

**Submission
No 355**

INQUIRY INTO COAL SEAM GAS

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**Submission to the New South Wales
Legislative Council's Inquiry into Coal Seam Gas**

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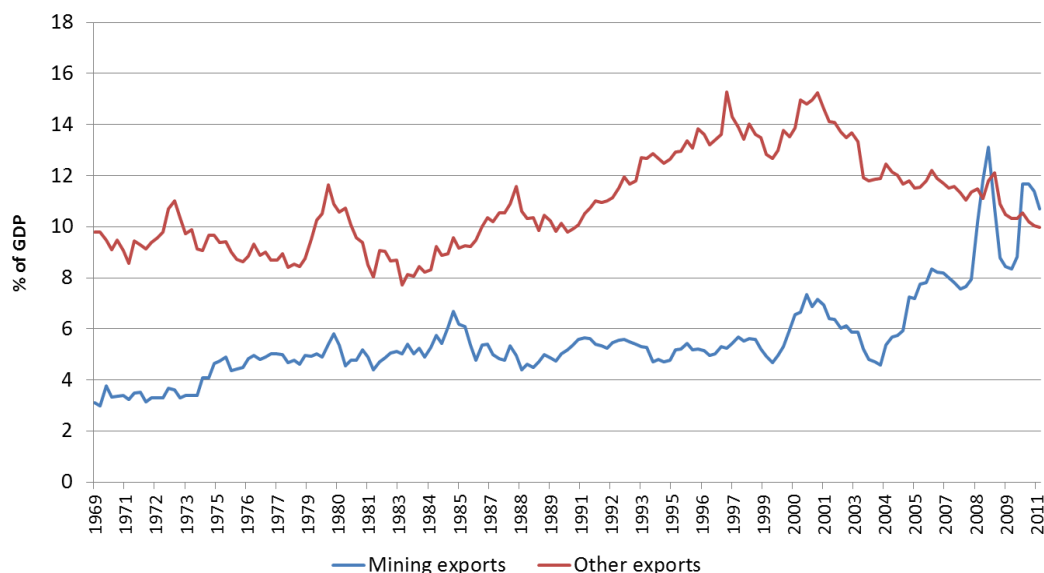
The following submission relates to Section 2c and all of Section 3 of the Terms of Reference for the New South Wales Legislative Council inquiry into coal seam gas

2. c. Regional development, investment and employment, and State competitiveness

The coal seam gas industry offers no net benefit to the NSW or Australian economies in terms of regional development, investment, employment or competitiveness:

Regional development

For every percentage point of GDP increase in resource exports over the last five years, there has been a corresponding decline in exports from other sectors of the economy (The Australia Institute 2011). These changes are due to resource boom driven appreciation of the Australian dollar.



Graph 1: Mining exports and other exports as a proportion of GDP, The Australia Institute (2011:27)

Movements in the Australian dollar closely reflect commodity price movements. The Australian dollar is often referred to as a “commodity currency.”

The appreciation of the Australian dollar adversely affects the competitiveness of national export industries, primarily for manufacturing, education, tourism and agricultural exports. Since the beginning of the mining boom in around 2004 there has been a significant upward trend in the Australian dollar against almost all major currencies. The decline in the value of the dollar in 2008 during the Global financial crisis coincided with a drop in export commodity prices. The rise of around 40% in the value of the Australian dollar relative to the US dollar, associated with the current resource boom is unprecedented.

A rising Australia dollar primarily impacts industries that export goods and services overseas. Manufacturing goods become relatively more expensive than the goods they are competing from other countries, tourists are less likely to visit Australia as it is relatively more expensive, and Australian educational institutions have more trouble attracting students from around the world.

The relative low prices of manufactured goods imported and overseas travel also impact the domestic market for locally manufactured goods and tourism in particular.

