1 Introduction: HRL group

HRL Limited is a privately owned Australian technology and energy company with more than 250 staff, and a turnover of around $60M. Around 37% of the shares in the company are held by current and former staff.

We do not profess particular expertise in the public policy of innovation but have extensive experience in power generation and our particular field of low emission technology viz., the gasification of low rank coals, called IDGCC. We will therefore confine our remarks in the framework of the Issues Paper 4 to our area of experience.

2 Context

We agree with comments on the stationary energy sector (page 3), and with much of the relevant comment in the paper by Grubb 2004. We agree that atmospheric stabilisation of CO_2 will require a wide range of policies affecting the three end-use sectors (buildings, industry & transport), but believe that policies for technological solutions applied to demand management and supply efficiency should also be added.

We strongly support the Grubb contention of the need for a combination of technology push AND market pull in that these forces act at different stages of the innovation chain.

Innovation is a process with an inherently high failure rate. It is generally accepted that about 95% of all consumer products emerging from RD&D processes fail in the lab- or pilot-scale stage prior to trial marketing. About half of the 5% that get marketed fail to attract customers and are dropped, leaving only 2%+ to pay for that process and provide profit for growth into the future. Innovation in other fields is no less challenging, or more successful.

We see these survival hurdles as the discipline on the emerging new technologies, not necessarily as evidence of market failure. These dismal statistics for successful commercialisation are more likely evidence of a disconnection between the RD&D stage and market pull. Only outstanding innovations with a large market pull, and committed management get pulled through the RD&D continuum to market testing, and commercialisation stages.

The Issues paper supports the RD&D phase of those areas of innovation that are seen to be socially desirable but for which the market pull is weak. But "failure" following this support could still be as high if the market does not demand the innovation. This is the risk inherent in RD&D.

We note the view of the Issues Paper 4 page 3 that power generation is "one of the least innovative sectors in the global economy" but refer to the Grubb paper page 25 that the industry normally involves:

- long time scale;
- multiple political risks; and
- very weak market drivers.

Despite these disabilities, we contend there has been great deal of investment (and progress made) in the global electric power generation industry over the last two decades. However, once installed, modifications to plants are likely to only achieve minor efficiency gains beyond the basic design.

The electricity generating industry is over a century old. Comparisons with newly emerging, high growth industries (like pharmaceuticals and IT) ignore stage of life cycle differences i.e. power generation is a mature industry in low growth phase. It also involves huge, long-term investments, is traditionally government owned and heavily regulated, and sells a commodity end product under highly competitive market pressures or strong price control. Profits are generally low, close to bank interest. The risk/return curve is heavily tilted against innovation in favour of low cost electricity to the public. As a result, Australia has one of the lowest retail price regimes for electricity within the OECD[1] and wholesale prices (providing revenue to the generators) are even lower[2].

Even so, technological advances have been made and introduced, even in the absence of a price for CO_2 emissions. Evidence for this can be seen in the progression in efficiency of brown coal-fired plants installed over time in the Latrobe Valley (Figure 1). Over the last two decades, similar innovations have been introduced, including high efficiency supercritical boilers, high efficiency combined cycle plants, and the gasification of coal, coke, biomass and wastes into syngas for power, chemicals and fuels.

The bulk of these innovations have been driven by global equipment suppliers of boilers and turbines seeking future market growth but with strong US and EU government support. For example, about US$5B of support has been provided by governments in gasification for power generation since the 1980s in the US and EU, with a matching investment by the private sector. This funding has facilitated the building of three commercial scale IGCC demonstration power plants in the US and two in the EU in the 1990s. The technologies flowing from this decades-long coal gasification program are now being offered globally by the developers: Shell, GE, ConocoPhillips, and Siemens. Commercial coal gasification plants are now spreading globally, especially in China.

