

GUIDE TO AEMO'S VPP DEMONSTRATION APIS

VERSION: Initial draft 0.01
EFFECTIVE DATE: 31 July 2019

PURPOSE

The Australian Energy Market Operator (AEMO) has prepared this Guide to VPP Demonstration APIs to provide information about VPP APIs. It provides participants with the API technical specifications to assist with the development of their own systems using VPP APIs.

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Available to the public.

DOCUMENT IDENTIFICATION

Application owner: IT Platforms

Document owner: Technology

Prepared by: Technology, Technical Writers

Last update: Tuesday, 30 July, 2019

DOCUMENTS MADE OBSOLETE

The release of this document changes only the version of Guide to AEMO's e-Hub APIs.

FURTHER INFORMATION

For further information, please visit AEMO's website www.aemo.com.au or contact:

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FEEDBACK

Your feedback is important and helps us improve our services and products. To suggest improvements, please contact AEMO's Information and Support Hub.

VERSION RELEASE HISTORY

Version	Effective Date	Summary of Changes
0.01	31 July 2019	Initial draft.

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1. INTRODUCTION

1.1. Purpose and scope

This document provides details of the API specification developed for VPP Demonstration project. The guide will help participants developing their own applications that will interface with AEMO system.

This is the initial draft API Specification document focused on VPP Enrolments. The final version of the API specification document will include VPP Operational Data APIs and FCAS Response APIs and will incorporate any enhancements to the Enrolment API specification.

1.2. Audience

The primary audience is the VPP participant's technical staff responsible for building application using AEMO APIs for the VPP demonstration project.

The secondary audience is anyone who has an interest in understanding how AEMO's APIs work.

1.3. How to use this guide

- This document is written in plain language for easy reading. Where there is a discrepancy between the National Electricity Rules (Rules) and information or a term in this document, the Rules take precedence.
- The references listed throughout this document are primary resources and take precedence over this document.
- Text in this format indicates a resource on AEMO's website.
- Glossary terms have the meanings listed against them in the Glossary section.
- This guide assumes you have knowledge of the RESTful programming architecture.

1.4. What's in this guide

AEMO has produced this document to provide participants with the guideline for data interface using the APIs developed by AEMO. This detail is to assist participants with design their own systems to use AEMO APIs. The guide explains the communication protocol and methods with examples.

1.5. Related documents

Table 1 Related documents

Title	Location
Guide to AEMO's e-Hub APIs	https://www.aemo.com.au/-/media/Files/Electricity/NEM/IT-Systems-and-Change/2018/Guide-to-AEMOs-eHub-APIs.pdf
Guide to User Rights Management	http://www.aemo.com.au/-/media/Files/Electricity/NEM/Retail and Metering/Metering-Procedures/2016/Guide_to_User_Rights_Management.pdf
aseXML	https://www.aemo.com.au/Electricity/IT-Systems/aseXML_standards/aseXML-Schemas
OpenAPI Specification	https://github.com/OAI/OpenAPI-Specification

2. OVERVIEW AND INTERFACE SCOPE

Virtual Power Plant (VPP) is an emerging concept being trialled across Australia, largely driven by subsidy schemes incentivising the uptake of thousands of residential battery units.

AEMO has launched the VPP Demonstrations to test a new specification for distributed energy resources (DER) to deliver frequency control ancillary services (FCAS), increasing competition for FCAS and allowing VPPs to explore the commercial feasibility of stacking multiple value streams.

AEMO is also developing its systems to receive operational data from VPPs that will provide visibility of the distribution connected DER to AEMO. This will help AEMO learn how to integrate VPPs into the market at scale, which will then inform appropriate regulatory and operational changes.

The VPP Demonstrations' functional scope includes building a system to support the VPP trials. The system will enable data transfer over internet via Open APIs between AEMO and VPP participants to facilitate and support the following functions:

- VPP Enrolment (i.e. enrolling in VPP demonstrations and ongoing data updates).
- Contingency FCAS assessment.
- Operational forecasting and on-boarding VPP operational data.

Table 2 Functional scope and releases

Functional areas	First release	Final release
VPP Enrolment	Yes	Yes
FCAS Assessment	No	Yes
Operational Forecasting	No	Yes

This document provides API specifications for the VPP Enrolment only.

These Open APIs will only be accessible by internet. These Open APIs will not be accessible via MarketNet.

