National Electricity Law (Schedule to the National Electricity (South Australia) Act 1996) and the National Electricity Rules applied as a law of New South Wales by the National Electricity (New South Wales) Act 1997

IN THE DISPUTE RESOLUTION PANEL AT SYDNEY

Between

Macquarie Generation

Applicant

and

National Electricity Market Management Company Limited ACN 072 010 327

Respondent

JOINT SUBMISSION TO

THE DISPUTE RESOLUTION PANEL

A Glossary

1. A number of terms and acronyms are used throughout this Submission.

2. Many of the terms used in this Submission are defined in the National Electricity Rules (***Rules***) and, for ease of reference, they are italicised in this Statement.

3. **Schedule 1** of this Submission contains a Glossary for those terms and acronyms that are not defined in the *Rules*.

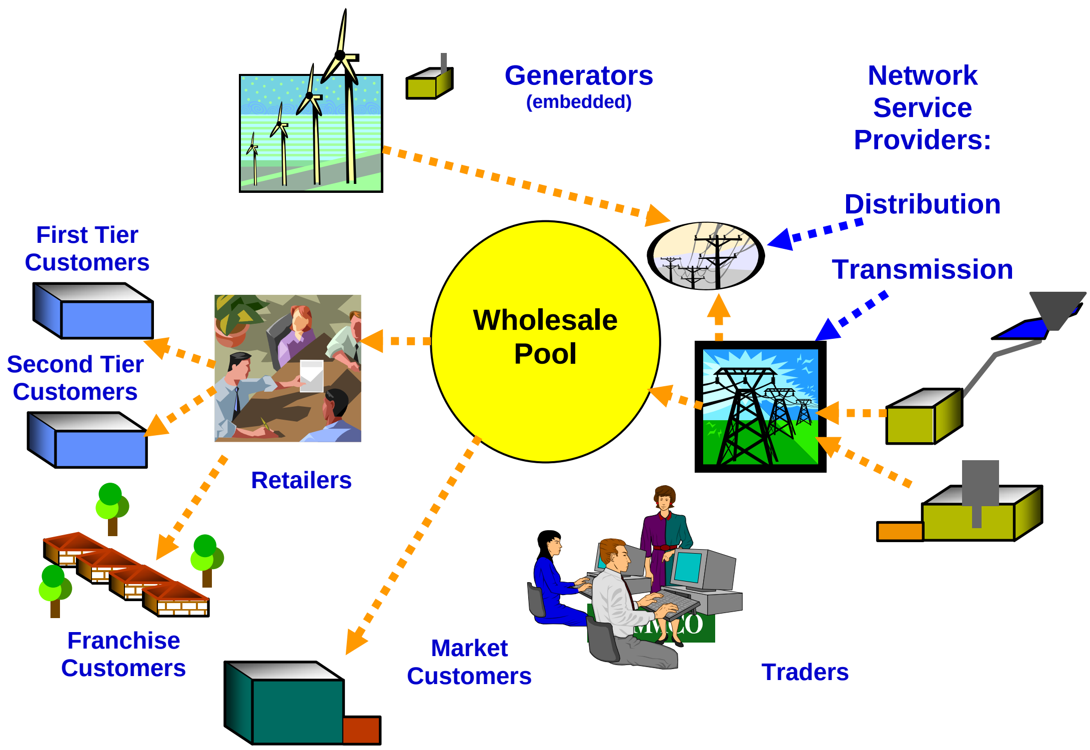
B NEMMCO and the National Electricity Market (NEM)

4. *NEMMCO* operates and manages the *NEM*. The *NEM* is essentially two things: It is the physical infrastructure that keeps electricity flowing from producers to consumers, and it is also a notional wholesale pool (or spot market) to which producers sell, and from which purchasers buy, electricity.

5. Electricity cannot be stored economically; it must be dynamically produced to satisfy demand that varies instantaneously. The *NEM* facilitates the instantaneous matching of supply and demand through a centrally co-ordinated process managed by *NEMMCO*.

6. **Figure 1** depicts the relationships between different participants in the *NEM*.

Figure 1 – The National Electricity Market



7. The *NEM* is a gross pool. This means that all *Generators* whose power output enters the grid must "sell" their output via the market conducted by NEMMCO, unless they are embedded in a distribution network and they have already sold their output to the local retailer for that network or to a *Customer* located at the same *connection point*. Also, all *Generators* whose capacity is greater than 30MW must participate in a central dispatch process operated by

NEMMCO, which controls when and how much power they may send into the NEM.

8. In geographic terms, the *NEM* covers the supply of electricity to South and Eastern Australia. It operates on one of the world's longest interconnected power systems, a distance of more than 4,000 kilometres.

