DISTRIBUTED ENERGY RESOURCES REGISTER INFORMATION GUIDELINES

ISSUES PAPER

Published: **January 2019**

Australian Energy Market Operator Ltd ABN 94 072 010 327 www.aemo.com.au info@aemo.com.au

NEW SOUTH WALES QUEENSLAND SOUTH AUSTRALIA VICTORIA AUSTRALIAN CAPITAL TERRITORY TASMANIA WESTERN AUSTRALIA

EXECUTIVE SUMMARY

The publication of this Issues Paper commences the first stage of the Rules consultation process conducted by AEMO to develop the Distributed Energy Resources (DER) Register Information Guidelines (Guidelines) required under Rule 3.7E of the National Electricity Rules (NER).

AEMO has prepared this Issues Paper to facilitate informed discussion and feedback by industry about the most efficient way to meet the objectives for the Guidelines.

In summary, the key proposals are to:

1. Provide for the ongoing collection and maintenance of *DER generation information*.
2. Focus on obtaining details relating to the collection and sharing (with relevant parties) of *DER generation information.*
3. Understand what information is desirable for inclusion in the *DER register report*.

AEMO invites stakeholders to suggest alternative options where they do not agree that AEMO's proposals would achieve the relevant objectives. AEMO also asks stakeholders to identify any unintended adverse consequences of the proposed changes.

Stakeholders are invited to provide written feedback on the issues and questions identified in this paper to DERRegister@aemo.com.au, by 5.00 pm (Melbourne time) on 07 March 2019.

The Notice of First Stage of Consultation published with this paper explains to stakeholders how to provide feedback to AEMO.

CONTENTS

1. STAKEHOLDER CONSULTATION PROCESS

As required by clause 3.7E(g) the NER, AEMO is consulting on the development of the Distributed Energy Resources Register Information Guideline in accordance with the Rules consultation process in Rule 8.9.

This Issues Paper includes information provided by interested parties through pre-consultation meetings held in November and December 2018.

Defined terms in the NER are intended to be identified in this Issues Paper by italicising them, but failure to italicise a defined term does not affect its meaning. Note that there is a glossary of terms used in this Issues Paper at Appendix A.

AEMO's indicative timeline for this consultation is outlined below. Dates may be adjusted depending on the number and complexity of issues raised in submissions and any meetings with stakeholders.

Deliverable	Indicative date
Issues Paper published	29 January 2019
Submissions due on Issues Paper	07 March 2019
Draft Report and Guideline published	29 March 2019
Submissions due on Draft Report	15 April 2019
Final Report and Guideline published	31 May 2019

Prior to the submissions due date, stakeholders can request a meeting with AEMO to discuss the issues and proposed changes raised in this Issues Paper.

2. BACKGROUND

2.1 NER requirements

This Issues Paper concerns the application of Rule 3.7E of the NER, which was finalised by the AEMC on 13 September 2018.[1]

Clause 3.7E(g) of the NER requires AEMO to develop, maintain and publish guidelines that require Network Service Providers (NSPs) to provide DER generation information to AEMO, including:

- The information required to be submitted by NSPs.
- The type of demand side participation (DSP) information, submitted to AEMO under 3.7D(b), that will be used in the register.
- When the information must be provided and updated by NSPs.
- How the information must be provided by NSPs.
- The manner and form in which AEMO will publish details in accordance with clause 3.7E(f).
- How AEMO will provide access to NSPs.
- The contents, form, timing and method of aggregation of the DER register report, to be published in accordance with clause 3.7E(l).
- AEMO's approach to the protection of confidential information.

Clause 3.7E(f) of the NER requires AEMO to, no less than annually, publish details on the extent that the information received has informed AEMO's development or use of *load* forecasts.

[1] AEMC, Register of distributed energy resources, Rule determination, 13 September 2018

Clause 3.7E(j) of the NER requires that, in this case, the *DER register information guidelines* will commence no sooner than three months following publication of the first version.

AEMO is required to develop and publish the *DER register information guidelines* by 1 June 2019, with a minimum of three months before they come into effect.

2.2 Context for this consultation

2.2.1 DER register rule change

On 13 September 2018, the AEMC finalised NER 3.7E for AEMO to establish a register of DER in the NEM, including small scale battery storage systems and rooftop solar.

The aim of the register is to give network businesses and AEMO visibility of where DER are connected to help in planning and operating the power system.

The new register must be in place by 1 December 2019. The transitional provisions, which will commence on 18 September 2018, include an obligation on AEMO to make and publish the first DER Register information guidelines by 1 June 2019.

2.2.2 DER register information

DER Register information is defined in the NER as the information contained in the *DER register*. This *DER register information* must include *DER generation information* and *DSP information*.

DER generation information is defined in the NER the standing data in relation to a *small generating unit.* A *small generating unit* is a *generating unit*.

(a) With a *nameplate rating* less than 30MW; and

(b) Which is owned, controlled or operated by a person that *AEMO* has exempted from the requirement to register as a *Generator* in respect of that *generating unit* in accordance with clause 2.2.1(c).

Clause 3.7E(h)(1) of the NER requires any minimum size of *small generating units* to be included as *DER generation information* to be specified in these Guidelines.

DSP information is defined in the NER as any information referred to in the NER 3.7D(e)(1). At a high level, this includes:

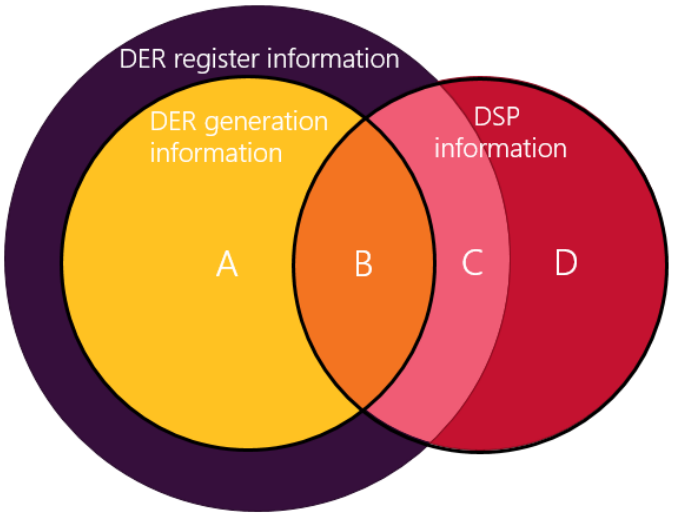
- Contracted demand side participation; and
- The curtailment of non-scheduled load or the provision of unscheduled generation in response to the demand for, or price of, electricity.

Figure 1, below, illustrates the following linkages between the *DER register information*, *DER generation information* and *DSP information*:

- Sections A + B: The DER register will contain all DER generation information, which is specified in the *DER register information guidelines*.
- Section B + C: *DSP information* that in AEMOs reasonable opinion will assist *NSPs* to meet their *regulatory obligations* or *requirements* will be included in the *DER register*.
- Section B: There may be some duplication of data between the DER information and DSP information, which may be for validation.
- Section D: Some *DSP information*, which is specified in the *DSP information guidelines,* but does not meet the criteria under 3.7E(b)(2) will not be available in the *DER register*.

Following the establishment of the DER Register AEMO will review the requirement on DSP Guidelines to include the static asset data details where a NMI is already specified.

Figure 1: DER register information



2.2.3 DER register collection process

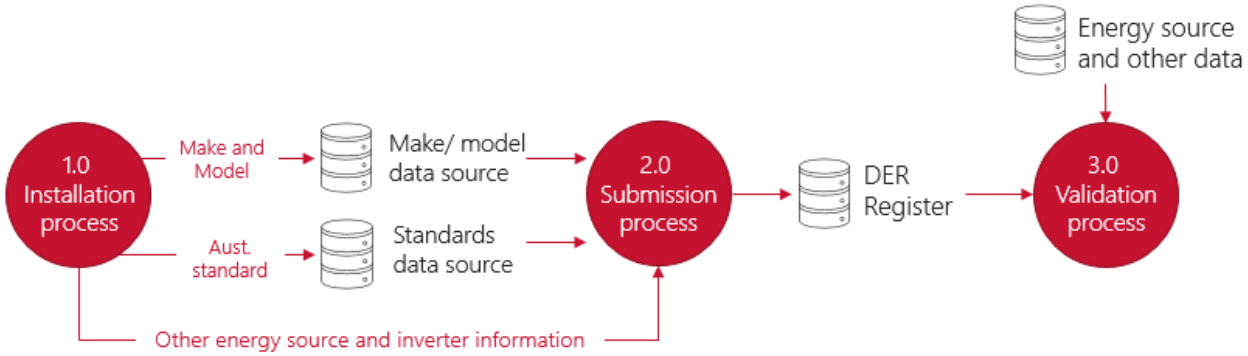
Rule 3.7E(d) specifies that NSPs must provide *DER register generation information* to AEMO in accordance with the *DER register information guidelines*. Whilst the NSPs must provide the data to AEMO, the actual input source of the data is part of this consultation.

Figure 2, below, is a conceptual diagram that illustrates how the collection process may work. It calls out key sub-processes and data sources that would be needed to collect, submit and validate *DER register information*.

The data set presented in Appendix B represents the overarching list of variables that AEMO proposes to capture in the *DER register*. A key principle of the *DER register* is that, where possible, data is pre-populated based on model and manufacturer information, as well as applicable Australian Standards (illustrated in Figure 2, below).

As part of this consultation, it needs to be determined what information can be automatically populated, what the DNSPs can input what should be provided form the installer. There is a column in the tables in Appendix B, which indicates the potential source of the *DER information*.