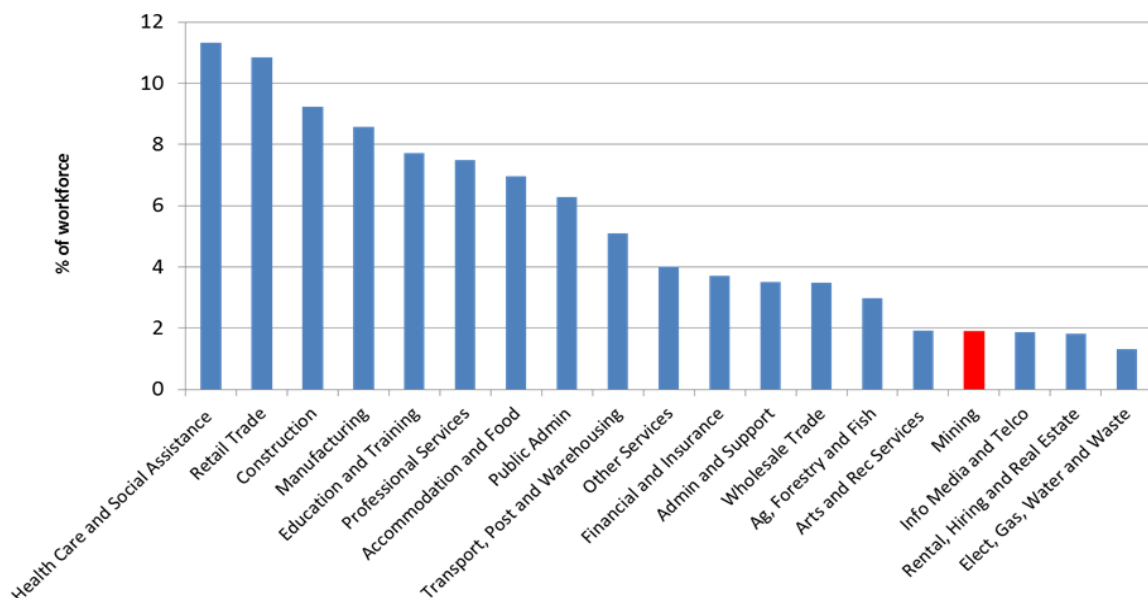
Another effect of an overheating of the resource sector on the currency is that it becomes more volatile. Volatility is a real threat to industries such as manufacturing that need to make investment decisions over very long periods. Car manufacturers or steel makers for example make huge investments in manufacturing plant and equipment over long periods, and volatility that undermines their competitiveness in local and international markets affects their investment decisions.

The expansion of the coal seam gas industry in New South Wales potentially represents a significant expansion in Australia's commodity exports which will put added upward pressure on the value of the Australian dollar and exacerbate the declining competitiveness of the non-resource sectors. Its expansion will effectively displace economic activity in other non-resource sectors, and the jobs in those sectors.

Employment

The resource industry, including gas, has the lowest rate of employment per unit of productivity of any sector of the Australian economy. Overall, it employs just 1.8 per cent of the Australian workforce. For comparison, manufacturing provides around 8.5 per cent, education around 8 per cent and tourism around 5 per cent of the employment in Australia. Total employment in the gas industry in Australia is less than 30,000 people, most of these are temporary construction jobs, compared to almost one million permanent ongoing jobs in manufacturing.

When the resource expansion displaces economic activity in other sectors of the economy, it risks a significant net loss of jobs.



Graph 2: Employment by sector as a percentage of Australian workforce (The Australia Institute 2011:17).

Competitiveness

NSW-based businesses exporting goods and services overseas will lose international competitiveness as the resource sector drives the appreciation of the Australian dollar and makes these goods and services relatively more expensive than their international competitors for the reasons discussed above.

NSW-based businesses will also lose competitiveness in local markets as the cost of imported goods and services decline and become more attractive. Local manufacturing and tourism in particular will be adversely affected by this trend.