9. The *NEM* is divided into six *regions* for *market* pricing purposes. They are:

   (a) Queensland;

   (b) New South Wales (which incorporates the Australian Capital Territory);

   (c) Snowy (which is close to the border of New South Wales and Victoria);

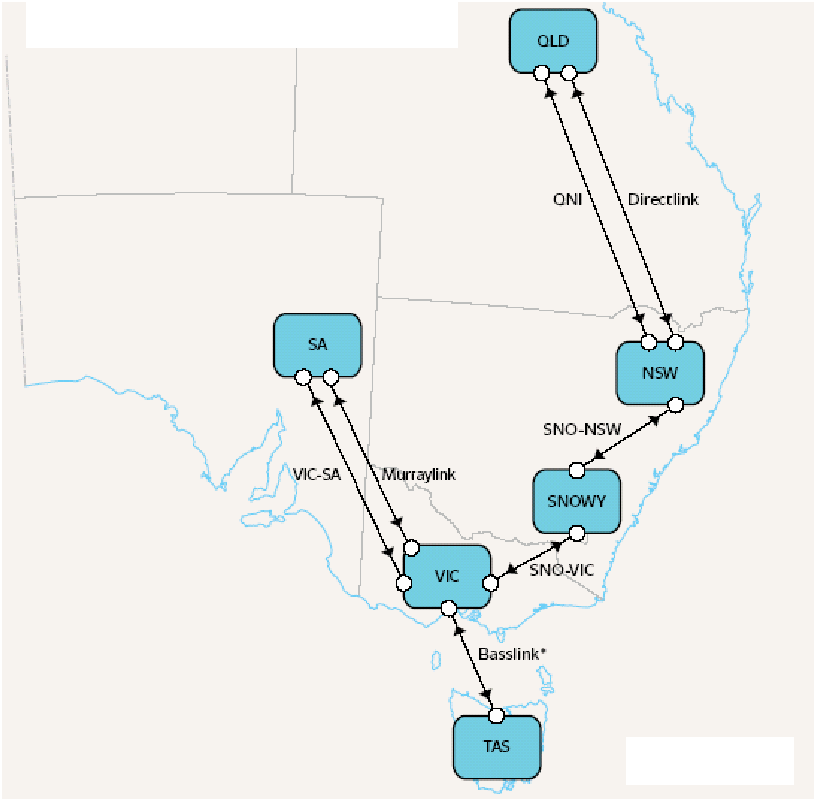
   (d) Victoria;

   (e) South Australia; and

   (f) Tasmania.

10. Each *region* is *connected* to its adjacent *regions* by *interconnectors*, which are a series of *transmission lines* that facilitate the flow of electricity between *regions*. **Figure 2** shows the *interconnectors*.

Figure 2 – Interconnectors in the NEM



11. A number of different types of organisations can participate in the *NEM*. These are called *Registered Participants.* Some are registered in their capacity as providers of infrastructure, such as *Network Service Providers* (**NSPs**) while others participate in the wholesale electricity exchange as *Market Participants*, buying and selling electricity.

12. The *Rules* allow potential participants in the NEM to register in a number of different categories. For example:

    (a) *Scheduled Generators*, who participate in the *central dispatch* process. Generally these are *Generators* with *generating units* whose nameplate rating is greater than 30 MW.

    (b) *Non - Scheduled Generators*, who are typically *Generators* with *generating units* whose nameplate rating is less than 30 MW and do not participate in the *central dispatch* process.

    (c) Generators that sell all of their electricity into the spot market are registered as *Market Generators*. *Market Generators* are paid the spot price applicable at their network connection for each trading interval during which they supply electricity to the market. A Generator that sells its entire output to either a *local retailer* or consumer located at the same *connection point* is classified as a *Non-Market Generator.*

13. Macquarie Generation is and was at all material times registered as both a *Market Generator and a Scheduled Generator*. That is, it sells its output through the NEM, and its output is controlled by the NEM scheduling process.

C The Regulatory Framework

14. The *NEM* is regulated by the *National Electricity Law* (**Law**), a schedule to the National Electricity (South Australia) Act 1996 that has been extended to each of the *participating jurisdictions* through the use of a co-operative legislative scheme. The National Electricity Rules (***Rules****)* were made under the Law; subsequent changes are approved by the *AEMC*.

15. Under the Law, *NEMMCO* has two core functions: power system operator and wholesale market operator.

16. As power system operator, *NEMMCO* is concerned primarily with meeting standards of security and reliability. *Power system security* refers to the *power system* operating within its technical limits so that *plant* is not damaged and the *power system* does not collapse. *Power system* reliability refers to there being enough supply to meet consumer demand.

17. As market operator, *NEMMCO* facilitates the wholesale trading of electricity through a centrally co-ordinated *dispatch* process.

D Central Dispatch

18. *Central dispatch* refers to the centrally-managed process of *dispatching* electricity to meet demand. *NEMMCO* manages this process in accordance with Chapter 3 of the *Rules*.

