Wizard Power™
Delivering Solar Energy 24*7

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The Committee Secretary
House of Representatives Standing Committee on Industry and Resources
PO Box 6021
Parliament House
Canberra, ACT

By email: ir.reps@aph.qov.au

Dear Sir

CASE STUDY INTO RENEWABLE ENERGY SECTORS IN AUSTRALIA

Wizard Power Pty Limited welcomes the opportunity to provide a submission to the Committee's case study examining the relative state of development of selected renewable energy sectors in Australia, namely solar, wave, tidal, geothermal, wind, bioenergy and hydrogen.

Wizard Power Pty Limited is an Australian company headquartered in Canberra in the Australian Capital Territory. Our mission is to deliver competitive renewable energy to the nation through integrated solar solutions that combine multi-megawatt solar energy collection and storage systems with industrial, domestic and agricultural end-use technologies.

At the heart of Wizard Power's solution portfolio is the exclusive technology licensing agreement and working arrangement with the Australian National University's (ANU) Solar Thermal Group. The licensed technology includes:

- The 'Big Dish' solar thermal concentrator. The Big Dish is the world's largest high-performance paraboloidal dish solar concentrator system; and
- The unique Ammonia-Dissociation thermochemical energy storage system which enables efficient large scale storage of solar energy.

Together, these technologies enable the delivery of multi-megawatt, zero emission and dispatchable power for baseload and power on-demand applications. Typical applications for this technology include electricity generation, minerals and chemical processing, delivering industrial process heat, and the production of hydrogen and hydrogen based fuels using thermochemical processes.

Concentrating Solar Power Technology and Market Overview

In its 2004 Survey of Energy Resources[1], the World Energy Council estimates that the annual solar radiation reaching the earth is almost 9 times greater than the total non-renewable energy resources (oil, gas, coal, uranium) available for exploitation. Another view of this statistic is that in one hour, the amount of sunlight falling upon the earth is close to the total energy used by the world's population in one year.

[1] World Energy Council, 2004 Survey of Energy Resources, available from http://www.worldenergy.org/wec-geis/publications/default/launches/ser04/ser04.asp

Wizard Power Pty Ltd
GPO Box 2700 ACN 008 636 495
CANBERRA ACT 2601
Australia

Wizard Building
15 Barry Drive
TURNER ACT 2612
AUSTRALIA

Telephone: +612 62 750 750
Facsimile: +612 62 750 777
Email: SolarSolutions@wizardpower.com.au
Home Page: www.wizardpower.com.au

The Australian continent has the highest average amount of solar radiation per square metre per year of any continent on the planet, ranging from 1500-1900 kWh/m^2/year. If it can be harnessed effectively, then by any reckoning, this vast quantity of perpetually reliable, sustainable and emission free energy is a strategic resource for Australia.

Common experience tells us that the sun is not always available due to the diurnal cycle, weather conditions and other events. This experience of the earth's natural cycles has led most people to an erroneous belief that, despite the vastness of the resource, solar energy is not suitable to the provision of reliable and large-scale baseload or on-demand power 'at the flick of a switch'.

Concentrating Solar Power (CSP) technology is a proven way of delivering multi-megawatt power systems that are capable of generating reliable dispatchable power.

Wizard Power's Big Dish solar thermal concentrator is an example of a CSP system. CSP uses mirrors to intercept, reflect and concentrate sunlight to produce a high temperature energy source that can be used to produce electrical power and drive chemical reactions. There are three basic types of CSP technology - dishes, troughs and tower systems. These clean energy technologies are appropriate for Sunbelt applications where direct solar radiation is high. Australia has a small but highly expert and world leading group of researchers, business people and commercial organisations in each area.

The first commercial CSP plants have been in operation in California since the mid-1980s, providing 354 MW_e of the world's lowest-cost solar power with a Levelised Energy Cost (LEC) between $US0.12 - $US0.15 per kWh_e. The plants range from 30MW_e to 80MW_e capacity and operate at more than 94% availability, a peak efficiency of more than 30% and an average of 20% solar-to-net electrical efficiency under good solar conditions. These plants deliver dispatchable power by using natural gas fired boiler backup to offset poor solar conditions[2].

The United States Department of Energy (DoE) has set a goal to install 1 Gigawatt (GW_e) of new CSP systems in the south-western United States as part of a '7 GW by 2015' renewable energy initiative. The DoE has estimated that this level of deployment could reduce CSP electricity costs to $US0.07 per kWh_e due to economies of scale in manufacturing and operations. In 2006 a 1MW_e plant was commissioned in Arizona and a 64MW_e plant was commissioned in Nevada in March 2007.

