Submission on the PC Draft Report on Energy Efficiency

27 May 2005

Preface

This submission is based on an intimate knowledge of the Victorian Electricity Industry Restructuring, the close involvement with the establishment of the National Electricity Market (NEM), over 15 years experience in electricity cost modeling and pricing development, both under a regulated environment and in the new competitive market and a keen interest in the techno-economics of energy use in Australia.

Electricity Markets Research Institute (EMRI) undertakes research with primary focus on:

- Public benefit aspects of competitive energy markets:
- Technical and market efficiency,
- Equity issues,
- Transition issues going from integrated utility in a monopoly market to competitive marketing.

A brief write-up of the work of EMRI and a short biography of the author are given in Attachment A.

Introduction

The present Inquiry by the Productivity Commission (Commission) is of national significance and timely:

- Increasing efficiency has been the driver for energy industry restructuring and it is opportune that 'energy efficiency' should be well understood and universally accepted / followed;
- It is now 10 years since the establishment of the National Electricity Market and it is opportune to assess whether any further improvements are necessary;
- Efficiency considerations have major impacts on much needed new investments to augment energy infrastructure estimated to be over $ 50 billion;
- Low cost of energy inputs are an important comparative advantage to most Australian businesses (both exports and import substitutes);
- Affordable energy is vital to the quality of life enjoyed by Australian households.

EMRI notes that the terms of reference (ToR) for the Commission inquiry refer to "economic and environment potential offered by energy efficiency" where energy efficiency is to be taken to encompass both supply side and demand side efficiency. There is the prospect that the potent of the word "potential" will be missed unless the inquiry covers the full gamut starting from energy sourcing (upstream) to energy end-use (downstream), including organisational structures like energy markets and regulatory control mechanisms where effective markets are not viable. Given that "what is good for

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BHP is not necessarily what is good for Australia", it is also important to dwell on the question whether Australia is getting the best use of it's energy resources?
EMRI takes serious issue with the Commission view that the ToR limits this inquiry to only the energy efficiency improvements which are cost-effective for individual producers and consumers, eg"Examination of measures that generate net public benefits despite not being privately cost effective, is beyond the scope of this inquiry". Commission attention is drawn to that part of the ToR providing elaboration of the Scope of the Inquiry under sub-section 4. "the potential for energy efficiency improvements which are cost-effective for individual producers and consumers arising from actions including:", which unambiguously states that the inquiry should also consider cases that have the potential to be cost-reflective for individual producers and consumers under the circumstances mentioned. Among the items listed under "arising from actions including" are "new and improved technologies and equipment," (dot point 6) and "financial incentives for improving energy efficiency, including, but not limited to subsidies, private sector rebates or discounts and levies on energy use;" (dot point 7). It should be recognized that good public policy would endeavor to provide financial incentives where there was net public benefit, the inference being that the financial incentives will tilt the balance for the measure under consideration to become 'privately cost effective'.

Supply side (factor analysis)

Australia is fortunate in having an abundance of energy raw materials, a very large proportion of which we export to all parts of the world. Foresight on the part of previous governments to provide direct funding for such schemes as - the La Trobe valley brown coal, Victorian government long term forward contracts for natural gas with Esso-BHP, Snowy Mountain Hydro-electric scheme, etc., has and still continue to provided handsome returns with significant impact on the well being of their constituents.

Ensuring the most economic / efficient extraction of energy raw materials and their transformation (done within Australia) into other more readily usable energy forms, eg electricity generation from coal, constitute an equally important supply side process step, as ensuring efficient energy efficiency in end-use (demand side). Chapter 3.1 of the Draft Report discusses the energy availability and use in Australia, but do not get down to the issues and options that need to be considered for a proper assessment of energy efficiency in these operations consistent with the objectives of the inquiry, viz "economic and environmental potential offered by energy efficiency", given that energy efficiency was broadly defined to "encompass supply side and demand side efficiency".

- **Coal** is by far the most abundant energy raw material available in Australia (as in other major energy consuming countries like USA, Canada, South America, Europe). Brown coal found in Victoria has lower heat content and higher moisture content but is found close to the earth's surface and so is cheaper to mine. Fortunately the sulphur content is also low. Due to higher world demand for black coal, there is a substantially high export price for black coal and so the price differential between the

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two is rising. USA has recognised that it is not enough to discourage coal use (also many US coal varieties have appreciable sulphur content) by imposing penalties but ways need to be found to reduce the level of undesirable emissions. US Government has allocated large sums of money for research into new ways to ensure cleaner burning of coal or its conversion to clean gas / liquids.