19. C*entral dispatch* should aim to maximise the value of *spot market* trading on the basis of *dispatch offers* and *dispatch bids* (that is, the lowest cost *generating units* needed for electricity supply to meet demand are *dispatched*) subject to a number of matters, such as *network constraints* and *power system security* requirements (clause 3.8.1(b)).

20. To participate in the *central dispatch* process, *Scheduled Generators* must submit *dispatch offers* to *NEMMCO* to *generate* electricity. These offers must

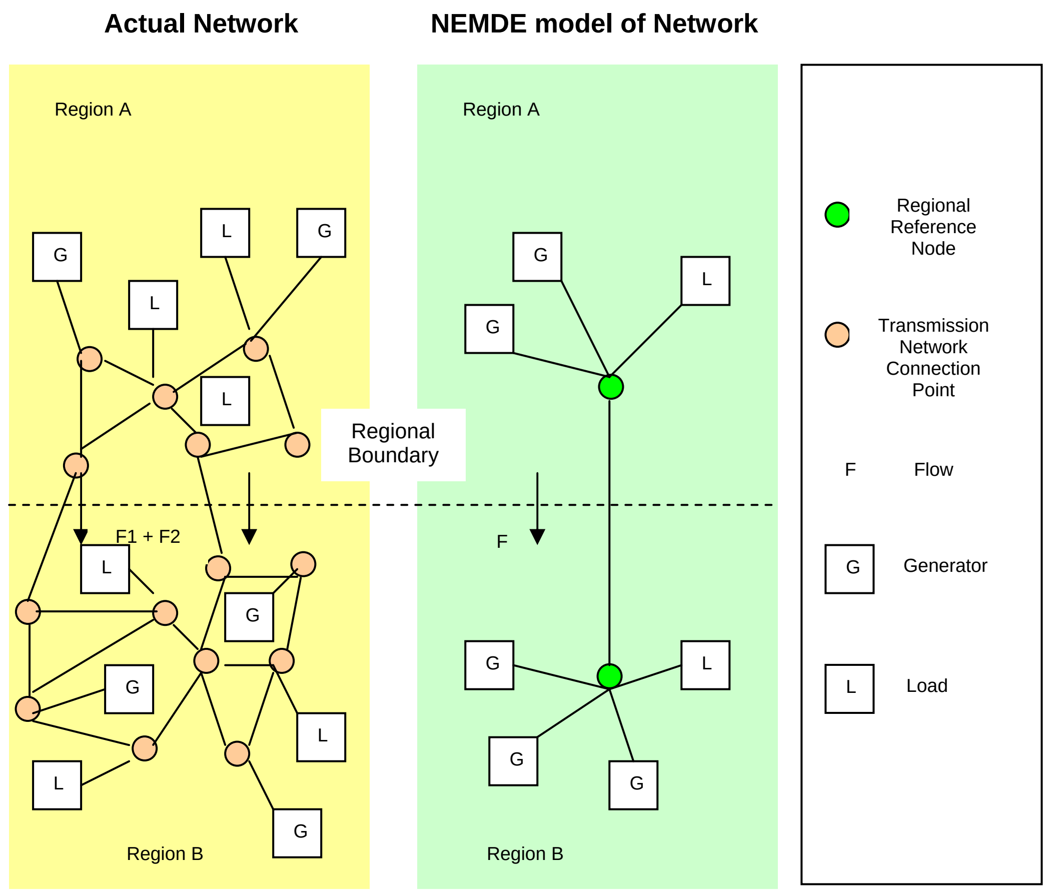
be submitted by 12:30 *EST* on the day before trading will occur. In each *dispatch offer*, *Scheduled Generators* must make an offer to provide a certain number of megawatts **(MW)** of electricity for each of the following 48 *trading intervals* and may make offers for up to ten (10) price bands for each *generating unit*.

21. A *Generator* can own one or more *generating units*. Unless *NEMMCO* approves an application to aggregate these into a single entity for bidding purposes, *NEMMCO* receives bids for, and then determines loading levels (**dispatch instructions**), on an individual *generating unit* basis.

22. *Dispatch offers* are processed by a computer system called the National Electricity Market Dispatch Engine (**NEMDE**).

