CERAMIC FUEL CELLS LIMITED

Clean Energy Finance Corporation

Expert Review

Submission by Ceramic Fuel Cells Limited

December 2011

Introduction

Ceramic Fuel Cells Limited welcomes the opportunity to make a submission to the Clean Energy Finance Corporation (**CEFC**) expert review.

This submission begins with an introduction to Ceramic Fuel Cells and our BlueGen® product, and then looks at how highly efficient distributed generation can help Australia meet its future energy needs with lower emissions and lower infrastructure costs.

We then provide comments on some of the specific questions raised in the CEFC Request for Submissions document.

We appreciate the opportunity to make a submission. If you would like any further information please contact us.

More information on Ceramic Fuel Cells is available at www.cfcl.com.au.

More information on our BlueGen product is available at www.bluegen.info.

Andrew Neilson

Group General Manager Commercial
Ceramic Fuel Cells Limited
Andrew.neilson@cfcl.com.au
Phone 03 9554 2300

About Ceramic Fuel Cells Limited

Ceramic Fuel Cells is an Australian company which has developed a world leading clean energy technology. Our products have the world's highest electrical efficiency of any small scale electricity generator.

Ceramic Fuel Cells was founded in 1992 by a consortium of the CSIRO, leading industrial companies and Government bodies. The Company employs more than 100 staff at its headquarters and research facility in Noble Park, Melbourne. All the Company's technology has been developed in Australia and all intellectual property is wholly-owned.

The Company has invested more than $280 million in developing its technology and products and is listed on the Australian Securities Exchange and the London Stock Exchange AIM market (code: CFU).

An introductory video about the Company and our BlueGen product is available at http://www.brr.com.au/event/65389.

BlueGen® – clean on-site power, controllable distributed generation

The Company's first product is called BlueGen. About the size of a dishwasher, BlueGen uses patented solid oxide fuel cell technology to convert natural gas into electricity with the world's highest electrical efficiency.

Each BlueGen operates constantly, all-year round, generating about 13,000 kilowatt hours of electricity per year, about twice the annual requirement of the average Australian home. The excess electricity is exported back to the power grid.

BlueGen also produces enough heat to make 200 litres of hot water per day, which matches the average home's daily needs for hot water.[1]

BlueGen products are installed in homes and other buildings, connecting directly into the existing gas, power and water infrastructure. BlueGen does not need expensive infrastructure upgrades and there is no adverse impact on neighbours or local wildlife. BlueGen generates electricity through an electrochemical reaction, so there is no noise or vibration.

[1] Australian Standards; Sustainable Energy Authority Victoria, Estimated Household Water Heater Energy Use Report 2005

Figure 1 - BlueGen installed in a Sydney home

A 2010 CSIRO report has confirmed the significant carbon savings from BlueGen units. Compared to the Victorian power grid, each BlueGen unit can save **14 tonnes** of carbon per year (when replacing a gas hot water unit – the savings are much higher if replacing an electric hot water unit).[2] A 2 kilowatt solar PV system in Victoria will save **3.2 tonnes** of carbon per year.

There are no nitrogen oxide or sulphur dioxide emissions; and BlueGen uses up to 95 percent less water than current brown coal power plants[3].

Importantly, the power output from each unit can be modulated up and down remotely over the internet. This creates truly ***controllable distributed generation*** – as distinct from intermittent and uncontrollable generation from solar PV.

2 http://www.cfcl.com.au/Assets/Files/20100719_CFCL_CSIRO_Report_BlueGen_Emissions_Savings.pdf

3 Assuming heat from the BlueGen is used as hot water. Compared to brown coal using 2.2 litres of water to generate 1kWh of electricity: Loy Yang Power Sustainability Report 2007