A new version of this specification will be published before the final release of the VPP Demonstrations APIs.

2.1. VPP Demonstration enrolment process

2.1.1. VPP enrolment steps

Figure 1 VPP enrolment process steps

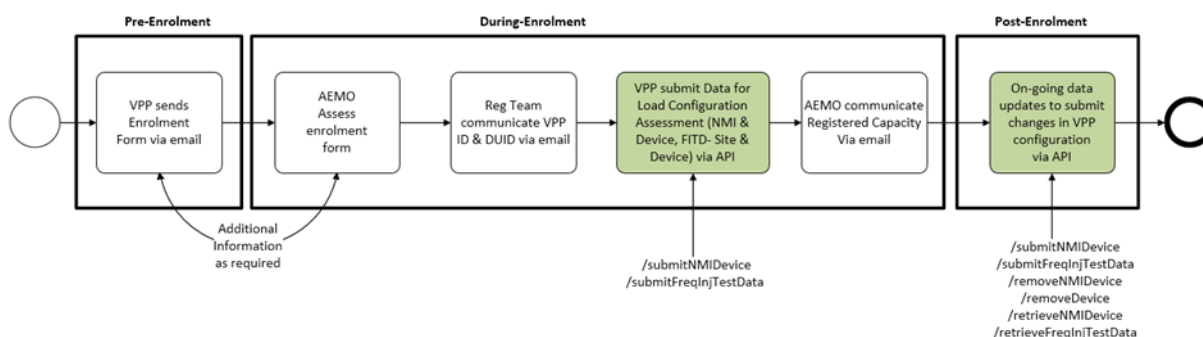


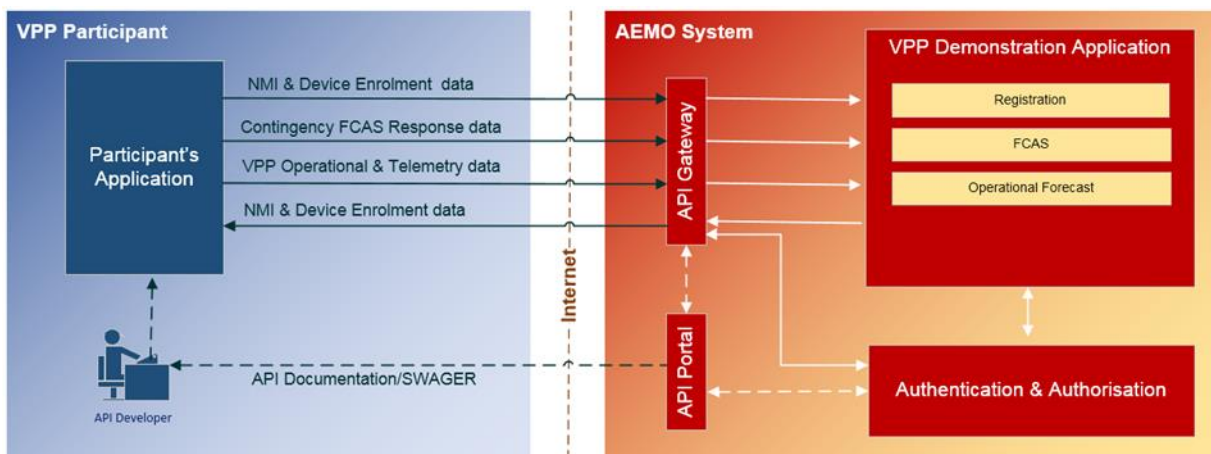
Table 3 Enrolment steps and interface type

VPP enrolment step	Description	Method	Outcome
Pre-enrolment	Interested participants to submit VPP Trial participation enrolment form.	Email/post	VPP ID and DUID Confirmed

VPP enrolment step	Description	Method	Outcome
During enrolment	A: VPP to submit data for the Load configuration assessment: 1. NMI and Device data (NMI & Devices associated to DUID & to VPP), 2. Frequency Injection Test Data for distinct Battery types and site (i.e. DUID) B: Additional data requested by AEMO	API	Determination of Load Configuration and Capacity to Deliver Contingency FCAS. Registration of VPP in trial
Post-enrolment	On-going data submission to update VPP fleet configuration (NMI and Device – data update)	API	Manage VPP's fleet capacity and configuration