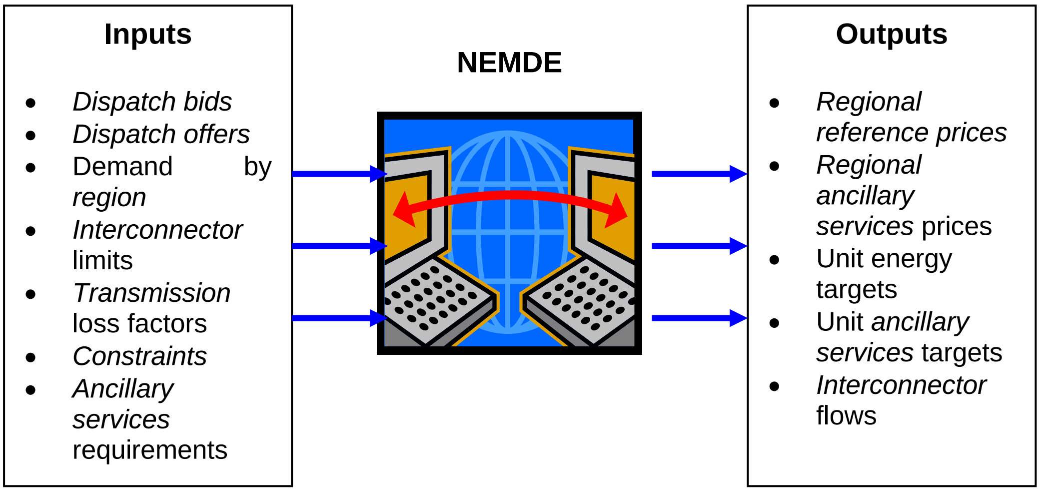
23. NEMDE is based on a constrained optimisation program that uses linear programming techniques that represents the *power system* in a manner that is reflected in **Figure 3**:

Figure 3 – How NEMDE Represents the Interconnected Network



24. *NEMMCO* forecasts electricity consumption in each *region*, identifies the capability of the *transmission network* to transmit electricity, and captures the present state of the *power system* from information provided by TNSPs. *NEMMCO* then determines the *generation* outputs for each *Generator* according to an overall optimisation process that is specified in the *Rules* and, in practice, performed by NEMDE. A simplified form of this optimisation process is depicted in **Figure 4**:

Figure 4 – NEMDE Optimisation Process



25. The optimisation process attempts to maximise the value of electricity traded and produces a *spot price* in each *region* that represents the marginal price of producing the next increment of electricity at that location.

26. The highest price *Scheduled Generators* can offer is $10,000 per MWh (also known as ***Value of Lost Load*** or ***VoLL***) and the lowest is -$1,000 per MWh (***market floor price***). *Scheduled Generators* must specify other technical matters in their *dispatch offers*, such as their rate of change for increasing or decreasing their output in MW/minute (***ramp rate***).

27. *NEMMCO* sends the *Scheduled Generators* a *pre-dispatch schedule* every 30 minutes. A *pre-dispatch schedule* is essentially a forecast that gives *Scheduled Generators* an indication of their expected *dispatch* schedule, when they will be *dispatched,* and for what level of output they will be *dispatched* for the *trading intervals* in the next two days. *Scheduled Generators* then have the opportunity to *rebid* the MW capacity that they can produce and other technical aspects of their capacity right up to 5 minutes before the event, but cannot change the prices for the ten price bands they have selected.

28. NEMDE sends the *Scheduled Generators* electronic dispatch instructions to increase or reduce the quantity of electricity they produce for each *dispatch interval*.

29. NEMDE will process all the data it has available to achieve the lowest cost and most efficient outcome taking into account *power system* limitations. In general, and without considering the impact of *constraints*, ramp rate and other limitations for each *dispatch interval*, *Scheduled Generators* will be *dispatched* in ascending price band order until enough electricity has been produced to meet the demand for electricity for that *dispatch interval*.

30. The *spot price* for a *trading interval* is the average of the six (6) *dispatch interval* prices within that *trading interval*.

31. All of the *Generators dispatched* during that *trading interval* will be paid the *spot price* times their loss factor for the energy they have produced in that *trading interval*, even if their *dispatch offers* were for a lower price. Any *Generators* whose offers were too expensive and were not needed to meet the demand were not *dispatched* and, consequently, do not get paid. In this way, the wholesale exchange encourages competition between *Scheduled Generators*.

E Impact of Power System Security on Dispatch

32. *NEMMCO's* obligation under clause 3.8.1 of the *Rules* is to manage c*entral dispatch* in order to balance supply and demand while using reasonable endeavours to maintain *power system security* and to maximise the value of spot trading*.*

33. *NEMMCO* is required by clause 4.3.2 of the *Rules* to use its reasonable endeavours, as permitted under the *Rules*, to achieve certain responsibilities in accordance with certain principles. One such principle is that, to the extent that this is practicable, the *power system* should be operated such that it is and will remain in a *secure operating state*. The requirements for the *power system* being in a *secure operating state* include that, in *NEMMCO's* reasonable opinion, it is in a *satisfactory operating state* and that it will return to a *satisfactory operating state* following the occurrence of a single *credible contingency event* (clause 4.2.4). The *power system* will be in a *satisfactory operating state* if certain parameters are satisfied, such as frequency and voltage.

