*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
DSO	Distribution System Operator
FO	Flexibility Operator
GUID	Global Unique Id; same as Universally Unique Identifier (UUID)
IIP	Integrated INVADE Platform
OCMP	Open Capacity Management Protocol

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.

In its operation, the Flexibility operator is dependent on well-functioning communication between the Integrated INVADE platform to the separate devices at the pilot sites. To enable this, a communication platform API has been developed. By using the API, master data, meter data, external data and control signals can be sent to and from the Integrated INVADE platform, ensuring that necessary information can be exchanged between the platform and the pilot sites.

This deliverable describes the plan for testing the necessary communication between the Integrated INVADE platform and the external pilots. The testing will be conducted by representatives from eSmart Systems and pilot owners.

1 Introduction

This document contains the deliverable D7.4 Communications Test Plan, Test and Test Report. The document describes the testing of the communication platform API, specified in delivery D7.2 Specification of the CP-API. The communication platform API enables the required communication between the Integrated INVADE platform (IIP) and the external pilot systems and devices.

Through the established communication platform API, the pilots are given the opportunity to transfer master data and time series to the IIP. The API also provides methods for sending control signals back to the external systems and devices. Lastly, external weather and price data is imported to the IIP through the API.

The main purpose of this deliverable is to describe the plan for the testing of the necessary communication between the IIP and the external pilot systems. It therefore focuses on test of the IIP's communication platform API. The pilot systems are treated as external systems, i.e. the test does not describe pilot specific functionality. The actual testing will be conducted by eSmart Systems (eSmart) and pilot owners.

The document is structured with separate sections for each pilot. The sections are similar, and the pilot only tests the functionality relevant for the specific pilot. In each section, there are sub sections for testing transferring of master data, meter values, events and external information and, finally, control signals. In each sub section, there are defined specific test steps (actions) and their expected results.

2 Specifications

2.1 Technical terminologies

As this is a document describing the testing of the Communication platform API, several technical terminologies are sited. All of these are defined in previous deliveries of the INVADE project. The relevant ones are:

1. D8.1: Describes the platform's asset management, asset control and data repository
2. D8.2: Describes the business intelligence part of the IIP
3. D7.2: The technical implementation of the Communication platform API

2.2 General timeline requirements

The IIP will run on a 15-minute schedule. Further, the 15 minute interval is divided into 5 minute slots covering the steps below:

1. Collect values, do initial calculations and generate required predictions.
2. Run optimization and generate control signals. Optimization will start on schedule using previous values if the collection and predictions are not finished.
3. Send control signals to pilot system and get acknowledge on these.

Collecting values should not take more than 2 minutes of the first sequence to be able to generate predictions in time for optimization.

3 Lyse pilot

3.1 Import of Master data (Assets)

This section describes the test cases related to the master data and configurations process.

3.1.1 Asset, area and zone management – Through API

3.1.1.1 Purpose

The purpose of this prosses is to import asset data through the API or import the predefine excel template of asset (InvadeAssetLoader.xls) through the API.

3.1.1.2 Assumptions and Pre-Conditions

The asset data that are going to be sent in must be ready at a pre-defined format (Described in D7.2)

3.1.1.3 Test Steps: Configure and send in New Asset to the INVADE platform

	Action	Expected result	Result
1.	Configure the asset in the InvadeAssetLoader.xls template or the pilot configured the asset in their own internal system.	Configuration is successful	
2.	Send configured Assets through the Assets API. Log into Swagger when sending the Assets by using the InvadeAssetLoader.xls template. URL: https://flexplatformapi.esmartapi.com/	Sending is successful	
3.	Login to the INVADE platform	Login is successful	
4.	Open the Asset Screen	Asset Screen is opened	
5.	Click on Search and enter the search name of the assets press enter or refresh	Assets are opened in the grid and imported assets are displayed in the list	

6.	Check that all assets are imported	List is complete accordingly to the pre-define list from step 1	
7.	Double click on an asset	Asset detail screen is open	
8.	Manually check that all properties are in place	Properties are manually correct	
9.	Click on the connectors tab and check if the connectors are correct	Connectors are correct	

3.2 Import of Meter values

This section describes the test cases related to the import of meter values trough APIs.

3.2.1 Receive meter values

3.2.1.1 Purpose

The purpose of this process is to import meter readings from different assets through the web-based time series APIs or through the Azure Event Hub (described in D7.2)

3.2.1.2 Assumptions and Pre-Conditions

The resources and its topology have already been defined in the system.

3.2.1.3 Test Steps

	Action	Expected result	Result
1.	Prepare the time series meter data to be sent to the INVADE platform in the pilot internal system.	Time series meter data are ready to be sent.	
2.	Send the time series data. There are two options for sending time series data:	Sending is successful	

	1. Through the Azure Event Hub using the assigned URL and the shared access signature. 2. Through the web-based time series API		
3.	When the values are imported these calculations/Workers will automatically be run: **Delta Calculation** – Converting Meter Reading to energy **Estimation Calculation** - If Meter Reading is missing the calculation will interpolate between the last value and the new value **Forecast Calculation:** Production time series are pushed to Prediction service. Prediction service returns the forecasted time series for production.	Energy and prediction Time Series are created	
4.	Login to the INVADE platform	Login is successful	
5.	Open the Asset Screen	Asset Screen is opened	
6.	Click on Search and enter the search name of the site. Click on Refresh or press enter.	All Assets matching search criteria are displayed in the grid.	
7.	Select the site asset and click on the Time Series Values icon 	The Time Series Values screen is opened.	
8.	Choose the period, press the plus on one of the resource assets, check off meter reading and Production/consumption and press refresh button.	Values are displayed in the graph and the grid.	