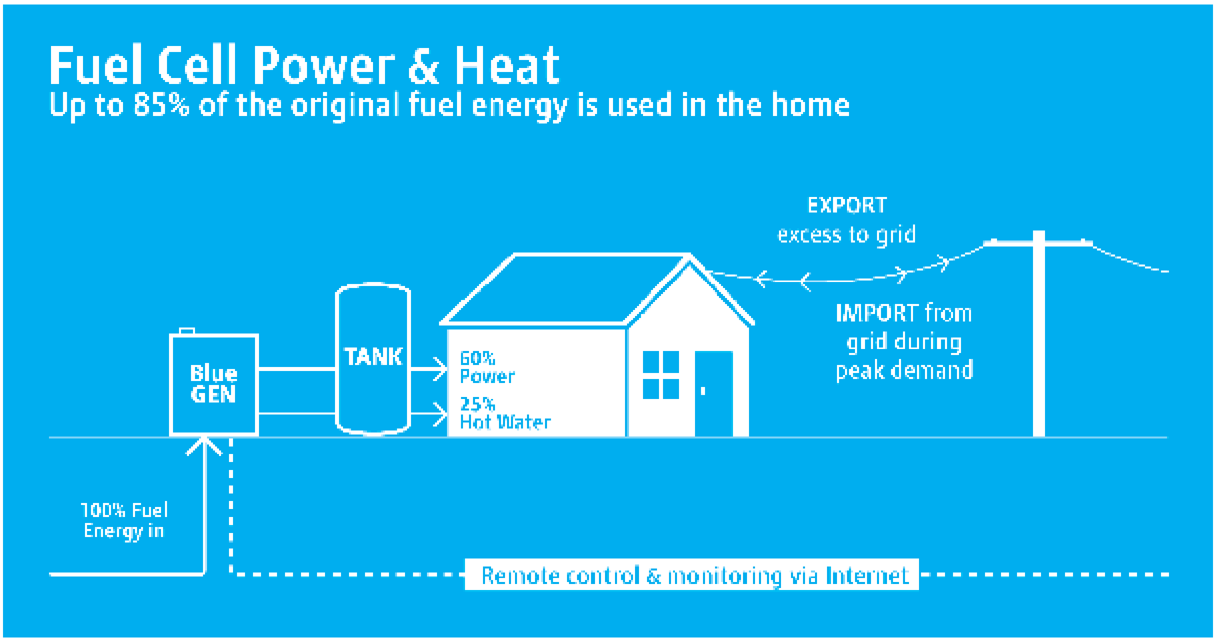

Figure 2 Controllable Distributed Generation

In April 2010 BlueGen received 'CE' safety approval, allowing units to be sold and installed throughout the European Union. In August 2011 BlueGen was certified by the Australian Gas Association for installation as an ordinary gas appliance. The connection to the power grid complies with the relevant Australian Standard (AS 4777).

Over the last year Ceramic Fuel Cells has increased its order book by more than ten times and today has orders for more than 400 BlueGen units from energy utilities and other foundation customers in nine countries: Germany, the UK, Switzerland, The Netherlands, France, Italy, Japan, USA and Australia. Our customers and partners include some of the largest energy companies in the world.

In Australia we have BlueGen units operating in Melbourne, Sydney, Canberra, Adelaide and Brisbane.

In Sydney, Ausgrid's 'Smart Home' showcases the latest in energy efficiency and demand side management. The home includes a BlueGen unit integrated with a battery system (as well as a small solar unit). The home is connected to the electricity grid but is effectively "self sufficient" in electricity, through on-site generation and storage.

In the first year of operation the BlueGen unit generated 10,753 kWh of electricity and saved 5.7 tonnes of CO2 compared to grid power.[4] More details are available at www.smarthomefamily.com.au, and http://www.bluegen.info/Smart_Home_Family/

Ausgrid is also installing 25 BlueGen units in Newcastle as part of the $100 million *Smart Grid, Smart City* project.

The Adelaide City Council and the South Australian State Government have installed a BlueGen unit as part of an Electric Vehicle (EV) charging station at Adelaide Central Markets. The BlueGen allows city shoppers to recharge their electric vehicles from low emission electricity rather than carbon intensive power from the electricity grid.

[4] http://www.smarthomefamily.com.au/smart-home-annual-stats-energy

The BlueGen unit was installed in around two hours and the entire installation completed in less than a day. The waste heat from BlueGen is recovered to provide ‘free' hot water for the Council cleaning staff. More case study details are available at http://www.bluegen.info/EV_Charging/

As a final example, the Victorian Government Office of Housing has installed 30 BlueGen units in social housing in Melbourne and regional Victoria, to demonstrate how BlueGen can reduce household energy costs – as well as cutting carbon emissions.

BlueGen units are available now for commercial customers through our distributors, Harvey Norman Commercial division and Hills Solar.

More details about BlueGen, including case studies and a carbon savings calculator, are available at www.bluegen.info.

Broad Policy Objectives

Before commenting on the specific issues raised by the CEFC, the following high level policy objectives (which cross State and Federal sectors) provide some useful context:

Reduce Emissions from Power Generation

All political parties have committed to reducing Australia's emissions by at least 5 percent by 2020. This will require a significant transformation to Australia's stationary energy sector.