Figure 2: DER generation information collection process



2.2.4 Principles for the DER register

AEMO will consider the following principles when developing the DER register information guideline:

- Data collected should initially comprise of the statically configured, physical, DER system, at the time of installation.
- Have regard to reasonable costs of efficient compliance compared to the likely benefits from the use of DER generation information.
- Best practice data collection should be implemented, wherever possible, leveraging existing data collection methods.
- Balancing information and transparency the DER register should be accessible and easy to use, while confidentiality and privacy are protected.

3. DISCUSSION

This Issues Paper seeks feedback on the development of the *DER register information guidelines* with particular focus on the information requirements, the *DER register report* and the method by which data will be submitted to AEMO. Details how the feedback is to be described in the Notice of First Stage of Consultation published with this paper.

3.1 Information requirements

3.1.1 AEMO Information Usage

Clause 4.9.1(c)(6)(a) provides that AEMO must take into account DER register information it receives in the development of load forecasts, to the extent that it is relevant to the forecasts. This includes, but is not limited to, the following:

- Annual consumption forecasting – including the Integrated System Plan (ISP).
- Maximum demand forecasting – including the National Electricity Forecasting Report (NEFR) and the associated DSP, and Transmission Connection Point Forecasting (TCPF) reports.
- Operational forecasting – such as the pre-dispatch forecasts, Short Term Projected Assessment of System Adequacy (STPASA), and Medium Term Projected Assessment of System Adequacy (MTPASA).

Annual consumption forecasting

DER information is relevant for forecasting annual consumption from the grid, as some technologies, like rooftop PV, generate power that offsets grid supplied electricity and others, such as Electric Vehicle chargers, adds additional consumption. Forecast annual consumption is an important input into the ISP, ensuring this plans for the optimal mix of generation and transmission to meet energy requirements across the year.

Maximum demand forecasting

DER information is equally relevant to forecasting maximum demand. This includes generating technologies, like rooftop PV, which can affect the timing of the maximum demand for grid supplied electricity, and technologies that change the load shape, such as battery storage, that charge/discharge across a day, and charging of electric vehicles. The maximum demand forecasts are relevant both for the ISP, Electricity Statement of Opportunities (ESOO) and TCPFs, used for network augmentation planning. Forecast change in maximum demand is one of the key drivers of investment and augmentation decisions across the NEM.

Operational forecasting

There are several ways in which DER information could be used in AEMO's operational forecasting functions:

- Information on the levels of DSP in each region is used as an input to MTPASA, which provides a medium-term assessment of power system security and reliability.
- AEMO is investigating the use of DER information from both active DER and passive DER (e.g. solar-PV installations) into their short-term demand forecasting models
- DER information can be used to investigate and correct anomalous behaviour in short term forecasts such as pre-dispatch by providing visibility on how demand is likely to respond at times of high market prices or network loading.

Operational forecasts directly impact market outcomes which, in turn, contribute to the management of power system security and reliability.

Rule 3.7E(e) provides that AEMO may use the *DER register information* for the purpose of the exercise of its statutory functions under the NEL or NER, including performing its *power system security* functions.

Power system modelling

DER information is relevant to the development of dynamic power system models (PSSE and PSCAD studies). As the uptake of DER increases, the characteristics of the generation fleet as a whole, and of load profiles in response to system disturbances changes, necessitating the inclusion of DER in these models. These power system models are an important input into AEMO's system strength assessments, inertia assessments, stability studies and constraint formulation and review.

3.1.2 Format and method of data submission

AEMO will develop a method for NSPs, or installers via NSPs, to securely submit and maintain *DER generation information*, giving consideration to:

- Minimising the effort required to submit the data.
- Leveraging existing processes and systems, where possible.

AEMO's current storage solution is for the DER register to reside in MSATS (see section 3.3, below). The format and method of data submission will leverage existing MSATS processes:

- Submission and maintenance would be done via change requests.
- aseXML would be modified to include the new data elements.
- Current communication methods in MSATS is via browser or batch. AEMO would also add an API for submission and change requests.
- The objection structure will be set to zero for these request types.

In addition, a Bulk upload may be required. This may be used to load initial (existing) DER information obtained from NSPs on or before 1 December 2019.

3.1.3 Frequency of data submission

Processes are currently established for the delivery, access and update of *NMI Standing Data.* At this stage, AEMO intends to collect *DER generation information* on an ongoing basis. The intention is that any physical changes to a DER installation (e.g. install, removal, retrofit) at a NMI would initiate an update to the *DER register*. An option is for the submission and maintenance of data to follow an MSATS Change Request transaction, which would be initiated by the NSP.

The frequency of data submission for the *DER register information* differs to that used for *DSP information.* As noted in section 2.2.2, the *DER register information* comprises of both *DER generation information* and *DSP information. DSP information* is collected on an annual basis in March, as set out in the *DSP information guidelines.*

Questions

1. Do you agree with the suggested format and method of data submission?
2. Are there adequate access arrangements for Installers and installation software providers to submit data on behalf of NSPs into the DER Register? If not, how might this be improved?
3. Are there any risks associated with the different submission frequency between the *DER generation information* and *DSP information*?
4. What is an alternate approach to the frequency of data submission? How would this be implemented?
5. Are there any other relevant issues that have not been considered?

3.2 DER register storage

AEMO intends to store the *DER register information* in two locations.

1. *DSP information* will continue as per its current solution (i.e. not stored in MSATS). See the DSP information guideline for further information.[2]
2. AEMO proposes to store the *DER generation information*, collected according to these Guidelines in new tables in the MSATS database. The separate storage of *DER generation information* and *DSP information* will not affect the access to data. Further, the data stored in MSATS will be in new tables and will not impact the existing settlement data.

Questions

1. Are there any issues associated with the separate storage of *DSP information* and *DER generation information*?
2. Are there any other relevant issues that have not been considered?

3.3 DER register information access to NSPs

Rule 3.7E(g)(7) requires AEMO to specify how it will provide NSPs with access to *DER register information* under paragraph (n). Rule 3.7E(o) requires that the NSP only uses this information for the purposes of meeting a *regulatory obligation or requirement.*

A number of options are being considered for NSPs to access the DER register information:

- Use of NMI discovery process to find DER at a site.
- Use of C1, C4 and C7 reports, and possible development of a new report for DER.[3]
- Access via an API, which enables the development of custom reports based on NSP requirements.

[2] Available on the AEMO website at https://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Planning-and-forecasting/Demand-Side-Participation-Information-Guidelines.

[3] Definition of C1, C4 and C7 reports available in the MSATS procedures (section 5) on the AEMO website at https://www.aemo.com.au/-/media/Files/Electricity/NEM/Retail_and_Metering/Market_Settlement_And_Transfer_Solutions/2017/MSATS-Procedures--CATS-v45.pdf

Questions

1. What *regulatory obligations or requirement* do NSPs intend to use DER register data for?
2. Do you have a preferred process for accessing *DER register information*?
    a. Is existing NMI discovery (adding in DER) useful?
    b. Are existing C1, C4 and C7 reports (including DER) suitable? Is an additional report required? If a new report is required, what should it include?
    c. What are your views on using an API to develop custom reports?
3. Do existing C1, C4 and C7 reports need to be provided if an API is provided?
4. Are there any other relevant issues that have not been considered?

3.4 AEMO reporting and publication

3.4.1 AEMO Reporting

Clause 3.7E(f) of the NER requires AEMO to publish, no less than annually, on the extent to which, in general terms, *DER register information* has informed AEMO's development of or use of *load* forecasts, or the performance of its *power system security* responsibilities under the *Rules*. These details will be available on the AEMO website, and will include;

(a) A list of *load* forecasts that have been informed by *DER register information*.

(b) A description of how *DER register information* was used in each of the forecasts.

(c) Where available, a reference to a document or location where the impact of the *DER register information* on the forecast can also be viewed (such as the MTPASA reports, available on the AEMO website).

3.4.2 DER Register Report

Rules 3.7E(l) and (m) require that AEMO publish a report of aggregated *DER register information* on its website. The information in this report must be aggregated such that it does not: directly or indirectly disclose *confidential information* or breach any privacy legislation.

Clause 3.7E(g)(8) requires AEMO to specify the contents, form and timing of the *DER register report* and how the report will be aggregated.

Contents

The information that *AEMO* proposed to publish in the *DER register report* are detailed as follows:

- Region.
- Installed capacity (MW, MWh).
- Fuel type.

AEMO proposes that the data be aggregated by postcode. Variables with *DER register information* recorded for fewer than 10 NMIs will be displayed as null values to preserve confidentiality.

Form and timing

AEMO proposes to publish the DER register report on a monthly basis, as a minimum, in both a csv data download and graphical format to the AEMO website.

Questions

1. Are there additional variables that should be published in the *DER register report* (see Appendix B for list of data)? Why?
2. Is aggregation at the post code level suitable? If not, what is an appropriate aggregation variable and why?
3. Do you agree with monthly updating of the *DER register report*? Why/ why not?
4. Are there any other relevant issues that have not been considered?

3.5 Confidentiality

Clause 3.7E(g)(9) obliges AEMO to specify their approach to the protection of any confidential information and personal information contained in the *DER register*.

In its role as market and system operator, AEMO receives a large volume of confidential information from participants. Under the National Electricity Law and National Gas Law, is subject to statutory obligations regarding confidentiality. These obligations will also apply to DER Register information where such information is given to AEMO in confidence.

To the extent that the DER Register contains personal information, this will be handled by AEMO in accordance with its Privacy Policy.

3.6 Initial stakeholder input

AEMO held a pre-consultation workshop on Tuesday, 13 November 2018 with 57 self-nominated stakeholders, representing 32 companies, to gain initial input. A further meeting was held with DNSPs on Tuesday, 18 December 2018. Further input was received during this meeting, specifically regarding the data model and collection process for DER register information. Input provided during these engagement sessions included the following:

Information requirements

- The *DER register* should be updated as DER is commissioned, modified, and decommissioned to ensure dataset is up to date.
- National Metering Identifiers (NMI) should be used so information can be easily linked with existing data, such as MSATS.