9.	Verify that the data is calculated correctly. Formula: MeterReading t+1 – MeterReading t = Energy per 15 min	Data is correct.	
10.	Verify that the estimation (interpolation) is correct where the Meter Reading was missing. Formula: Interpolate between previous value and last value.	Data is correct	
11.	Repeat from step 5-10 to test more resources.		

3.3 Events and external information

This section describes the test cases related to the events and external information process.

3.3.1 Import weather observations and forecasts

3.3.1.1 Purpose

The purpose of this process is to import weather observations and forecasts.

3.3.1.2 Assumptions and Pre-Conditions

The weather area and its topology have already been defined in the system.

3.3.1.3 Test Steps: Import of weather observations and forecasts

3.3.1.4

	Action	Expected result	Result
1.	Open the Asset Screen in the Client	Asset Screen is opened	
2.	Click on Search and enter pilot name. Click on Refresh or press enter.	All Assets matching search criteria are displayed in the grid.	
3.	Select the weather asset and click on the Time Series Values icon 	The Time Series Values screen is opened.	
4.	Choose the period, press the plus on Weather asset, check off the ActualTemperature and press refresh.	Values are shown in the graph and the grid.	
5.	Login to Energy Quantified. URL: https://app.energyquantified.com	Temperature curve is opened	

	Go the local forecasts page and open the actual temperature curve.		
6.	Compare ActualTemperature curve in the INVADE platform and the curve on Energy Quantified to check that they are identical.	The values stored in the system are the same as the source	
7.	Repeat step 4 and 5 for: - ForecastedTemperature - ActualSolarRadiation - ForecastedSolarRadiation		

3.3.2 Scheduled request for day ahead prices

3.3.2.1 Purpose

The purpose of this process is to import historic day ahead prices and forecasts.

3.3.2.2 Assumptions and Pre-Conditions

The Price Area and its topology have already been defined in the system.

3.3.2.3 Test Steps: Import of day ahead prices

	Action	Expected result	Result
1.	Open the Asset Screen	Asset Screen is opened	
2.	Click on Search and enter asset name . Click on Refresh.	All Assets matching search criteria are displayed in the grid.	
3.	Select the Pilot - PriceArea and click on the Time Series Values icon 	The Time Series Values screen is opened	

4.	Choose the period, press the plus on Pilot – PriceArea, check off the SpotPrice and press refresh.	Values are displayed in the graph and the grid.	
5.	Login to Energy Quantified. URL: https://app.energyquantified.com Go the data search page and open the relevant spot price curve.	Spot price curve is opened	
6.	Compare SpotPrice curve in the INVADE platform and the curve on Energy Quantified to check that they are identical.	The values stored in the system are the same as the source	

3.4 Export of Control Signals

This section describes the test cases related to the export of control signals trough APIs.

3.5 Export Control Signals

3.5.1.1 Purpose

The purpose of this process is to export control signals as Control On/Off Message or as Control Regulation message over eSmart APIs, or as OptimalCapacityForecast over OCMP.

3.5.1.2 Assumptions and Pre-Conditions

The pilot's endpoint is registered in the IIP for receiving control signals.

The IIP is configured, historic values imported and calculated as time series, predictions have been updated and optimization algorithm have produced the required control signals.

3.5.1.3 Test Steps

	Action	Expected result	Result
1.	As soon as optimization has run, all control signals will be exported to customers endpoint and then forward to the external pilot system.	Control signals are received for execution in the external pilot system. (No errors in the system communication log)	
2.	Open the Asset Screen	Asset Screen is opened	
3.	Click on Search and enter the search name of the site. Click on Refresh or press enter.	All Assets matching search criteria are displayed in the grid.	
4.	Select the site asset and click on the Time Series Values icon 	The Time Series Values screen is opened.	

5.	Control that control signals shown in Time Series Value screen are identical to control signals received in the external pilot system.	Control signals are identical.	
6.	Repeat step 6 for all control signal series.		

3.6 BRP/DSO flexibility API

This section describes the test cases related to the Contract Message API for handling of BaseLine, Flexibility and Delivery messages.

3.6.1 Contract Message API

3.6.1.1 Purpose

The purpose of this process is to exchange messages between BRP/DSO and the IIP.

3.6.1.2 Assumptions and Pre-Conditions

The BRP/DSO endpoint is registered in the IIP for exchange of messages between BRP/DSO and the Flexibility Operator.

3.6.1.3 Test Steps

	Action	Expected result	Result
1.	BaselineEnergyNotice – Sent to BRP/DSO endpoint The base line use of energy for an Asset (Area) associated to a Flexibility contract, prior to any BRP or DSO Flexibility request acceptances for that Area and contract). The message details will consist of the Net Energy PTU (Per time unit) forecasted per Area. This is the base	BRP/DSO has received the BaseLineEnergyNotice successfully	

	line that will be used as a basis for flexibility acceptance, in terms of evaluation delivered flexibility.		
2.	FlexibilityRequest – Received from BRP/DSO A Request for Flexibility for an Asset (Area) associated to a Flexibility contract	The BRP/DSO's request for flexibility is successfully received	
3.	FlexibilityOffer – Sent to BRP/DSO An Offer of Flexibility for an Asset (Area), generated from optimization, associated to a Flexibility contract, based on the Flexibility Request.	BRP/DSO has received the FlexibilityOffer successfully	
4.	FlexibilityOfferAcceptance – Received from BRP/DSO An Offer of Flexibility for an Asset (Area) associated to a Flexibility contract, based on receipt of a Flexibility Request.	The acceptance of the complete FlexibilityOffer is received from the BRP/DSO	

4 Greenflux and ElaadNL pilot

4.1 Import of Master data (Assets)

This section describes the test cases related to the master data and configurations process.

