Australian Government
Australian Renewable Energy Agency

ARENA

11 December 2025

Anna Collyer
Chair
Australian Energy Market Commission
Submitted via www.aemc.gov.au

Dear Anna,

Proposed rule change – Creating an open NEM network model

The Australian Renewable Energy Agency (ARENA) and DIgSILENT Pacific jointly submit the enclosed rule change request seeking to create an "Open NEM Model" framework under the National Electricity Rules (NER). The proposal is intended to improve access to, and use of, information that is fundamental to the operation, planning and development of the National Electricity Market (NEM).

ARENA is a crown agency that provides financial assistance to support innovation and the commercialisation of renewable energy and enabling technologies that help advance the energy transition. The return on this investment is a commitment to disseminate the valuable insights gained by the projects and activities it supports for use by the wider industry and Australia's energy market institutions. ARENA is co-sponsoring this rule change as part of this commitment.

DIgSILENT Pacific is a specialist power systems consultancy serving the Australian energy sector since 2001. The company is part of the DIgSILENT international group of companies, developers of the PowerFactory power systems modelling software. DIgSILENT Pacific staff experience the inefficiencies caused by the current information provision framework daily in our service to the industry. DIgSILENT Pacific is co-sponsoring the rule change proposal because we believe these changes could make significant improvements to efficiency across investment, the connections process and operation of the NEM.

The rule change proposal attached seeks to make fundamental changes to the confidentiality framework within the NER, so that modelling information is only designated as confidential where it is strictly necessary, as assessed against a single set of principles. This contrasts with the current situation where key modelling information is treated as confidential by default, leaving critical information gaps that interfere with efficient investment and connection of generation and loads in the NEM.

We are proposing that the best available (non-confidential) modelling information on the current and future NEM grid be made freely available to people registered on an AEMO-administered online portal forum and portal. This online portal and forum would provide a single source of truth and allow AEMO ready access to the entire modelling community. The online forum would improve data quality by helping to identify and solve modelling information issues, provide online access to experts and helping to prioritise areas for further development.

The proposal also seeks to advance interoperability of models between power modelling simulation tools by requiring models to be available and provided in a non-vendor specific format. This would promote more innovative and effective studies and presentation of results, as well as competition between different vendors of power system modelling simulation tools.

While the package of initiatives proposed is not trivial and will require careful design of transition arrangements, we consider that these changes are both achievable and necessary. In our assessment, they have the potential to deliver industry-wide benefits, improve transparency and data quality, streamline the connection process for new generation and load, and better support achievement of the national electricity objective, including the energy transition.

Yours sincerely

Darren Miller

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Chief Executive
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Open NEM Model

Rule change request

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ARENA

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Version Control

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1.0	09/12/2025	Final	J Crisp J Eggleston,	G Williams, J Leung, T Bertes	Final

Executive summary

Information about the power system is fundamental to the operation of the Australian national grid, the National Electricity Market (NEM) and to development of the future power system. Policy makers, academics and students, developers, industry participants such as Generators and Network Operators and most importantly, the power system and market operator AEMO, all benefit from accessible quality information about the existing and future power system. Efficiency is enhanced when that information is available in forms that can be easily used for multiple purposes.

This rule change proposal addresses five aspects of the power system information framework:

- accessibility of the information to a wide range of stakeholders, while protecting sensitive information,
- availability of past, present and future power system information, considering the best available information,
- the level of detail of information accessible, to make it useful across the widest range of applications,
- forms of information provided, to facilitate efficient use in multiple applications and development of innovative products to meet emerging needs, and
- quality of information, to support quality decisions about investment in and operation of the power system.

The initiatives proposed are not trivial and will entail time, effort and industry involvement to manage confidential information and plan the transition pathway.

Nevertheless, the changes proposed could result in overall benefits to the electricity industry and ultimately to consumers in the hundreds of millions of dollars and will contribute to the achievement of the energy transition.

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GLOSSARY OF TERMS

ABS	Australian Bureau of Statistics
AEMC	Australian Energy Market Commission
AEMO	Australian Energy Market Operator.
AER	Australian Energy Regulator
APR	Annual planning report – a report publishing the results of an NSP's annual planning review. See TAPR and DAPR.
DAPR	Distribution annual planning report - an APR published by a DNSP under NER 5.13.2.
DNSP	Distribution network service provider.
EMT	Electromagnetic Transient. EMT simulations involve solving differential equations that capture the instantaneous values of voltages and currents, making them ideal for analysing fast transient phenomena such as switching operations, fault conditions, and lightning strikes. More recently, EMT simulations have been used for detailed modelling of the operation of IBR.
ESOO	Electricity statement of opportunity.
HVDC	High voltage, direct current. An alternative form of electrical transmission used for transmission of power over long distances and within power electronics devices.
IBR	Inverter based resources.
IEEE	Institute of Electrical and Electronics Engineers.
IRS	Integrated resource system
ISP	Integrated system plan
kV	Kilovolts, one thousand volts, a measure of electric potential.
NEL	National electricity law.
NEM	National electricity market; the inter-connected electricity grid of the Australian eastern states.
NEO	National electricity objective, defined in section 7 of the NEL.
NER	National Electricity Rules, the rules that govern the planning and operation of the national electricity network of Australia.
NSP	Network Service Provider.
OEM	Original Equipment Manufacturer.
RIT-D	Regulatory investment test for distribution
RIT-T	Regulatory investment test for transmission
RMS	Root mean square. RMS simulations use phasor representations of voltages and currents to solve the power system equations. This approach assumes a quasi-steady-state operation and effectively studies the system's behaviour over longer periods and under steady-state conditions.
Schedule 5.2 Participant	A person described in clause S5.2.1(b) of the NER
Schedule 5.3 Participant	A person described in clause S5.3.1a(a1) of the NER
Schedule 5.3a Participant	A person described in clause S5.3a.1a(b) of the NER
TAPR	Transmission annual planning report — an APR published by a TNSP under NER 5.12.2.
TNSP	Transmission Network Service Provider.

1 Introduction

1.1 Objective of the rule change request

Efficient operation of the NEM power system, and efficient investment in future NEM infrastructure, relies on access to accurate modelling data for the existing NEM power system and known future investments. Without access to this information stakeholders may make inefficient operational and investment decisions that would ultimately increase the costs of electricity to consumers.

Therefore, the objective of this rule change request is to improve:

- access to power system modelling data to all stakeholders, except where it is essential to keep the models confidential,
- the interoperability of the models so that stakeholders can choose the software tools that best suit their needs,
- the availability of the best available and up to date modelling information for future network, generation and customer investments,
- the accuracy of the modelling information made available to stakeholders, and
- the level of detail of the modelling information available beyond the current snapshots that only include single phase representations of the system at fundamental frequency.

In addition, the rule change request includes a proposal to implement an on-line community of model information and data users to facilitate the objectives above.

1.2 The proponents of the rule change request

The proponents of this rule change request are the Australian Renewable Energy Agency (ARENA) and DIgSILENT Pacific.

The Primary Contact for this proposal is:

- Greg Williams (ARENA): E: Greg.Williams@arena.gov.au. T: (02) 6168 7845

This rule change request includes:

- Section 2 – a description of the proposed rule,
- Section 3 – a statement of the nature and scope of the issue concerning the existing rules that is to be addressed by the proposed rule change request and an explanation of how the proposed rule change request will address the issue,
- Section 4 – an explanation of how the proposed rule change request will or is likely to contribute to the achievement of the national electricity objective (NEO), and
- Section 5 – an explanation of the expected potential impacts of the proposed change to the rules on those likely to be affected including costs and benefits.

1.3 Open NEM Model

The term “Open NEM Model” refers to a proposed framework for the management, accessibility, and interoperability of power-system modelling data in the NEM. The Open NEM Model aims to make non-confidential modelling data openly available to all stakeholders, enable use of interoperable and vendor-neutral data formats, and establish mechanisms for ongoing data quality improvement and user feedback through an online community.

2 Description of the proposed rule

This section describes the Open NEM Model rule that is being proposed.

2.1 Access to data

2.1.1 AEMO review of which modelling data should be confidential

Require AEMO to conduct a review through a Rules Consultation process and publish a determination for which modelling data (explicitly excluding information in Table 1) should remain confidential.[1] This would be based on the principle that:

- All modelling data is regarded as non-confidential unless releasing a class of information would be likely to:
  - materially reduce the efficiency of the market,
  - significantly increase the risks to the power system from cyber or other terrorist attack, considering the current availability of equivalent or similar information from public and other legal sources, or
  - reveal personal or sensitive financial information of an individual or business.
- Classes of data and information could be divided into categories that should:
  - A. be made generally accessible from AEMO and Network Service Providers where held, and provided on request within reasonable timeframes, including at least the information listed in Table 1.
  - B. have access restricted to Registered Participants.[2] [3]
  - C. allow access to AEMO only (in line with the principle defined above).
- At the commencement of the rule, until AEMO completes its review of the confidentiality of the data:
  - all data described in Table 1 would be publicly accessible – category A.
  - all encrypted or compiled user-defined dynamic models would be available to Registered Participants (the current requirement) – category B.
  - all detailed unencrypted user-defined dynamic models (source code) would be in category C.

The review need not be exhaustive (as the potential range of data types is very broad) but should at least consider in the first instance the types of data considered to be, on the rule's commencement, in category B and C as described above. The rule should allow AEMO to propose a scope for the review, but the rule should also provide stakeholders the opportunity to propose additional types of information to be considered in the same review.

AEMO would be required to complete the review within 12 months of the commencement of the rule. It would be able to repeat the review and amend its guidelines as required, such as when data requirements and modelling techniques evolve. A stakeholder may also initiate a review if they wish another type of data or information to be considered. The review would not have the effect of reducing the accessibility of information described in Table 1, which would remain in category A.

[1] Instead of AEMO performing this review, it could be performed by another entity such as the Reliability Panel or as part of the Rule change process. A review performed by any entity would rely significantly on the advice of AEMO.
[2] Depending on the outcome of the Improving Access Standards in the NEM Package 2 Rule change request and AEMO's current review of access standards for large loads, AEMC might consider if this category should be extended to Schedule 5.3 Participants, who are mostly not Registered Participants, but may need a similar level of access to power system model information as Schedule 5.2 Participants in future.
[3] At present this includes information provided under NER 3.13.3(k). It is possible that this class of data and information is not required, depending on the outcome of the confidentiality review.

2.1.2 AEMO to develop a data platform

Require AEMO to develop a data platform that:

- provides access to Registered Participants only to category B data and models, and
- allows open access to category A models and information for at least the transmission system, plant connected to transmission connection points, and bulk supply point aggregated data, in the level of detail contemplated in Table 1 or higher level of detail, if applicable, to the outcomes of the confidential information consultation described in section 2.1.1.

Require AEMO to complete a consultation with the industry within 18 months of the commencement of the rule on the types the data or models provided through the platform, so that stakeholders' interests are considered, having regard to providing the information in interoperable form (section 2.2). This consultation should include a reasonable attempt to identify potential future users of the NEM modelling data,[4] and should be undertaken in conjunction with the consultation contemplated under section 2.2.

