Comments on Resource Adequacy in the Australian Competitive Electricity Industry

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***Abstract*-- Resource adequacy is a complex concept in a competitive electricity industry. In principle, end-users should purchase their preferred levels of assurance for future availability and quality of supply in a competitive commercial environment. However, competitive electricity industry design may never become sufficiently sophisticated to support this concept. An interim objective is to design and implement a consistent, efficient and compatible set of regimes for managing security, commercial trading, industry regulation and policy formation. The Australian competitive electricity industry design illustrates this approach and is described and discussed in these comments. Its strengths include a real-time spot market that implements a security-constrained dispatch and is interfaced to a strong security management regime. Its weaknesses include the lack of a formally designed derivative market, excessive reliance on demand forecasting and as yet limited active end-user participation. Its robust performance to date will be tested as temperature-sensitive load grows and greater reliance is placed on non-storable renewable energy fluxes.**

***Index Terms*-- competitive electricity industry, resource adequacy, Australia.**

I. Introduction

An electricity industry consists of sets of generation, network, end-use and protection and control components. It operates by maintaining a continuous flow of energy from primary energy forms to end-use energy forms using electrical energy as an intermediate energy form.

The advantages of the electricity industry energy conversion chain include:

1. The versatility of electrical energy in conversion to and from other energy forms, and
2. The ease of transmission of electrical energy to resolve differences in the geographical distributions of primary energy resources and end-use applications.

The disadvantages of the electricity industry energy conversion chain include:

1. The potential for rapid changes in operating conditions due a lack of cost-effective electrical energy storage coupled with its transmission at the speed of light.
2. The institutional challenges in designing, planning, operating and funding electricity industries of large geographical scope and complexity.

In essence, an electricity industry has to operate continuously as a single, fragile machine made up of a very large number of generation, network, end-use and protection and control components that may be owned and operated by many different industry participants.

Moreover, the industry must continue to operate effectively while being continually modified as participants connect and disconnect individual components, invest in new components and retire old ones. This requires technical rules for connection that are appropriate for the role that each component may play, with detailed requirements and protocols for large, critical components, while supporting “plug and play” for small components.

The concept of resource adequacy implies that the electricity industry “machine” should meet reasonable social expectations that it will continue to operate effectively into the near and then long term future. In the traditional regulated monopoly model, each vertically integrated electricity supply industry was given an “obligation to serve” and considerable discretion to meet that obligation. That approach usually provided reasonable reliability but also often expensive electricity supply.

Resource adequacy is a more complex concept in a competitive electricity industry. In principle, electricity industry design and operation would be handed over to market processes. Thus, end-users should be able to purchase their preferred levels of assurance for future availability and quality of supply in a competitive market. However, electricity market designs may never be sophisticated enough to support this concept.

An interim objective for a competitive electricity industry is to design and implement a consistent, efficient and compatible set of regimes for managing security, commercial trading, industry regulation and policy formation. This set of regimes may be characterized as a decision-making framework that is designed to ensure that the electricity industry “machine” continues to operate effectively while continuing to evolve. This is to be achieved by assigning authority and accountability in a coordinated and appropriate manner to those decision-makers who are best placed to understand and manage the risks associated with each decision, while providing clear and appropriate interfaces between decision-makers.

Table I sets out the various decision-making regimes for a competitive electricity industry. While the broad characteristics of these regimes can be readily defined, detailed specifications are much more complex and the interfaces between the regimes must also be carefully

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TABLE I. DECISION-MAKING FRAMEWORK FOR A COMPTEITIVE ELECTRICITY INDUSTRY

Regime	Role
Governance regime	The set of formal institutions, legislation and policies that provide the framework in which a competitive electricity industry operates. This includes the formal regulatory arrangements for industry participants as well as the broader social context in which the industry operates. It may involve more than one national jurisdiction.
Commercial regime	The commercial arrangements for the competitive electricity industry. This may include spot and derivative markets for electrical energy as well as ancillary service markets and commercial interfaces for regulated industry participants, such as network service providers.
Technical regime	The set of rules that allow the various components of an electricity industry, when connected together, to function effectively as a single machine, providing a continuous flow of electrical energy of appropriate availability and quality between generation and end-use equipment, tracking decision-maker targets, rejecting disturbances and degrading gracefully if equipment faults occur.
Security regime	The task, assigned to one or more system operators, of maintaining the integrity of a local or the industry-wide core of an electricity industry in the face of threats posed by plausible large disturbances. The security regime typically has authority to restrict and, if necessary, override the commercial regime in defined circumstances. For example, it may direct participants to operate their components at specified levels and, under defined circumstances, disconnect components.

Competitive electricity industries now face a number of emerging challenges that will test the interpretation of resource adequacy and the robustness of their decision-making frameworks in efficiently managing uncertainty:

1. There are a number of electricity industries of continental scale that involve several countries. These combine engineering complexity with institutional and legal complexity.
2. Constraints on fossil fuel energy flows are appearing due either to physical flow constraints (eg ‘peak oil’) or a need to contain environmental impacts such as climate change.
3. Partly in response to climate change and high fuel prices, there is increasing use of embedded generation connected to distribution networks, which introduces new technical, regulatory and commercial challenges.
4. Reliance on non-storable renewable energy forms is increasing for similar reasons, with associated uncertainties in energy flows that will need efficient management.

II. THE AUSTRALIAN ELECTRICITY INDUSTRY DECISION-MAKING FRAMEWORK

Reference [1] discusses the underlying principles for, and experience to date with, electricity industry restructuring in Australia. Key features of the decision-making framework are set out in the following sub-sections, using the regime roles defined in Table I.