4.1.1 Asset, area and zone management – Through API

4.1.1.1 Purpose

The purpose of this prosses is to import asset data through the API or import the InvadeAssetLoader.xls through the API

4.1.1.2 Assumptions and Pre-Conditions

The input-data that are going to be input must be ready at a pre-defined format.

4.1.1.3 Test Steps: New Asset, area and zone

	Action	Expected result	Result
10.	Configure the asset in the InvadeAssetLoader.xls template or in external pilot system.	Configuration is successful	
11.	Send configured Assets through the Assets API. Log into Swagger when sending the Assets by using the InvadeAssetLoader.xls template. URL: https://flexplatformapi.esmartapi.com/	Sending is successful	
12.	Login to the INVADE platform	Login is successful	
13.	Open the Asset Screen	Asset Screen is opened	

14.	Click on Search and enter the search name of the assets press enter or refresh	Assets are opened in the grid and imported assets are displayed in the list	
15.	Manually check that all assets are imported	List is complete	
16.	Double click on an asset	Asset detail screen is open	
17.	Check that all properties are in place	Properties are correct	
18.	Click on the connectors tab and check if the connectors are correct	Connectors are correct	

4.2 Import of Meter values

This section describes the test cases related to the import of meter values trough APIs.

4.2.1 Receive meter values

4.2.1.1 Purpose

The purpose of this process is to import meter readings from different assets through the web-based time series APIs or through the Azure Event Hub.

4.2.1.2 Assumptions and Pre-Conditions

The resources and its topology have already been defined in the system.

4.2.1.3 Test Steps

	Action	Expected result	Result
12.	Prepare the time series data to be sent to the INVADE platform in the external pilot system	Time series data are ready to be sent.	

13.	Send the time series data. There are two options for sending time series data: 1. Through the Azure Event Hub using the assigned URL and the shared access signature. 2. Through the web-based time series API	The data are sent out from pilot internal system.	
14.	When the values are imported these calculations/Workers will automatically be run: **Delta Calculation** – Converting Meter Reading to energy **Estimation Calculation** - If Meter Reading is missing the calculation will interpolate. **Forecast Calculation:** Production time series are pushed to Prediction service. Prediction service returns the forecasted time series for production.	Energy and prediction Time Series are created	
15.	Login to the INVADE platform	Login is successful	
16.	Open the Asset Screen	Asset Screen is opened	
17.	Click on Search and enter the search name of the site. Click on Refresh or press enter.	All Assets matching search criteria are displayed in the grid.	
18.	Select the site asset and click on the Time Series Values icon 	The Time Series Values screen is opened.	

19.	Choose the period, press the plus on one of the resource assets, check off meter reading and Production/consumption and press refresh button.	Values are displayed in the graph and the grid.	
20.	Verify that the data is calculated correctly. Formula: MeterReading t+1 – MeterReading t = Energy per 15 min	Data is correct.	
21.	Verify that the estimation (interpolation) is correct where the Meter Reading was missing. Formula: Interpolate between previous value and last value.	Data is correct	
22.	Repeat from step 5-10 to test more resources.		

4.3 Events and external information

This section describes the test cases related to the events and external information process.

4.3.1 Import weather observations and forecasts

4.3.1.1 Purpose

The purpose of this process is to import weather observations and forecasts.

4.3.1.2 Assumptions and Pre-Conditions

The weather area and its topology have already been defined in the system.

4.3.1.3 Test Steps: Import of weather observations and forecasts

4.3.1.4

	Action	Expected result	Result
8.	Open the Asset Screen	Asset Screen is opened	
9.	Click on Search and enter pilot name. Click on Refresh or press enter.	All Assets matching search criteria are displayed in the grid.	
10.	Select the weather asset and click on the Time Series Values icon 	The Time Series Values screen is opened.	
11.	Choose the period, press the plus on Weather asset, check off the ActualTemperature and press refresh.	Values are shown in the graph and the grid.	
12.	Login to Energy Quantified. URL: https://app.energyquantified.com	Temperature curve is opened	

	Go the local forecasts page and open the actual temperature curve.		
13.	Compare ActualTemperature curve in the INVADE platform and the curve on Energy Quantified to check that they are identical.	The curves are identical.	
14.	Repeat step 4 and 5 for: - ForecastedTemperature - ActualSolarRadiation - ForecastedSolarRadiation		

4.3.2 Scheduled request for day ahead prices

4.3.2.1 Purpose

The purpose of this process is to import historic day ahead prices and forecasts.

4.3.2.2 Assumptions and Pre-Conditions

The Price Area and its topology have already been defined in the system.

4.3.2.3 Test Steps: Import of day ahead prices

	Action	Expected result	Result
7.	Open the Asset Screen	Asset Screen is opened	
8.	Click on Search and enter asset name . Click on Refresh.	All Assets matching search criteria are displayed in the grid.	
9.	Select the Pilot - PriceArea and click on the Time Series Values icon 	The Time Series Values screen is opened	

10.	Choose the period, press the plus on Pilot – PriceArea, check off the SpotPrice and press refresh.	Values are displayed in the graph and the grid.	
11.	Login to Energy Quantified. URL: https://app.energyquantified.com Go the data search page and open the relevant spot price curve.	Spot price curve is opened	
12.	Compare SpotPrice curve in the INVADE platform and the curve on Energy Quantified to check that they are identical.	The curves are identical.	

