Electricity Reform Task Force
Government of Western Australia

BACKGROUND PAPER NOVEMBER 2001

Submission by BrianJ Fleay
For Robin Chapple MLC

BACKGROUND

Government involvement inevitable

Today electricity is vital to everyday existence. Water supply and sewage systems depend heavily on electric pumping. Communications are electrically driven and increasingly financial and commercial systems through electronic fund transfer and accounting systems. Homes and industry are electrically powered. Economic development and employment are invariably affected by electric power availability and cost. Electric power systems are capital intensive with assets lives of up to 50 years and there are significant environmental consequences in the production, distribution and use of electricity.

State governments compete vigorously in a 'race to the bottom' to attract commercial investment and economic growth by offering all manner of concessions and subsidies, including for electric power. They are equally apprehensive about giving up or sharing the power to do so, fearing decline and unemployment.. The tendency for governments to behave in this way has increased as tariff protection of local industry has been reduced in the name of free trade and international competitiveness. Significant electric power failures become major political and economic crises.

Consequently state governments are reluctant to forgo any control they have over power supply whether by privatisation, sharing of authority or what they perceive to be too much public scrutiny that might limit their freedom to act.

These circumstances, among others, have led to a series of poor investments, capacity over supply and poor fuel choice in Australia's electric power utilities. In eastern states there has been a failure to exploit the advantages of interstate transmission connections. Cross-subsidies between customers through uniform tariffs, mostly for the benefit of rural and regional customers, have inhibited the pursuit of energy efficiency and renewable energy where it can be most cost effective.

In the 1980s these problems reached extreme heights in NSW and Victoria after massive over-investment in power stations to service a boom in aluminium smelters that subsequently petered out. For example, Victorian power supply subsidies to ALCOA for an aluminium smelter at Portland amount to $190-200 million per year.

There were similar but lesser problems in other states. In Western Australia these were associated with a large take-or-pay contract for natural gas with Woodside Petroleum to make the NW Shelf gas project viable, with similar but lesser contracts for coal and controversy over a new power station and the appropriate fuel. By 1993 the then State Electricity Commission had borrowed $300 million to pay for gas from Woodside Petroleum that it could not immediately use or on-sell, after borrowing $1000 million dollars in the early 1980s to build the Dampier Bunbury Natural Gas Pipeline.

Therefore governments will always be heavily involved in electric power supply. They can be held to ransom by vested interests and monopoly power in a power supply crisis.

The Commonwealth initiated an Industries Assistance Commission inquiry into these extravagances, leading by the mid-1990's to Competition Policy, reform of the Trade Practices Act and formation of the Australian

Consumer and Competition Commission (ACCC). One aim was to facilitate the end of vertical integration of the electric power industry and introduce competitive markets. This happened while the belief was growing in business and political circles around the world that 'free' markets and competition with minimal government involvement would lead to superior investment decisions and favourable social and environmental outcomes. This still prevailing ethos maintains 'markets' make sound decisions, governments do not – hence the less government is involved the better! The theory under-pinning this ethos is embodied in so-called rational economics, or neo-classical economics.

Jeff Kennett's government led the way by privatising Victoria's electric power industry, following Margaret Thatcher's UK example of the late 1980s. The initial concepts had some merit with a customer focus, respect and understanding of the relevance of the technical characteristics of the industry.

However, as the reforms proceeded the eagerness of treasury to collect billions of dollars from assets sales prevailed, as did ideology and the related utopian views of economists who enthusiastically intervened in the design of markets. They all glossed over the unique technical features of electricity that MUST be taken into account in the structure of an efficient electric power market (see below). Their haste and greed, plus the resistance of vested interests, state rivalry and Kennett Government arrogance has led to poor regulation and a complex rule book in eastern Australia that few understand. The cumbersome system has scant regard for the customer. There is no direct opportunity for consumers to contract directly with generators for power.

This original UK system where privatised generators sell in to a central power pool for on-sale to electricity distribution companies has created a system where generators in particular can and do readily manipulate the market in their self-interest. While productivity has apparently improved the benefits have gone to the companies, their senior executives, consultants and financial service companies. Privatisation has led to foreign ownership of Victoria's once publicly owned power systems. Electricity charges for most consumers have gone up. Profits now go overseas.

The background to this and the outcomes are well described in Dr Robert Booth's book, *Warring Tribes: The Story of Power Development in Australia* (www.bardak.com.au). See also papers by Booth on this website.

How do electricity's technical characteristics shape emerging power markets?

Firstly, electricity cannot be stored, it must be consumed the instant it is generated. And at all times some 20% of excess generating capacity is needed as a contingency against power station failure. Supply reliability requires redundancy in generation and transmission capacity. Daily and seasonal consumption variations mean *some generators only operate for a few hours each day or year.* High capital, low fuel cost generators are favoured for base load, whereas low capital high fuel cost generators are preferred for short-term peaking purposes – unit production costs from the latter are usually high. In Australia this has translated to large coal fired plants for base load and hydro or gas turbines for intermediate and peak power. Renewable energy, end-use energy efficiency and demand management have yet to find their proper place in this supply spectrum.

Secondly, the rotational speed and load on all generators must be tightly controlled at the generator. Power flow in the transmission system must be controlled by centralised automatic control systems that maintain a balanced system load between generators and transmission lines and a constant 50Hz frequency, while minimising transmission power losses.

Thirdly, the whole alternating current system must be operated to avert transmission system electromagnetic influences - capacitance and impedance effects that can impede the flow of electricity, lead to instability and system failure. This requires some customers to install equipment to correct power factors, and some to be installed and controlled by system operators in the transmission and distribution systems.

Fourthly, large systems must be designed, operated and monitored centrally in ways that prevent unstable power oscillations developing that can lead to cascading system failures. Reliable supply and centralised on-line fine control of supply voltage, frequency and power factor are essential with instantaneous response to system failures. The latter issues have significantly increased in importance with the growth of information technology which is making extreme demands on supply quality and reliability. The bigger the supply network the more critical this aspect becomes. Another factor that gives generators market leverage.

Electric power systems are intrinsically unstable. Constant effort is needed to keep the instability within acceptable bounds. Successful operation is technically sophisticated, becoming more so, and requires a continuous high level of networking, co-operation, technical skill and discipline by all parties. Too much competition can have an adverse impact on system performance.

The UK market model for electric power

The UK power pool market model was adopted by Victoria and a version of it is becoming the eastern seaboard model (Booth 2000).

There are separate generator companies, transmission and retail distribution companies with no direct contracts between generators and consumers. The generators sell power to a central wholesale pool for on-sale via the high voltage transmission system to distribution companies. The pool manager invites generators to bid prices 24 hours ahead to supply defined power demands in half hour segments. *For any segment all generators get paid the price of the last bid that achieves the defined power demand – the so-called marginal supply cost.*

In practice generators can, and do, easily manipulate supply to boost prices under this system, a practice reinforced by the fact that the electricity must be consumed the instant it is generated and by the other system characteristics outlined above. Even small generators can have exceptional market power in these circumstances. *These tendencies are also inherent in economists conventional market models (see below).*

There have been efficiency improvements and cost reductions at power stations and in transmission, but the benefits have not gone to the customers, as everyone was led to believe. The market is supervised by government regulators.

