

WIND GENERATION INVESTIGATION PROJECT

Scope

1. Introduction

1. Wind generation investment is under active consideration by a number of parties, and there is a widespread expectation that this type of generation will become an increasingly significant proportion of New Zealand's overall generation mix. The Government has clearly signalled its commitment to climate change policies and removing barriers to entry for renewable generation technologies.
2. The nature of wind generation technology is such that there may be technical and economic issues associated with the connection of new wind generation as the proportion of demand it meets increases over time. These issues arise as a result of the technology involved, the intermittent nature of the generation and the associated possible effects on system operation, market arrangements and security of supply. Until the nature and extent of these issues is well-understood, it is not clear what, if any, changes might be necessary or appropriate to the manner in which the assets are connected or co-ordinated.
3. Some amendments were made to the Electricity Governance Rules (Rules) in 2004, to assist with immediate issues for integration of intermittent generation. The Electricity Commission (Commission) has now established two projects to address further wind generation integration issues:
 - The Tactical Wind Generation Project, which is now considering requirements over the following two year period; and
 - The Wind Generation Investigation Project (WGIP), which will consider the potential longer term impacts of wind generation on the New Zealand power system, with a view to identifying what, if any, rules, standards or policies might be required to enhance overall benefits. The period to be considered by this project is up to 10 years from now.
4. The objectives of the WGIP are to:
 - Identify and quantify the technical and electricity market impacts of wind generation upon the New Zealand power system over the next ten years;
 - Recommend (if and as required) amendments to the Electricity Governance Rules and other relevant arrangements / processes to ensure power system security and market outcomes are achieved that are consistent with the Government Policy Statement on Electricity Governance (GPS) and Commission's Principal Objectives and Outcomes; and
 - Recommend an implementation plan for proposed changes, to the extent that this is required.

5. Achieving this will ensure that there are clear and effective arrangements in place regarding wind generation, with appropriate signals for investment in, and operation of, such generation in the context of the wholesale market.

2. Background

6. The Commission's Principal Objectives, as set out in the Electricity Act, are to ensure that electricity is produced and delivered to all classes of consumers in an efficient, fair, reliable and environmentally sustainable manner. Consistent with this, the Commission is required by the Act to seek to achieve a number of specific outcomes including that “the electricity sector contributes to achieving the Government's climate change objectives by ...removing barriers to investment in new generation technologies, renewables and distributed generation.”¹
7. In addition, the GPS notes that there is a range of factors for which the Commission does not have accountability, which will impact on the electricity sector (including climate change policy, the RMA and its associated processes, gas sector regulation and the National Energy Efficiency and Conservation Strategy), and states that the Government expects the Commission to take into account and contribute as appropriate to the Government's wider policy objectives.²
8. The original New Zealand Electricity Market (NZEM) rulebook, from which the Electricity Governance Rules were drafted, was written at a time when wind generation was not prevalent. In 2004, prior to the commissioning of the Te Apiti wind farm, some amendments were made to the Rules to address immediate issues for wind generators operating in the wholesale market. At that time it was envisaged that further work would need to be undertaken to address the security and common quality issues that were initially addressed using dispensations, and to address the situation where significant capacities of new wind generation are connected to the power system.
9. The purpose of the WGIP is to continue the evolution of the Rules and processes consistent with potential uptake of wind generation technology. It is not intended that wind generation should receive preferential treatment over other types of plant.
10. It is intended that the WGIP focus on wind generation rather than intermittent generation in general. However, this work may provide a framework for addressing future issues related to other types of intermittent generation that may emerge.

3. Scope of the WGIP

3.1 Outline

11. There are differing views as to the extent of new wind investment, and the capabilities of such plant. This project will include development of a set of scenarios and assumptions for the location, timing and size of new wind generation over the

¹ Part (g).

² GPS final version, Oct 2004, <http://www.med.govt.nz/ers/electric/governance-gps/final/index.html>

next ten years, and the likely technology trends, technical capabilities and wind flow patterns.³