Data submission and validation

- Initial input indicated that submission and maintenance of data should not be onerous. Automation and leveraging existing processes should be considered, where possible.
- Although out of scope for the *DER register information guidelines*, input from stakeholders indicated that a streamlined, easy collection method for installers and unified collection process across DNSPs is preferred. AEMO will look to facilitate development of these collection processes. It was also noted that when DER is installed there are data requirements for several different bodies, including the Clean Energy Regulator (creation of Small-scale Technology Certificates), DNSPs (connection application, etc), safety regulators (requirements differ across jurisdictions), and AEMO (DER Register). Feedback indicated that it would be preferable to have one, single point of data entry that could be utilised to fulfil multiple requirements.

- Groups in the pre-consultation workshop discussed how data should be validated by the NSP and submitted to AEMO. Several groups discussed iterative/ feedback loop processes, which may be supported by supplementary datasets.[4]

AEMO reporting

- AEMO would not be disclosing any protected or commercially sensitive DER information as part of its reporting function. Only aggregated data will be published. There will also need to be a minimum number of results per aggregation category before the information will be displayed in order to protect privacy.

Confidentiality

- Customer privacy and cyber security should be carefully considered by AEMO when designing the storage, access and reporting solutions.

Future-proofing the DER register

- AEMO should build a register that is extensible. The initial DER solution should, if possible, use existing systems and methods. However, flexible solutions should be considered, to enable the capture of more active data and other types of DER devices, as technologies progress.

4. PROPOSED DATA

To help stakeholders and other interested parties respond to this Issues Paper, AEMO has included a draft of the proposed data to be collected in Appendix B.

The proposed data model will be split into four levels:

Table 1: Data requirements and usage

	Requirements
Level 1: NMI	• Records the Master NMI record information as per the MSATS Procedures.
Level 2: DER Installation	• Details on the DER installation system that is associated with a NMI. Note a NMI may have multiple DER Installations.
Level 3: AC connection	• Relevant for inverter connected devices, which are part of a DER installation. • Specific details on inverter capacity, protection settings, etc.
Level 4: DER Device	• Details on DER devices (e.g. solar panels, batteries, etc). DER devices that exhibit the same attributes are proposed to be grouped together.

Further detail on the proposed data model, with sample data, is contained in Appendix B.

Please note that the variables represented in Appendix B is exhaustive. Some variables may be considered for automation and pre-population during the collection process. This process will be discussed in further stakeholder engagement, to be run in parallel with this consultation. See section 2.2.3 for details.

Questions

1. What are the costs and impacts of AEMO's proposed data requirements? Please break down and describe the costs based on:
    a. Upfront once-only costs vs ongoing costs

[4] See DER register pre-consultation workshop summary for details. Available at: https://www.aemo.com.au/-/media/Files/Stakeholder_Consultation/Consultations/NEM-Consultations/2018/DER-Register-workshop-summary.pdf.

b. Separation of internal labour costs, contracted labour, system improvement

2. Do you agree with the proposed data requirements? Why/ why not?
3. Do you agree with the proposed data structure (see appendix B, figure 3)? If not, please explain why it would not work and propose an alternative.
4. Should data variables that have default values prescribed by the AS4777 standards (e.g. Under-frequency protection, Over-frequency protection, Undervoltage protection, Overvoltage protection, etc) be requested as discrete inputs? Why/ why not?
5. For the AC connection table (appendix B), is it relevant to include protection modes for non-inverter DER? If so, what is the relevant information that should be captured?
6. Do you agree with the data source/ providers for the physical collection, listed in Appendix B? If not, explain why and who else or what other data sources should be involved.
7. Are there any other requirements that have not been considered? Why are these important? Which table are they relevant to?
8. In terms of the examples given, are their other DER installation configurations that AEMO should consider?
9. Are there any other relevant issues that have not been considered?

5. SUMMARY OF MATTERS FOR CONSULTATION

AEMO is seeking feedback on any aspect of this Issues Paper or other relevant issues associated with developing the DER Information Guidelines. In particular, AEMO is seeking response to the questions below (these are a summary of the questions provided throughout this paper):

Questions

(3.1) Information Requirements

1. Do you agree with the suggested format and method of data submission?
2. Are there adequate access arrangements for Installers and installation software providers to submit data on behalf of NSPs into the DER Register? If not, how might this be improved?
3. Are there any risks associated with the different submission frequency between the *DER generation information* and *DSP information*?
4. What is an alternate approach to the frequency of data submission? How would this be implemented?
5. Are there any other relevant issues that have not been considered?

(3.2) DER Register Storage

1. Are there any issues associated with the separate storage of *DSP information* and *DER generation information*?
2. Are there any other relevant issues that have not been considered?

(3.3) DER Register information access to NSPs

1. What *regulatory obligations or requirement* do NSPs intend to use DER register data for?
2. Do you have a preferred process for accessing *DER register information*?

a. Is existing NMI discovery (adding in DER) useful?

b. Are existing C1, C4 and C7 reports (including DER) suitable? Is an additional report required? If a new report is required, what should it include?

c. What are your views on using an API to develop custom reports?

3. Do existing C1, C4 and C7 reports need to be provided if an API is provided?
4. Are there any other relevant issues that have not been considered?

(3.4) AEMO reporting and publication

1. Are there additional variables that should be published in the *DER register report* (see Appendix B for list of data)? Why?
2. Is aggregation at the post code level suitable? If not, what is an appropriate aggregation variable and why?
3. Do you agree with monthly updating of the *DER register report*? Why/ why not?
4. Are there any other relevant issues that have not been considered?

(4.0) Proposed Data

1. What are the costs and impacts of AEMO's proposed data requirements? Please break down and describe the costs based on:

   a. Upfront once-only costs vs ongoing costs

   b. Separation of internal labour costs, contracted labour, system improvement

2. Do you agree with the proposed data requirements? Why/ why not?
3. Do you agree with the proposed data structure (see appendix B, figure 3)? If not, please explain why it would not work and propose an alternative.
4. Should data variables that have default values prescribed by the AS4777 standards (e.g. Under-frequency protection, Over-frequency protection, Undervoltage protection, Overvoltage protection, etc) be requested as discrete inputs? Why/ why not?
5. For the AC connection table (appendix B), is it relevant to include protection modes for non-inverter DER? If so, what is the relevant information that should be captured?
6. Do you agree with the data source/ providers for the physical collection, listed in Appendix B? If not, explain why and who else or what other data sources should be involved.
7. Are there any other requirements that have not been considered? Why are these important? Which table are they relevant to?
8. In terms of the examples given, are their other DER installation configurations that AEMO should consider?
9. Are there any other relevant issues that have not been considered?

Submissions on these and any other matter relating to the proposal discussed in this Issues Paper must be made in accordance with the Notice of First Stage of Consultation published with this paper by 5.00 pm (Melbourne time) on Thursday, 07 March 2019.

APPENDIX A. GLOSSARY

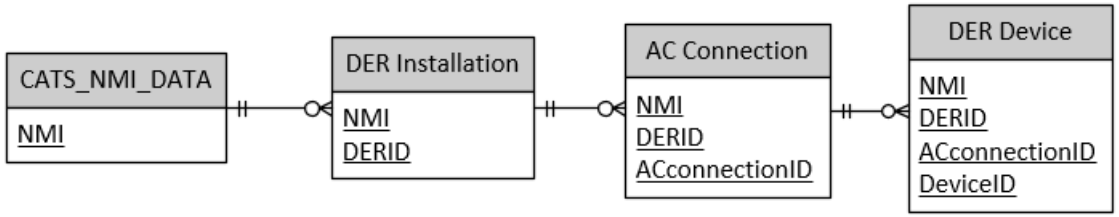
Term or acronym	Meaning
AEMC	Australian Energy Market Commission
AEMO	Australian Energy Market Operator
API	Application Programming Interface
CSV	Comma separated value
DER	Distributed Energy Resources
DNSP	Distribution Network Service Provider
DSP	Demand Side Participation
ISP	Integrated System Plan
MSATS	Market Settlement and Transfer Solutions
MTPASA	Medium Term Projected Assessment of System Adequacy
MW	Megawatt
MWh	Megawatt hour
NEFR	National Electricity Forecasting Report
NEM	National Electricity Market
NER	National Electricity Rules
NMI	National Metering Identifier
NSP	Network Service Provider
PSCAD	Power Systems Computer Aided Design
PSSE	Power System Simulator for Engineering
PV	Photovoltaic
STPASA	Short Term Projected Assessment of System Adequacy
TCPF	Transmission Connection Point Forecast

APPENDIX B. DATA MODEL

The proposed data model will be split into 4 levels, as described in the table below. Figure 3, below, depicts the relationships between the 4 levels.

	Description
Level 1: NMI	• Records the Master NMI record information as per the MSATS Procedures. • Each NMI may have many DER Installations referenced to it.
Level 2: DER Installation	• This level applies to a DER installation in aggregate. • Each DER installation is uniquely identified by NMI and DERID. • Each DER Installation may only be associated with 1 NMI. • Each DER installation may have many AC connections related to it.
Level 3: AC connection	• Each Inverter is uniquely identified by NMI, DERID and ACconnectionID. • Each AC connection may only be associated with 1 DER Installation. • Each AC connection may have many DER devices related to it.
Level 4: DER Devices	• Each DER Device is uniquely identified by NMI, DERID, ACconnectionID and DeviceID. • Contains information relating to the DER Device specifications (e.g. solar panel, battery cell, etc), including device type, nominal capacity, etc. • A DER device may be one or many devices that have exactly the same specifications. • Each DER Device is related to a single AC connection.