One consequence of this focus on a daily market in the UK model, in the absence of adequate supplementary provisions, has been neglect of investment in new peak demand generation capacity and transmission capacity which requires large investments over a two year time-frame for gas turbines and five years for coal fired plant. This is the principal reason why power shortages could occur during 2001-2 summer peak demand in Victoria and South Australia (air conditioning load), as reserve capacity is eroded.

In Victoria the market and initial price structures favoured a significantly higher-than-average rate of return on investment on privatised components of the SECV and buyers paid an inflated price to government for these assets, in part why the five retail utilities have asked regulators for price rises of up to 18% from January. As reserve capacity has shrunk generators have been able to exploit the situation to push up wholesale prices (Booth 2001).

Flaws in neo-classical economic theory

Some economists have examined the theoretical relationships between short-run marginal costs (fuel and power losses) and long-run marginal costs (all costs including a return on investment) for the operation of electric supply systems (Booth 2000). *Conventional economic theory claims when such an equilibrium is* *reached, we have the most efficient market outcome, when multiple decisions made in the short-term lead to the most desirable long-term result.*

They found that short-run and long-run marginal costs only match up when a number of highly specific conditions are met. These include:

- the electricity system is perfectly balanced, always just the right amount of reserve plant – this can never be the case with capacity added in large increments, even if it were possible to know what was the perfect balance;
- there is no delay in installing new capacity – implies adding or subtracting capacity in small increments *with no delay* and knowing precisely what is required – an impossible task;
- an infinite number of participants produce electricity from a perfectly optimum mix of plant, such that the lowest cost of electricity was always obtained – implies a large number of small plants without market leverage;
- electricity is sold at every hour of the year at the short-run marginal cost of the last plant to be loaded to meet demand; plus
- electricity sold at peak times is charged, in addition to the short-run marginal cost, a marginal capacity cost corresponding to the lowest cost of providing peaking capacity on the system.

Also that all market participants have all the information needed past, present and future, to make rational choices – almost *divine* knowledge. The smaller customers are at a disadvantage here. This condition suggests limiting the right to commercial confidentiality, among other issues.

These are utopian conditions that can never be met, especially in Australia where:

- the number of power stations is small and unit sizes are large;
- major load centres are widely spaced and far from power plants with extensive low load regional distribution systems in between;
- consequently there are not strongly meshed transmission systems;
- except in Victoria, power plants are mostly owned by state governments;
- construction lead times are long, not instantaneous; and
- plant mix may vary widely from the optimum for long periods.

Furthermore, market participants need an overwhelming amount of information to make the rational decisions called for by economic theory. These departures from the 'ideal' also provide opportunities for market manipulation, especially under the UK market model.

Different views and assumptions on depreciation provision for capital intensive service utilities with long-life assets can have a significant bearing on costs, rate of return on assets, and therefore prices.

Financial rate of return, on assets as *the prime performance criteria* for corporations is a concept at the heart of neo-classical economics. It is an inadequate basis for service utilities generally, including for electric power. There are inherent uncertainties in assessing the provision for depreciation in the accounts due to the long lives of assets and their capital intensive nature that make rate of return an unreliable and even dangerous primary indicator of overall performance.

This issue has been analysed for the water utility industry by Christopher Sheil (2000) in *Water's Fall: Running the risks with economic rationalism,* He argues that such an approach in the water utility industry *necessarily* leads over time to failure of the supply system.

He illustrates his case by analysing the failure of a sewage treatment works in Adelaide in 1997 that led to Adelaide being engulfed in a '"Big Pong" for three months, and the circumstances leading to Sydney's "boil water" episodes in 1998. Both crises arose, he says, because of the single-minded focus on "the financial bottom line" leading to the neglect of critical public interest and ecological issues in such an essential capital intensive industry.

The key argument centres around the wide variation possible for depreciation provision arising from the high replacement cost and long life of many water utility assets – well in excess of 100 years for many pipelines and dams. Sound reasons can be argued for these variations. One-third of the WA Water Corporation's revenue is allocated to depreciation. In these circumstances, when depreciation is applied to the accounts, it can lead to the 'bottom line' being either a horrendous loss or an outrageous profit! There is a very weak connection between the published rate of return on assets and the productivity of the corporation and the health of its assets. There is scope for maintaining the appearance of a physically and financially 'healthy' performance when in fact the assets may be deteriorating.

Furthermore, these assets consist of a range of interdependent sub-systems with varying lives and value and differing rates of return. Some have very low or negative returns, such as catchment management and scientific services to monitor water quality from catchment to kitchen tap. Likewise for community service obligations (CSO) imposed by government. Sheil argues that the 'self-interested manager pursuing a rate of return maximising agenda' would give priority to the high rate of return sub-systems and neglect the others, which he says happened in Sydney for its catchments and scientific services, leading to the supply failure. The subsequent Inquiry into the Sydney incident dramatically describes the height of the crisis leading up to the "boil water" orders and the subsequent 'meltdown' of Sydney Water's senior management unable to reconcile a primary focus on rate of return with their community and environmental obligations. Also there is an incentive for the manager to argue that low rate of return sub-systems are in fact CSOs and therefore the financial responsibility of government.

Sheil argues, that for these reasons, the corporatisation/privatisation model is not appropriate for water utilities and leads NECESSARILY to a system failure over time, crises that can hold governments to ransom. Nevertheless, he says reform is needed, and one would agree. It is never easy to get the agenda for a large utility right, It requires continual hard work and not all the reforms associated with the corporatisationprivatisation model are wrong.

A 'triple bottom line' approach is *necessary* integrating for the long-term social, financial and environmental objectives.

Sheil believes similar conclusions could also be applicable to the energy and communications industries. However, such a conclusion could only be confirmed after specific study of these industries taking account of their specific features and historical development.

Both the UK and California have abandoned the compulsory power pool approach for electric power systems – the latter only after the three major utilities incurred debts of US$14 billion during 2000-01. High peak demand growth, erosion of reserve generation capacity (mostly gas powered) plus an unexpected natural gas supply shortage in North America (see discussion below) were responsible. A transitional retail distribution price cap as part of the reform agenda and manipulation of the market by generators amplified the crisis. One major utility has filed for bankruptcy and the State of California spent several billion dollars in 2001 purchasing electricity from generators so the utilities could maintain supply! The taxpayers and customers were held to ransom. Booth (2001a) summarises the Californian power crisis.

It is not possible for an electric utility to close down because of bankruptcy! The power pool approach is fatally flawed.

Given this background the states have good reason to be wary of radical change.

It is inevitable eastern Australia will abandon the UK power pool system for ones that permit direct supply contracts between generators and consumers of electricity with residual trading to meet the uncertainties of supply variations. This approach is used successfully in Scandinavia, and elsewhere in Europe and should be adapted to our circumstances, respecting the unique physical characteristics of our electric power systems.

Utopian economists with their over-emphasis on the universal virtues of competitive markets need to be kept at arms length.