2.2. Conceptual architecture

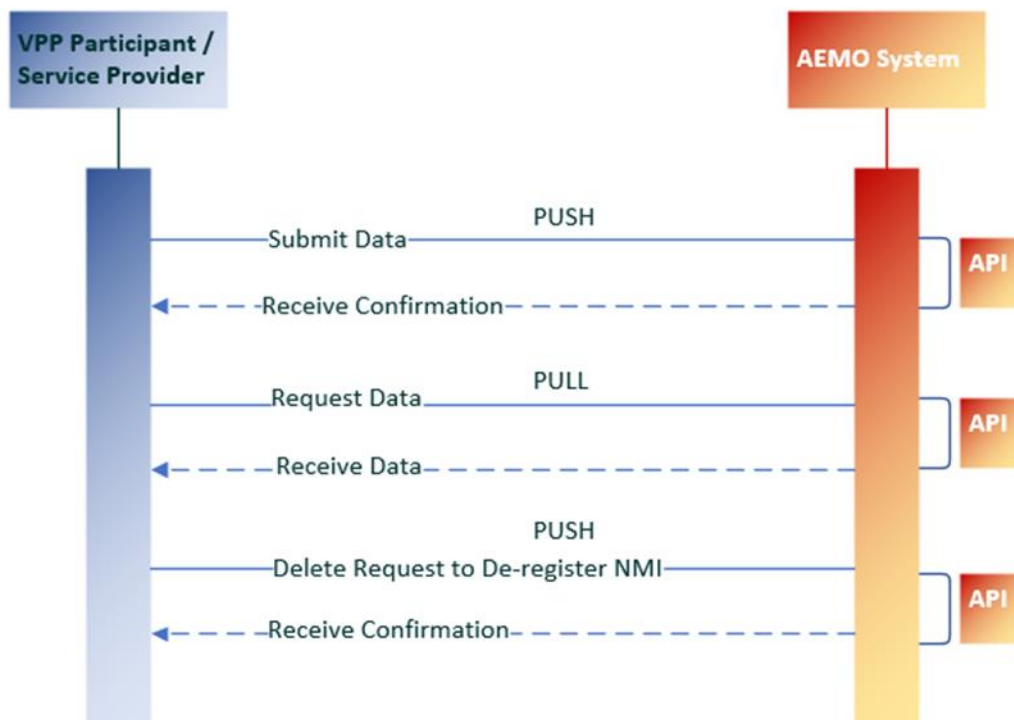
Figure 2 Architecture context diagram



2.2.1. Interface message pattern

The VPP Demonstration interface will follow both PUSH and PULL message patterns from the participants' perspective. The diagram below describes the data exchange pattern for the VPP Demonstrations.

Figure 3 Message pattern



2.2.2. Interfaces

Table 4 Interface List

Interface ID and name	Data	Message pattern	Description
Interface 1-Submit NMI & Device	NMI & Device Enrolment Data	PUSH	Participant submits list of NMIs and associated device(s) with relevant attribute values for enrolment into VPP demonstration trial and load configuration assessment.
Interface 2- Retrieve NMI & Device	NMI & Device Enrolment Data	PULL	Participant retrieve (i.e. requests) the list of enrolled NMIs and associated devices for a specific DUID in an VPP.
Interface 3- Remove NMI & Device	NMI Enrolment Data	PUSH	Participant submits a NMI or list of NMIs that needs to be disassociated (i.e. removed) from the DUID and the VPP. This will also disassociate all the devices attached to the NMI from the DUID in the VPP.
Interface 4- Remove Device	Device Enrolment Data	PUSH	Participant submits a device or list of devices that needs to be disassociated from a NMI. In addition to removing association to NMI, this will result in device(s) being removed from the DUID and VPP configuration as well.
Interface 5-Submit Frequency Injection data	Frequency Injection Test Data	PUSH	Participant submits Frequency Injection test data for the device and site (i.e. DUID) for Load Configuration Assessment for Contingency FCAS.

For all the interfaces, AEMO chose RESTful (REST) APIs because of its lightweight nature and ability to transmit data using HTTPS and JSON. The following section provides the detail protocol and API specification for VPP registrations.

3. API STANDARD

The VPP demonstration project uses AEMO e-Hub platform standards and leverages the current security framework. The AEMO e-Hub platform uses OpenAPI Specification (OAS).

For detail about AEMO's e-HUB platform, architecture, and common standards, please refer to the AEMO e-Hub API guide (see Section 1.5 for link).