34. The effect of this requirement is that the *power system's* physical limits can impact which *Scheduled Generators* are *dispatched*, not just their *dispatch prices*. For example:

(a) *power system* plant, such as *interconnectors* and *transmission lines*, can only carry a certain amount of electricity before they become overloaded;

(b) *power system* plant may require planned *outages* to enable their owners/operators to service and maintain them; and

(c) *power system* plant may experience unplanned failures (**trip**).

35. To identify potential *constraints* on the *power system* arising from the non-availability of *power system* assets, *Scheduled Generators* and NSPs are required to notify *NEMMCO* of planned *outages* for up to two years in advance. The impact of these is included in the *Medium Term Projected Assessment of System Adequacy* published by *NEMMCO* on a weekly basis. In addition, every two hours, *NEMMCO* publishes the *Short Term Projected Assessment of System Adequacy*, which includes the impact of expected outages for the next seven (7) days.

F Constraints

36. TNSPs provide *NEMMCO* with limit equations that are reviewed and used by *NEMMCO* to develop constraint equations to ensure that *transmission lines* are operated within their limits, and that the *power system* is secure.

37. Limitations on the *power system* are represented in NEMDE as a series of mathematical constraint equations.

38. There are constraint sets containing constraint equations that represent the *power system* for "system normal" conditions and many others to represent a range of single and multiple *transmission* circuit *outages.*

39. The constraint sets that are invoked at any particular time are selected from a library to approximate the *power system* conditions at that time.

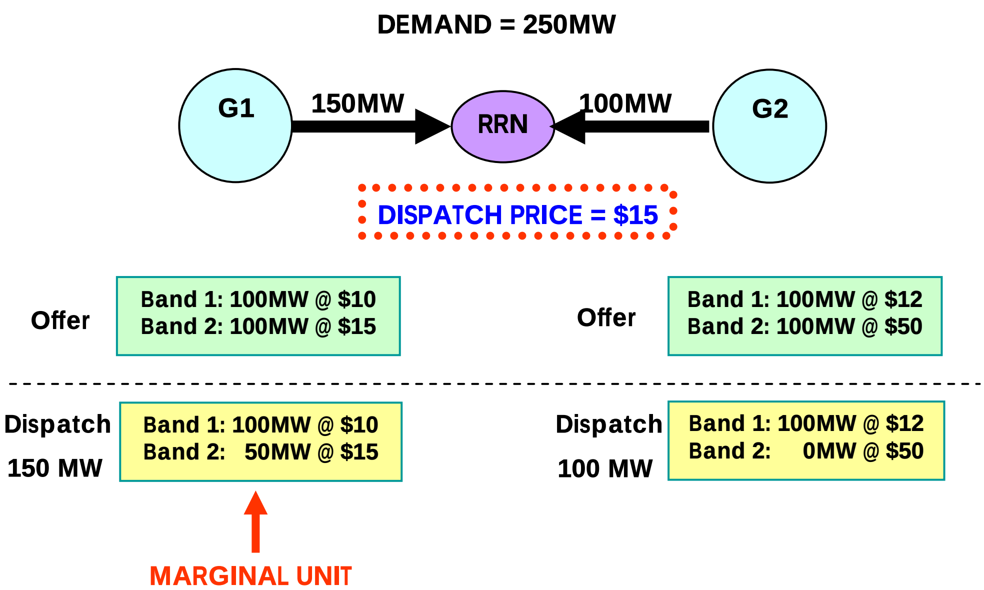
40. Constraint sets are used by NEMDE to model what the *transmission network* is capable of doing during each *dispatch interval* in an effort to ensure that *power system security* is maintained.

56. The need for constraint equations by NEMDE to model what the *transmission network* is capable of doing gives rise to certain risks for *Market Participants*:

- Volume risk – *Generators* might not be able to *generate* as much electricity as they had anticipated due to *constrained transmission lines*;
- Price risk – *constraints* can cause price separation between *regions*. This means that, in any *trading interval*, *Market Participants* can be affected by more than one *spot price*.

57. How these risks manifest in practice is best illustrated by way of example: **Figure 5** shows two *generating units* in a *region* whose demand is fixed at 250MW. Generator G1 offers its capacity of 150MW in two bands: 100MW @$10 and 100MW @$15; Generator G2 offers its capacity of 100MW in two bands: 100MW @$12 and 100MW @$50. Generator G1 is *dispatched* first for 100MW @$10, and then Generator G2 is *dispatched* for 100MW @$12. The remaining 50MW is *dispatched* at the next cheapest price, which is G1's offer @$15, which also determines the *dispatch price* for that *dispatch interval*.