- **Natural gas** was considered the global panacea to overcome the environmental problems associated with the use of coal, but countries like the UK, USA and Europe have found that their own natural gas sources were not enough for sustainable use in large scale electricity generation. The fall back option of importing liquefied natural gas is not economically attractive as using indigenous natural gas.

    - Victoria was fortunate to have had natural gas for industrial and domestic use at prices significantly below the cost of using electricity (on general purpose tariffs) for such applications. As the stable operation of brown coal power stations needed higher minimum loads than black coal power stations, maintaining a high rate of electricity use during off-peak hours was very important. The very low short run marginal cost of brown coal enabled the price of off-peak electricity to be reduced to a low enough level so that use of storage water / space heating became price competitive with the use of natural gas for such purposes. Greater use of natural gas for electricity generation and the new gas pipelines allowing natural gas to be exported to interstate markets will no doubt tend to raise the price of natural gas in Victoria (once the present contracts expire) giving a welcome boost to brown coal power station profitability.
    - Very large reserves of natural gas on the north west shelf off Western Australia can provide natural gas for Australian needs over a long time horizon. One drawback is that short-term private profitability favours export of natural gas to resource poor countries like Japan, Korea and China who are prepared to pay higher prices than currently available from Australian users. The other drawback is the lack of pipelines (infrastructure) to connect the vast natural gas resources on the Australian north west coast to the main markets in the Australian south east seaboard. Public benefit from investing in such grid pipelines include: a substantial market for Australian manufactured steel pipe, jobs for Australian people, opportunity for railway, electricity lines, and water lines along the path for the gas pipeline with townships at the inter-mediate gas pressure booster stations also housing electricity generators and water pumping stations. Public funding to makeup the shortfall in private profitability, within a well structured public-private partnership arrangement will deliver more aggregate long-term public benefit per dollar of public funding compared to most other handouts and ad-hoc projects undertaken by the Federal Government in recent years. Alternative model that can be used is the one used in the USA when they build their railroads, involves the vesting of the adjoining lands along the path of the pipeline / railroad / electricity grid across Australia, so that future increases in real estate value can be used to repay the initial financing of the project.

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  - Australia is fortunate in that the various oil and gas extraction / refining processes provide a constant supply of LPG more than adequate for Australian needs. Most of this LPG finds use in cooking, space / water heating and industrial applications, in areas where there is no reticulated natural gas. Most vehicles used for taxi purposes use LPG, since it is substantially cheaper than diesel / petrol and the vehicle engines run cleaner with LPG than with petrol / diesel. There is also a fair amount of private vehicles running on LPG but the growth of this market segment has been rather slow.

- Australia is a net importer of crude oil but considering the extensive exports of liquefied Natural Gas (LNG), indigenous production of **petroleum** products exceeds demand for them on an equivalent barrels of oil basis. Supplementing petrol and diesel with ethanol produced from agricultural raw materials will increase the degree of self sufficiency at the same time as reducing the environmental impact of harmful emissions. The key success factor is the further development of the processes so that government subsidies are not necessary for viable operation. Considering that the price of crude oil has been rising sharply within the last nine months, there is bound to be more exploration and more efforts at increasing conversion and end-use efficiencies. Also there are more benefits in converting vehicles systems to alternate fuels like LPG and CNG.

- In very remote areas, or where **wood** is readily available, eg Tasmania, wood is a very low cost source of energy for space and water heating and sometimes for cooking as well. Some of the old cast iron stoves were not only pretty to look at but also was very functional - in that they served as a cooker, space heater and a water heater all combined into one unit. A five hectare property with average amount of native gum trees will generally provide enough firewood from falling branches and uprooted trees to sustain a wood fired space heater and a water heater. Considering the substantial export of wood chips for a fairly small price and the large amount of residue burnt on the forest floor when the logs are harvested for making the wood chips, there is both private and public benefit is burning forest residues as firewood in well designed wood heaters / stoves.