SolarPaces[3], an international cooperative organisation established under the auspices of the International Energy Agency, is promoting the Concentrating Solar Power Global Market Initiative. The initiative's overall goal is to deploy 5 GW_e of CSP globally by 2015. In May 2007, a 11MW_e CSP plant was commissioned near Seville in Spain and another 700MW_e is currently under construction in that country. CSP projects are in various stages of development in China, North Africa, the Middle East, India and Australia[4].

Based upon a worldwide recognition of the value of zero emission dispatchable power, Figure 1 shows the World Bank's assessment of the potential for global growth of CSP[4].

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[2] See National Renewable Energy Laboratory (US), http://www.nrel.gov/csp/

[3] See SolarPACES, http://www.solarpaces.org/

[4] World Bank GEF (2006), Assessment of the World Bank/GEF Strategy for the Market Development of Concentrating Solar Thermal Power.

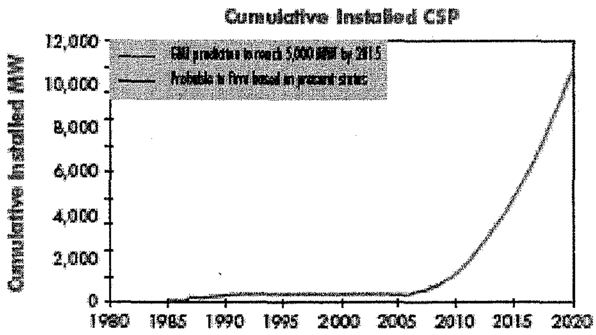

Figure 1 - World Bank Assessment of Potential CSP Cumulative Installed Capacity

The 2006 *Uranium Mining, Processing and Nuclear Energy Review* looked at the estimated levelised costs of different energy technologies. An adapted graph of this analysis is shown in Figure 2. Solar thermal (i.e. CSP) power (in green bar on left side / middle) is within the estimated cost range of nuclear power and fossil fuels with Carbon Capture and Storage (CCS) included.

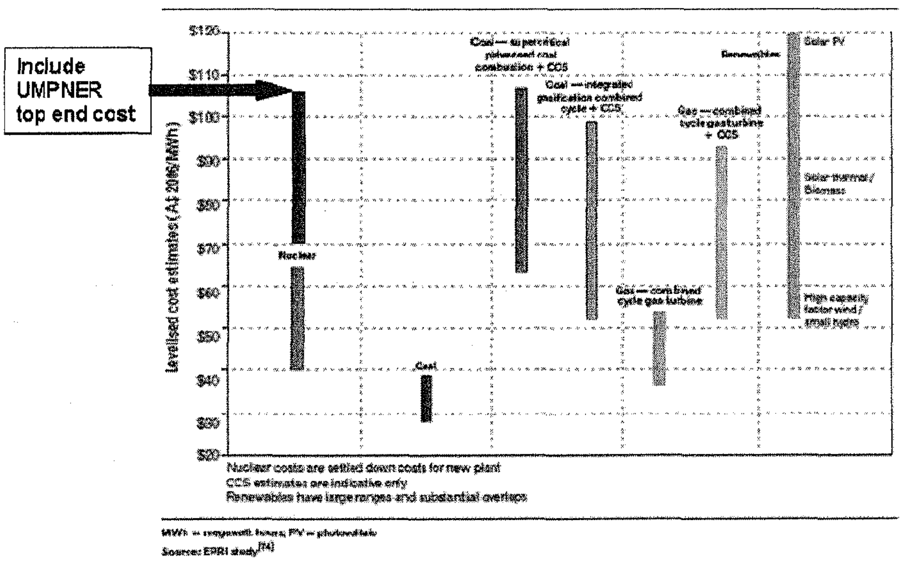

Figure 2 - Levelised Energy Cost Ranges for Various Technologies[5]

An Overview of Wizard Power's Technology

The Big Dish

Solar Thermal research and development began at the Australian National University (ANU) in 1971. This work lead to the design and construction of a 400m^2 paraboloidal dish concentrator prototype in 1994, which remains fully operational today. This system is the world's largest high performance dish solar concentrator by a factor of nearly three. Built using space-frame technology, the dish structure

[5] Department of Prime Minister and Cabinet (2006), Uranium Mining, Processing and Nuclear Energy Review. Note: the upper level costs for nuclear power identified by the EPRI study have been added to the figure.

weighs 19 tonnes, the foundations weigh 50 tonnes. Maximum achievable temperatures are over 1200°C, however this dish is configured to super heat steam to 500°C at a pressure of about 5MPa. This temperature and pressure combination is typical of the operating conditions of steam turbines used in coal fired power plants. It delivers 320kW of thermal power as a feed into a steam engine.