The flaws and limitations of conventional economics

An examination of some of the deficiencies of neo-classical economics will add even more weight to the above discussion and is necessary before exploring options for electricity markets in Western Australia.

Since the mid-1960's there have been numerous critics of economic theory that challenge the validity of its market models, the mathematics employed, the assumptions made, hedonistic human behaviour models and other facets upon which the edifice is based. There is hardly any facet of economic theory that has not been found seriously deficient to a significant and even fundamental degree.

The totality of the criticisms is devastating.

The comments below are based on the book *Debunking Economics: The Naked Emperor of the Social Sciences,* Steve Keen (2001). Not all the issues he raises will be covered. We will focus on static versus dynamic models and equilibrium theory as discussed in his chapter 8. *The core ideological beliefs of economists are tied up in these concepts.*

Keen does not address the serious failure of economists to give energy the central position in economics that it deserves, a subject also discussed below.

Economic theory in general ignores processes which take time to occur – like building power stations. Instead economists assume that everything occurs in equilibrium – implying that only negative feedback applies. This requires that the dynamic processes of a market economy be stable, yet it has been known for over 40 years that those processes are unstable; that a small divergence from equilibrium will *not* set up forces which return the system to equilibrium, there are positive feedback processes at work as well. The dynamic path of the economy cannot be ignored.

Economic processes do take time, yet economists do not consider time in analysing demand, supply or any other key variables. The quantity demanded of a commodity and the quantity supplied are both treated as functions only of price, and that the outcome is an equilibrium state, the 'efficient' outcome. This is done by comparing 'static' situations in terms of their impact upon consumer welfare, etc. The time path from one such static equilibrium state to another is ignored. Economists believe this to be a short-term, transitory phenomenon that leads to equilibrium. As a result, time itself, the change in variables over time, and disequilibrium situations are all ignored. Yet disequilibrium is the normal state. We live in a changing and so far growing economy and should be concerned with the *rates of change* of both demand and supply, not just their absolute levels.

This obsession with equilibrium has imposed enormous costs on economics – and on everyone else as well. A shift to non-equilibrium analysis would not only be more relevant, it would be even easier.

The static equilibrium approach fails in several ways.

Firstly, unreal assumptions are needed to maintain conditions under which there will be a unique 'optimal' equilibrium. Some of these were outlined above for electric power systems.

Secondly, even the unreal assumptions of general equilibrium theory are insufficient to save it from irrelevance, since even the model of equilibrium has been shown to be unstable, so that no modelled or real economy could ever be in a state of equilibrium – see discussion below.

Thirdly, the emphasis on modelling everything as a static equilibrium phenomenon has isolated economics from most if not all other sciences, where dynamics – and in particular evolutionary analysis – is now dominant. This means isolation from the resources of the other disciplines. Economists are now virtually the only 'scientists' who attempt to model a real world system using static equilibrium tools. *In fact, modern research in mathematics, physics, biology and many other disciplines has shown that dynamic analysis leads to results that contradict those of static analysis!*

The modern discipline is known colloquially as 'chaos theory' which has established that the equilibrium of a real-world system can be unstable without the system itself breaking down. The operation of electric power supply systems would be an example.

So-called chaos theory is an aspect of the thermodynamics of open non-linear systems far-from-equilibrium. Open systems are ones able to exchange energy and matter with the environment in which they are embedded. The theory arises from powerful new insights into the operation of the second law of thermodynamics in such systems (Prigogine & Stengers 1984, Prigogine 1996). Such systems can have a capacity to 'self-organise' by dissipating energy, a concept that includes biological, social and economic systems (Jantsch 1980).

Economists attach importance to mathematical models - econometrics. What static analysis means in technical terms is that the equations most neo-classical economists (and many unorthodox economists) use in their mathematical models are 'algebraic' rather than 'differential'. Most of the equations use only straight line relationships rather than more complicated shapes like parabolas etc. Algebraic techniques with these equations scale indefinitely – you can have equations with hundreds of 'straight lines' and still get unique solutions.

Differential equations (a part of the mathematics of calculus), on the other hand, are more complicated and are expressed in terms of rates of change of X and rates of change of Y. Differential equations deal with 'the rate of change of Y with respect to itself, other variables and time. Straight line relationships in differential equation models with unstable eqilibria lead to ultimately absurd outcomes, such as negative prices, or cycles which approach infinite amplitude as time goes on. Non-linear relationships, however, result in bounded behaviour; the forces which repel the system when it is close to equilibrium are eventually overwhelmed by attractive forces when the system is substantially distant from equilibrium. Once there are more than two variables in a system of non-linear differential equations, there is in fact *no solution available by analysis alone.* Such systems must be simulated to see what is actually going on which modern computers are capable of doing. *These systems are inherently unstable.*

There are four lessons for economics in this model.

Firstly, a system with unstable equilibria doesn't have to 'break down'. Instead, such a system *can* display complex cyclical behaviour and is closer to the real world. An example would be volatile price in the UK common pool model for electric power markets.

Secondly, if the equilibria of a model are unstable, then neither the initial nor the final position of the model will be equilibrium positions. The economic belief that dynamic analysis simply plots the movement between one static equilibrium and another is therefore *wrong*. Even simple economic models will display 'far from equilibrium' behaviour.

Rather than equilibrium being where the action is, equilibrium tells you where the model will never be. The system cycles around an equilibrium domain.

Thirdly, in extrapolating from models to the real world, actual economic variables are always likely to be in disequilibrium – even in the absence of external shocks which are the economists usual explanation for cycles. The conditions which economists have ‘proven’ to apply at equilibrium will therefore be irrelevant in actual economies.

Static economic analysis cannot be used as a simplified proxy for dynamic analysis.

Finally, even simple systems with just three variables and three constants can display incredibly complex dynamics because the variables are non-linear.

Abandoning static equilibrium analysis does not mean abandoning the ability to say meaningful things about the economy. *What has to be abandoned is the economic obsession with achieving some optimal outcome*. The real question is whether we can control such an unstable system – whether we can constrain its instability within acceptable bounds *for desired outcomes.*

Which leads to an appreciation of the central role that energy plays in economic activity – *no energy flux no economic activity*. And the second law of thermodynamics, the most economic of all physical laws, is therefore central to the understanding of the role that energy fluxes plays in economic systems, and which should be a central theme in economics. Yet conventional economics regards energy as just another commodity - if a primary energy source becomes scarce, the price rises and new energy sources are developed to take its place, ad infinitum. This proposition ignores the fact that we must spend energy to extract energy sources from nature and convert them into a useable form. *It is the net energy yield that counts.* A higher unit price implies more energy consumption by the energy industry and a lower net energy yield. *This relationship sets definite limits to the scope for substitution, a proposition ignored by economic theory.*

As net energy yield declines the economic benefits of a fuel decline. In addition liquid fuels are more convenient and useful than solid fuels on a joule for joule basis.

To paraphrase George Orwell in his book Animal Farm, ‘all fuels are equal but some are more equal than others’.

The erroneous static equilibrium approach of neo-classical economics underpins Competition Policy and the amendments to the Trade Practices Act that established the federal Competition Council and the Australian Consumer and Competition Commission.