  - In Launceston there was a subsidy to convert wood fire units to electricity heaters, but this raises two problems. First, Tasmanian electricity demand has outgrown it's sustainable supply source (mainly hydro with a small contribution from natural gas generation) so converting wood use to electricity use per se is not in the public interest. Second, the operating cost for the customer using electricity is substantially more than when using wood. Since the intent of the subsidy was reducing the air pollution from smoking flues, the more efficient option would have been to provide a subsidy for replacing the old wood heaters with better designed ones.

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  - The compulsory exercise involved in chopping firewood is also a significant public benefit as well as a private benefit - although not always well appreciated by the individual beneficiary.

- Australia is a significant producer / exporter of **Uranium** - the raw material used in nuclear power stations. Public policy bans nuclear power stations in Australia. This poses a risk that at a future date there could be expensive litigation that while Australia recognised the dangers of using Uranium within it's boarders it allowed their export thereby exposing others to the dangers Australians realised were real. There is an opportunity in this situation that Australia needs to evaluate, ie to develop expertise in nuclear energy generation so that appropriate advise could be given in the safe use of uranium for power generation. Also, to develop the expertise and the capacity to implement long-term storage of spent uranium in safe locations within Australia or elsewhere. The European Union has been innovators in this regard by requiring (initially computer and household appliance) manufacturers take responsibility for recycling their products at the end of their economic life. Unless Australia does a proper assessment of these risks and opportunities, allowing (by issuing an export licence) private entities to enjoy private profit that creates a potential economic cost to Australia (potential public cost) in the future, is not consistent with efficient energy (raw material) use.

- Electricity is accorded the highest order of energy, since other forms of contained energy, eg coal or natural gas, are normally used in the energy transformation into electricity. By definition, efficiency increases if an intermediate step or process can be eliminated. So where it is possible to use natural gas to heat water, that would be more efficient than to use electricity which is produced from natural gas. If we assume that market prices correctly reflect value society places on the different forms of contained energy, then their price on a common yardstick (say $ per mega Joule) will indicate the prevailing economic order of energy sources. Since electricity is almost always derived from some other energy source material, the attributed price will depend also on the particular source material used in the transformation. Transport of energy to the place of energy use is another element in the value chain and so the efficiency of energy transport is an important part of the current inquiry. Unfortunately the Commission draft report seems to have missed this important aspect of their brief "encompasses both supply side and demand side efficiency".

  - Since storing electricity in appreciable quantities is not economic, electricity needs to be produced & transported at the same instant it is used by the customer. To maintain such a system, the system operator resorts to having redundant transport capacity and reserve generating capacity able to provide a substantial increment of energy (usually equivalent to the capacity of the largest generator on-line) as and when needed. Aggregate energy demand at any instant varies by the time of day, the day in the week and by season (weather / temperature). In Victoria, South Australia, New south Wales and Queensland the highest annual system demand usually occurs on a hot summer afternoon when the air-

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conditioners are going flat out. Each region needs between 300 MW to 500 MW of generating capacity to service these high load periods that may only last for less than 100 hours in the year;

- Different customers place differing values on power system reliability. Domestic customers on average place the least value on power system reliability and commercial customers in high rise offices on average place a substantially higher value on power system reliability. But the power system design sets a common level of reliability for all customer classes, only differentiated by supply region (city centre, urban or rural). Generally the design level of reliability corresponded to a level of reliability slightly lower than what commercial customers were prepared to pay for but significantly higher that what residential customers were prepared to pay for if they had the choice. This situation is definitely not cost-effective to individual producers and consumers;
- Wider use of demand side response and distributed generation methodologies enable this redundant network capacity and the expensive generation short-term peaking capacities to be reduced, thereby improving supply side efficiency;
- In the past economy of scale in electricity generation has seen the size of generating plant gradually increase to units of around 600 MW, but their energy conversion efficiency has not gone beyond 55%. Combined cycle gas turbines have increased this efficiency barrier to around 65%. Much smaller co-generation plant at the customers premises are now able to achieve around 85% conversion efficiency, a substantial improvement to large scale central power stations. When considering the transmission and distribution power losses (10% – 25%), there is a very significant gain in energy efficiency although market prices for fuel inputs at retail level can completely reverse this technical efficiency gain. This is an area for further study and policy development that the Commission should flag at this inquiry;
- Mass production of small stand-by generator sets have seen their prices drop very significantly (around $300 per Kw compared to around $600 per kW for a industrial type gas turbine generator) paving the way for distributed co-generation even at the residential customer level provided the retail fuel pricing issue can be satisfactorily resolved.

