Minimal set of use case KPIs and measurement methods to perform the technical and economic analysis of the resulting definitions

Version 1.0

Deliverable D2.2

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Short Description

This deliverable defines the KPIs and measurement methods of the Interflex project.

Revision history

Version	Date	Modifications' nature	Author
V0.1	24/07/2017	Draft document	ČEZ Distribuce
V0.2	28/07/2017	Additional Avacon information and comments	Avacon
V0.3	02/08/2017	Addition E.ON information and comments	E.ON
V0.4	01/09/2017	Added and applied ČEZd, Enexis, E.ON reviews	ČEZd, Enexis, E.ON
V0.6	20/09/2017	Prepared for finalizing with WPLs	E.ON
V0.7	22/09/2017	Almost ready after call with WPLs	Jan
V0.9	02/10/2017	Addition from Enedis, ready for Content Review	Thomas, Jan
V1.0	13/10/2017	Connection between D2.2, D2.4 and D2.5	Jan

Accessibility

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Owner/Main responsible

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Approver(s): company name(s)

Company	Name(s)
Enedis, Avacon, ČEZ Distribuce, E.ON, Enexis, RWTH	

Work Package ID	WP2	Task ID	Task 2.2

EXECUTIVE SUMMARY

As defined in the Description of Work, the scope of WP2.2 is the Definition of the Key Performance Indicators of the Project, which will allow measuring the success of the Project in relation to its overall technical objectives. The precise measurement methodologies and specificities will be DEMO specific. It should be noted that Interflex Project KPIs are those indicators that are common across at least two different DEMOs.

For this Deliverable, a template was created to define Key Performance Indicators. A similar template is also used in the DEMO specific KPIs. The template has been organized into four main sections:

1. Basic KPI Information - General Project KPI Info (common to different DEMOs)
2. KPI Calculation Methodology – Methodology for calculating KPI (DEMO specific)
3. KPI Data Collection – Data required for calculating indicator (DEMO specific)
4. KPI Baseline – Baseline for calculating KPI (DEMO specific)

Two types of KPIs have been defined; Technical and Social. Regarding the lack of economic KPIs, it was considered that at this stage of KPI definition, it is very difficult to foresee a measurable economic Key Performance Indicator. This will be considered later on if an economic translation of the technical benefits measured in the project future can be proposed, but at this stage of KPI definition, no economic indicator is defined. Furthermore, a reasonable economic indicator would be related to deployment activities where full cost-benefit analysis can be performed, and not only demonstration activities.

The list of Interflex Project KPIs is provided below:

Interflex Project KPI	KPI ID	KPI TYPE	KPI Description
Flexibility	WP2.2_KPI_1	Technical	Flexible power that can be used for balancing specific grid segment.
Hosting capacity	WP2.2_KPI_2		Percentage increase of network hosting capacity for DER.
Islanding	WP2.2_KPI_3		Capacity of the energy system to switch to islanding whilst keeping the power quality requirement.
Customer recruitment	WP2.2_KPI_4	Social	Measure whether demos are managing to recruit enough customer bases in order to attain demo objectives.
Active participation	WP2.2_KPI_5		Reflects how versatile the demos are in leveraging flexibility from different technologies.

TABLE OF CONTENT

LIST OF FIGURES AND TABLES

1. INTRODUCTION

1.1. Scope of the document

The aim of this document is to define a first set of Interflex Project KPIs which are defined as common indicators across different DEMOs. This means that different demonstration projects providing different solutions will use these same indicators to measure specific benefits brought about by tested solutions in the different demonstration projects. The methodology for measuring these indicators will vary from DEMO to DEMO, but the indicator definition could be common to the different demos. The deliverable is divided into chapters by individual indicators and their descriptions.

1.2. Notations, abbreviations and acronyms

The table below provides an overview of the notations, abbreviations and acronyms used in the document.

DER	Distributed Energy Resources
DSO	Distribution System Operator
ESCO	Energy Service Company
EC	European Commission
EC-GA	European Commission Grant Agreement
EU	European Union
EV	Electric Vehicle
GA	General Assembly
WP	General Work Package
KPI	Key Performance Indicator
PC	Project Coordinator
SC	Steering Committee
TC	Technical Committee
TD	Technical Director
WP	Work Package
WPL	Work Package Leader

Figure 1 List of acronyms

2. SUMMARY LIST OF INTERFLEX PROJECT KPIS

The five proposed KPIs are detailed below. Three indicators will monitor technical aspects of the DEMOs, while two will be "softer" indicators, measuring social aspects of the different DEMOs.