It is appropriate now to consider fuel supply for electric power in Western Australia.

FUEL SUPPLY

Western Australian energy production and use - 1999/2000

The three principal fuels used for electricity generation in Western Australia are Collie coal, natural gas and diesel for local regional schemes. There is a minor contribution from hydroelectric, wind power, methane from landfill sites and photovoltaics. There is not much scope for hydroelectric in WA.

In 1999/2000 WA primary energy production was 1626 petajoules (PJ), with natural gas 49%, crude oil & condensate 42%, coal 8% and renewables 1%.

Net exports of primary energy were 861 PJ, with crude & condensate 52%, natural gas 48%. Some crude oil is imported.

Primary energy use was 695 PJ, with natural gas 48%, crude & condensate, 33% coal 17% and 2% for renewables.

Final energy use was 450 PJ, with petroleum products 46%, natural gas 30%, electricity 16%, coal 5%, solar and wood 3%. Power generation and transmission, LNG production and natural gas transmission and oil refinery operation dissipated 245 PJ (15%).

Final energy use by sector was manufacturing 36%, transport 32%, mining and agriculture 17%, residential 8%, commercial 3% and other 4%.

The coal reserves were 42,000 PJ and natural gas 85,000 PJ – 2150 billion cubic metres (Energy 2001).

However, there would be a wide range of as yet undetermined net energy yields from these reserves and it would be unwise to read too much into these seemingly abundant resources, both for coal and natural gas. There are acute environmental problems associated with many of the coal resources. The economic potential of these resources tends to be over-stated. This issue for natural gas is summarised below.

Australian natural gas supply is limited

These issues are discussed in more detail in Appendix 1, A Lot of Gas.

There is a clear trend in Western Australia to favour gas over coal for future electric power generation. The same trend is apparent in the other states, especially South Australia. Gas is particularly favourable for cogeneration (combined heat and power) and to meet peak power demand. Electric power from gas turbines with heat recovery for supplementary steam turbine operation (combined cycle) has high thermal efficiency and can compare with coal fired plant for intermediate and base load demand. The initial investment is lower than for coal and has a shorter construction time. Gas turbines lend themselves to unmanned remote operation and can be put on line at short notice, making them suitable for peak power. One attraction of natural gas is perceived lower greenhouse gas emissions per kwh of output compared to coal, see below.
There is a perception promoted by the natural gas industry and governments that Australia has an abundant supply of natural gas. It is not as abundant as people think and most do not understand the depletion characteristics of oil and gas fields – the peak of production comes long before it ceases. Current gas production comes from fields up to 110 km offshore in water up to 120m deep. However, 40% of Australia's discovered reserves are up to 400 km offshore in waters 800-1000m deep, as will be much of the undiscovered. Production and development costs will be high. 80% of our natural gas is offshore between Carnarvon and Darwin, some 3,500 km from markets on the eastern seaboard. Some has a significant carbon dioxide content, eg the Gorgon fields in the Carnarvon Basin (12-15%). The electric power industry is just beginning to recognise these issues.

The Executive Director of the Australian Petroleum Producers and Exploration Association, Barry Jones, in a paper to a Sydney energy conference says that reform of the electric power industry **IS NOT** as important an energy issue for this country as the expected rapid decline in our self-sufficiency in liquid petroleum fuels. We are currently 85-90% self-sufficient, expected to decline to 55% by 2008-10 (50% probability) with a consequent increase in crude oil imports (Jones 2001). Jones says this is occurring when leading analysts are saying that world oil production will peak over the same period and that the focus of world supply is shifting to the politically unstable Persian Gulf oil producers.

Barry Jones advocates urgent federal initiatives to shift from petrol and diesel land transport fuels to ones based on natural gas. Consumption of these petroleum products in Australia is equivalent to 85% of natural gas production. This has major implications for the future of natural gas based industries, LNG exports and gas fired electric power generation.

North American natural gas supply crisis

North America (USA, Canada and Mexico) produces and consumes 30% of the world's natural gas. Last year there was a major natural gas supply crisis - consumption exceeded supply and wholesale prices in the USA increased 400% from January to December. An article, *Methane Madness*, on www.altenergy.org/core gives a good overview of these events. The unexpected shortage occurred when the US electric power industry had begun a massive surge to install gas turbines (some 52,000 MW since January 2000).

The assessment of the availability of natural gas was seriously flawed, an issue discussed by Matthew Simmons (2000) in *Natural Gas: Is a Train Crash Pending*? Simmons heads a Houston, Texas based company that specialises in financial services to the US upstream oil and gas industry. He is a key adviser to President George W Bush on energy issues.

This natural gas shortage has been a major driver of the electric power crisis in California over the last two years - 25% of peak power capacity is gas fired. The impact of flawed electricity market deregulation was a secondary factor in the crisis which amplified the impact of the gas shortages.

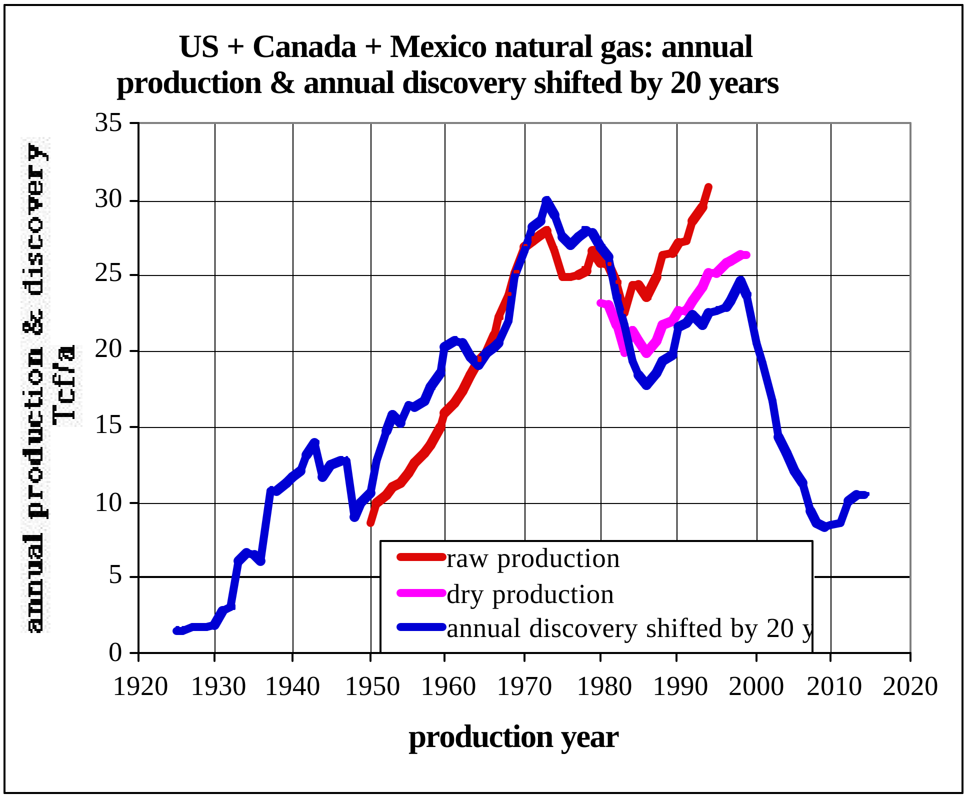
There has been a slight fall in US gas consumption in 2001 and gas prices have fallen nearer to 1999 levels. Fuel substitution, energy efficiency responses, closure of gas consuming industries, an economic slow-down, milder weather and greater use of coal-fired and nuclear power has temporarily taken the pressure off supply. 40,000 gas wells drilled since 1995 have only served to sustain US production at its 1995 level. Gas wells drilled in 1999 have an *average* 53% exponential decline rate – these wells are now only producing at one quarter of the rate on full start-up (Simmons 2001).