As the clearest example: Victoria relies on brown coal fired generators for 95 percent of its electricity.[5] These generators have an efficiency of about 28 percent. By the time the power gets to where it is used, the efficiency has dropped to less than 25 percent, meaning three quarters of the energy has been wasted[6]. By contrast, Ceramic Fuel Cells' products have a peak electrical efficiency of up to 60 percent, and recover heat for a total efficiency of up to 85 percent.

Encourage Distributed Generation

Distributed generation can provide significant benefits to the environment and the energy network – and significant cost savings. The benefits of moving away from relying only on large coal power plants towards a *distributed generation* system have been widely recognised in many studies in Australia and internationally, including:

- A 2010 CSIRO report estimates that the value of wide-scale deployment of distributed energy in Australia could be **$130 billion** by 2050[7].

- A 2010 report by Boston Consulting Group[8] says the emergence of distributed power generation is the biggest transformation to the power sector since the invention of the light bulb. The report finds that:
    - by 2020 renewable technologies and combined heat and power units could jointly provide more than 50 percent of all electricity consumed within the European Union;
    - old centralised systems that deliver a one-way supply of electricity to consumers will be increasingly displaced by localised generation, and the future power landscape will include a larger proportion of small-scale sources, such as cogeneration through combined heat and power (CHP) plants.
    - "*Some energy will be produced by consumers themselves, through a distributed network of power that incorporates everything from rooftop wind turbines and solar panels to CHP microplants (micro-CHPs) in consumers' cellars*."

- University of Technology Sydney has studied the savings on grid infrastructure from distributed generation. Its June 2009 report[9] shows that distributed generation and demand side measures can meet all New South Wales' electricity demands to 2020, with savings of $1.4 to $3.9 billion – and of course much lower greenhouse gas emissions than new coal fired power stations. The national savings would be far higher than this.

---

5 Victorian Climate Change Green Paper 2009, page 33

6 Commonwealth Government, Generator Efficiency Standards; Loy Yang Power Sustainability Report 2007

7 *The Intelligent Grid*: http://www.csiro.au/resources/IG-report.html

8 *Toward a Distributed-Power World: Renewables and Smart Grids Will Reshape the Energy Sector*: http://www.bcg.com/expertise_impact/publications/PublicationDetails.aspx?id=tcm:12-51645.

9 *Meeting NSW Electricity Needs in a Carbon Constrained World*: http://igrid.net.au/sites/igrid.net.au/files/images/Meeting%20NSW%20Electricity%20Needs%20in%20a%20Carbon%20Constrained%20World%20%28June%202009-1%29.pdf

- Several submissions to the Prime Minister's Task Group *Energy Efficiency Issues Paper*, released in May 2010,[10] highlighted the benefits of distributed generation of electricity using fuel cells.

  In its submission, The Energy Networks Association (ENA) – the peak national body for Australia's gas and electricity network providers – said:

  > *In the future, a typical active customer could potentially transform their energy profile by purchasing a 3kW combined heat and power (CHP) fuel cell, a 1.5kW solar PV system, a 5 kWh battery and a Home Area Network (HAN). They could reduce their reliance on the grid – which features 90% coal-fired generation, 60% combustion and line losses and around 10% renewable generation – and move towards a more environmentally sustainable profile based on natural gas-fired generation, 15% energy conversion losses and 30% renewable generation.*
  >
  > *Active customers are also likely to be net exporters of electricity. This example highlights the fact that greater deployment of distributed generation has the potential to significantly improve the energy efficiency of individual businesses and households, which may have consequences for energy prices and the overall efficiency of the total energy delivery chain.*

  The Gas Industry Alliance (GIA) states in its submission:

  > *The GIA has identified two key areas of great opportunity to drive a stepwise change in energy delivery and use throughout Australia. Firstly small to medium sized distributed generation including co/tri-generation and fuel cell technologies have the potential to deliver significant low cost emission intensity reductions in the stationary energy use sector. The second key opportunity is the increased use of gaseous fuels (LPG, CNG and LNG) in the transport sector.*

  The Task Group's Issues Paper itself says:

  > *Energy efficiency measures and cost-effective distributed generation (such as solar roof panels, wind turbines, co-generation and tri-generation) can help delay the need for new electricity infrastructure investment.*
  >
  > *Energy efficiency and distributed generation may play a role in increasing the security, stability and cost-effectiveness of energy markets. Distributed or embedded generation can result in lower transmission line losses because the generator is located close to the load. Distributed generators are also capable of higher overall energy efficiency if using co-generation or tri-generation, because waste heat can be used for heating and cooling. Distributed generation can help delay the need for new electricity infrastructure investment.*

- In January 2010 the Australian Academy of Science released a report on *Australia's Renewable Energy Future*[11]. The report includes a strong endorsement of the benefits of highly efficient fuel cell generators and recommends a feed-in tariff for natural gas combined heat and power (CHP) domestic generation.