Figure 3: Relationships between levels



This appendix provides a description of the data model, followed by 4 examples of how the DER Register might be populated for different DER system scenarios.

Data Model Level 1 – CATS_NMI_DATA table

This is a representation of the CATS_NMI_DATA table, which records Master NMI Record information. AEMO do not intend to alter this table to accommodate the DER Register, but propose to have several relational tables, that reference the CATS_NMI_DATA table[5].

Category of data	Description	Field type/ validation
NMI(s)	Unique identifier for each connection point where DER installation is	Alpha-numeric

Data Model Level 2 – DER Installation

Level 2 applies to DER installation in aggregate, where each DER installation is uniquely identified by NMI and DERID. All fields are mandatory, where relevant.

Interpretation of Data Model level 2:

- Where a field type of 'pick list' is indicated, one of the listed options must be selected. A field type of 'Multi-select' indicates that one or more options must be selected.
- Where relevant, the provision of a 'null' value indicates that the settings are not enabled.

Category of data	Description	Field type/ validation	Data source/ provider	Other comments
DERID	Aggregate DER installation unique identifier within the NMI.	Alpha-numeric	AEMO	
Export limit	Maximum amount of energy (kW) that may be exported form an electrical installation to the grid. Exceeding this limit will require the installation to disconnect. A null value indicates no limit.	Numeric	NSP	Defined for inverter connected energy systems in AS4777.1:2016 3.4.8.1. These settings may differ for other energy devices.
Status code	Code used to indicate the status of the DER Installation. This will be used to identify if an installation is active or inactive or decommissioned.	Pick list {active, inactive)	NSP	This status will also track commissioning and decommissioning date. When a new record is inserted in the database, the installation date/ start date is defined by the user and may be backdated.
Under-frequency protection (F<)	For a DER installation indicates the protection function limit for underfrequency protection (F<). A null value indicates that these settings are not enabled.	Numeric	NSP	For example, the default value for inverter connected energy systems is 47Hz (Aust) under AS/NZS 4777.1:2016 table 2. These settings may differ for other energy devices.
Over-frequency protection (F>)	For a DER installation indicates the protection function limit for over-frequency protection (F>). A null value indicates that these settings are not enabled.	Numeric	NSP	For example, the default value for inverter connected energy systems is 52Hz under AS/NZS 4777.1:2016 table 2. These settings may differ for other energy devices.

[5] For more information on the CATS_NMI_DATA table, please see MSATS Procedures: CATS Procedure Principles and Obligations on the AEMO website.

Category of data	Description	Field type/ validation	Data source/ provider	Other comments
Undervoltage protection (V<)	For a DER installation indicates the protection function limit for undervoltage protection (V<). A null value indicates that these settings are not enabled.	Numeric	NSP	For example, the default value for inverter connected energy systems is 180V (Aust) under AS/NZS 4777.1:2016 table 2. These settings may differ for other energy devices.
Overvoltage protection 1 (V>)	For a DER installation indicates the protection function limit for overvoltage protection (V>). A null value indicates that these settings are not enabled.	Numeric	NSP	For example, the default value for inverter connected energy systems is 260V (Aust) under AS/NZS 4777.1:2016 table 2. These settings may differ for other energy devices.
Overvoltage protection 1 (V>>)	For a DER installation indicates the protection function limit for overvoltage protection (V>>). A null value indicates that these settings are not enabled.	Numeric	NSP	For example, the default value for inverter connected energy systems is 265V (Aust) under AS/NZS 4777.2:2015, table 13. These settings may differ for other energy devices.

Data Model Level 3 – AC Connection

Level 3 applies to the AC grid connection source of the DER installation (e.g. inverter). In the case of AC sources (e.g. rotating machines) that are connected to a DER installation, only the AC Connection ID and AC equipment type need to be populated. All fields are mandatory, where relevant.

Interpretation of level 3:

- Some categories of data have sub-categories that are only mandatory under certain conditions. For example, when filling in data for underfrequency protection settings, specific information on setting limits will only be mandatory if underfrequency protection settings are enabled.
- Categories that have sub-categories are shown in orange, alongside the options that may be selected for that category. Sub-categories are listed underneath, alongside the categories that they apply to.
- Where a field type of 'pick list' is indicated, one of the listed options must be selected. A field type of 'Multi-select' indicates that one or more options must be selected.

Category of data	Sub-category of data	Applies to category	Description	Field type/ validation	Data source/ provider	Other comments
AC connection ID		All	Unique identifier for each AC connection in a DER installation.	Alpha-numeric	AEMO	

Category of data	Sub-category of data	Applies to category	Description	Field type/ validation	Data source/ provider	Other comments
AC equipment type		All	Indicates whether the DER device is connected via an inverter (and what category of inverter it is) or not (e.g. rotating machine).	Pick list {Inverter, other}	Installer	There is the option to expand this pick list to align with the CEC Equipment Categories: grid connect PV inverter, stand along inverter - battery only, Standalone PV inverter, grid connect inverter – other energy source, multiple mode inverter – other energy source, UPS multiple mode inverter – other energy source, grid connect inverter – PV and battery, multiple mode inverter – PV and battery, UPS multiple mode inverter – PV and battery, Grid connect inverter – Battery only, multiple mode inverter – battery only, UPS multiple mode inverter – battery only, power conversion equipment, integrated energy storage system.
Inverter/ Generator Manufacturer		If AC connection type = inverter	The name of the inverter manufacturer.	Codified or pick-list	Installer	Definitions align to the CEC accredited inverters list (here). May be limited relevance for non-inverter connections.
Inverter Series		If AC connection type = inverter	The inverter series.	Codified or pick-list	Installer	Definitions align to the CEC accredited inverters list (here).
Inverter Model Number		If AC connection type = inverter	The model number of the inverter.	Codified or pick-list	Installer	Definitions align to the CEC accredited inverters list (here).
Status code		If AC connection type = inverter	Code used to indicate the status of the Inverter. This will be used to identify if an inverter is active or inactive or decommissioned.	Pick list {Active, Inactive)	Installer	This status will also track commissioning and decommissioning date. When a new record is inserted in the database, the installation date/ start date is defined by the user and may be backdated. This is not a duplicate of the Aggregate installation table, as inverters may become active or inactive without a change of status to the overall system.
Inverter device capacity (kW)		If AC connection type = inverter	The rated AC output power that is listed in the product specified by the manufacturer.	Numeric	Model/ Manufacturer data source	

Category of data	Sub-category of data	Applies to category	Description	Field type/ validation	Data source/ provider	Other comments
What standard applies to the inverter		If AC connection type = inverter	What standard is the inverter manufactured and installed under.	Pick list	Installer	This should be the most stringent standard that tis applicable. Examples include AS4777.2:2015.
$V_{nom-max}$ (sustained operation overvoltage limit)		If AC connection type = inverter	Indicates the sustained operation overvoltage limit, when the average voltage for a 10-minute period exceeds the $V_{nom-max}$.	Numeric	Standards data source (if default settings enabled)	For example, the default value for inverter connected energy systems is 255V (Aust), but may vary between 244-258V (see AS/NZS 4777.2:2015, section 7.5.2). These settings may differ for other energy devices.
F_{stop} (over-frequency)		If AC connection type = inverter	Frequency (stop)	Numeric	Standards data source (if default settings enabled)	For example, the default value for inverter connected energy systems is 52 Hz (Aust), but may vary between 51 – 52 Hz under AS/NZS 4777.2:2015, section 7.5.3.1. These settings may differ for other energy devices.
$F_{stop-CH}$ (under frequency)		If AC connection type = inverter	Frequency (stop)	Numeric	Standards data source (if default settings enabled)	For example, the default value for inverter connected energy systems is 49 Hz (Aust), but may vary between 47 – 49 Hz under AS/NZS 4777.2:2015, section 7.5.3.2. These settings may differ for other energy devices.
Inverter demand response modes		If AC connection type = inverter	What demand response mode/s (DRMs) are enabled. More than one mode may be selected for each inverter. DRM enables the inverter to respond to signals sent to it remotely. These signals trigger the inverter to change the mode of operation, potentially turning it off, on, or ramping the output up or down.	Multi-select {DRM0, DRM1, DRM2, DRM3, DRM4, DRM5, DRM6, DRM7, DRM8}	Model/ Manufacturer data source	Description of demand response modes (DRM) in field type validation is available in AS4777.2:2015, table 5.
	Does the inverter interact with a demand response enabling device (DRED)	If AC connection type = inverter		Pick list {yes, no}	Installer	

Category of data	Sub-category of data	Applies to category	Description	Field type/ validation	Data source/ provider	Other comments
	Reactive power supply	If inverter demand response mode = DRM3	Reactive power set point Default 0% up to 60% inverter rating	Numeric	Standards data source (if default settings enabled)	As described in AS4777.2:2015, section 6.2.2.
	Reactive power sink	If inverter demand response mode = DRM 7	Reactive power set point Default 0% up to 60% inverter rating	Numeric	Standards data source (if default settings enabled)	As described in AS4777.2:2015, section 6.2.2.
Inverter power quality response modes - Voltage response modes – volt-watt response		If AC connection type = inverter		Enabled/ Not Enabled	Model/ Manufacturer data source	This mode is described in AS4777.2:2015, section 6.3.2.1 An inverter may have the capability of operating in modes which will (a) contribute to maintaining the power quality at the point of connection with the customer installation; or (b) provide characteristics which are outside the typical operation of an inverter for the purpose of providing support to a grid.
	V1	If Inverter power quality response modes - Voltage response modes – volt-watt response = Enabled	Only to be populated if mode enabled. These settings are described in AS4777.2:2015, section 6.3.2.1.	Numeric	Standards data source (if default settings enabled)	
	V2			Numeric		
	V3			Numeric		
	V4			Numeric		
	P at V1			Numeric		
	P at V2			Numeric		
	P at V3			Numeric		
	P at V4			Numeric		