4.4 Export of Control Signals

This section describes the test cases related to the export of control signals trough APIs.

4.5 Export Control Signals

4.5.1.1 Purpose

The purpose of this process is to export control signals as Control On/Off Message or as Control Regulation message over eSmart APIs, or as OptimalCapacityForecast over OCMP.

4.5.1.2 Assumptions and Pre-Conditions

The pilot's endpoint is registered in the IIP for receiving control signals.

The IIP is configured, historic values imported and calculated as time series, predictions have been updated and optimization algorithm have produced the required control signals.

4.5.1.3 Test Steps

	Action	Expected result	Result
7.	As soon as optimization has run, all control signals will be exported to customers endpoint and then forward to the external pilot system.	Control signals are received for execution in the external pilot system. (No errors in the system communication log)	
8.	Open the Asset Screen	Asset Screen is opened	
9.	Click on Search and enter the search name of the site. Click on Refresh or press enter.	All Assets matching search criteria are displayed in the grid.	
10.	Select the site asset and click on the Time Series Values icon 	The Time Series Values screen is opened.	

11.	Control that control signals shown in Time Series Value screen are identical to control signals received in the external pilot system.	Control signals are identical.	
12.	Repeat step 6 for all control signal series.		

4.6 BRP/DSO flexibility API

This section describes the test cases related to the Contract Message API for handling of BaseLine, Flexibility and Delivery messages.

4.6.1 Contract Message API

4.6.1.1 Purpose

The purpose of this process is to exchange messages between BRP/DSO and the IIP.

4.6.1.2 Assumptions and Pre-Conditions

The BRP/DSO endpoint is registered in the IIP for exchange of messages between BRP/DSO and the Flexibility Operator.

4.6.1.3 Test Steps

	Action	Expected result	Result
5.	BaselineEnergyNotice – Sent to BRP/DSO endpoint The base line use of energy for an Asset (Area) associated to a Flexibility contract, prior to any BRP or DSO Flexibility request acceptances for that Area and contract). The message details will consist of the Net Energy PTU (Per time unit) forecasted per Area. This is the base	BRP/DSO has received the BaseLineEnergyNotice successfully	

	line that will be used as a basis for flexibility acceptance, in terms of evaluation delivered flexibility.		
6.	FlexibilityRequest – Received from BRP/DSO A Request for Flexibility for an Asset (Area) associated to a Flexibility contract	The BRP/DSO's request for flexibility is successfully received	
7.	FlexibilityOffer – Sent to BRP/DSO An Offer of Flexibility for an Asset (Area), generated from optimization, associated to a Flexibility contract, based on the Flexibility Request.	BRP/DSO has received the FlexibilityOffer successfully	
8.	FlexibilityOfferAcceptance – Received from BRP/DSO An Offer of Flexibility for an Asset (Area) associated to a Flexibility contract, based on receipt of a Flexibility Request.	The acceptance of the complete FlexibilityOffer is received from the BRP/DSO	

5 Albena pilot

5.1 Import of Master data (Assets)

This section describes the test cases related to the master data and configurations process.

5.1.1 Asset, area and zone management – Through API

5.1.1.1 Purpose

The purpose of this prosses is to import asset data through the API or import the InvadeAssetLoader.xls through the API

5.1.1.2 Assumptions and Pre-Conditions

The input-data that are going to be input must be ready at a pre-defined format.

5.1.1.3 Test Steps: New Asset, area and zone

	Action	Expected result	Result
19.	Configure the asset in the InvadeAssetLoader.xls template or in external pilot system.	Configuration is successful	
20.	Send configured Assets through the Assets API. Log into Swagger when sending the Assets by using the InvadeAssetLoader.xls template. URL: https://flexplatformapi.esmartapi.com/	Sending is successful	
21.	Login to the INVADE platform	Login is successful	
22.	Open the Asset Screen	Asset Screen is opened	

23.	Click on Search and enter the search name of the assets press enter or refresh	Assets are opened in the grid and imported assets are displayed in the list	
24.	Check that all assets are imported	List is complete	
25.	Double click on an asset	Asset detail screen is open	
26.	Check that all properties are in place	Properties are correct	
27.	Click on the connectors tab and check if the connectors are correct	Connectors are correct	

5.2 Import of Meter values

This section describes the test cases related to the import of meter values trough APIs.

5.2.1 Receive meter values

5.2.1.1 Purpose

The purpose of this process is to import meter readings from different assets through the web-based time series APIs or through the Azure Event Hub.

5.2.1.2 Assumptions and Pre-Conditions

The resources and its topology have already been defined in the system.

5.2.1.3 Test Steps

	Action	Expected result	Result
23.	Prepare the time series data to be sent to the INVADE platform in the external pilot system	Time series data are ready to be sent.	

24.	Send the time series data. There are two options for sending time series data: 3. Through the Azure Event Hub using the assigned URL and the shared access signature. 4. Through the web-based time series API	Sending is successful	
25.	When the values are imported these calculations/Workers will automatically be run: **Delta Calculation** – Converting Meter Reading to energy **Estimation Calculation** - If Meter Reading is missing the calculation will interpolate. **Forecast Calculation:** Production time series are pushed to Prediction service. Prediction service returns the forecasted time series for production.	Energy and prediction Time Series are created	
26.	Login to the INVADE platform	Login is successful	
27.	Open the Asset Screen	Asset Screen is opened	
28.	Click on Search and enter the search name of the site. Click on Refresh or press enter.	All Assets matching search criteria are displayed in the grid.	
29.	Select the site asset and click on the Time Series Values icon 	The Time Series Values screen is opened.	