A. *Governance regime*

1. The Council of Australian (Federal and State) Governments plays a key role in the policy formation process, enhancing uniformity and consistency in the governance regime.
2. Uniform industry-specific legislation, the National Electricity Law (NEL) defines the decision-making framework for the electricity industry, including commercial, technical, security and regulatory arrangements. The specific details of these arrangements are set out in the National Electricity Rules, which are managed and further developed by the Australian Energy Market Commission.
3. The Australian Energy Regulator implements a consistent regulatory regime for transmission network service providers and is also scheduled to assume this role for distribution network service providers over the next few years.

B. *Commercial regime*

1. The National Electricity Rules set out the design of a uniform National Electricity Market. This includes a real-time set of spot markets for energy and frequency-related ancillary services that implements a security-constrained dispatch and is interfaced to a strong security regime. The National Electricity Market Management Company (NEMMCO) is both the market and system operator and thus has responsibility for implementing both the security regime and the short-term aspects of the commercial regime.
2. The long-term commercial regime is implemented via spot market derivatives and is largely left to the commercial participants to organize in conjunction with financial market providers.
3. There are supplementary markets in environmental instruments at both state and federal levels.

C. *Technical regime*

1. The National Electricity Rules contain uniform rules for connection for generators and loads. The complexity of the requirements depends on component size. These call on national and international standards where appropriate.

D. *Security regime*

1. As indicated above, NEMMCO is both the market and system operator. Its security management powers extend with decreasing authority from a very strong role in the

short-term to an information-provision role on a daily basis to a two-year horizon and on an annual basis to a ten-year horizon. The intent is to allow competitive processes to manage the investment aspects of resource adequacy, supported by the energy-only spot market design and the associated derivative markets.

III. Experience to Date with Resource Adequacy in the Australian National Electricity Market

Each year, NEMMCO releases a Statement of Opportunities incorporating an Annual National Transmission Statement [2]. These formally prepared and jointly published companion documents report to a ten-year horizon on projected overall supply-demand balance and major transmission flow constraints respectively. All Australian governments and all electricity industry participants contribute to this process, according to procedures and obligations set out in the National Electricity Rules.

Each year, these documents predict that in a few years time, constraints will emerge in both overall supply-demand balance and in transmission capacity [2]. This is to be expected in an electricity industry with growing demand and a relatively low reserve margin. However to date, experience has shown that those emerging constraints have been deferred by investment in generation and network capacity. Achieved transmission-level reliability, which is also reported on annually [3], has remained within target levels since the start of the National Electricity Market in 1998. NEMMCO anticipates that similar achievements will continue [2].

IV. Future Challenges

Increasing use of temperature-sensitive load such as air-conditioning is testing the design of the decision-making framework for the Australian electricity industry. This is because it is worsening the load shape and increasing its uncertainty and, as a result, increasing the cost of electricity supply and placing upwards pressure on retail prices. Key policy responses include encouraging enhanced end-use energy efficiency, extending the use of interval meters to small commercial and residential end-users, encouraging innovation in retail pricing arrangements, and encouraging active end-user participation in the electricity industry. There is reasonable consistency in policy responses between State and Federal governments.

Climate change presents another major challenge. To date, Australia has relied heavily on low-cost coal-fired power stations to meet base load. Australia also has abundant natural gas and renewable energy resources, however these are more expensive than coal in terms of direct costs. While there is some policy support for low-emission generation, this is not yet consistent between State and Federal governments, nor is it particularly effective.

Moreover, growing reliance on non-storable primary energy resources such as wind and solar energy, will introduce additional ambiguity into the meaning of resource adequacy and additional uncertainties for the decision-making framework to manage. In that regard, NEMMCO has recently taken an important step in issuing a call for proposals to provide an Australian Wind Energy Forecasting System [4] that is designed to be compatible with NEMMCO's security management responsibilities.

V. Conclusions

Resource adequacy is a complex concept in a competitive electricity industry that has more to do with defining and implementing a decision-making process than targeting a specific outcome. In time, it may be possible to complete devolve the management of resource adequacy to a commercial environment in which end-users purchase their preferred levels of assurance for future availability and quality of supply. However, competitive electricity industry design may never become sufficiently sophisticated to support this concept. At present, it is more practical to design an overarching decision-making framework for an electricity industry, which implements coordinated and compatible regimes for governance, commercial arrangements, technical requirements and security management.

A coordinated regime of this kind has been implemented in association with the Australian National Electricity Market and has delivered target levels of reliability since market inception in 1988. However, the robustness of these arrangements is now being tested by growing use of temperature-sensitive load such as air-conditioning and by the need to reduce climate change emissions. Key policy responses to date include encouraging enhanced end-use energy efficiency, extending the use of interval meters to small commercial and residential end-users, encouraging innovation in retail pricing arrangements, and encouraging active end-user participation in the electricity industry. In addition, an Australian Wind Energy Forecasting System has now been specified and put out to tender.

VI. Acknowledgment

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VIII. Biographies

Hugh Outhred (M'1968) was born in Sydney Australia in 1947. He holds BE (Elec) Hons 1, BSc and PhD degrees from the University of Sydney.

He has held academic appointments at the University of New South Wales since 1973 where he is now Presiding Director, Centre for Energy and Environmental Markets.

Since 1979, Hugh has contributed to the theory of electricity industry restructuring and to its design and implementation in Australia. In 1985 and 1986, he was seconded to the Energy Authority of New South Wales as an advisor on electricity restructuring, energy planning and renewable energy. In 1995 and 1996 he led a project for the National Grid Management Council to undertake electricity-trading experiments to trial the proposed National Electricity Market trading rules prior to their formal implementation. He was a member of the NSW Licence Compliance Advisory Board throughout its existence from 1997 to 2000 and a member of the National Electricity Tribunal throughout its existence from 1998 to 2006.