12. There are also differing views as to what (if anything) can or ought to be changed in the New Zealand power system to accommodate new wind investment in an economic manner. An objective assessment of the likely impacts of new generation in terms of the existing arrangements for system operation and the wholesale market is therefore another key aspect of the project. This assessment may, for instance, identify possible constraints and/or costs imposed on various parties, as well as the benefits derived from the new generation and who they accrue to. This assessment will not involve developing a central plan for development of wind or any other type of generation.
13. Finally, therefore, there is a need to identify what options there may be for removing possible constraints and/or opportunities for enhancing the manner in which the power system and market are operated, then assessing the costs and benefits of those options in order to make a well-considered set of recommendations. Technology trends and developments in overseas jurisdictions, as well as New Zealand specific options will provide an important input to this aspect of the project.
14. Thus the project can be broadly thought of as addressing the following key questions:
 - “Where might we be headed?”
 - “What are the implications?”
 - “What are the options?”
 - “What should be done?”
15. A set of core project tasks has been designed around these questions, and revised following consultation. Some tasks are sequential; others can be carried out in parallel. Many involve detailed research, modeling and analysis, and the need to make a number of key assumptions. Some aspects of the latter phases of the project are heavily dependent on the earlier work, and accordingly some requirements and tasks may only become clear once the earlier work has been completed. The proposed design of the project tasks reflects these factors, in particular the careful phasing.

3.2 Deliverables

16. The outcomes expected of the WGIP are:
 - A comprehensive understanding of potential technical and market impacts of large scale wind generation integration into the power system;
 - A recommended set of arrangements to address issues or barriers that may prevent achievement of economic wind generation integration consistent with the GPS objectives and the Commission’s Principal Objectives and Outcomes.

³ This will involve determining temporal and spatial correlations from historical wind data. It is recognised that future wind patterns may differ from this, due to climate change effects, but noted that such effects will only be included to the extent that data and analysis show clear relationships.

These recommendations will be made following widespread consultation, and may include amendments to the market rules and processes, changes to technical codes, operating policies and cost allocation arrangements; and new contractual arrangements;

- A plan for implementation of proposed rule and process changes.

17. A detailed project plan for the WGIP has been prepared. The project is expected to be completed (excluding any implementation that may be required, but including planning for implementation) by late 2006.

3.3 Project Structure and Interactions

18. The WGIP is a Commission-led project. A Project Team, made up of personnel from the Commission, the System Operator, and the Energy Efficiency and Conservation Authority (EECA) will undertake analytical and development work. A Technical Stakeholder Group (TSG) will review the work of, and provide advice to the Project Team. Communications between the groups and with other relevant parties will be managed by the WGIP Project Manager.

19. It is expected that there may be significant interaction with the Commission's Wholesale Market and Common Quality work streams.⁴ In cases where the WGIP considers changes to the Rules, it will work with the relevant Commission Senior Advisors to ensure that coordinated outcomes are achieved. Work will be carried out where the required skills and knowledge are located. A register will be maintained of issues that fall outside the Scope of the Project.

20. Outcomes of the tactical wind generation project will also be taken into consideration by the Project Team and TSG.

21. It is important that stakeholders have opportunities to provide input to this project. In addition to input from the TSG, formal consultation is included at key points in the process to ensure that this occurs.

22. The Commission will also interact with other Government agencies as required.

4. Key Project Tasks

23. This section of the paper sets out the key project tasks in greater detail. It is constructed around the four questions the project is designed to address and has been revised following consultation:

- *"Where might we be headed?"*
- *"What are the implications?"*
- *"What are the options?"*
- *"What should be done?"*

⁴ For example, the Wholesale Market Advisory Group (WMAG) is currently undertaking a review of the offer and dispatch rules for plant with special circumstances.

4.1 Question: “Where might we be headed?”

24. There are differing views as to the extent of new wind investment, and the capabilities of such plant. This project task constitutes three main parts:
- a. Understanding the physical relationships between output from wind farms in a number of different locations and over a variety of time periods;
 - b. Development of a set of “wind installation scenarios” for the location, timing and size of new wind generation over the next ten years;
 - c. Combining the wind installation scenarios with the underlying physical relationships to forecast what variability the power system may need to accommodate over the next ten years.

Develop modeling framework and methodology

25. This task involves developing an overall framework and methodology for the wind generation variability modeling, and development of scenarios and impact assessment models.
26. The wind generation output variability model will consider both geographical and temporal variability. It will consider variability both within a region and across regions, and on a variety of time scales, from real time to well in advance of real time. This includes models of the variability of wind with location and time and wind generation output (relationship between generator output and wind input). This modeling will provide the physical relationships that are utilised in scenario modeling, and enable critical model parameters to be identified.
27. It is recognised that the developed models are likely to contain simplifications and approximations. Wind generation and meteorological expertise will be required in developing the methodology and framework, and in developing the wind generation variability models.

