*Smart system of renewable energy storage based on **IN**tegrated E**V**s and b**A**tteries to empower mobile, **D**istributed and centralised **E**nergy storage in the distribution grid*

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Abbreviations and Acronyms

Acronym	Description
API	Application programming interface
BRP	Balance Responsible Party
CMO	Capacity Management Operator
CP	Communication platform
CPO	Charging Point Operator; also Charging Station Operator (CSO)
DSO	Distribution System Operator
EV	Electric Vehicle
FC	Flexibility Cloud
FCS	Flexibility Cloud Software
FES	Front End Systems
FO	Flexibility Operator
GUID	Global Unique Id; same as Universally Unique Identifier (UUID)
IIP	Integrated INVADE Platform
OCMP	Open Capacity Management Protocol
NA	Not Applicable
PV	Photovoltaic
SM	Smart Meter
TBD	To Be Determined
ToU	Time-of-Use
TSO	Transmission System Operator
WP	Work Package

Executive summary

In the INVADE project, a central delivery is the cloud-based Integrated INVADE platform, which will be used by the Flexibility Operator to manage flexibility from flexibility providers and offer this to flexibility customers. The first version of the Integrated INVADE platform will be delivered in June 2018 and implemented at pilots during the autumn 2018.

The aim of this document is to specify how data can be sent to and from the Integrated INVADE platform through its communication platform API.

This deliverable is structured as follows: First in the introduction a summary of how the work in this document relates to the other INVADE deliveries is given. Then a summary of the modelling is given to provide context to the data that is to be interfaced. Further, the platform Web API, Event Hub and the methods that can be utilized to communicate back to external systems are detailed and finally any interfacing using specific agreed protocols is defined.

As each pilot case is further defined at a technical level, it could be additional data needs to be integrated, so this document should be treated as a working document that is likely to be expanded on during later stages of the project.

1 Introduction

This document contains the deliverable D7.2 Specification of the Communication Platform (CP) API. The main purpose of the document is to define the CP API, which enables the required communication between the Integrated INVADE platform (IIP) and the external pilot systems and devices.

The deliverable focuses on the technical implementation of the CP API. The WP8 deliverables *D8.1 Cloud based flexibility management system: Flexibility Cloud, phase 1* and *D8.2 Cloud based flexibility management system: Flexibility Cloud, phase 2* present the IIP use cases, which lay the foundation for the required communication that the CP API need to support. The document also builds on the communication platform specified in D7.1 Communications Specification Plan, in addition to input from other INVADE deliverables: D4.1, D4.2, D5.3 and D10.1.

The document is structured as follows: Section 2 introduces the general communication setup in the pilots, while Section 3 goes through the general modelling of assets and associated time series data required by the IIP. Section 4 details the Web API for data management (for configuration of assets, topology and time series data) and section 5 details the Azure Event Hub API which can be utilized to send time series data from devices into the IIP (the Azure Event Hub API will not be available for the first version of the IIP). Further, section 6 details communication from IIP to External Systems, while the last section, section 7, details communication via Open Capacity Management Protocol (OCMP), which is utilized in the Dutch pilot.

2 Communication setup at pilot sites

In the INVADE project, there are five pilots. At all pilot sites, there will be a local cloud or control system which will be in direct control of the controllable and non-controllable resources at the pilot sites. For the Bulgarian and Spanish pilots, the local control systems are SCADA systems, while the Dutch, German and Norwegian pilots all have local smart-home or other cloud-based systems. The IIP will always communicate with these local systems and never directly with pilot resources. Consequently, the communication interface between the IIP and the pilot sites are between the IIP and the local system, not the IIP and the pilot resources. The IIP will indirectly communicate with the pilot resources through the CP API, but the direct communication with pilot resources is managed locally at pilot sites. See Figure 1 for a pilot example.

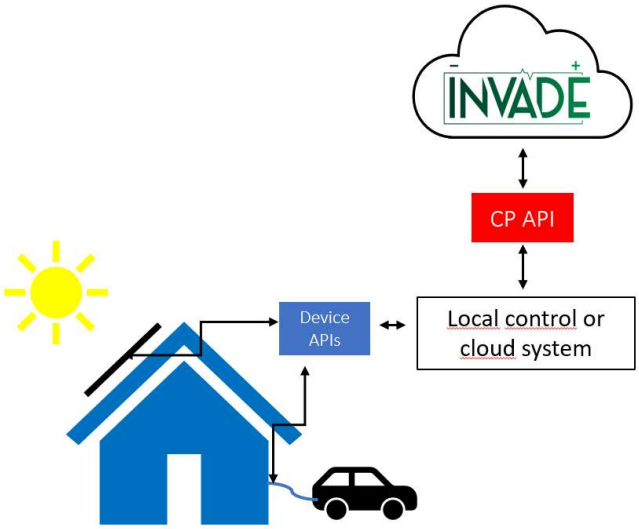

Figure 1: Example pilot site with PV production, EV charging and local control or cloud system

3 Modelling

Delivery D8.1 details the INVADE platform modeling of assets. See *Deliverable D8.1 – Flexibility Cloud Phase 1* for details. However, to provide context to the reader of this specification the key points of the modelling are included in this section, as these are important to understand, for interfacing data via the APIs.

3.1 Assets (Areas, Sites & Resources)

The asset management API specified in section “4.2 Asset Management API” is provided so an external system can manage the asset repository related to the context of the pilot.

Within the IIP there is need to understand a logical topology of the assets to be able to perform predictions and optimizations. For each pilot this needs to be configured within the platform. Generally, the IIP will support two approaches for this:

1. The data can be provided via the asset management API. This has the advantage that if this interface is built, it can be easily adjusted during the pilot phase and alternative configurations can be analyzed.
2. Or alternatively, the data can be provided by supplying the pilot configuration data in the INVADEAssetLoader Excel template, and eSmart will facilitate the load of this data into the platform. The template is distributed to all pilot owners.

Assets are modelled as areas or resources as shown below.

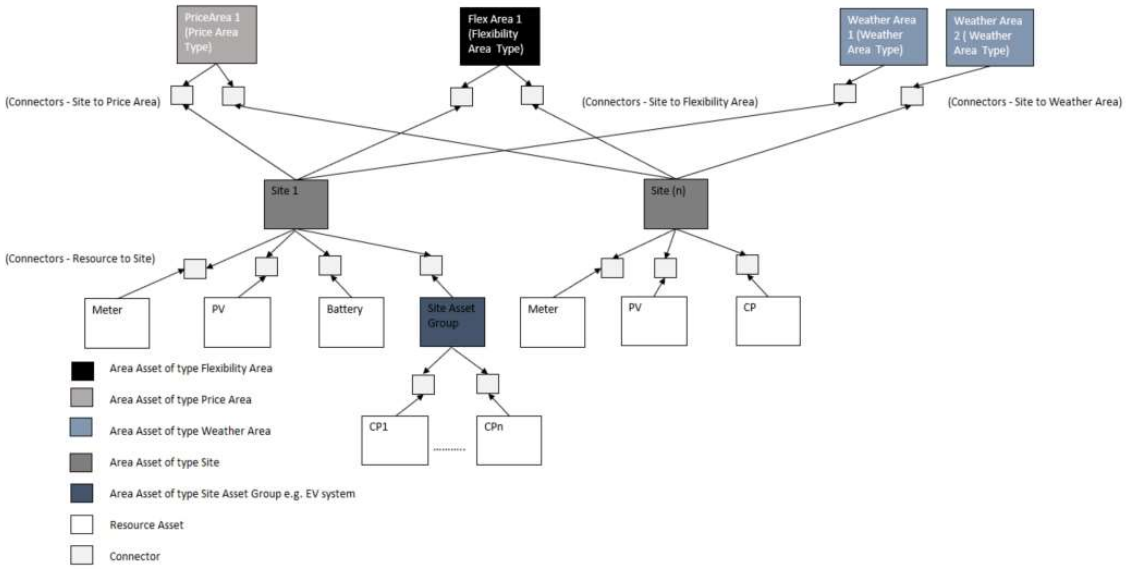

Figure 2. Relationships between Price Areas, Flexibility Areas, Weather Areas, Sites, Site Asset Groups and Resource Assets

The example above shows two sites, each site is connected to a flexibility area, a price area and a weather area. The first site has a site asset group where a number of charging points are attached, a main meter, PV generation and a Battery. The second site has a main meter, PV and a single charge point attached to it.

Definitions

Within the IIP data repository, there is a generic data type called asset that is used to model entities that have common attributes, traits or relationships. For the purpose of the pilots, the generic asset entity type will be used to model areas, sites and resource assets.

Area is defined to be a grouping entity with an Area Type classification. Typical area type classifications could be Zone, Flexibility Area, Weather Area, Price Area, Site and Site

Asset Group. For most pilots the following area types will be used: Flexibility Area, Weather Area, Price Area, Site and Site Asset Group. Additionally, if some aspect of a transportation system is required e.g. to model a constraint in a transportation zone then the Area type of Zone type may be used.

Typically, the area will represent a grouping where one wants to have summarized data and collect data that can be utilized by the relations of what sites are within the area. For example, to find the weather forecast for a site based on its connection to a Weather area.

For most pilots cases a site should always be connected to a price area, a weather area and a flexibility area to facilitate the flexibility optimization.

- The price area will indicate which spot price to use for pricing the contract (depending on the contract product configuration set up).
- The flexibility area relationship can be used to connect the site to a flexibility contract (via the link) which defines the pricing information related to consumption and production at the site for retail, grid and flexibility pricing.
- The weather area connects the site to the “closest” weather area where we have weather data (forecasts) that will be used as part of the optimization.

Site is defined to be a grouping entity with an area type classification of Site. The site type classifications are Household, Office, Car Park, Hotel or Not Specified.

The site will represent a grouping where one wants to have summarized data for a set of resource assets that can be managed collectively within the site, and where one can manage any mixture of generation, consumption, storage, and charging and related flexibility collectively. Each site generally will be configured with one Main Meter (where the main meter meters the net exchange with the grid, i.e. the purchase and the sales).

Site Asset Group is defined to be a grouping entity with an area type classification of Site Asset Group, it is always a group within a site. Typical site asset group type classifications could be EV System, etc.

The site asset group will represent a grouping where one wants to group a set of assets together, typically this could be where one has an EV System with a capacity restriction for a set of Charging points. The capacity restriction can then be associated to this entity. Validation will restrict the Site Asset groups parent to always be a Site and its children must always be resource assets.

Resource Asset is defined to be a representation of a physical or virtual asset (or collection of assets) that have a classification type of generation, consumption, storage, charging or metering. Examples of resource assets include PV, Battery, Meter, Water heaters and EV Charger.

Site to Area Connections

In general, all site assets will be connected to areas via asset connector of type *Area*. Validation ensures a site only has one active connection to one area (of a particular classification type) over any period of time.

Site Asset Group to Site Connections

All site asset groups will be connected to sites via asset connector of type *SiteAssetGroup*. Validation ensures a site asset group only has one active connection to a site over any period of time.

Resource to Site Connections or to Site Group Connections

In general, all Resource assets will be connected to a site via asset connector of type *Site,* or for Site Group within a Site via asset connector of type *SiteAssetGroup*. Validation ensures a resource asset has only one active connection to one site or site asset group over any period of time.

3.1.1 Asset Properties

The following table details the prevailing asset properties that will be supported on each asset type for the pilot cases.
This list may be extended if required, but it provides the basic set of properties one would expect for each asset to facilitate the modelling of flexibility.

Notes: This list can be retrieved in JSON format from API method specified in section “4.2.2 API Method: Get Asset Supported Property List”.

Asset Type	Asset SubType	Classification Type	PropertyName	Property Value Type	Is Mandatory	Description	Selection Value Type
All	All	General	AssetType	string	TRUE	The asset type. Valid values for property name from selection list(AssetType : Resource,Area)	AssetType
All	All	General	AssetSubType	string	TRUE	The asset subtype. Valid values for property name from selection list(AssetSubType : Generation,Load,Storage,Charging,Meter,Flexibility Area,PriceArea,WeatherArea,Site,SiteAssetGroup)	AssetSubType
All	All	General	Name	string	TRUE	The name of the asset.	null
All	All	General	Description	string	FALSE	Description of the asset	null
All	All	General	ValidFromTime	dateTime	FALSE	The asset's valid from date (ISO8601-format).	null
All	All	General	ValidToTime	dateTime	FALSE	The asset's valid to date (ISO8601-format).	null
All	All	General	EntityStatus	string	TRUE	Entity Status. Valid values for property name from selection list(EntityStatus : Active,InProgress,Deleted). By default set to 'Active'.	EntityStatus
All	All	Geographical Location	TimeZone	string	FALSE	The time zone the asset is located in.	null
All	All	Geographical Location	Longitude	decimal	FALSE	Longitude reference of the asset (decimal degrees WSG84)	null
All	All	Geographical Location	Latitude	decimal	FALSE	Latitude reference of the asset (decimal degrees WSG84)	null