30.	Choose the period, press the plus on one of the resource assets, check off meter reading and Production/consumption and press refresh button.	Values are displayed in the graph and the grid.	
31.	Verify that the data is calculated correctly. Formula: MeterReading t+1 – MeterReading t = Energy per 15 min	Data is correct.	
32.	Verify that the estimation (interpolation) is correct where the Meter Reading was missing. Formula: Interpolate between previous value and last value.	Data is correct	
33.	Repeat from step 5-10 to test more resources.		

5.3 Events and external information

This section describes the test cases related to the events and external information process.

5.3.1 Import weather observations and forecasts

5.3.1.1 Purpose

The purpose of this process is to import weather observations and forecasts.

5.3.1.2 Assumptions and Pre-Conditions

The weather area and its topology have already been defined in the system.

5.3.1.3 Test Steps: Import of weather observations and forecasts

5.3.1.4

	Action	Expected result	Result
15.	Open the Asset Screen	Asset Screen is opened	
16.	Click on Search and enter pilot name. Click on Refresh or press enter.	All Assets matching search criteria are displayed in the grid.	
17.	Select the weather asset and click on the Time Series Values icon 	The Time Series Values screen is opened.	
18.	Choose the period, press the plus on Weather asset, check off the ActualTemperature and press refresh.	Values are shown in the graph and the grid.	
19.	Login to Energy Quantified. URL: https://app.energyquantified.com	Temperature curve is opened	

	Go the local forecasts page and open the actual temperature curve.		
20.	Compare ActualTemperature curve in the INVADE platform and the curve on Energy Quantified to check that they are identical.	The curves are identical.	
21.	Repeat step 4 and 5 for: - ForecastedTemperature - ActualSolarRadiation - ForecastedSolarRadiation		

5.3.2 Scheduled request for day ahead prices

5.3.2.1 Purpose

The purpose of this process is to import historic day ahead prices and forecasts.

5.3.2.2 Assumptions and Pre-Conditions

The Price Area and its topology have already been defined in the system.

5.3.2.3 Test Steps: Import of day ahead prices

5.3.2.4

	Action	Expected result	Result
13.	Open the Asset Screen	Asset Screen is opened	
14.	Click on Search and enter asset name . Click on Refresh.	All Assets matching search criteria are displayed in the grid.	

15.	Select the Pilot - PriceArea and click on the Time Series Values icon 	The Time Series Values screen is opened	
16.	Choose the period, press the plus on Pilot – PriceArea, check off the SpotPrice and press refresh.	Values are displayed in the graph and the grid.	
17.	Login to Energy Quantified. URL: https://app.energyquantified.com Go the data search page and open the relevant spot price curve.	Spot price curve is opened	
18.	Compare SpotPrice curve in the INVADE platform and the curve on Energy Quantified to check that they are identical.	The curves are identical.	

5.4 Export of Control Signals

This section describes the test cases related to the export of control signals trough APIs.

5.5 Export Control Signals

5.5.1.1 Purpose

The purpose of this process is to export control signals as Control On/Off Message or as Control Regulation message over eSmart APIs, or as OptimalCapacityForecast over OCMP.

5.5.1.2 Assumptions and Pre-Conditions

The pilot's endpoint is registered in the IIP for receiving control signals.

The IIP is configured, historic values imported and calculated as time series, predictions have been updated and optimization algorithm have produced the required control signals.

5.5.1.3 Test Steps

	Action	Expected result	Result
13.	As soon as optimization has run, all control signals will be exported to customers endpoint and then forward to the external pilot system.	Control signals are received for execution in the external pilot system. (No errors in the system communication log)	
14.	Open the Asset Screen	Asset Screen is opened	
15.	Click on Search and enter the search name of the site. Click on Refresh or press enter.	All Assets matching search criteria are displayed in the grid.	
16.	Select the site asset and click on the Time Series Values icon 	The Time Series Values screen is opened.	

17.	Control that control signals shown in Time Series Value screen are identical to control signals received in the external pilot system.	Control signals are identical.	
18.	Repeat step 6 for all control signal series.		

5.6 BRP/DSO flexibility API

This section describes the test cases related to the Contract Message API for handling of BaseLine, Flexibility and Delivery messages.

5.6.1 Contract Message API

5.6.1.1 Purpose

The purpose of this process is to exchange messages between BRP/DSO and the IIP.

5.6.1.2 Assumptions and Pre-Conditions

The BRP/DSO endpoint is registered in the IIP for exchange of messages between BRP/DSO and the Flexibility Operator.

5.6.1.3 Test Steps

	Action	Expected result	Result
9.	BaselineEnergyNotice – Sent to BRP/DSO endpoint The base line use of energy for an Asset (Area) associated to a Flexibility contract, prior to any BRP or DSO Flexibility request acceptances for that Area and contract). The message details will consist of the Net Energy PTU (Per time unit) forecasted per Area. This is the base	BRP/DSO has received the BaseLineEnergyNotice successfully	

	line that will be used as a basis for flexibility acceptance, in terms of evaluation delivered flexibility.		
10.	FlexibilityRequest – Received from BRP/DSO A Request for Flexibility for an Asset (Area) associated to a Flexibility contract	The BRP/DSO's request for flexibility is successfully received	
11.	FlexibilityOffer – Sent to BRP/DSO An Offer of Flexibility for an Asset (Area), generated from optimization, associated to a Flexibility contract, based on the Flexibility Request.	BRP/DSO has received the FlexibilityOffer successfully	
12.	FlexibilityOfferAcceptance – Received from BRP/DSO An Offer of Flexibility for an Asset (Area) associated to a Flexibility contract, based on receipt of a Flexibility Request.	The acceptance of the complete FlexibilityOffer is received from the BRP/DSO	

6 EPESA pilot

6.1 Import of Master data (Assets)

This section describes the test cases related to the master data and configurations process.