- A December 2010 report by think tank Per Capita, a *Case Study on Distributed Gas Power*[12], explores the role of distributed gas-fired power generation in Australia's transition to a low carbon economy. The report identifies the large benefits of distributed generation and the market settings which need to be changed to unlock these benefits.

---

[10] Submissions are available at: http://www.climatechange.gov.au/government/submissions/pm-task-group/paper.aspx

[11] http://www.science.org.au/reports/documents/AusRenewableEnergyFuture.pdf

[12] http://www.percapita.org.au/_dbase_upl/Energy%20Market%20Design.pdf

Submission to the CEFC

In this section we provide comments on some of the questions asked in the CEFC Request for Submissions.

Scope of the CEFC

Ceramic Fuel Cells supports the intended scope of the CEFC's operations, notably that the body:

- Will not make grants;
- Will be commercially oriented and intends to make a positive return on its investments.

1. *How do you expect the CEFC to facilitate investment?*

   There is a wide range of tools available to CEFC to facilitate investment in clean energy deployment. These tools have been identified in many studies[13] and include:

   - Direct equity investment
   - Debt or quasi debt
   - Loans on concessional terms and rates (eg no or limited recourse loans) as well as commercial loans
   - Loan guarantees.

   The tools adopted by Low Carbon Australia (http://www.lowcarbonaustralia.com.au) provide a good example of the types of financing tools available.

2. *Are there principles beyond financial viability that could be used to prioritise investments, such as emissions impact or demonstration affect?*

   Yes, there are non-financial criteria such as:

   - Environmental benefits;
   - Demonstration value;
   - Local technology development (ie favouring technology which is developed or manufactured in Australia).

   However, applying too many of these criteria may lead to subjective and sub-optimal allocation of funding. As the Garnaut Review notes:

   > *These overlapping objectives may include greenhouse gas abatement, industry support and regional development….The introduction of a carbon price should allow such programs to be focused on innovation market failures. And there is no case for objectives of industry support and regional*

[13] For example: Ernst & Young, *Navigating the Valley of Death*, March 2010; Baker & McKenzie, *Hypothecating Revenue from a Carbon Price*, May 2010 (both available at www.cleanenergycouncil.org.au) and Garnaut Review, *Update Paper No 7 Low Emission Technology and the Innovation Challenge,* March 2011, page 36 (available at www.garnautreview.org.au)

development to be mixed with and to dilute the correction of innovation market failures.[14]

While government and the bureaucracy may over time develop expertise, the process of selecting projects at the demonstration and commercialisation stage should rely on the wisdom of the market. If the economics of a project are promising, the project can be initially identified by the private sector.

Market-led project selection is only possible if programs are designed to capitalise on this via a simple but precise set of project selection criteria:

- *Criteria 1: Will the technology contribute to lowering the cost of mitigation?*
- *Criteria 2: Does the project qualify as an early-mover innovation?*
- *Criteria 3: Are there expected spillovers associated with the project?*

Another important question is how the CEFC intends to allocate funding between different types of technologies.

There are two elements here: renewable vs low emission technologies; and the stage of commercialisation.

Renewable vs Low Emission

The CEFC mandate is to divide funding into two streams:

a. a *renewable energy and enabling technology* stream which will have $5 billion funding allocated; and

b. an *energy efficiency and low emissions technologies* stream which will have the other $5 billion funding allocated.

We suggest one of the most important issues for the CEFC to address up-front is how it will allocate funding between renewable and low emissions technologies.

The clearest solution would be to quarantine the funding in separate pools.

We suggest that it is not appropriate that renewable energy technologies end up with the full $10 billion funding and energy efficiency and low emissions technologies end up with nothing, given that:

- The clear policy intent is for CEFC to support non-renewable low emissions technologies as well as renewable technologies;
- Renewable energy technologies already receive substantial subsidies and funding which are not available to low emissions technologies, such as the Renewable Energy Target; Solar Flagships ($1.5 billion); ARENA ($3.2 billion) and State Government feed in tariffs.