In addition, many laboratories in the US, EU and Japan are competitively focused onto innovation in the field of the RD&D of carbon capture and sequestration (CCS) to mitigate CO_2 emissions from fossil fuel-fired power generation. They are investing tens of millions

1 ABARE. Energy in Australia 2008. http://www.abareconomics.com/publications_html/energy/energy_08/energyAUS08.pdf

2 NEMMCO. http://www.nemmco.com.au/data/avg_price/averageprice_main.shtm

of dollars annually into laboratory, pilot and demonstration work, from a mix of private and government support. Proprietary carbon capture processes are already available for pre-combustion capture. Post-combustion capture is still under intensive development. The main focus of work in CCS is towards lowering of the cost per tonne of CO_2 captured and sequestered.

Government support supply push and private funded demand pull can therefore be seen at work in these innovations in power plant design, and CO_2 emissions mitigation.

Turning to the HRL experience, basic research (Grubb page 18) on the IDGCC technology was completed within the SECV over the period 1985-89, at a cost of about $20M in dollars of the day. The pull for investing these funds was the goal of the SECV Board to secure its competitive future against potential competition from natural gas and black coal in its market. Brown coal gasification power generation was selected in 1989 for further development by its technology arm, the Herman Research Laboratory. Technology specific research, development, and demonstration followed in the years after 1989 to today via $38M spending by the SECV to 1994 including the design/build of a 0.5MW coal gasification rig at Mulgrave was $25M.

This phase was followed by the privatisation of the technology into HRL Limited with the investment of $100M by an investment syndicate over 1994-97. This funded the design/build/operate program of a 10MW IDGCC pilot plant at Morwell.

Since the end 1997, HRL Limited has invested a further $15M in the development of a 400MW commercial scale market demonstration of the IDGCC technology in the Latrobe Valley, planned to be operating by 2012.

This new Low Emission Technology (LET) has been developed on the expectation it will have a higher efficiency/lower CO_2 emissions, lower water use, and be cost competitive with existing (and future) boiler technologies operating on the same moist brown coal fuel. The $100M syndicate support was a key factor in bridging the technology across the "valley of death" between 0.5MW and 10MW-scale proof of concept. This was made available under R&D legislation operating in 1994. However, in 1997, market pull was weak and wholesale prices were low. This was due to the excess supply capacity released by operational improvements that accompanied privatisation of the existing power stations. It has taken around 10 years for demand to use up this excess supply capability and for prices to recover.

Current promises totaling $150M by the Victorian State and Commonwealth governments (less around $50M tax) should help carry the IDGCC technology into its fully commercial phase. Diffusion globally via commercial technology licensing will follow without the need for further public support.

HRL therefore has been part of a global RD&D innovation in power generation since the mid 1980s. The $150M invested to date has been a mix of private and public monies, driven by staff, management and shareholders committed to a LET future for power generation from the reactive coals of the Latrobe Valley and elsewhere in the world.

We believe that the reward for IDGCC technology globally will more than offset the $150M government support once the 400MW IDGCC demonstration plant is successful. It will not require further public support but could be blocked locally by an inappropriate cap and trade or other carbon penalty system.

For example, if the carbon penalty is significant and existing power stations are "grandfathered" but this project has to pay the full cost of carbon as a new entrant, the project could be priced out of its market.

If however, the cost of carbon (whether tax, or cap and trade) is levied equally on a per tonne basis, IDGCC would enjoy a price advantage arising from its low emissions of less than 0.8 tonne CO_2/MWh compared to the Latrobe Valley generator average of 1.3 tonne/MWh. This advantage arising from its LET status would provide the differential return needed to establish and replicate the technology in the Latrobe Valley and elsewhere into the future as commercial opportunity and demand dictates.

The potential impact of adopting IDGCC technology in the Latrobe Valley alone is:

Scenario	**CO_2 emissions Mt p.a.**	**Impact on Kyoto Target[3]**
Current Latrobe Valley (LV) power stations	57	
Replace existing LV plant by IDGCC plants	35	-4%
Replace existing LV plant by IDGCC plants with CCS	10	-8%

The difficulties and cost of this hypothetical replacement should not be underestimated.

With regard to diffusion of IDGCC globally, a successful 400MW demonstration project will be followed by additional installations internationally in line with the agreement with our Chinese engineering partner, Harbin Power Equipment of Heilongjiang Province. This diffusion will take place via an arms length technology license and royalty agreements without further public support. The agreement with Harbin is for 5 projects outside China and a joint venture arrangement for projects within China.

