cent for the metropolitan area. This means that growth in solar water heating jobs and cost savings would be greatest in regional areas.

In our modelling we have conservatively assumed that 700 GWh of electricity savings could be achieved by 2015 through accelerating the phase out of electric water heaters and supporting residential energy efficiency activities through the extension of the VEET scheme. In total we assume that improvement in energy performance occurs in 233,000 households across Victoria (largely regional).

8. Demand management and load shedding

It has long been recognised that encouraging demand side response is one of the most cost effective ways to meet growing peak power needs. Demand side management (DSM) not only reduces the need to generate peak power during periods of high summer demand but can also obviate the need for expensive distribution and transmission investment.

DSM includes any actions that reduce electricity consumption during periods of peak demand or supply shortfalls. There may be a payment to entities which undertake such actions. Very little DSM has been successfully implemented in Australia to date.

In a report prepared for the Energy Users Group in April 2005 "Demand Side Response in the National Electricity Market – Case Studies", four case studies analysed a number of industry sectors to determine the commercial benefit of demand side response (DSR[12]). Based on the four industries considered (dairy, chemicals, glass and commercial buildings) it was found that most large electricity consumers should be able to provide some DSR either through shifting the use of some electrical loads or by offsetting some of their demand to an on-site generator for the critical demand period.

The results were conservatively extrapolated to indicate that organizations undertaking similar business functions could provide around 600MW of DSR nationally.

If we assume that the opportunities in Victoria are in proportion with Victoria's share of electricity consumption (23 per cent) then a conservative estimate of the DSM potential would be 138 MW. With the correct policy support measures we would expect that at least this amount of DSR could be accessible.

In our analysis we have assumed that DSM can provide 100 MW of load reduction during the peak summer period at an average capacity factor of 1 per cent. As some DSM will involve the operation of generators we have assumed an average emission intensity of 0.3 tonnes per MWh.

9. Mix of clean energy options to replace Hazelwood

There are more than enough gas-fired generation projects on the drawing board to replace Hazelwood's generation more than two times over. However, by accelerating the implementation of renewable power generation projects and energy efficiency activities we can replace Hazelwood's output in a manner that results in more than 14.5 million tonnes per annum of greenhouse gas reductions. This amounts to total emission reductions of more than 116 million tonnes over the eight year period from 2013 to 2020.

In our modelling we have selected the clean energy options that not only replace Hazelwood's peak summer generation but also replace the amount of electricity it produces over the course of a year. In practical terms this means replacing 1179 MW of peak summer capacity and 10,301 GWh of electricity generation each year.

The scenarios: We have considered two scenarios in replacing Hazelwood's generation. Under Scenario 1, we simply replace generation from Hazelwood with generation from gas and renewables. This is a "like with like" replacement – we replace coal-fired generation with cleaner generation options. Under Scenario 2, we consider a broader replacement profile which includes energy efficiency and demand side options so as to maximise the reduction in greenhouse gas emissions. Refer to Attachments 3 and 4 for the detailed results for each of these scenarios.

Scenario 1: Under Scenario 1, gas-fired generation capacity of 1180 MW is brought forward and installed by 31 December 2012. This represents around 31 per cent of the projects that have been identified and are currently under development. Gas replaces around 96 per cent of the summer peak capacity provided by Hazelwood and is assumed to operate at an average capacity factor of 65 per cent. Renewables capacity of 1500 MW (45 per cent of the projects currently under development) is assumed to be installed by the end of 2012 operating at 30 per cent capacity factor. Renewables (predominantly wind) is assumed to contribute only a modest 45 MW to meeting summer peak power demand (refer to Table 9). In terms of replacing Hazelwood's annual generation, renewables makes a much more significant contribution accounting for 37 per cent of generation. This scenario would replace Hazelwood's current greenhouse emissions of 16.2 million tonnes per year with projects that would have annual emissions of 2.5 million tonnes, thereby reducing Victoria's emissions by 13.6 million tonnes. This represents an 11.4 per cent reduction in the State's greenhouse gas emissions based on 2007 emissions (the most recently reported year).