We suggest that to provide certainty to the market, the CEFC should be transparent and up-front on how the CEFC intends to allocate funding between renewable and low emission technologies; specifically, what rules will the CEFC put in place to ensure that low emission technologies receive funding under the CEFC scheme?

[14] Garnaut Review, *Update Paper No 7*, 2011, page 28 and page 35

Defining "Low Emission" Technologies

The CEFC will need to define which technologies fit within the *energy efficiency and low emissions technologies* pool.

The policy is targeted at emerging products and solutions which combine energy efficiency and low emissions. Until recently energy efficiency traditionally focused entirely on reducing *consumption* of energy; many Government energy efficiency schemes explicitly exclude equipment which *generates* electricity. This distinction is now starting to break down, as there is more recognition of products and solutions which combine a reduction in consumption as well as more efficient generation.

Typically these solutions are implemented at the customer's end of the energy supply chain, as part of a ***distributed generation*** system.

A clear example is small scale power and heat generation.

Ceramic Fuel Cells suggests that small scale "low emission" technologies be defined by reference to the existing emissions intensity of the national electricity grid, which is already measured, publicly reported and used in Government energy regulations.[15] The Australian grid has an emissions intensity of 1.04 t CO2-e per MWh[16]. "Low emissions" could be defined as less than half this amount, or 0.50 t CO2-e per MWh.

We suggest this simple criteria of "less than half the emissions of the current grid" would be intuitive (and easy to communicate) rather than a more complicated "technical" assessment of the emissions of marginal generation technology etc. This also has the benefit of being referenced to emissions data already measured, reported and used in Government energy regulations.

Any technology or product which generates electricity with an emissions intensity of less than this amount should be eligible, subject to the other criteria such as 'small scale' generators and emerging (not mature) technologies.

As the important output of the policy is to encourage the generation of low emission *electricity*, we suggest the emissions intensity of the product should be measured by electrical efficiency, not by overall system efficiency.

Stage of Development

The other dimension for the CEFC to consider is what 'stage' of technologies should be supported.

The CEFC says that it will invest in the "*commercialisation and deployment* of clean energy technologies" – ie deployment and scale up, not research and development.

We support this approach. We think the CEFC is right to focus on technologies and products which are in the well known 'valley of death'[17] – that is, they are developed and proven (at small scale) and now need capital to grow and deploy in commercial volumes.

We suggest this should exclude technologies which are mature and commercially generally available, such as large gas turbines.

[15] For example this is the figure which retailers use to calculate emissions on electricity bills, under Guideline 13 of the Victorian *Electricity Industry Act*.
[16] Department of Climate Change, National Greenhouse Accounts (NGA) Factors, July 2011, table 39, page 69. This includes scope 2 and 3 emissions.
[17] Ernst & Young, *Navigating the Valley of Death*, March 2010, page 41

Again, a clear statement by the CEFC as to what *commercialisation* includes (and does not include) would provide certainty to the market.

3. *What are the opportunities for the CEFC to partner with other organisations to deliver its objectives?*

   CEFC can partner directly with the developers and manufacturers of clean energy technologies.

   CEFC an also partner with the distributors or customers of those companies.

   CEFC can also facilitate investment by co-investing with private sector partners and by leading investment rounds in projects which have a "near-commercial" return.

   Finally the CEFC could partner with other Government funding bodies, whereby the other funding body (such as ARENA) provides grants to develop earlier stage technologies, which, when they are proven at small scale, then migrate over to the CEFC programs for commercial deployment.

The Market Gap and Overcoming It

4. *How could the CEFC catalyse the flow of funds from financial institutions?*

   Like Low Carbon Australia, the CEFC could bridge the gap between private sector demands for a payback in say six years (or less) with the reality of paybacks of say ten or 12 years from clean energy projects.

   CEFC could offer partial loan guarantees; or loans at 'near commercial' rates and terms.

   CEFC funding should be directed to reducing the risk profile of projects for commercial lenders so to allow the projects to compete against alternative funding opportunities that those lenders have. This would require the CEFC to provide appropriate mezzanine funding instruments that:

   - Reduce the repayment risk to commercial lenders; and
   - Improve the certainty for commercial lenders on early stage cashflow for interest and principal repayments.

5. *What experiences have firms in the clean energy sector had with trying to obtain finance; have term, cost or availability of funds been the inhibitor?*

   Commercial lenders require IRR and simple payback returns which are difficult for early stage products to achieve because capital costs are higher in low volumes. Many products get trapped in a 'Catch 22': they need to expand production to drive down unit costs; but to expand production they need demand, which only comes with lower prices.