2.1. KPI description summary list

Interflex Project KPI	KPI ID	KPI TYPE	KPI Description
Flexibility	WP2.2_KPI_1	Technical	Flexible power that can be used for balancing specific grid segment.
Hosting capacity	WP2.2_KPI_2		Percentage increase of network hosting capacity for DER.
Islanding	WP2.2_KPI_3		Capacity of the energy system to switch to islanding whilst keeping the power quality requirement.
Customer recruitment	WP2.2_KPI_4	Social	Measure whether demos are managing to recruit enough customer bases in order to attain demo objectives.
Active participation	WP2.2_KPI_5		Reflects how versatile the demos are in leveraging flexibility from different technologies.

Figure 2 Interflex project KPIs summary table

2.2. KPI formulas summary list

See below further details of measurement methodology of the different KPIs.

Project KPI	KPI Definition and formula
Flexibility WP2.2_KPI_1	$$\text{Flexibility}_{\%} = \frac{\sum P_{Available\ flexibility}}{\sum P_{Total\ in\ area}} * 100$$ $\text{Flexibility}_{\%}$ — Percentage of flexible power used available in reporting period. $P_{Available\ flexibility}$ — Power in MW of available flexibility in reporting period. $P_{Total\ in\ area}$ — Total power in MW used in DEMO grid segment.
Hosting capacity WP2.2_KPI_2	$$HC_{\%} = \frac{HC_{SG} - HC_{Baseline}}{HC_{Baseline}} \times 100$$ HC_{SG} — Hosting Capacity for DER with Smart Grid solutions (kW). This hosting capacity should measure DER that can be connected to the grid after the Smart Grid solution is implemented. $HC_{Baseline}$ — Hosting Capacity for DER in Baseline situation (kW). This hosting capacity should measure DER that can be connected to the grid before the Smart Grid solution is implemented.
Islanding WP2.2_KPI_3	$$I_{capacity} = \frac{\sum D_{isl}}{\sum D_{req}} \times 100$$ Where: $I_{capacity}$: the capacity of demo's islanding to last as long as required. D_{isl} : the duration of a single islanding. D_{req} : the required duration of an islanding, after an intentional or unintentional disconnection from the grid.
Customer recruitment WP2.2_KPI_4	$$CR_{\%} = \frac{CR_{successful}}{CR_{required}} \times 100$$ $CR_{\%}$ — Percentage of required customer base that use case was able to recruit. $CR_{successful}$ — Number of customers (installed capacity, energy volume) actually recruited. $CR_{required}$ — Number of customers (installed capacity, energy volume) needed to obtain enough flexibility in demo in order to verify use cases.

Active participation WP2.2_KPI_5	$$\text{Participation}_{\%} = \frac{N_{leverage\ technology}}{\text{N}_{target\ technology}} * 100$$ $\text{Participation}_{\%}$ Percentage of technologies leveraged $N_{leverage\ technology}$ number of different technologies leveraged in DEMO $\text{N}_{target\ technology}$ number of types of technologies initially targeted in DEMO

Figure 3 Table of KPI formulas

2.3. Collecting KPI data and connection with Tasks 2.4 and 2.5

Deliverable 2.2 describes project KPIs. Task 2.4 will define database structure according to KPI definitions. Depending on the reporting period of every KPI, WPL will send the data and calculated KPIs to Enedis (Task 2.4 including Clearing House). Evaluation of WP and project KPIs will be included in Task 2.5 (ČEZ Distribuce).

2.4. KPI relationship to each DEMO

Related to the DEMOs for which these KPIs apply, this is detailed in the figure below:

Project KPI	Germany Avacon	Czech Rep. ČEZd	Netherlands Enexis	Sweden E.ON	France Enedis
Flexibility WP2.2_KPI_1	✓	✓	✓	✓	✓
Hosting capacity WP2.2_KPI_2	✓	✓		✓	
Islanding WP2.2_KPI_3				✓	✓
Customer recruitment WP2.2_KPI_4	✓			✓	✓
Active participation WP2.2_KPI_5	✓			✓	✓

Figure 4 Mapping Interflex Project KPIs applicable to each DEMO

3. RELATIONSHIP WITH INTERFLEX USE CASES

The table below summarizes the close relationship with the Interflex Use Cases and the defined Project Key Performance Indicators.