Table 9 – Scenario 1, Gas and renewables replacing Hazelwood

	Peak Summer Contribution (MW in 2020)	Annual Electricity Contribution (GWh/a in 2020)	Greenhouse Savings (mt/a in 2020)
Combined cycle gas plant (1180 MW Gross)	1,133	6,450	7,555
Renewable generation (1500 MW Gross)	45	3,942	6,031
Total	**1,178**	**10,392**	**13,586**

Scenario 2: Under Scenario 2, we have assumed that 970 MW of gas-fired generation and 1500 MW of renewable generation would be brought forward by 31 December 2012. In the case of gas-fired generation we have assumed that capacity factor is 50 per cent in 2013 and progressively reduces to 43 per cent by 2020. By 2020 gas would be providing 33% of Hazelwood's generation, while renewable energy will contribute a larger share of 37 per cent. We have also included an increasing contribution from energy efficiency and demand side management which combined will account for the remaining 30 per cent of Hazelwood's generation by 2020.

This scenario achieves deeper emissions reductions than the first, replacing Hazelwood's current emissions profile of 16.2 million tonnes with a mix of supply side and demand side measures with emissions of 1.8 million tonnes in 2013 and 1.6 million tonnes in 2020. This would reduce the State's emissions by 14.4 million tonnes by 2013 and 14.5 million tonnes by 2020, representing a 12% reduction in the State's emissions by 2013.

Table 10 – Scenario 2, Gas, renewables and energy efficiency replacing Hazelwood

	Peak Summer Contribution (MW in 2020)	Annual Electricity Contribution (GWh/a in 2020)	Greenhouse Savings (mt/a in 2020)
Combined cycle gas plant (970 MW Gross)	931	3,508	4,027
Renewable generation (1500 MW Gross)	45	3,942	6,031
Residential energy efficiency		701	1,072
Business energy efficiency	169	2,365	3,382
Demand side management	100	9	11
Total	**1,245**	**10,524**	**14,524**

10. Policy options to support the replacement of Hazelwood with clean energy

Victoria has access to a range of clean energy options that combined could be used to replace the electricity produced from the Hazelwood Power Station many times over. It is arguable that a number of these would be progressively implemented in the event that an effective carbon price signal was provided through an emissions trading scheme.

The deferral of the CPRS has increased business uncertainty with particular implications for new generation investment. New generation will be required to meet growing electricity demand however without a price on carbon it will be more difficult to finance new clean energy projects. Energy efficiency projects will be similarly impacted.

To bring clean energy options forward requires the Victorian Government to implement additional policy measures that would transition to (and complement) the eventual introduction of a price on carbon. In the short to medium term, state governments have an important role to play to ensure that a policy framework exists to support new investment.

We have considered a range of possible policy options that would deliver our mix of clean energy options to replace Hazelwood and have summarised these below.

Bringing forward new gas-fired generation capacity

The simplest approach to get gas-fired generation built and ready for service by the end of 2012 would be to seek competitive proposals from new project proponents to access financial assistance for their projects. The government would need to fund the financial gap to make these projects economic and could do this through a competitive process. The Government could issue a 'request for proposals' and proponents would submit costed proposals that would compete against other bids. Payments could be structured into "capacity" and "energy" components to reflect the service being provided by the generator. A capacity payment based on the MW made available can be made to ensure that the generation is in place to meet peak summer demand. The energy based payment would be based on the actual generation required and would be geared to deliver a prescribed level of emissions reductions. Victoria's desalination plant was built using a similar 'request for proposals' process, with the costs of the project met by increasing water bills.

Demand management or demand side response could also be supported in a similar manner.

There are other approaches that could also be adopted including implementing a market based Gas Certificate Scheme as is currently operating in Queensland. This scheme has supported a number of new gas-fired generation projects and given new gas projects a financial advantage over coal projects. Another option is to introduce a broader Greenhouse Gas Abatement Scheme which can be structured as a market based scheme similar to the scheme that was introduced by the NSW Government.

The above approaches can be implemented through Electricity Retailer license obligations with the costs passed on to electricity consumers rather than through the budget process. These schemes effectively establish a 'shadow' carbon price which could be phased out as an effective carbon price signal is introduced that provides appropriate signals for new investment.

Bringing forward new renewable generation capacity

Renewable generation will be supported by the new "Enhanced RET" scheme and we expect that Victoria will secure its share of new projects. To secure early construction of 1500 MW of renewable energy projects will require some additional policy support.

Additional policy support could be provided through a capacity acquisition program similar to the approach suggested to support gas-fired generation. Other approaches could be adopted that may address some of the impediments and barriers that are being experienced by project proponents such as transmission connection and assistance with securing project finance.