Investment

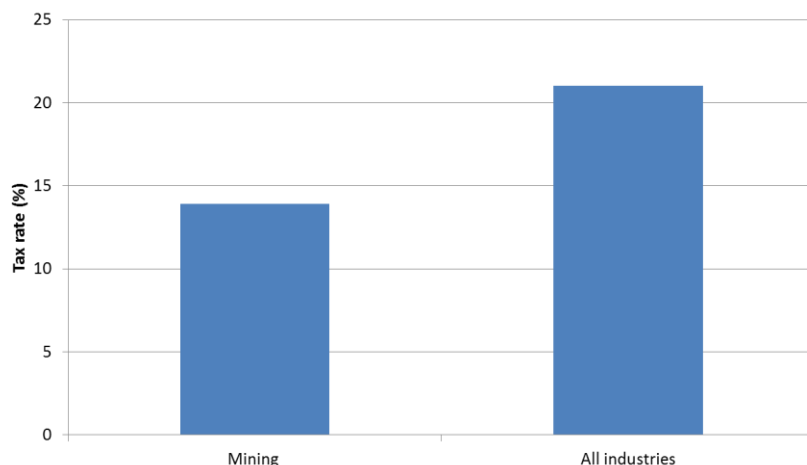
Supporters of the coal seam gas sector point to the investment it will attract. It is likely that only a small proportion of that investment will make its way into the NSW economy.

Some 83 per cent of the resource sector operating in Australia is foreign owned (Edwards 2011). Although export income is technically counted as Australian GDP, international buyers of resource commodities, including gas, directly pay the international company, and profits are distributed to predominantly to overseas shareholders.

The relatively low levels of employment limit the flow-through from wages (particularly as the gas industry is likely to displace many more jobs than it creates). Supply chains for machinery and plant are mostly sourced overseas which deliver few benefits for the domestic economy. The much vaunted “indirect employment” or multiplier effect is actually lower than for the industries displaced for all of the above reasons.

Government Revenue

The resource industry has the lowest effective rate of corporate tax in Australia. In NSW there is a five year royalty holiday for coal seam gas.



Graph 3: Effective corporate tax rate, mining compared to all industries (Source: ATO Taxation Statistics, 2008-09 and ABS 5204.0)

3. The role of CSG in meeting the future energy needs of New South Wales including the:

a. Nature and extent of CSG demand and supply

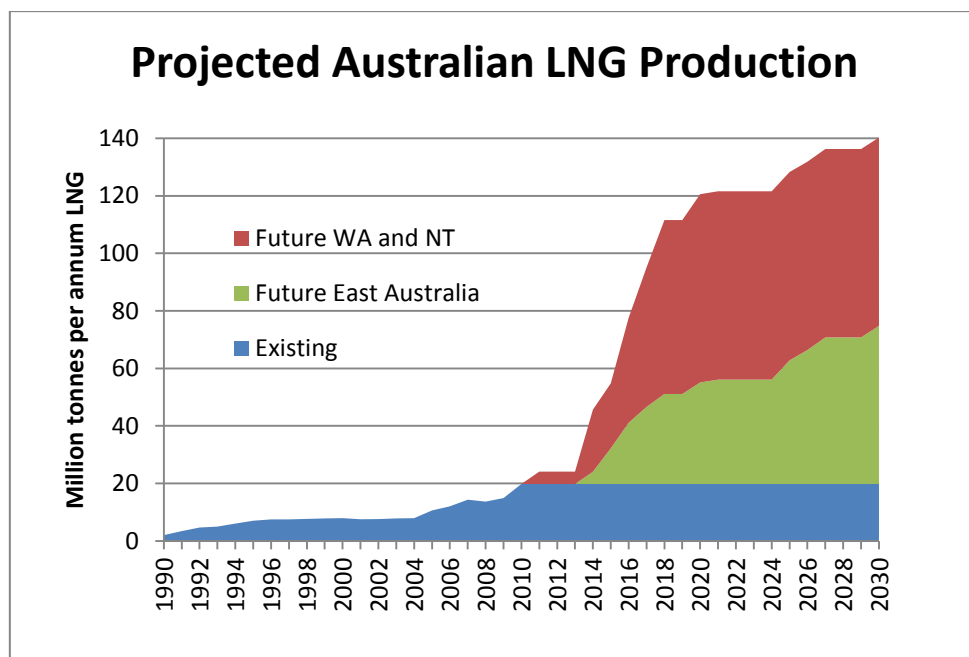
CSG demand is driven overwhelmingly by demand for export LNG from overseas, primarily from Asia. Gas is expected to be the fastest growing energy source globally up to 2030. Asia is expected to be the fastest growing consumer of natural gas, with China accounting for 56 per cent of that growth. The gas will be used for a mixture of industrial heat and power generation. The *BP World Energy*