The Californian crisis has given a huge boost to renewable energy and energy efficiency, according to Don Osborn at a December Adelaide renewable energy conference. He is the Superintendent of Renewable Energy Generation, Sacramento Municipal Utility District. He says the utility no longer needs to subsidise such initiatives (Parker 2001). The Sacramento Municipal Utility District has been a leader in this field since the early 1980s.

North American natural gas consumption has peaked and is about to undergo a steep decline that should become very visible over the next two years. Jean Laherrere (2001) discusses these issues for both oil and gas in a paper given to a seminar at the OPEC September meeting in Vienna. He discusses the future of North American gas on pages 18-21 and for world gas on pages 24-25.

Figure 1 shows his assessment of the discovery pattern for North American raw natural gas shifted forward 20 years to illustrate how the production profile is broadly mimicking the discovery profile. The discovery profile from 1980 is corrected for the removal of liquids from natural gas since that date to give dry production. Since the late-1980s methane production from coal fields and gas from deep water discoveries in the Gulf of Mexico have added to supply – the latter accounts for the small upturn in discoveries since 1990.

FIGURE 1



From Laherrere (2001)

The inference is a very steep fall in production over the next decade, perhaps 40% or more. North America produces and consumes 30% of the world's natural gas.

On page 26 of his paper Laherrere compares his estimates of world natural gas production to 2100 to those in the 40 IPCC models for greenhouse emissions. His production estimates are below all these IPCC models.

A paper by Laherrere on North American gas supply will be published in the London International Journal of Energy Technology and Policy early in 2002.

What are some of the consequences of this North American crisis for the electric power industry in Australia? Some key issues are outlined below.

- An urgent need for a National Energy Strategy will emerge that takes hydrocarbon depletion issues into account.
- Attention will be sharply focussed on the validity of assessments of Australian oil and natural gas reserves and of estimates for the undiscovered, ultimate extraction and likely production profiles.
- There will be a review of priorities for natural gas based development and a factoring in of a significant priority to gas for transport.
- Energy efficiency will become a high priority.
- Appropriate renewable energy sources will gain enhanced priority.
- Neo-classical economics will face a crisis of legitimacy.
- Energy and natural gas prices generally can be expected to be on a rising trend.
- There will be significant global economic and social consequences.
- There will be a shift of focus from Greenhouse gas emissions to hydrocarbon depletion issues.

Western Power's fuel supply

Fuel supply for future power generation needs to take into account the issues raised above. A sea change of attitudes is about to take place.

Collie coal fuels about half of Western Power's electricity generation supplied to the South West Integrated System (SWIS). It is a sub-bituminous black coal and has a lower energy content per tonne than NSW and Queensland coal and does not occur in extensive thick seams as in those states (ABARE 1996). Collie coal will always be more expensive on a joule for joule basis for these reasons.

Fuel purchases comprise about half of Western Power's generation costs (Empower 2001). However, commercial confidentiality clauses in existing contracts make it difficult to assess the relative costs of gas and coal and the scope for reduction of these costs to Western Power.

Western Power's existing long-term coal and gas contracts specify minimum take-or-pay volumes of around 95% of the total contract volume and the corporation has from time to time accumulated substantial coal and pre-purchased gas inventories. Table 1 gives some details on these fuel contracts.

Table 1
Western Power's existing fuel contracts

		Contract Information
Natural Gas:		
North West Shelf Gas Project	Woodside Energy	To 2002 the amount is 90 TJ/d, and thereafter 115.8 TJ/d until 2006.
East Spar Joint Venture	Apache Energy	To 2005 at 8 TJ/d
Coal:		
Wesfarmers Coal/ Griffin Coal	Wesfarmers Coal/ Griffin Coal	To 2003 total coal volume is 5.2 Mt/a, then declining to 4.5 Mt/a to 2007, then declining to 3.5 Mt/a to 2010.

In addition the South West Cogeneration Joint Venture (SWCJV), comprising Fletcher Challenge Energy (50%) and Western Power (50%), has a contract with the East Spar Joint Venture for the supply of 32 TJ/d of gas to the SWCJV cogeneration facility at Worsley. All of the steam and approximately 30 MW of the electricity capacity is purchased by Worsley Alumina, with the remaining electricity (~ 90 MW) being supplied to the SWIS.

These contracts may be a liability on Western Power if more competitive markets for fuel and electric power evolve which has implications for Western Power and its fuel suppliers. This situation should not be exacerbated by new fuel contracts, or extensions of existing ones, that are incompatible with the course of reform. The State Government could acquire liabilities similar to those associated with the excess supply of gas resulting from the 1979 contracts. These contracts are an important aspect of reform and must be taken into account.

The extent of these inventories and their history, their likely future trend, price schedules and associated liability should be published. It is important information needed by stakeholders to assess reform proposals.

Coal fuelled power stations are most economical when close to a dedicated coal mine, provided there is an adequate water supply available. With perhaps two power stations at Collie economically viable, given the water supply constraints there, plus the long time-frame for investment in power stations and coal mines, it is unrealistic to expect effective competition in such a duopoly situation. A power station and its coal mine are essentially one project.

.

Competition can only be with alternative fuels like natural gas. But there are limitations here as well.

Natural gas supply is currently dominated by Woodside Petroleum (85% of WA production in 2000), with lesser supplies from small fields that can never match Woodside's output. Indeed the small companies can only exist by virtue of infrastructure made possible by Woodside's projects. And there is only ever likely to be one pipeline owner to the south west of the state.

The only significant potential competitor to Woodside from the NW Shelf is the Gorgon project. But most of this gas is in fields in water up to 800m deep and it is dry gas. Liquids stripped from Woodside's 'wet' gas was critical to Woodside's financial viability in the 1980s before the LNG export project was commissioned. Furthermore, Gorgon gas has a 12-15% carbon dioxide content that will need removal for greenhouse gas reasons.

Gorgon gas will most likely be more expensive than Woodside's present NW Shelf gas supply – obtained from offshore fields in water 125m deep.

The other moderately large field on the North West Shelf is Scarborough 400 km offshore in water 900m deep. The major discovery's in the Browse Basin off the Kimberley coast are well offshore in such deep water as well. Significant new discoveries are likely to be offshore in such deep water. The scope for competition in natural gas supply is limited. There will always be one or two dominant suppliers.