Figure 5 – Example

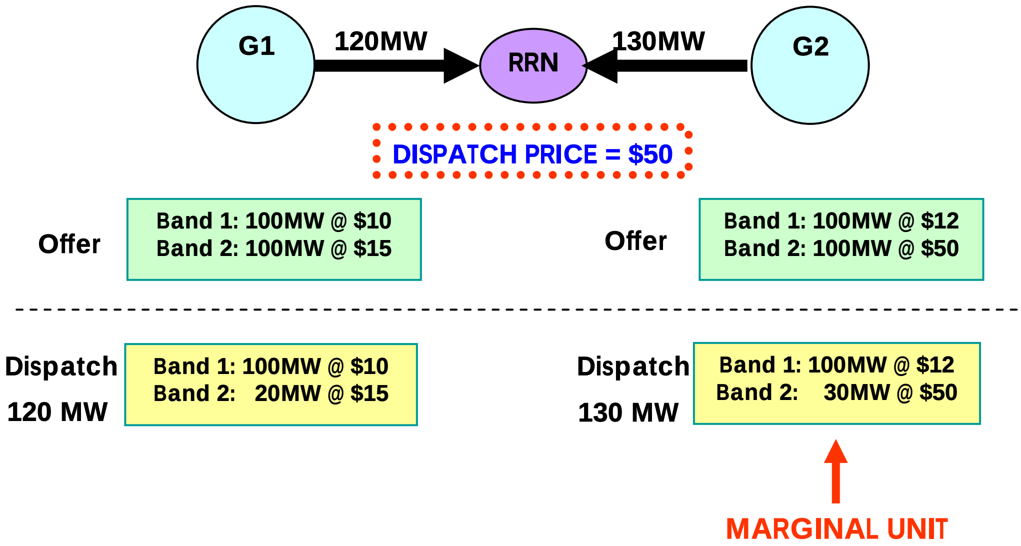


58. If this simple situation were to be complicated by the existence of a *constraint* on the *transmission line* linking Generator G1's *generating unit* to the *power system* such that flow on that *transmission line* had to be limited to 120MW or less, NEMMCO would formulate a constraint equation to address this. The simplest form of constraint equation could be formulated:

G1 <= 120MW

59. If G1 <= 120MW were to be used by NEMDE, demand would be met in the following way. Generator G1 would *dispatch* 100MW @$10, then Generator G2 would *dispatch* 100MW @$12, but because the *constrained transmission line* can only carry an extra 20MW, Generator G1 would only be permitted to *dispatch* another 20MW @$15, with the remaining 30MW coming from Generator G2 @$50. The *dispatch price* for the *dispatch interval* would be $50. This is illustrated in **Figure 6**:

Figure 6 – Example (continued)



60. At times, NEMDE will be forced to *dispatch Scheduled Generators* into higher price bands than would otherwise be required because of the constraint equations that are invoked at the time, so as to ensure that the *power system* is not overloaded and demand is met. Accordingly, the constraint equations in each *dispatch interval* may determine whether a *Scheduled Generator* is *constrained-on* or *constrained-off* in order to maintain *power system security*.

61. When a constraint equation is having an effect on *dispatch* of a generator and the equation is being complied with (or satisfied mathematically) the constraint equation is referred to as “binding”. If there is no feasible solution to the *dispatch* of *generation* that can satisfy all the applicable constraint equations, one or more constraint equations will be breached (or not satisfied mathematically). When this occurs, the relevant constraint equations are said to be “violating”.

62. There are usually several thousand constraint equations that in total define the “space” or “envelope” that the *dispatch* solution can lie within in order for the *power system* to be secure.

63. When the power system configuration changes, such as when a transmission circuit is taken out of service, a new set of constraint equations must be invoked for that particular situation. NEMMCO’s policy is to invoke outage constraint equation sets “on top” of (ie in addition to) the system normal set of constraint equations. This policy assumes that the technical envelope for an *outage* is more restrictive that the system normal envelope, and avoids the risks of identifying, concurrently revoking, and ultimately re-invoking the system normal set of constraint equations.

G Macquarie Generation Units

64. Macquarie Generation operates both Liddell and Bayswater Power Stations. Each station has four operating units, designated Units 1 to 4 at each station.

65. On the 22 October 2007, Units 1, 2, 3 & 4 at Bayswater and Units 2 & 3 at Liddell were in service.

H The Events of 22 October 2007

66. The 330kV *transmission* line 87 from Armidale to Coffs Harbour (**TL 87**) was out of service for a planned outage that commenced at 07:00.

67. During this *outage*, constraint equations commenced to drive power flows from Queensland to New South Wales and at the same time constrain off *generation* at Bayswater and Liddell in the Hunter Valley. The operation of those constraint equations was trying to limit the risks of overloading the 132kV *network* between Armidale and Kempsey.

68. The combined restriction on power flows from Queensland and *generation* in the Hunter Valley, together with an increasing power demand, required energy from other NSW generators to be dispatched, which were offered at higher prices. This resulted in prices reaching $9,700 per MWh in NSW.