All	All	Address	StreetNumber	int	FALSE	Street number of the asset	null
All	All	Address	Street	string	FALSE	The street the asset is located in.	null
All	All	Address	City	string	FALSE	The city the asset is located in.	null
All	All	Address	PostalCode	string	FALSE	The postal code the asset is located in.	null
All	All	Address	StateOrProvinceCode	string	FALSE	The state or province code the asset is located in.	null
All	All	Address	StateOrProvince	string	FALSE	The state or province the asset is located in.	null
All	All	Address	Country	string	FALSE	The country the asset is located in.	null
Area	Site	General	SiteType	string	FALSE	Used when AssetSubType is Site. Indicates site type. Valid values for property name from selection list(SiteType : NotSpecified,Household,Office,CarPark,Hotel). By default set to 'NotSpecified'.	AssetSiteType
Area	Site	General	NonControllableConsumptionProductionDerivedFromMainMeter	bool	FALSE	True if non-controllable consumption/production assets are not metered individually and usage should be derived from main meter readings (minus the controllable asset readings), else false. Defaults to false for insert.	
Area	SiteAssetGroup	General	SiteAssetGroupType	string	FALSE	Used when AssetSubType is SiteAssetGroup. Indicates site asset group type. Valid values for property name from selection list(SiteAssetGroupType : NotSpecified,EVSystem). By default set to 'NotSpecified'.	SiteAssetGroupType
Resource	AllResourceTypes	Monitoring	IsMetered	bool	FALSE	Resource property. Indicates if asset is metered. By default set to 'FALSE'.	null
Resource	AllResourceTypes	Meter	MeterType	string	FALSE	Indicates meter type. Valid values from selection list (MeterType: EnergyConsumption,EnergyProduction,EnergyProductionAndConsumption). By default set to 'NotSpecified'.	AssetMeasurementType
Resource	AllResourceTypes	Meter	IsMainMeter	bool	FALSE	Monitoring property. Indicates if meter is main for a site. By default set to 'FALSE'.	null
Resource	AllResourceTypes	Controllable	IsContollable	bool	FALSE	Resource property. Indicates if asset is controllable. By default set to 'FALSE'.	null
Resource	AllResourceTypes	Controllable	ControllableType	string	FALSE	Controllable property. Indicates controller type. Valid values for property name from selection	AssetControllableType

						list(AssetControllableType : None,OnOff,Continuous). By default set to 'None'.	
Resource	AllResource Types	Controllable	FlexibilityType	string	FALSE	Flexibility property. Indicate flexibility type. Valid values for property name from selection list(AssetFlexibilityType : None,Disconnectable,Reducible,ShiftableVolume,ShiftableProfile). By default set to 'None'.	AssetFlexibilityType
Resource	AllResource Types	IoT	IsGateway	bool	FALSE	Resource property. Indicates if asset is gateway. By default set to 'false'. NOT supported in June 2018 pilot release.	null
Resource	AllResource Types	IoT	IsIoTEnabled	bool	FALSE	Resource property. Indicates of asset is IoT Device. By default set to 'false'. NOT supported in June 2018 pilot release	null
Resource	AllResource Types	IoT	Manufacturer	string	FALSE	IoT property. The manufacturer of the IoT asset. NOT supported in June 2018 pilot release	null
Resource	AllResource Types	IoT	IoTItemGuid	string	FALSE	IoT property. Its unique IoT GUID, auto set (to asset key) if IsIoTEnabled = True and not already set. NOT supported in June 2018 pilot release	null
Resource	AllResource Types	IoT	DeviceId	string	FALSE	IoT property, its Unique DeviceId, auto set (to asset key) if IsIoTEnabled = True and not already set. NOT supported in June 2018 pilot release	null
Resource	Load	Load	LoadType	string	FALSE	The load type. Valid values for property name from selection list(AssetLoadType : WaterHeater,FloorHeating,None). Use 'None' for other type of load. By default set to 'None'.	AssetLoadType
Resource	Load	Load	InstalledMaxCapacity	int	FALSE	The installed maximum capacity of the load.	null
Resource	Generation	Generation	GenerationType	string	FALSE	The generation type. Valid values for property name from selection list(AssetGenerationType : PV, None). Use 'None' for other type of generation. By default set to 'None'.	AssetGenerationType
Resource	Generation	Generation	InstalledMaxCapacity	int	FALSE	The Maximum Capacity of the installed generation. Unit: kW.	null
Resource	Charging	Charging	ChargingType	string	FALSE	The charging type. Valid values for property name from selection list(AssetStorageType : None, EVCharger). Use 'None' for other type of charging assets. By default set to 'None'.	

Resource	Charging	Charging	InstalledMaxCapacity	double	FALSE	The installed charging capacity. Unit: kW.	null
Resource	Charging	Charging	MaxChargingPower	double	FALSE	The maximum charging capacity. Unit: kW.	null
Resource	Charging	Charging	MaxDischargingPower	double	FALSE	The maximum discharging capacity. Used when the EV has V2X capabilities. Unit: kW.	null
Resource	Charging	Charging	EfficiencyOfCharging	double	FALSE	The charging efficiency. Factor between (0-1). Filled in with default values if omitted.	null
Resource	Charging	Charging	EfficiencyOfDischarging	double	FALSE	The discharging efficiency. Factor between (0-1). Filled in with default values if omitted.	
Resource	Charging	Charging	ChargingOnly	bool	FALSE	Indicates if the Charging asset has V2X capabilities. 'True' if it only can be charged, else false. By default set to 'FALSE'	null
Resource	Storage	Storage	StorageType	string	FALSE	The storage type. Valid values for property name from selection list(AssetStorageType : None,Battery,EVBattery). Use 'None' for other type of storage assets. By default set to 'None'.	AssetStorageTyp e
Resource	Storage	Storage	InstalledMaxCapacity	int	FALSE	The maximum capacity of the storage asset. Unit: kWh.	null
Resource	Storage	Storage	InstalledMinCapacity	int	FALSE	The minimum level the storage can be discharged to. Unit: kWh.	null
Resource	Storage	Storage	MaxChargingPower	double	FALSE	The maximum charging capacity. Unit: kW.	null
Resource	Storage	Storage	MaxDischargingPower	double	FALSE	The maximum discharging capacity. Unit: kW.	null
Resource	Storage	Storage	EfficiencyOfCharging	double	FALSE	The charging efficiency. Factor between (0-1). Filled in with default values if omitted.	null
Resource	Storage	Storage	EfficiencyOfDischarging	double	FALSE	The discharging efficiency. Factor between (0-1). Filled in with default values if omitted.	
Resource	Storage	Storage	ThresholdCharge	double	FALSE	The maximum Threshold or SOC which the storage should not charge above. Factor between (0-1). Filled in with default values if omitted.	
Resource	Storage	Storage	ThresholdDischarge	double	FALSE	The minimum Threshold or SOC which the storage should not discharge below. Factor between (0-1). Filled in with default values if omitted.	
Resource	Storage	Storage	ThresholdStoredEnergy EndP	double	FALSE	The Threshold or SOC which the storage level should be at by the end of the planning horizon. Factor between (0-1). Filled in with default values if omitted.	

Resource	Storage	Storage	CostCharging	double	FALSE	Cost Charging in currency/ kWh. Filled in with default values if omitted.	
Resource	Storage	Storage	CostDischarging	double	FALSE	Cost Discharging in currency/ kWh. Filled in with default values if omitted.	

Table 1 - Asset properties which will be supported on each asset type

3.2 Time Series

The table below describes all types of technical time series based information that can be sent from the external communication system to the IIP. The exact details will vary per pilot.

A Time Series is defined as a series of values obtained at successive times (each at a single point in time or for a specific time period), often with equal intervals between them, in a specific unit of measure.

The time series per asset type that are to be utilized within the IIP are highlighted. These are generally either supplied directly from the external partner, via an interface to an external system or calculated from the other time series provided, as commented on in the table below.

Generally, when sourcing data from an external system on a real time basis, it is preferred that energy data are interfaced from the accumulated readings in kWh. That way, if any messages or data is missed the actual consumption/production over a period can still be calculated/inferred.

Table Note:

- Data Capture Key: S= Supplied, R = Required (but may be calculated from supplied), O = optional (to be clarified later in the project) , C= calculated, OUT – output.
- for time series, names can be supplied in any lower/upper case combination, when exported will be pascalcase (see en.wikipedia.org/wiki/PascalCase)
- Resolution/Interval: *Frequent* is used on time series types where exact frequency can vary. An example of this is meter readings where the exact time between readings isn't always equal. *E.G. 15 minute* is used for time series where the frequency doesn't vary. An example is time series calculated by the IIP.

Asset Type(s)	Variable (time series)	Unit	Resolution /Interval	Comment	Data Capture
Metering (Main Meter)	Net Energy Meter Reading	kWh	Frequent	Signed values(+ve, -ve) +ve = Consumption -ve = Production If used it is assumed data will not be supplied on Production Meter Reading and Consumption Meter Reading	S

Asset Type(s)	Variable (time series)	Unit	Resolution /Interval	Comment	Data Capture
Metering (Main Meter)	Production Meter Reading	kWh	Frequent	Unsigned values Additionally for meters with phases there are 3 series types (Production Meter Reading Phase n where n = 1..3)	S
Metering (Main Meter)	Consumption Meter Reading	kWh	Frequent	Unsigned values Additionally for meters with phases there are 3 series types (Consumption Meter Reading Phase n where n = 1..3)	S
Metering (Main Meter)	Net Energy	kWh	e.g. 15 minute	Signed values(+ve, -ve) Calculated from Net Energy Meter Reading if supplied	R/C
Metering (Main Meter)	Production	kWh	e.g. 15 minute	Unsigned values Calculated from Production Meter Reading if supplied Alternatively Calculated from Net Energy is supplied (-ve values) Additionally for meters with phases there are 3 series types (Production Phase n where n = 1..3), then it is calculated from sum of all 3 phases	R/C
Metering (Main Meter)	Consumption	kWh	Frequent	Unsigned values Calculated from Consumption Meter Reading if supplied Alternatively Calculated from Net Energy is supplied (+ve values) Additionally for meters with phases there are 3 series types (Consumption Phase n where n = 1..3)), then it is calculated from sum of all 3 phases	R/C
Metering (Main Meter)	Net Instant Power	kW	e.g. 15 minute	Signed values(+ve, -ve)	O
Metering (Main Meter)	Production Instant Power	kW	e.g. 15 minute	Unsigned values	O
Metering (Main Meter)	Consumption Instant Power	kW	e.g. 15 minute	Unsigned values	O
Generation	Production Meter Reading	kWh	Frequent	Unsigned values Additionally for meters with phases there are 3 series types (Production Meter Reading Phase n where n = 1..3)	S

Asset Type(s)	Variable (time series)	Unit	Resolution /Interval	Comment	Data Capture
Generation	Production Instant power	kW	Frequent	Unsigned values	O
Generation	Production	kWh	e.g. 15 minute	Unsigned values Calculated from Production Meter Reading if supplied Alternatively Calculated from Net Energy is supplied (-ve values) Additionally for meters with phases there are 3 series types (Production Phase n where n = 1..3)), then it is calculated from sum of all 3 phases	R/C
Generation	Flexibility Down	kW	e.g. 15 minute	Reduction of Flexibility down	C/OUT/O
Generation	Production Power Regulation	kW	e.g. 15 minute	Set point for control	C/OUT
Generation	Production OnOff Power Regulation		e.g. 15 minute		C/OUT
Load	ConsumptionMeter Reading	kWh	Frequent	Unsigned values Additionally for meters with phases there are 3 series types (Consumption Meter Reading Phase n where n = 1..3)	S
Load	Consumption	kWh	e.g. 15 minute	Unsigned values Supplied or calculated from Consumption Meter Reading Additionally for meters with phases there are 3 series types (Consumption Phase n where n = 1..3), then it is calculated from sum of all 3 phases	R/C
Load	Consumption Instant power	kW	Frequent	Unsigned values	O
Load	Flexibility Up	kW	e.g. 15 minute	Prediction of Flexibility up	C/OUT/O
Load	Load Power Regulation	kW	e.g. 15 minute	Set point for control	C/OUT
Load	Load OnOff Power Regulation		e.g. 15 minute		C/OUT
Storage	Charging current	A	Frequent		O
Storage	Charging power	kW	Frequent		O
Storage	Discharging current	A	Frequent		O
Storage	Discharging power	kW	Frequent		O
Storage	Charging Meter Reading	kWh	e.g. 15 minute	Unsigned values	S
Storage	Discharging Meter Reading	kWh	e.g. 15 minute	Unsigned values	S
Storage	Charging Energy	kWh	e.g. 15 minute	Unsigned values Supplied or calculated from Meter Reading	R/C
Storage	Discharging Energy	kWh	e.g. 15 minute	Unsigned values Supplied or calculated from Meter Reading	R/C

Asset Type(s)	Variable (time series)	Unit	Resolution /Interval	Comment	Data Capture
Storage	Energy Level Meter Reading	kWh	Frequent	Unsigned values Supplied or calculated from Meter Reading	R/C
Storage	Energy Level	kWh	e.g. 15 minute	Unsigned values Calculated from Energy Level Meter Reading	R/C
Storage	Flexibility Up	kW	e.g. 15 minute	Calculated from Energy Level to minimum capacity, limited to discharge abilities	C/OUT
Storage	Flexibility Down	kW	e.g. 15 minute	Calculated from Energy Level to maximum capacity, limited to charge abilities	C/OUT
Storage	Charging Power Regulation	kW	e.g. 15 minute		C/OUT
Storage	Discharging Power Regulation	kW	e.g. 15 minute		C/OUT
Charging	Charging Power	kW	Frequent		O
Charging	Discharging Power	kW	Frequent		O
Charging	ChargingCurrent	A	Frequent		O
Charging	DischargingCurrent	A	Frequent		O
Charging	Charging point state	0, 1, 2	e.g. 15 minute	Charging point state – possible values: 0-suspended/out of order, 1-available/not connected, 2-charging	S
Charging	Charging Meter Reading	kWh	Frequent	Unsigned values	S
Charging	Discharging Meter Reading	kWh	Frequent	Unsigned values	S
Charging	Net Meter Reading	kWh	Frequent	Signed values(+ve, -ve)	S
Charging	Charging Energy	kWh	e.g. 15 minute	Unsigned values Supplied or calculated from Meter Reading	R/C
Charging	Discharging Energy	kWh	e.g. 15 minute	Unsigned values Supplied or calculated from Meter Reading	R/C
Charging	Net Energy	kWh	e.g. 15 minute	Signed values(+ve, -ve) Supplied or calculated from Meter Reading	R/C
Charging	Flexibility Up	kW	e.g. 15 minute	Prediction of Flexibility up	C/OUT/O
Charging	Charging Power Regulation	kW	e.g. 15 minute	Set point for control	C/OUT
Charging	Charging Power OnOff Regulation	kW	e.g. 15 minute		C/OUT
Area (typically held at Site or zone)	Max Capacity	kW	e.g. 15 minute	Unsigned values, used to represent a max Capacity constraint for an Area	S
Area (typically held at Site or zone)	Flexibility Up	kW	e.g. 15 minute	Flexibility up, total flexibility up within the area	C/OUT/O
Area (typically held at Site or zone)	Flexibility Down	kW	e.g. 15 minute	Flexibility down, total flexibility down within the area	C/OUT/O

Asset Type(s)	Variable (time series)	Unit	Resolution /Interval	Comment	Data Capture
Site/Area (typically held at Site or zone)	Optimal Capacity Regulation	kW	e.g. 15 minute	Unsigned values an optional capacity profile for an Area, based on information such as PV production based on weather predictions.	C/OUT
Area	Actual Temperature	C	e.g. 15 minutes	The actual/average temperature assigned to an area (of type Weather). Usage: Areas will be configured to receive weather information, the sites will be connected to these areas so data related to the associated weather at the site can be forecasted.	S/R
Area	Actual Cloudiness	%	e.g. 15 minutes	The actual/average cloudiness between 0-100 assigned to an area (of type Weather). Usage: Areas will be configured to receive weather information, the sites will be connected to these areas so data related to the associated weather at the site can be forecasted.	S/R
Area	Forecasted Temperature	C	e.g. 15 minutes	The forecasted temperature assigned to an area. Usage as per Actual Temperature description above	S/R
Area	Forecasted Cloudiness	%	e.g. 15 minutes	The forecasted/average cloudiness between 0-100 assigned to an area (of type Weather). Usage: Areas will be configured to receive weather information, the sites will be connected to these areas so data related to the associated weather at the site can be forecasted.	S/R
Area	Spot Price	e.g. Euro/ MWh	Hourly	The price for an Area (market Area)	S/R
Area	Forecasted Spot Price	e.g. Euro/ MWh	hourly	The forecasted price for an Area (market Area)	S/C
	Other (other properties may be added if needed)			Additional time series types may be required	

Table 2 - Types of technical time series based information that can be sent from the external communication System to IIP

3.3 Messaging Data Standards

3.3.1 Units

For the IIP, the following units will be expected for data input and display, no other units will be accepted.