Remove the ability of AEMO to charge a fee for the provision of data. Rather, allow AEMO to recover its costs as normal capital and operating costs.

In the interim, before the data portal is implemented, there will need to be transitional arrangements that make existing data accessible. It may be burdensome for AEMO to provide the data manually in multiple formats, especially if the volume of requests is high. This could be addressed by AEMO:

- publishing a set of Category A data / models that it considers will cover the types of information most likely to be in high demand,
- addressing requested custom information requests, in a form agreed with the requestor (noting that some formats of data would be more readily achievable in the short term than others),
- in the provision of published and custom request data described above, progressively including information from TNSPs, as it becomes available to AEMO and as updated (This relates to information contemplated in section 2.3 and section 2.4.),
- prioritising requests for information relevant to connections over other data requests and providing information requested for a connection application or alteration to plant within one week, and
- if it cannot provide the information requested, promptly providing reasons for its inability, to the requestor.

Note that nothing in this proposal is intended to prevent a network service provider (NSP) from publishing category A information, or requires an NSP to publish information.

2.2 Make the modelling data and information available in an interoperable, non-vendor specific format

Require AEMO to:

- make model data available in interoperable non-vendor specific format(s), and
- consult with stakeholders to determine the most appropriate model data format standards to be used for the different types of data[5] [6] in conjunction with the consultation on data formats to be provided through the portal (see section 2.1.2).

The selection of the standard should be based on the following principles:

[4] Future users of the NEM model are likely to include energy market economic modelling consultants, power system and energy market academics and students, and various government departments and agencies.
[5] The formats used for the model data provided by AEMO should be based on international standards where possible as most power system modelling tools are developed by international vendors, and most equipment OEMs (who provide the plant models) are international vendors.
[6] A public consultation would be desirable as an open NEM model is likely to be attractive to entities such as academics and consultants that currently don't have access to NEM modelling data.

- the standard should have a published vendor-non-specific open standard format,
- the choice should preference standards internationally accepted by various system operators and network businesses in various jurisdictions,
- the standard should be likely to be supported into the future, and
- consideration should be given to standards that are adopted in other disciplines to increase the level of flexibility when modelling new technologies.

Consideration should be given to providing the data in usable form for the widest range of applications.

Require AEMO to:

- consult with stakeholders on implementation of the chosen standard(s) including the transition pathway and timing, having regard to:
  - the need to maintain an accessible, functional set of models over the transition period and beyond,
  - achieving an efficient process for all parties, and
  - completing the transition in a timely manner.
- follow the agreed implementation strategy, implement the agreed interoperable format(s) in the:
  - model data and information AEMO requires from other parties (in the PSMG), and
  - model data and information provided by AEMO to other parties.

2.3 Existing network data held by NSPs

For existing network data held by NSPs:

- TNSPs must provide the network models and information described in Category A and Category B to AEMO[7] and promptly provide an update of any changes,
- DNSPs must provide the network models and information described in Category A and Category B to AEMO on request and promptly provide an update of any changes to that data, and
- NSPs and AEMO must provide to a Schedule 5.2 Participant, Schedule 5.3 Participant or Schedule 5.3A Participant, promptly on request, the outputs of simulations and associated inputs and assumptions for studies related to the connection or alteration of relevant participant's project.

Nothing in this section 2.3 requires a DNSP to create network models or information solely for the purpose of providing them on request to another party. That is, the models and information is provided to AEMO on a best available information basis.

Require AEMO to provide information from category A and Table 1, to any requestor, and category B, to a party eligible to access it, promptly on request.

2.4 Future projects

This section covers projects not yet in service, from planning stage through to and including commissioning. The intent is that the model level of detail and accuracy are progressively updated and improved as the project progresses through its stages of development. The term "best available" is intended to reflect the quality and detail commensurate with the project's stage of development. The purpose of status information is to inform users of the quality level of the models available to them so they can properly allow for it in their analyses. It is anticipated that the status information would be retained in the AEMO data repository after the plant is in service, as it is useful for data audit purposes.

[7] Some of this data is already provided to AEMO, but not all. Currently the rules require it to be updated only annually, which is not consistent with a reasonable duty to provide the best available data.

Require TNSPs to provide to AEMO models of their future networks[8] required for all types of modelling considered in the AEMO review above (all categories) and in Table 1 along with proposed date when the project will be in service. Require model information to be updated promptly when changed to represent best available models available at that time[9] and include status information as follows:

- conceptual, for example, a model used in the integrated system plan (ISP) and APRs,
- preliminary design, for example models used in the regulatory investment test for transmission (RIT-T) or regulatory investment test for distribution (RIT-D), or equivalent in a renewable energy zone (REZ),
- detailed design, models reflecting expected primary plant characteristics (for example, in a specification),
- as-built, following construction, and
- post-commissioning, reflecting any revisions following commissioning, where relevant, including dynamic models validated by comparison with measurements.

Require a DNSP to provide to AEMO models and information of the type described above for their networks on request.

Nothing in section 2.4 requires an NSP to create network models or develop information solely for the purpose of providing them on request to AEMO. That is, future models and information are to be provided to AEMO on a best available information basis.

Require AEMO to maintain equivalent generating system and integrated resource systems future project data[10] with status information as follows:

- preliminary models for publicly announced projects as used in the ISP and ESOO, with the scope of these models including at least the location, rating and technology, and may include generic dynamic models,
- as designed models for models received under connection applications or plant alterations and updated for committed projects,
- as-built models (aligned with R1 registered data in the NER S5.5.2), and
- validated (aligned with R2 registered data in NER S5.5.2) models.

Require a TNSP to provide to AEMO network limit advice (for stability limits) associated with a future network project that has been either approved under a RIT-T or for which construction has commenced, and update that information as necessary to represent best available information.

Require AEMO to provide best available information including from Category B models (to parties eligible to receive them), Category A and Table 1 (to any stakeholder) on request in an appropriate format (see section 2.2), including the model status and when the project is expected to be in service.

2.5 On-line community of data users and repository of modelling resources

Require AEMO to host and moderate an online forum platform for modellers, allowing anyone with a valid email address to participate in an online modelling community. The platform should also establish a change management system to enable user feedback to be collected and used to improve the quality and completeness of the modelling data provided to stakeholders.

Require AEMO to consult with stakeholders on the online platform and its features and the change management system. The consultation could be undertaken in conjunction with the consultations contemplated under sections 2.1.2 and 2.2, as a similar timeframe would be appropriate.

[8] The present rule covers existing network data but is silent on provision of models for future network data and only required data to be updated annually, rather than providing best available models.
[9] Note that considered projects (as defined in NER chapter 10) are intended to be covered by this list, but the network project statuses described in this section is broader than those projects that would meet considered project status.
[10] AEMO already presently holds modelling information for connection applications, committed projects and existing plant. It also has planning data for the ISP that includes basic generation.

The forum should enable stakeholders to share knowledge about modelling issues and their resolutions[11] and to share non-confidential information. It would enable members to provide informal feedback to AEMO, which could be incorporated into the change management portal (where appropriate). The forum's rules[12] and moderation would minimise the chance that confidential information is published.

Require AEMO to provide a change management portal, allowing users of the modelling data and information to provide formal feedback on the accuracy, currency and completeness and performance of models. The portal could be:

- used to report inaccuracies, incompleteness or functional problems with the models and associated information, and
- available to both internal AEMO and external users of the model data and information.

AEMO would:

- use the feedback from users to review and amend the information and data as appropriate to improve the quality of the model, and
- use the change management portal to advise stakeholders when model data and information is updated.

This would include at least:

- the source of the feedback,
- the associated plant,
- a description of the change to the data or information,
- reason for the change,
- the date when the modelling database was amended, and
- the date from which the amendment is effective.

Together these tools provide avenues for improving information sharing, transparency and model data quality. The functionality has been described separately because the forum could be hosted on a commercially available forum platform, which might provide seamless access to the feedback portal. The intent for both tools is that the information on issues and resolutions is publicly accessible.

[11] Online discussion about modelling issues is currently prevented by the current NER definition of confidential information, especially the part of the definition that states "It also includes any information which is derived from such information". To work around this, the rule would need to allow specifically for matters that the forum members were permitted to discuss. The AEMC might consider whether the confidentiality definition could be made more targeted. It might, for example, be limited by reference to the principles outlined in section 2.1.1.

[12] Contributors are typically required to register to participate, and participation is subject to rules that the participant would need to agree, to join the forum.

Table 1 List of data proposed to be non-confidential

Type of data
The models and information to be considered non-confidential include the following time frames and representations, as relevant to the type of data/models listed below. **1. Historical, current and future timeframes.** **2. Point in time representation:** **Relevant power system plant information, coincident power system quantities, and other information necessary to define power system conditions at a particular time.** **3. Time sequential representation:** **One or more power system quantities, timestamped, with various time scales depending on the nature of the data.** **Can include a series of point in time representations (e.g. a set of sequential load flow models representing power system conditions over a period).**
Power system model - Transmission system Sufficient detail for steady state and quasi-dynamic representation of the power system. Suitable for: • load flow, • harmonics assessment, and • fault level calculation. Includes: • sequence components, • three phase representation, • geometric line information, • rating information, and • geographic information on power system elements. Plant covered includes: • network elements, • generating systems, • integrated resource systems (IRS), • HVDC plant, • synchronous condensers, and • loads (at transmission level and aggregate to bulk supply level). Power system models also include configuration and time-variant data necessary to define the power system operation, such as: • setpoints, transformer tap positions, plant status, plant active and reactive power output and consumption (including terminal quantities, and reactive plant output and consumption), control modes and relevant controller settings for steady state assessment (e.g. voltage droop, power factor setpoint), plant reactive power capability curves, transformer automatic voltage regulator configuration, energy storage levels, • for connections, the model detail includes primary plant elements within the connection (production units, reactive power plant, cables, lines transformers etc), and • load voltage and frequency indices.
Power system model - Distribution system • same types of data as for the transmission power system model.
Limits advice • transmission limits and constraint equations.
Protection systems and related information • details of protection systems and clearance times on network elements (transmission and sub-transmission).
Transmission system load forecasts to transmission connection point and bulk supply level • maximum loads, minimum loads (5-year horizon) active power and reactive power, • regional co-incident maximum and minimum loads (10-year horizon), active power, and • load forecast information used for the ISP scenarios, active power.