As significant economies of scale exist in network investment to support new renewable projects, the Government could support significant transmission upgrades to areas of high wind resources. Another option that could be considered is for the Government to provide funding guarantees to support project finance. This approach has proven successful in the United States.

Supporting Energy Efficiency

The Victorian Energy Efficiency Target (VEET) scheme has been very successful in supporting residential energy efficiency activities to date and could be readily expanded to deliver further energy and greenhouse reductions. The scheme essentially offers consumers a rebate for undertaking energy saving activities like installing efficient light bulbs and solar water heating. The current VEET scheme has met its targets ahead of time and under the anticipated costs. There is plenty of scope to increase the VEET target for residential energy efficiency.

Accelerating the replacement of electric water heaters with solar water heaters could most readily be achieved through rebate programs. Sustainability Victoria has a successful track record in rolling out these rebates. However the level of rebate for solar water heaters was reduced early 2009 with a corresponding reduction in the number of solar water systems installed. Increasing the rebate for electric water heater replacement would accelerate the uptake of solar water heating.

The simplest and most effective way to support commercial and industrial energy efficiency projects would be to increase the VEET target and expand the scheme to include these sectors. The NSW Government's Energy Savings Scheme covers commercial and industrial activities and whilst it is still early in its implementation we have observed an extensive array of energy efficiency activities supported.

11. Implications for employment

Investment in cleaner energy technologies will lead to the creation of additional clean energy jobs and more than offset the likely job losses from the early closure of the Hazelwood power station and the Morwell mine.

In total we expect between 1900 – 2500 construction jobs will be created building the generation facilities to replace Hazelwood. In addition around 2300 ongoing jobs will be created across all activities[13].

Gas

It is assumed that up to 1180 MW of gas-fired generation projects and resultant pipeline infrastructure will be built to replace Hazelwood. Based on information released by the project proponents (listed in Table 5) this will result in more than 1000 construction jobs and a further 60 or more ongoing positions.

Renewable Energy

To meet the Enhanced Renewable Energy Target around 1300 MW of renewable power generation projects need to be committed each year. Bringing forward wind projects in Victoria over the next two years will largely displace renewable projects in other states. There will be a number of construction and ongoing operational jobs that are brought forward, however again this will likely be at the expense of jobs in other states.

Based on jobs information provided by wind farm proponents in their public statements, construction jobs tend to amount to between 60 to 100 jobs for each 100 MW of installed capacity and ongoing jobs amount to between 6 to 12 jobs for each 100 MW of installed capacity. Based on bringing forward 1500 MW of renewables projects (largely wind) we can expect between 900 and 1500 construction jobs and between 90 and 180 ongoing jobs.

Energy Efficiency

The diverse range of activities and the diffuse nature of the energy efficiency industry makes it extremely difficult to determine the employment impact of the energy efficiency activities assumed to be implemented. In the case of residential energy efficiency the energy savings of 700 GWh per annum through solar hot water and other activities are assumed to involve around 233,000 households. We have pro-rated this impact based on the analysis conducted by Jay Rutovitz from the University of Technology, Sydney for Environment Victoria's 2009 study entitled "Victoria – The Green Jobs State: Seizing the Opportunities", to arrive at a range of between 710 and 1580 jobs.

For the employment impacts of commercial and industrial energy efficiency activities we have pro-rated the job figures that were included in the National Framework for Energy Efficiency study; Towards a National Framework for Energy Efficiency – Issues and Challenges Discussion Paper, November 2003. In this study, employment was expected to increase by 9000 with a 213 PJ reduction in energy consumption and 32 million tonnes per annum emission reduction. If we applied these ratios to the assumed energy savings from commercial and industrial activities we arrive at additional employment of around 650 people.

Transition plan for the Latrobe Valley

While more jobs will be brought forward and created compared to the job losses at the Hazelwood Power Station and Morwell mine these jobs will be distributed across the state. It is important that a transition program be implemented for Latrobe Valley workers in particular and the Latrobe Valley community more generally. These workers and communities will be impacted as brown coal generation contracts over time in response to more stringent greenhouse targets.

Some of the construction and ongoing jobs from the projects that would replace Hazelwood are located in Gippsland. At least one of the gas projects under development and several renewable projects are located in south eastern Victoria.

South East Victoria, while not having the wind energy potential of the Western part of the state, does have access to bioenergy resources and has been found to have considerable geothermal potential. Importantly the Latrobe Valley has ready access to the Bass Strait gas fields and is well serviced by electricity transmission infrastructure.