- In Australia you rarely see water wheels that were the early mode of using **hydro-power**. The best known hydro-electric facility in Australia is the Snowy Mountains hydro-electric scheme - initiated by Victorian and New South Wales governments and completed with financial input from the federal government. It is unfortunate that the long-term implications of diverting a large percentage of the water flows from the Murray Darling rivers to New South Wales was not properly assessed at the design stage and no proper framework was available to assess the scheme as a multipurpose water use facility.

    - Although evaluation of the Snowy Mountains hydro-electric scheme would have to be a study in its own right, the scope of the present inquiry requires the PC flag the need to develop a proper framework for evaluating future hydro-electric

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schemes taking into account potential economic and environmental benefits / costs.

- Commercial imperatives have led to compromising of well established long term planning norms like 'sustainable capacity of hydro-electric schemes', exposing electricity customers to power interruptions during draught periods like what happened in Tasmania, New Zealand and California. Without proper study of long-term impacts on weather patterns from modern phenomena like land clearing and increase in greenhouse gas levels, reliable forecasting of rainfall patterns is almost impossible. Potential economic consequences of forecast failure can be very significant. The present inquiry should flag the need for such studies.

- Introduction of the Mandatary Renewable Energy Targets (MRET) provided a boost for the **Wind Energy** industry in Australia. Various reports have drawn attention to two key characteristics common to most wind projects – they are located in isolated areas remote from the power grid and the amount of energy generated at any instant in time is very unpredictable. Although the MRET subsidy almost doubled the price wind generators get doe the energy they produce, the extra expense of new dedicated transmission lines was a significant burden. Also, the unpredictability of wind generation meant that, when there is a significant contribution of wind energy to the power system, the normal reserve capacity - to cater for a possible tripping of an on-line generator, needs to be increased. While the planning approval process provides for an evaluation of environmental factors associated with a specific wind generator proposal, what is lacking is a proper public benefit assessment of available site, it's peak and sustainable capacity for electricity generation, technology development in wind generation, site specific power system constraints and transmission augmentation requirements, impact of subsidies and other concessions being. It is regrettable that the Commission has left out such an important part of their brief.

- Of the other Renewable Energy modes, solar water heating is very important in that it is one of the most economical use of renewable energy and the most amenable to implementation on a mass scale. Most subsidy schemes for solar water heating is categorised according to the existing fuel source for water heating, to determine whether the solar energy captured replaces gas or electricity. In common with wind energy (where there is no reference to existing appliances) solar water heating taps into a renewable source which is sustainable unlike using fossil fuel resources that are finite. In addition it extracts ambient heat that otherwise would increase global warming. What source of energy is used for normal water heating that the solar unit displaces, is fairly inconsequential. If we consider renewable energy as a 'free' input, the use of renewable energy increases energy efficiency irrespective of what energy source it displaces. Correcting this anomaly is very important (given the very large number of customers with gas water heating) as it has a significant impact when assessing the private cost-effectiveness of solar water heating. EMRI recommends the Commission include a reference to this anomaly in regard to subsidies for solar water heaters when preparing it's final Report.

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Efficient energy transport / delivery

Efficient energy transport increases energy efficiency because more of the energy produced is available for consumption. Laws of physics teach us that losses in electrical networks are proportional to the square of the current that is flowing. Since the power system voltage is kept almost constant, instantaneous load is proportional to current drawn by the load. If the current flow at the peak period is twice the current flow at the off-peak period, the losses during the peak period is four times (2 squared) the losses during the off-peak period. Cost reflective pricing is one way to get customers to shift their load from a peak period to an off-peak period and is the reason why Sub-section 4 dot point one of the ToR makes specific mention of "more efficient cost-reflective price signalling in the market, particularly at peak times"

Because the electricity supply industry is now dis-aggregated, for larger customers pricing of the energy component is separated from the regulator approved network prices. As such the network price is about half the aggregate price and amounts to around 3 cents per kWh, hardly sufficient to provide a worthwhile differential between peak and off peak periods.