Outlook (2011:55) forecasts that unconventional gas including CSG will increase, but acknowledges “risks from costs and access exist.”

Coal seam gas reserves in NSW are very large and constantly increasing with more being discovered and proven up. 3P reserves of coal seam gas in the NSW are around 6,000 PJ, including the Clarence- Morton, Gunnedah, Gloucester and Sydney prospective reserves are around 75,000 PJ and are increasing. For perspective, Australia currently consumes around 600 PJ per year (AEMO 2010).

The proposed expansion of the export of LNG across Australia is of an enormous scale as illustrated by the chart below. Northern territory and Western Australian gas that will be exported as LNG (shown in the red and blue wedges in Graph 3 below) will be predominantly conventional gas. Gas from Eastern Australia (shown in Green) however will predominantly be coal seam gas. Of this, the industry is most advanced in QLD, with around 4000 operating wells and three major projects approved already (APLNG, GLNG and GCLNG).

Although the industry in NSW is less advanced, the reserves are comparable to Queensland, and major industry players including Santos, AGL and Dart have very extensive petroleum titles. NSW seems certain to follow closely behind Queensland as a major site for coal seam gas extraction unless policies are introduced prevent this eventuating.



Graph 3: Projected expansion of LNG in Australia (Beyond Zero Emissions)

b. Relative whole-of-lifecycle emission intensity of CSG versus other energy source

The oil and gas industry often refer to fossil gas as “clean energy.” They claim that given the chemical make-up of gas and the way that it can be used in modern equipment such as gas turbines, it can have a smaller greenhouse footprint than coal. However, recent research has found that in some situations, fossil gas production and combustion can have a greenhouse footprint that is in fact greater than that of coal.

Claims that coal seam gas is “clean energy” generally focus on the point of combustion, but ignore or underestimate fugitive and other lifecycle emissions, particularly relating to export LNG.

Fugitive emissions

Greenhouse forcing: methane is a far more powerful greenhouse gas than carbon dioxide. Over a 100 year timeframe methane is considered to have a greenhouse warming potential (GWP) of 23 times CO₂. However, due to the fact that it breaks down into CO₂ over time, it has an even greater impact in the short term. When averaged over a 20 timeframe it is considered to have an impact of 72 times CO₂ (IPCC 2007). Recent research published in 2009 by NASA (Shindell et.al 2009), which takes into account the reaction of methane with other chemical components of the atmosphere, shows that methane could actually be 105 times worse than carbon dioxide over a 20 year timeframe.

The 20-year time horizon is important because it is increasingly likely that global climate tipping points will have been reached far earlier than 100 years from now.

The amount of fugitive emissions, or leakage of methane directly into the atmosphere is therefore of great concern. If, for example 1 per cent of gas from a field is lost to the atmosphere as fugitive emissions, under the 100 year timeframe, this is around a 7 per cent increase in the greenhouse gas impact of that field. If measured over a 20 year timeframe, it would result in over 20 per cent increase. In Wyoming in the United States Engineers working on CSG technologies have found that the amount lost as entrained gas varies from 2 per cent of total well yield to 30 per cent, with a typical well at present losing 15 per cent of its output as entrained gas (US Department of Energy 2010).