The second scenario to replace Hazelwood involves considerable growth in energy efficiency activities, in particular the rapid uptake of solar water heating to replace electric water heaters. This would create hundreds of regional jobs in solar water heater installation, some of which would be in the Latrobe Valley and Gippsland. Adoption of the CFMEU proposal to establish a tank manufacture facility for solar water heaters in the Latrobe Valley (the 'Eureka's future' project) would create 39 additional direct jobs in manufacturing in the next 3 years[14].

Despite there being considerable opportunities for new jobs creation in energy industries it is unlikely that all coal jobs lost would be replaced with new energy jobs in the Latrobe Valley. This highlights the urgent need to develop and fund a Gippsland Economic Transition strategy. Such a strategy could assess the region's assets and identify opportunities to develop new industries or expand existing industries.

The Latrobe Valley and Gippsland have strong agricultural, manufacturing, tourism, education, plantation timber and small business sectors. The region also has some comparative advantages in infrastructure including a rail line, access to ports, and electricity and gas transmission and pipelines, and enjoys relative water security. The replacement of Hazelwood offers the opportunity to diversify the region's economic base in advance of further power station retirement.

The Rudd Government's CPRS package had earmarked $200 million for structural adjustment provision for workers and communities nationally that were disproportionately affected by the introduction of the CPRS. This amount of funding was criticised as inadequate by many of the submissions from coal communities. Substantial transition and structural adjustment funding would need to be part of any decision to replace Hazelwood to ensure the Latrobe Valley was not unduly impacted. Such a funding package could also assist Hazelwood workers find alternative employment or compensate workers who are unable to find work elsewhere.

12. Investment required to replace Hazelwood

A detailed assessment of the cost of replacing Hazelwood is beyond the scope of this project; however we have considered cost implications and have undertaken some preliminary analysis of some of the issues that should be considered in determining a range of possible costs.

International Power stated in their submission to the Australian Government on the CPRS (10 September 2008) that they estimated that the cost to switch from brown coal to gas under the CPRS is in the range $20-$30 per tonne based on the prevailing east coast gas price at the time.

In the same submission International Power also argued that compensation for the introduction of the CPRS (which would result in the eventual closure of Hazelwood) should maintain the pre-CPRS value of its assets. International Power stated that the combined pre-CPRS value of the Hazelwood and Loy Yang B power stations was more than $4 billion. They also advanced an alternative approach to compensation – "Greenhouse Gas Abatement Purchase Agreement" which would be based on the phased withdrawal over a fixed number of years, in return for a tariff derived from the pre-CPRS market value.

In determining the cost of replacing Hazelwood there are three types of costs that need to be considered (i) the cost of any compensation paid to International Power to ensure that it closes Hazelwood; (ii) the cost of bringing forward new clean energy projects that would replace Hazelwood's electricity generation in a way that maximises greenhouse reduction, and (iii) the cost of transitional support for Hazelwood workers and the Latrobe Valley community.

If Hazelwood were to close, for whatever reason, then we would expect that electricity prices would rise to a level that would support new investment taking place that replaces Hazelwood's capacity and energy contribution. In the short term (in the absence of the CPRS) it is likely that the most cost-effective solutions delivered by the market might be for open-cycle gas plant to replace the peak capacity provided by Hazelwood, and the energy replaced by reducing exports to other states and instead increasing imports largely from black-coal fired generation in NSW and Queensland. The market would not deliver a "greenhouse effective" solution without a carbon price in place or other policy measures implemented.

Alternatively, if the Government only supported the early commitment of new clean energy projects as we have discussed (with Hazelwood still operating), then we would see an oversupply in the electricity market that would result in lower wholesale prices and the highest cost producers reducing their generation. In the absence of a price on carbon, this would not necessarily be brown coal plant in Victoria but could be higher cost black-coal plant in NSW. The cost of supporting new clean energy technologies would be lower if Hazelwood is not operating, as we would expect wholesale power prices to be higher. Similarly, any required compensation to Hazelwood may well be lower if new clean energy technologies are introduced that result in lower wholesale electricity prices.

As a result, in order to be sure that a significant reduction in greenhouse emissions takes place, Hazelwood would need to be forced or paid to close and at the same time new investment in clean energy technologies brought forward to replace it. The actual cost of replacing Hazelwood would be a combination of the cost of achieving both of these outcomes.

