Submission

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INQUIRY INTO THE ECONOMICS OF ENERGY GENERATION

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Summary

PARLIAMENT OF NEW SOUTH WALES

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INQUIRY INTO ECONOMICS OF ENERGY GENERATION

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- **SUMMARY**

- The opportunity for NSW to have increasing employment and standards of living for its citizens requires the State to expand existing industries and commercial businesses and attract new industry and commerce. The capacity to achieve this objective will only arise if it has reliable, nationally and internationally competitive, (i.e. lower relative cost), grid-supplied electricity tariffs.

  Such is not currently the case, but it was for decades, in the past. The State has increased its electricity cost to levels that now exceed those in the United States, and some other more developed economies, and the carbon tax effect from 1 July 2012 will worsen the position. There is no prospect that NSW can attract any investment from such economies when NSW's electrical energy cost is higher than theirs. Why is it so? It is the cost of **The Energy Mix.**

- The principal reason for high, and uncompetitive costs, is the enforced inclusion in electricity tariffs of the subsidising uneconomic and intermittent forms of primary energy, e.g. wind and solar, forming part of the NSW Greenhouse Gas Abatement Scheme. To attract and hold industry there needs to be competitive and stable pricing, with no place in the electricity tariff for investments which cost more than the currently available and lower cost forms, e.g. coal and gas. While there is a place for solar and wind in selected off-grid applications they have no place in a grid-system. Such sources are intermittently available, are high cost producers and require government decree and subsidisation to attract investment. The fact that they cannot 'follow the load' means they are not a base load power option, and their installed capacity must be matched by the excess provision of 'idling rotating base load generating equipment' to take up supply when the sun is hidden or wind ceases. It is said, and money is being wasted examining, that storage can overcome renewable intermittency. Energy storage would add even further uneconomic investment, and is a meaningless proposition for renewables in a grid-system, adding cost without value.

- The conclusion which arises from the prior paragraph's self-evident truth is that electricity tariffs should not include the costs, over and above those costs of the highest baseload supplier, of any electrical energy production, which would not, without government fiat, occur. These excess politically prescribed costs should be passed direct to all taxpayers, and not be hidden in tariffs, which inhibit investment, growth and employment. Taxpayers can then consider whether they would choose to have such costs, and the schemes prescribing them, imposed. The Pricing Regulator should be required to preclude all claims by any electricity producer for price support over and above those of the highest cost baseload supplier.

- The need is clear. Base-load primary energy sources in NSW comprise coal and gas, both, when converted to electricity 'add value', an economic good which enhances the wealth contribution of the mineral. These sources should be encouraged to meet energy needs for the next 50 years during which time nuclear fission will replace aging coal and high cost gas plant heat sources (gas reflecting international oil pricing) at a lower and even more stable cost. Uranium cost per kWh is about 5% of the total price, compared with coal at 50%. These measures ensure **long term energy security in NSW** and provide the incentive for growth in kWh demand.

- Only a small portion of Australian mineral production has 'value added' within the country, coal and gas to electricity, iron ore to steel, copper to copper ingot, nickel to nickel metal, and alumina to aluminium, all of which are now threatened by the pricing effect of Greenhouse Gas Abatement Schemes and the Carbon Tax on electricity tariffs, thus driving the Australian and NSW economies backward to the 'hewing of wood and a quarrying of minerals', as it they were in the 1800s. NSW will suffer the major loss if all these industries disappear.

- **INTRODUCTION**

According to the Australian Institute of Energy Conference in 2006, the NSW Department of Energy, Utilities & Sustainability reported:

> Total installed domestic capacity in NSW was 12,700MW (excluding any Snowy capacity)
> Interconnector capacity available for importing energy to NSW was around 4,500MW
> Maximum demand ever experienced in NSW was 13,188MW
> The number of hours (in the past five years) demand has exceeded domestic capacity is 74.5 – or less than 0.2 percent of the time
> In the past five years, QNI was at 100 percent capacity only 0.7 percent, Snowy-NSW percent and Directlink less than 0.15 percent of the time

The State had a reasonable balance of internally matching its supply and demand. Since then the increased base-load and peak demand has been largely met by new gas fired stations and upgrades at coal fired stations, and the 'good luck' of a falling rate of, or steady, demand as customers try to conserve electricity use because of significant cost increase of several times inflation. Such demand suppression will, hopefully, not last if economic activity is to be renewed.