Develop draft wind installation scenarios

28. A wind generation installation model will be developed to determine where wind generation may be connected over the next five to ten years.
29. Where and when wind generation is installed is affected by a variety of factors including economic factors (quality of wind resources, cost of connection, expected electricity prices) and barriers to wind generation (for example, rules or processes such as resource consent processes that may affect uptake⁵).
30. The purpose of developing a number of scenarios is to test the robustness of the existing power system (in terms of factors such as reserve requirements, scheduling and dispatch tools and processes, etc) by examining the effects of a variety of wind installation scenarios, and determining the factors that will limit wind installation on the current system and at what installation level. Later in the WGIP process, scenarios will also enable testing of market and technical options that may be used to extend the limits in the future.

⁵ Note that issues such as this will be considered only in an aggregate sense, i.e. no attempt will be made to regionalise the effect of constraints though the potential impact on total uptake may be considered.

31. While scenarios will be described in terms of the factors in paragraph 29, it is important to note that development of scenarios will be focused on situations that will test the limits of the power system. For example, a low installation scenario may be plausible, but not be used in this analysis if it is not expected to place further stress on the system. Similarly, some high installation scenarios may place greater stresses on the system than others, and would therefore receive greater focus. It is therefore clear that the step of developing scenarios requires examination of the outputs of the physical spatial and temporal variability modeling described earlier.
32. Four to six scenarios (plus sensitivities) are likely to be required. Additional sensitivities will be used if required to test particular situations. Some scenarios could be:
- A high degree of wind penetration concentrated in a few locations;
 - A high degree of wind penetration widely dispersed;
 - A low degree of wind generation concentrated in a few regions;
33. Scenarios will then be combined with the underlying physical relationships determined through the wind generation output variability modeling. This will provide an understanding of the magnitude of wind generation variability (both regionally and nationally) under a variety of wind generation installation scenarios.
34. Establishing suitable datasets will be an important aspect of developing the framework and methodology, and also for determining model parameters and identifying appropriate scenarios.⁶

Develop Impact Assessment models

35. The impact of increased wind generation on the power system operation is likely to be assessed by developing the following set of models:
- Impact of variability on frequency management;
 - Impact of variability on voltage management;
 - Impact of variability on scheduling and dispatch; and
 - Impact of variability on constraints.

4.2 Question: “What are the implications?”

36. This project task involves making an objective assessment of the likely impacts of new wind generation in terms of the existing arrangements for system operation and the wholesale market. This assessment may, for instance, identify possible constraints and/or costs imposed on various parties, as well as the benefits derived from the new generation and who they accrue to.
37. The previously developed models and scenarios are combined to produce forecasts of variability on the power system and other relevant impacts for each scenario. Regional and national effects will be considered. The impacts of this variability on

⁶ Data will be sought from wind farm developers, on a confidential basis.

the power system operation, security of supply and operation of the market will be established assuming no other changes are introduced.

Examine power system implications

38. The impact of increased variability upon the power system and assets connected to the power system is likely to be assessed in terms of:
- Impact on reserves requirements (both type and volume), including frequency regulating and fast / sustained instantaneous reserves;
 - Impact on power system transient stability and voltage stability (fault ride-through, etc);
 - Impact on power quality (harmonics, voltage flicker, etc);
 - Impact on system operator dispatch tools and processes; and
 - Impact of long periods of no wind.
39. Wind generation expertise will be required in this task, in order to account for the technology available for wind generation. It is also envisaged that the WGIP Project Team will work with the Commission's Senior Advisor Common Quality on this task.

Examine market implications

40. The impact of increased variability upon the current market arrangements and cost allocations for frequency management, voltage management and scheduling and dispatch are likely to be assessed in terms of
- Impact of the variability on forecast quantities and prices, and on scheduling and dispatch;
 - Impact on NZ-wide capacity and energy requirements (including investment signals for different types of generation, and effect on generation mix);
 - Impact on losses and constraints; and
 - Impact on other participants.
41. It is envisaged that the WGIP Project Team will work with the Commission's Senior Advisor Wholesale on this task.

4.3 Question: "What are the options?"

42. There are also differing views as to what (if anything) can or ought to be changed in the New Zealand power system to address the identified implications and accommodate new wind generation investment. Thus, there is a need to identify what options there may be for removing possible constraints and/or providing opportunities for enhancing the manner in which the power system and market are operated, then assessing the costs and benefits of those options in order to make a well-considered set of recommendations. Technology trends and developments in overseas jurisdictions and New Zealand experience to date with wind generation integration will be important inputs to this project task. The focus of this phase is to identify high level options for consultation. The key tasks are described here.

International Research

43. This task is a review of measures applied in relevant overseas jurisdictions to accommodate wind generation. The rationale, implementation and market arrangements in each case will be noted and assessed.