Category of data	Sub-category of data	Applies to category	Description	Field type/ validation	Data source/ provider	Other comments
Inverter power quality response modes - Voltage response modes – volt-var response		If AC connection type = inverter		Enabled/ Not Enabled	Model/ Manufacturer data source	This mode is described in AS4777.2:2015, section 6.3.2.1 An inverter may have the capability of operating in modes which will (a) contribute to maintaining the power quality at the point of connection with the customer installation; or (b) provide characteristics which are outside the typical operation of an inverter for the purpose of providing support to a grid.
	V1	If Inverter power quality response modes - Voltage response modes – volt-var response = Enabled	These settings are described in AS4777.2:2015, section 6.3.2.1.	Numeric	Standards data source (if default settings enabled)	
	V2			Numeric		
	V3			Numeric		
	V4			Numeric		
	Q at V1			Numeric		
	Q at V2			Numeric		
	Q at V3			Numeric		
	Q at V4			Numeric		
Inverter power quality response modes - Reactive power mode		If AC connection type = inverter	Select which power quality response modes are enabled on the inverter.	Enabled/ Not Enabled	Model/ Manufacturer data source	Default not enabled. Must be not enabled if either of the voltage response modes are enabled.
	Fixed reactive power	If Inverter power quality response modes - Reactive power mode = Enabled	Reactive Power. Specified in % rating of the system.	Numeric	Standards data source (if default settings enabled)	
Inverter power quality response modes - Fixed power factor mode		If AC connection type = inverter	Select which power quality response modes are enabled on the inverter.	Enabled/ Not Enabled	Model/ Manufacturer data source	Default not enabled. Must be not enabled if either of the voltage response modes are enabled.
	Fixed power factor		Power factor (0.8 lead to 0.8 lag)	Numeric (0.8 – 1.0)		To be populated if mode enabled.

Category of data	Sub-category of data	Applies to category	Description	Field type/ validation	Data source/ provider	Other comments
	Fixed power factor quadrant	If Inverter power quality response modes - Fixed power factor mode = Enabled	Power factor quadrant	Pick List {lead, lag}	Standards data source (if default settings enabled)	Must be between 0.8 lead and 0.8 lag. To reduce fields, a convention on sign required.
Inverter power quality response modes - Power factor curve / power response mode		If AC connection type = inverter	Select which power quality response modes are enabled on the inverter.	Enabled/ Not Enabled	Model/ Manufacturer data source	Default not enabled. Must be not enabled if either of the voltage response modes are enabled.
	P1	Inverter power quality response modes - Power factor curve / power response mode = Enabled	Reference point for P1	Numeric (0 – 100%)	Standards data source (if default settings enabled)	To be populated if mode enabled. The curve is described in AS4777.2:2015, section 6.3.4. Needs to be defined by NSP and provided to installation.
	P2		Reference point for P2	Numeric (0 – 100%)		
	Power factor at P1		Power factor (0.9 to 1.0 lead)	Numeric (0.9 – 1.0)		
	Power factor quadrant at P1		Power factor quadrant	Pick List {lead, lag}		
	Power factor at P2		Power factor (0.9 to 1.0 lead)	Numeric (0.9 – 1.0)		
	Power factor quadrant at P2		Power factor quadrant	Pick List {lead, lag}		
Inverter power quality response modes - Power rate limit mode – ac operation and control change		If AC connection type = inverter	Select which power quality response modes are enabled on the inverter.	Enabled/ Not Enabled	Model/ Manufacturer data source	This mode is described in AS4777.2:2015, section 6.3.5.3.3 An inverter may have the capability of operating in modes which will (a) contribute to maintaining the power quality at the point of connection with the customer installation; or (b) provide characteristics which are outside the typical operation of an inverter for the purpose of providing support to a grid.
	Power ramp gradient (Wgra)	Inverter power quality response modes - Power rate limit mode – ac operation and control change = Enabled	Power ramp rate (default 16.67 %)	Numeric	Standards data source (if default settings enabled)	As described in AS4777.2:2015, section 6.3.5.1.

Category of data	Sub-category of data	Applies to category	Description	Field type/ validation	Data source/ provider	Other comments
Inverter power quality response modes - Voltage response modes – volt-watt response for energy storage systems		If AC connection type = inverter AND If device type = battery storage		Enabled/ Not Enabled	Model/ Manufacturer data source	This mode is described in AS4777.2:2015, section 6.3.2.1 An inverter may have the capability of operating in modes which will (a) contribute to maintaining the power quality at the point of connection with the customer installation; or (b) provide characteristics which are outside the typical operation of an inverter for the purpose of providing support to a grid.
	V1	If Inverter power quality response modes - Voltage response modes – volt-watt response = Enabled	Only to be populated if mode enabled. These settings are described in AS4777.2:2015, section 6.3.2.1.	Numeric	Standards data source (if default settings enabled)	
	V2			Numeric		
	V3			Numeric		
	V4			Numeric		
	P at V1			Numeric		
	P at V2			Numeric		
	P at V3			Numeric		
	P at V4			Numeric		
Non-inverter generator – voltage/reactive power regulation		If AC connection type NOT inverter		None/ Voltage droop/ fixed power factor	NSP	
	Voltage set point	If generator voltage/reactive power regulation mode = voltage droop	Only to be populated if mode enabled.	Numeric	NSP	% Nominal voltage, or V
	Deadband			Numeric		± x%
	Droop			Numeric		In %
	Base for droop			Numeric		In MVA
	Reactive power source limit			Numeric		
	Reactive power sink limit			Numeric		

Category of data	Sub-category of data	Applies to category	Description	Field type/ validation	Data source/ provider	Other comments
	Fixed power factor	If generator voltage/reactive power regulation mode = fixed power factor	Power factor (0.8 lead to 0.8 lag)	Numeric (0.8 – 1.0)	NSP	To be populated if mode enabled. Must be between 0.8 lead and 0.8 lag. To reduce fields, a convention on sign required.
	Fixed power factor quadrant		Power factor quadrant	Pick List {lead, lag}	NSP	
Non-inverter Generator ramp rate		If AC connection type NOT inverter	Generator ramp rate	Enabled/ Not Enabled	NSP	A generator may have a ramp rate applied.
	Power ramp gradient	If generator ramp rate = Enabled	Power ramp rate (%/min)	Numeric	NSP	
Non-inverter Generator frequency response mode		If AC connection type NOT inverter	Frequency sensitive mode	Enabled/ Not Enabled	NSP	A generator may operate in a frequency sensitive mode whereby it adjusts output to help support frequency control.
	Frequency deadband	If frequency sensitive mode = Enabled		Numeric	NSP	
	Frequency droop			Numeric	NSP	

Data Model Level 4 – DER Device

Level 4 applies to DER energy sources (e.g. battery modules, solar panels, tri/co-generation units, micro wind turbines, etc). These energy sources may or may not be inverter connected technologies. All fields are required to be completed, where data is available.

Interpretation of table 4:

- Some categories of data have sub-categories that are only required under certain conditions. For example, when filling in data for device sub-type, specific information on the device sub-type if that device is installed.
- Categories that have sub-categories are shown in orange, alongside the options that may be selected for that category. Sub-categories are listed underneath, alongside the categories that they apply to.
- Where a field type of 'Pick List' is indicated, one of the listed options must be selected. A field type of 'Multi-select' indicates that one or more options must be selected.

Category of data	Sub-category of data	Applies to category	Description	Field type/ validation	Data source/ provider	Other comments
Device ID			Unique identifier for a group of DER devices with the same attributes.	Alpha-numeric	AEMO	
Number of devices			Number of devices in the group. Note the devices must have the same attributes.	Numeric	Installer	
Manufacturer			The name of the device manufacturer.	Pick list	Installer	Definitions align to the CEC approved modules list (here).
Model Number			The make/brand of the device.	Pick list	Installer	Definitions align to the CEC approved modules list (here).
Status			Code used to indicate the status of the device. This will be used to identify of the device is active or inactive or decommissioned.	Pick list {active, inactive)	Installer	This status will also track commissioning and decommissioning date. When a new record is inserted in the database, the installation date/ start date is defined by the user and may be backdated. This is not a duplicate of the Aggregate installation table, as devices may become active or inactive without a change of status to the overall system.
Device Type			Used to indicate the primary technology used in the DER device.	Pick list {Fossil, Hydro, Wind, Solar PV, Renewable/Biomass/Waste, Geothermal, Storage}	Model/ Manufacturer data source	May potentially use an expanded version of the NEM generator registration guide list of primary and secondary fuel sources, available at: https://www.aemo.com.au/-/media/Files/Electricity/NEM/Participant_Information/Application-forms-and-supporting-documentation/NEM_GENERATOR_REGISTRATION_GUIDE.pdf
	Device sub-type		Used to indicate the primary technology used in the DER device.	Pick list {list is dependent on the device type selection}	Model/ Manufacturer data source	For example, if Solar PV is selected the pick list should contain monocrystalline, polycrystalline, thin-film, concentrating PV, silicon, biohybrid, cadmium telluride, if battery storage is selected the pick list should contain lithium-ion, lead acid, lead carbon, sodium nickel, lead crystal, absorbed glass matt, vanadium, aqueous hybrid ion, tubular gel, zinc bromide, etc.
Nominal export capacity (kW)			Maximum output in kW that is listed in the product specification by the manufacturer. This refers to the capacity of each unit within the device group.	Numeric	Model/ Manufacturer data source	E.g. for a system comprised of 10 x 0.37kW solar PV panels of the same make/ model, you would put 0.37kW as the nominal export capacity, rather than 3.7kW for the whole system

Category of data	Sub-category of data	Applies to category	Description	Field type/ validation	Data source/ provider	Other comments
Nominal storage capacity (kWh)		If device type = battery storage	Maximum storage capacity in kWh. This refers to the capacity of each storage module within the device group.	Numeric	Model/ Manufacturer data source	E.g. for a system comprised of 3 x 14kWh battery modules of the same make/ model, you would put 14kWh as the nominal storage capacity, rather than 42kWh for the whole system.