The technology was licensed to Wizard Power in 2005. The next generation of Big Dish technology is under development and will be ready for deployment in 2008. The next-gen dish will be 25% larger at $500m^2$, it will include improved mirror technology and be optimised for mass production and rapid deployment in order to deliver competitive power. It will also be capable of generating temperatures approaching 2000°C. The potential of Big Dishes was recognised by the Australian Government with a grant of $3.5M, under the Renewable Energy Development Initiative, towards the $7.0M next-gen dish development project. This work also includes R&D into solar gasification of biomass and coal.

A direct steam generation solar thermal power station would consist of multiple dishes with steam lines joined to a central steam turbine generating power with about 8 - 10 dishes per MW_e (depending on the solar resource). The steam temperature and pressure of a dish array can be matched to the operating conditions of any steam turbine, including state-of-the-art supercritical steam turbines. This also means that Big Dishes can be integrated with coal fired plants to provide a supplementary steam feed and thereby lower greenhouse emissions from that plant. Another application of dishes is to take lower temperature steam from sources like cogeneration plants, geothermal fields, lower temperature CSP technology, and to super heat that steam in order to deliver a large increase in turbine efficiency.

24 hour Solar Power Production

The high-temperatures generated by dishes are ideal for powering a large range of thermochemical reactions. The Solar Thermal Group at the ANU has been working for over two decades on a system for dissociating ammonia with concentrated solar energy so that the products can be stored and recycled through a conventional ammonia synthesis converter to achieve 24-hour power production. This technology was also licensed to Wizard Power in 2005.

It is a closed loop system that continuously recycles the ammonia and does not need any replenishment. The stored solar energy can be used instantaneously or remain in storage for any period of time without energy losses at the point of storage. The energy can be recovered on-demand, at any time of day or night and regardless of weather conditions. The recovered solar energy is used to superheat steam for powering a steam turbine. The system is suitable for high capacity storage. For example 1,500 tonnes of ammonia dissociation / synthesis per day will deliver about $10MW_e$ baseload power over 24 hours. Such a synthesis reactor is a standard 'off-the-shelf' product used in the ammonia manufacturing industry.

A prototype was built at the ANU in 1998 and was first demonstrated to deliver continuous power over 24 hrs in 2000. In May 2007, the potential of the ammonia solar energy storage concept was recognised by the Australian Government with a announcement of the intent to grant $7.4M, under the Advanced Electricity Storage Technology Programme, towards a $14.4M demonstration project to be built in Whyalla South Australia. This will be a world first demonstration of a multiple dish plant fully integrated with the ammonia solar energy store and a power block to generate 24 hour power.

The ammonia system is expected to be ready for commercial deployment in 2009.

Solar Gasification for Hydrogen and Liquid Fuels

The temperature and pressure of steam delivered by Big Dishes is suitable for powering thermochemical gasification reactions for producing high value fuels. Examples of this approach include:

- Solar gasification of carbonaceous materials, like coal and biomass, can provide high value fuels, with an energy content that is around 30% attributable to the direct solar input. As well as this energy increase, gaseous fuels can be the feed-stocks for synthesis of transport fuels, like methanol, or can be used in high efficiency conversion processes such as fuel cells or combined cycle power plants. Wizard Power is currently undertaking R&D in this area.

  The process is similar to the gasification of coal in proposed 'clean coal' Integrated Gasification Combined Cycle (IGCC) plants. The key difference is that solar power rather than coal combustion is used for the heat used in gasification;
- In the future, fuels will be made from the thermochemical splitting of water to produce hydrogen and hydrogen-based liquid fuels like ammonia. As carbonaceous feed stock is not used in this approach, then it results in the elimination of carbon from the fuel cycle altogether. This area is a future focus of R&D for Wizard Power.

In Conclusion

Australia is a world-leader in Concentrating Solar Power research and development. A national strategy that encompasses the CSP industry, power generators, power users and Governments has the potential to establish Australia as a world leader in commercialising CSP for domestic application and the development of export markets.

The key benefits of such a strategic approach include:

- The delivery of reliable, multi-megawatt and emission free dispatchable power on a 24 x 7 basis;
- The development of an export industry based on Australian CSP technology and services;
- The development of an export industry based on the next generation of high-value and low emission fuels by value-adding coal, through solar gasification, to produce hydrogen based fuels.

  In the long term to progress to also produce fuels from biomass gasification and eventually the thermochemical splitting of water.

Concentrating Solar Power has an important role to play as a part of Australia's energy mix. This technology can underpin a strategy that adds value to our vast reserves of coal, whilst also enabling an economic and social transition strategy to a low carbon future.

I thank you again for the opportunity to contribute to the enquiry. We are at your disposal should you require any further information

Yours Sincerely

A. Zawadski

Artur Zawadski
Manager, Business Development & Project Delivery
Wizard Power Pty Limited