69. The system normal set of constraint equations (for the *power system* with all elements in service) started binding from *dispatch interval* 7.30 and violated between *dispatch interval* 08:05 to *dispatch interval* 09:55 during the planned

outage of TL 87. Under the TL 87 prior outage condition, the system normal constraint equation was found to be unnecessarily restrictive on the controlled variables (eg Hunter Valley generation) since the coefficients in the constraint equation were not appropriate for the actual *power system* configuration with TL 87 out of service. The overly conservative constraint equation was removed at 9:55am and a modified equation that was robust against the *outage* of TL 87 was tested and invoked in time for *dispatch interval* 10:15. The revised constraint equation was designed to be automatically relaxed so that it could not bind when TL 87 was out of service.

70. *NEMMCO* has reviewed its management of the constraint equation replacement that occurred during the event. The constraint equation was identified by *NEMMCO* as having an impact on *dispatch* when it began to violate at around 08:00am and the issue was referred to off-line support staff. The overly conservative constraint equation was removed just prior to 09:55am for *dispatch interval* 10:00. *NEMMCO* formed the view that although the overly conservative operation of the system normal constraint equation could not have been reasonably foreseen at the time it was constructed or the *outage* was approved, *NEMMCO* staff could have acted more quickly to remove the overly conservative constraint equation to address the *dispatch* issue without compromising power system security under the circumstances of the day. *NEMMCO* considered that it would have been reasonable to expect that this overly conservative constraint equation could have been removed while still preserving *power system security* by 9:15am (or about one hour from when the off-line support staff became involved i.e. from dispatch interval 9:20), rather than leave the it in place until *dispatch interval* 10:00. The new constraint equation had been developed, tested and implemented in time for *dispatch interval* 10:15.

71. *NEMMCO* subsequently investigated these events and published a report "Market Event Report, 22 October 2007" dated 28th December 2007 attached as **Schedule 2**. In this report *NEMMCO*, under clause 3.8.24 of the *Rules*, declared that a *scheduling error* had occurred for the *dispatch intervals* ending 09:20 through to 10:00.

72. Had the *scheduling error* not occurred and the less conservative constraint equation replaced by *dispatch interval* 09:20, Macquarie Generation's

production from Bayswater and Liddell power stations would have rapidly increased, reaching full output by about 09:40am.

73. Between *dispatch interval* 09:35 and *dispatch interval* 09:55 the NSW *spot price* was more than $9,000 per MWh.

74. As a result Macquarie Generation's *spot market* revenue was reduced by $4,544,638 over what it would have been if the overly conservative constraint equation was replaced by 09:20.

I Calculation of Macquarie Generation's loss

75. The magnitude of the loss incurred by Macquarie Generation as a result of this *scheduling error* has been calculated by Macquarie Generation based on reductions in output (as generated MW) shown in the table below:

Time	Actual	Expected	Reduction	Sched Error?
9:05:00 AM	2,505	2,505	-	No
9:10:00 AM	2,468	2,468	-	No
9:15:00 AM	2,438	2,438	-	No
9:20:00 AM	2,411	2,718	307	Yes
9:25:00 AM	2,342	2,998	656	Yes
9:30:00 AM	2,322	3,275	953	Yes
9:35:00 AM	2,275	3,439	1,164	Yes
9:40:00 AM	2,240	3,440	1,200	Yes
9:45:00 AM	2,161	3,440	1,279	Yes
9:50:00 AM	2,078	3,440	1,362	Yes
9:55:00 AM	2,009	3,440	1,431	Yes
10:00:00 AM	2,217	3,440	1,223	Yes
10:05:00 AM	2,236	3,440	1,204	No
10:10:00 AM	2,333	3,440	1,107	No
10:15:00 AM	2,589	3,440	851	No
10:20:00 AM	2,798	3,440	642	No
10:25:00 AM	3,004	3,440	436	No
10:30:00 AM	3,185	3,440	255	No
10:35:00 AM	3,287	3,440	153	No
10:40:00 AM	3,272	3,440	168	No
10:45:00 AM	3,377	3,440	63	No
10:50:00 AM	3,394	3,440	46	No
10:55:00 AM	3,419	3,440	21	No
11:00:00 AM	3,440	3,440	-	No

76. These reductions were calculated on the basis of the following assumptions:

a. The expected total output of the *generating units* in service, that would have occurred if the *scheduling error* had not occurred was 2,438 MW (generated) for the *dispatch interval* ending 09:15, as this was the output of the plant in the period immediately prior to the *scheduling error* being declared.

b. From the *dispatch interval* ending 09:20 until the end of *dispatch interval* ending 10:00 the expected output of the *generating units* was 2,438 MW plus the increase in output that could be achieved if the units increased their output at nominated ramp rates. The expected output of each of the units would continue to increase at this rate until the total expected output reached 3,440 MW.