APPENDIX C. DATA MODEL EXAMPLES

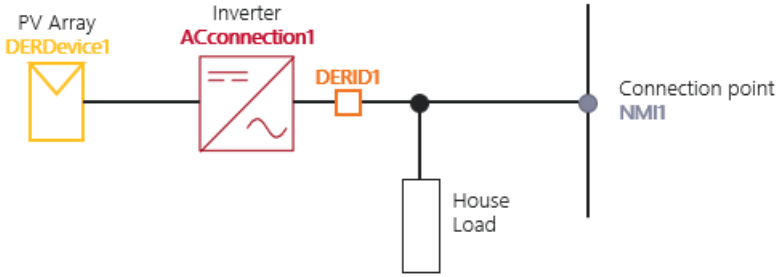
This section contains five examples, which demonstrate how the DER register would be populated for different installations, as follows:

1. Solar PV only.
2. Solar PV and Battery Storage (AC battery configuration) with one DER Installation.
3. Solar PV and Battery Storage (AC battery configuration) with two DER Installations.
4. Solar and Battery Storage (DC battery configuration).
5. Landfill generator (AC connected device).

Figures have been colour-coded to identify the data levels.

Example 1: Solar PV only

The following example shows how the DER Register might be populated for a DER system which contains a PV array (made up of the same types of panels). Note that for a PV system with different types of panels, multiple DER Device entries would be required. Further, if more than one inverter was present in the DER installation, multiple AC connection entries would be required.



Data Level 1 - CATS_NMI_DATA table

Category of data	Example data (NMI1)
NMI(s)	1234567890

Data Level 2 – DER Installation

Category of data	Example data (DERID1)
NMI(s)	1234567890
DERID	123456ABC
Export limit	10 kW
Status code	Active
Under-frequency protection (F<)	47 Hz
Over-frequency protection (F>)	52 Hz
Undervoltage protection (V<)	180 V
Overvoltage protection 1 (V>)	260 V
Overvoltage protection 1 (V>>)	265 V

Data Level 3 – AC Connection

Category of data	Sub-category of data	Example data (ACconnection1)
NMI		1234567890
DERID		123456ABC
AC connection ID		ABC1254ABC
AC equipment type		Grid-connect PV inverter
Inverter/ generator Manufacturer		ABC Inverter Company
Inverter Series		String Inverter
Inverter Model Number		SE5.0-AUS
Status code		Active
Inverter device capacity (kW)		5 kW
What standard applies to the inverter		AS4777
$V_{nom-max}$ (sustained operation overvoltage limit)		255 V
F_{stop} (over-frequency)		52 Hz
$F_{CH-stop}$ (under-frequency)		49 Hz
Inverter demand response modes		DRM0

Category of data	Sub-category of data	Example data (ACconnection1)
	Does the inverter interact with a demand response enabling device (DRED)	Yes
	~~Reactive power supply~~	
	~~Reactive power sink~~	
Inverter power quality response modes - Voltage response modes – volt-watt response		Enabled
	V1	207 V
	V2	220 V
	V3	250 V
	V4	265 V
	P at V1	100%
	P at V2	100%
	P at V3	100%
	P at V4	20%
Inverter power quality response modes - Voltage response modes – volt-var response		Not Enabled
	V1	207 V
	V2	220 V
	V3	250 V
	V4	265 V
	Q at V1	30 %
	Q at V2	0 %
	Q at V3	0 %
	Q at V4	30 %
Inverter power quality response modes - Reactive power mode		Not Enabled
	~~Fixed reactive power~~	
Inverter power quality response modes - Fixed power factor mode		Not Enabled
	~~Fixed power factor~~	

Category of data	Sub-category of data	Example data (ACconnection1)
	~~Fixed power factor quadrant~~	
Inverter power quality response modes - Power factor curve / power response mode		Not Enabled
	~~P1 (0 – 100%)~~	
	~~P2 (0 – 100%)~~	
	~~Power factor at P1~~	
	~~Power factor quadrant at P1~~	
	~~Power factor at P2~~	
	~~Power factor quadrant at P2~~	
Inverter power quality response modes - Power rate limit mode – ac operation and control change		Not Enabled
	~~Power ramp gradient (Wgra~~	
Inverter power quality response modes - Voltage response modes – volt-watt response for energy storage systems		Not Enabled
	~~V1~~	
	~~V2~~	
	~~V3~~	
	~~V4~~	
	~~P at V1~~	
	~~P at V2~~	
	~~P at V3~~	
	~~P at V4~~	
Non-inverter generator – voltage/reactive power regulation		None
	~~Voltage set point~~	
	~~Deadband~~	
	~~Droop~~	
	~~Base for droop~~	
	~~Reactive power source limit~~	

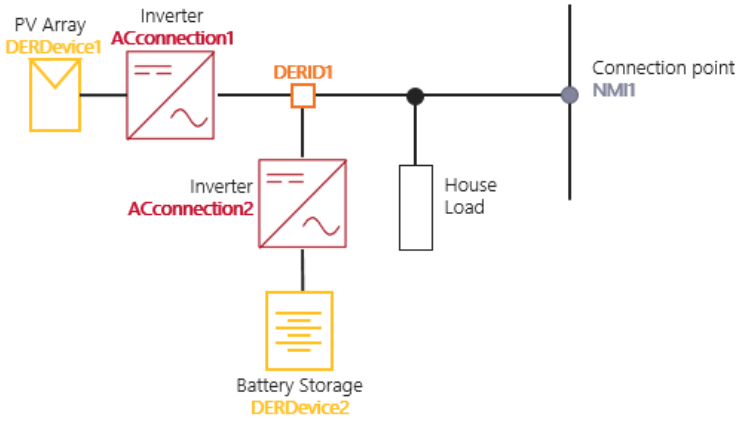
Category of data	Sub-category of data	Example data (ACconnection1)
	~~Reactive power sink limit~~	
	~~Fixed power factor~~	
	~~Fixed power factor quadrant~~	
Non-inverter Generator ramp rate		Not Enabled
	~~Power ramp gradient~~	
Non-inverter Generator frequency response mode		Not Enabled
	~~Frequency deadband~~	
	~~Frequency droop~~	

Data Level 4 – DER Device

Category of data	Sub-category of data	Example data (DERdevice1)
NMI		1234567890
DERID		123456ABC
AC connection ID		ABC1254ABC
Device ID		XYZ2345AX
Number of devices		8
Manufacturer		XYZ Solar Corporation
Model Number		P6C-355-Series-4BB
Status		Active
Device Type		Solar Photovoltaic
	Device sub-type	Polycrystalline Silicon
Nominal export capacity (kW)		0.355
~~Nominal storage capacity (kWh)~~		

Example 2: Solar PV and Battery Storage (AC battery configuration) with 1 DER installation

This example shows how the DER Register might be populated for a DER system which contains a PV array (made up of the same types of panels) and a battery. The battery and the PV array have their own separate inverters (i.e. two inverters) which are each then connected at the AC side to the house load and the network.



Data Level 1 - CATS_NMI_DATA table

Category of data	Example data (NMI1)
NMI(s)	60312345678

Data Level 2 – DER Installation

Category of data	Example data (DERID1)
NMI	60312345678
DERID	123456ABC
Export limit	9 kW
Status code	Active
Under-frequency protection (F<)	47 Hz
Over-frequency protection (F>)	52 Hz
Undervoltage protection (V<)	180 V
Overvoltage protection 1 (V>)	260 V
Overvoltage protection 1 (V>>)	265 V

Data Level 3 – AC Connection

Category of data	Sub-category of data	Example data (ACconnection1)	Example data (ACconnection2)
NMI		60312345678	60312345678
DERID		123456ABC	123456ABC
AC connection ID		ABC1254ABC	ABC6654XYZ
AC equipment type		Grid-connect PV inverter	Grid-connect Inverter – battery only
Inverter/ generator Manufacturer		ABC Inverter Company	ABC Inverter Company
Inverter Series		String Inverter	SE
Inverter Model Number		SE5000-AUS	SE5000-AUS
Status code		Active	Active
Inverter device capacity (kW)		3.0	5.0
What standard applies to the inverter		AS4777	AS4777
$V_{nom-max}$ (sustained operation overvoltage limit)		255 V	255 V
F_{stop} (over-frequency)		52 Hz	52 Hz
$F_{CH-stop}$ (under-frequency)		49 Hz	49 Hz
Inverter demand response modes		DRM0, DRM1, DRM2, DRM3, DRM4, DRM5, DRM6, DRM7, DRM8, DRM9	DRM0
	Does the inverter interact with a demand response enabling device (DRED)	Yes	Yes
	~~Reactive power supply~~		
	~~Reactive power sink~~		
Inverter power quality response modes - Voltage response modes – volt-watt response		Not Enabled	Not Enabled
	~~V1~~		
	~~V2~~		
	~~V3~~		
	~~V4~~		
	~~P at V1~~		