6.1.1 Asset, area and zone management – Through API

6.1.1.1 Purpose

The purpose of this prosses is to import asset data through the API or import the InvadeAssetLoader.xls through the API

6.1.1.2 Assumptions and Pre-Conditions

The input-data that are going to be input must be ready at a pre-defined format.

6.1.1.3 Test Steps: New Asset, area and zone

	Action	Expected result	Result
28.	Configure the asset in the InvadeAssetLoader.xls template or in external pilot system.	Configuration is successful	
29.	Send configured Assets through the Assets API. Log into Swagger when sending the Assets by using the InvadeAssetLoader.xls template. URL: https://flexplatformapi.esmartapi.com/	Sending is successful	
30.	Login to the INVADE platform	Login is successful	
31.	Open the Asset Screen	Asset Screen is opened	

32.	Click on Search and enter the search name of the assets press enter or refresh	Assets are opened in the grid and imported assets are displayed in the list	
33.	Check that all assets are imported	List is complete	
34.	Double click on an asset	Asset detail screen is open	
35.	Check that all properties are in place	Properties are correct	
36.	Click on the connectors tab and check if the connectors are correct	Connectors are correct	

6.2 Import of Meter values

This section describes the test cases related to the import of meter values trough APIs.

6.2.1 Receive meter values

6.2.1.1 Purpose

The purpose of this process is to import meter readings from different assets through the web-based time series APIs or through the Azure Event Hub.

6.2.1.2 Assumptions and Pre-Conditions

The resources and its topology have already been defined in the system.

6.2.1.3 Test Steps

	Action	Expected result	Result
34.	Prepare the time series data to be sent to the INVADE platform in the external pilot system	Time series data are ready to be sent.	

35.	Send the time series data. There are two options for sending time series data: 5. Through the Azure Event Hub using the assigned URL and the shared access signature. 6. Through the web-based time series API	Sending is successful	
36.	When the values are imported these calculations/Workers will automatically be run: **Delta Calculation** – Converting Meter Reading to energy **Estimation Calculation** - If Meter Reading is missing the calculation will interpolate. **Forecast Calculation:** Production time series are pushed to Prediction service. Prediction service returns the forecasted time series for production.	Energy and prediction Time Series are created	
37.	Login to the INVADE platform	Login is successful	
38.	Open the Asset Screen	Asset Screen is opened	
39.	Click on Search and enter the search name of the site. Click on Refresh or press enter.	All Assets matching search criteria are displayed in the grid.	
40.	Select the site asset and click on the Time Series Values icon 	The Time Series Values screen is opened.	

41.	Choose the period, press the plus on one of the resource assets, check off meter reading and Production/consumption and press refresh button.	Values are displayed in the graph and the grid.	
42.	Verify that the data is calculated correctly. Formula: MeterReading t+1 – MeterReading t = Energy per 15 min	Data is correct.	
43.	Verify that the estimation (interpolation) is correct where the Meter Reading was missing. Formula: Interpolate between previous value and last value.	Data is correct	
44.	Repeat from step 5-10 to test more resources.		

6.3 Events and external information

This section describes the test cases related to the events and external information process.

6.3.1 Import weather observations and forecasts

6.3.1.1 Purpose

The purpose of this process is to import weather observations and forecasts.

6.3.1.2 Assumptions and Pre-Conditions

The weather area and its topology have already been defined in the system.

6.3.1.3 Test Steps: Import of weather observations and forecasts

6.3.1.4

	Action	Expected result	Result
22.	Open the Asset Screen	Asset Screen is opened	
23.	Click on Search and enter pilot name. Click on Refresh or press enter.	All Assets matching search criteria are displayed in the grid.	
24.	Select the weather asset and click on the Time Series Values icon 	The Time Series Values screen is opened.	
25.	Choose the period, press the plus on Weather asset, check off the ActualTemperature and press refresh.	Values are shown in the graph and the grid.	
26.	Login to Energy Quantified. URL: https://app.energyquantified.com	Temperature curve is opened	

	Go the local forecasts page and open the actual temperature curve.		
27.	Compare ActualTemperature curve in the INVADE platform and the curve on Energy Quantified to check that they are identical.	The curves are identical.	
28.	Repeat step 4 and 5 for: - ForecastedTemperature - ActualSolarRadiation - ForecastedSolarRadiation		

6.3.2 Scheduled request for day ahead prices

6.3.2.1 Purpose

The purpose of this process is to import historic day ahead prices and forecasts.

6.3.2.2 Assumptions and Pre-Conditions

The Price Area and its topology have already been defined in the system.

6.3.2.3 Test Steps: Import of day ahead prices

	Action	Expected result	Result
19.	Open the Asset Screen	Asset Screen is opened	
20.	Click on Search and enter asset name . Click on Refresh.	All Assets matching search criteria are displayed in the grid.	
21.	Select the Pilot - PriceArea and click on the Time Series Values icon 	The Time Series Values screen is opened	

22.	Choose the period, press the plus on Pilot – PriceArea, check off the SpotPrice and press refresh.	Values are displayed in the graph and the grid.	
23.	Login to Energy Quantified. URL: https://app.energyquantified.com Go the data search page and open the relevant spot price curve.	Spot price curve is opened	
24.	Compare SpotPrice curve in the INVADE platform and the curve on Energy Quantified to check that they are identical.	The curves are identical.	

6.4 Export of Control Signals

This section describes the test cases related to the export of control signals trough APIs.