AEMO and the VPP Demonstrations project team are currently assessing the alignment with IEEE 2030.5. However, this API specification is developed based on current AEMO e-Hub specification.

3.1. Design principles

VPP Demonstrations API design uses the following principles:

- APIs are RESTful and use open standards.
- APIs are secure.
- APIs provide a good user experience for participants and developer.

3.2. URL format

VPP Demonstrations API URL design follows AEMO's e-Hub APIs standards. The VPP Demonstrations APIs can only be accessed through internet. These APIs will not be accessible through MarketNet. VPP Demonstrations API endpoints will have the following format:

```
https://<host server>/<business function>/<API version>/<resource>?<Query string parameters>
```

Example URL for VPP Enrolment:

```
https://api.aemo.com.au/NEMWholesale/DER/VPP/v1/submitNMIDevice
```

3.3. HTTP request header

Table 5 Header attributes

Header parameter	Description	Allowed value / example
Content-Type	HTTP request format	Content-Type: application/json
Accept	HTTP response format	Accept: application/json
Content-Length	Content length of file. The value is populated when the request is sent.	Content-Length: nnn
X-initiatingParticipantID	The Participant ID	X-initiatingParticipantID:123456
X-market	The market type that the request applies.	NEMWholesale
Authorization	Specifies basic HTTP authentication containing the Base64[1] encoded username and password. The participant's URM username and password are concatenated with a colon separator and then Base64 encoded.	Authorization: Basic YXNhc2FzOmFzYXNhc2Fz (for URM username "VPP01" and password "nsicu@\$@#8asdsad")
Accept-Encoding	HTTP payload compression	gzip, deflate

3.4. HTTP methods

Table 6 Methods

HTTP methods	Usage
GET	For retrieval of information (single or collation)
POST	<ul style="list-style-type: none"> • To create a resource item • To spawn an action • Changes the state of the resource • To disassociate NMI and/or Device from a DUID & VPP configuration

3.5. HTTP Response

The HTTP Response will have a response code and description, with

- A successful request indicated by 200 OK.
- Other response codes for technical and Payload validation failures.
- Optional Payload.

