

Submission to Office of
Energy: Econnect
Consultation Draft
Report on Penetration of
Intermittent Generation

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REPORT DETAILS

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EXECUTIVE SUMMARY

The Office of Energy (OOE) has retained Econnect to review and evaluate information and experience that is available from other jurisdictions within Australia and elsewhere that can be applied to mitigating the impediments to increased penetration of intermittent generation technologies on the South West Interconnected System (SWIS). Econnect's Consultation Draft covers a broad range of topics in considerable depth. The Independent Market Operator (IMO) is pleased to provide the following comments on appropriate areas within this report.

In accordance with their brief, Econnect has gathered operational information from a range of other jurisdictions. This provides useful guidance to decision makers within Western Australia but policies should only be put in place after appropriate consideration of the specific features of the SWIS. In particular, the relative inflexibility of high efficiency gas fired combined cycle and cogeneration plant needs to be taken into account when considering the appropriate proportion of intermittent generation. In regard to this, the IMO makes the following recommendation:

The IMO recommends that detailed system modelling be undertaken to assess the operational impact on the South West Interconnected System of increasing levels of intermittent generation. This should specifically consider the impact on operation of high efficiency gas fired combined cycle and cogeneration plant.

A number of strategies have been developed to reduce the level of greenhouse gas emissions due to power generation. The Australian Greenhouse Office and the West Australian Environmental Protection Authority have both supported the use of efficiency standards. There has also been strong support for new base load power generation to be provided by gas fired plant rather than coal.

These strategies will encourage the introduction of more gas fired combined cycle and cogeneration plants into the SWIS. This, however, will lead to a mix of generating plant that is less able to accommodate the generation swings that would be imposed by higher levels of intermittent generation. The IMO considers that the encouragement of fuel switching, higher efficiency plant and intermittent renewable generation can all contribute to the reduction of emissions. However, an overemphasis on any one may lead to a sub-optimal outcome. The IMO makes the following recommendation:

The IMO recommends that the Office of Energy liaise closely with other agencies to ensure that greenhouse gas mitigation strategies are applied in an integrated manner and do not conflict.

Econnect have made comment on work currently being undertaken to develop systems to provide short and medium term forecasts of output from windfarms. The IMO strongly supports this work and considers that significant benefits could be achieved. It is the IMO's opinion that windfarm owners and developers should take responsibility for development of such a system. This work could be coordinated through an appropriate industry association or through an industry funded Centre of Excellence established within a university.

The IMO recommends that windfarm owners and developers be encouraged to collaboratively develop a system to forecast the short and medium term output from their systems.

In addition to these specific recommendations, the IMO has made comment on a number of other statements contained within the report.

INTRODUCTION

The OOE has commissioned Econnect to undertake a study aimed at maximising the penetration of intermittent generation in the SWIS. The OOE has now published a Consultation Draft prepared by Econnect reporting on work undertaken to review and evaluate information and experience that is available from other jurisdictions in Australia and elsewhere.

Econnect has provided a considerable amount of information concerning experience gained with intermittent generators, in particular windfarms. The report outlines a number of areas of concern and suggests various mitigation approaches that can be considered. The IMO has considered the report on the basis of how the various recommendations may impact upon the achievement of the Wholesale Electricity Market objectives. The report discusses a number of network issues, such as recovery from system faults and islanding. The IMO considers that it would be more appropriate for Western Power Networks to comment on these matters.

As required by the IMO, Econnect has provided information concerning the impact of windfarms on other generators in other countries and this provides useful background information. The specific impacts, and their extent, will be strongly influenced by the specific characteristics of each particular power system. The IMO considers that detailed modelling should be undertaken of the SWIS before specific policy commitments are made and this is the focus of the main recommendation within this submission.

OBJECTIVES OF THE WHOLESALE ELECTRICITY MARKET

The Wholesale Electricity Market, which is being established within the SWIS, aims to achieve a set of objectives established within the Electricity Industry Act 2004. The IMO has sought to determine whether Econnect's recommendations would support or detract from the achievement of these objectives. The objectives set out in the Act are:

- a) to promote the economically efficient, safe and reliable production and supply of electricity and electricity related services in the South West interconnected system;
- b) to encourage competition among generators and retailers in the South West interconnected system, including by facilitating efficient entry of new competitors;
- c) to avoid discrimination in that market against particular energy options and technologies, including sustainable energy options and technologies such as those that make use of renewable resources or that reduce overall greenhouse gas emissions;
- d) to minimise the long-term cost of electricity supplied to customers from the South West interconnected system; and

- e) to encourage the taking of measures to manage the amount of electricity used and when it is used.