c. The nominated ramp rates for this calculation are based on the ramp rates that were bid for the period immediately following the *scheduling error*. Macquarie Generation advise that it is highly likely that these ramp rates would have been achieved as the Macquarie Generation traders would have been aware that the *spot prices* being forecast in *pre-dispatch* were in excess of $9,000 and they would have ensured that the plant achieved these ramp rates. The ramp rates that were bid are well within the technical capability of the *plant*.

d. The losses between the *generating units* and the *regional reference node* are assumed to be 6.17% for Bayswater and 6.13% for Liddell, in accordance with the published NEMMCO loss factors for the financial year 2007/08.

e. The amount of *energy* consumed in works is advised by Macquarie Generation to be 5.92% at Bayswater and 3.28% at Liddell, which is based on the *energy* that would have been consumed if the *scheduling error* had not occurred.

77. The loss incurred by Macquarie Generation during the *scheduling error* period is calculated using the following formula for each *trading interval* within the period of the *scheduling error* as declared by *NEMMCO*:

Loss = Spot price * (Expected output – Actual output) – avoided fuel cost

78. As shown in the table above, an additional loss was incurred as the *generating units* still remained below the expected level after the period of the *scheduling error,* due to the time period required to increase the rate of power output from the constrained level to a normal operating level. This loss has been calculated using the same formula.

79. The total loss incurred is the sum of the loss calculated in 77 and 78 above.

80. It should be noted that this loss calculation excludes losses that were incurred by Macquarie Generation in the *dispatch intervals* from around 08:05 until the commencement of the *scheduling error* period. Also the loss is reduced by the avoided fuel cost.

81. The detailed calculations of this loss are contained in the Spreadsheet attached In **Schedule 3**.

J Participant Compensation fund

82. Under Clause 3.16.1 of the *Rules*, *NEMMCO* is required to "*maintain, in the books of the corporation, a fund called the Participant compensation fund for the purpose of paying compensation to Scheduled Generators ... as determined by the dispute resolution panel for scheduling errors…".*

83. *NEMMCO* is required to pay to this fund contributions from certain *Market Participants* of no more than $1,000,000 per annum if the fund has a balance of less than $5,000,000.

84. The *Participant compensation fund* currently has a balance of $5,964,786.

85. Since the commencement of the *market* there has only been one payment made from the fund. This was an amount of $438,892 to Snowy Hydro Limited as compensation for a *scheduling error* that occurred on 31 October 2005.

86. There have been no other formal claims for compensation for *scheduling errors* in recent years. Since the incident on 22 October 2007, *NEMMCO* has not declared any further *scheduling errors*. However, *NEMMCO* has been advised by another *Market Participant* that it is seeking legal advice to establish whether a problem it has been raising constitutes a *scheduling error*. The participant has made an unsubstantiated comment to *NEMMCO* that it had been disadvantaged by more than $7 million. *NEMMCO* is not aware of the legal reasoning on which it is being asserted that *scheduling error* arose. No further indication has been received from the participant since 7 February 2008.

87. If the compensation was paid for the full amount of Macquarie Generation's loss, the balance in the fund would be $1,420,148.

88. Under clause 3.16.1(c) of the *Rules* and the current Participant Fee Determination, *NEMMCO* will be able to increase this to $1,420,148 plus $1,000,000 by 30 June 2009, subject to no further claims being made against the fund.

89. Macquarie Generation seeks compensation to cover its full loss of $4,544,638. *NEMMCO* does not oppose this.

K Issues for Dispute Resolution Panel

90. *NEMMCO* has already determined, under Clause 3.8.24(a)(2) of the *Rules*, that a *scheduling error* has occurred.

91. The matters to be determined by the Dispute Resolution Panel (**DRP**) are:

   a. the amount of compensation to be paid to Macquarie Generation for its loss (under Clause 3.16.2(d) of the **Rules**); and
   b. the manner and timing of that payment (under Clause 3.16.2(i) of the **Rules**).

92. In making its determination, the DRP must use the *spot prices* which were determined by the central dispatch process pursuant to Clause 3.9 of the *Rules*;[1]

93. The DRP needs to also take into account the matters referred to in Clauses 3.16.2(4) and (5) of the *Rules*.

[1] Rule 3.16.2(h)(3)

SCHEDULE 1 – GLOSSARY

EMS	Energy Management System
Law	*National Electricity Law*
MNSP	*Market Network Service Provider*
MW	Megawatt
MWh	Megawatt hour
NEM	National Electricity Market
NEMDE	National Electricity Market Dispatch Engine
NSP	*Network Service Provider*
TNSP	*Transmission Network Service Provider*
VoLL	*value of lost load*

SCHEDULE 2 – MARKET EVENT REPORT ON 22 OCTOBER 2007

SCHEDULE 3 – SPREADSHEET