Figure 4 Example response

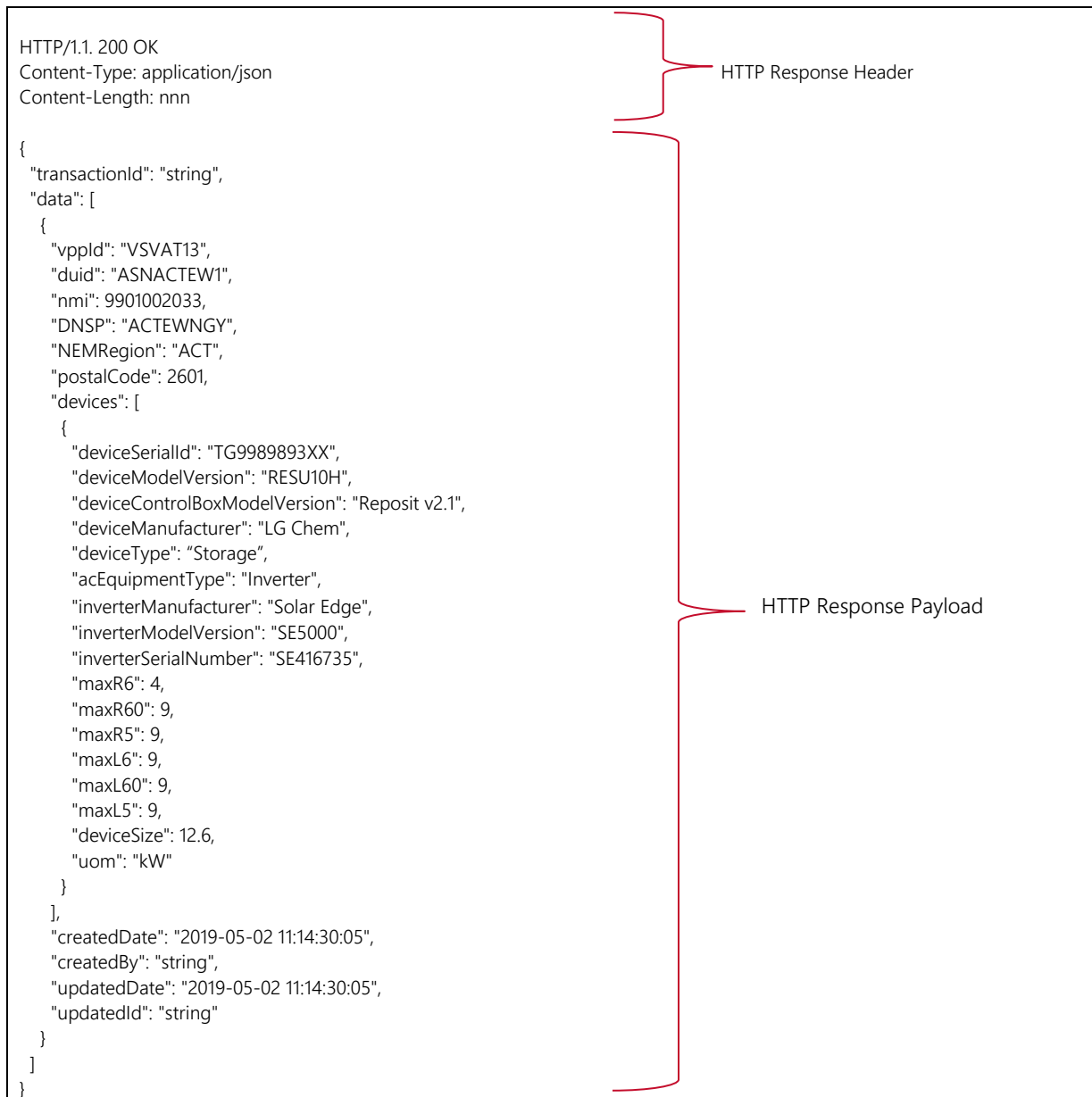


Table 7 HTTP response code

Response code	Description	Data condition
200	OK	Request Processed Successfully
400	The service cannot be found for the endpoint reference	Invalid API URL
400	Bad Request	Malformed payload (JSON)
401	Unauthorized	Invalid Credentials
401	Unauthorized	Expired User Password
401	Unauthorized	No BASIC Auth information in HTTP Request Header

Response code	Description	Data condition
401	Unauthorized	ParticipantID in the payload does not match to the ParticipantID in the URM (against the user name sent in the Basic Auth)
404	Not Found	Resource Not Found
405	Method Not Allowed	Invalid Method used (e.g. GET used instead of POST)
422	Business validation failure	Business validation failure
429	Too Many Requests	Exceeds Throttling Limits
500	Application Unavailable	VPP Application are not available
500	Any other validation failure	Any other validation failure
500	Internal Server Error	SSL Cert configured in is not associated with a valid user

3.6. Data Validation

The validations for the incoming API requests are categorised as:

1. Technical validations
 - Connectivity (for example, SSL authentication).
 - Throttling limits
2. Payload validations
 - Payload (for example, validation of the JSON payload)
 - HTTP request / response header parameters (for example, missing / invalid HTTP request / response header parameters)
 - Data Attribute Validation

3.7. Security

3.7.1. SSL Certificate

All communications between the e-HUB and a participant’s gateway are carried out using HTTPS. HTTP is not supported on the e-HUB. mTLS/SSL encryption is managed using public/private key pairs, with a different key pair required to connect to each environment (pre-production/production). Each participant must create / obtain a private key and a Certificate Signing Request (CSR).

A private key and CSR is usually created at the same time, making a key pair. A CSR is usually generated on the server where the certificate will be installed and contains information that will be included in the certificate such as the organisation name, common name (CN), locality and country. It also contains the public key that will be included in the certificate.