While the sums of money involved are large it is worth noting that under the CPRS Hazelwood stood to receive substantial amounts of compensation for continuing to operate. Under the initial $3.9 billion compensation package for generators, financial analysts Innovest had estimated that Hazelwood would receive around $990 million (25.5%) in compensation[15]. The Australian Government's latest changes to the CPRS increased compensation to generators from $3.9 billion to $7.4 billion, which would likely nearly double Hazelwood's compensation to close to $2 billion.

At a $20 per tonne carbon price which is at the lower end of International Power's estimates of the cost of gas displacing coal[16], the carbon cost of Hazelwood's generation amounts to around $320 million per annum. This level of cost may be sufficient to deliver the 15 million tonnes of abatement under Scenario 2 and this cost could be shared between compensation to Hazelwood and support to new clean energy technologies.

If the cost was to be recovered from electricity consumers then electricity prices would increase by around $6 per MWh. This is equivalent to an increase in average household electricity bills of $36[17] per annum. There would be a need to moderately increase energy concessions to low income consumers to ensure that they are not disproportionately impacted by such a price rise.

To put the household impact into context, modelling by the Australian Government on the costs of implementing the CPRS indicated that electricity costs would increase by $30 per MWh by 2020, or $180 per annum per household, under scenarios involving 5 to 10% emission reduction targets by 2020. This is equivalent to one fifth of the Federal Government's modelled cost impact of the CPRS under the 5 to 10 per cent emissions reductions targets by 2020.

Conclusion

Replacing Hazelwood represents a significant and comparatively low cost opportunity to reduce greenhouse emissions and begin the process of de-carbonising Victoria's electricity supply.

Victoria's energy mix is dominated by coal with 92% of the state's electricity generation provided by brown coal. Hazelwood power station is the most greenhouse intensive major power station operating in Australia. Committing to accelerating the replacement of Hazelwood would provide the opportunity to cut Victoria's emissions by 11to 12 per cent by as soon as the end of 2012. Additionally it would free up 27 billion litres of water each year to be used for other purposes, and reduce other pollutants.

This report finds that Victoria is endowed with a diverse range of clean energy resources. Many clean energy projects are well advanced and have planning approvals. Government action and investment to ensure that a proportion of these projects are committed would make possible the replacement of Hazelwood Power Station by the end of 2012.

The scenarios outlined in this report demonstrate that clean energy projects can replace both Hazelwood's peak generation and also its annual contribution by the end of 2012.

Deploying energy efficiency as part of the policy mix will maximise the greenhouse emissions reductions and job creation, and reduce the costs of replacing Hazelwood. While more jobs will be created in the construction and operation of the replacements for Hazelwood than Hazelwood currently supports, it will be important to invest in transitional programs for workers and in industry development in Gippsland to minimise social impacts and safeguard the region's economic future.

With the delay of the CPRS, there is increased attention on 'direct action' to reduce Australia's emissions. Replacing Hazelwood would make a large impact on emissions quickly and demonstrate renewed commitment to taking action on climate change.

Endnotes

1. Latrobe Valley Express, March 10, 1971, p.24
2. International Power Australia, Submission on the Carbon Pollution Reduction Scheme Green Paper 10 September 2008
3. Alan Smart, Adam Aspinall 2009, *Water and the electricity generation industry,* Waterlines report, National Water Commission, Canberra, p.34
4. Hazelwood Power Station's transmission loss factor for 2010/11 as published by AEMO is 0.9691, meaning that 3.09% of electricity is lost in transmission.
5. ACIL Tasman, Fuel resource, new entry and generation costs in the NEM, April 2009
6. Australian Energy Market Operator data for 2009
7. ACIL Tasman, Fuel resource, new entry and generation costs in the NEM, April 2009
8. AEMO, South Australian Existing and Committed Scheduled and Semi Scheduled Generation (April 2010)
9. ClimateWorks Australia, Low Carbon Growth Plan, March 2010
10. ABARE 2007-08
11. ABS – Environmental Issues: Energy Use and Conservation, March 2008
12. Also commonly referred to as Demand Side Management
13. The midpoint of the estimates in the range of jobs has been included in the total.
14. Esther Abram, T. Krishnan and Laura Jane for CFMEU, "Eureka's Future: A business plan for a solar hot water social enterprise in the Latrobe Valley", March 2010
15. Innovest Strategic Value Advisors, Research Note 18 December 2008
16. We have used the lower $20 per tonne price as Hazelwood is one of the higher cost brown-coal generators in Victoria
17. We have assumed average household electricity consumption of 6 MWh per annum