The large number of wells per-unit of gas extracted, relative to conventional gas, makes it likely that there will be significantly higher fugitive emissions from unconventional coal seam gas than conventional gas. Fugitive methane emissions can be released into the atmosphere at various points and during certain steps in the drilling and fracking processes such as:

- from the well during drilling,
- from the well during well “completion” operations,
- when the initial “flow-back” waters are removed from the ground during well “clean-up”,
- from production equipment,
- from the coal or shale layers via uncontrolled fissures opened up in the earth by the fracking process that allow gas to find its way to the surface.

Very little research has been conducted anywhere in the world to fully quantify the fugitive emissions associated with “unconventional” gas production. However venting to atmosphere of 7.9 per cent (Howarth 2011) and 30 per cent (Hycap Energy 2010) of all gas brought to the surface has been reported. Major CSG projects being developed in Australia, on the other hand, have assumed extremely optimistic levels of fugitive emissions of around 0.1 per cent.

Currently, despite thousands of wells in production in QLD, and tens of thousands more approved, there has been no research done specifically on the fugitive or lifecycle emissions of CSG (Sydney Morning Herald 2011a, DERM 2009).

There are disturbing indications of the scale of the fugitive emissions problem. Assumptions made on the level of fugitive emissions in Australia are based on API (American Petroleum Institute) compendium. The API Compendium is in turn based on the Greenhouse Research Institute paper by the US EPA from 1996. A re-evaluation by the United States Environment Protection Agency (2010)

of the fugitive emissions of unconventional gas including CSG found some factors used in calculating emissions from were severely underestimated. The factor for emissions released during unconventional well completions was increased by 8,850 times.

Table 1: Comparison of Emissions Factors from Four Updated Emissions Sources

Emissions Source Name	EPA/GRI Emissions Factor	Revised Emissions Factor	Units
1) Well venting for liquids unloading	1.02	11	CH ₄ – metric tons/year-well
2) Gas well venting during completions			
<i>Conventional well completions</i>	0.02	0.71	CH ₄ – metric tons/year-completion
<i>Unconventional well completions</i>	0.02	177	CH ₄ – metric tons/year-completion
3) Gas well venting during well workovers			
<i>Conventional well workovers</i>	0.05	0.05	CH ₄ – metric tons/year-workover
<i>Unconventional well workovers</i>	0.05	177	CH ₄ – metric tons/year-workover
4) Centrifugal compressor wet seal degassing venting	0	233	CH ₄ – metric tons/year-compressor

1. Conversion factor: 0.01926 metric tons = 1 Mcf

Table: US EPA (2010)

The clear implication is that the API Compendium methods used in Australia for estimation fugitive emissions from gas extraction can no longer be relied on. Calculations of overall US emissions from gas extraction based on these updated figures indicate that **"3.25 % of US natural gas production leaks into the atmosphere as methane gas."** (Lewis 2010)

Deutsche Bank (2011) suggests more research is needed on gas footprint and caution analysts and stakeholders not to come to premature conclusions.

A peer reviewed paper by Cornell University academics shows that though the direct CO₂ emissions from burning gas are lower than those formed from burning coal, when fugitive and other emissions are added, fossil gas, and in particular unconventional fossil gases such as shale gas, can have a much higher greenhouse footprint than coal (Howarth & Santoro 2011).

Direct venting of CO₂ and methane

In addition to fugitive emissions, it must also be noted that fossil gas often contains naturally-occurring carbon dioxide. Gas processing companies must remove most of this carbon dioxide contaminant from the fossil gas before it can be sold into a pipeline or sent to an LNG processing plant. Long-standing and normal oil and gas industry practice means that any carbon dioxide removed in this way is simply vented into the atmosphere where it contributed to global warming.