3 How Innovation happens

ETS driving innovation

An emission trading scheme or carbon tax is essential to drive further substantial innovation in LET power generation. The current power generation system is a response to the market requirement for the lowest cost power per kWh, on a continuous supply basis. At present, technologies largely based on coal, gas or hydro deliver this. The current market applies no

3 Calculated as percentage reduction against Australia's 2008-2012 CO_2 emissions target under the Kyoto protocol. http://www.climatechange.gov.au/projections/pubs/tracking2007.pdf

CO_2 constraint or penalty to this supply. If society wants to add a CO_2 constraint to the production and/or consumption of electricity then a carbon penalty must be added to the existing market signals of demand, quality and price.

If this carbon penalty is certain and large enough, the market will shift production and consumption towards a lower CO_2 emissions equilibrium. If the carbon penalty is not certain or large enough, the incumbent system will resist adjustment, or only comply at the margin. For example, the Kyoto protocol induced cost of carbon in the EU has been uncertain in impact (through the distribution of certificates) fluctuating from €40 down to below €10 in recent years, with an uncertain future beyond 2012. It has required a range of subsidies and support programs to induce alternative technologies into this market, but with limited success.

In Australia, a long-term certain carbon penalty of $40/tonne of CO_2 without exemptions and passed through to customers would probably double wholesale power prices. This would probably render wind, geothermal, nuclear and natural gas power profitable against baseload coal-fired plant without additional subsidies, and call forth extensive additions to capacity employing these low- to zero-emissions technologies.

It would also accelerate the adoption of carbon capture and sequestration (CCS) from existing fossil fuel power stations once a regulatory framework and disposal infrastructure at reasonable cost was operating. It would also encourage RD&D of lower cost alternative lower emission technologies by attaching a known reward for their success.

If however, this penalty was $10/tonne, or uncertain into the future, or fluctuating so that no firm investment or altered consumption decisions could be based securely on it, then it is likely to confirm a more expensive status quo in the production, and consumption, of electric power with limited reduction in the rate of CO_2 emissions growth.

Market failure

No market signal has been provided to the electric power industry on CO_2 emissions in the past so there can hardly be said to have been a "market failure" of LET innovation. Rather, the government regulatory framework within which the industry operates failed to put any price/cost on the emissions of CO_2 to the atmosphere.

This situation is in contrast to the situation in the USA with regard to SO_2 emissions to air. These were "controlled" under environmental regulation up to the late 1980s, when acid rain and other damage prompted a more robust approach by government. A cap and trade system for SO_2 was instituted in 1990 and by 2006 total emissions of SO_2 had been reduced by 40% (9.4 Mt in 2006, c.f. 15.7 Mt in 1990[4]).

4 US EPA. "Acid Rain and Related Programs. 2006 Progress Report" http://www.epa.gov/airmarkets/progress/docs/2006-ARP-Report.pdf

Alternative frameworks
No comment

4 Market failures and barriers across the innovation system

4.1 Policy clarity, continuity and coherence

In general we concur with this section but repeat the view that a significant, certain, long term penalty for CO_2 will reduce or remove altogether the need for administrative guidance involving complex policy programs of learning curves or selection of preferred technologies (government "picking winners"). The market will make those and other decisions at least cost.

4.2 Risk management

See comments on Section 4.1.

Questions: picking winners (rules)
Set a significant CO_2 penalty, with long term certainty (20 years +).
Support RD&D as in the past, but enhanced in line with societal goals.
Support demonstration plants selected by competitive tender process, e.g. LETDF.
Leave commercial rollout and diffusion to market pull for successful technologies.

4.3 Technological lock-in

It is our experience that regulatory certainty is essential for investment, but investment flows towards the profit potential of innovations tempered by their prospect of risk. Investment opportunities that do not offer sufficient return for the attendant risk, like most early R&D projects, have difficulty attracting private capital. But such capital is available for an investment that offers a return significantly higher than its inherent risk.