Attachment 1 – Hazelwood's Total Emissions Profile

Substance	Air Total (kg)	Water (kg)	Total (kg)
Ammonia (total)	21,841	48	21,889
Arsenic & compounds	59	11	70
Beryllium & compounds	29	2	31
Boron & compounds	104,163	1,744	105,907
Cadmium & compounds	42	0	42
Carbon monoxide	7,696,562		7,696,562
Chlorine & compounds	172	172	
Chromium (III) compounds	151	2	153
Chromium (VI) compounds	103	1	104
Copper & compounds	104	48	152
Cumene (1-methylethylbenzene)	2	2	
Ethylbenzene	61	61	
Fluoride compounds	8,064	2,840	10,904
Hydrochloric acid	7,731,684		7,731,684
Lead & compounds	136	3	139
Magnesium oxide fume	0	0	
Manganese & compounds	3,528	114	3,642
Mercury & compounds	27	0	27
Nickel & compounds	571	6	577
Oxides of Nitrogen	26,100,211		26,100,211
Particulate Matter 10.0 um	1,328,536		1,328,536
Particulate Matter 2.5 um	8,273		8,273
Polychlorinated dioxins and furans (TEQ)	0		0
Polycyclic aromatic hydrocarbons (B[a]Peq)	16		16
Sulfur dioxide	12,858,183		12,858,183
Sulfuric acid	26,881		26,881
Total Volatile Organic Compounds	344,749		344,749
Xylenes (individual or mixed isomers)	62	62	
Zinc and compounds	1,243	23	1,266
Total			**56,240,295**

Source: National Pollutant Inventory, March 2010

Attachment 2 – Renewable power projects under development

Project	Company	Status	Capacity (MW)
Bald Hills Wind Farm	Mitsui	New project, planning approval received	104
Drysdale Wind Farm	Wind Farm Developments	New project, planning approval received	30
Hawkesdale Wind Farm	Union Fenosa Wind Australia	New project, planning approval received	62
Lal Lal Wind Farm	West Wind Energy	New project, planning approval received	131
Lexton Wind Farm	Wind Power	New project, planning approval received	38
Morton's Lane	NewEn Australia	New project, planning approval received	30
Mount Gellibrand Wind Farm	Acciona Energy	New project, planning approval received	232
Mount Mercer Wind Farm	West Wind Energy	New project, planning approval received	131
Naroghid Wind Farm	Wind Farm Developments	New project, planning approval received	42
Ryan Corner Wind Farm	Union Fenosa Wind Australia	New project, planning approval received	136
Woolsthorpe Wind Farm	Wind Farm Developments	New project, planning approval received	40
Woorndoo (Salt Creek)	NewEn Australia	New project, planning approval received	30
			1,006
Ararat Wind Farm	RES Australia	New project, planning approval under way	225
Berrybank Wind Farm	Union Fenosa Wind Australia	New project, planning approval under way	180-250
Crowlands Wind Farm	Pacific Hydro	New project, planning approval under way	126
Mortlake Wind Farm	Acciona Energy	New project, planning approval under way	144
Portland stage 4	Pacific Hydro	New project, planning approval under way	54
Sidonia Hills Wind Farm	Roaring 40s	New project, planning approval under way	68
Stockyard Hill Wind Farm	Origin Energy	New project, planning approval under way	484
The Sisters Wind Farm	Wind Farm Developments	New project, planning approval under way	30
Yaloak Wind Farm	Pacific Hydro	New project, planning approval under way	30
Port Phillip Heads Tidal Energy Project	Tenax Energy Pty Ltd	New project, planning approval under way	34
			1,375
Baynton	Transfield Services	New project, feasibility study under way	130
Ben More	Transfield Services	New project, feasibility study under way	90
Darlington Wind Farm	Union Fenosa Wind Australia	New project, feasibility study under way	270-450
Moorabool Wind Project	West Wind Energy	New project, feasibility study under way	220-360
Orford	Future Energy	New project, feasibility study under way	100
Tarrone	Union Fenosa Wind Australia	New project, feasibility study under way	30-40
Tuki Wind Farm	Wind Power	New project, feasibility study under way	38
Waubra North	Acciona Energy	New project, feasibility study under way	75
			953
Grand Total			**3,334**