High Level Options for NZ Application

44. This task follows on from the international research phase and considers options that may be applicable to the New Zealand power system, including incorporating what has been learnt from the integration and operation of existing wind generation plant in New Zealand.

45. High level options are identified, potentially including market rule changes, ancillary service changes, technology standards, Asset Owner and System Operator performance obligations, power system operation and process changes. Costs and benefits for each option will be identified as far as possible.

46. Further options and information for the costs and benefits will be sought through industry consultation. In addition, criteria for ranking options will be developed and consulted on at this time. Criteria will be based on attainment of Commission and Government policy objectives.

4.4 Question: “What should be done?”

47. The purpose of this phase is to refine and then assess the options, taking into account earlier consultation and investigation results, and develop a set of recommendations. The formal recommendations will undergo industry consultation. Following consultation the recommendations will be finalised and an implementation plan developed. The key tasks are described here.

Refine Options

48. The options will be refined in light of the consultation and any further investigation and analysis work undertaken. The assessment of costs and benefits for each option will be refined. The set of criteria for ranking the options will be finalised.

Assess against criteria

49. The refined options are assessed against the evaluation criteria and ranked.

Develop Draft Recommendations

50. Recommended options and a high level implementation plan are developed. The draft recommendations are released for consultation.

Finalise Recommendations

51. Following consultation, recommendations will be finalised and an implementation plan developed. Depending on the nature of the arrangements, implementation might involve some or all of formal rule change processes, establishment of contracts or adjustments to policies and procedures.

Peer Review

52. At relevant points throughout the project, the Commission intends to have the process and outcomes peer reviewed.

Draft Terms of Reference for the Technical Stakeholder Group

Background

The Technical Stakeholder Group (TSG) will be established to advise and assist the Commission and the Project Team with tasks relating to the Wind Generation Investigation Project (WGIP).

Terms of Reference

The initial Terms of Reference for the TSG are to provide technical advice and industry expertise as requested by the Project Manager.

Objectives and Principles

The TSG must provide advice and report the extent to which its advice meets or is consistent with the objectives of the WGIP.

Membership

The TSG consists of an Independent Chair, and up to six members appointed by the Electricity Commission Board from nominees from participants and other parties.

Members are selected for their particular expertise, and accordingly:

- Members are to act in the national interests;
- Members have a duty to prepare for meetings;
- Members do not represent their own organisations (although the range of commercial and technical experience inevitably adds diversity to the group's capabilities);
- Any views expressed by members are not taken as being those of their employer or their organization.

The members of the TSG will be appointed for the full period of the WGIP.

Roles and Responsibilities

The Project Manager will:

- Coordinate communications between the TSG and the Project Team;
- Report the activities of the TSG to the Commission in accordance with arrangements agreed with the Commission; and
- Arrange administrative support.

Commission staff will be accountable for the following:

- The resourcing, support and output of the TSG;
- Conveying the relevant Commission policies to the TSG; and

- Providing alternative recommendations to the Commission Board in addition to those recommended by the TSG, where there are material differences of view.

Remuneration

Members' organisations shall meet the costs of members' travel and time spent preparing for meetings and attending meetings. The Electricity Commission may elect, at its discretion, to reimburse part of the expenses incurred by members not remunerated for their involvement in the TSG. Remuneration and reimbursement of expenses incurred will be on a basis that is consistent with other similar roles in the public sector.

Transparency

In general, the operation of the TSG, including agenda, action points and papers, will be transparent, in accordance with the Commission's normal policies. However, TSG activities may touch on sensitive matters (matters of commercial confidence and market impacts), and unless specifically agreed otherwise:

- Papers circulated in advance of meetings are to be amongst TSG members only; and
- Papers will be published at the Commission's discretion.

Confidentiality

Due to the commercial confidentiality of some of the information that will be discussed by the TSG, members will be required to sign a confidentiality contract.

Meetings

Reasonable notice of meetings must be given to every member, including details of the time and venue. Notice may be given by electronic or other means.

A meeting of the TSG may be held by a number of the members of the Technical Stakeholder Group who constitute a quorum, being at the date and time appointed for the meeting. As a general rule, meetings must be held in person. A quorum for TSG meetings will be more than 50% of members (including the Chair, but excluding the Project Manager and any other Commission staff present) of the group. No business may be transacted at a meeting of the TSG while a quorum is not present.

Members of the TSG are not entitled to send an alternate in their place if they cannot attend a meeting.

Any member of the TSG who, without leave of the TSG, misses two consecutive TSG meetings will be deemed to be removed from the TSG, except where leave is given by the Chair or the WGIP Project Manager.

The Chair will ensure that actions and outcomes from TSG meetings are recorded.