Distribution system load forecast • forecast information as required for the distribution annual planning reviews, and • energy storage system forecasts.[13]
Power system measurements Includes: • active power and reactive power flows, voltage levels, • Measurements at connection points and other locations in the network, • power system disturbance measurements (high speed or other measurements including from connection points and other locations in the power system), • harmonic voltage and current emissions, • voltage fluctuations (flicker) measurements, and • voltage and current unbalance measurements.
Generic dynamic models of power system dynamic plant For generating systems, IRS, HVDC, loads, network dynamic plant, synchronous condensers. Includes: • associated settings and parameters to represent actual plant behaviours, and • Information identifying suitable generic models for a particular application.
Dynamic model outputs and inputs • simulated outputs from detailed dynamic models (including RMS and EMT models) and corresponding inputs for all types of dynamic plant.
Immittance scans • impedance or admittance as a function of frequency (Immittance scan) of connections and of the power system from a connection point derived from detailed EMT models or measurements.
Harmonic impedances • harmonic polygons (representing a set of harmonic impedances for a range of power system configurations), • list of power system conditions corresponding to each of the harmonic impedances, and • associated information about the methodology and assumptions used to generate the harmonic polygons.
Information to improve transparency and foster knowledge sharing about power system models[14] **Includes:** • information identifying issues with accuracy, currency and completeness and performance of models or data and associated resolutions, mitigation measures or workarounds, and • information to guide tuning of models.

2.6 Other proposed rule changes

In addition to the above it is recommended that:

- NER clause 3.13.3(l4) be deleted (discussed further in section 3.2.1), and
- Consideration be given to amending the confidential information definition to allow AEMO to declare information non-confidential (following the rules consultation outlined in section 2.1.1).

[13] Unclear whether NER 5.13 on the distribution annual planning review requirements covers energy storage forecast, but given recent growth in small battery systems, it will be increasingly difficult to interpret forecasts without that information.

[14] This category has been included to enable the modelling forum, so that forum participants are not in breach of the confidentiality obligations under the NER.

3 Statement of the nature and scope of the issues

This section contains a statement of the nature and scope of the issue concerning the existing rules that is to be addressed by the proposed rule change request, and an explanation of how the proposed rule change request would address the issue.

3.1 Decision making in the NEM

Decision makers and other stakeholders in the NEM

The NEM has a disaggregated market structure with many different market participants undertaking one or more different activities within the market. Each participant makes their own operational and investment decisions based on their own business strategies using the information that is available to it.

In addition, various government, private and academic entities also have an interest in the operation of the NEM for their own purposes. These purposes include (but not limited to):

- policy development to regulate the operation of the market or the operation of a related industry or the environment,
- providing technical or financial services market participants and related entities, and
- academic research on aspects of the NEM and its interaction with other industries, which provides valuable insights and training for their students.

Decision-makers are supported by service providers such as power system and market modelling consultants, and their analyses are supported by developers of specialist tools.

The quality of the decisions and analyses made by all the different NEM stakeholders depends greatly on access to good quality data and information.

Sources of information and data for decision making

There are many sources of the information and data used to make important decisions for the development, planning and operation of the NEM. One important source of this information and data is AEMO. Under the NER, AEMO is required to publish many documents such as the ESOO and ISP that provide information to all stakeholders.

AEMO sources some of its information from NSPs, including about their networks and parties and their plant (such as customer loads and generation). NSPs hold additional information that is not shared with AEMO but is of interest for decision making in the NEM.

Parties making connection enquiries, Connection Applicants and Registered Participants also contribute information to NSPs and AEMO, which is of use for decision-making in the NEM.

In addition, Registered Participants can access some data that is confidential information (as explained in section 3.2).

Limitations on the power system modelling data available to stakeholders

Currently the power system modelling information and data available to stakeholders in the NEM is limited in several ways including:

1. access to NEM power system models and model data is restricted,
2. the scope of the power system modelling data is limited, and
3. the format of information provided is limited.

3.2 Confidentiality of power system model data

3.2.1 Confidential information

As the market and power system operator for the NEM, AEMO holds and generates large quantities of data and information that is required by registered participants for electricity and gas market operations. While much of this data is publicly available, some of the data and information is confidential to Registered Participants.

Framework for management of confidential information in the NEM

Sections 54 to 54G of the NEL set out AEMO's obligations in respect of confidential information ('protected information') that it receives or generates in performing its functions. AEMO may disclose confidential information only under specific circumstances outlined in the NEL, either:

1. if authorised by the NER (section 54A(2) of the NEL), or
2. with the written consent of the person who provided the information (section s.54B of the NEL).

The NER defines confidential information (in the glossary, chapter 10):

> "In relation to a *Registered Participant* or *AEMO*, information which is or has been provided to that *Registered Participant* or *AEMO* under or in connection with the *Rules* and which is stated under the *Rules*, or by *AEMO*, the *AER* or the *AEMC*, to be *confidential information* or is otherwise confidential or commercially sensitive. It also includes any information which is derived from such information."

The NER provides a list of exemptions on disclosure of confidential information (NER clause 8.6.2), including relevant information that is generally and publicly available (other than through a breach of confidence of the Registered Participant or any person to whom the Registered Participant has disclosed the information).

The NER also requires the publication of information that otherwise might be covered by restrictions such as confidential information, and the provision of information to specified parties in particular circumstances.

The NER also requires the provision of information between various parties necessary for various purposes, such as for the operation of the power system and the connections of plant to the national grid. This includes some information that is otherwise stated to be confidential information.

NER obligations on Registered Participants and other parties

The NER (rule 8.6) applies obligations on Registered Participants using all reasonable endeavours to keep confidential any confidential information that comes into its possession or of which the Registered Participant becomes aware (clause 8.6.1(a)). The Registered Participant (clause 8.6.1(b)):

- must not disclosed confidential information to any person except as permitted by the Rules,
- must only use or reproduce confidential information for the purpose for which it was disclosed or another purpose contemplated by the NER, and
- must not permit unauthorised persons to have access to confidential information.

The confidentiality provisions described above are also extended (under NER clause 8.6.1A) to Metering Providers, Metering Data Providers, Embedded Network Managers, Third Party B2B Participants and project developers.[15]

NER clause 8.6.2 permits Registered Participants (and the other parties listed above) to disclose confidential information to:

- employees and officers of the participant, and

[15] A project developer is an entity that can demonstrate to AEMO that it intends to develop plant to be connected to the transmission system or distribution system in respect of which another person (other than an intermediary) must or may be registered as a Registered Participant.

- professional advisers, auditors and consultants of the participant.

where they require the information for the purposes of the rules or for advice to the Registered Participants.

Application to NEM power system models

In the case of NEM power system models this restricts AEMO to providing the information to Registered Participants, including Intending Participants and Project Developers. The information and data are only available on request and only for the purposes nominated in the NER clauses 3.13.3(k)(2) and (3), that is:

> "(2) information that is reasonably required by the *Registered Participant* to carry out *power system* simulation studies (including load flow and dynamic simulations) for planning and operational purposes; and
>
> (3) operation and maintenance procedures and practices for *transmission network* or *distribution network* operation, developed for the purposes of schedule 5.1 sufficient to enable the *Registered Participant* to carry out *power system* modelling under normal, *outage* and emergency conditions."

Clause 3.13.3(l4) further restricts AEMO from providing to Registered Participants model information about a plant that is subject of an application to connect or a connection agreement until the earlier of:

(1) the date when the connection agreement is executed, or

(2) three months before the proposed start of commissioning.

This clause is unreasonable because:

- The existence of the plant is public knowledge (e.g. through the key connection information that AEMO is required to publish under NER clause 3.7F(3)), so there is no commercially sensitive information involved, and
- The new plant affects the operation of the power system, interacts with other plant and can affect performance standards for other plant that are being negotiated at the same time.

It would therefore be more appropriate to make the information available to all relevant parties that are connecting plant at the same time. Connection Applicants can then optimise the control settings for plants that are going through the connection process in parallel so that there are no adverse interactions between them, and each plant can meet its performance standards. This clause 3.13.3(l4) creates unnecessary rework and inefficiency in the connection process and additional investment risk for Connection Applicants.

3.2.2 The case to keep some NEM power system modelling data confidential

As discussed in section 3.1, planning, operational and policy decisions rely on access to information and modelling data. Therefore, by default, all information should be accessible to all stakeholders involved in any aspect of the power system and market, unless a case can be made against disclosing the information.

A case can be made for preventing or limiting information disclosure if it:

1. leads to material adverse market impacts from:
   a. exposure of intellectual property, or
   b. market collusion.
2. materially increases the risks to the power system from malevolent actors, or
3. violates privacy laws.

The definition of confidential information in the NER is very broad, and ambiguous (for example who decides if a piece of information is 'otherwise confidential or commercially sensitive', and how far does the 'any information derived from such information' extend). The NER also contains very broad statements about information types that are classified as confidential information (for example information provided under rules 5.2A Transmission network

connection and access, 5.3 Establishing or Modifying Connection and 5.3A Establishing or Modifying Connection – distribution connected systems, is confidential information.) The broad classification of information as confidential information in combination with the broad confidential information definition effectively inhibits the access of stakeholders to information that would otherwise make the market more efficient and cost-effective. The confidential information provision makes it easy for AEMO, the AEMC or the AER to declare a piece of information confidential, but not to make it non-confidential.

Power system models, by their nature are used to derive information about the power system or the market. The part of the confidential information definition that states: "It also includes any information which is derived from such information" creates information asymmetry and restricts access of stakeholders to the input conditions and outputs of models, which would otherwise improve the efficiency of the NEM (for example, in the connection process).

Intellectual property and patents

The original equipment manufacturers (OEMs) of power system equipment and the providers of related services may rely on intellectual property to maintain a competitive advantage over their competitors. Detailed NEM models might sometimes include advanced control algorithms that are commercially sensitive.

Releasing this type of intellectual property could be detrimental to the NEM and the efficient operation of the market as it could result in:

- OEMs not supplying equipment to the NEM, to avoid their intellectual property being disclosed. This would reduce the number of OEMs operating in the NEM which would reduce competition for the provision of equipment and be expected to increase costs,
- OEMs being disincentivised to provide their best and most innovative equipment in the NEM. This would lead to lower performance equipment in the NEM, and
- OEMs attempting to provide limited models of the equipment to hide some of the more sensitive details. This would introduce the risk that assessment of power system secure and connection studies would not identify all potential issues.

Commercially sensitive information is more likely to exist in a more detailed model than a high-level model. This is because, at a high level the operation of controllers is similar across many OEMs for the same type of technology (e.g. type 4 wind turbines). Whereas, in the details of the firmware, there may be proprietary information of a sensitive nature, at the more abstracted level of the structures of controllers that interface the power system there is less confidential information. Newer technologies are also typically more commercially sensitive than older well-established ones for which the technology has converged towards common designs.

Therefore, a strong case can be made for preventing detailed electromagnetic transient (EMT) dynamic models of inverter-based production units or HVDC converters from being shared unless in an encrypted form. Likewise, models derived from firmware of plant are more likely to contain commercially sensitive information that should be protected.

At the lower end of detail are the generic dynamic models[16] and impedance or admittance frequency scans (also known as immittance scans). For these models there is not a strong case for them to be confidential information, for which reason, in this rule change request they have been listed in Table 1 to be explicitly made publicly accessible. Between these extremes are user-defined RMS dynamic models, for which it would be useful to consult with industry to determine whether they need to be treated as confidential information.