Clean energy products have a high need for working capital – they are different to software or other IT companies:

"In energy, the risk is in the scale up, not the R&D, and the end application is so massive, so capital intensive, and so utterly dependent on commodity prices, that you can't invest in it like you invest in IT. It takes longer, 10x as much money, and the ante up to play the game for one project is the size of your largest fund. At scale, there is no capital efficient strategy in energy."[18]

6. *What non-financial factors inhibit clean energy projects?*

Energy market failures

There is a range of market failures which hinders the uptake of clean energy innovation in general and demand side participation or small scale generation in particular.

These market failures have been documented in many reviews and reports over several years, for example the Garnaut Review reports in 2008[19] and the update reports in 2011.

For instance, the 2011 Garnaut Review Update Paper 7: *Low emissions technology and the innovation challenge* includes a section on market failures in demonstration and commercialisation, which notes that "*the primary market failure at the demonstration and commercialisation phase is one of spillovers*".

The 2010 Per Capita report on *Distributed Gas-Fired Power Generation* documents the following market failures[20]:

- Barriers to entry for new producers
- Distorted electricity pricing structures
- Information gaps
- Subsidies to existing producers
- Failures to capture externalities.

More specifically, the relevant market failures include:

- Barriers to participation in the energy market:
  - It is impractical for individual consumers (homeowners or businesses) to try to participate in the energy market by negotiating individual deals with incumbent gen-tailers.
  - This barrier to entry means the benefits of demand side participation – which includes small scale *generation* as well as reducing consumption – are not captured.

- Externalities: The current regulatory and pricing system does not fully account for;
  - Negative externalities of the current system of generating, transmitting and consuming electricity (eg the incentives of the distribution businesses to over-invest in supply-side solutions; the inefficiency of building capacity to cope for peak demand occurring for only a few days per year; the true cost of consumers' peak demand does not flow through into retail pricing – eg there is no cost penalty to homeowners who install inefficient air-conditioners, which drives up distribution investment) or

[18] http://www.cleantechblog.com/2008/10/cleantech-venture-capitalists-beware.html

[19] Including a separate report by MMA on *NEM Market Failures and Governance Barriers for New Technologies*, 1 July 2008 (link here)

[20] http://www.percapita.org.au/_dbase_upl/Energy%20Market%20Design.pdf

- Positive externalities of small scale embedded generation and other forms of demand side participation (eg the public good of generating low emission power close to where it is used with far less strain on the transmission and distribution system).

- Pricing:
    - Caps on retail prices can limit the benefits of on-site generation during peak price periods
    - Lack of a feed in tariff means that small scale distributed generators do not capture all the benefits they deliver to the market. The owner of the generator gets the benefit of the energy used on-site but without a feed in tariff, receives no benefit for the energy exported to the grid.

The structure of the energy market

The business models of incumbent energy retailers and distributors are generally not supportive of clean energy innovation in general (and demand side participation or small scale generation in particular).

The major electricity retailers are also generators. The 'gentailers' have large centralised generation assets to protect. Their business models do not support demand side participation. Secondly, the retailers make money by selling more electricity: they have not introduced business models which make them more money by selling fewer electrons.

The distributor business models are not supportive of demand side participation. As has been widely recorded in many other reviews, the distributors have a strong incentive to maximise their investment in supply-side solutions.

For example, the following extracts are from the Garnaut Review's *Update Paper 8: Transforming the electricity sector*[21]*:*

> *Co-generating electricity uses thermal energy which would otherwise go to waste. Gas-fired co-generation, for example, has large thermodynamic advantages over burning gas for heat alone. Electricity prices that embody the cost of carbon will allow the environmental benefit of this to be internalised. However, producing downstream electricity through distributed generation has other advantages which are hard for the distributed generator proponent to capture, such as the avoidance of network expenditure if the output of the distributed generator is correlated with the demand peak.*
>
> *Greater commercialisation of existing demand-side technologies and practices can only come about when they are considered as a normal part of network company business.*
>
> *As discussed in this section, there are numerous signs of excessive investment in regulated network infrastructure assets. Correcting any over-investment will offer not only lower, and more efficient, prices for consumers, but will also reduce the current conflict between the desire to over-invest in one's own assets, and connecting and contracting with distributed generation. When the network company can profit from investing less rather than more, then it will seek ways to foster distributed generation and to set economically efficient tariffs.*

[21] http://www.garnautreview.org.au/update-2011/update-papers/up8-transforming-the-electricity-sector.html#t5 (emphasis added)