Western Power fuel contract and other relevant information needs to be made public if stakeholders are to make sound judgements on electric power market design proposals.

Western Power's participation in joint venture cogeneration projects entrenches its position as an electricity generator and supplier. Almost all are associated with major mineral processing and oil refining with sale of electricity as a secondary objective. Electricity sector structures and market conditions at the time were probably such that the corporation's role was important in the viability of the cogeneration projects associated with Mission Energy and the South West Cogeneration Joint Venture (See Table 2). The effect, however, was to maintain Western Power as the dominant supplier of electricity. The Mission Energy project at BP Refinery supplies 76 MW and the South West Cogeneration Joint Venture around 90 MW of capacity to Western Power under long term take or pay power contracts.

The relevant contract information in these contracts should be published so that stakeholders can assess their future and any transition arrangements in a reformed electric power industry. There are currently restrictions under State Agreement Acts that require surplus energy from private generators to be offered to Western Power after supplying their own needs. The appropriateness of these arrangements should be reviewed.

POWER SYSTEMS IN WESTERN AUSTRALIA

South West Integrated System - SWIS

The principal Western Power installed generating capacity in SWIS and its age is summarised below. Coal fired plant has a life of 45 years, gas turbines less so depending on their supply role.

By 2010:

4x60 MW units at Muja will be 45 years old and the 4x200 MW units 25-29 years old;

the 2x120 MW and 2x200 MW coal and gas fired units at Kwinana will be 34 and 40 years old respectively and the 2x120 MW gas fired units 40 years old;

the 21 MW gas turbines at Kwinana and Geraldton will be 38 years old but have probably had limited operation;

the 760 MW of gas turbine capacity at Pinjar, Kalgoorlie and Mungarra will be mostly 20 years old in 2010 and a 20 MW wind farm was commissioned at Albany in 2000.

Total 3420 MW, with 23% as gas turbines. Peak power demand on SWIS in 2001 was 2,500 MW in summer on a hot afternoon – commercial and domestic air conditioning load.

Major plant at Muja and Kwinana is reaching the end of its life. Significant replacement is on the agenda.

In addition there are a number of company owned combined heat and power plants (806 MW) that service the industry and sell their residual surplus power to Western Power. These are summarised in Table 2.

Table 2
Privately owned generating plant (over 10 MW) connected to the SWIS.

Alcoa of Australia	Alcoa	Natural Gas	254
Goldfields Power	Normandy	Natural Gas	110
Mission Energy	BP and Western Power	Natural Gas	116
South West Cogeneration JV	Worsley Alumina and Western Power	Natural Gas	120
Southern Cross Energy	WMC	Natural Gas	76
Worsley Alumina	Worsley Alumina	Coal	96
		Heat Recovery (Natural Gas)	34

The major load centre on SWIS is the greater Perth metropolitan region and Mandurah with lesser centres at coastal towns from Geraldton to Albany plus Kalgoorlie. Industry use outside Perth would be primarily for mining, mineral processing and water pumping.

The major transmission lines are from Collie to Perth and within the Perth Region. There is a 220 kv power line from Muja to Kalgoorlie. The 62 MW gas turbine plant at Kalgoorlie was originally diesel powered standby capacity to cater for transmission failures from Collie. When gas was piped to Kalgoorlie from Karratha in 1997 mining companies installed their own power plants and it became possible for Western Power to run its gas turbines for normal supply. The capacity of the 220 kv line must now be largely redundant and the transmission losses very high. The Geraldton gas turbine was originally installed as standby plant for use when transmission lines from Perth failed.

The status of all the Kalgoorlie power infrastructure, its capacity utilisation and detailed cost structure is an important reform issue and needs to be made public now.

The rest of the SWIS mostly services small rural towns, farms and water pumping on an extensive grid with a low customer density. Through uniform power tariffs the non-metropolitan residential and some other small customers supplied by Western Power in SWIS and NWIS (see below) are subsidised by some $150 million per year, which is 10% of Western Power's revenue and *averages* about $1000 per customer. The reliability and quality of supply deteriorates over this network compared to the major load centres. The power loss in transmission on this rural network would be high. In 1998 8.2% of electricity leaving power stations was lost in transmission.

In Western Australia close to 90% of public water supply and some 75% of wastewater is pumped. The Water Corporation would be a major customer of Western power. Power used by private bore pumping for irrigation and industry would be additional. Horticulture is particularly dependent on pumped bore water. The proportion of public water supply pumped is likely to increase as the supply focus shifts to ground water, desalination and more remote water sources for Perth. Disruption of power supply for water pumping would have dire consequences for Western Australia.

North West Integrated System – NWIS

NWIS is a Western Power distribution system serving the coastal towns from Dampier to Port Hedland and the inland towns of Panawonica, Mt Tom Price and Paraburdoo. Western Power purchases electricity from mining company power plants. Residents and small commercial businesses are on the uniform tariff regime. There is scope for renewable energy and energy efficiency here.

Comprehensive performance and cost data on the components of SWIS and NWIS need publishing as part of the reform agenda, including power usage by the Water Corporation and its location. Otherwise stakeholders cannot make sound judgement on good market design, identify opportunities for renewable energy, energy efficiency and transition arrangements. This is a major issue.

Independent Regional Power Systems - IRPS

These are mostly independent Western Power systems with diesel power plants serving 24,000 customers. Total installed capacity is 110 MW in 28 towns but 80% of this is in just five towns with 10-19 MW - Broome, Carnarvon, Derby, Esperance and Kunnanura. The latter is now supplied by a 30 MW hydro electric power plant at the Ord River Dam. There is a 2 MW wind farm at Esperance. The diesel plants are ageing and major replacement is imminent. These towns are highly subsidised through the uniform tariff regime - $45.8m in 2000/01for operating costs alone before borrowing and income tax equivalent charges, an *average* of $1900 per customer. There are probably considerable variations in costs and in the subsidy per customer between towns, with these much higher in the smaller towns.

There is major scope for renewable energy and energy efficiency. The cost of photovoltaics is expected to fall in the near future as thin film silicon technology matures. Similar advances seem to be occurring in fuel cells using hydrogen to produce electricity. Does this combination have a future in these towns? Innovative ways of using subsidies to introduce these technologies to replace ageing diesel plants, and to promote energy efficiency need exploring. The amount of the subsidy should be stated on customer accounts to stimulate interest in the issue. There is a case for such subsidies from major urban populations to households in these towns, many of which fulfil a significant state economic role. But the subsidy should not facilitate inappropriate and inefficient use of energy. If diesel plant is abandoned, Western Power depreciation provision for its replacement could be used as a source of funds for renewable energy and energy efficiency as well.

Such initiatives could also find significant application in NWIS and the rural and regional parts of SWIS.

To be successful such schemes need to involve the local communities at all stages. There support is critical to success and will only happen if they see real benefits in the outcomes.

There is major scope for renewable energy and energy efficiency in these towns. Detailed performance data for each of the schemes needs publishing as for SWIS, including on daily and seasonal peak demand, to aid the reform process and to identify opportunities. Similar town schemes would exist elsewhere in Australia and these need identifying in like manner to widen the market opportunities for alternatives. Local communities need to be involved in these processes at all stages.