The inputs and outputs of detailed models can be used to derive the settings that would best fit generic models and to determine immittance scans of models, without exposing the highly detailed content of the detailed models. Immittance scans can be very useful for tuning models for stable operation as part of a connection process. The generic models are more useful for wide area studies, particularly of future systems or large power systems, where the precise response of individual plant is less important than the overall power system behaviour. There are not

[16] In generic models the model structure is published, thereby promoting interoperability. The settings are fitted to match plant performance.

many generic models in use in the NEM, presently,[17] but if input and outputs of models were made accessible it would be possible for the broader industry and academic community to develop these models.

Models of network passive elements (e.g. lines, capacitors, reactors and transformers) have very low levels of intellectual property embedded in them. These types of equipment have been very well defined from a modelling perspective for many years. This is true also for these types of plant behind connection points as well as in the NSPs' assets. Consequentially, the types of information represented in a load flow program should not be treated as confidential information in the NEM. This includes the information that has been described in Table 1 as "quasi dynamic" which is used to establish the steady-state operating conditions of plants such as transformers, generators and bi-directional plant, switched capacitors and reactors, the output of dynamic reactive plant such as static var compensators and synchronous condensers and HVDC plant in a load flow. Without this information, a load flow is not in a useable form. Higher detail representations of steady-state data also contain little commercially sensitive information.

Access to load information in the NEM has traditionally been more restricted than generator information. However, there is no strong argument or evidence to support that the information is inherently more sensitive than the generator information that is published daily in the NEM. For load flow information to be usable, the loads at least to transmission connection and bulk supply level (for a transmission-focussed study) would be necessary.

There are other types of model representations beyond those described above, for which the commercial sensitivity of the information is more arguable, and for which the proposed rules consultation would provide a means to test which types of data should be made generally accessible.

Market collusion

Collusion occurs when entities work together to influence a market or pricing to their advantage. This can arise in tendering process when those submitting tenders compare their offers in advance. Similarly larger participants in a market can collude to increase the price of goods or services. This type of behaviour is more likely to occur if pricing and cost information is shared inappropriately. In the NEM this risk could occur, for example, if bid information was made accessible prior to dispatch.

The types of information proposed in Table 1 should not exacerbate the risk of collusion.

Malevolent actors

The disclosure of detailed network models might mean malevolent actors could more easily interfere with the operation of the power system, potentially causing supply interruptions. Potentially, this could include physical attacks on the network equipment or cyber security attacks. However, in the case of the NEM, sufficient information can be derived from publicly available sources such as Google Maps and NSP planning documents to identify points of likely weakness in the power system, and other mitigation measures are therefore required to manage these risks.

Therefore, disclosing power system models does not increase the risks from malevolent actors compared with the status quo.

Privacy of personal information and financial information

The protection of personal information and financial information is important to prevent fraudulent activity against individuals and companies. AEMO and NSPs are subject to Australian laws[18] around the sharing of such information, which would generally prevent it from being treated as anything other than strictly confidential.

[17] Mainly this is because, historically, AEMO has not considered generic models (other than for synchronous generators) to be suitable for connection studies so Registered Participant have provided user-defined models instead, and the confidential information provisions have prevented other stakeholders from accessing the information to derive good quality settings to fit plant performance to generic models. The quality of generic models has improved in recent years so that, in many cases the model is similar in quality to a user-defined RMS model.
[18] For example, the Privacy Act 1988.

There may be some types of information that could be used for power system modelling that might overlap with information that must be kept confidential under other laws. AEMO would need to consider this within its review of confidential information, under this rule change request.

3.2.3 The negative consequences of making power system modelling data confidential

The restrictions on the access to the NEM power systems models, as a result of the data being classified as confidential information in the NER, can:

- add significant cost and time delays for project planning and connection in the NEM, impeding the energy transition to renewables,
- impede informed policy development and public discourse,
- impede development of related services to the NEM stakeholder,
- inhibit NEM-specific academic research, development and training,
- increase administrative burden for AEMO and the users of the power system models and data, and
- prevent stakeholder discussion around power system model quality issues, thereby limiting the quality improvements that can be gained by feedback, and the benefits of knowledge sharing.

Project developers access to suitable models

To receive information under 3.13.3 or 3.13.3AA an entity must already be registered with AEMO as a Registered Participant; or apply to be registered as an Intending Participant or a Project Developer.

The application be an Intending Participant or a Project Developer must include:[19]

- project evidence
  - evidence that the applicant has a relationship with the specific plant (e.g. a partner in a consortium),
  - a copy of the connection inquiry for the plant and a favourable response from the NSP,
  - evidence of a long-term arrangements for access to the associated land,
  - projected project milestones, and
  - the project is already registered in AEMO's generation information publications[20] or a request to AEMO has been made to include the project.
- plant details including the name, site location, size and classification of the associated generating units.

The implications for a project developer that is considering multiple potential projects at different locations are that:

- separate applications to be a project developer must be made for each potential plant,[21] [22]
- each application incurs a cost to prepare and a fee for AEMO to assess,[23]
- each application relies on the costs of preparing a connection inquiry, including a fee from the NSP, and
- additional fees (for each potential sites) are required to receive the NEM power system model data.

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19 https://www.aemo.com.au/energy-systems/electricity/national-electricity-market-nem/participate-in-the-market/registration/applying-to-be-a-project-developer

20 https://www.aemo.com.au/energy-systems/electricity/national-electricity-market-nem/nem-forecasting-and-planning/forecasting-and-planning-data/generation-information

21 https://www.aemo.com.au/-/media/files/electricity/nem/participant_information/registration/2024/application-guide-nem-general-application-forms.pdf?la=en

22 https://www.aemo.com.au/-/media/files/electricity/nem/participant_information/registration/2024/application-guide-nem-general-application-forms.pdf?la=en

23 The fee for each site for the 2025/26 financial year is $9500 https://www.aemo.com.au/-/media/files/about_aemo/energy_market_budget_and_fees/2025/aemo-final-budget-and-fees-fy26.pdf?la=en

This process is inefficient in the early stages when a project developer may be considering multiple potential projects and wants to perform based load flow modelling to give an early indication of expected network congestion.

Therefore, access to network accurate network models would potentially assist some Project Developers at the earlier stages of project and site selection.

The process of investigating and planning a development and following that, connecting to the NEM, is made more inefficient by the inability to obtain suitable quality of information on future projects. Some information on future projects is published,[24] but this does not include all the information necessary for the proponents to model the impacts of their potential future plants, even though the information would be available to AEMO and the NSPs. Likewise, some information about future network is published in Annual Planning Reviews, but insufficient detail is provided to project developers to model these augmentations and upgrades, even when the network is under construction. For transparency and efficient investment in the NEM, future network information should be publicly available at the best available level of detail and accuracy on a consistent basis in each state. The information that can be made available would generally be more detailed and more accurate as the project progresses towards completion.

Connection process inefficiencies

In the NEM, the connections framework involves the development of performance standards. Connection Applicants must propose performance standards either at automatic or negotiated access levels, which they do based on modelling reports for their plant's performance. AEMO and NSPs have become increasingly reliant on EMT modelling, but AEMO has restricted access to EMT models of the power system and does not permit Connection Applicants to access the model outputs from EMT models of other plant in the power system. This information asymmetry makes it difficult and inefficient for Connection Applicants to diagnose performance and modelling issues, which is necessary to tune controllers properly and establish performance standards.

The diagnosis and correction of model quality issues could also be greatly improved if stakeholders were permitted to discuss modelling issues, but this is prevented presently by the confidentiality provisions.

Large customer modelling requirements not met by current access

Customer access to modelling data is even more restrictive than for Generators, as a high percentage of customers are not and do not intend to become Registered Participants. Therefore, they do not have access to even the limited models that Registered Participants can receive, even for those who are required to develop performance standards in accordance with Schedule 5.3 of NER. Large load customers (such as large mining operations) need to undertake planning and operational studies similar to distribution network service providers for their future power system needs, but they have no direct access at present to the data that they need for these purposes.

Policy development and public discourse

The quality of policy development and general public discourse depends on the quality of information available to the associated stakeholders. In many cases, the level and quality of information is very good, including from the Australian Bureau of Statistics (ABS) and AEMO. However, access to the NEM power system models is limited to NEM Registered Participants, and only for specific purposes, which is expected to inhibit some types of policy development and public discourse.

For example, of particular interest to some stakeholders has been the potential costs and benefits of some major transmission network augmentations. Access to network models would increase the transparency of the assessment processes.

[24] For example, the Key Connection Information at https://www.aemo.com.au/energy-systems/electricity/national-electricity-market-nem/nem-forecasting-and-planning/forecasting-and-planning-data/generation-information

Development of related services

Currently, there are many engineering and economic consultants that provide a range of services and advice to NEM stakeholders. This advice includes:

- projections of demand and future energy prices,
- congestion, and
- marginal loss factors.

The restricted access to NEM power system models means these consultants are limited in their ability to develop better more detailed and accurate NEM models.

The types of analysis in the examples above rely on a steady state model of the power system. As discussed in section 3.2.1, it can be argued that this information is not very sensitive and does not need to be confidential. Thus, providing greater access to NEM power systems models would enable these consultants to develop additional services for NEM stakeholders. This could potentially improve both the investment and operational decisions of NEM participants and related stakeholders.

It is difficult to estimate the nature of additional services that could be offered, and hence the potential benefits. There is significant research and development in the energy sector at present around improvements in dynamic modelling and tuning for low system strength conditions. Other research is looking at better utilisation of network by combination of storage and variable renewable energy.

Therefore, it is reasonable to assume that many new and innovative tools and services would be offered if the required data was readily accessible.

NEM-specific academic research

Australian has many world-class academic institutions performing a range of research related to the operation and planning of the NEM power system. At present these institutions do not have access to accurate models of the NEM power system.

This means that the new tools and methodologies that they develop cannot be tested on the NEM power system model. The relevance of their research to the NEM power system would be significantly enhanced with open access to NEM models. Similarly, the operation and effectiveness of the NEM cannot be assessed in detail without such access.

In addition, the students at these academic institutions are required to model artificial power systems such as the various IEEE standard network models. While using these models allows academics to compare methodologies and results with their international colleagues, allowing the students access to the actual NEM model would increase their familiarity with the NEM power system which would make them more valuable to the market after graduation.

Allowing academics to access the real power system data, including measurements and models would enable them to gain a better understanding of the issues of highest importance to the Australian electricity industry, to focus research on areas in which it would be of most value to Australia, and to demonstrate the effectiveness of their research outcomes. It may also facilitate the transfer of academic research into innovative products.

Therefore, making NEM models available to academics and their students would lead to more relevant research and better trained graduates, with potential flow on effects to better products and services.

Administrative burden for AEMO and Registered Participants

If sufficient NEM modelling information and data to perform most or all planning and operational studies was no longer classified as confidential then a significant administrative burden would be removed from AEMO. AEMO would no longer need to:

- ensure recipients of the information were registered, removing the need to assess the information assembled and provided by potential recipients.