Project KPI	DE			CZ				NL			SE					FR		
	UC1	UC2	UC3	UC1	UC2	UC3	UC4	UC1	UC2	UC3	UC1	UC2	UC3	UC4	UC5	UC1	UC2	UC3
	Feed In Management	Demand Side Management	Ancillary Services	Increase DER hosting capacity of LV distribution networks by smart PV inverters	Increase DER hosting capacity in MV networks by volt-var control	Smart EV charging	Smart energy storage	Improve grid flexibility	Improve grid flexibility	Usability of an integrated flex market	Use of DSR to optimize DSO operation by exploiting the interaction with different energy carriers	Use of an industrial Heat Pump to optimize DSO operation by exploiting the interaction with different energy	Technical management of a grid-connected Local Energy System that can run in an islanded mode with 100%	Micro Grid Customer Flexibility facilitated by a peer to peer market platform and enabled by Demand Side	Increased ability to observe and steer the operations of a micro-grid in response to distribution network	Automatic Islanding	Multiservice approach for centralized storage systems	Local flexibility mechanism
Flexibility WP2.2_KPI_1	✓	✓	✓			✓	✓			✓	✓	✓	✓					✓
Hosting capacity WP2.2_KPI_2	✓	✓	✓	✓	✓		✓				✓	✓	✓		✓			
Islanding WP2.2_KPI_3													✓			✓		
Customer recruitment WP2.2_KPI_4	✓	✓	✓								✓		✓	✓				✓
Active participation WP2.2_KPI_5			✓								✓		✓	✓				✓

Figure 5 Matrix Interflex Project KPI addressing Use Cases

4. INTERFLEX PROJECT KPIS IN DETAIL

This chapter describes in detail the list of proposed Interflex Project KPIs, with the detailed measurement methodologies and precise formulas applicable to each KPI. As described in Chapter 1, these are indicators that are common to different DEMOs, even though the specifics, measurement methodologies, baseline conditions, and precise data required collecting will be strictly related to the tested solutions, and will therefore vary from DEMO to DEMO.

4.1. Technical KPIs

4.1.1. Flexibility

BASIC KPI INFORMATION					
KPI Name	Flexibility			**KPI ID**	WP2.2_KPI_1
Strategic Objective	Flexible power that can be used for balancing specific grid segment.				
DEMO where KPI applies	GERMANY ☑	CZECH REP ☑	NETHERLANDS ☑	SWEDEN ☑	FRANCE ☑
Owner	Germany – Thorsten Gross (Avacon) Czech Republic – Stanislav Hes (ČEZ Distribuce) Netherlands - Marcel Willems (Enexis) Sweden – Anna Eriksmo, Luis Hernandez (E.ON) France – Thomas Drizard (Enedis)				
KPI Description	The available power flexibility in a defined period (eg. per day) that can be allocated by the DSO at a specific grid segment. Measured in MW. This in relation with the total amount of power in the specific grid segment in the same period.				
KPI Formula	$\text{Flexibility}_{\%} = \frac{\sum P_{Available\ flexibility}}{\sum P_{Total\ in\ area}} * 100$ $\text{Flexibility}_{\%}$ - percentage of flexible power used available in reporting period $P_{Available\ flexibility}$ - power in MW of available flexibility in reporting period $P_{Total\ in\ area}$ - total power in MW used in DEMO grid segment				
Unit of measurement	% of flexible power				
Expectations	Germany - >0 Czech – Flexibility in case of emergency situations (WP6_3: 40%, WP6_4: 20%) Netherlands - Amount of power that can be used in case of congestion problems on the LV network Sweden - Flexibility from responsive technology (WP8_1: 10%, WP8_2: 20%, WP8_3*: 10%) France – UC3 5%				
Reporting Period	Germany - At the end of each use case demonstration Czech Republic - At the end of each use case demonstration Netherlands - Once a month Sweden - At the end of each use case demonstration France - At the end of each use case demonstration				
Relevant Standards	None				
Connection / Link with other relevant defined KPIs	Sweden - Same as WP8_KPI_N8_DSR Potential				
Reporting Audience and Access Rights	PUBLIC ☑	INTERFLEX PARTNERS ☑	DEMO PARTNERS ☑	OTHER (please specify) ☐	
OTHER (please specify)					