Wind and solar have increased installed capacity because of prescribed greenhouse credit requirements, but supply only a tiny proportion of energy at multiples of base-load cost both in their primary installations and the costs to connect them to the grid and provide for their electrical influence on the grid. Provision of such capacity without semblance of balance can lead to the extraordinary position of South Australia, a 'basket case' with energy costs 20% higher than NSW, an installed wind capacity of 1,200 MW, a wind which mostly blows between 3:00 AM and 7:00 AM, and a night-time load of 800 MW!

The Potential for, and barriers to, development of alternative forms of energy generation.

Renewable energy, de facto, excluding hydro, provides its own barrier to any economic scale generation.

For the sake of good order we include:

a) Hydro power, where NSW has access to hydro power in conjunction with Victoria under the Snowy Mountains Hydro-electric Act 1949. The Snowy Scheme and other minor hydro producers are unlikely to increase in capacity and there is negligible additional hydro power potential elsewhere in the State;

b) Minor biomass installed generation capacity exists in the timber and sugar industries and there is potential for other speculative renewables, such as wave and geothermal. Wind and solar and the several speculative sources should not be considered seriously because they all lack sufficient energy density per unit of cost to ever quality for grid supply. The untested are truly research projects, and not grid-power production possibilities. They may have magnificent technical merit but will never have economic merit because of their very low energy density generation capacity versus coal, gas or nuclear. **Best practice in alternative energy generation in other jurisdictions** does alter the fundamentals of their energy conversion inefficiency and economic inadequacy.

c) It has been proposed that CO2 emissions will be assisted by Carbon Capture and Storage (CCS). Very large sums have been spent on CCS research and nothing has been produced which suggests it can be a physical possibility, let alone economic, for fossil fuel

power generation in the NSW in the next 20 years, or ever. It is suggested that CCS will help coal to survive. Putting "lead in the saddle" always crates losers. One should stop wasting money on these dreams.

Long term energy security in NSW

The average life for modern base load plant is 50 years. The NSW base load power system has no alternative, in the next round of large generating units, to install coal or gas to meet competitively priced demand, but followed by the first nuclear power plant in 15 years, given a long-term average expected 2 ½% energy growth and the replacement of obsolete equipment. Coal is postulated as the preferred cost option because of gas's expected pricing relationship to oil pricing. . Candidate plant types for the next phase of fleet addition, in lowest cost priority, could be Integrated Gasification Combined Cycle (IGCC) coal based and Combined Cycle (CC) gas.

Present renewables should be held at their present level; new renewables could be permitted at the investor's risk, absent incentives and subsidies.

The nuclear option is clearly the choice for subsequent increases in base load capacity and particularly if CO2 emission limits are still prevailing as a political exercise. A Commonwealth regulatory framework should be progressed so that the nuclear option is included. Reference is made later in this submission to the nuclear option and in particular, Small Modular Reactors (SMR). A case is presented for the trial of one or more of these reactors for ultimate replacement of part of the coal and gas fleet in the next decade.

The 20% Renewable Energy target will not be achieved by 2020 and, if it were to be, NSW may as well close the doors on industrial activity as no one will be able to afford the electricity tariff if renewable costs are included. Currently there is about 10% of the state's energy generated from renewable sources, including hydro comprising 7%, but consumers are paying for more than 33% at renewable rates for just 3% of wind & solar, due to the surplus of renewable energy certificates issued, mainly resulting from photovoltaic feed in tariff distortions.

Coal sourced energy, while resulting in higher CO2 emissions per unit of energy than gas, is currently a cheaper source of electrical energy allowing for carbon tax imposts. While fossil fuel prices will escalate, coal is not expected to escalate at the same rate as gas, the latter being a far more versatile fuel, subject to international pricing and geared to oil prices. Coal, on the other hand, is still readily available in NSW, in particular higher ash thermal varieties, which without coal preparation resulting in low yield and margin, are not exportable.

The potential for NSW sourcing electrical energy interstate

Interstate sourcing occurs today in the competitive grid system NSW needs to reduce its average generating cost and install new, more efficient plants to reduce its costs and compete with low cost brown-coal sourced energy from Victoria, and competitively priced Queensland surplus kWhs. The level of carbon tax will have distorting effects on pricing, and therefore interstate movement of kWhs.

But why should NSW, an energy rich state, not seek to be better than others, and supply them instead of purchasing from them? It can be done. The coal resources, and developing coal seam gas, infrastructure and distribution are all there awaiting Government support of new installations to encourage bank funding, currently denied, to be provided.