Prospective technologies based on aggregating small scale units with inherently high cost (solar, wind, ocean, mini hydro) are not facing so much an "incumbency" disadvantage as an inherent wholesale electricity cost disadvantage as against large scale, centralised, low cost fossil fuel power stations with no carbon penalty. Where this cost disadvantage is of an order greater (as for solar power) no amount of "market learning" will offset this and render the technology commercial except in niche applications.

We cannot suggest "appropriate policies" for introducing such high cost technologies, at the expense of lower cost incumbents except perhaps via the carbon penalty route noted above that would reward them for their low/zero CO_2 emission status, if that was the intention of government in pursuing that societal goal.

5 Market failures along the innovation chain

We cannot usefully comment.

FIGURES

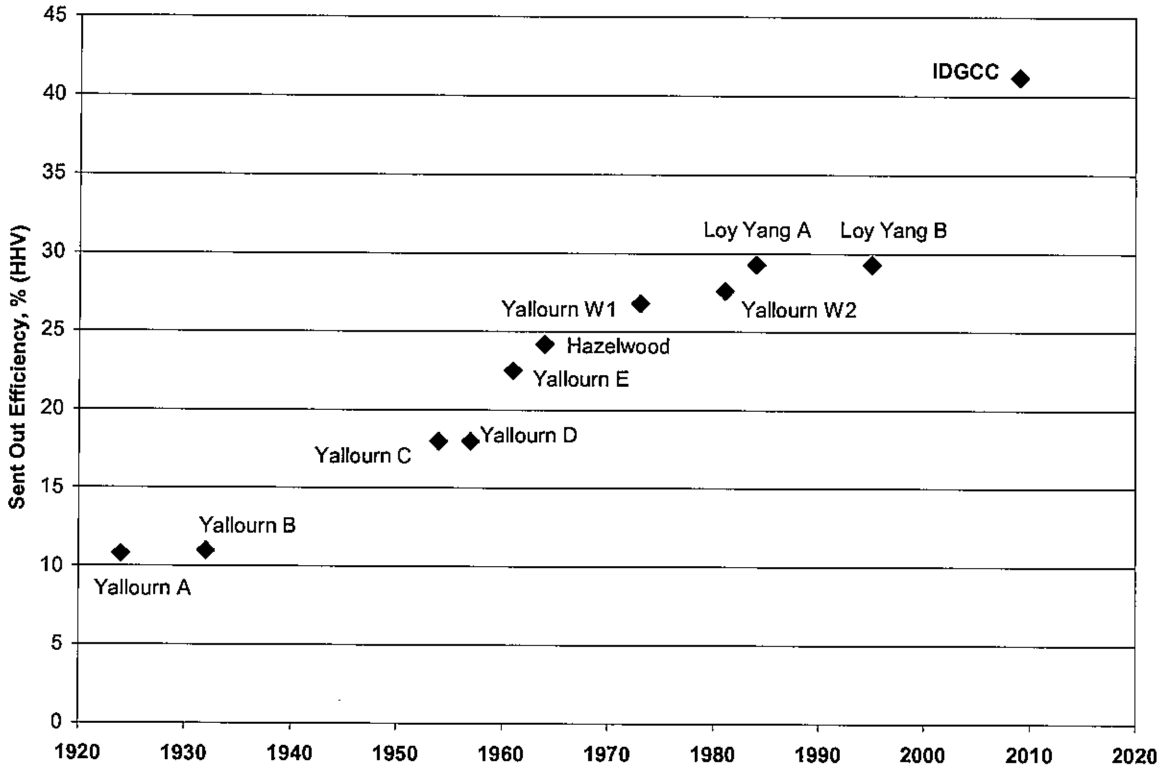

Figure 1: Efficiency of Coal-Fired Power Stations Installed in Latrobe Valley versus Time

Sent out efficiencies for previous and existing power stations calculated from data in:

- "Yallourn Power Station. A History 1919 to 1989". Published 1973. Colin Harvey. State Electricity Commission of Victoria.
- "The SECV and the Greenhouse Effect. Discussion Paper Number 2 – April 1992". State Electricity Commission of Victoria.