Some retail market aspects

Full retail contestability down to residential level will be introduced in Victoria, NSW and South Australia in January 2002, and is on the Government's agenda for Western Australia for 2005.

An issue being debated in eastern Australia is ***interval metering*** *- whether to use meters that record power consumption at intervals throughout the day enabling competitive markets to develop with prices varying between peak and off-peak demand. The aim is to foster shifting demand to off-peak times to limit the provision of expensive peak power load. There maybe some stimulus to more energy efficient processes and equipment.*

The issue is summarised in the November issue of the Electric Supply Association of Australia's magazine.

The cheaper but less accurate alternative to interval meters, is ***load profiling.*** The ACCC have endorsed load profiling but prefer the more accurate interval metering for the long term. Email claims it can manufacture these meters at $65 each for an order of 350,000 over three years. The aim is to create a market for energy efficiency and to transfer peak load to off-peak by letting market forces bring it about.

There seems to be a naïve belief that introducing competition is sufficient to achieve this outcome.

Queensland has postponed introducing full retail contestability because it would lead to a threefold increase in charges for most regional and remote small customers based on a model that does not ensure the delivery of uniform tariff outcomes. The decision will be reviewed in two to three years. The State may lose up to $150 million in Commonwealth Competition Policy payments as a consequence of this decision (Energy 2001). A similar situation could arise in Western Australia.

Full retail contestability down to household level is based on creating a market where electricity retailers compete for customers. The retailers purchase power from generators and negotiate transport fees with transmission companies and then on-sell to end-users. Different rates are possible throughout the day or according to some other schedule. Large computer systems are needed plus the use of the ubiquitous call centres that have already alienated the public in many commercial areas.

It has been estimated that several million customers are needed to justify the cost of the software required That is, transaction costs are very high in relation to small customer electricity consumption!

Furthermore, few small customers will have the technical sophistication and information needed to make sound judgements on sales talk for energy efficiency options etc, contrary to neo-classical economics assumption of 'complete knowledge of all relevant information'. *Another utopian assumption!*

However, the issues are relevant but need to be tackled in other ways.

Full retail contestability is being introduced to an uninformed public inviting a strong political backlash. Equity and social justice aspects between different classes of customers cannot be ignored. Neither can the transaction costs incurred by the customers (an 'externality' in the jargon of economics). The public is also expected to cope with full retail contestability for natural gas.

The essence of energy efficiency and demand management strategies is for consumers to make appropriate investments in energy efficiency to achieve the same or better service by using less energy at *lower total cost*, even though the *price* per kwh may be slightly higher. In aggregate the outcome also reduces the substantial investment needed in power supply systems. There are numerous institutional and structural barriers to this happening. For example, owners invest in buildings but tenants pay the power bills and neither is aware of the potential impact of their actions on the investment agenda of power suppliers. There is an extensive literature on this subject with many innovative and imaginative ideas.

There is a strong case for energy utilities investing in their customers energy efficiency to avoid much higher investments in capacity expansion or replacement.

The inherent instability of electric supply systems and of markets in this context is very relevant, as discussed above. Swings in peak power prices can become extreme when supply shortages develop, especially for peak power. The classic behaviour of unstable non-linear systems. The adverse impact on customers needs to be considered and on hedge market outcomes for large customers. Were the large swings in electricity, gas and oil prices in the USA last year partly responsible for the bankruptcy of Enron?

Hedge markets in these circumstances would be prone to unproductive speculation activity.

A hard look is needed at the desirability of full retail contestability in view of the high transaction costs involved and the practical difficulties that ordinary people face in adopting appropriate technology. The initial investment required for energy efficient technology is often significant which raises equity and social justice issues.

Co-operation as well as competition between all parties is needed, including the service providers of energy efficiency technology as well, if energy efficiency programs are to achieve the least cost and most energy efficient outcome for everyone. Access to relevant information is critical and training in its interpretation is essential. A major task is identifying and overcoming institutional and structural barriers to achieving energy efficiency, such as the landlord-tenant relationship.

This is another example of the unbalanced approach of neo-classical economics with its one-sided focus on competition alone.

The key electric utilities must be structured primarily as businesses that MARKET the services that energy provides, rather than being just being energy SUPPLIERS. Creating the right framework for such an approach to flourish must be a key aim of reform. The framework must include regulatory and other initiatives to overcome the structural and institutional barriers to introduction of a flourishing energy efficiency industry.

The Water Corporation and its predecessors over the last 25 years has been forced through a combination of water resource, environmental and economic constraints to pursue a strategy of demand management and water efficiency. *Its commercial advertising pleads with its customers to buy less of its product!* A one-sided focus on competition encourages the pursuit of sales growth.

The Background Paper does not discusses these extremely important issues. The deficiency needs correcting. A working party on the energy efficiency aspects of reform is needed. For households some adaptation of the direct marketing approach of Travelsmart, the Dept. of Planning and Infrastructure's urban transport demand management initiative should be explored.

SYSTEM OPERATION AND ELECTRICITY MARKET DESIGN

Overview

1) The approaching world peak of cheap oil and of cheap natural gas in North America calls for electric power reform in Australia to be conducted within the framework of a 50 year Federal Energy Strategy. Greenhouse related as well as social, economic and structural adjustment issues need including in the strategy as well as energy market issues. A focus on energy efficiency, demand management and greater use of appropriate renewable energy must follow. In the absence of federal initiatives Western Australia should take interim steps along these lines.

2) In this context urgent studies are needed on the net energy yield from existing fossil fuels sources, and their derivatives such as petroleum products and electricity, including net energy profiles over their production life as well. Likely future trends in net energy yields need evaluating as an important strategic indicator of future economic development options. Similar net energy assessments of renewable energy sources are needed, including the extent of their long-term dependence on fossil fuel inputs.

3) Studies are needed into the embodied energy content of goods and services to identify priority areas for strategic energy demand management and energy efficiency programs. These programs need criteria to ensure that implementation initiatives do not consume more energy than is saved.

4) Implementation of a National Energy Strategy must recognise the all-pervasive role energy plays in nature and economic systems and which dictate an appropriate complementary role for co-operation and competition in markets and generally. A one-sided focus on competitive markets, as occurs under Competition Policy and based on the static equilibrium framework of neo-classical economics, is inefficient, inadequate and cannot consistently address the dynamic interaction between economic, social and environmental constraints.

5) Pursuing the approaches outlined above may run into conflict with the Competition Council and ACCC. If so the approaches should be defended by the 'dynamic' equilibrium approach to markets as opposed to the 'static' equilibrium basis of neo-classical economics.

6) Electricity markets combine two inherently unstable systems, as in the 'chaos theory' context discussed in this submission. These are the physical electric power system itself and the market system. As electricity cannot be stored and must be consumed the instant it is generated, *so the combination can be particularly unstable*. This probably explains many of the problems arising from recent attempts to create competitive markets, such as price volatility, and the tendency for cumbersome regulation to arise.