- **THE NUCLEAR OPTION – the main challenge is fear, not the technology**

Nuclear power generation is demonstrably safer technology than coal, oil and gas equivalents In spite of Chernobyl, Three Mile Island and Fukushima. The volume of waste generated in comparison with fossil based fuels is miniscule and can be safely stored on site, initially underwater and then when it has cooled, on the surface. It can be reprocessed and has future value. With the advent of generation IV reactors, the small amount of existing waste will be substantially reduced in volume and potency. Nuclear energy costs are now approaching competitiveness with coal and with increasing standardization are projected to become cheaper than coal, more so when provision is made for a carbon tax.

Fears regarding proliferation are exaggerated in the case of commercial power generation reactors. Nuclear weapons require 90 percent U235 which compares mostly with 6 percent U235 and maximum 30 percent for small commercial reactors. To suggest that terrorists are going to raid an operating reactor, which is radioactively 'hot' to recover low grade plutonium to make a bomb is unbelievably imaginative. If the objective is to make a 'dirty weapon', it would be more effective to follow the germ warfare route. Terrorists can steal nuclear weapons but power station waste fuel rods are not weapons grade.

There is now a re-appraisal to build new nuclear power plants in USA, and the UK is fully committed to new plants. France, the world's largest nuclear power producer, now a €3 billion per annum business, continues with its nuclear program and the export of power to its neighbours. Closer to home, China has a very active nuclear program, with 25 plants under construction. Significantly more are planned with 14 now operating. Its current plan is committed to nuclear as the foundation for its power system, with 200 GWe planned by 2050. It is developing its own technology but has purchased Westinghouse (Toshiba) AP1000 reactors, French technology and the Russian BN 800 fast reactor engineering designs.

South Korea has 23 reactors operating supplying 31% (20.7 GWe) of its current power needs. It plans to have a 60 percent nuclear fleet of 40 units (43 GWe) by 2030. Korea Hydro & Nuclear is currently supplying 4 reactors under a $20 billion contract to UAE. These reactors will replace aging gas units, making the gas available for export.

Hong Kong currently sources, through China Light and Power (TRUEnergy), significant amounts of its electrical energy needs from the 1,880 MWe Chinese nuclear power plant at Daya Bay. Its current 2020 plan is to have 50% nuclear power, sourced from China and 40 percent gas generated from imported LNG with the balance from renewables. Hong Kong power was initially predominantly oil fired.and replaced by coal after the 1970's oil shock. The coal fleet has now been replaced by nuclear, gas and nominal (cosmetic) renewables.

India has 7 operating reactors with 4 under construction and currently 3% of its power is attributed to nuclear with a program to increase to 9%. It is also developing low enriched uranium thorium reactors given its indigenous thorium resource potential.

Vietnam has elected to introduce nuclear into its energy mix and has negotiated with the Russian nuclear provider Rosatom to build their first reactor, commencing in 2014. Thailand and Indonesia are actively considering nuclear power as is Singapore which is focusing on underground SMR's. These do not have the site area requirements of larger utility reactors and can be located closer to load centres which suits Singapore's land constraints.

To the north, many of Australia's other trading partners are committed to establishing significant nuclear power bases. Their objective is to achieve world competitive electrical energy prices. It is becoming clear, that others will take industry and commerce from Australia whilst we continue to prioritize wind and solar, and try to avoid the lowest cost energy from coal and ignore nuclear energy. Our prosperity is clearly threatened, and the Australian community knows it.

The mature thinking of all Asian countries acknowledges the currently lower cost of using coal. Even with the nuclear drive the construction of new coal-fired power stations is proceeding at a rapid rate. Coal demand is increasing at 5% per annum, from which Australia is benefitting. Their program of coal, some gas and then nuclear is precisely the basis our submission.

- **SMALL MODULAR REACTORS (SMR's)**

Small land based reactors have been operating in selected locations like McMurdo Sound in Antarctica since 1962, where a 1.5 MWe reactor, operated for 10 years. More recently over 50 SMR reactor designs have been under development to provide power sources to isolated networks and for applications such as, barge mounted power stations for back-up power at remote locations. SMR technology had its genesis in naval applications and has proved to be exceptionally reliable, with over 50 years of naval operational experience by a number of the world's major navies. It has been proven to have an excellent safety record.

SMR's are reactors sized in the range 10 MWe to 300 MWe and cover a wide range of technologies from the earlier Generation II naval Pressure Water Reactors (PWR) to Generation IV Advanced High

Temperature Liquid Metal (HTLMR) reactors. A number of these reactors is scheduled to be licensed by the Nuclear Regulatory Commission (NRC) by 2013-2014 when they will be available for manufacture.