Direct venting of methane to the atmosphere is also an issue. Exploration wells and production wells at certain stages of the extraction process produce methane that cannot be captured for useful energy. Because the GWP of methane is so high, this gas is usually flared to convert it into CO₂ to reduce its impact. However this is not always the case. Methane is often vented directly to the atmosphere for a number of reasons. It is difficult to gain an accurate measure of the scale of this practice but anecdotal evidence is concerning. In the Pilliga for instance, the fire risk of flaring has led to widespread and documented direct venting of methane to the atmosphere.

Greenhouse gas emissions are produced throughout the LNG cycle

Processing coal seam gas for export LNG is energy intensive and is thought to use more than 20 per cent of gas extracted in the first place over the full lifecycle of extraction, water treatment, transport, compression, liquification, shipping and revaporisation in the destination country (Citigroup2011). These added lifecycle emissions are will significantly negate any emissions advantage gas has at the point of combustion.

Displacement of other energy generation sources

Industry claims that export LNG is a relatively clean energy source often rest on the assumption that it is replacing the most inefficient lignite power stations. The reality is that LNG is likely to displace higher cost nuclear and renewable power generation with far lower carbon intensity than LNG.

Domestic emissions

A single LNG train raises Australia's gas emissions (conservatively) by at least a half per cent (assumes 1.5 per cent leakage of gas and GWP for methane of 21, plus the CO₂ generated when powering LNG plants). This is equivalent to putting a half a million cars back on to the road.

Up to about 30 LNG export trains are mooted for Queensland and Western Australia and for Newcastle and South Australia. If these are built, they would increase Australia's emissions about 15 per cent (at least). This does not include the emissions when the gas is used overseas, and is still equivalent to doubling the amount of cars on Australia's roads.

Emissions from combustion overseas

If Australia's LNG exports reach 140 million tonnes per annum as projected, the resulting GHGs when LNG is combusted will be in the order of 420 million tonnes of CO₂e, the equivalent to 75% Of Australia's entire domestic emissions.

c. Dependence of industry on CSG for non-energy needs (eg. chemical manufacture)

Coal seam gas products have limited application in the non-energy sector. A very small proportion of chemical processes associated use methane as an input. Mostly heavier carbon compounds such as ethylene and propylene are used, which are by products oil refining. In the small percentage of cases that methane is currently used, alternatives are available.

d. Installed and availability costs of CSG versus other stationary energy sources***Gas prices are increasing***

Gas prices in Australia are currently around \$3-4 GJ. Over the last decade however, international gas prices have been as high as \$12 GJ (BP 2011b). When LNG trains begin exporting Australian gas to Asia in large quantities, domestic gas prices are expected to be linked to international prices.

Current Levelised Cost of Energy (LCOE) of gas electricity generation (without carbon price) would be around the \$70/MWh mark for current gas prices (~\$4/GJ). The cost would increase to around

\$100/MWh when priced at \$9/GJ. The carbon price (\$20/t) would increase both examples to approximately \$110-\$120 dollars/MWh.

Gas prices in Australia are expected to be linked to global prices as LNG trains come on line. This is in fact already beginning to happen with industrial gas uses having to pay up to double previous prices in order to secure long term supply contracts (The Australian 2011) This will increase the cost of gas for the domestic market. When global prices again reach 2008 levels, with the addition of a low carbon price, wind energy will be directly competitive with gas even before expected cost reductions in wind are taken into account.

Renewable energy is costs are reducing

Solar Photovoltaic

The cost of electricity from Solar photovoltaic is rapidly reducing. As the cost reaches the equivalent of retail electricity prices is said to have reached what is known as grid parity. This is the point that it is providing electricity to households at effectively the same cost as they would pay to their retailer to supply electricity. At this point electricity provided by solar PV will displace large amounts of coal- and gas-fired electricity on the electricity market.