6.5 Export Control Signals

6.5.1.1 Purpose

The purpose of this process is to export control signals as Control On/Off Message or as Control Regulation message over eSmart APIs, or as OptimalCapacityForecast over OCMP.

6.5.1.2 Assumptions and Pre-Conditions

The pilot's endpoint is registered in the IIP for receiving control signals.

The IIP is configured, historic values imported and calculated as time series, predictions have been updated and optimization algorithm have produced the required control signals.

6.5.1.3 Test Steps

	Action	Expected result	Result
19.	As soon as optimization has run, all control signals will be exported to customers endpoint and then forward to the external pilot system.	Control signals are received for execution in the external pilot system. (No errors in the system communication log)	
20.	Open the Asset Screen	Asset Screen is opened	
21.	Click on Search and enter the search name of the site. Click on Refresh or press enter.	All Assets matching search criteria are displayed in the grid.	
22.	Select the site asset and click on the Time Series Values icon 	The Time Series Values screen is opened.	

23.	Control that control signals shown in Time Series Value screen are identical to control signals received in the external pilot system.	Control signals are identical.	
24.	Repeat step 6 for all control signal series.		

6.6 BRP/DSO flexibility API

This section describes the test cases related to the Contract Message API for handling of BaseLine, Flexibility and Delivery messages.

6.6.1 Contract Message API

6.6.1.1 Purpose

The purpose of this process is to exchange messages between BRP/DSO and the IIP.

6.6.1.2 Assumptions and Pre-Conditions

The BRP/DSO endpoint is registered in the IIP for exchange of messages between BRP/DSO and the Flexibility Operator.

6.6.1.3 Test Steps

	Action	Expected result	Result
13.	BaselineEnergyNotice – Sent to BRP/DSO endpoint The base line use of energy for an Asset (Area) associated to a Flexibility contract, prior to any BRP or DSO Flexibility request acceptances for that Area and contract). The message details will consist of the Net Energy PTU (Per time unit) forecasted per Area. This is the base	BRP/DSO has received the BaseLineEnergyNotice successfully	

	line that will be used as a basis for flexibility acceptance, in terms of evaluation delivered flexibility.		
14.	FlexibilityRequest – Received from BRP/DSO A Request for Flexibility for an Asset (Area) associated to a Flexibility contract	The BRP/DSO's request for flexibility is successfully received	
15.	FlexibilityOffer – Sent to BRP/DSO An Offer of Flexibility for an Asset (Area), generated from optimization, associated to a Flexibility contract, based on the Flexibility Request.	BRP/DSO has received the FlexibilityOffer successfully	
16.	FlexibilityOfferAcceptance – Received from BRP/DSO An Offer of Flexibility for an Asset (Area) associated to a Flexibility contract, based on receipt of a Flexibility Request.	The acceptance of the complete FlexibilityOffer is received from the BRP/DSO	

7 Badenova pilot

7.1 Import of Master data (Assets)

This section describes the test cases related to the master data and configurations process.

7.1.1 Asset, area and zone management – Through API

7.1.1.1 Purpose

The purpose of this prosses is to import asset data through the API or import the InvadeAssetLoader.xls through the API

7.1.1.2 Assumptions and Pre-Conditions

The input-data that are going to be input must be ready at a pre-defined format.

7.1.1.3 Test Steps: New Asset, area and zone

	Action	Expected result	Result
37.	Configure the asset in the InvadeAssetLoader.xls template or in external pilot system.	Configuration is successful	
38.	Send configured Assets through the Assets API. Log into Swagger when sending the Assets by using the InvadeAssetLoader.xls template. URL: https://flexplatformapi.esmartapi.com/	Sending is successful	
39.	Login to the INVADE platform	Login is successful	
40.	Open the Asset Screen	Asset Screen is opened	

41.	Click on Search and enter the search name of the assets press enter or refresh	Assets are opened in the grid and imported assets are displayed in the list	
42.	Check that all assets are imported	List is complete	
43.	Double click on an asset	Asset detail screen is open	
44.	Check that all properties are in place	Properties are correct	
45.	Click on the connectors tab and check if the connectors are correct	Connectors are correct	

7.2 Import of Meter values

This section describes the test cases related to the import of meter values trough APIs.

7.2.1 Receive meter values

7.2.1.1 Purpose

The purpose of this process is to import meter readings from different assets through the web-based time series APIs or through the Azure Event Hub.

7.2.1.2 Assumptions and Pre-Conditions

The resources and its topology have already been defined in the system.

7.2.1.3 Test Steps

	Action	Expected result	Result
45.	Prepare the time series data to be sent to the INVADE platform in the external pilot system	Time series data are ready to be sent.	

46.	Send the time series data. There are two options for sending time series data: 7. Through the Azure Event Hub using the assigned URL and the shared access signature. 8. Through the web-based time series API	Sending is successful	
47.	When the values are imported these calculations/Workers will automatically be run: **Delta Calculation** – Converting Meter Reading to energy **Estimation Calculation** - If Meter Reading is missing the calculation will interpolate. **Forecast Calculation:** Production time series are pushed to Prediction service. Prediction service returns the forecasted time series for production.	Energy and prediction Time Series are created	
48.	Login to the INVADE platform	Login is successful	
49.	Open the Asset Screen	Asset Screen is opened	
50.	Click on Search and enter the search name of the site. Click on Refresh or press enter.	All Assets matching search criteria are displayed in the grid.	
51.	Select the site asset and click on the Time Series Values icon 	The Time Series Values screen is opened.	