Aviation industry is another capital intensive industry like the electricity networks, and there they have developed techniques for optimising the use of their expensive assets (yield management). One technique is an extreme form of curtailment pricing where the airline consistently overbook customers based on best forecasts of the number of cancellations that are expected for that particular flight. Should their forecast be proven wrong and more passengers turn-up than there are seats, the airline starts a reverse auction process to buy off already booked customers. Since the airline has been able to earn substantial amounts of money by regular overbooking (compared to not overbooking – so had to fly with more unfilled seats) they can afford to pay handsomely for a few customers to take a different flight.

Australian Patent No 748800 describes a method that uses a real-time pricing system incorporating a single platform to accommodate pricing signals both from the pool market and from network operators. Since the method uses automatic load control facilities (and stand-by generation where available) that act according to price trigger points set by the customer, the operation is seamless and almost instantaneous. The system captures the benefits of the airline yield management system in that there is a virtual auctioning process to realise a desired level of demand side response.

Current treatment of network losses is the customer purchases extra energy equivalent to the losses derived as the product of metered energy over the settlement period and the loss factor at the transmission / distribution connection node. The loss factor is the marginal loss factor at that node, in other words the extra energy that must be sent out at the generators to enable extra delivery of one unit of energy from the said node. The

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problem with this methodology is that while the marginal loss factor gives a correct derivation of the losses, the apportionment of losses to customers does not take account of the laws of physics that say losses are proportional to the square of the current (or load when the voltage remains constant). Australian Innovative Patent No 2001100206 describes an improved loss apportioning methodology for network losses.

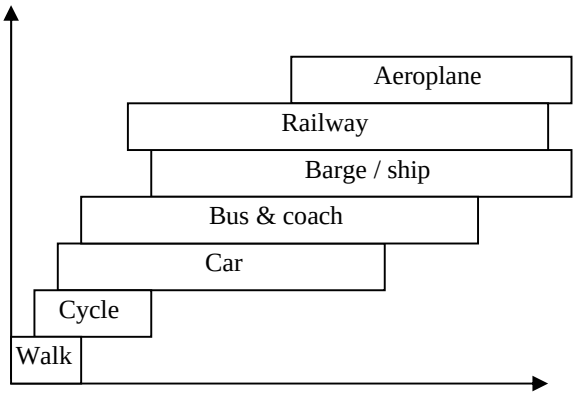
EMRI view is that the Commission must incorporate analysis of measures that are effective in achieving the objective mentioned in the ToR, viz "more efficient cost-reflective price signalling in the market, particularly at peak times".

Energy Efficient Transport

EMRI view is that an inquiry into energy efficient transport should start by looking at the question whether Australia has got the correct mix of transport modes, as getting the mix wrong perpetuates transport inefficiency, and improving a particular part of the sub-optimal mix will only be tinkering at the edges.

What constitutes an economically efficient mode of transport depends largely on distance to be travelled. The following figure comes to mind:

Each mode of transport requires some or more supporting infrastructure, eg roads for cars, railway lines for railways, river or sea access for transport by barge / ship.



A large continent like Australia needs affordable air travel facilities and airlines like Virgin has shown that such business is viable. Unlike in Europe, the Australian rivers have not been developed for barge / boat transport due to poor planning in the past.

Poor coordination between state and federal governments have held back the proper development of a unified and viable railway system in Australia. The strong lobby efforts from interested parties like the automobile clubs and truckie organizations have tended to distort the evaluation process, compounded by ideological differences that have tended to focus attention on public ownership and labour unions rather than inspired planning and adequate funding. The lobby groups have missed the point that governments raise revenue from possible alternatives (eg income taxes, exercise duties, land & financial transaction taxes, royalties, etc) and there is no intention that specific revues streams should be devoted to the underlying industry / user group. Aggregate asset base servicing the road system (including land values, traffic control systems, public lighting, etc) would definitely be substantially higher than for the rail system. Given the capacity for the

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railways to more efficiently transport most general requirements like food, clothing and shelter requirements of the population, passenger numbers should not be the sole criteria for assessment. Efforts by companies like Toll Holdings and Patrick Corporation to develop complementary facilities like inter-modal transfer points, break-bulk / distribution whare houses and re-distribution fleets, clearly demonstrate what has been lacking in past transport planning. The fact that the National Road Transport Commission (NRTC) was set-up by the Council of Australian Governments only in 1992 and two years later was reconstituted as the National Transport commission (NTC) show how ad-hoc transport planning in Australia has been up to now.