Data Type	Unit	Comment
Energy	kWh	All data that is related to energy should be provided in kWh.
Power	kW	All power based values should be supplied in kW.
Current	A	All Current should be provided in amps.
Temperature	C	Celsius
Cloudiness	%	0-100

Table 3 – Data units supported by the IIP

3.3.2 Message Content

All API Data content type will be application/json.

3.3.2.1 Decimals

All Decimal data will use a period as the decimal separator.

3.3.2.2 Dates

All Dates should be supplied in UTC in the ISO 8601 string format e.g. "2018-02-23T13:55:05.455Z"

3.3.2.3 Enums

For any external facing API, enum values will be represented as strings. As APIs grow, enum values may be added, removed or changed. Using strings as enum values ensures that downstream clients can gracefully handle changes to enum values.

3.3.2.4 Valid from and Valid To Times

These are present on assets and asset connectors and other entity types. They enable the configuration of the system to evolve over time, e.g. models the fact a site may be connected to different flexibility areas over different time periods. As this is not the focus of the pilot use cases, it is recommended to leave all valid from and to dates as null for the pilots.

4 Web API (Hosted in Azure)

4.1 Overview

4.1.1 API Overview

This overview provides the reader with details of the methods that are available in the platform for retrieving and interfacing data.

Api	Method	Description
Asset Management	GetAssetSupportedPropertyList	Given an asset type (default all) and asset sub type (default all) returns a list of supported properties on each asset by its type and sub type. This provides a list of valid properties that can be utilized in the Save Asset & Save Asset List methods and can be returned in the Get Asset methods.
Asset Management	GetAssetSelectionValueList	Given a selection value type returns the valid values for that selection type. This provides a list of valid properties for the supplied selection type. E.g. AssetType property is restricted to the options returned from this method with input parameter of selectionValueType=AssetType.
Asset Management	GetAssetV1	Given an Asset External reference (key of the asset, can supply an external reference or an internal platform key) returns the Asset. The request options supplied will also control which properties and connectors are returned.
Asset Management	GetAssetV1List	Given an Asset list request, with search criteria returns the list of Assets that match the supplied criteria. The request options supplied will also control which properties and connectors are returned.
Asset Management	SaveAssetV1	Given an Asset with the required properties and connectors to save, saves the asset and returns a response message with the details of whether the save was a success, the platform internal key and any error details. The supplied asset includes control arguments to indicate which property classification types are supplied and which connector types are supplied so partial updating of data can be achieved.
Asset Management	SaveAssetV1List	Given an Asset list with the required properties and connectors to save for each asset, saves the assets and returns a list of response message (corresponding to the supplied list of assets). Each response includes details of whether the asset was saved successfully, the platform internal key and any error details. The supplied assets include control arguments to indicate which property classification types are supplied and which connector types are supplied so partial updating of data can be achieved.
Time Series Management	GetTimeSeriesV1	Given a Time Series Request consisting of an Entity External reference (key of the asset/contract/other entity, can supply an external reference or an internal platform key), the required time series returns the time series. The request options supplied will also control the range, and required data level of the data to be returned.
Time Series Management	GetTimeSeriesListForEntityV1	Given a Time Series entity request consisting of an Entity External reference (key of the

Api	Method	Description
		asset/contract/other entity, can supply an external reference or an internal platform key), returns the set of time series associated with the entity. The request options supplied will also control which time series types to return, the range, and required data level of the data to be returned.
Time Series Management	SaveTimeSeriesV1	Given a Time Series consisting of an Entity External reference (key of the asset/contract/other entity, can supply an external reference or an internal platform key), the required properties (including the time series type) and values list to save, saves the supplied time series for the entity and returns a response messages. The response includes details of whether the time series was saved successfully, the platform internal key and any error details.
Time Series Management	SaveTimeSeriesListForEntitiesV1	Given a Time Series list, where each time series consisting of an Entity External reference (key of the asset/contract/other entity, can supply an external reference or an internal platform key), the required properties(including the time series type) and values list to save, saves each of the supplied time series for the entity and returns a list of response messages (corresponding to the supplied list of time series). Each response includes details of whether the time series was saved successfully, the platform internal key and any error details

Table 4 - Methods available in the IIP for retrieving and interfacing data

4.1.2 Entity Cross referencing to External systems

Internal in the IIP, entities will have a unique key (GUID), from an integration perspective the same entity in another platform may have its own unique identifier.

The external facing API will support the maintenance of data by the client of the API providing either the platform key (entity GUID) or by providing a system name, the entity type and its unique identifier.

Internally, the IIP will hold a mapping table between each external system's key and the platform key for each entity.

This cross-referencing system also supports the ability to cross reference entities to common standardized coding schemes e.g. when dealing with country entity one could cross reference a country to its ISO ALPHA-2-Code, ISO ALPHA-3-Code and its ISO NUMERIC code, via this cross-referencing system.

An example is provided below:

Entity	Platform Key (GUID)	Friendly Name	External Name	External Key
Area Site Asset	*3794C7B1-3B18-40B2-829A-FF09AD8948E5*	*Site 123, London Rd,Reading*	*External System 1*	*12344534457*
Area Site Asset	*3794C7B1-3B18-40B2-829A-FF09AD8948E5*	*Site Abcd*	*External System 2*	*Abcd*
Resource Asset	*E117387B-30E8-44A1-8C21-536D995672CD*	*PV @ Site 123*	*External System 1*	*243456886*

The external cross referencing allows data to be passed to/from the platform via the API with the entity keys the external system is familiar with (i.e. the IIP holds cross referencing to the external systems). Alternatively, because on entity creation in the IIP, the platform's entity key is returned to the caller, then the external system can hold references to the IIP entity keys if it prefers.

Ultimately for each pilot, there is a need to agree on the cross-referencing approach.

4.1.3 Security

4.1.3.1 Communication

Communication between the caller/client and this API must be encrypted using the transport layer security protocol (TLS, the successor to Secure Sockets Layer, SSL). Only TLS version 1.1 or higher are supported. Modern tools and programming languages handle this implicitly when using HTTPS. The API uses a wildcard certificate issued for *.esmartapi.com.

4.1.3.2 Authentication

Each request must be authenticated using basic authentication (https://en.wikipedia.org/wiki/Basic_access_authentication). eSmart provides each external party with a distinct pair of GUIDs which is used as username and password. Before the password is stored internally it is salted with a unique salt and encrypted using SHA512.

4.1.3.3 Authorization

Each authenticated request is associated with an internal participant. API calls from a participant will only have access to its own data.

4.1.3.4 Tenant Key

All APIs now include a tenant key, each pilot will use the same published APIs and each pilot will be set up with its own tenant key and each user name is associated to one tenant key. The tenant Key must be provided in the header to each API call. Each tenant has its own data storage repositories so the data between the pilots is totally segregated.

4.2 Asset Management API

This API enables the definition of the master data required for the pilots to be loaded into the platform externally, rather than using the platforms UI.

The API is an external facing restful web API service. It will be a façade to the internal platform services providing a consistent externally facing API for management of asset data.

API	Description
Asset Management	▪ Supports retrieval, creation, amendment and deletion of Assets (Areas, Sites and Resources) ▪ Additional supports the management of connections between assets. For the purpose of the pilots it will be to support connections between Areas and Sites and Sites and Resources.

4.2.1 Common JSON Types & Examples

4.2.1.1 Common JSON Types

The table below defines the common types that are used for retrieving and saving assets. It is useful to define them here as they are utilized in multiple methods.

Description : AssetV1 is utilized as the common data structure for getting and saving assets to the platform, it consists of a reference to the asset, a set of properties and a set of connectors associated to the asset.

AssetV1 {
AssetKey (**ExternalEntityReference**): key of the Asset to be retrieved,
AssetProperties (**AssetProperties**, optional),
AssetConnectors (**AssetConnectors**, optional)
}

Description : ExternalEntityReference is utilized to indicate an entity cross reference between the platform and an external system for a specific entity as described in section “4.1.2 Entity Cross referencing to External systems”
ExternalEntityReference { **SystemIdentifier** (string, optional): System Identifier: name of external system/cross referencing scheme , **ExternalEntityReferenceType** (string): External Entity Reference Type : ['Resource', 'Site', 'Zone', 'Weather'] ,

Key (string, optional): Platform Key, if supplied will be used as preference over the ExternalKey if also supplied , **ExternalKey** (string, optional): External key, if supplied the System Identifier should also be supplied, **FriendlyName** (string, optional): FriendlyName, information only used as a friendly indicator to the entities content e.g. its name, useful in messaging to give context as keys will often be a GUID or non-descriptive. }
Description : AssetProperties, collects together a set of properties for the asset to be retrieved or saved, it supports the possibility to control which property categories are retrieved/saved and contains a list of the specific properties.
AssetProperties { **ListOption** (string, optional): List option: ['PartialList', 'FullList', 'NotSupplied'] , **AssetPropertyClassificationTypeList** (Array[string], optional): Asset Property Classification Type List, list of Property Types included: e.g. subset of ['General', 'Generation', 'Load', 'Charging', 'Storage', 'Monitoring', 'Controllable', 'Installation', 'Communication', 'IoT', 'GeographicalLocation', 'Address'] , **AssetPropertyList** (Array[**AssetProperty**], optional): Asset Property List, the properties to add or change **}**
Description : AssetConnectors, collects together a set of connectors (links between areas, sites and resources) for the asset to be retrieved or saved, it supports the possibility to control which connector types are retrieved/saved and contains a list of the specific connectors.

AssetConnectors {
ListOption (string, optional): List option: ['PartialList', 'FullList', 'NotSupplied'] ,
AssetConnectorTypeList (Array[string], optional): Asset Connector Type List, list of types supplied can include: e.g. subset of ['Site', 'Zone', 'Weather', 'Market'] ,
ReferenceDirectionList (Array[string], optional): Reference Direction List, list of connection directions included in data: e.g subset of ['Parent', 'Child'] ,
AssetConnectorList (Array[**AssetConnector**], optional): Asset Connector List, list of connections to parent of child assets.
}

Description : AssetProperty, represents a specific property on the asset

AssetProperty {
PropertyName (string): the name of the property,
PropertyValue (object): the property value,
PropertyValueType (string, optional): Property Value Type: ['string', 'int', 'dateTime', 'double', 'bool', 'decimal'], not required on save methods, will be set on retrieval methods,
AssetPropertyClassificationType (string, optional): Asset Property Classification Type: ['General', 'Generation', 'Load', 'Charging', 'Storage', 'Monitoring', 'Controllable', 'Installation', 'Communication', 'IoT', 'GeographicalLocation', 'Address'], if not supplied will be derived unless the same property exists in multiple classifications
}

Description : AssetConnector, represents a specific connector on the asset

AssetConnector {
ReferenceDirection (string, optional): Reference direction: ['NotSupplied', 'Parent', 'Child'] ,
ConnectorType (string, optional): Type of the connector: e.g. ['Site', 'Zone', 'Weather', 'Market'], if not supplied will derive ,
AssetReferenceKey (ExternalEntityReference): Key to the Asset being referenced ,
ValidFromTime (string, optional): Gets or sets the valid from time ,
ValidToTime (string, optional): Gets or sets the valid to time ,
EntityStatus (string, optional): Entity status: 'Active', 'Deleted', defaults to Active
}

Description : SaveAssetResponseV1, the response for a save asset operation. The response includes the original AssetKey (ExternalEntityReference) and details of whether it saved ok or any error message. Additionally, the internal key of the saved entity is returned.

SaveAssetResponseV1 {
AssetKey (**ExternalEntityReference**): The external reference key,
Success (boolean): Gets or sets a value indicating whether this entity save is success,
Key (string, optional): internal key of the entity,
ErrorMessage (string, optional): any error message details
}