- assemble bespoke packages of NEM modelling information and data for each stakeholder wishing to perform NEM power system modelling.

In addition, making the NEM power system models publicly available would reduce the time required for stakeholder to access the modelling information that they need.

International comparison

Note that access to the transmission network models is common in some other power systems. Examples include:

- New Zealand where Transpower compiles a model, which includes a steady state network model and (mostly) generic RMS dynamic models, which is published by the Electricity Authority,[25]
- Chile,[26] and
- United Kingdom, where a network model is published.[27]

3.3 The scope of the power system modelling data is limited

At present, the power system models and modelling data available to Registered Participants is limited to:

- a positive sequence (or balanced) steady state model of the current network that is suitable for load flow analysis,
- unbalanced impedance information suitable for balanced and unbalanced fault level calculations, and
- compile RMS models that can be used in dynamic RMS models.

In addition, the NSPs provide supplementary information in specific circumstances, such as harmonic impedance information to connecting network users to allow them to demonstrate that the connecting plant would meet relevant power quality standards.

However, there are many other types of information that could be useful to Registered Participants and other stakeholders. Examples include:

- three phase steady state network models, which can be used to analyse unbalanced networks, including fault level calculations and voltage unbalance,
- transmission line tower geometry and conductor types, which allows stakeholders to perform additional EMT and harmonic studies, as well as being used to derive balanced and unbalanced transmission line impedances for steady state modelling,
- immittance scans[28] to improve the tuning of inverter-based resource (IBR) plant, potentially accelerating the planning and connection of IBR, and
- network models for planned and committed network augmentations that can be used to plan connections.

3.4 Restrictive format for the NEM power system models and model data

Currently the NEM power system models and data provided to AEMO by Registered Participants must be in vendor specific formats corresponding to AEMO's various preferred simulation tools.[29] Similarly, the NEM models and data provided by AEMO to Registered Participants is in the same formats. This can:

[25] https://www.emi.ea.govt.nz/Wholesale/Datasets/Transmission/PowerSystemAnalysis/PowerFactoryCaseFiles
[26] https://www.coordinador.cl/modelacion-sen/documentos/bd-operacion/2025/enero-2025-bd-operacion/
[27] https://www.neso.energy/publications/electricity-ten-year-statement-etys/etys-documents-and-appendices
[28] https://aemo.com.au/energy-systems/electricity/national-electricity-market-nem/participate-in-the-market/network-connections/connection-resources/focus-areas-and-initiatives/frequency-scanning#.
[29] Tools and versions of tools which AEMO requires for connections are nominated under the Power System Model Guidelines at AEMO | Power System Model Guidelines (PSMG) and Data Sheets Consultation

- prevent stakeholders from undertaken certain types of modelling, because the information is not provided in the models to which stakeholders have access, even though it may be held by AEMO or NSPs,
- make sharing of models between organisations, and between different simulation tools costly, difficult and inefficient, and
- adds significant data conversion cost to studies that require any type of modelling other than that provided by AEMO's choice of simulation tools.

3.5 Interoperability of the power systems models

3.5.1 Current format of the NEM models available

At present, the NEM models provided to AEMO are in the following vendor specific formats:

- RMS models, including network models and RMS dynamic models, in PSS®E format,
- EMT models in PSCAD format, and
- small signal models in SSAT format.

Registered Participants provide these models to AEMO and the associated NSP as required, usually when they are connecting new generating systems or modifying their existing ones. AEMO and the NSPs share these models between themselves. AEMO provides the RMS models in compiled PSS®E format to Registered Participants, upon request.

The data formats used in these software packages are not compatible with each other or with standard open-source model formats.

Lack of inter-operability:

- adds costs to OEMs because they need to develop and maintain models in multiple formats,
- adds cost to connections by additional effort to prepare site-specific models in multiple formats, benchmark between them and maintain them when models change for any reason,
- adds significant maintenance cost and effort for everyone using simulation tool or responsible for a model, when a simulation tool is updated to a new version and the existing models need to be updated,
- impedes the development of new simulation tools and more efficient or fit-for-purpose modelling techniques because of the preferencing of particular products,
- impedes the use of modelling techniques not supported by the specified packages, that may be more technically suitable, or more efficient than those provided by the specified packages,
- impedes the combination different types of models in the same simulation (co-simulation), which improves efficiency by reducing simulation time, and
- reduces competition for provision of simulation tools, which can potentially increase the cost and reduce the quality of the simulation tools available to NEM stakeholders.

In addition, the specific forms of the interface between the specified software and the models means that the models may need to be rewritten to use a later version of the software. This has recently been experienced with PSS®E version upgrade and a PSCAD version upgrade because these products do not use an industry standard interface.

3.6 Power system model quality and detail impacts

Power system model quality is of critical importance to the electricity industry as:

- the operation of the power system within a secure operating envelop depends on the quality of power system model – inadequate models can either result in excessively high safety margins on power transfer capability and other operating limits or incorrect decisions that could lead to loss of supply incidents, and

- investment in the electricity industry depends on the quality of power system models for planning decisions and setting performance requirements for connection – poor quality models can lead to poor investment decisions and poor alignment between performance expectations and actual performance, for both financial and technical performance.

Quality of models is influenced by many factors. Some factors of relevance to the present proposal include:

- *A single source of truth* – ideally there should be a single source of truth for each piece of information – having multiple sources of the same information increases the risk of differences between each source and the cost of rectifying them.
- *Storing information at highest level of detail required and in raw form* – To maximise auditability of data, it should be stored in a form as close to possible to raw form. This facilitates confirmation of information against original sources. To facilitate the widest application, store the data at the highest level of detail, because information is lost when data is simplified, and cannot be re-gained, except from a detailed source.
- *Keeping information about the source of the data, its status and history of changes* – For management of data, and information to users about the level of uncertainty in the data its history and status should be maintained and accessible. This enables data to be periodically reviewed and updated as required to keep it current so that best available information can be accessed.
- *Having a large user base and feedback mechanism* – The quality of information is maximised if the user base is widened and there is an effective feedback mechanism whereby users can report errors and verify that they have been rectified promptly.
- *Ownership by a user with a vested interest in quality* – The party owning the data should be a user with a strong incentive to maintain the data to a high level of quality.

The proposed rule change is intended to support the development of industry practices and information systems that reflect good practice for information management, including those outlined above. At present, the NEM lacks effective processes for maintaining model data quality. Public information is fragmented, inconsistent and incomplete, and there is a lack of transparency around the quality of data provided, and a lack of feedback mechanisms for improving the quality of data provided by AEMO and NSPs to stakeholders.

4 The proposed rule is likely to contribute to achieving the NEO

This section provides an explanation of how the proposed rule change request will or is likely to contribute to the achievement of the NEO.

4.1 The national electricity objective or NEO

The NEO is:

"to promote efficient investment in, and efficient operation and use of, electricity services for the long term interests of consumers of electricity with respect to:

a. price, quality, safety, reliability and security of supply of electricity; and

b. the reliability, safety and security of the national electricity system; and

c. the achievement of targets set by a participating jurisdiction—

i. for reducing Australia's greenhouse gas emissions; or

ii. that are likely to contribute to reducing Australia's greenhouse gas emissions."

The AEMC may only make a Rule if it is satisfied that the Rule will or is likely to contribute to the achievement of the national electricity objective.[30]

In addition, the National Electricity Regulations also requires that a request for the making of a Rule must contain an explanation of how the proposed Rule will or is likely to contribute to the achievement of the NEO.[31] Section 4.2 describes the impacts of the elements of the rule on factors contributing to the NEO. Section 4.3 then summarises the contributions by NEO element.

4.2 Impact of the components of the proposed rule changes

The section divides the explanation into five elements:

1. Accessibility to modelling information,
2. High quality modelling information,
3. Interoperability of modelling information,
4. Forward looking models, and
5. Thorough models.

The benefits of implementing these elements together are likely to likely to exceed the benefits from implementing the elements individually.

Similarly, the costs of implementing these elements together are likely to be less than the costs of implementing them separately. This is because the costs of developing and testing the IT systems necessary to implement these elements would not be duplicated if the elements were to be implemented together.

[30] Section 88 of the National Electricity Law "Application of national electricity objective".
[31] Section 8 of the National Electricity Regulations "Contents of requires for Rule".

4.2.1 Accessibility to modelling information

More efficient operation and investment in the NEM is likely to be achieved by making more modelling information available to a larger range of stakeholders. Examples of where efficiency is likely to be increased include:

- Investors and developers making more informed investment decisions based on greater accessibility to data particularly future network, supply and load data.
- The connection process can be made more streamlined and lower cost by greater access and transparency around model outputs and corresponding inputs, and by accessibility of best available future data at an earlier stage. Current information access restrictions impede efficient connections.
- Accessibility of modelling data to policy makers, their consultants, research organisations and other stakeholders:
  - Improves the quality of public debate about infrastructure developments such as large network augmentations. This can in turn impact the quality of power system augmentation plans and the cost of these investments.
  - Allows for greater transparency of AEMO and NSP practices including the formulation of network limits and constraint equations, and the calculation of ancillary services.
- Making modelling information available to engineering and economic consultants that can develop services for their clients that operate in the NEM, including both registered participants and proponents of smaller scale services including behind the meter equipment and services.
- Making power system models accessible to researchers, universities and students has multiple potential benefits consistent with the NEO. It would both:
  - Assist researchers to make more valuable research contributions better focussed on real power system issues in the NEM and thus their finds would be more relevant and could contribute to innovative solutions better tailored to the needs of the Australian power system.
  - Enable students to better understand the NEM so that they are more immediately effective employees, which would help alleviate the shortage of skilled workers in the electricity services sector.
- Establishing a community forum for modellers to meet online, share their issues and resolve them provides a free troubleshooting service and gives AEMO valuable information about the community, potential problem areas and needs.

4.2.2 High quality model information

High quality modelling is essential for the secure and efficient operation of the power system. Poor model quality increases the risk of incorrect decisions that can lead to loss of supply incidents. Poor model quality also increases the cost of operation of the power system because the uncertainty around modelling outcomes means that greater safety margins are required. Similarly, poor quality modelling data is likely to result in poor investment decisions by both the providers and consumers of energy services.

The proposal addresses data quality by establishing feedback mechanisms and increasing the ability of parties to share information about model issues so that they can be rectified. It also promotes and supports the use of effective data management outcomes by the proposed arrangements for storing and sharing data. The proposal also requires that information about changes to modelling information be published so that stakeholders can assess whether their analyses must be updated to reflect new information. The proposed requirements are likely to reduce rework and poor performance outcomes that can arise from incorrect or inadequate data.

The proposed modelling forum would also foster knowledge sharing across the industry which would potentially lead to quicker resolution of modelling issues, either through workarounds or more timely model updates. In contrast, the current situation is one where stakeholders are forbidden by the rules from discussing or sharing modelling outcomes. Note that this improved outcome would also depend on making the outcomes and associated inputs of models non-confidential (as proposed in Table 1 of this proposal). Better information sharing is likely to lead to better quality

models. Better quality models and quicker resolution of modelling issues will improve the efficiency of the connection process and are also likely to achieve better plant performance outcomes which could improve power system security over time.