Source: Green Energy Market Database and ABARE (Electricity generation, Major development projects, October 2009 listing)

Attachment 3 – Summary of Results

Scenario 1 Gas and Renewable Generation Only

		2013	2014	2015	2016	2017	2018	2019	2020
Replacing Peak Summer Supply									
Hazelwood Generation – Net	MW	1,179	1,179	1,179	1,179	1,179	1,179	1,179	1,179
Replaced by:									
1. Gas – combined cycle	MW	1,133	1,133	1,133	1,133	1,133	1,133	1,133	1,133
2. Gas – open cycle	MW	–	–	–	–	–	–	–	–
3. Renewable Generation	MW	45	45	45	45	45	45	45	45
4. Energy Efficiency – Residential	MW	–	–	–	–	–	–	–	–
5. Energy Efficiency – Business	MW	–	–	–	–	–	–	–	–
6. Load Shedding – Business	MW	–	–	–	–	–	–	–	–
		1,178	**1,178**	**1,178**	**1,178**	**1,178**	**1,178**	**1,178**	**1,178**

Replacing Energy Generation									
Hazelwood Generation – Net	GWh	10,301	10,301	10,301	10,301	10,301	10,301	10,301	10,301
Replaced by:									
1. Gas – combined cycle	GWh	6,450	6,450	6,450	6,450	6,450	6,450	6,450	6,450
2. Gas – open cycle	GWh	–	–	–	–	–	–	–	–
3. Renewable Generation	GWh	3,942	3,942	3,942	3,942	3,942	3,942	3,942	3,942
4. Energy Efficiency – Residential	GWh	–	–	–	–	–	–	–	–
5. Energy Efficiency – Business	GWh	–	–	–	–	–	–	–	–
6. Load Shedding – Business	GWh	–	–	–	–	–	–	–	–
		10,392	**10,392**	**10,392**	**10,392**	**10,392**	**10,392**	**10,392**	**10,392**

Replacing Greenhouse Emissions									
Hazelwood Greenhouse Emissions	'000 tpa	16,166	16,166	16,166	16,166	16,166	16,166	16,166	16,166
Replaced by:									
1. Gas – combined cycle	'000 tpa	2,580	2,580	2,580	2,580	2,580	2,580	2,580	2,580
2. Gas – open cycle	'000 tpa	–	–	–	–	–	–	–	–
3. Renewable Generation	'000 tpa	–	–	–	–	–	–	–	–
4. Energy Efficiency – Residential	'000 tpa	–	–	–	–	–	–	–	–
5. Energy Efficiency – Business	'000 tpa	–	–	–	–	–	–	–	–
6. Load Shedding – Business	'000 tpa	–	–	–	–	–	–	–	–
		2,580	**2,580**	**2,580**	**2,580**	**2,580**	**2,580**	**2,580**	**2,580**

Emissions saved	**'000 tpa**	**13,586**	**13,586**	**13,586**	**13,586**	**13,586**	**13,586**	**13,586**	**13,586**
Cumulative emissions saved	**'000 tpa**	**13,586**	**27,172**	**40,758**	**54,344**	**67,930**	**81,516**	**95,102**	**108,687**

Emissions Saved by Activity									
1. Gas – combined cycle	'000 tpa	7,555	7,555	7,555	7,555	7,555	7,555	7,555	7,555
2. Gas – open cycle	'000 tpa	–	–	–	–	–	–	–	–
3. Renewable Generation	'000 tpa	6,031	6,031	6,031	6,031	6,031	6,031	6,031	6,031
4. Energy Efficiency – Residential	'000 tpa	–	–	–	–	–	–	–	–
5. Energy Efficiency – Business	'000 tpa	–	–	–	–	–	–	–	–
6. Load Shedding – Business	'000 tpa	–	–	–	–	–	–	–	–
	'000 tpa	**13,586**	**13,586**	**13,586**	**13,586**	**13,586**	**13,586**	**13,586**	**13,586**