SMR's are factory manufactured with the reactor and steam generator integrally housed in a containment vessel. The steam turbine power generation plant is external to the reactor steam generation vessel and of traditional engineering design. Augmentation of a conventional power plant may be with a single SMR but in most cases 2 or more reactors would be installed, particularly for isolated stand alone sites where redundancy is a necessity. SMR's are eminently suited to base load power generation and many designs have very good load following characteristics.

While cooling of reactors can be from external circulating water from the sea, rivers or lakes, it is most likely in the Australian setting, that air cooling will be the norm. This form of cooling will reduce thermal efficiency by about 10 percent.

Reactors can be fueled at time of manufacture or fuel canisters shipped separately for installation at site. Fuel is enriched uranium of from 5 to 20 percent and fuel replacement cycles vary from about 5 to 30 years. The longer term, in most cases, being for the life of the plant, which is returned to maker for scrapping, refurbishment and/or upgrade once the fuel is exhausted.

Handling of fuel waste from SMR's entails removal of fuel canisters and storage on site under water for a number of years until the radiometric sourced heat dies down, when the canisters can be safely shipped in standard safety nuclear shielded containers back to the supplier. This is the general procedure adopted by ANSTO for handling waste from the old HIFAR and new OPAL reactors at Lucas heights NSW.

All SMR's are located in reinforced concrete open chambers below ground. Some containment structures are water filled providing a high level of radiation protection and attenuation against seismic forces.

Simplicity of operation is a feature of all new reactor designs. These design rely on convection for circulation of heat transfer medium, without the need for pumps, in addition to passive valve systems eliminating the need for external auxiliary power. Most of the Generation IV SMR's, which will not be licensed for some years, will be 'Fast Reactors' operating at temperatures of $800^{o}C$ and higher, being of increased efficiency and incorporating 'Negative Temperature Reactivity' whereby the reactor automatically goes into shutdown mode when the temperature reaches a critical value. Generation IV Fast reactors will use predominantly plutonium based fuel made from U238 providing at least 60 times more available energy from natural uranium than the current Generation II reactors. This will release much of the U238 in store from past U235 enrichment in addition to reprocessed waste. Progressive development of nuclear technology is therefore leading to more efficient use of natural uranium and less waste with half-life periods of about 300 years. These exciting trends virtually eliminate the waste management issue. The potential upside for substantial improvements in nuclear power generation efficiency, reduction in fuel costs per unit of energy, improved safety and reduced waste in volume and potency will lead to significant future cost reductions. Australia cannot afford to ignore this technology.

The factory manufacture of SMR's will result in shorter construction cycle times and progressive cost reductions due to volume production. It is projected that the first SMRS will require a 3 year construction period which will fall with volume production to 2 years.

It is too early to provide reliable nuclear energy power cost estimates but it is suggested, later in this submission, that government gives serious consideration to trialing an SMR, under the supervision of ANSTO, to establish reliable cost base information and to act as a precursor to the formulation of a Commonwealth Government Regulatory Framework. A trial would cost much less than funding currently committed to photovoltaic and thermal solar projects committed in NSW and Queensland.

Both coal and gas fired power costs have low capital and high fuel cost components. All nuclear reactors including SMR's have high capital cost and low fuel cost components. SMR's are therefore suited for long term applications, i.e. at least 30 years. As the nuclear fuel component is about 5 percent of the total dispatched energy cost, nuclear power is very stable in cost, a factor which will become increasing relevant in countries with dominant nuclear fleets i.e. France.

- **APPLICATION SITING AND COMMERCIAL FACTORS FOR SMR'S**

  It is envisaged that the most likely applications for SMR sourced power in NSW would be resource projects both mining and the processing of mineral concentrates. For example, with abundant base load power, not only can one operate a mine but depending on the mineral produce manufacture a refined metal on site, thus circumventing the need to transport concentrate overseas for refining. Electric arc smelting of scrap for mini-steel mill production is also an ideal base load application. Desalination is almost a 'free cost' off-peak option with nuclear.

  With the maturity of plantation timber, the processing and value adding of the product to produce sawn timber, plywood, particle board and kraft paper are possible applications for SMR's. Food processing and abattoirs are potential candidates as would be the integration of an SMR into a major wind farm grid to produce a more customer orientated source of power in a semi isolated location.