4.2.3 Interoperability of modelling information

Model interoperability contributes to the NEO by promoting efficient investment in and operation of the NEM by:

- Promoting competition amongst software vendors, on price and quality of product, which improves quality and reduces cost of modelling outcomes. Competition amongst vendors contributes to efficiency by driving efficient prices for products. The prices reflect onto the cost of developing and operating the power system, and through this, to the cost of electricity to consumers.
- Promoting competition by allowing stakeholders to choose the most appropriate simulation tool for the modelling application. This reduces the time and effort required to undertake studies and may also lead to more accurate results and better-informed decision-making.
- Facilitating the sharing of modelling information across organisations (e.g. between adjacent NSPs who may choose to use different software vendors).
- Potentially reducing the number of separate models that need to be maintained by AEMO and Registered Participants. This also promotes efficiency, because all models need to be maintained and checked for alignment (benchmarking). When models do not align there is additional work involved to investigate and correct the errors. Maintaining fewer models therefore leads to lower costs across the industry, and more efficient use of resources.
- Reducing the cost to OEMs for producing and maintaining models for multiple software applications. The model maintenance costs will generally be reflected into the price of products that OEM sell to electricity industry participants, and therefore contribute to the cost of developing the power system.
- Potentially reducing the periodic cost to the industry of upgrading models when software versions change (as the models would work through a standard interface not affected by the software vendor's version update).
- Improving modelling efficiency and speed by facilitating the use of co-simulation techniques. Through use of co-simulation, results can be achieved more quickly and with less computing power (an operating cost impact). More efficient modelling techniques could substantially reduce the duration of connections, which will contribute to achieving the energy transition, and therefore contribute to meeting greenhouse emissions targets.
- Reducing the barriers to development of new innovative modelling tools to meet industry needs. The barriers arise because of the vendor-specific model requirements currently employed in the NEM. This make it very expensive and difficult for other vendors to compete because the models need to be rewritten in a different format. Use of modelling tools that are well-adapted to the task can make the planning, design and connection of plant, and the evaluation of operational matters (such as dynamic security assessment, network constraints or marginal loss factors) quicker and less resource intensive, which can result in more efficient investment and operation of the power system.

The current NER does not prevent model interoperability but also does not promote it. AEMO has indicated that it supports the concept of interoperability.[32] Requiring power systems models to be usable in a range of simulation tools is consistent with the NEO for the reasons outlined above, so it is reasonable for the NER to require the transition to use open, non-vendor-specific industry standard model interfaces to support interoperability. A key element would be design of a transition pathway, while maintaining modelling capability throughout the transition. For this reason, the proposed rule includes a requirement for AEMO to consult with industry on the implementation including the transition pathway and timing. Consultation with industry would assist to achieve the transition more efficiently.

[32] For example, in this document, AEMO indicates it has commenced work on a long-term initiative mapping out a plan to develop model data that is not dependent on a specific simulation tool: https://www.aemo.com.au/-/media/files/electricity/nem/network_connections/psse_v36_transition_final.pdf.

4.2.4 Forward-looking models

In the energy transition, the rate of change in the power system is high, so access to the best available future modelling data is important for the efficient investment in the power system.

The best available information would change over time – generally as a project progresses from planning through to connection the level of detail and accuracy of the information is improved. Fortunately, less detailed information is required for planning timeframes and more detailed and accurate information is required for connection and operation. The concept of best available information requires information to be updated when changed and that the best information can be used for analysis. Information about the status would also assist in decision-making because it is an indication of the level of accuracy that should be expected from a piece of information. Availability of higher quality forward-looking information is likely to result in better targeted and more timely decisions about investment, thereby contributing to efficiency in the NEM. Better access to forward-looking model information by policy makers and the academic community will likely lead to better-informed policy debate, which in turn may result in better policy and investment decisions that affect the energy sector over time.

As noted above, inaccurate or insufficient information in connections can lead to poor performance outcomes, rework and additional costs so it is important that the best available future project information is made available for considerations in near term decisions (such as for control system tuning for connections). Unavailability of information such as models for committed network augmentations is also detrimental to the efficiency of connections and the accuracy of modelling outcomes. Therefore, accurate near-term future models, as promoted by this rule change proposal, are particularly beneficial for improving efficiency in the connections process.

Having the best available forward-looking models is therefore consistent with efficient investment and operation of the power system.

4.2.5 Thorough models

This aspect of modelling is indirectly addressed through the proposed rule change by:

- the inclusion, in information to be provided from NSPs to AEMO, of Table 1 data, which includes a wider range of data than is currently obtained by AEMO from NSPs, some of which requires higher detail level, and
- the description of data and models to be made available through the data portal referencing the level of detail described in Table 1.

The proponents of the rule change consider that data quality is best served by having a single source of truth for each type of information. If multiple applications are to be serviced, this implies that the information needs to be stored in the highest level of detail required for any application and then models requiring lower levels of detail can be derived from the single detailed source. Note that EMT applications require high level of network model detail for accurate modelling, and this is also required to derive accurate immittance scans and is similar to the level of detail required for studying harmonics levels. It makes sense to use the same data source for each application, to avoid duplication and the extra work required to maintain and reconcile differences between different datasets. Corrections to data can be made in one place and will benefit quality of modelling for all categories of data if a single dataset is used.

The proponents of the rule change request understand that AEMO is currently contemplating the development of a comprehensive modelling database consistent with these principles. The proposed rule change is consistent with this concept, which the proponents understand to be good practice for information management that would drive quality improvement and data maintenance cost reduction over time.

4.3 How the rule change request is likely to contribute to the achievement of the NEO

The proponents consider that the proposed rule changes would likely contribute to the achievement of many aspects of the NEO by allowing stakeholders to make more effect operational and investment decisions that would be in the long-term interests of consumers of electricity. The proposed rule is a multi-faceted approach which contributes more

to the NEO when all parts are implemented together. Contributions to each element of the NEO are presented in the following subsections.

4.3.1 Efficient operation of electricity services – productive efficiency

The efficient operation of the NEM electricity services will lead to productive efficiency gains when the services required to meet the needs to electricity consumers can be provided at the lowest cost.

The proposed rule change is likely to promote productive efficiency by:

- Increasing the range of stakeholders that can access NEM power system models so that they can make more prudent operational decisions when providing electricity services such as energy and ancillary services.
- Reducing the administrative burden and barriers, and the associated delays and costs, to stakeholders when accessing modelling data.
- Allowing consultants to prepare advice for their clients to better understand of how their services impact the operation of the NEM and thus make more efficient operational decisions.
- Better decision making by improving transparency of the operation of the NEM including the constraint equations and the ancillary service requirements.
- Improving the accuracy of information available to AEMO, the NSPs and other stakeholders that improve their operational decision making.
- Providing stakeholders with models in a non-vendor specific interoperable format so they can choose a range of simulation tools to inform their operational decisions. This could potentially be enhanced by new and innovative simulation methodologies that are not currently available, while promoting competition between vendors of these simulation tools.

4.3.2 Efficient use of electricity services – allocative efficiency

The efficient operation of the NEM needs to consider the allocation of electricity services to those who value them the most.

The proposed rule change is likely to promote allocative efficiency by:

- Increasing the range of stakeholders with access to NEM power system models so that they can make more effective operational decisions when using electricity services such as energy and ancillary services.
- Improving the accuracy of information available to AEMO that it uses to operate the NEM to calculate the quantity required of electricity services, including energy, while maintaining the system in a secure operating state. NEM dispatch relies on network constraint equations to maintain power system security, which depend on power system models, so the quality of those models affects the efficient allocation of electricity services. Efficient allocation of system strength, inertia and network support control and ancillary services is also similarly impacted by the quality of the underlying power system models.
- Allowing consultants to prepare advice for their clients to better understand how investment proposals would affect the operation of the NEM, and thus lead to more efficient investment decisions.
- Providing greater transparency of the likely future operation of the NEM including less conservative constraint equations and ancillary service requirements.
- Providing stakeholders with models in a non-vendor specific interoperable format so they can use the most suitable simulation tools to inform their operational decisions, potentially fostering the development of new and innovative methodologies and tools, while promoting competition between vendors of these simulation tools.

4.3.3 Investment in electricity services – dynamic efficiency

Dynamic efficiency is enhanced when investors in facilities for the provision or consumption of electricity services have access to appropriate and accurate information about the future grid, which in many cases would require the use of power systems models. These investors will include:

- Registered Participants, such as generators, developers and NSPs,
- other potential investors who are considering becoming a Registered Participant, including potential developers that have are not able to be a project developer because they have not committed to a specific project and site,
- consumers of electricity services, particularly large loads, who currently cannot obtain power system models unless they register as a Customer or Demand Response Provider or become a project developer, and
- smaller service providers and consumers who also invest in the provision or use of electricity services.

The proposed rule change is likely to promote dynamic efficiency by:

- Increasing the range of stakeholders and number of potential investors that can access NEM power system models so that they can make more effectively assess potential investment decisions in the provision or consumption of electricity services such as energy and ancillary services.
- Increasing the quality of models received by Connection Applicants for use in connection applications. This will reduce the time, effort and expense preparing connection studies (for example adding in additional models to snapshots) and decrease the likelihood of incorrect model outcomes caused by incorrect input information.
- Reducing delays and accelerating the connection process by improving access to model information, particularly around outputs from simulations. Current limitations on access to information about the power system behaviour in EMT wide area simulations makes it difficult for Connection Applicants to diagnose performance issues and negotiate performance standards.
- Reducing the administrative burden and barriers on stakeholders when accessing modelling data.
- Improving the optimisation of future investment by providing stakeholders with the best available forward-looking information on future network augmentation, as well as load and generation facilities.
- Allowing consultants to prepare advice for their clients to better understand of how their services impact the operation of the NEM and thus make more efficient investment decisions.
- Providing greater transparency of the operation of the NEM, including the constraint equations and the ancillary service requirements.
- Improving the accuracy of information available to AEMO, the NSPs and other stakeholders to improve their operational decisions.
- Providing stakeholders with models in a non-vendor specific format so they can use a range of simulation tools to inform their operational decisions. This could potentially be enhanced by new and innovative simulation methodologies that are not currently available while also promoting competition between vendors of these simulation tools.
- Providing NEM models to universities which will allow students to gain a better knowledge of the NEM and its issues. This would help reduce the current shortage of experienced workers in parts of the industry.

4.3.4 Price of electricity services

Efficient prices occur when consumers see the full benefits and costs of their choices through the prices they see. This is expected to occur when the productive efficiency, production at the lowest cost, and allocative efficiency, costs reflecting the costs of production, are enhanced.

As discussed in sections 4.3.1, 4.3.2 and 4.3.3, the proposed rule change is likely to promote productive efficiency and allocative efficiency in the short-term and dynamic efficiency over time.