Table 5 - Common types that are used for retrieving and saving assets

4.2.1.2 Common JSON Examples

Example 1: AssetV1. This example shows an array of 3 assets, an area asset of subtype zone, a site asset with a connection to the area asset and a battery storage resource asset with a connection to the parent site.


```
[
  {
    "AssetKey": {
      "SystemIdentifier": "System xyz",
      "ExternalEntityReferenceType": "Zone",
      "Key": null,
      "ExternalKey": "1",
      "FriendlyName": "Zone 123"
    },
    "AssetProperties": {
      "ListOption": "PartialList",
      "AssetPropertyClassificationTypeList": [
        "General"
      ],
      "AssetPropertyList": [
        {
          "PropertyName": "AssetType",
          "PropertyValue": "Area",
          "PropertyValueType": null,
          "AssetPropertyClassificationType": "General"
        },
        {
          "PropertyName": "AssetSubType",
          "PropertyValue": "Zone",
          "PropertyValueType": null,
          "AssetPropertyClassificationType": "General"
        },
        {
          "PropertyName": "Name",
          "PropertyValue": "Zone 123",
          "PropertyValueType": null,
          "AssetPropertyClassificationType": "General"
        },
        {
          "PropertyName": "ValidFromTime",
          "PropertyValue": "2018-02-23T13:40:32.3868657Z",
          "PropertyValueType": null,
          "AssetPropertyClassificationType": "General"
        }
      ]
    },
    "AssetConnectors": null
  },
  {
    "AssetKey": {
      "SystemIdentifier": "System xyz",
      "ExternalEntityReferenceType": "Site",
      "Key": null,
      "ExternalKey": "2",
      "FriendlyName": "12 Grosvenor Rd"
    },
    "AssetProperties": {
      "ListOption": "PartialList",
      "AssetPropertyClassificationTypeList": [
        "General"
      ],
      "AssetPropertyList": [
        {
          "PropertyName": "AssetType",
          "PropertyValue": "Area",
          "PropertyValueType": null,
          "AssetPropertyClassificationType": "General"
```

```
        },
        {
          "PropertyName": "AssetSubType",
          "PropertyValue": "Site",
          "PropertyValueType": null,
          "AssetPropertyClassificationType": "General"
        },
        {
          "PropertyName": "Name",
          "PropertyValue": "12 Grosvenor Rd",
          "PropertyValueType": null,
          "AssetPropertyClassificationType": "General"
        },
        {
          "PropertyName": "ValidFromTime",
          "PropertyValue": "2018-02-23T13:40:32.3868657Z",
          "PropertyValueType": null,
          "AssetPropertyClassificationType": "General"
        }
      ]
    },
    "AssetConnectors": {
      "ListOption": "PartialList",
      "AssetConnectorTypeList": null,
      "ReferenceDirectionList": [
        "Parent"
      ],
      "AssetConnectorList": [
        {
          "ReferenceDirection": "Parent",
          "ConnectorType": null,
          "AssetReferenceKey": {
            "SystemIdentifier": "System xyz",
            "ExternalEntityReferenceType": "Zone",
            "Key": null,
            "ExternalKey": "1",
            "FriendlyName": "Zone 123"
          },
          "ValidFromTime": "2018-02-23T13:40:32.3868657Z",
          "ValidToTime": null,
          "EntityStatus": null
        }
      ]
    }
  },
  {
    "AssetKey": {
      "SystemIdentifier": "System xyz",
      "ExternalEntityReferenceType": "Resource",
      "Key": null,
      "ExternalKey": "3",
      "FriendlyName": "Battery"
    },
    "AssetProperties": {
      "ListOption": "PartialList",
      "AssetPropertyClassificationTypeList": [
        "General",
        "Storage",
        "Controllable"
      ],
      "AssetPropertyList": [
        {
          "PropertyName": "AssetType",
          "PropertyValue": "Resource",
          "PropertyValueType": null,
          "AssetPropertyClassificationType": "General"
        },
        {
          "PropertyName": "AssetSubType",
          "PropertyValue": "Storage",
          "PropertyValueType": null,
          "AssetPropertyClassificationType": "General"
        },
```

```
        {
          "PropertyName": "Name",
          "PropertyValue": "Battery",
          "PropertyValueType": null,
          "AssetPropertyClassificationType": "General"
        },
        {
          "PropertyName": "StorageType",
          "PropertyValue": "Battery",
          "PropertyValueType": null,
          "AssetPropertyClassificationType": "Storage"
        },
        {
          "PropertyName": "InstalledMaxCapacity",
          "PropertyValue": 10,
          "PropertyValueType": null,
          "AssetPropertyClassificationType": "Storage"
        },
        {
          "PropertyName": "InstalledMinCapacity",
          "PropertyValue": 0,
          "PropertyValueType": null,
          "AssetPropertyClassificationType": "Storage"
        },
        {
          "PropertyName": "IsContollerable",
          "PropertyValue": true,
          "PropertyValueType": null,
          "AssetPropertyClassificationType": "Controllable"
        },
        {
          "PropertyName": "ControllableType",
          "PropertyValue": "OnOff",
          "PropertyValueType": null,
          "AssetPropertyClassificationType": "Controllable"
        },
        {
          "PropertyName": "ValidFromTime",
          "PropertyValue": "2018-02-23T13:40:32.3868657Z",
          "PropertyValueType": null,
          "AssetPropertyClassificationType": "General"
        }
      ]
    },
    "AssetConnectors": {
      "ListOption": "PartialList",
      "AssetConnectorTypeList": null,
      "ReferenceDirectionList": [
        "Parent"
      ],
      "AssetConnectorList": [
        {
          "ReferenceDirection": "Parent",
          "ConnectorType": null,
          "AssetReferenceKey": {
            "SystemIdentifier": "System xyz",
            "ExternalEntityReferenceType": "Site",
            "Key": null,
            "ExternalKey": "2",
            "FriendlyName": "Zone 123"
          },
          "ValidFromTime": "2018-02-23T13:40:32.3868657Z",
          "ValidToTime": null,
          "EntityStatus": null
        }
      ]
    }
  }
]
```

Here is the data in tabular form for ease of reading.

AssetKey	
SystemIdentifier	System xyz
ExternalEntityReferenceType	Zone
Key	
ExternalKey	1
FriendlyName	Zone 123

AssetProperties

ListOption	PartialList
AssetPropertyClassificationTypeList	
General	

AssetPropertyList

PropertyName	PropertyValue	PropertyValueType	AssetPropertyClassificationType
AssetType	Area		General
AssetSubType	Zone		General
Name	Zone 123		General
ValidFromTime	2018-02-23T13:40:32.3868657Z		General

AssetConnectors

ListOption	PartialList
AssetConnectorTypeList	
ReferenceDirectionList	
Parent	

AssetConnectorList

ReferenceDirection	ConnectorType	AssetReferenceKey		ValidFromTime	ValidToTime	EntityStatus
Parent		SystemIdentifier	System xyz	2018-02-23T13:40:32.3868657Z		
		ExternalEntityReferenceType	Zone			
		Key				
		ExternalKey	1			
		FriendlyName	Zone 123			

SystemIdentifier	System xyz
ExternalEntityReferenceType	Site
Key	
ExternalKey	2
FriendlyName	12 Grosvenor Rd

ListOption	PartialList
AssetPropertyClassificationTypeList	
General	

AssetPropertyList

PropertyName	PropertyValue	PropertyValueType	AssetPropertyClassificationType
AssetType	Area		General
AssetSubType	Site		General
Name	12 Grosvenor Rd		General
ValidFromTime	2018-02-23T13:40:32.3868657Z		General

ListOption	PartialList
AssetConnectorTypeList	
ReferenceDirectionList	
Parent	

AssetConnectorList

ReferenceDirection	ConnectorType	AssetReferenceKey		ValidFromTime	ValidToTime	EntityStatus
Parent		SystemIdentifier	System xyz	2018-02-23T13:40:32.3868657Z		
		ExternalEntityReferenceType	Site			
		Key				
		ExternalKey	2			
		FriendlyName	Zone 123			

SystemIdentifier	System xyz
ExternalEntityReferenceType	Resource
Key	
ExternalKey	3
FriendlyName	Battery

ListOption	PartialList
AssetPropertyClassificationTypeList	
General	
Storage	
Controllerable	

AssetPropertyList

PropertyName	PropertyValue	PropertyValueType	AssetPropertyClassificationType
AssetType	Resource		General
AssetSubType	Storage		General
Name	Battery		General
StorageType	Battery		Storage
InstalledMaxCapacity	10		Storage
InstalledMinCapacity	0		Storage
IsContollerable	true		Controllerable
ControllerableType	OnOff		Controllerable
ValidFromTime	2018-02-23T13:40:32.3868657Z		General

ListOption	PartialList
AssetConnectorTypeList	
ReferenceDirectionList	
Parent	

AssetConnectorList

ReferenceDirection	ConnectorType	AssetReferenceKey		ValidFromTime	ValidToTime	EntityStatus
Parent		SystemIdentifier	System xyz	2018-02-23T13:40:32.3868657Z		
		ExternalEntityReferenceType	Site			
		Key				
		ExternalKey	2			
		FriendlyName	Zone 123			

4.2.2 API Method: Get Asset Supported Property List

Given asset type (Default All types) and asset subtype (Default All types) returns a list of supported properties on each asset by its type and sub type. This provides a list of valid properties that can be utilized in the Save Asset & Save Asset List methods.

Method

Method	Request URI	HTTP version
Get	https://{hostname}/api/Asset/GetAssetSupportedPropertyList?assetType={assetType}&assetSubType={assetSubType}	HTTP/1.1

Parameter name	Type	Optional	Description
assetType	Query - string	Y	['All', 'Resource', 'Area'], default is All
assetSubType	Query - string	Y	['All', 'AllResourceTypes', 'AllAreaTypes', 'Generation', 'Load', 'Storage', 'Charging', 'Metering', 'Site', 'Zone', 'Weather', 'Market'], default is All

Returns (body)

Description
[AssetPropertyType] : An Array of AssetPropertyType as defined below
AssetPropertyType { **AssetType** (string): Asset Type: ['All', 'Resource', 'Area'] , **AssetSubType** (string): AssetSubType: ['All', 'AllResourceTypes', 'AllAreaTypes', 'Generation', 'Load', 'Storage', 'Charging', 'Metering', 'Site', 'Zone', 'Weather', 'Market'] , **AssetPropertyClassificationType** (string): Asset Property Classification Type: ['General', 'Generation', 'Load', 'Charging', 'Storage', 'Monitoring', 'Controllable', 'Installation', 'Communication', 'IoT', 'GeographicalLocation', 'Address'], If not supplied will de derived unless the same property exists in multiple classifications , **PropertyName** (string): The name of the property , **PropertyValueType** (string): Property Value Type: ['string', 'int', 'dateTime', 'double', 'bool', 'decimal'] ,

IsMandatory (boolean): indicating whether this instance is mandatory (i.e. applies to Inserts, on updates value will be unchanged if not supplied) ,
Description (string, optional) ,
SelectionValueType (string): Selection Value Type: ['AssetType', 'AssetSubType', 'ResourceType', 'AssetPropertyClassificationType', 'PropertyValueType', 'AssetPropertyTypeOption', 'ConnectorType', 'EntityStatus', 'ExternalEntityReferenceType', 'ListOption', 'ReferenceDirection', 'AssetSiteType', 'AssetMonitoringResourceType', 'AssetMeasurementType', 'AssetControllableType', 'AssetFlexibilityType', 'AssetLoadType', 'AssetGenerationType', 'AssetChargingType', 'AssetStorageType']
}

Example Call

```
GET https://{hostName}/api/Asset/GetAssetSupportedPropertyList?assetType=All&assetSubType=All
```

Example Response

Note: Full list is shown in Table 1 - Asset properties which will be supported on each asset type. The example below is just a small sample.


```
[
  {
    "AssetType": "All",
    "AssetSubType": "All",
    "AssetPropertyClassificationType": "General",
    "PropertyName": "AssetType",
    "PropertyValueType": "string",
    "IsMandatory": true,
    "Description": "Asset Type, valid values for property name from selection list(AssetType :
Resource,Area)",
    "SelectionValueType": "AssetType"
  },
  {
    "AssetType": "All",
    "AssetSubType": "All",
    "AssetPropertyClassificationType": "General",
    "PropertyName": "AssetSubType",
    "PropertyValueType": "string",
    "IsMandatory": true,
    "Description": "Asset Subtype, valid values for property name from selection
list(AssetSubType : Generation,Load,Storage,Charging,Metering,Site,Zone,Weather,Market)",
    "SelectionValueType": "AssetSubType"
  }
]
```


4.2.3 API Method: Get Asset Selection Value List

Given selection value type, the method returns the valid values for that selection type. This provides a list of valid properties for that selection type.

The GetAssetSupportedPropertyList specified in the previous section has a property indicating if the property value should be restricted to a list defined by a selection value type. E.g. AssetType property is restricted to the options returned from this method with input parameter of selectionValueType=AssetType.

Note only options marked as persisted can be used for saving, non-persisted options are sometimes present to facilitate flexible retrieval.

Method

Method	Request URI	HTTP version
Get	https://{hostname}/api/Asset/GetAssetSelectionValueList?selectionValueType={selectionValueType}	HTTP/1.1

Parameter name	Type	Optional	Description
selectionValueType	Query - string	Y	['AssetType', 'AssetSubType', 'ResourceType', 'AssetPropertyClassificationType', 'PropertyValueType', 'AssetPropertyTypeOption', 'ConnectorType', 'EntityStatus', 'ExternalEntityReferenceType', 'ListOption', 'ReferenceDirection', 'AssetSiteType', 'AssetMonitoringResourceType', 'AssetMeasurementType', 'AssetControllableType', 'AssetFlexibilityType', 'AssetLoadType', 'AssetGenerationType', 'AssetChargingType', 'AssetStorageType']

Returns (body)

Description
[SelectionValue] : An Array of SelectionValue as defined below

SelectionValue{
Id (integer),
Name (string): Gets or sets the name. ,
SelectionValueType (string, optional): SelectionValueType : ['AssetType', 'AssetSubType', 'ResourceType', 'AssetPropertyClassificationType', 'PropertyValueType', 'AssetPropertyTypeOption', 'ConnectorType', 'EntityStatus', 'ExternalEntityReferenceType', 'ListOption', 'ReferenceDirection', 'AssetSiteType', 'AssetMonitoringResourceType', 'AssetMeasurementType', 'AssetControllableType', 'AssetFlexibilityType', 'AssetLoadType', 'AssetGenerationType', 'AssetChargingType', 'AssetStorageType'] ,
IsPersistable (boolean, optional)
}

Example Call

```
GET https://{hostname}/api/AssetApi/GetAssetSelectionValueList?selectionValueType=AssetType
```

Example Response

Note: Full list of options is shown in the description column in Table 1 - Asset properties which will be supported on each asset type. The example below is just a small sample.

```
[
  {
    "Id": 0,
    "Name": "All",
    "SelectionValueType": "AssetType",
    "IsPersistable": false
  },
  {
    "Id": 1,
    "Name": "Resource",
    "SelectionValueType": "AssetType",
    "IsPersistable": true
  },
  {
    "Id": 2,
    "Name": "Area",
    "SelectionValueType": "AssetType",
    "IsPersistable": true
  }
]
```

Here is the data in tabular form for ease of reading.

Id	Name	SelectionValueType	IsPersistable
0	All	AssetType	false
1	Resource	AssetType	true
2	Area	AssetType	true

4.2.4 API Method: Get Asset

Given an Asset External reference (key of the asset, can supply an external reference or an internal platform key) the method returns the Asset. The request options supplied will also control which properties and connectors are returned.