Attachment 4 – Summary of Results

Scenario 2 Including Energy Efficiency and DSM

		2013	2014	2015	2016	2017	2018	2019	2020
Replacing Peak Summer Supply									
Hazelwood Generation – Net	MW	1,179	1,179	1,179	1,179	1,179	1,179	1,179	1,179
Replaced by:									
1. Gas – combined cycle	MW	931	931	931	931	931	931	931	931
2. Gas – open cycle	MW	–	–	–	–	–	–	–	–
3. Renewable Generation	MW	45	45	45	45	45	45	45	45
4. Energy Efficiency – Residential	MW	–	–	–	–	–	–	–	–
5. Energy Efficiency – Business	MW	125	131	138	144	150	156	163	169
6. Load Shedding – Business	MW	100	100	100	100	100	100	100	100
		1,201	**1,207**	**1,214**	**1,220**	**1,226**	**1,232**	**1,239**	**1,245**
Replacing Energy Generation									
Hazelwood Generation – Net	GWh	10,301	10,301	10,301	10,301	10,301	10,301	10,301	10,301
Replaced by:									
1. Gas – combined cycle	GWh	4,079	3,997	3,916	3,834	3,752	3,671	3,589	3,508
2. Gas – open cycle	GWh	–	–	–	–	–	–	–	–
3. Renewable Generation	GWh	3,942	3,942	3,942	3,942	3,942	3,942	3,942	3,942
4. Energy Efficiency – Residential	GWh	526	613	701	701	701	701	701	701
5. Energy Efficiency – Business	GWh	1,752	1,840	1,927	2,015	2,102	2,190	2,278	2,365
6. Load Shedding – Business	GWh	9	9	9	9	9	9	9	9
		10,307	**10,401**	**10,494**	**10,500**	**10,506**	**10,512**	**10,518**	**10,524**
Replacing Greenhouse Emissions									
Hazelwood Greenhouse Emissions	'000 tpa	16,166	16,166	16,166	16,166	16,166	16,166	16,166	16,166
Replaced by:									
1. Gas – combined cycle	'000 tpa	1,631	1,599	1,566	1,534	1,501	1,468	1,436	1,403
2. Gas – open cycle	'000 tpa	–	–	–	–	–	–	–	–
3. Renewable Generation	'000 tpa	–	–	–	–	–	–	–	–
4. Energy Efficiency – Residential	'000 tpa	–	–	–	–	–	–	–	–
5. Energy Efficiency – Business	'000 tpa	175	184	193	201	210	219	228	237
6. Load Shedding – Business	'000 tpa	3	3	3	3	3	3	3	3
		1,809	**1,785**	**1,762**	**1,738**	**1,714**	**1,690**	**1,666**	**1,642**
Emissions saved	**'000 tpa**	**14,357**	**14,381**	**14,404**	**14,428**	**14,452**	**14,476**	**14,500**	**14,524**
Cumulative emissions saved	**'000 tpa**	**14,357**	**28,737**	**43,142**	**57,570**	**72,022**	**86,498**	**100,998**	**115,522**
Emissions Saved by Activity									
1. Gas – combined cycle	'000 tpa	5,005	4,770	4,534	4,433	4,331	4,230	4,129	4,027
2. Gas – open cycle	'000 tpa	–	–	–	–	–	–	–	–
3. Renewable Generation	'000 tpa	6,031	6,031	6,031	6,031	6,031	6,031	6,031	6,031
4. Energy Efficiency – Residential	'000 tpa	804	938	1,072	1,072	1,072	1,072	1,072	1,072
5. Energy Efficiency – Business	'000 tpa	2,505	2,631	2,756	2,881	3,006	3,132	3,257	3,382
6. Load Shedding – Business	'000 tpa	11	11	11	11	11	11	11	11
	'000 tpa	**14,357**	**14,381**	**14,404**	**14,428**	**14,452**	**14,476**	**14,500**	**14,524**

About Green Energy Markets:
Green Energy Markets (GEM) is a dynamic research and advisory business established in 2008 with a focus on reducing greenhouse gas emissions, increasing renewable energy and distributed generation, and improving energy efficiency. Our services are directed at sustainable energy businesses, government and government agencies, energy producers and energy consumers.
For more see: http://www.greenenergymarkets.com.au

About Environment Victoria:
Environment Victoria is the peak non-government, not-for-profit environment organisation in Victoria. As the state's leading environment group, we believe that our future depends on all Victorians. That's why our goal is to mobilise all 5 million to safeguard our environment. At the heart of our work is our belief that people are part of the environment, and not separate to it. So we work with people from all walks of life and levels of environmental awareness to solve the challenges common to all of us.
For more see: http://www.environmentvictoria.org.au