Therefore, the proposed rule change is likely to promote efficient prices for electricity services by promoting all three types of efficiency in the operating and planning of the NEM, including the national electricity system.

4.3.5 Reliability

The reliability of the power system depends on an adequate supply of generation and storage capacity to meet consumer demand, net of any demand side response. Similarly, the reliability of supply to consumers depends on the capability of the network to meet the needs of consumers.

The proposed rule change is likely to promote better reliability by:

- Giving investors better access to NEM models so that more prudent decisions on new capacity and networks can be made.
- Improving the accuracy of information available to AEMO, the NSPs and other stakeholders to improve their operational decisions. This could include:
  - better utilisation of the network infrastructure by using more accurate network models to reduce the safety margins required in network constraint equations, which may reduce loss of supply, particularly at times of scarcity.
  - a better understanding of how their potential investments might impact the future operation of the NEM.
- Elements of this proposal that target model quality, interoperable models, and access to relevant information (such as detailed harmonic models, and simulations results and inputs) potentially contributing to faster and more efficient connections of new generation thereby promoting reliability of supply, as there would be less reliance on end-of-life generation remaining in service.
- Promoting broader understanding of NEM reliability issues and possible remedies through research undertaken by the academic community and consultants using actual NEM power system models.
- Promoting better transparency and understanding of matters that could contribute to NEM reliability issues through the on-line community of modellers.
- Making the best available forward-looking information on future network augmentation, as well as load and generation facilities. This can contribute to reliability by improving locational signals to investors so that the power system can be developed more optimally to achieve reliability at lowest cost.

4.3.6 Security and safety

Security of the power system and supply refers to the ability of the power system to continue to operate within acceptable technical limits for major system events such as the loss of generation, network and consumer plant. Failure to manage security correctly increases the risk of safety incidents, equipment damage, and major supply disruptions, including black system events. Maintaining security of the power system relies extensive modelling of the operation of the NEM power system.

The proposed rule change is likely to promote better security of the power system by:

- Improving the accuracy of information available to AEMO, the NSPs and other stakeholders to improve their operational decisions. This could include:
  - a reduced risk of power system security incidents by having more efficient and accurate network constraint equations derived from more accurate network models,
  - a better understanding of how their potential investments would impact the future operation of the NEM, and
  - considering whether new plant, such as generating systems, can provide additional system security services.
- Increasing the range of simulation tools available to stakeholders by providing NEM models in a non-vendor specific interoperable format may enable the use of tools that identify security issues in a more effective or

timely manner, thereby assisting the maintenance of power system security, particularly when the power system is under stress.

- Promoting better collective understanding of potential NEM security issues through information shared by the on-line community of modellers, which may reduce the risk of power system events adversely impacting power system security.
- Promoting broader understanding of NEM security issues and possible remedies through research undertaken by the academic community and consultants using actual NEM power system models.

4.3.7 Power quality

Power quality refers to the characteristics of the voltage waveform at a given connection point in the network. These characteristics are voltage distortion from harmonics, voltage unbalance and voltage flicker, and should be kept within acceptable limits. Poor power quality can result in maloperation of, or damage to, network equipment or equipment connected to the network. Therefore, the NSPs have an obligation to maintain the power quality at their connection points within power quality standards, while network users are required to connect only equipment that meets the respective power quality standards. This is managed by a combination of modelling and monitoring of the power system.

The proposed rule change is likely to promote better power quality by:

- Making the harmonic models, and associated assumptions, accessible to Connection Applicants, so that they can better understand the scenarios that result in potential non-compliance, and the efficient options for mitigation. Better quantity and quality of information and improved transparency may avoid unnecessary capital expenditure on mitigation measures such as harmonic filters, and the consequential impact on power system voltages due to the reactive power from too many harmonic filters.
- Potential developers being able to access NEM power system models at an earlier stage of their project development to assess the power quality challenges of potential development sites, prior to committing to registering as a developer for a specific site.
- Enabling better coordination of harmonic mitigation efforts between connections that are electrically close and connecting at the same time, through access to best available models. This will potentially improve power quality outcomes, at lower overall cost.
- Improving the quality of NEM models through the transparency of the on-line community of modellers. This will allow stakeholders to better quantify power quality issues to identify the need for power quality mitigation measures, such as harmonic filters, earlier in the development of the project and potentially avoid the implementation of unnecessary mitigation.
- Allowing consultants and universities access to complete NEM power quality models to enable them to undertake research to be better understand and propose mitigation strategies for power quality issues in the NEM.
- Making the power quality models available in non-vendor specific interoperable format so that stakeholders can select the simulation tools they consider most suitable.
- Enhancing stakeholders' ability to maintain power quality as the power system evolves by making the best available forward-looking models available to stakeholders.

4.3.8 Emissions reductions

The likelihood that emissions reduction targets set by the jurisdictional will be met or exceeded depends on the speed of the energy transition.

The proposed rule change is likely to help achieve these emissions targets by improving dynamic efficiency, as discussed in section 4.3.3, which helps facilitate a faster energy transition with an associated reduction in emissions.

5 Costs and benefits to those affected

This section provides an explanation of the expected potential impacts of the proposed change to the rules on those likely to be affected including costs and benefits.

AEMO

- Costs
  - AEMO is currently considering major changes to the ways it manages modelling data.[33] The scope of the developments required for the Open NEM Model could be significant. However, incorporating the changes proposed in this Rule change request into AEMO's ongoing work would be much more efficient than addressing these changes separately. The costs would be incremental to the cost of the work that AEMO is currently undertaking. If this opportunity to enhance information provision in the NEM is lost, the subsequent cost of undertaking the work later would be much higher. The costs that AEMO incurs would be spread across NEM Participants through fees and ultimately reflect in cost of electricity to customers.
- Benefits

  AEMO would be a major beneficiary of the proposed initiatives. These benefits would reflect on the cost of operating the NEM and ultimately the cost of electricity to consumers:
  - AEMO would receive feedback from data users to identify errors in the modelling information. Correcting these errors would increase AEMO's confidence when accurately managing system security, potentially allowing a reduction in safety margins on network constraints and affecting operating practices in ways that reduce the cost of operating the NEM.
  - AEMO's risks from poor quality data would be substantially reduced if AEMO can harness the benefits of feedback from a wide stakeholder base to improve model quality.
  - AEMO would benefit significantly from having modelling tools that are interoperable, because it would be able to use the best available modelling tools for the application and can make use of innovative modelling techniques not currently available to it. The use of models conforming to standard interfaces would also likely substantially reduce the effort to maintain models when software versions change.
  - If the formats of models support multiple applications, it may be possible to reduce the number of different models managed by AEMO and NSPs. This would have substantial efficiency benefits for model maintenance across the NEM.
  - AEMO would avoid the cost of upgrading legacy models when new software tools and versions become available (or old ones are no longer supported).
  - Increased efficiency in connection processes associated with more effective information sharing and transparency would likely reduce AEMO's resource burden associated with connections processes.
  - Modelling processes could also be significantly more efficient if the benefits of co-simulation (facilitated by interoperable models) can be realised.
  - AEMO would no longer have the administrative burden of charging for access to most data which would be classified as non-confidential.
  - AEMO would be able to procure new services from service providers, such as engineering and economic consultants, based on the service providers access to non-confidential modelling information.
  - New graduates from Australian universities would have a more detailed knowledge of the NEM and its operation, and would be more useful to AEMO.

33 https://www.aemo.com.au/energy-systems/electricity/national-electricity-market-nem/participate-in-the-market/network-connections/power-system-analysis-tools

Network service providers

- Costs
  - NSPs may incur additional costs in providing more detailed data to AEMO and other stakeholders. There may need to be additional IT facilities established for this purpose (for example, to ensure proper cyber security).
- Benefits
  - NSPs use the same modelling information as AEMO and would benefit from improved data quality and interoperability of models. This may improve the quality of investments and the performance of their networks. Interoperable models would facilitate sharing of information between organisations and enable each NSP to use the best available tool for the modelling application.
  - Improved information sharing between NSPs and connection applicants would reduce the effort required, and the pressure on NSP resources for connections.
  - New Employees who are graduates from Australian universities would have a more detailed and relevant knowledge of the NEM and its operation, allowing them to develop and contribute to the NSP more quickly.
  - NSPs would be able to engage with universities on issues that are relevant and important and would be able to share relevant data with researchers.
  - NSPs would likely benefit from innovative products that can be developed because of the better accessibility to information.
  - NSPs would be among the wider stakeholder group to benefit from quality improvements in models over time.

Project developers

- Costs
  - No material costs.
- Benefits
  - Access to non-confidential information at the early stages of identifying potential project sites, without the administrative cost and associated delays of applying to be a registered developer for every potential individual site.
  - Access to better quality information (particularly on future developments) improves investment decisions and reduces risk by lowering uncertainty. Lower uncertainty may lower financing costs and facilitate financing.
  - Access to information in more complete and usable form would reduce the cost of modelling.
  - Able to procure new services from service providers, such as engineering and economic consultants, based on the service providers access to non-confidential modelling information.
  - Graduates from Australian universities would have a more detailed knowledge of the NEM and its operation, and hence would be productive employees more quickly.
  - Developers would be among the wider stakeholder group to benefit from quality improvements in models over time.

Connection applicants and Registered Participants for generating systems/ integrated resource systems

- Costs
  - Depending on how the conversion is managed there may be additional costs to Registered Participants from converting dynamic models to a form that is interoperable.
- Benefits

- Following the conversion of models to interoperable form Connection Applicants would be major beneficiaries of the added flexibility to use alternative simulation tools.
  - Costs of preparing connection studies are likely to fall if licensing costs of simulation tools are reduced as a result of greater interoperability of models, either through increased competition, or need of fewer tools because those tools can be used for multiple purposes.
  - Interoperability of models could potentially result in fewer models needing to be created and maintained, reducing the cost of connections.
- Connection Applicants and Registered Participants would also benefit significantly from improved transparency and sharing of information between parties which would improve the efficiency of the connection process, for example, reducing the number of iterations needed to achieve good tuning outcomes.
- Connection applicants and Registered Participants would be among the wider stakeholder group to benefit from quality improvements in models over time.
- Access to broader and better-quality information will:
  - Reduce the amount of effort for each connection project to modify study files.
  - Reduce the risk of incorrect outcomes of connection studies that arise from model inaccuracies, which lowers the risk of non-compliance and unnecessary delays to connection or commissioning (and associated loss of production).
  - Assist engineers in proposing and agreeing to negotiated access standards that support efficient investment outcomes in the NEM, while ensuring power system security and quality of supply are not adversely affected.
  - Facilitate a collaborative approach to problem solving throughout the connection process.
  - Facilitate better coordination between nearby projects that are connecting at the same time, with potential to reduce capital expenditure (for example, optimising siting and size of harmonic filters) and improve performance outcomes and rework (for example, by coordination of plant controller tuning).

Large loads connection applicants and existing customers

- Costs
  - No material costs.
- Benefits
  - Large load customers and connection applicants would benefit significantly from being able access NEM models for planning and operational purposed, as well as for connections, without applying to be a Registered Participant.
  - Customers new and existing would be among the wider stakeholder group to benefit from quality improvements in models over time.