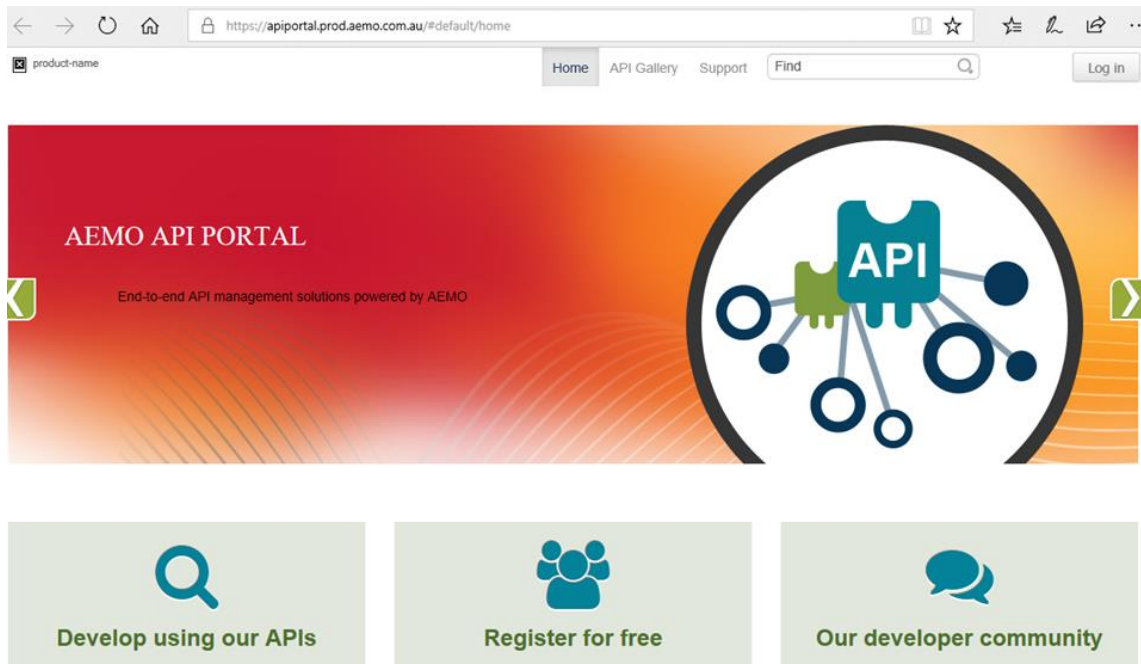
3.7.2. Authentication and Authorisation

When calling the VPP API(s), the Participants must authenticate their identity using Basic Authentication (by passing username & password). Participant Administrator (PA) will provide the username and password to the API development team. The HTTP Basic authentication header takes the following format:

```
Authorization: Basic {Base64 hash of user:password}, for example:
Authorization: Basic QWxhZGRpbjpvYVlHNC2FtZQ==
```

3.8. API Portal

AEMO provides the API portal for detail documentation and access to API swagger files.



The API portal can be accessed using the following URLs:

Pre-production: <https://preprod.apiportal.aemo.com.au>
 Production: <https://apiportal.aemo.com.au>

Please refer to Guide-to-AEMOs-eHub-APIs (link Section-1.5) for details on the AEMO API Portal.

4. VPP ENROLMENT APIS

The VPP NMI and the devices need to be enrolled through APIs. The enrolment information needs to include Participant ID and NMI for each device. The following resources are implemented by AEMO for the VPP Demonstration APIs.

4.1. API summary

Table 8 VPP API common header attributes

API Name: VPP

Accept	application/json
Production Base URL (internet)	https://api.aemo.com.au/NEMWholesale/DER/VPP/v1
Pre-production Base URL (internet)	https://preprod.api.aemo.com.au/NEMWholesale/DER/VPP/v1
Content-Type	application/json
Content-Length	Nnn
Accept-Encoding	Gzip

X-initiatingParticipantID	X-initiatingParticipantID:123456
X-market	NEMWholesale
Authorization	Authorization: Basic YXNhc2FzOmFzYXNhc2Fz (for URM username "VPP01" and password "nsicu@\$@#8asdsad")

Table 9 VPP enrolment API resources

Interface ID	Transaction	Resource	Method	Description
1	Submit NMI & Device data	submitNMIDevice	POST	Submit NMIs and attached devices under VPP ownership or control associated to the DUID, that are part for the VPP fleet
2	Retrieve NMI & Device data	retrieveNMIDevice	GET	Retrieve (to get a) list of valid NMIs and devices data associated to a specific DUID under a VPP
3	Remove NMIs from VPP fleet	removeNMIDevice	POST	Submit the list of NMIs that needs to be disassociated from DUID and removed from the VPP fleet. Removing/disassociating NMI will also remove the devices attached to the NMI from the DUID and the VPP.
4	Remove device from VPP fleet	removeDevice	POST	Submit a list of devices that needs to be disassociated from a NMI. Thus removed from the DUID and the VPP fleet.
5	Submit Frequency Injection Test Data for Load Configuration	submitFreqInjTestData	POST	Submit the Frequency Injection Test Data for Contingency FCAS Load Configuration Assessment for the devices (distinct batteries in VPP) and site (i.e. DUID).