It can be seen that one objective, objective c, requires the market to be designed and operated so as not to discriminate against any particular technology. In response to this objective, the design of the WEM has included several features specifically to ensure that intermittent generators are not disadvantaged. These are:

- the certified capacity of intermittent plant is determined on their annual average output rather than their output at peak demand periods;
- intermittent generators are not required to balance their output with a production schedule; and
- the market will absorb all excess production, and make-up any supply shortfall, at the Marginal Cost Administered Price.

CHARACTERISTICS OF GENERATORS USED IN THE SWIS

Most of the electricity produced within the SWIS is generated from steam turbine plant. Steam is produced in a boiler that is fuelled by coal, gas or oil and is used to drive a turbine connected to the generator. Important characteristics of steam turbine plant are:

- it operates at an efficiency of around 35% at maximum output;
- it is flexible in that output can be reduced to about 25% of maximum; and
- the efficiency does not drop significantly when operating at lower output.

Over the last 20 years, a substantial quantity of open cycle gas turbine (OCGT) plant has been installed. The majority of this has been of the “heavy” or “industrial” design which is characterised by:

- a full load efficiency of around 30%;
- high flexibility being able to operate down to around 20% of maximum output and able to change output very quickly; but
- greatly reduced efficiency when operated at lower output levels.

On the SWIS, this plant has been mainly used for peak load operation and, as far as possible, is operated at close to full load.

There is a small amount of OCGT plant of the “aero-derivative” type on the SWIS. This has higher efficiency than the industrial design and can maintain a better efficiency at reduced output. However, this design of plant is generally more

expensive than an industrial OCGT and is only available in relatively small output size. In addition, aero-derivative OCGT plant has lower inertia that can lead to system stability issues.

More recently, a number of higher efficiency gas fired plants have been constructed or are under development. In these plants, gas is used to fuel a gas turbine that drives a generator as in an OCGT. The hot exhaust gases from the gas turbine are then directed into a boiler that produces steam which is used to drive a turbine to generate more electricity (as a combined cycle or CCGT) or for use in an industrial process (as a cogeneration or cogen plant).

The use of a boiler to capture the energy in the hot gas turbine exhaust allows the efficiency to be raised substantially. A CCGT can achieve an efficiency of around 50% while cogen can reach 80%. However, combining the gas and steam cycles into a single machine results in a relatively inflexible plant. CCGT plant can only reduce output to around 70% of maximum while the cogen output will be strongly influenced by the demand for steam from the host industry.

More flexibility can be achieved through the use of duct firing. Here additional gas is burned in the duct between the gas turbine and the steam boiler to maintain or boost the output from the boiler. However, this boost process only operates at the same efficiency as a conventional steam boiler and turbine.

IMPACT OF INTERMITTENT GENERATORS ON OTHER GENERATORS

The output from intermittent generators is both variable and unpredictable over short time periods. This variability must be accommodated by the remaining generation plant on the system which means that a proportion of flexible plant must be kept in operation at all times. This has several consequences as the penetration level of intermittent generation increases:

- an increasing proportion of OCGT plant must be kept in operation to give the power system the ability to accommodate variations in generation;
- as the proportion of OCGT plant increases, it will force high efficiency gas fired plant off the system;
- the proportion of electricity that can be provided by high efficiency gas fired plant will decrease;
- the economic incentive to build gas fired plant rather than coal fired plant will decrease; and
- the overall efficiency of the non-intermittent plant will decrease.

These consequences will flow through to two significant factors:

- the amount of energy used to produce each unit of electricity from the non-intermittent plant will increase;
- this will lead to higher exhaust emissions per unit of electricity and higher prices.

The Econnect report acknowledges this issue and refers (page 23) to a UK study which indicates that a cost increase of around 2% may result. The UK system contains a substantial proportion of coal and oil fired steam turbine plant as well as significant pumped-storage capacity. The flexibility of this plant may well mean that the UK system is better able to accommodate the generation variations arising from windfarms than is the SWIS. This can only be determined by modelling of the SWIS.

Modelling can be used to determine the amount of emissions from non-intermittent plant based on a range of wind penetration levels. This will show that emissions will be reduced as wind penetration increases. However, it may also indicate a penetration level at which emissions increase due to increased generation from OCGTs and coal fired plant.

The IMO recommends that detailed system modelling be undertaken to assess the impact on operations, fuel use and emissions within the South West Interconnected System of increasing levels of intermittent generation. This should specifically consider the impact on operation of high efficiency gas fired combined cycle and cogeneration plant.

OTHER GREENHOUSE GAS MITIGATION STRATEGIES

A number of strategies have been developed with the objective of reducing the level of greenhouse gas (GHG) emissions from power generation. A significant option adopted in the SWIS is switching from coal to gas as the fuel source for new base load generating capacity. However, as indicated above, both combined cycle and cogeneration plant are less flexible than coal fired plant. For this reason, increasing the penetration of intermittent generators will tend to weaken the economic case for fuel switching.