Original Equipment Manufacturers

- Costs
  - There would likely be an upfront cost for OEMs from developing models with industry standard interfaces and a cost to convert existing models to have industry standard interfaces.
- Benefits
  - OEMs would benefit from having models with industry standard interfaces because this would significantly reduce the overhead from developing and maintaining models for different simulation tools and updating models to accommodate changes to vendor-specific models when those simulation tools are updated.

Economic and other consultants

- Costs
  - Consultants who have invested in training and developing processes and internal tools to support use of particular software products may incur similar costs for other products, but this is discretionary.
- Benefits
  - Access to non-confidential models would mean that they can provide a greater range of services to more parties including those who are not Registered Participants.
  - If future modelling information is the best available at the time, this would improve the quality of services, and therefore demonstrate more value to clients.
  - Interoperability of models allows consultants the flexibility to use a range of products, rather than being locked into products specified by AEMO. This competition benefit will impact small consultants and new entrants more than established consultants and other larger market participants, as software licenses can be a significant fixed cost for power system and economic modelling consultancies,[34] but all software users are impacted to some extent. Small consultant and new entrant cost competitiveness, relative to all consultancy services, is likely to be affected more by licence costs and increases.
  - Interoperability would also allow consultants to utilise the best tool for the application, with potential associated efficiency benefits and more useful modelling outcomes, demonstrating more value for clients.
  - The use of interoperable models with standard interfaces potentially reduces the cost of developing tools to interrogate model outputs, as the same tools could interface with different software products with less adjustment. This facilitates the development of innovative techniques that improve efficiency and effectiveness of consultants' services to the market.
  - Reducing rework and other inefficiencies from poor quality models and data and lack of access to important technical information is beneficial to the well-being of consultants, contributing positively to workplace heath and safety. This may reduce staff-turn over, from stress-related causes. A high staff attrition rate is a phenomenon commonly experienced in the industry, particularly among employees engaged in connections-related work. The retention of experienced staff in connections-related roles is valuable to consultants and the broader industry more generally as it facilitates quality and efficiency of services.

Academic researchers

- Costs
  - No material costs.
- Benefits
  - Access to non-confidential models would mean that they can undertake research that is relevant to the NEM. This could include developing new modelling techniques and potential improvements to the operation and planning of the NEM.
  - Access to non-confidential models would mean that they can provider a greater range of services to market participants, including potential project developers, and other NEM stakeholders.
  - The associated students would have a more detailed knowledge of the NEM power system and hence be of greater value to NEM participants and other stakeholders.
  - There would be greater value from collaboration between industry and academic researchers which should foster collaborative and more innovative research.

[34] There may also be licence volume price differentiation, which amplifies cost differences between small and large volume users.

Simulation tool developers

- Costs
  - Costs to simulation tool developers would depend on whether they support the industry standard interface(s) that AEMO would consult on and choose under this rule. This is a commercial consideration. At present the three simulation tools that AEMO uses do not support industry standard interfaces. These vendors may stand to lose market share if interoperable models are adopted. They may choose to make modifications to their products to support the selected industry standard interfaces.
- Benefits
  - Those simulation tool developers that support the industry standard interfaces may benefit from increased opportunity to provide simulation tools to a wider market in Australia (and overseas), if competitive on price and quality.
  - New simulation tool developers would have fewer barriers to entry into the market for their products than under existing arrangements.

Appendix A Summary of NER treatment of information provision matters

Types of information	Present status of NER requirements
Open access to model data and information	
• **General requirements for modelling data and information confidentiality**	• NER defines as confidential information. • Selected data is available from AEMO to Registered Participants: – NER 3.13.3(k)(2) allows a registered participant to request modelling information from AEMO for planning and operational purposes. – NER 3.13.3AA allows project developers may request the same information. – NER 3.13.3(k1) requires AEMO to set out in the PSMG the circumstances in which AEMO considers the information in 3.13.3(k)(2) to be reasonably required. – NER 3.13.3(l) requires AEMO to provide the requested information to the Registered Participant as soon as practicable if it holds the information requested. – NER 3.13.3(l) requires the recipient of the information to treat it as confidential. – NER 3.13.3(l1) allows AEMO to charge a fee. • NER 3.13.3(l3) describes various other information that AEMO may provide under 3.13.3(l):[35] – historical information relating to operating conditions of the power system. – network capability and operating procedures provided under 3.13.3(f)(1) & (f)(3). – network dynamic model parameters obtained under clauses 3.13.3(f)(2) and 3.13.3(g). – model parameter values derived from a releasable user guide, excluding EMT data. – network model of the national grid, suitable for load flow and fault studies. – other technical data listed in schedules 5.5.3 including network and plant data of equipment at or near connection point and 5.5.4 including network plant and apparatus setting data. • In addition: – NER S5.2.5(f) requires all information provided under S5.2.4 to be confidential. – NER 4.3.4(q) requires information provided to AEMO and the relevant NSPs under paragraph 4.3.4(o) to be treated as confidential information.
• **Treatment of specific types of data and information**	
– **Steady state network model (sufficient for single phase load flow)**	• NER defines as confidential information. Available to Registered Participants at a cost.
– **Steady state network model (sufficient for three phase load flow and fault level calculation)**	• Some sequence impedance information available as part of the network model. Available to Registered Participants at a cost. • The current AEMO simulation tools do not use three phase load flow modelling.

[35]This information is limited to the current NEM power system and does not include future network augmentations.

Types of information	Present status of NER requirements
– **Steady state bulk supply point aggregate load data**	• Some data are published as part of Annual Planning Reviews.
– **Network - spatial and geometric, 3 phase data**	• NER silent. Not available.
– **Network/ load /generation harmonic modelling data**	• NER silent. Not available. • Harmonic polygons available from NSP for specific connection points as part of the connection process. NER is silent on provision of information and on methodology and assumptions. NSPs vary in information they provide about the associated power system conditions.
– **Connection point generation data – historical**	• Dispatch information is available via AEMO website.
– **Frequency scan into a connection point**	• NER silent. Not available. • AEMO website suggests it may become available to Registered Participants for connection applications in future.[36]
– **Balance of plant within connection points including unit level production unit information (or aggregate unit)**	• Not available. NER defines as confidential information.
– **Frequency scans of generating systems and IRS**	• Not available. May be considered confidential information under NER (not tested).
– **Encrypted RMS dynamic models** – **Small signal user defined dynamic models**	• NER defines as confidential information. RMS dynamic models available to Registered Participants at a cost. • NER defines as confidential information. Small signal user defined models required from Generator/IRPs. Not provided to these parties.
– **Encrypted EMT user defined plant dynamic models**	• NER defines as confidential information. Required from Generators/IRPs/Connection Applicants. Not provided to these parties.
– **Detailed unencrypted models**	• NER defines as confidential information. Only available within AEMO. • S5.2.4(b)(6) requires Generators to provide source code (i.e., the unencrypted model) to AEMO. Typically only provided for RMS models.
Forward looking steady state model (future projects)	
• **Future network augmentations – transmission and significant distribution (very relevant to new generation projects on new network augmentations, including interconnectors**	• NER silent but AEMO's 2025 Congestion Information Resource consultation agreed to the publication of transmission line diagrams annually, commencing end of 2025.[37] • AEMO snapshots only include commissioned network augmentations in the snapshots. • Models do exist for NSP and AEMO planning purposes including: – initial models used in ISP (approximate) – not provided. – as designed models used in RIT-T and RIT-D (held by NSP) – not provided. – ISP models for market modelling (available but not interoperable format).
• **Future generation and load data**	• ESOO and TAPR/DAPR may contain some information on rating and general location. • AEMO maintains a register:[38]

[36] AEMO | Frequency Scanning
[37] https://www.aemo.com.au/consultations/current-and-closed-consultations/2025-congestion-information-resource-guidelines. It is not clear, at time of writing the extent to which this will include information on future network.
[38] AEMO | Generation information

Types of information	Present status of NER requirements
	– existing and committed scheduled and semi-scheduled generation capacities over the next 10 years. – changes and limitations to existing generation. – proposed developments. – existing non-scheduled generation. • NER 3.13.3(l4) prevents AEMO providing information on plant that is the subject of an application to connect or a connection agreement, until the earlier of: – the date when a connection agreement relating to the plant is executed – three months before proposed start of commissioning of that plant • NER 3.7F(3) requires Key Connection Information to be published, including earlier stages of the connection process such as connection enquiries and connection applications submitted, with general information about the project. Not sufficient to model accurately. Not best available information.
High quality data	
• **The accuracy of the models needs to be fit for purpose. This includes the data and information being:** – **Complete** – **Corrected when errors are detected** – **Updated when plant changes or better information becomes available (see forward looking, information is updated to represent best available information)**	• NER does not impose any direct obligation on AEMO or NSP to provide accurate or fit for purpose data. • Section 49(3) of the NEL requires AEMO to have regard to the NEO when it undertakes its functions under the NER. Since AEMO uses the same information sources as it provides to others, this implies an obligation on having fit-for-purpose data, since that data will affect the efficient and secure operation of the NEM. • Power System Model Guidelines define accuracy requirements on models provided by Connection Applicants/Generators/IRPs to AEMO. • S5.2.4 requires information from Connection Applicants/Generators/IRPs to be updated when changed. • NER 3.13.3(f) requires NSPs to update information on their network annually. There is no requirement to update AEMO on future network or changes as they occur or to correct errors when they are found.
Detailed data	
• **Sufficient detail for most detailed applications**	• NER silent. Not prevented. NER places no obligation on NSPs to provide detailed network data to AEMO or anyone else.
• **Data can be removed for simplified models**	• AEMO is free to manage its data in this way. NSP is also free to manage its data in this way.
Interoperable models	
• **Open model standard suitable for multiple simulation tools** – **Data format is not vendor specific** – **Allows stakeholders to import data into any simulation tool that supports the open format** – **The data standard should be an international standard for broadest application**	• NER silent on what format AEMO should provide modelling data in – AEMO specifies this (NER 3.13.3(k)(2)(ii)). • NER specifies that Connection Applicants provide models to AEMO in simulation product specified by AEMO (S5.2.4(b)(5)(ii)(D) and S5.2.4(b)(6)). • NER also requires the encrypted models of the same simulation product are provided to the NSP (S5.2.4(b)(5)).
• **The data that is agreed to be available to stakeholders, including** – **steady state network models**	• S5.2.4(b)(6) A Generator, Integrated Resource provider … must provide… to AEMO, the model source code (in the circumstances required by the Power System Model Guidelines) associated with the power system simulation model in subparagraph (ii)(D) in an unencrypted form suitable for at least one of the software simulation

Types of information	Present status of NER requirements
– **steady state load and generation data** – **dynamic models (if specified)**	products nominated by AEMO in the Power System Model Guidelines, and in a form that would allow conversion for use with other software products nominated by AEMO in the Power System Model Guidelines;

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