4.2. API – submit NMI and Device Data

Resource name	/submitNMIdevice
Request parameter	None
Request payload	<pre> { data* deviceSchema { vppld* string duid* string nmis* [{ nmi* string devices* [device { deviceSerialId* string deviceModelVersion* string deviceControlBoxModelVersion* string deviceManufacturer* string deviceType* string acEquipmentType* string inverterManufacturer string inverterModelVersion string inverterSerialNumber string maxR6* integer maxR60* integer maxR5* integer maxL6* integer maxL60* integer maxL5* integer deviceSize* integer uom* string }] }] } } </pre>

<p>Example</p>	<pre>{ "data": { "vppld": " VSVAT13", "duid": " ASNACTEW1", "nmis": [{ "nmi": 9901002033, "devices": [{ "deviceSerialId": "TG9989893XX", "deviceModelVersion": "RESU10H", "deviceControlBoxModelVersion": "Reposit v2.1", "deviceManufacturer": "LG Chem", "deviceType": "Storage", "acEquipmentType": "Inverter", "inverterManufacturer": "Solar Edge", "inverterModelVersion": "SE5000", "inverterSerialNumber": "SE416735", "maxR6": 4, "maxR60": 9, "maxR5": 9, "maxL6": 9, "maxL60": 9, "maxL5": 9, "deviceSize": 12.6, "uom": "kW" }] }] } }</pre>
<p>Response</p>	<p>200 - Submit Data for VPP Profile - Success 422 - Business validation failure 429 - This response is provided when the throttling limits are reached 500 - Internal Server Error</p>
<p>Example</p>	<pre>{ "transactionID": "b85a35f8-f741-40ac-a701-a8cfebb25669", "data": {}, "errors": [{ "code": "429", "title": "Too Many Requests", "detail": "Number of inbound requests exceeded the throttling limits; try after sometime", "source": null }] }</pre>

4.3. API – retrieve NMI and device data

Resource name	/retrieveNMIdevice
Query parameter	"vppld": "string", "duid": "string",
Request parameter	None
Request payload	None
Response payload example	<pre>{ "transactionId": "string", "data": [{ "vppld": "VSVAT13", "duid": "ASNACTEW1", "nmi": 9901002033, "dnsp": "ACTEWNGY", "nemRegion": "ACT", "postalCode": 2601, "devices": [{ "deviceSerialId": "TG9989893XX", "deviceModelVersion": "RESU10H", "deviceControlBoxModelVersion": "Reposit v2.1", "deviceManufacturer": "LG Chem", "deviceType": "Storage", "acEquipmentType": "Inverter", "inverterManufacturer": "Solar Edge", "inverterModelVersion": "SE5000", "inverterSerialNumber": "SE416735", "maxR6": 4, "maxR60": 9, "maxR5": 9, "maxL6": 9, "maxL60": 9, "maxL5": 9, "deviceSize": 12.6, "uom": "kW" }], "createdDate": "2019-05-02 11:14:30:05", "createdBy": "string", "updatedDate": "2019-05-02 11:14:30:05", "updatedId": "string" }] }</pre>
Response	200 - Success 429 - This response is provided when the throttling limits are reached 500 - Internal Server Error

4.4. API – remove NMI and device data

Resource name	/removeNMIDevice
Query parameter	None
Request parameter	<pre>{ data* nmiSchema { nmis [{ nmi string }] } }</pre>
Request payload	<pre>{ "data": { "nmis": [{ "nmi": 9901002033 }] } }</pre>
Response payload example	<p>200 - Submit Data for VPP Profile - Success 422 - Business validation failure 429 - This response is provided when the throttling limits are reached 500 - Internal Server Error</p>
Response	<pre>{"transactionID": "b85a35f8-f741-40ac-a701-a8cfebb25669", "data": {}, "errors": [{ "code": "429", "title": "Too Many Requests", "detail": "Number of inbound requests exceeded the throttling limits; try after sometime", "source": null }] }</pre>