Method

Method	Request URI	HTTP version
Post	https://{hostname}/api/Asset/GetAssetV1	HTTP/1.1

Parameter name	Type	Optional	Description

assetRequestV1	Body		**AssetRequestV1** {
			ExternalEntityReference (**ExternalEntityReference**), IncludePropertyClassificationTypes (boolean, optional), **RestrictToAssetPropertyClassificationTypes** (Array[string], optional): Asset Property Classification Type List, list of Proerty Types included: e.g subset of ['General', 'Generation', 'Load', 'Charging', 'Storage', Meter', 'Controllable', 'Installation', 'Communication', 'IoT', 'GeographicalLocation', 'Address'] , **IncludeAssetConnectorTypes** (boolean, optional), **RestrictToAssetConnectorTypes** (Array[string], optional): Restrict To Asset Connector Types: e.g. subset of ['Site', 'Zone', 'Weather', 'Market'] , **RestrictToReferenceDirection** (string, optional): Reference Direction : ['NotSupplied', 'Parent', 'Child']
			}
			
			ExternalEntityReference: See section “4.2.1 Common JSON Types & Examples”

Returns (body)

Description
AssetV1: The Asset with the properties and connectors set as per the settings in the request message. See section “4.2.1 Common JSON Types & Examples” for details of the AssetV1 format

Example Call

```
POST https://{hostname}/api/Asset/Asset/GetAssetV1
```

Example Call body (ExportAssetRequestV1])

```
{
 "externalEntityReference": {
   "SystemIdentifier": "System 123",
   "ExternalEntityReferenceType": "Resource",
   "ExternalKey": "1234567675",
```

```
    "FriendlyName": "Battery"
  },
  "IncludePropertyClassificationTypes": true,
  "RestrictToAssetPropertyClassificationTypes ": [
    "General,Controllable"
  ],
  "IncludeAssetConnectorTypes": true,
  "RestrictToAssetConnectorTypes": [],
  "RestrictToReferenceDirection": "Parent"
}
```


Here is the data in tabular form for ease of reading.

externalEntityReference	
SystemIdentifier	System 123
ExternalEntityReferenceType	Resource
ExternalKey	1234567675
FriendlyName	Battery
IncludePropertyClassificationTypes	true
RestrictToAssetPropertyClassificationTypes	
General,Controllable	
IncludeAssetConnectorTypes	true
RestrictToAssetConnectorTypes	
RestrictToReferenceDirection	Parent

Example Response


```
{
    "assetKey": {
      "systemIdentifier": "System xyz",
      "externalEntityReferenceType": "Resource",
      "externalKey": "1",
      "friendlyName": "Battery"
    },
    "assetPropertyList": [
      {
        "propertyName": "AssetType",
        "propertyValue": "Resource"
      },
      {
        "propertyName": "AssetSubType",
        "propertyValue": "Storage"
      },
      {
        "propertyName": "Name",
        "propertyValue": "Battery"
      },
      {
        "propertyName": "StorageType",
        "propertyValue": "Battery"
      },
      {
        "propertyName": "InstalledMaxCapacity",
        "propertyValue": 10
      },
      {
        "propertyName": "InstalledMinCapacity",
        "propertyValue": 0
      },
      {
        "propertyName": "IsContollable",
        "propertyValue": true
      },
      {
        "propertyName": "ControllableType",
        "propertyValue": "OnOff"
```

```
      },
      {
        "propertyName": "ValidFromTime",
        "propertyValue": "2018-02-07T17:05:11.2480907Z"
      }
    ],
    "assetConnectorList": [
      {
        "referenceDirection": "Parent",
        "assetReferencKey": {
          "systemIdentifier": "System xyz",
          "externalEntityReferenceType": "Site",
          "key": "56ed7f60-363c-4638-b422-24aa6d5169cf",
          "externalKey": "1",
          "friendlyName": "Site 123"
        },
        "validFromTime": "2018-02-07T17:05:11.2490947Z"
      }
    ]
}
```


Here is the data in tabular form for ease of reading.

assetKey	
systemIdentifier	System xyz
externalEntityReferenceType	Resource
externalKey	1
friendlyName	Battery

assetPropertyList	
propertyName	propertyValue
AssetType	Resource
AssetSubType	Storage
Name	Battery
StorageType	Battery
InstalledMaxCapacity	10
InstalledMinCapacity	0
IsContollable	true
ControllableType	OnOff
ValidFromTime	2018-02-07T17:05:11.2480907Z

assetConnectorList			
referenceDirection	assetReferencKey		validFromTime
Parent	systemIdentifier	System xyz	2018-02-07T17:05:11.2490947Z
	externalEntityReferenceType	Site	
	key	56ed7f60-363c-4638-b422-24aa6d5169cf	
	externalKey	1	
	friendlyName	Site 123	

4.2.5 API Method: Get Asset List

Given asset list request, with search criteria, the method returns the list of Assets that match the supplied criteria. The request options supplied will also control which properties and connectors are returned.

Method

Method	Request URI	HTTP version
Post	https://{hostname}/api/Asset/GetAssetV1List	HTTP/1.1

Parameter name	Type	Optional	Description
assetListRequestV1	Body		**AssetListRequestV1** { **AssetType** (string, optional): Asset Type: ['All', 'Resource', 'Area'] ,

Parameter name	Type	Optional	Description
			AssetSubType (string, optional): AssetSubType: ['All', 'AllResourceTypes', 'AllAreaTypes', 'Generation', 'Load', 'Storage', 'Charging', 'Metering', 'Site', 'Zone', 'Weather', 'Market'] , **IncludePropertyClassificationTypes** (boolean, optional): Gets or sets a value indicating whether [include property classification types]. , **RestrictToAssetPropertyClassificationTypes** (Array[string], optional): Asset Property Classification Type List, list of Proerty Types included: e.g subset of ['General', 'Generation', 'Load', 'Charging', 'Storage', 'Monitoring', 'Controllable', 'Installation', 'Communication', 'IoT', 'GeographicalLocation', 'Address'] , IncludeAssetConnectorTypes (boolean, optional): Gets or sets a value indicating whether [include asset connector types]. , **RestrictToAssetConnectorTypes** (Array[string], optional): Restrict To Asset Connector Types: e.g. subset of ['Site', 'Zone', 'Weather', 'Market'] , **RestrictToReferenceDirection** (string, optional): Reference Direction : ['NotSupplied', 'Parent', 'Child'] , **ActiveOnly** (boolean, optional): value indicating whether [active only] , **LiveAtDateTime** (string, optional): live at date time. , **Search** (string, optional): search (of name) }
pageNum	Query - int		The page number (default 1)
pageSize	Query - int		Size of the page (default 10000, minimum 1000).

Returns (body)

Description
[AssetV1]: Array of Assets with the properties and connectors set as per the settings in the request message. See section “4.2.1 Common JSON Types & Examples” for details of the AssetV1 format

Example Call

```
POST https://{hostname}/api/Asset/Asset/GetAssetListV1
```

Example Call body (ExportAssetRequestV1])

```
{
  "AssetType": "Area",
  "AssetSubType": "Site",
  "IncludePropertyClassificationTypes": true,
  "RestictToAssetPropertyClassificationTypes": [
    "General"
  ],
  "IncludeAssetConnectorTypes": true,
  "RestrictToAssetConnectorTypes": [],
  "RestrictToReferenceDirection": "Parent",
  "ActiveOnly": true,
  "LiveAtDateTime": "2018-02-23T13:55:05.455Z",
  "Search": ""
}
```

Here is the data in tabular form for ease of reading.

AssetType	Area
AssetSubType	Site
IncludePropertyClassificationTypes	true
RestictToAssetPropertyClassificationTypes	
General	
IncludeAssetConnectorTypes	true
RestrictToAssetConnectorTypes	
RestrictToReferenceDirection	Parent
ActiveOnly	true
LiveAtDateTime	2018-02-23T13:55:05.455Z
Search	

Example Response

See section “4.2.1.2 Common JSON Examples: Example 1” for details.

4.2.6 API Method: Save Asset

Given an Asset with the required properties and connectors to save, this method saves the asset and returns a response message with the details of whether the save was a success, the platform internal key and any error details. The supplied asset includes control arguments to indicate which property classification types are supplied and which connector types are supplied so partial updating of data can be achieved.

Method

Method	Request URI	HTTP version
Post	https://{hostname}/api/Asset/SaveAssetV1	HTTP/1.1

Parameter name	Type	Optional	Description
assetV1	Body		**AssetV1** See section “4.2.1 Common JSON Types & Examples”
saveType	Query - String		Type of the save: ['Upsert': will update if exists else will insert , 'Insert', 'Update']

Returns (body)

Description
SaveAssetResponseV1 See section “4.2.1 Common JSON Types & Examples” for details of the format

Example Call

```
POST https://{hostname}/api/Asset/Asset/SaveAssetV1
```

Example Call body (AssetV1])


```
{
    "assetKey": {
      "systemIdentifier": "System xyz",
      "externalEntityReferenceType": "Resource",
      "externalKey": "1",
      "friendlyName": "Battery"
    },
    "assetPropertyList": [
      {
        "propertyName": "AssetType",
        "propertyValue": "Resource"
      },
      {
        "propertyName": "AssetSubType",
        "propertyValue": "Storage"
      },
      {
        "propertyName": "Name",
        "propertyValue": "Battery"
      },
      {
        "propertyName": "StorageType",
        "propertyValue": "Battery"
      },
      {
        "propertyName": "InstalledMaxCapacity",
        "propertyValue": 10
      },
      {
        "propertyName": "InstalledMinCapacity",
        "propertyValue": 0
      },
      {
        "propertyName": "IsContollable",
        "propertyValue": true
      },
      {
        "propertyName": "ControllableType",
        "propertyValue": "OnOff"
      },
      {
        "propertyName": "ValidFromTime",
        "propertyValue": "2018-02-07T17:05:11.2480907Z"
      }
    ],
    "assetConnectorList": [
      {
        "referenceDirection": "Parent",
        "assetReferencKey": {
          "systemIdentifier": "System xyz",
          "externalEntityReferenceType": "Site",
          "key": "56ed7f60-363c-4638-b422-24aa6d5169cf",
          "externalKey": "1",
          "friendlyName": "sITE 123"
        },
        "validFromTime": "2018-02-07T17:05:11.2490947Z"
      }
    ]
}
```

Here is the data in tabular form for ease of reading.

assetKey	
systemIdentifier	System xyz
externalEntityReferenceType	Resource
externalKey	1
friendlyName	Battery

assetPropertyList	
propertyName	propertyValue
AssetType	Resource
AssetSubType	Storage
Name	Battery
StorageType	Battery
InstalledMaxCapacity	10
InstalledMinCapacity	0
IsContollable	true
ControllableType	OnOff
ValidFromTime	2018-02-07T17:05:11.2480907Z

assetConnectorList		
referenceDirection	assetReferencKey	validFromTime
Parent	systemIdentifier: System xyz externalEntityReferenceType: Site key: 56ed7f60-363c-4638-b422-24aa6d5169cf externalKey: 1 friendlyName: sITE 123	2018-02-07T17:05:11.2490947Z

Example Response


```
{
    "AssetKey": {
      "SystemIdentifier": "System xyz",
      "ExternalEntityReferenceType": "Resource",
      "ExternalKey": "1",
      "FriendlyName": "Battery"
    },
    "Success": true,
    "Key": "7911910D-ABBE-457C-AE53-B26D1A6EF47B"
}
```


Here is the data in tabular form for ease of reading.

AssetKey	
SystemIdentifier	System xyz
ExternalEntityReferenceType	Resource
ExternalKey	1
FriendlyName	Battery
Success	true
Key	7911910D-ABBE-457C-AE53-B26D1A6EF47B

4.2.7 API Method: Save Asset List

Given an Asset list with the required properties and connectors to save for each asset, the method saves the assets and returns a list of response message (corresponding to the supplied list of assets). Each response includes details of whether the asset was saved successfully, the platform internal key and any error details. The supplied assets include control arguments to indicate which property classification types are supplied and which connector types are supplied so partial updating of data can be achieved.

Method

Method	Request URI	HTTP version
Post	https://{hostname}/api/Asset/SaveAssetListV1	HTTP/1.1

Parameter name	Type	Optional	Description
[assetV1]	Body		Array of **AssetV1** See section "4.2.1 Common JSON Types & Examples" for details of the format
saveType	Query - String		Type of the save: ['Upsert': will update if exists else will insert , 'Insert', 'Update']

Returns (body)

Description
[SaveAssetResponseV1]: array of **SaveAssetResponseV1** See section "4.2.1 Common JSON Types & Examples" for details of the format

Example Call

```
POST https://{hostname}/api/Asset/Asset/SaveAssetListV1
```

Example Call body ([AssetV1])

See section "4.2.1.2 Common JSON Examples: Example 1 : Example 1" for details.

Example Response


```
[
  {
    "AssetKey": {
      "SystemIdentifier": "System xyz",
      "ExternalEntityReferenceType": "Zone",
      "Key": null,
      "ExternalKey": "1",
      "FriendlyName": "Zone 123"
    },
    "Success": true,
    "Key": "0bc96a38-b67a-4637-b5b4-aba0f643f66e",
    "ErrorMessage": null
  },
  {
    "AssetKey": {
      "SystemIdentifier": "System xyz",
      "ExternalEntityReferenceType": "Site",
      "Key": null,
      "ExternalKey": "2",
      "FriendlyName": "12 Grosvenor Rd"
    },
    "Success": true,
    "Key": "1402d633-8e07-4c82-9b41-cb5ded4faba4",
    "ErrorMessage": null
  },
  {
    "AssetKey": {
      "SystemIdentifier": "System xyz",
      "ExternalEntityReferenceType": "Resource",
      "Key": null,
      "ExternalKey": "3",
      "FriendlyName": "Battery"
    },
    "Success": true,
    "Key": "3424a932-e01b-4809-91ee-d9c3f8eaa3ca",
    "ErrorMessage": null
  }
]
```

Here is the data in tabular form for ease of reading.

AssetKey		Success	Key	ErrorMessage
SystemIdentifier	System xyz	true	0bc96a38-b67a-4637-b5b4-aba0f643f66e	
ExternalEntityReferenceType	Zone			
Key				
ExternalKey	1			
FriendlyName	Zone 123			
SystemIdentifier	System xyz	true	1402d633-8e07-4c82-9b41-cb5ded4faba4	
ExternalEntityReferenceType	Site			
Key				
ExternalKey	2			
FriendlyName	12 Grosvenor Rd			
SystemIdentifier	System xyz	true	3424a932-e01b-4809-91ee-d9c3f8eaa3ca	
ExternalEntityReferenceType	Resource			
Key				
ExternalKey	3			
FriendlyName	Battery			

4.3 Time Series management API

This API enables the time series data associated with the assets or other entity types within the pilots to be saved to and retrieved from the platform externally.

The API is an external facing restful web API service. It will be a façade to the internal platform services providing a consistent externally facing API for management of time series data.

API	Description
Time Series Management	Supports retrieval, creation, amendment of Time series Associated to assets such as Areas, Sites and Resources and other entity types.

4.3.1 Common JSON Types & Examples

4.3.1.1 Common JSON Types

The table below introduces some common types that are used for retrieving and saving time series. It is useful to introduce them here as they are utilized in multiple methods.

Description : TimeSeriesV1 is utilized as the common data structure for getting and saving timeseries to the platform, it consists of a reference to the owning entity, the time series type and related properties and a set of TimeSeriesValues associated to the time series.
TimeSeriesV1 { **EntityKey** (ExternalEntityReference) : key of the Entity the time series relates to, **TimeSeriesType** (string): The time series type , **FromDateTime** (string, optional): data from date time , **ToDateTime** (string, optional): Data to date time ,

Unit (string, optional): The unit. , **TimeZone** (string, optional): The time zone: default UTC , **Resolution** (string, optional): Resolution of the time series data: ['None', 'Second', 'Minute', 'FiveMinutes', 'TenMinutes', 'FifteenMinutes', 'HalfHour', 'Hour', 'Frequent', 'Rarely', 'Occasionally', 'Day', 'Week', 'Month', 'Year', 'Quarter'] , **TimeSeriesValueList** (Array[TimeSeriesValue], optional): Time series value list. }
Description : ExternalEntityReference is utilized to indicate an entity cross reference between the platform and an external system for a specific entity as described in section "4.1.2 Entity Cross referencing to External systems". It is the same type as specified in 4.2.1 Common JSON Types & Examples
Description : TimeSeriesValue, represents a specific time series value within a time series

TimeSeriesValue {
ValueTime (string): Date time of the value ,
ValueToTime (string, optional): To Date Time of the Value, generally not set if implicit from resolution ,
Value (number): Gets or sets the value. ,
Status (string, optional): Status: indicates the status of the associated value in terms of a set of defined status categories, such as OK, EstimatedPriority1, EstimatedUncertain, FinallyEstimated, NotUsable, Error
}

Description : SaveTimeSeriesResponseV1, the response for a save time series operation. The response includes the original EntityKey (ExternalEntityReference) and details of whether it saved ok or any error message. Additionally, the internal key of the saved entity is returned.
SaveTimeSeriesResponseV1 { **EntityKey** (ExternalEntityReference): The external reference key, **TimeSeriesType** (string), **Success** (boolean), **Key** (string, optional), **ErrorMessage** (string, optional): The error message.