A second strategy is the establishment of generation efficiency standards by the Australian Greenhouse Office. Again, as outlined above, increases in efficiency of gas fired plant tends to result in reduced flexibility making it less able to match the demand swings resulting from intermittent generation.

The IMO makes the following recommendation:

The IMO recommends that the Office of Energy liaise closely with other agencies to ensure that greenhouse gas mitigation strategies are applied in an integrated manner and do not conflict.

FORECASTING OF GENERATOR OUTPUT

The IMO strongly supports the concept of developing systems that can predict the short or medium term output from intermittent generators. A number of windfarm developers within the SWIS have commented that such systems are under active development in Europe. The IMO agrees with Econnect that good forecasting systems could provide substantial benefits.

Econnect discuss the issue of who should have responsibility for developing, implementing and operating such systems. It is the opinion of the IMO that wind farm owners or developers, rather than System Management or the IMO, should undertake this. The reasons for this opinion are:

- it is in the commercial interests of owners/developers for forecasting to be undertaken so they have the greater incentive than other market participants;
- as active participants in the wind generation industry, owners will be more likely to be abreast of the latest developments in forecasting technology and practice;
- forecasts may well be influenced by topography, or other local features, and owners will have much better data on this; and
- windfarm owners will have local monitoring systems in place for optimisation of their plant.

Econnect raises the valid issue that the development of multiple systems would be inefficient and proposes that this suggests that the IMO or system management should fulfil this function. The IMO suggests that windfarm owners could be encouraged to participate in a collaborative system, which might be coordinated through an industry association.

Recommendation 3: The IMO recommends that windfarm owners and developers be encouraged to collaboratively develop a system to forecast the short and medium term output from their systems.

COMMENTS ON OTHER MATTERS

Page 13: Econnect notes that wind generation may need to be constrained overnight and proposes that payment be made for any reduction in output. Under the Market Rules, each intermittent generator is required to nominate a price, to be paid

to the generator, at which it will reduce its output (Appendix 1 (e) (v)). In general, however, it is anticipated that negative prices in the STEM would provide a signal to wind generators to reduce their output.

Page 17: Econnect quotes examples of very high wind penetration levels in some electricity systems. The IMO suggests that comparison with very small systems, where generation would otherwise be provided by flexible, and expensive, diesel generators, is not appropriate. The comparison, which Econnect makes with Ireland, which has a similar plant mix to that in the SWIS, is more relevant.

Page 18: The reliability of individual wind turbines is high and their diversity minimises the system impact of a unit failure. Care must be taken in design, however, to make sure that failure of a single plant item, such as a transformer or other network element, cannot result in a major loss of supply. The use of multiple connection points, as is used in the SWIS at present, limits potential losses to a maximum of around 40 MW.

Page 22: As identified in Section 5, the need to provide a larger “frequency raise” service to accommodate wind generation will tend to lead to lower efficiency plant displacing high efficiency plant. This may give rise to a larger adverse impact than has been experienced in other jurisdictions.

Page 23: A specific concern in the SWIS is simultaneous shutdown of many individual wind turbines due to the passage of a storm front. Windfarm developers have been addressing this issue by ensuring that machines shut down relatively slowly. This reduces the need for spinning reserve coverage.

Page 24 & 25: Econnect suggests that a single forecasting system should be developed to predict the output of windfarms. As indicated in Section 7, the IMO supports this and considers that windfarm owners should take on this responsibility.

Page 26: The report notes that some types of non-conventional generation possess a great deal of flexibility in their control systems and that this may help the power system during fault situations. It may be appropriate for developers of windfarms to be required to adopt world's best practice in this respect in the same way that conventional generators are required to adopt best practice in respect to emissions.

Page 27 & 28: The report suggests that intermittent generators and loads should be treated differently in respect to their payments for load following. Econnect suggests that “it is therefore load and not generation that ultimately imposes energy variations on networks” and that “intermittent generators should only incur a charge for

variability to the extent that it is (collectively) greater than would be the case were the generators not present.

This has been an area of significant discussion during development of the Market Rules. The IMO notes the arguments put forward by Econnect. However, if the penetration of intermittent generation is raised substantially, it may well be necessary to both increase the amount of generation capacity used and change the type of plant used (to fast response gas turbines) for load following. Any such additional costs should be applied to intermittent generators rather than to loads.

Page 39: Econnect recommend that a limited amount of network data be made publicly available to assist developers in assessing new generation sites. The IMO supports the principle of data publication but is unsure as to whether the network data, on its own, will be sufficient for developers.

To ensure that the power system will remain stable under various contingency conditions, it may well be necessary to undertake studies requiring modelling of generator performance including any interaction with other windfarms. The IMO has been led to believe that wind turbine manufacturers have been very reluctant to make the information required for this publicly available.