4.5. API – remove device data

Resource name	/removeDevice
Query parameter	None
Request parameter	<pre>{ data: [deviceRemoveSchema { vppld* string duid* string nmi* string devices [{ deviceSerialId* string deviceModelVersion* string deviceControlBoxModelVersion* string deviceManufacturer* string deviceType* string acEquipmentType* string inverterManufacturer string inverterModelVersion string inverterSerialNumber string }] } }</pre>
Request payload	<pre>{ "data": [{ "vppld": "VSVAT13", "duid": "ASNACTEW1", "nmi": "9901002033", "devices": [{ "deviceSerialId": "TG9989893XX", "deviceModelVersion": "RESU10H", "deviceControlBoxModelVersion": "Reposit v2.1", "deviceManufacturer": "LG Chem", "deviceType": "Storage", "acEquipmentType": "Inverter" "inverterManufacturer": "Solar Edge", "inverterModelVersion": "SE5000", "inverterSerialNumber": "SE416735", }] }] }</pre>
Response payload example	<p>200 - Submit Data for VPP Profile - Success 422 - Business validation failure 429 - This response is provided when the throttling limits are reached 500 - Internal Server Error</p>
Response	<pre>{"transactionID": "b85a35f8-f741-40ac-a701-a8cfebb25669", "data": {}, "errors": [{ "code": "429", "title": "Too Many Requests", "detail": "Number of inbound requests exceeded the throttling limits; try after sometime", "source": null }] }</pre>

4.6. API – submit frequency injection test data

Resource name	/submitFreqInjTestData
Query parameter	None
Request parameter	<pre> { data* FITDSchema { vppld* string duid* string fcasMarketType string samplingRate* string uom* string freqTestData* [freqTestData { samplingInterval* integer frequency* integer power* integer gridPower* integer measurementDatetime* string deviceName string }] } </pre>
Request payload	<pre> { "data": { "vppld": "VSVAT13", "duid": "ASNACTEW1", "fcasMarketType": "R6", "samplingRate": "20ms", "uom": "kW", "freqTestData": [{ "samplingInterval": -4.6, "frequency": 50.00032169, "power": -12.24, "gridPower": 12.24, "measurementDatetime": "2019-05-02 11:14:30:05", "deviceName": "LG" }] } } </pre>
Response payload example	<p>200 - Submit Data for VPP Profile - Success</p> <p>422 - Business validation failure</p> <p>429 - This response is provided when the throttling limits are reached</p> <p>500 - Internal Server Error</p>
Response	<pre> {"transactionID": "b85a35f8-f741-40ac-a701-a8cfebb25669", "data": {}, "errors": [{ "code": "429", "title": "Too Many Requests", "detail": "Number of inbound requests exceeded the throttling limits; try after sometime", "source": null }] } </pre>

APPENDIX A. GLOSSARY

Abbreviation/term	Explanation
API Gateway	The gateway on AEMO's side providing participant communication options, accessible only over the internet. It uses resources and methods to push messages to Participants' API Gateways.
API	Application Programming Interface; a set of clearly defined methods of communication between various software components.
API Web Portal	Where you can view available APIs, view and manage your API Keys, obtain OAS files.
CSR	Certificate Signing Request is a block of encoded text given to a Certificate Authority when applying for an SSL Certificate. It also contains the Public Key to include in the certificate. Usually, a Private Key is created at the same time, making a Key Pair.
e-Hub	Consists of the API Web Portal and the API Gateway for both electricity and gas.
JSON	JavaScript Object Notation
Key Pair	SSL uses a technique called public-key cryptography, based on the concept of a Key Pair. The Key Pair consists of encrypted Public and Private Key data. It is only possible to decrypt the Public Key with the corresponding Private Key.
MarketNet	AEMO's private data network connection. VPP APIs are not available via MarketNet.
OAS	OpenAPI Specification
Participant API Gateway	The interface implemented by participants where AEMO's API pushes messages.
Participant ID	Registered participant identifier
Payload	The data sent by a POST request. The Payload sections sits after the header.
PID	Participant ID
Private Key	The secret Private Key is a text file used initially to generate a Certificate Signing Request (CSR), and later to secure and verify connections.
Public Key	The Public Key is included as part of your SSL certificate, and works together with your Private Key to make sure your data is encrypted, verified, and not tampered with. Anyone with access to the Public Key (i.e. the certificate) can verify the digital signature is authentic without having to know the secret Private Key.
SSL	Secure Sockets Layer, cryptographic protocol providing API communication security.
Swagger file	The OpenAPI Specification (OAS) definition of the API.
TLS	Transport Layer Security, cryptographic protocol providing API communication security.
VPP	Virtual Power Plant
XML	Extensible Markup Language