7) The all pervasive role of energy makes mandatory an integrated 'triple bottom line' approach necessary – integrated criteria for social and ecological responsibility as well as financial return on assets. Therefore key components of the electric utility system must be government owned. At present only government bodies can function sufficiently in this way, but then only effectively within the guiding framework of an appropriate 50 year National Energy Strategy.

8) The principles for assessing depreciation provision for long-life assets need defining. In particular the assumptions involved need review along with more sophisticated auditing of these aspects.

9) The complementary character of competition and co-operation in this context requires open, inclusive and democratic processes.

10) There should be a reduction if not elimination of commercial confidentiality in energy contracts. Economic theory says efficient markets require all to be fully informed on market issues. However, this proposition needs to be balanced against the leverage such a proposition could give large businesses against small customers. But far too many energy supply contracts are confidential.

Reshaping of Western Power

An important universal service like electric power should remain as far as possible under local ownership for supply security and broad local commitment. Realistically that means keeping the main components of Australian electric utilities in public ownership in the present global context.

There is a good case for separating Western Power's generation from its transmission and distribution functions – whether the latter two need further separation is another matter. If they are not separated the two functions should be ring–fenced.. There are problems with this approach, as the critics would say, and these should be tackled. But we regard local ownership as having higher priority.

The responsibility for transmission, distribution and system operation (the System Utility) should be in a single publicly owned entity, but NOT with the corporatisation model. The 'triple bottom line' approach is necessary here, integrating social, environment and financial accountability, after drawing lessons from the Sydney Water 'boil water' episode in 1998.

The System Utility's objectives should be explicitly defined, firstly as an energy service utility, and only secondly as an energy supply utility.

A prime focus would be demand management and customer end-use energy efficiency. Likewise for the appropriate promotion of renewable energy in niches where it is viable. We believe a sole focus on competition and rate of return on assets as a performance criteria for the System Utility is a barrier to the promotion of energy efficiency programs. A complementary role for cooperation and competition is necessary.

An important function would be monitoring the need for and timing of new, replacement and reserve generation capacity. Further discussion is needed on how this capacity is introduced.

The relationship between the System Utility and the proposed Sustainable Energy Development Authority needs exploring further. What role these organisations should have in financing energy efficiency programs needs exploring.

If Western Power's generation division remains intact the four main power stations, Muja, Collie, Kwinana and Pinjar should be ring fenced. This still leaves open the future of its three gas turbine installations at Geraldton and Kalgoorlie. *If ring fencing is adopted then it is essential that there be no confidential fuel and power contracts and that independent auditing of the effectiveness of the ring fencing is carried out.*

The UK power pool model for an electricity market is a failure, it should be avoided for the reasons discussed above. The Nordic Pool concept in Scandinavia seems to function successfully. In this system generators can sell directly to the larger customers and retailers – about 80% of the market. Many would be on long term contracts. For the remainder there is a pool system, a 'balancing market' with variable transmission charges depending on where the load is located. There may be a problem here in the SWIS context with its low density rural and regional network in comparison to Scandinavia. At all times the reality of dynamic unstable markets and power systems should be borne in mind – this will ensure that simple and effective market rules can be devised, avoiding the utopian model of neo classical economics.

There should be a move away from confidential contracts.

A crucial issue is whether the transaction costs of a market down to residential level exceed the claimed benefits from the market. A hard-nosed assessment is needed and alternatives considered, with a clear understanding of the outcomes desired. We reserve comment on this aspect until the assessment has been completed.

Independent Regional Power Systems

The IRPS do not fit at all into the disaggregated Western Power framework. How is the tariff subsidy to be funded? An independent utility? Should it be a division in the Systems Utility? Given that pursuit of energy efficiency is a priority this may be an option.

Renewable energy

These are principally wind turbines and photovoltaics and have the characteristic of variable output according to wind intensity and sunshine respectively. PVs should be most effective in SWIS in summer on hot days when peak power demand occurs. *Rules are needed that give these sources the maximum opportunity to exploit their favourable niches.*

Information is needed on the grid power quality and reliability control problems that can arise if PVs become widespread.

The cost and reliable performance of systems to convert DC powe from PV systems to AC and the two-way metering required to exchange power between the grid and PV owners are a barrier to its introduction. Options for several households sharing a common conversion/two-way metering installation need exploring.

CONCLUSION

Reforming electric power supply systems towards a more market orientated structure is always a complex task due to the legacies of historical development and electricity's manifold and pervasive role in today's world. The problems have been compounded by an excessive enthusiasm for a seriously flawed neo-classical economic theory and insufficient attention being given to the unique character of electric power systems. Add to that the various vested interests with conflicting agendas.

Above all care is needed to ensure that such a vital industry's operation is not weakened or impaired in the process while at the same time ensuring that the scope for its evolvution in new directions is enhanced.

In the new era it is important not to lose sight of the environmental and social aspects and to take on board the rapidly emerging issue of the peaking of production of cheap hydrocarbon fuels.

REFERENCES

ABARE, 1995. *Australian Energy Consumption and Production 2009-10,* Australian Bureau of Agricultural and Resource Economics, Canberra.

Booth, Dr Robert, 2000. *Warring Tribes: The Story of Power Development in Australia*, www.bardak.com.au.

Booth, Dr Robert R, 2001. *Is the "Compulsory Pool" Inherently Unstable?* www.bardak.com.au,

Empower 2001. Magazine of Western Power, November.

Energy 2001. Office of Energy WA, magazine, November.

Jantsch, E 1980. *The Self-Organizing Universe,* Pergamon Press.

Jones, B 2001. *Liquid Hydrocarbon Production – Where To Go?* AIE Conference, Sydney Nov. 22.

Keen, Steve 2001. *Debunking Economics: The Naked Emperor of the Social Sciences,* Pluto Press, Sydney.

Laherrere, J 2001. *Forecasting Future Production From Past Discovery,* OPEC Seminar; *OPEC and the Global Energy Balance: Towards a Sustainable Energy Future,* Vienna September 29. http://hubbertpeak.com/laherrere.

Parker, Dr Bill 2001. Personal communication.

Prigogine, I. 1997. *The End of Certainty,* The Free Press, New York.

Prigogine, I & Stengers I 1984. *Order Out of Chaos,* Bantam Books, Sydney.

Sheil, C 2000. *Water's Fall: Running the Risks With Economic Rationalism*, Pluto Press, Sydney

Simmons, M 2000. *Natural Gas: Is A Train Crash Pending,* U.S. Department of Energy Office of Natural Gas and Petroleum Technology; Strategic Initiatives Workshop, December 5-6. www.simmonsco-intl.com.

Simmons, M 2001. *Outlook for Natural gas: Does Violent Volatility Risk its Future?* Paper to Southern Gas Association Executive Conference, Florida 12 November. www.simmonsco-intl.com.

Udall, R 2001. *Methane Madness: A Natural Gas Primer,* Community Office for Resource Efficiency, Colorado USA. www.altenergy.org/core.

REFER TO APPENDIX

A LOT OF GAS

Visions, Fantasies and Reality

By Brian J Fleay

December 2001

ALotOfGas.pdf