  Automated processing supported with cheap decentralized power would make NSW an attractive destination for food processing industries

  SMR power would also be suitable for a stand-alone supply to a new satellite town, military base, ski resort or a location such as Lord Howe Island, although the latter would possibly need a load source such as adesalination plant to maintain optimum load on the SMR. Stable power prices in a new satellite town of say 20,000 inhabitants could be achieved with SMR stand alone power.

  Ideally the location of SMR's would be on an existing or decommissioned power station site where there is likely to be infrastructure which may require refurbishment and possible augmentation. Disused mine sites, plantation forest areas and large grazing (pastoral leases) may also have potential.

  The manufacture and site works engineering for SMR's are subject to very low levels of change during manufacture and construction providing a strong basis for a fixed price contract covering supply, installation and commissioning. Given the size and the precise definition of the scope of work it is envisaged that debt finance would be available for installation of SMR's subject to the financial standing of the proponent.

  It is most likely that Development Consent would require a performance bond to cover decommissioning, plant removal and site rehabilitation, which would in all likelihood be the proponent's responsibility

  The environmental impact for an SMR plant is less obtrusive than an equivalent above ground plant, in view of the relatively small footprint and the substantial containment of the reactor and steam generator underground.

- **ENERGY PLAN STRATEGY AND RECOMMENDATIONS**

  NSW electrical energy usage could triple by 2050. This may seem to be an over optimistic target but given a competitive stable pricing regime for electricity sales, the factors which are most likely to attract industry and stimulate increased electricity usage will be population growth and immigration, industrial development, increase in energy intensive life style such as air conditioning, wide screen television, computers, wine coolers, escalators, rail transport and electric cars and motor scooters.

  Those factors mitigating energy growth will be predominantly improvements in equipment and appliance efficiency, economic green building techniques and new technology. It would be a tragedy if electricity cost excludes growth in the 'value adding' industries, aluminium, steel, copper and nickel refined metal processing.

  The advent of the all electric car and motor scooter have the potential to impact power usage significantly, particularly in urban areas. This technology is projected to grow rapidly should oil prices maintain their current escalation rate. There is a strong likelihood that car and scooter prices will fall with the advent of mass production. The impact on electricity usage will be an increase in off-peak demand for battery re-charging, resulting in a flattening of the demand curve providing improved plant utilisation and a general lowering of generation costs.

The State should, with AEMO's (Australian Energy Market Operator) involvement, draw up a 50 year plan, projecting the future electricity generation mix. The plan should be subject to constant review and be updated every 2 years in the light of technology and electricity demand changes.

As explained in the Introduction to this submission, priority should be given to the addition of high efficiency coal and gas plants, i.e. IGCC and CC plant, to the fleet in the initial 20 year period. The higher efficiency of this plant will reduce the per capita emissions and will be subject to less Carbon Tax.

Pending the preparation of an energy plan along the lines suggested, it is recommended that a hold be placed on further wind and solar developments and attention be directed to coal and possibly some gas expansions at Mt Piper and Bayswater power stations. Concurrent with the augmentation of the two existing fossil power stations Federal Government consideration should be given to a trial of an SMR in the size range 50 to 125 MWe . The trial would be contracted with an accredited nuclear reactor company or joint venture and carried out under the supervision of Australian Nuclear Science and Technology Organisation (ANSTO) at a selected site ref; " Application Siting & Commercial Factors" in this submission. The trial period would be for up to 10 years duration, with provision to continue to say 30 years under commercial terms, incorporating an obligation to remove the facility and rehabilitate the site at the end of the 30 year period. Framework nuclear regulatory legislation would be introduced during the earlier part of the reactor trials and the reactor trial contract would have provision for takeover by the contractor subject to Federal Government regulatory control enactment and acceptance by contracting parties. Any move to introduce an SMR trial as a precursor to acceptance of nuclear energy would have to wait for a change of the Australian government.

Energy development and operating costs are now emerging from developed countries (Germany, UK, Spain, Czechoslavakia, Australia) which demonstrate, quite conclusively, that wind and solar are not providing reliable competitively priced base load power. Nuclear must be considered if we are not to depend solely on fossil fuels and are to provide an attractive manufacturing destination. Our competitors and near neighbours in the Asian and India regions have accepted nuclear as a safe, stable long term source of power and are moving ahead of us in the race. The cost and reliability of nuclear electricity will outstrip other candidate source. Australia and New South Wales must consider this technology in its energy mix. Accidents such as Fukushima may delay the global progress of commercial nuclear energy but will not stop the development and improvements in the technology.