4.3.1.2 ValueTime Conventions

For TimeSeriesValue.ValueTime where a specific data frequency is set for the time series e.g 15 minutes, the value for the period should be provided based on the period start time, e.g for the last 15 minute reading of a day it would be 23:45.

4.3.1.3 Common JSON Examples

Example 1: TimeSeriesV1. This example shows a time series which is for a Battery Resource asset (indientified by the Time Series Key, cross referencing to the key of the asset in the external system in this case). The data represents the energy level in the Battery at each 15 minute interval.

```
{
    "EntityKey": {
      "SystemIdentifier": "System xyz",
      "ExternalEntityReferenceType": "Resource",
      "ExternalKey": "3",
      "FriendlyName": "Battery"
    },
    "TimeSeriesType": "Energy Level",
    "FromDateTime": "2018-02-22T00:00:00Z",
    "ToDateTime": "2018-02-28T00:00:00Z",
    "Resolution": "FifteenMinutes",
    "TimeSeriesValueList": [
      {
        "ValueTime": "2018-02-22T00:00:00Z",
        "Value": 100.1234
      },
…repeated until…
      {
        "ValueTime": "2018-02-27T23:45:00Z",
        "Value": 120.145234
      }
    ]
  }
```

Here is the data in tabular form for ease of reading.

EntityKey	
SystemIdentifier	System xyz
ExternalEntityReferenceType	Resource
ExternalKey	3
FriendlyName	Battery
TimeSeriesType	Energy Level
FromDateTime	2018-02-22T00:00:00Z
ToDateTime	2018-02-28T00:00:00Z
Resolution	FifteenMinutes
TimeSeriesValueList	
ValueTime	Value
2018-02-22T00:00:00Z	100.1234
2018-02-27T23:45:00Z	120.145234

Note: Only 2 values shown in the table as examples, in the real message there would be one entry for each 15 minute interval.

4.3.2 API Method: Get Time Series

Given a Time series request, with details of the owning entity of the time series, the required time series type and data range of values to be retrieved, this method returns the time series with its associated values over the required date range of the request.

Method

Method	Request URI	HTTP version
Post	https://{hostname}/api/TimeSeries/GetTimeSeriesV1	HTTP/1.1

Parameter name	Type	Optional	Description

timeSeriesRequestV1	Body		**TimeSeriesRequestV1** {
			ExternalEntityReference (ExternalEntityReference),
			TimeSeriesType (string): The time series type to be retrieved ,
			FromDateTime (string): Data from date time. ,
			ToDateTime (string, optional): Data to date time ,
			TimeZone (string, optional): The time zone: all dates should be in UTC, however for resolution Daily and above the time zone should be specified to get the correct day alignment of values ,
			Resolution (string, optional): Resolution of the time series data: ['None', 'Second', 'Minute', 'FiveMinutes', 'TenMinutes', 'FifteenMinutes', 'HalfHour', 'Hour', 'Frequent', 'Rarely', 'Occasionally', 'Day', 'Week', 'Month', 'Year', 'Quarter']
			}
			
			ExternalEntityReference: See section "4.3.1 Common JSON Types & Examples" for details of format

Returns (body)

Description
TimeSeriesV1: The Time series with the values populated based on the requested date range. See section "4.3.1 Common JSON Types & Examples" for details of the TimeSeriesV1 format

Example Call

```
POST https://{hostname}/api/TimeSeries/GetTimeSeriesV1
```

Example Call body (TimeSeriesRequestV1])

```
{
  "externalEntityReference": {
    "SystemIdentifier": "System 123",
    "ExternalEntityReferenceType": "Resource",
    "ExternalKey": "1234567675",
    "FriendlyName": "Battery"
  },
  "TimeSeriesType": "Energy Level",
  "FromDateTime": "2018-02-22T00:00:00Z",
  "ToDateTime": "2018-02-28T00:00:00Z"
}
```

Here is the data in tabular form for ease of reading.

externalEntityReference	
SystemIdentifier	System 123
ExternalEntityReferenceType	Resource
ExternalKey	1234567675
FriendlyName	Battery
TimeSeriesType	Energy Level
FromDateTime	2018-02-22T00:00:00Z
ToDateTime	2018-02-28T00:00:00Z

Example Response

See section “4.3.1 Common JSON Types & Examples : Example 1” for details.

4.3.3 API Method: Get Time Series List For Entity

Given a Time series Entity List request, with details of the owning entity of the time series, the required time series types to return (or All) and data range of values to be retrieved, the method returns the set of time series (based on the required types) with their associated values over the required date range of the request.

Method

Method	Request URI	HTTP version
Post	https://{hostname}/api/TimeSeries/GetTimeSeriesListForEntityV1	HTTP/1.1

Parameter name	Type	Optional	Description

timeSeriesEntityListRequestV1	Body		**TimeSeriesEntityListRequestV1** {
			ExternalEntityReference (ExternalEntityReference),
			RetrieveAllTimeSeriesTypes (boolean, optional),
			TimeSeriesTypeList (Array[string], optional): The list of Time Series types to include in the retrieval, ignored if RetrieveAllTimeSeriesTypes = true, else returns types that match this list ,
			FromDateTime (string): Data from date time. ,
			ToDateTime (string, optional): Data to date time ,
			TimeZone (string, optional): The time zone: all dates should be in UTC, however for resolution Daily and above the time zone should be specified to get the correct day alignment of values ,
			Resolution (string, optional): Resolution of the time series data: ['None', 'Second', 'Minute', 'FiveMinutes', 'TenMinutes', 'FifteenMinutes', 'HalfHour', 'Hour', 'Frequent', 'Rarely', 'Occasionally', 'Day', 'Week', 'Month', 'Year', 'Quarter']
			}
			
			ExternalEntityReference: See section “4.3.1 Common JSON Types & Examples” for details of format

Returns (body)

Description
[TimeSeriesV1]: Array of The Time series (for the supplied entity and based on the supplied time series types to be retrieved) each with the values populated based on the requested date range. See section "4.3.1 Common JSON Types & Examples" for details of the TimeSeriesV1 format

Example Call

```
POST https://{hostname}/api/TimeSeries/GetTimeSeriesListForEntityV1
```

Example Call body (TimeSeriesRequestV1])

```
{
 "ExternalEntityReference": {
   "SystemIdentifier": "System 123",
   "ExternalEntityReferenceType": "Resource",
   "ExternalKey": "1234567675",
   "FriendlyName": "Battery"
 },
 "RetrieveAllTimeSeriesType": false,
 "TimeSeriesTypeList": ["Energy Level","Charging Energy","Discharging Energy"],
 "FromDateTime": "2018-02-22T00:00:00Z",
 "ToDateTime": "2018-02-28T00:00:00Z"
}
```

Here is the data in tabular form for ease of reading.

ExternalEntityReference	
SystemIdentifier	System 123
ExternalEntityReferenceType	Resource
ExternalKey	1234567675
FriendlyName	Battery
RetrieveAllTimeSeriesType	false
TimeSeriesTypeList	
Energy Level	
Charging Energy	
Discharging Energy	
FromDateTime	2018-02-22T00:00:00Z
ToDateTime	2018-02-28T00:00:00Z

Example Response

See section "4.3.1 Common JSON Types & Examples : Example 1" for details. The response will be an array of these items, related to the TimeSeriesTypeList requested (all, or as specified).

4.3.4 API Method: Save Time Series

Given a Time Series with the required properties and values list to save, this method saves the time series (and values) and returns a response message with the details of whether the save was a success, the platform internal key and any error details. If Data already exists for the period of supplied values, then the values are always merged into the existing list.

Method

Method	Request URI	HTTP version
Post	https://{hostname}/api/TimeSeries/SaveTimeSeriesV1	HTTP/1.1

Parameter name	Type	Optional	Description
timeSeriesV1	Body	N	**TimeSeriesV1:** See section "4.3.1 Common JSON Types & Examples" for details of format

Returns (body)

Description
SaveTimeSeriesResponseV1 See section "4.3.1 Common JSON Types & Examples" for details of the format

Example Call

```
POST https://{hostname}/api/TimeSeries/SaveTimeSeriesV1
```

Example Call body (TimeSeriesV1])

See section "4.3.1 Common JSON Types & Examples : Example 1" for details.

Example Response


```
{
    "EntityKey": {
      "SystemIdentifier": "System xyz",
      "ExternalEntityReferenceType": "Resource",
      "ExternalKey": "3",
      "FriendlyName": "Battery"
    },
    "TimeSeriesType": "Energy Level",
    "Success": true,
    "Key": "7911910D-ABBE-457C-AE53-B26D1A6EF47B"
}
```


Here is the data in tabular form for ease of reading.

EntityKey	
SystemIdentifier	System xyz
ExternalEntityReferenceType	Resource
ExternalKey	3
FriendlyName	Battery
TimeSeriesType	Energy Level
Success	true
Key	7911910D-ABBE-457C-AE53-B26D1A6EF47B

4.3.5 API Method: Save Time Series List For Entities

Given a list of Time Series for a set of entities with the required properties and values list to save, saves the list of time series (and values) and returns a list of response message (corresponding to the supplied list of time series). Each response includes details of whether the time series was saved successfully, the platform internal key and any error details. For each time series when saving, if data already exists for the period of supplied values, then the values are always merged into the existing list.

Method

Method	Request URI	HTTP version
Post	https://{hostname}/api/TimeSeries/SaveTimeSeriesListForEntitiesV1	HTTP/1.1

Parameter name	Type	Optional	Description
[timeSeriesV1]	Body	N	Array of **[TimeSeriesV1]:** See section "4.3.1 Common JSON Types & Examples" for details of TimeSeriesV1 format.

Returns (body)

Description
[SaveTimeSeriesResponseV1]: array of **SaveTimeSeriesResponseV1** See section "4.3.1 Common JSON Types & Examples" for details of the format

Example Call

```
POST https://{hostname}/api/TimeSeries/SaveTimeSeriesListForEntitiesV1
```

Example Call body ([TimeSeriesV1])

See section "4.3.1 Common JSON Types & Examples : Example 1" for details of TimeSeriesV1 format (It will be an array of those).

Example Response

```
[
    {
      "EntityKey": {
        "SystemIdentifier": "System xyz",
        "ExternalEntityReferenceType": "Resource",
        "ExternalKey": "3",
        "FriendlyName": "Battery"
      },
      "TimeSeriesType": "Energy Level",
      "Success": true,
      "Key": "7911910D-ABBE-457C-AE53-B26D1A6EF47B"
    },
    {
      "EntityKey": {
        "SystemIdentifier": "System xyz",
        "ExternalEntityReferenceType": "Resource",
        "ExternalKey": "3",
        "FriendlyName": "Battery"
      },
      "TimeSeriesType": "Charging Energy",
      "Success": true,
      "Key": "7911910D-ABBE-457C-AE53-B26D1A6EF47B"
```

```
    },
    {
      "EntityKey": {
        "SystemIdentifier": "System xyz",
        "ExternalEntityReferenceType": "Resource",
        "ExternalKey": "3",
        "FriendlyName": "Battery"
      },
      "TimeSeriesType": "Discharging Energy",
      "Success": false,
      "Key": "7911910D-ABBE-457C-AE53-B26D1A6EF47B",
      "ErrorMessage": "Entity with the supplied key could not be found"
    }
]
```


Here is the data in tabular form for ease of reading.

EntityKey		TimeSeriesType	Success	Key	ErrorMessage
SystemIdentifier	System xyz	Energy Level	true	7911910D-ABBE-457C-AE53-B26D1A6EF47B	
ExternalEntityReferenceType	Resource				
ExternalKey	3				
FriendlyName	Battery				
SystemIdentifier	System xyz	Charging Energy	true	7911910D-ABBE-457C-AE53-B26D1A6EF47B	
ExternalEntityReferenceType	Resource				
ExternalKey	3				
FriendlyName	Battery				
SystemIdentifier	System xyz	Discharging Energy	false	7911910D-ABBE-457C-AE53-B26D1A6EF47B	Entity with the supplied key could not be found
ExternalEntityReferenceType	Resource				
ExternalKey	3				
FriendlyName	Battery				

5 Azure Event Hub

The event hub is the preferred method for retrieving time series data, both event-based and scheduled, when there are either a large number of assets (e.g. 1000 +) and or for retrieving data at a high frequency (<5 minutes). The web API will be used for the first version of the IIP, while Azure Event Hub will be made available for pilots during autumn 2018.

5.1 Availability

The Azure Event Hub API will not be available for the first version of the IIP in June 2018, its planned release date is start of September 2018.

5.2 Azure Event Hubs

Azure Event Hub is the preferred platform communication channel from external systems to the IIP for real time, time series data.

Azure Event Hub is a highly scalable data ingress service that can handle millions of events per second. This enables processing and analysis of massive amounts of data produced by connected devices and applications. Event Hubs acts as the "front door" for an event pipeline, and once data is collected into an event hub, it can be transformed and stored using any real-time analytics provider or batching/storage adapters. Event Hubs decouples the production of a stream of events from the consumption of those events, so that event consumers can access the events on their own schedule.

Event Hubs is a processing service that provides event and telemetry ingress to the cloud at massive scale, with low latency and high reliability. This service is especially useful for:

- Application instrumentation
- User experience or workflow processing
- Internet of Things (IoT) scenarios

5.2.1 Security

An Event Hub is created at the namespace level in Service Bus, similar to queues and topics. Event Hubs uses AMQP or HTTP as its primary API interfaces.

The Event Hubs security model meets the following requirements:

- Only devices that present valid credentials can send data to an Event Hub.

- A device cannot impersonate another device.
- A rogue device can be blocked from sending data to an Event Hub.

The Event Hubs security model is based on a combination of Shared Access Signature (SAS) tokens and event publishers. An event publisher defines a virtual endpoint for an Event Hub. The publisher can only be used to send messages to an Event hub. It is not possible to receive messages from a publisher.

Typically, an Event hub employs one publisher per device. All messages that are sent to any of the publishers of an Event hub are queued within that Event hub. Publishers allow fine-grained access control and throttling.

Each device is assigned a unique token, which is uploaded to the device. The tokens are produced such that each unique token grants access to a different unique publisher. A device that possesses a token can only send to one publisher, but no other publisher. If multiple devices share the same token, then each of these devices share a publisher.

5.3 External System – IIP interface (Azure Event Hub Send Event)

As mentioned above, a dedicated Azure Event Hub can be used for all communications from External systems.