Public transport by means of tram, bus and coach is another area that needs emphasis. The legacy of trams in Melbourne is a good example. Their continued expansion speaks volumes. Buses in Hobart needs special mention as a system that works well and is heavily patronised due to their punctuality and low cost. Maybe their success stems from the lower per capita income in Tasmania and the foresight of the economic regulator.

Walking and cycling in the course of normal economic activity (going to and from work, going to the shops, or the playing field instead of going by car or 4 wheel drive) have the lowest public and private economic cost, and proper evaluation would not be complete without giving due consideration to the public and private benefit of the resulting exercise – which so many Australians including the Prime Minister engage in with no other purpose than for exercise.

Earlier discussion noted that Australia was fortunate in having ample supplies of LPG while needing to supplement own production of other petroleum products with imports. Although the Draft Report mentions (page 210) that evaluation of alternate fuel sources is beyond the scope of the current inquiry, EMRI suggests that the PC will not be following it's mandate if it did not consider 'policy options for improving energy efficiency in the transport sector'. There is a significant public / private benefit in encouraging greater use of LPG in vehicles and measure worth pursuing include:

- Requiring car manufacturers / importers provide prospective customers the choice of normal petrol / diesel or LPG models;
- requiring petrol dealerships stock and serve LPG at increasing number of outlets in gradually shrinking designated areas in a manner designed to provide adequate cover within each designated area according to a given time-table.

The next step change in realising the potential for energy efficient transport comes from the use of compressed natural gas (CNG) in vehicles. After considerable trials, commercial use of CNG has started with large vehicles such as trucks and buses, albeit on a small scale. The federal government provides a subsidy for converting buses and trucks to run on CNG and extends the Diesel and Alternative Fuels Grant Scheme (DAFGS) to eligible vehicles to receive a fuel rebate of 12.132c/m3 for each m3 of CNG purchased. What is now needed is to provide subsidies so that CNG filling points can be made available at many more locations.

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Attachment A

Electricity Markets Research Institute (EMRI) undertakes research with primary focus on:

- Public benefit aspects of competitive electricity markets:
- Technical and market efficiency,
- Equity issues,
- Transition issues going from integrated utility in a monopoly market to competitive marketing.

Other research & consultancy work cover:

- demand side response in the context of the electricity pool market;
- retail pricing and value studies;
- distributed generation;
- network and ancillary services pricing.

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Biography of Lasantha Perera, Director - National Electricity Markets Research Institute

September 2001 to January 2004, was Assistant Director at the Office of the Tasmanian Energy Regulator responsible for setting up the Performance Monitoring and Reporting section and providing technical advise to the Regulator. Also provided technical and secretarial support to the Reliability and Network Planning Panel responsible for setting standards for the Tasmanian power system and making recommendations to the Regulator on network investment proposals

Until July 1999, was Manager Pooling with Eastern Energy Ltd. Played a significant part in the deliberations of various bodies connected with the setting up of the National Electricity Market, including membership in the Dispatch and Pricing Reference Group. Was a founding member of the National Retailers Forum and have made many submissions to NEMMCO, NECA and the ACCC on different facets of the National Electricity Market.

Was inducted into Eastern Energy at its inception in 1994 and as Manager Pricing and Forecasting set up their Pricing and Forecasting section, participated actively in the trade sale process and managed the contestable customer pricing process.

As Pricing Analysis Manager with SECV spent seven years working on pricing development, cost of supply studies and the development of industry cost models, and defining price paths to reduce cross-subsidies. Was an active participant in the Victorian Electricity Supply Industry Restructuring process involving industry codes, Tariff Order and network pricing.

Has a MSc in Technological Economics from the University of Stirling in Scotland, is a Chartered Engineer from both the Electrical and Mechanical Institutes in the UK. Has over 35 years experience as an engineer / techno-economist, with work experience covering electricity generation, distribution, contracting, engineering jobbing, co-generation plant maintenance and R&D into renewable energy sources.