Category of data	Sub-category of data	Example data (ACconnection1)	Example data (ACconnection2)
	~~P at V2~~		
	~~P at V3~~		
	~~P at V4~~		
Inverter power quality response modes - Voltage response modes – volt-var response		Not Enabled	Enabled
	V1		207 V
	V2		220 V
	V3		244 V
	V4		255 V
	Q at V1		30
	Q at V2		0
	Q at V3		0
	Q at V4		30
Inverter power quality response modes - Reactive power mode		Not Enabled	Not Enabled
	~~Fixed reactive power~~		
Inverter power quality response modes - Fixed power factor mode		Not Enabled	Not Enabled
	~~Fixed power factor~~		
	~~Fixed power factor quadrant~~		
Inverter power quality response modes - Power factor curve / power response mode		Enabled	Not Enabled
	P1	25 %	
	P2	100%	
	Power factor at P1	1.0	
	Power factor quadrant at P1	Lead	
	Power factor at P2	0.95	
	Power factor quadrant at P2	Lag	
Inverter power quality response modes - Power rate limit mode – ac operation and control change		Not Enabled	

Category of data	Sub-category of data	Example data (ACconnection1)	Example data (ACconnection2)
	~~Power ramp gradient (Wgra~~		
Inverter power quality response modes - Power rate limit mode – ac operation and control change		Not Enabled	Not Enabled
	~~Power ramp gradient (Wgra~~		
Inverter power quality response modes - Voltage response modes – volt-watt response for energy storage systems		Not Enabled	Not Enabled
	~~V1~~		
	~~V2~~		
	~~V3~~		
	~~V4~~		
	~~P at V1~~		
	~~P at V2~~		
	~~P at V3~~		
	~~P at V4~~		
Non-inverter generator – voltage/reactive power regulation		None	None
	~~Voltage set point~~		
	~~Deadband~~		
	~~Droop~~		
	~~Base for droop~~		
	~~Reactive power source limit~~		
	~~Reactive power sink limit~~		
	~~Fixed power factor~~		
	~~Fixed power factor quadrant~~		
Non-inverter Generator ramp rate		Not Enabled	Not Enabled
	~~Power ramp gradient~~		
Non-inverter Generator frequency response mode		Not Enabled	
	~~Frequency deadband~~		

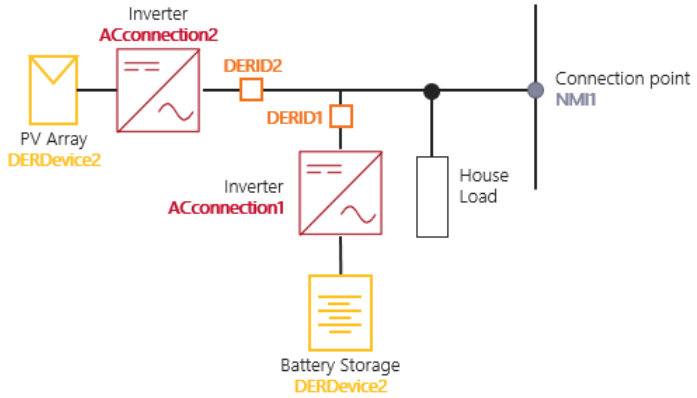
Category of data	Sub-category of data	Example data (ACconnection1)	Example data (ACconnection2)
	~~Frequency droop~~		

Data Level 4 – DER Device

Category of data	Sub-category of data	Example data (DERdevice1)	Example data (DERdevice2)
NMI		60312345678	60312345678
DERID		123456ABC	123456ABC
AC connection ID		ABC1254ABC	ABC6654XYZ
Device ID		XYZ2345AX	BATT1256XX
Number of devices		12	2
Manufacturer		XYZ Solar Corporation	
Model Number		P6C-30-Series-4BB	BS2345-XC
Status		Active	Active
Device Type		Solar Photovoltaic	Battery Storage
	Device sub-type	Polycrystalline Silicon solar cells	Lead Acid
Nominal export Capacity (kW)		0.365	2.8
Nominal storage capacity (kWh)		-	28.2

Example 3: Solar PV and Battery Storage (AC battery configuration) with 2 DER installations

This example shows how the DER Register might be populated for a DER system which contains a PV array (made up of the same types of panels) and a battery. The battery and the PV array have their own separate inverters (ie. two inverters) which are each then connected at the AC side to the house load and the network.



Data Level 1 - CATS_NMI_DATA table

Category of data	Example data
NMI(s)	60312345678

Data Level 2 – DER Installation

Category of data	Example data (DERID1)	Example data (DERID2)
NMI	60312345678	60312345678
DERID	123456ABC	5656FG256
Export limit	9 kW	9 kW
Status code	Active	Active
Under-frequency protection (F<)	47 Hz	47 Hz
Over-frequency protection (F>)	52 Hz	52 Hz
Undervoltage protection (V<)	180 V	180 V
Overvoltage protection 1 (V>)	260 V	260 V
Overvoltage protection 1 (V>>)	265 V	265 V

Data Level 3 – AC Connection

Category of data	Sub-category of data	Example data (ACconnection1)	Example data (ACconnection2)
NMI		60312345678	60312345678
DERID		123456ABC	123456ABC
AC connection ID		ABC1254ABC	ABC6654XYZ
AC equipment type		Grid-connect PV inverter	Grid-connect Inverter – battery only
Inverter/ generator Manufacturer		ABC Inverter Company	ABC Inverter Company
Inverter Series		String Inverter	SE
Inverter Model Number		SE5000-AUS	SE5000-AUS
Status code		Active	Active
Inverter device capacity (kW)		3.0	5.0
What standard applies to the inverter		AS4777	AS4777
$V_{nom-max}$ (sustained operation overvoltage limit)		255 V	255 V
F_{stop} (over-frequency)		52 Hz	52 Hz
$F_{CH-stop}$ (under frequency)		49 Hz	49 Hz
Inverter demand response modes		DRM0, DRM1, DRM2, DRM3, DRM4, DRM5, DRM6, DRM7, DRM8, DRM9	DRM0
	Does the inverter interact with a demand response enabling device (DRED)	Yes	Yes
	~~Reactive power supply~~		
	~~Reactive power sink~~		
Inverter power quality response modes - Voltage response modes – volt-watt response		Not Enabled	Not Enabled
	~~V1~~		
	~~V2~~		
	~~V3~~		
	~~V4~~		
	~~P at V1~~		

Category of data	Sub-category of data	Example data (ACconnection1)	Example data (ACconnection2)
	~~P at V2~~		
	~~P at V3~~		
	~~P at V4~~		
Inverter power quality response modes - Voltage response modes – volt-var response		Not Enabled	Enabled
	V1		207 V
	V2		220 V
	V3		244 V
	V4		255 V
	Q at V1		30
	Q at V2		0
	Q at V3		0
	Q at V4		30
Inverter power quality response modes - Reactive power mode		Not Enabled	Not Enabled
	~~Fixed reactive power~~		
Inverter power quality response modes - Fixed power factor mode		Not Enabled	Not Enabled
	~~Fixed power factor~~		
	~~Fixed power factor quadrant~~		
Inverter power quality response modes - Power factor curve / power response mode		Enabled	Not Enabled
	P1	25 %	
	P2	100%	
	Power factor at P1	1.0	
	Power factor quadrant at P1	Lead	
	Power factor at P2	0.95	
	Power factor quadrant at P2	Lag	
Inverter power quality response modes - Power rate limit mode – ac operation and control change		Not Enabled	

Category of data	Sub-category of data	Example data (ACconnection1)	Example data (ACconnection2)
	~~Power ramp gradient (Wgra~~		
Inverter power quality response modes - Power rate limit mode – ac operation and control change		Not Enabled	Not Enabled
	~~Power ramp gradient (Wgra~~		
Inverter power quality response modes - Voltage response modes – volt-watt response for energy storage systems		Not Enabled	Not Enabled
	~~V1~~		
	~~V2~~		
	~~V3~~		
	~~V4~~		
	~~P at V1~~		
	~~P at V2~~		
	~~P at V3~~		
	~~P at V4~~		
Non-inverter generator – voltage/reactive power regulation		None	None
	~~Voltage set point~~		
	~~Deadband~~		
	~~Droop~~		
	~~Base for droop~~		
	~~Reactive power source limit~~		
	~~Reactive power sink limit~~		
	~~Fixed power factor~~		
	~~Fixed power factor quadrant~~		
Non-inverter Generator ramp rate		Not Enabled	Not Enabled
	~~Power ramp gradient~~		
Non-inverter Generator frequency response mode		Not Enabled	
	~~Frequency deadband~~		

Category of data	Sub-category of data	Example data (ACconnection1)	Example data (ACconnection2)
	~~Frequency droop~~		

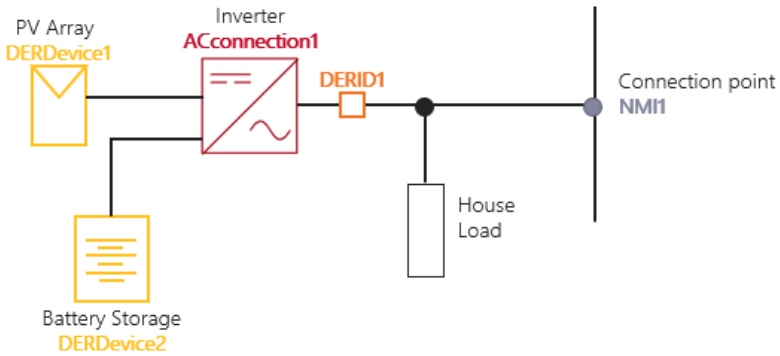
Data Level 4 – DER Device

Category of data	Sub-category of data	Example data (DERID1)	Example data (DERDevice1)
NMI		60312345678	60312345678
DERID		123456ABC	123456ABC
AC connection ID		ABC1254ABC	ABC6654XYZ
Device ID		XYZ2345AX	BATT1256XX
Number of devices		12	2
Manufacturer		XYZ Solar Corporation	
Model Number		P6C-30-Series-4BB	BS2345-XC
Status		Active	Active
Device Type		Solar Photovoltaic	Battery Storage
	Device sub-type	Polycrystalline Silicon solar cells	Lead Acid
Nominal export Capacity (kW)		0.365	2.8
Nominal storage capacity (kWh)		-	28.2

Example 4: Solar PV and Battery Storage (DC battery configuration)

This example shows how the DER Register might be populated for a DER system which contains a PV array (made up of the same types of panels) and a battery. The battery and the PV array are both connected to the DC side of a shared/single inverter.