5.3.1 Azure event hub REST API: Request

Method	Request URI	HTTP version
Post	https://{serviceNamespace}.servicebus.windows.net/{eventHubPath}/publishers/{gatewayid}/messages	HTTP/1.1

The *serviceNamespace, eventHubPath* are parameters that are unique for each IIP installation. The IIP environment created for the INVADE project will be configured with the following parameters:

- {serviceNamespace} = “to be confirmed” (to be confirmed, depends on pilots set up)
- {eventHubPath} = "iotexternaleh" (to be confirmed)

The parameter {gatewayId} is a (globally) unique identifier of the sending device that is sending the data. A dedicated *gatewayId* will be created in the IIP for each sending gateway. For each gateway there is a corresponding SAS token, which is used for authentication. For cloud to cloud solutions, the same integration strategy can be adopted, here a virtual Gateway can be configured to support the connection to all Devices (if preferred).

5.3.1.1 Request Headers

Request Header	Description
Authorization	A SAS token.
Content-Type	Set to **application/atom+xml;type=entry;charset=utf-8**

5.3.1.2 Request body

The body of the event message is a JSON formatted message. (no encoding)

5.3.2 Response

The response includes an HTTP status code and a set of response headers.

5.3.2.1 Response Codes

Code	Description
201	Success
401	Authorization failure.
500	Internal error.

5.3.2.2 Response headers

None

5.3.2.3 Response Body

If the request is successful, the body is empty. If the request is not successful, the body contains an error code and error message.

5.3.3 Message Time Series Data

All technical information for a Resource asset (Production, Load, Storage, Charging, Meter) will be sent to the IIP in a periodically manner.

An asset register in IIP must be populated with detailed information about each asset. The IIP asset register will be initialized and maintained either by the External system/or pilot responsible calling the Asset management API to provide details of the assets in the Pilot, or alternatively the data can be provided by supplying the pilot configuration data in the INVADEAssetLoader Excel template (see **Error! Reference source not found.**), and eSmart will facilitate the load this data into the platform.

The technical information (time series data) can be sent to the IIP by posting messages to the Azure Event Hub (described in Azure Event Hub section), alternatively the data can be provided by calling the Web API described in section (4.3 Time Series management API). The exact approach may vary from pilot to pilot. All technical information from the Assets will be stored as time series in the IIP.

The Azure event hub is designed so that it works better when receiving smaller data packages frequently rather than receiving large data packets less frequently. Therefore,

there is one message for each variable when sending values from the external system to the IIP. The message format shall be JSON, and the message is described in a more detailed manner below. The IIP also supports message formats where multiple time series can be provided in a single message. This could be used on a case by case basis if the sending system prefers sending less finely grained data. However, only the preferred message format is specified in this document.

The table in section "3.2 Time series" describes all types of technical information that can be sent from the external communication System to the IIP.

5.3.3.1 Time Series message format

The following describes a JSON message format for sending messages for a resource to the IIP event hub, which is the ingestion point of the IIP IoT service.

Property name	Type	Optional	Description
deviceid	string	N	This id is a unique identifier for the device, See Asset DeviceId property defined in section "3.1.1 Asset Properties"
property	string	N	This uniquely identify the property of the value sent. See section "1.1 **Error! Not a valid result for table.**" for valid values
format	string	Y	
timezone	string	Y	Time zone of the start and end times in the Value object (see below). This is optional, and preferred practice is to include time zone in the time fields. For IIP all data should be transferred in UTC, so this should be left blank or set to UTC.
Unit	string	Y	Unit of value. This is optional. For IIP all data should be transferred in the units specified in section "3.3.1 Units", so this should be left blank or set to the correct string.
values	array	N	This is an array of value objects. The value object is described below. The values array is required and must have at least one value object.

Table 6 - Time Series message format

5.3.3.2 Value object format for time series message format

Property name	Type	Description
starttime	string datetime	Start time of the value. This is normally required, but may be omitted for a device continuously sending instantaneous values. The time is given as an ISO 8601 date time formatted string, including time zone: E.g. "2015-04-30T14:32:52Z" If no time zone is given UTC is assumed.
endtime	string datetime	End time of a value that applies for a duration of time (e.g. metered consumption for an hour, maximum temperature for a day). This is optional and would normally not be included for instantaneous values. The time is given as an ISO 8601 date time formatted string, including time zone: E.g. 2015-04-30T14:32:52Z If no time zone is given UTC is assumed.
value	number	The value. Note that "." is always used as decimal separator for JSON messages. value is an optional field, but either the value or the message field must be present in a Value object.

Table 7 - Value object format for time series message format

5.3.3.3 Time Series Import message schema

The schema for the message is presented below:

```
{
    "$schema": "http://json-schema.org/draft-04/schema#",
    "name": "Sample",
    "type": "object",
    "properties": {
        "deviceid": {
            "type": "string",
            "description": "Device identifier"
        },
        "property": {
            "type": "string",
            "description": "Property identifier"
        },
        "format": {
            "type": "string",
            "description": "Message format including version number"
        },
        "timezone": {
            "type": "string",
            "description": "Time zone for starttime and endttime in values
array"
        },
        "unit": {
            "type": "string",
            "description": "values unit"
        },
        "values": {
            "type": "array",
            "items": {
                "type": "object",
                "properties": {
                    "starttime": {
                        "type": "string",
                        "format": "date-time",
                        "description": "start time of value in time zone of
timezone (or UTC if missing)"
                    },
                    "endtime": {
                        "type": "string",
                        "format": "date-time",
                        "description": "end time of value in time zone of
timezone (or UTC if missing)"
                    },
                    "value": {
                        "type": "number",
                        "description": "value"
                    }
                }
            }
        }
    },
    "required": ["deviceid",
    "values"]
}
```

6 IIP to External Systems

6.1 IIP Platform to External API

The end point needs to be configured for any external endpoint the IIP needs to send data to. Typically, these will be for messages to do with control signals to switch devices on/off or regulate devices based on a plan, or to send messages for the system operator to consume and act on (for example when they have the role of applying the regulation).

6.1.1 API Endpoint Configuration

Registration of the End Point needs to be supplied to the IIP. The details of this need to be agreed with each pilot as they may be specific to the receiving system.

Details such as the End Point address, user & password, need to be configured for each end point. Additionally, within the IIP there is a need to configure which messages that need to be produced and for which assets and or contracts the message is relevant for. More details on this is provided in delivery D8.2 Cloud based flexibility management system: Flexibility Cloud, phase 2.

Additionally, as part of the configuration for the message recipient, one must configure for the message what key to use for an asset. The configuration will support the concept of entity cross referencing detailed in section “4.1.2 Entity Cross referencing to External systems”.

For the IIP version 1, this will be handled as follows:

For each tenant (Invade pilot)

- The end point URL for sending control signals/time series messages as described in the section below will be set, this is to be done by using the security approach as per section “4.1.3 Security”. Additionally, a username and password must be provided that will be held in out configuration settings.

- The external System Name, to use for cross referencing (see section 4.1.2 Entity Cross referencing to External systems) will also be set up as a configuration setting. Note: This should be the same system name used when supplying asset and time series data). If the external system is not using external cross referencing, then it can be left blank. In which case, data with only the IIPs (internal) key populated will be returned.

- All messages produced from the flexibility optimization will be sent as messages. These can be utilized by the receiving system or ignored if not relevant.

6.1.2 Message Time Series Data

The table in section "3.2 Time series" describes all types of technical information that can be sent from the external communication System to/from the IIP.

For the results of the flexibility optimization, the following time series types will be sent out to the external systems end point.

Time series type	Message Type	Comment
ProductionPowerRegulation	ControlRegulationMessage	For controllable generation assets of type continuous control
ProductionOnOffPowerRegulation	ControlOnOffMessage	For controllable generation assets of type on/off control
LoadPowerRegulation	ControlRegulationMessage	For controllable load assets of type continuous control
LoadOnOffPowerRegulation	ControlOnOffMessage	For controllable load assets of type on/off control
ChargingPowerRegulation	ControlRegulationMessage	For controllable EV Chargers or Battery assets of type continuous control
ChargingOnOffPowerRegulation	ControlOnOffMessage	For controllable EV Chargers assets of type continuous control
DischargingPowerRegulation	ControlRegulationMessage	For controllable EV Chargers or Battery assets of type continuous control
DischargingOnOffPowerRegulation	ControlOnOffMessage	For controllable EV Chargers assets of type continuous control
OptimalCapacityRegulation	CapacityRegulation	When we have a Max Capacity Constraint for a site or zone, the optional usage within that constrain is produced

Table 8 – Optimization time series results sent to external systems.

6.1.3 Common JSON Types & Examples

The exact message types to be communicated may vary between pilots. However, any messages that relate to or can be represented as a time series, should be built around this format for all outgoing messages.

6.1.3.1 Common JSON Types

The table below introduces the common types that are used in the messaging

Description : TimeSeriesMessageV1 is utilized as a wrapper to the time series data being sent, it contains a MessageId, Name and Action type, other meta data may be included if needed at a later stage.

TimeSeriesMessageV1 {
MessageId (string): Unique GUID of message,
MessageName (string): The name of the message,
ActionType (string): Action type: ['Set', 'Info','Offer'],
TimeSeries (TimeSeriesV1): The time series and values.
}

Description : TimeSeriesV1 is utilized as the common data structure for getting and saving timeseries to the platform, it consists of a reference to the owning entity, the time series type and related properties and a set of TimeSeriesValues associated to the time series. As described in section "4.3.1 Common JSON Types & Examples"

6.1.4 Asset Control On/Off Message

Will be sent as a result of the Optimization of Flexibility to the configured endpoint.

The message format will be as defined in section "6.1.3 Common JSON Types & Examples: **TimeSeriesMessageV1**"

The message name will be set as "Control On/Off Message", the time series type will be set as "On/Off Setting".

Example Request - For site X, turn the floor heating off (asset Y) from 28/02/18 15:00 to 16:15 (utc)

Here data at 15-minute interval are shown.


```
{
  "MessageId": "11a87780-c1bc-44f4-b2c0-90fb52bebb45",
  "MessageName": "ControlOnOffMessage",
  "ActionType": "Set",
  "TimeSeries": {
    "EntityKey": {
      "SystemIdentifier": "System xyz",
      "ExternalEntityReferenceType": "Resource",
      "Key": "fab564f5-a6b8-4242-8809-9e6ed68885fa",
      "ExternalKey": "3",
      "FriendlyName": "floor Heater"
    },
    "TimeSeriesType": " LoadOnOffPowerRegulation",
    "FromDateTime": "2018-02-28T15:00:00Z",
    "ToDateTime": "2018-02-28T16:15:00Z",
    "Unit": null,
    "TimeZone": null,
    "Resolution": "FifteenMinutes",
    "TimeSeriesValueList": [
      {
        "ValueTime": "2018-02-28T15:00:00Z",
        "ValueToTime": "2018-02-28T15:15:00Z",
        "Value": 0
      },
      {
        "ValueTime": "2018-02-28T15:15:00Z",
        "ValueToTime": "2018-02-28T15:30:00Z",
        "Value": 0
      },
      {
        "ValueTime": "2018-02-28T15:30:00Z",
        "ValueToTime": "2018-02-28T15:45:00Z",
        "Value": 0
```

```
      },
      {
        "ValueTime": "2018-02-28T15:45:00Z",
        "ValueToTime": "2018-02-28T16:00:00Z",
        "Value": 0
      },
      {
        "ValueTime": "2018-02-28T16:00:00Z",
        "ValueToTime": "2018-02-28T16:15:00Z",
        "Value": 0
      }
    ]
  }
}
```


Here is the data in tabular form for ease of reading.

MessageId	11a87780-c1bc-44f4-b2c0-90fb52bebb45	
MessageName	ControlOnOffMessage	
ActionType	Set	
TimeSeries		
EntityKey		
SystemIdentifier	System xyz	
ExternalEntityReferenceType	Resource	
Key	fab564f5-a6b8-4242-8809-9e6ed68885fa	
ExternalKey	3	
FriendlyName	floor Heater	
TimeSeriesType	LoadOnOffPowerRegulation	
FromDateTime	2018-02-28T15:00:00Z	
ToDateTime	2018-02-28T16:15:00Z	
Unit		
TimeZone		
Resolution	FifteenMinutes	
TimeSeriesValueList		
ValueTime	**ValueToTime**	**Value**
2018-02-28T15:00:00Z	2018-02-28T15:15:00Z	0
2018-02-28T15:15:00Z	2018-02-28T15:30:00Z	0
2018-02-28T15:30:00Z	2018-02-28T15:45:00Z	0
2018-02-28T15:45:00Z	2018-02-28T16:00:00Z	0
2018-02-28T16:00:00Z	2018-02-28T16:15:00Z	0

However, this should also be acceptable, where control signal is returned in one value (shown in tabular form only):

MessageId	11a87780-c1bc-44f4-b2c0-90fb52bebb45	
MessageName	ControlOnOffMessage	
ActionType	Set	
TimeSeries		
EntityKey		
SystemIdentifier	System xyz	
ExternalEntityReferenceType	Resource	
Key	fab564f5-a6b8-4242-8809-9e6ed68885fa	
ExternalKey	3	
FriendlyName	floor Heater	
TimeSeriesType	LoadOnOffPowerRegulation	
FromDateTime	2018-02-28T15:00:00Z	
ToDateTime	2018-02-28T16:15:00Z	
Unit		
TimeZone		
Resolution	FifteenMinutes	
TimeSeriesValueList		
ValueTime	ValueToTime	Value
2018-02-28T15:00:00Z	2018-02-28T16:15:00Z	0

6.1.5 Control Regulation Message

Will be sent as a result of the Optimization of Flexibility to the configured endpoint.

The message format will be as defined in section “6.1.3 Common JSON Types & Examples: **TimeSeriesMessageV1**”

The message name will be set as "Control Regulation Message", the time series type will be dependent on the asset time series being controlled, “Power” in the example below.

Example Request - For site X, regulate the space heating from 15:00 to 16:15 to Power Level 20.1, 16:15 to 18:15 to ….at 20.5 kW

Note: Message time series data can be returned either at a specific resolution or as banded values. The examples below show the values with a banded representation.


```
{
  "MessageId": "11a87780-c1bc-44f4-b2c0-90fb52bebb45",
  "MessageName": "ControlRegulationMessage",
  "ActionType": "Set",
  "TimeSeries": {
    "EntityKey": {
      "SystemIdentifier": "System xyz",
      "ExternalEntityReferenceType": "Resource",
      "Key": "fab564f5-a6b8-4242-8809-9e6ed68885fa",
      "ExternalKey": "3",
      "FriendlyName": "Floor Heater"
    },
    "TimeSeriesType": "LoadPowerRegulation",
```

```
    "FromDateTime": "2018-02-28T15:00:00Z",
    "ToDateTime": "2018-02-28T16:15:00Z",
    "TimeZone": null,
    "TimeSeriesValueList": [
      {
        "ValueTime": "2018-02-28T15:00:00Z",
        "ValueToTime": "2018-02-28T16:15:00Z",
        "Value": 20.1
      },
      {
        "ValueTime": "2018-02-28T16:15:00Z",
        "ValueToTime": "2018-02-28T18:15:00Z",
        "Value": 20.5
      }

    ]
  }
}
```


Here is the data in tabular form for ease of reading.