Image: Rooftop mounted photovoltaics

Solar PV is currently one third of cost per unit of electricity that it was 10-years ago and expected to reduce by a further 20 per cent for every doubling of capacity. Germany added 8GW of PV last year alone, and China has experienced a 20-fold increase in capacity in four years. China is already the world's largest manufacturer of PV has just introduced a feed-in tariff for solar electricity that is expected to result in huge amounts of installed new capacity. These developments will continue to drive down prices. The Sydney Morning Herald (2011b) reported in August that PV is already at grid parity in much of NSW.

Wind

In Australia, the Levelised Cost of Energy (LCOE) of wind is around \$110-120/MWh compared to gas at \$80-90/MWh.



Image: Wind turbines.

Wind power capacity has been increasing by roughly 30 per cent globally for the past decade. The combination of large increases in the installed capacity of wind (an established learning rate of 7-10 per cent continuing to drive cost reductions) and the increasing cost of gas in Australia—especially as it links to international parity prices with the expansion of export LNG/CSG—present the real possibility of wind power producing cheaper electricity than gas within the next decade. This has already occurred in Brazil where Wind power is now cheaper than gas (Business Green 2011).

Concentrating Solar Thermal

Solar thermal power (CST) is an established commercially available technology that concentrates the sun's energy to produce heat that is then used to create steam to produce electricity in the same way as a conventional coal fired power station. Because it produces heat rather than electricity directly (as with wind or solar PV), it has the capability for efficient, low cost energy storage.

Electricity itself is very difficult and expensive to store at a utility scale, however heat can be banked in large highly insulated tanks of molten salt, and dispatched at any time to produce steam and generate electricity. This energy storage capacity makes it dispatchable or effectively baseload electricity, as it is able to produce electricity at any time of the day or night.

Spain currently has fifty, 50 MW solar thermal power plants either in operation or under construction and due for completion by 2013, a total of 2440MW of capacity (ProtermoSolar 2011). Many of these have molten salt energy storage, and are currently dispatching baseload solar energy to the Spanish grid.

One of the most recently completed plants is the Gemasolar plant (pictured below). This plant has 15 hours of energy storage, meaning it has a higher capacity factor than the average for NSW black coal plants. This same tower technology with molten salt energy storage is also being commercialized by a company called solar reserve in the US with much larger plants at Tonopah, Nevada and Rice, California (SolarReserve 2011).



Image: Torresol's Gemasolar Concentrating Solar Power tower in Spain.

Cost reductions depend on the rate of deployment but are projected to be rapid. The International Energy Agency (IEA) projects the cost per MWh to decrease to around the \$120-\$130 range by 2020. In a separate report for the Garnaut Review, the CSIRO expect solar thermal electricity to cost \$135/MWh by 2017.

However, these forecasts could be underestimating the trajectory of cost reductions. BrightSource Energy, the world most established solar thermal company, has just announced that it has molten salt energy storage technology for its tower systems. The CEO, John Woolard announced that the cost of the solar tower technology it has developed will be competitive with solar PV as early as 2014/15, as the second phase of developments are rolled out (Climate Spectator 2011).

The 100MW Solar Reserve Solar Thermal tower plant recently approved in Tonopah Nevada is expected to cost between \$US 700-800m (Tonopah 2009) This is the same power tower technology with molten salt storage as the Gemasolar plant in Spain. This means that the cost will be around double the cost of the



Image: In August 2011, Federal MP Tony Windsor and Professor Ross Garnaut visited the Gemasolar CST plant in Spain.