Items are shown crossed out when they do not apply.



Data Level 1 - CATS_NMI_DATA table

Category of data	Example data (NMI1)
NMI(s)	60312345678

Data Level 2 – DER Installation

Category of data	Example data (DERID1)
NMI	60312345678
DERID	123456ABC
Export limit	9 kW
Status code	Active
Under-frequency protection (F<)	47 Hz
Over-frequency protection (F>)	52 Hz
Undervoltage protection (V<)	180 V
Overvoltage protection 1 (V>)	260 V
Overvoltage protection 1 (V>>)	265 V

Data Level 3 – AC Connection

Category of data	Sub-category of data	Example data (ACconnection1)
NMI		60312345678
DERID		123456ABC
AC connection ID		ABC1254ABC
AC equipment type		Grid-connect Inverter - PV and Battery
Inverter/ generator Manufacturer		ABC Inverter Company
Inverter Series		BLU7000U
Inverter Model Number		BLU7000U-4.6TKS
Status code		Active
Inverter device capacity (kW)		4.6
What standard applies to the inverter		AS4777
$V_{nom-max}$ (sustained operation overvoltage limit)		255 V
F_{stop} (over-frequency)		52 Hz
$F_{CH-stop}$ (under-frequency)		49 Hz
Inverter demand response modes		DRM0, DRM1, DRM2, DRM3, DRM4, DRM5, DRM6, DRM7, DRM8, DRM9
	Does the inverter interact with a demand response enabling device (DRED)	Yes
	Reactive power supply	1
	Reactive power sink	1
Inverter power quality response modes - Voltage response modes – volt-watt response		Enabled
	V1	207 V
	V2	220 V
	V3	250 V
	V4	265 V
	P at V1	100%
	P at V2	100%

Category of data	Sub-category of data	Example data (ACconnection1)
	P at V3	100%
	P at V4	20%
Inverter power quality response modes - Voltage response modes – volt-var response		Not Enabled
	~~V1~~	
	~~V2~~	
	~~V3~~	
	~~V4~~	
	~~Q at V1~~	
	~~Q at V2~~	
	~~Q at V3~~	
	~~Q at V4~~	
Inverter power quality response modes - Reactive power mode		Enabled
	Fixed reactive power	100%
Inverter power quality response modes - Fixed power factor mode		Not Enabled
	~~Fixed power factor~~	
	~~Fixed power factor quadrant~~	
Inverter power quality response modes - Power factor curve / power response mode		Not Enabled
	~~P1 (0 – 100%)~~	
	~~P2 (0 – 100%)~~	
	~~Power factor at P1~~	
	~~Power factor quadrant at P1~~	
	~~Power factor at P2~~	
	~~Power factor quadrant at P2~~	
Inverter power quality response modes - Power rate limit mode – ac operation and control change		Not Enabled

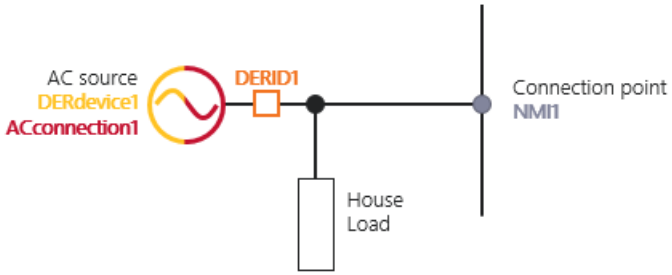
Category of data	Sub-category of data	Example data (ACconnection1)
	~~Power ramp gradient (Wgra~~	
Inverter power quality response modes - Power rate limit mode – ac operation and control change		Not Enabled
	~~Power ramp gradient (Wgra~~	
Inverter power quality response modes - Voltage response modes – volt-watt response for energy storage systems		Enabled
	~~V1~~	207
	~~V2~~	220
	~~V3~~	250
	~~V4~~	265
	~~P at V1~~	0%
	~~P at V2~~	100%
	~~P at V3~~	100%
	~~P at V4~~	100%
Non-inverter generator – voltage/reactive power regulation		None
	~~Voltage set point~~	
	~~Deadband~~	
	~~Droop~~	
	~~Base for droop~~	
	~~Reactive power source limit~~	
	~~Reactive power sink limit~~	
	~~Fixed power factor~~	
	~~Fixed power factor quadrant~~	
Non-inverter Generator ramp rate		Not Enabled
	~~Power ramp gradient~~	
Non-inverter Generator frequency response mode		Not Enabled
	~~Frequency deadband~~	
	~~Frequency droop~~	

Data Level 4 – DER Device

Category of data	Sub-category of data	Example data (DERDevice1)	Example data (DERDevice2)
NMI		60312345678	60312345678
DERID		123456ABC	123456ABC
AC connection ID		ABC1254ABC	ABC6654XYZ
Device ID		XYZ2345AX	BATT1256XX
Number of devices		7	3
Manufacturer		XYZ Solar Corporation	Australian Battery Company
Model Number		P6C-30-Series-4BB	BS2345-XC
Status		Active	Active
Device Type		Solar Photovoltaic	Battery Storage
	Device sub-type	Polycrystalline Silicon solar cells	Lead Acid
Nominal export Capacity (kW)		0.255	1.2
Nominal storage capacity (kWh)		-	2.5

Example 4: Landfill generator (AC connected device)

This example shows how the DER Register might be populated for a DER system which contains a AC source, which does not require an inverter.



Data Level 1 - CATS_NMI_DATA table

Category of data	Example data (NMI1)
NMI(s)	60312345678

Data Level 2 – DER Installation

Category of data	Example data (DERID1)
NMI	60312345678
DERID	123456ABC
Export limit	1000 kW
Status code	Active
Under-frequency protection (F<)	47 Hz
Over-frequency protection (F>)	52 Hz
Undervoltage protection (V<)	180 V
Overvoltage protection 1 (V>)	260 V
Overvoltage protection 1 (V>>)	265 V

Data Level 3 – AC Connection

Category of data	Sub-category of data	Example data (ACconnection1)
NMI		60312345678
DERID		123456ABC
AC connection ID		000000000
AC equipment type		Rotating machine
Inverter/ generator Manufacturer		ABC company
~~Inverter Series~~		
~~Inverter Model Number~~		
~~Status code~~		
~~Inverter device capacity (kW)~~		
~~What standard applies to the inverter~~		
~~$V_{nom.max}$ (sustained operation overvoltage limit)~~		
~~F_{stop} (overfrequency)~~		
~~$F_{CH\ stop}$ (under frequency)~~		
Inverter demand response modes		Not Enabled

Category of data	Sub-category of data	Example data (ACconnection1)
	~~Reactive power supply~~	
	~~Reactive power sink~~	
Inverter power quality response modes - Voltage response modes – volt-watt response		Not Enabled
	~~V1~~	
	~~V2~~	
	~~V3~~	
	~~V4~~	
	~~P at V1~~	
	~~P at V2~~	
	~~P at V3~~	
	~~P at V4~~	
Inverter power quality response modes - Voltage response modes – volt-var response		Not Enabled
	~~V1~~	
	~~V2~~	
	~~V3~~	
	~~V4~~	
	~~Q at V1~~	
	~~Q at V2~~	
	~~Q at V3~~	
	~~Q at V4~~	
Inverter power quality response modes - Reactive power mode		Not Enabled
	~~Fixed reactive power~~	
Inverter power quality response modes - Fixed power factor mode		Not Enabled
	~~Fixed power factor~~	
	~~Fixed power factor quadrant~~	

Category of data	Sub-category of data	Example data (ACconnection1)
Inverter power quality response modes - Power factor curve / power response mode		Not Enabled
	~~P1 (0 – 100%)~~	
	~~P2 (0 – 100%)~~	
	~~Power factor at P1~~	
	~~Power factor quadrant at P1~~	
	~~Power factor at P2~~	
	~~Power factor quadrant at P2~~	
Inverter power quality response modes - Power rate limit mode – ac operation and control change		Not Enabled
	~~Power ramp gradient (Wgra~~	
Inverter power quality response modes - Voltage response modes – volt-watt response for energy storage systems		Not Enabled
	~~V1~~	
	~~V2~~	
	~~V3~~	
	~~V4~~	
	~~P at V1~~	
	~~P at V2~~	
	~~P at V3~~	
	~~P at V4~~	
Non-inverter generator – voltage/reactive power regulation		Fixed power factor
	~~Voltage set point~~	
	~~Deadband~~	
	~~Droop~~	
	~~Base for droop~~	
	~~Reactive power source limit~~	
	~~Reactive power sink limit~~	

Category of data	Sub-category of data	Example data (ACconnection1)
	Fixed power factor	0.9
	Fixed power factor quadrant	Lead
Non-inverter Generator ramp rate		Not Enabled
	~~Power ramp gradient~~	
Non-inverter Generator frequency response mode		Not Enabled
	~~Frequency deadband~~	
	~~Frequency droop~~	

Data Level 4 – DER Device

Category of data	Sub-category of data	Example data (DERDevice1)
NMI		60312345678
DERID		123456ABC
AC connection ID		000000000
Device ID		XYZ2345AX
Number of devices		3
Manufacturer		Land Fill Gas Turbine Company
Model Number		TRASH-56-GAS
Status		Active
Device Type		Biogas
	Device sub-type	Open Cycle Gas turbines
Nominal export capacity (kW)		1000 kW
~~Nominal storage capacity (kWh)~~		