MessageId	11a87780-c1bc-44f4-b2c0-90fb52bebb45	
MessageName	ControlRegulationMessage	
ActionType	Set	
TimeSeries		
EntityKey		
SystemIdentifier	System xyz	
ExternalEntityReferenceType	Resource	
Key	fab564f5-a6b8-4242-8809-9e6ed68885fa	
ExternalKey	3	
FriendlyName	Floor Heater	
TimeSeriesType	LoadPowerRegulation	
FromDateTime	2018-02-28T15:00:00Z	
ToDateTime	2018-02-28T16:15:00Z	
TimeZone		
TimeSeriesValueList		
ValueTime	**ValueToTime**	**Value**
2018-02-28T15:00:00Z	2018-02-28T16:15:00Z	20.1
2018-02-28T16:15:00Z	2018-02-28T18:15:00Z	20.5

Example 2 Request - For site ABCD, regulate the capacity from 15:00 to 16:15 to max power of 10 kW, 16:15 to 18:15 to ….at to max power of 25 kW


```
{
  "MessageId": "11a87780-c1bc-44f4-b2c0-90fb52bebb45",
  "MessageName": "ControlRegulationMessage",
  "ActionType": "Set",
  "TimeSeries": {
    "EntityKey": {
      "SystemIdentifier": "System xyz",
      "ExternalEntityReferenceType": "Site",
      "Key": "fab564f5-a6b8-4242-8809-9e6ed68885fa",
      "ExternalKey": "ABCD",
      "FriendlyName": "ABCD Grosvenor Place"
    },
    "TimeSeriesType": "OptimalCapacityRegulation",
    "FromDateTime": "2018-02-28T15:00:00Z",
    "ToDateTime": "2018-02-28T16:15:00Z",
    "Unit": "kW",
    "TimeSeriesValueList": [
      {
        "ValueTime": "2018-02-28T15:00:00Z",
        "ValueToTime": "2018-02-28T16:15:00Z",
        "Value": 10
```

```
      },
      {
        "ValueTime": "2018-02-28T16:15:00Z",
        "ValueToTime": "2018-02-28T18:15:00Z",
        "Value": 25
      }

    ]
  }
}
```


Here is the data in tabular form for ease of reading.

MessageId	11a87780-c1bc-44f4-b2c0-90fb52bebb45		
MessageName	ControlRegulationMessage		
ActionType	Set		
TimeSeries			
EntityKey			
SystemIdentifier	System xyz		
ExternalEntityReferenceType	Site		
Key	fab564f5-a6b8-4242-8809-9e6ed68885fa		
ExternalKey	ABCD		
FriendlyName	ABCD Grosvenor Place		
TimeSeriesType	OptimalCapacityRegulation		
FromDateTime	2018-02-28T15:00:00Z		
ToDateTime	2018-02-28T16:15:00Z		
Unit	kW		
TimeSeriesValueList			
ValueTime	**ValueToTime**	**Value**	
2018-02-28T15:00:00Z	2018-02-28T16:15:00Z	10	
2018-02-28T16:15:00Z	2018-02-28T18:15:00Z	25	

6.1.6 Create Flexibility Offer Message

Will be sent on schedule or based on an event to the configured endpoint. The message format will be as defined in section “6.1.3 Common JSON Types & Examples: **TimeSeriesMessageV1**”

The message name will be set as "Flexibility Offer Message", the time series type will be dependent on the offer. Generally, it is for “Flexibility Up” or “Flexibility Down”.

Example - The FO, offers Flexibility Up For zone K123 to the DSO, at hourly intervals (note hourly used just so the example content are not too long) for the 28/2/18.


```
{
  "MessageId": "917c5468-5b95-40f5-8cfe-12b6a505910f",
  "MessageName": "FlexibilityOfferMessage",
  "ActionType": "Offer",
  "TimeSeries": {
    "EntityKey": {
      "SystemIdentifier": "System xyz",
      "ExternalEntityReferenceType": "Zone",
      "Key": "bf723cc3-3eff-4f48-bad2-630019c6b912",
      "ExternalKey": "334254665",
      "FriendlyName": "zone K123"
```

```
    },
    "TimeSeriesType": "FlexibilityUp",
    "FromDateTime": "2018-02-28T00:00:00Z",
    "ToDateTime": "2018-03-01T00:00:00Z",
    "Unit": "kW" ,
    "Resolution": "Hour",
    "TimeSeriesValueList": [
      {
        "ValueTime": "2018-02-28T00:00:00Z",
        "ValueToTime": "2018-02-28T01:00:00Z",
        "Value": 10.4
      },
      {
        "ValueTime": "2018-02-28T01:00:00Z",
        "ValueToTime": "2018-02-28T02:00:00Z",
        "Value": 11.4
      },
      {
        "ValueTime": "2018-02-28T02:00:00Z",
        "ValueToTime": "2018-02-28T03:00:00Z",
        "Value": 12.4
      },
      {
        "ValueTime": "2018-02-28T03:00:00Z",
        "ValueToTime": "2018-02-28T04:00:00Z",
        "Value": 13.4
      },
      {
        "ValueTime": "2018-02-28T04:00:00Z",
        "ValueToTime": "2018-02-28T05:00:00Z",
        "Value": 14.4
      },
      {
        "ValueTime": "2018-02-28T05:00:00Z",
        "ValueToTime": "2018-02-28T06:00:00Z",
        "Value": 0
      },
      {
        "ValueTime": "2018-02-28T06:00:00Z",
        "ValueToTime": "2018-02-28T07:00:00Z",
        "Value": 0
      },
      {
        "ValueTime": "2018-02-28T07:00:00Z",
        "ValueToTime": "2018-02-28T08:00:00Z",
        "Value": 0
      },
      {
        "ValueTime": "2018-02-28T08:00:00Z",
        "ValueToTime": "2018-02-28T09:00:00Z",
        "Value": 18.4
      },
      {
        "ValueTime": "2018-02-28T09:00:00Z",
        "ValueToTime": "2018-02-28T10:00:00Z",
        "Value": 19.4
      },
      {
        "ValueTime": "2018-02-28T10:00:00Z",
        "ValueToTime": "2018-02-28T11:00:00Z",
        "Value": 20.4
      },
      {
        "ValueTime": "2018-02-28T11:00:00Z",
        "ValueToTime": "2018-02-28T12:00:00Z",
        "Value": 21.4
      },
      {
        "ValueTime": "2018-02-28T12:00:00Z",
        "ValueToTime": "2018-02-28T13:00:00Z",
        "Value": 22.4
      },
      {
```

```
        "ValueTime": "2018-02-28T13:00:00Z",
        "ValueToTime": "2018-02-28T14:00:00Z",
        "Value": 23.4
      },
      {
        "ValueTime": "2018-02-28T14:00:00Z",
        "ValueToTime": "2018-02-28T15:00:00Z",
        "Value": 24.4
      },
      {
        "ValueTime": "2018-02-28T15:00:00Z",
        "ValueToTime": "2018-02-28T16:00:00Z",
        "Value": 25.4
      },
      {
        "ValueTime": "2018-02-28T16:00:00Z",
        "ValueToTime": "2018-02-28T17:00:00Z",
        "Value": 26.4
      },
      {
        "ValueTime": "2018-02-28T17:00:00Z",
        "ValueToTime": "2018-02-28T18:00:00Z",
        "Value": 27.4
      },
      {
        "ValueTime": "2018-02-28T18:00:00Z",
        "ValueToTime": "2018-02-28T19:00:00Z",
        "Value": 28.4
      },
      {
        "ValueTime": "2018-02-28T19:00:00Z",
        "ValueToTime": "2018-02-28T20:00:00Z",
        "Value": 29.4
      },
      {
        "ValueTime": "2018-02-28T20:00:00Z",
        "ValueToTime": "2018-02-28T21:00:00Z",
        "Value": 30.4
      },
      {
        "ValueTime": "2018-02-28T21:00:00Z",
        "ValueToTime": "2018-02-28T22:00:00Z",
        "Value": 31.4
      },
      {
        "ValueTime": "2018-02-28T22:00:00Z",
        "ValueToTime": "2018-02-28T23:00:00Z",
        "Value": 32.4
      },
      {
        "ValueTime": "2018-02-28T23:00:00Z",
        "ValueToTime": "2018-03-01T00:00:00Z",
        "Value": 33.4
      }
    ]
  }
}
```

Here is the data in tabular form for ease of reading.

MessageId	917c5468-5b95-40f5-8cfe-12b6a505910f	
MessageName	Flexibility Offer Message	
ActionType	Offer	
TimeSeries		
EntityKey		
SystemIdentifier	System xyz	
ExternalEntityReferenceType	Zone	
Key	bf723cc3-3eff-4f48-bad2-630019c6b912	
ExternalKey	334254665	
FriendlyName	zone K123	
TimeSeriesType	Flexibility Up	
FromDateTime	2018-02-28T00:00:00Z	
ToDateTime	2018-03-01T00:00:00Z	
Unit	kW	
Resolution	Hour	
TimeSeriesValueList		
ValueTime	**ValueToTime**	**Value**
2018-02-28T00:00:00Z	2018-02-28T01:00:00Z	10.4
2018-02-28T01:00:00Z	2018-02-28T02:00:00Z	11.4
2018-02-28T02:00:00Z	2018-02-28T03:00:00Z	12.4
2018-02-28T03:00:00Z	2018-02-28T04:00:00Z	13.4
2018-02-28T04:00:00Z	2018-02-28T05:00:00Z	14.4
2018-02-28T05:00:00Z	2018-02-28T06:00:00Z	0
2018-02-28T06:00:00Z	2018-02-28T07:00:00Z	0
2018-02-28T07:00:00Z	2018-02-28T08:00:00Z	0
2018-02-28T08:00:00Z	2018-02-28T09:00:00Z	18.4
2018-02-28T09:00:00Z	2018-02-28T10:00:00Z	19.4
2018-02-28T10:00:00Z	2018-02-28T11:00:00Z	20.4
2018-02-28T11:00:00Z	2018-02-28T12:00:00Z	21.4
2018-02-28T12:00:00Z	2018-02-28T13:00:00Z	22.4
2018-02-28T13:00:00Z	2018-02-28T14:00:00Z	23.4
2018-02-28T14:00:00Z	2018-02-28T15:00:00Z	24.4
2018-02-28T15:00:00Z	2018-02-28T16:00:00Z	25.4
2018-02-28T16:00:00Z	2018-02-28T17:00:00Z	26.4
2018-02-28T17:00:00Z	2018-02-28T18:00:00Z	27.4
2018-02-28T18:00:00Z	2018-02-28T19:00:00Z	28.4
2018-02-28T19:00:00Z	2018-02-28T20:00:00Z	29.4
2018-02-28T20:00:00Z	2018-02-28T21:00:00Z	30.4
2018-02-28T21:00:00Z	2018-02-28T22:00:00Z	31.4
2018-02-28T22:00:00Z	2018-02-28T23:00:00Z	32.4
2018-02-28T23:00:00Z	2018-03-01T00:00:00Z	33.4

7 Communication via OCMP

The new (working) protocol called Open Capacity Management Protocol (OCMP) will be used for the Maximum Capacity, Data & Optimized Capacity messages as part of the pilots in the Netherlands.

In the case of the Dutch pilot these messages are being used:

- The IIP will be having the CMO role (Capacity Management Operator. This is a 3rd party that can be optionally involved to improve charging profiles.)
- Greenflux and Elaad NL will be acting as the CSO role: (Charging Station Operator. Also known as Charge Point Operator) for different use cases. It is the party that operates a network of charging stations and has contracts with EMSPs to allow their customers to use the charging facilities.)

The following table summarizes the messages to be utilized between the IIP (the CMO role) and the pilot responsible (CPO role). See the OCMP 1.0 Open Charge Alliance 2018 specification for details.

Message	Direction	Description
UpdateGroupMaximumCapacityForecast	From CPO to CMO	The UpdateGroupMaximumCapacityForecast message contains a forecast of the maximum capacity of a certain aggregated group which can for example be created based on measurements from a trafo or household energy consumption statistics at a certain moment in time. This message is sent from the DSO to the CSO and from CSO to CMO which should generate an optimal forecast value for the capacity that can be used in this specific group. This optimal forecast should be followed by CSO as a maximum value for the capacity that should be used in the group. The message is based on the principle of time division, so the message contains blocks. There will be one message for a Site or Zone area within the pilot. **Unit for capacity constraint is fixed at Amps.** Frequency will approx. every 15-minutes, but may be sent ad-hoc. Data will be on a rolling 24-hour basis at 15-minute data level for the pilot use cases.
UpdateGroupOptimalCapacityForecast	From CMO to CPO	The UpdateGroupOptimalCapacityForecast message is a more sophisticated capacity forecast that is based on the UpdateGroupMaximumCapacityForecast message enriched with for instance weather forecasts (for PV), type of energy etc. This

Message	Direction	Description
		message is sent from CMO to the CSO which should follow this capacity as a maximum value for the capacity that can be used in this specific group. The message is based on the principle of time division, so the message contains blocks. For each UpdateGroupMaximumCapacityForecast a UpdateGroupOptimalCapacityForecast will be produced at the same level. **Unit for capacity constraint is fixed at Amps.** Data will be on a rolling 24-hour basis at 15-minute data level for the pilot use cases. Will generally be triggered on a schedule or event such as receipt of an UpdateGroupMaximumCapacityForecast or external event such as a new weather forecast.
UpdateDetailedMeteringData	From CPO to CMO	This notification contains various types of meter values and is sent by the CSO to the CMO. The CMO can use this information for composing an optimized profile (which in turn is sent back within an UpdateGroupOptimalCapacityForecast message). There will be one message for each asset at the Site. **Unit for metering data will be accumulated kWh.** Frequency will be on a 15-minute basis for the pilot use cases.
Handshake	From CPO to CMO & From CMO to CPO	Used to pass end point details to the counterpart and to specify heartbeat frequency For the Pilot Heartbeat frequency will be 15 minutes.
Heartbeat	From CPO to CMO & From CMO to CPO	Sent to indicate the endpoint is alive and well, useful to know when messages are not being received to determine if any communication errors.

Table 9 - Messages to be utilized between the IIP (the CMO role) and the pilot responsible (CPO role)

Note: prior to the communication above being initiated the CPO is responsible for configuring the assets into the IIP, see section “3.1 Assets (Areas, Sites & Resources)” for an overview of the required configuration.

If any errors occur processing the messages sent to the IIP, a response is sent with details of the errors as per the agreed standard. A typical error may relate to an assetId not being found in the IIP (in the case of misconfiguration of master data). The response contains a list of errors as some data may be ok whist other data is erroneous.

Communication will be over HTTPS using basic authentication.

Full details of the communication protocol can be found in OCMP-1.0 specification.