For more on information on current and projected costs of renewable energy, see the *Renewable Energy Technology Costs Review* (Hearps & McConnell 2011).

e. Proportion of NSW energy needs which should be base load or peaking supply and the extent to which CSG is needed for that purpose

Coal seam gas is unnecessary for either baseload or peak energy supply. In NSW, the baseload generation capacity is approximately 17GW of which 12 GW is comprised of black coal and combined cycle gas. CSG currently represents a small proportion of NSW energy which can be easily replaced with new renewable energy capacity. Electricity demand in NSW is reducing, probably due to the wind back in the manufacturing sector as a result of the resources boom. If electricity demand does begin to grow again, renewable energy will be well placed to replace existing coal and gas infrastructure over time.

It is possible to integrate large amounts of variable renewable energy sources such as wind and solar PV into existing grids. For instance, Denmark is actively planning on 50 per cent of its electricity coming from wind by 2025 (Beyond Zero Emissions 2010a: 66), and a recent US DoE study has shown that by interconnecting wind farms and transmission grids in the eastern United States, 14-27 per cent or more of nameplate wind capacity could be relied on as baseload generation (NREL 2010: 74-6). British wind energy expert David Milborrow estimated that the UK grid could incorporate 40 per cent penetration of wind (Beyond Zero Emissions 2010b).

Solar PV matches New South Wales' electricity demand profile well, and would have the effect of reducing peak demand. Increasing PV capacity would reduce electricity prices to consumers due to the merit order effect.

When high penetrations of wind and PV are reached (above 30 to 40 per cent), it becomes more necessary to have dispatchable or firming power like solar thermal power or hydro. There are some opportunities for increased hydro, particularly pumped hydro, but environmental impact is a limiting factor. Solar thermal power on the other hand is a completely reliable commercially available technology that can be scaled to meet any the proportion of dispatchable electricity required. As outlined above, it is rapidly decreasing in cost, and local deployment will accelerate this reduction.

f. Contribution of CSG to energy security and as a transport fuel.

Reliance on CSG dangerously compromises energy security. For years, the people of Eastern Australia have been able to access the cheapest gas in the developed world. But companies such as Santos (2011) have not been happy with this. They would rather that gas in Eastern Australia be linked to global oil prices, as it is elsewhere in the developed world, including in Western Australia. By exporting vast amounts of gas from Queensland at volumes greater than all the gas presently used in Eastern Australia, domestic gas prices are going up. "Cheap" gas will no longer be available for electricity generation and anyone using gas to heat their homes and water or for other purposes is going to pay more.

Additionally, high levels of foreign ownership of coal seam gas companies diminish Australian control over these resources. Two thirds of the coal seam gas reserves have been sold off to these foreign companies: Shell (Dutch), British Gas, Conoco Phillips (USA), KOGAS (Korea), Mitsui and Toyota Tsusho (Japan), Petronas (Malaysia), Sinopec (China) and Total (France). There is no guarantee that the remaining majority Australian owned companies, Origin and Santos won't be bought out tomorrow by Exxon or BP.

Renewable energy sources have no fuel costs, so energy costs are more or less locked in once the plants are built. Renewable energy infrastructure would decouple Australian consumers from increasing and increasingly volatile global gas prices. Solar and wind power produced in Australia cannot be exported offshore at the expense of domestic energy supplies.

It is also worth remembering that gas processing plants at Longford Victoria and Varanus Island in West Australia have both had major explosions resulting in loss of life (in the case of Lonford) and severely disrupted the energy supply for extended periods. This is not a risk with renewable energy.



Image: Varanus Island gas processing plant explosion 2007 triggered energy crisis.

Transport fuel

Electrification of passenger and freight transport has benefits over the use of gas as a transport fuel. Electrified automobiles and transport use far less energy per passenger kilometres travelled, and have the potential to be zero emissions if linked to renewable sources. Firms such as Better Place are now rolling out electric vehicle infrastructure in Australia and the entry of Chinese electric vehicle automakers will lower the cost of them for the domestic market. The potential for rapid electric vehicle uptake over the coming decade should be taken into account. Policy makers should not assume there will be strong demand for CSG in the transport sector.



Image: Electric vehicles and High Speed Rail has the potential to be zero-carbon transport.

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