52.	Choose the period, press the plus on one of the resource assets, check off meter reading and Production/consumption and press refresh button.	Values are displayed in the graph and the grid.	
53.	Verify that the data is calculated correctly. Formula: MeterReading t+1 – MeterReading t = Energy per 15 min	Data is correct.	
54.	Verify that the estimation (interpolation) is correct where the Meter Reading was missing. Formula: Interpolate between previous value and last value.	Data is correct	
55.	Repeat from step 5-10 to test more resources.		

7.3 Events and external information

This section describes the test cases related to the events and external information process.

7.3.1 Import weather observations and forecasts

7.3.1.1 Purpose

The purpose of this process is to import weather observations and forecasts.

7.3.1.2 Assumptions and Pre-Conditions

The weather area and its topology have already been defined in the system.

7.3.1.3 Test Steps: Import of weather observations and forecasts

	Action	Expected result	Result
29.	Open the Asset Screen	Asset Screen is opened	
30.	Click on Search and enter pilot name. Click on Refresh or press enter.	All Assets matching search criteria are displayed in the grid.	
31.	Select the weather asset and click on the Time Series Values icon 	The Time Series Values screen is opened.	
32.	Choose the period, press the plus on Weather asset, check off the ActualTemperature and press refresh.	Values are shown in the graph and the grid.	
33.	Login to Energy Quantified. URL: https://app.energyquantified.com Go the local forecasts page and open the actual temperature curve.	Temperature curve is opened	

34.	Compare ActualTemperature curve in the INVADE platform and the curve on Energy Quantified to check that they are identical.	The curves are identical.	
35.	Repeat step 4 and 5 for: - ForecastedTemperature - ActualSolarRadiation - ForecastedSolarRadiation		

7.3.2 Scheduled request for day ahead prices

7.3.2.1 Purpose

The purpose of this process is to import historic day ahead prices and forecasts.

7.3.2.2 Assumptions and Pre-Conditions

The Price Area and its topology have already been defined in the system.

7.3.2.3 Test Steps: Import of day ahead prices

	Action	Expected result	Result
25.	Open the Asset Screen	Asset Screen is opened	
26.	Click on Search and enter asset name . Click on Refresh.	All Assets matching search criteria are displayed in the grid.	
27.	Select the Pilot - PriceArea and click on the Time Series Values icon 	The Time Series Values screen is opened	

28.	Choose the period, press the plus on Pilot – PriceArea, check off the SpotPrice and press refresh.	Values are displayed in the graph and the grid.	
29.	Login to Energy Quantified. URL: https://app.energyquantified.com Go the data search page and open the relevant spot price curve.	Spot price curve is opened	
30.	Compare SpotPrice curve in the INVADE platform and the curve on Energy Quantified to check that they are identical.	The curves are identical.	

7.4 Export of Control Signals

This section describes the test cases related to the export of control signals trough APIs.

7.5 Export Control Signals

7.5.1.1 Purpose

The purpose of this process is to export control signals as Control On/Off Message or as Control Regulation message over eSmart APIs, or as OptimalCapacityForecast over OCMP.

7.5.1.2 Assumptions and Pre-Conditions

The pilot's endpoint is registered in the IIP for receiving control signals.

The IIP is configured, historic values imported and calculated as time series, predictions have been updated and optimization algorithm have produced the required control signals.

7.5.1.3 Test Steps

	Action	Expected result	Result
25.	As soon as optimization has run, all control signals will be exported to customers endpoint and then forward to the external pilot system.	Control signals are received for execution in the external pilot system. (No errors in the system communication log)	
26.	Open the Asset Screen	Asset Screen is opened	
27.	Click on Search and enter the search name of the site. Click on Refresh or press enter.	All Assets matching search criteria are displayed in the grid.	
28.	Select the site asset and click on the Time Series Values icon 	The Time Series Values screen is opened.	

29.	Control that control signals shown in Time Series Value screen are identical to control signals received in the external pilot system.	Control signals are identical.	
30.	Repeat step 6 for all control signal series.		

7.6 BRP/DSO flexibility API

This section describes the test cases related to the Contract Message API for handling of BaseLine, Flexibility and Delivery messages.

7.6.1 Contract Message API

7.6.1.1 Purpose

The purpose of this process is to exchange messages between BRP/DSO and the IIP.

7.6.1.2 Assumptions and Pre-Conditions

The BRP/DSO endpoint is registered in the IIP for exchange of messages between BRP/DSO and the Flexibility Operator.

7.6.1.3 Test Steps

	Action	Expected result	Result
17.	BaselineEnergyNotice – Sent to BRP/DSO endpoint The base line use of energy for an Asset (Area) associated to a Flexibility contract, prior to any BRP or DSO Flexibility request acceptances for that Area and contract). The message details will consist of the Net Energy PTU (Per time unit) forecasted per Area. This is the base	BRP/DSO has received the BaseLineEnergyNotice successfully	

	line that will be used as a basis for flexibility acceptance, in terms of evaluation delivered flexibility.		
18.	FlexibilityRequest – Received from BRP/DSO A Request for Flexibility for an Asset (Area) associated to a Flexibility contract	The BRP/DSO's request for flexibility is successfully received	
19.	FlexibilityOffer – Sent to BRP/DSO An Offer of Flexibility for an Asset (Area), generated from optimization, associated to a Flexibility contract, based on the Flexibility Request.	BRP/DSO has received the FlexibilityOffer successfully	
20.	FlexibilityOfferAcceptance – Received from BRP/DSO An Offer of Flexibility for an Asset (Area) associated to a Flexibility contract, based on receipt of a Flexibility Request.	The acceptance of the complete FlexibilityOffer is received from the BRP/DSO	