KPI CALCULATION METHODOLOGY		
DEMO Germany		
KPI Step Methodology ID [KPI ID #]	**Step**	**Responsible**
WP2.2_KPI_1_AVA_1 a	Determine rated, maximum and average feed in power that is available for Use Case demonstration in Use Case 1	Avacon
WP2.2_KPI_1_AVA_1 b	Determine total rated, maximum and average feed in power during Use Case 1 period	Avacon
WP2.2_KPI_1_AVA_2 a	Determine rated, maximum and average demand power that is available for Use Case demonstration in Use Case 2	Avacon
WP2.2_KPI_1_AVA_2 b	Determine total rated, maximum and average demand power during Use Case 2 period	Avacon
WP2.2_KPI_1_AVA_3 a	Determine rated, maximum and average demand and feed in power that is available for Use Case demonstration in Use Case 3	Avacon
WP2.2_KPI_1_AVA_3 b	Determine total rated, maximum and average demand and feed in power during Use Case 3 period	Avacon
DEMO Czech Republic		
KPI Step Methodology ID [KPI ID #]	**Step**	**Responsible**
WP2.2_KPI_1_CEZd_ 1a	Evaluation of EV charging station power will be checked from the device specification (manufactures datasheet).	ČEZd
WP2.2_KPI_1_CEZd_ 2a	After smart solution implementation - evaluation of EV charging station charging power curtailment in case of under frequency or in case of under voltage or in case of DSO command will be evaluated by field tests.	ČEZd
WP2.2_KPI_1_CEZd_ 1b	Evaluation of PV production peak will be checked from the PV systems specifications (sum of PV modules power under Standard Test Conditions).	ČEZd
WP2.2_KPI_1_CEZd_ 2b	After smart solution implementation (smart charging of home energy storage) - evaluation of PV production peak will be secured by field measurements for PV systems.	ČEZd
DEMO Netherlands		
KPI Step Methodology ID [KPI ID #]	**Step**	**Responsible**
WP2.2_KPI_1_Enexis _1	Inventory of available resources in the grid segment in a specific period	Aggregator
WP2.2_KPI_1_Enexis _2	Inventory of available power the resources can deliver in the grid segment in a specific period	Aggregator
WP2.2_KPI_1_Enexis _3	Forecast of expected load in the grid segment in a specific period	Enexis
WP2.2_KPI_1_Enexis _4	Allocation of the expected amount of flexible power in the grid segment in a specific period	Enexis
DEMO Sweden		
KPI Step Methodology ID [KPI ID #]	**Step**	**Responsible**
WP2.2_KPI_1_EON_1a	Calculation/estimation of the % of thermal flexibility available per connected customer (residential multifamily buildings).	E.ON
WP2.2_KPI_1_EON_2a	Calculation/estimation of the flexibility available in low temperature thermal grids.	E.ON

WP2.2_KPI_1_EON_3a	Calculation/estimation of the flexibility available per connected customer (single family house) depending on the installed technology.	E.ON
WP2.2_KPI_1_EON_3a	Calculation/estimation of the % of thermal flexibility available per connected customer (single family house).	E.ON
WP2.2_KPI_1_EON_3b	Measurement of the RES Power in the grid.	E.ON

DEMO France		
KPI Step Methodology ID [KPI ID #]	**Step**	**Responsible**
WP2.2_KPI_1_Enedis_1	Calculation/estimation of the % of gas/electric flexibility available	GRDF
WP2.2_KPI_1_Enedis_2	Calculation/estimation of the % of storage available	ENGIE/Enedis
WP2.2_KPI_1_Enedis_3	Calculation/estimation of the % of residential flexibility available	EDF
WP2.2_KPI_1_Enedis_4	Calculation/estimation of the % of industrial flexibility available	ENGIE/EDF

KPI DATA COLLECTION

DEMO Germany

Data	Data ID	Methodology for data collection	Source/Tools/Instruments for Data collection	Location of Data collection	Frequency of data collection	Minimum monitoring period	Data collection responsible
Rated power of participating DER	RP_DER	Database analysis	Data sheets of participating DER	Avacon	Once at beginning of DEMO		Avacon
Rated power of participating flexible loads	RP_FL	Database analysis	Data sheets of participating flexible loads	Avacon	Once at beginning of DEMO		Avacon
Rated power and capacity of participating batteries	RP_ES	Database analysis	Data sheets of participating energy storage systems	Avacon	Once at beginning of DEMO		Avacon
Maximum feed in power during use case demo	MP_DER		Data collection and documentation via smart metering devices, grid control and smart grid hub	Avacon	Continuous during Use Case demonstration		Avacon
Maximum demand power during use case demo	MP_FL	Measurement	Data collection and documentation via smart metering devices, grid control and smart grid hub	Avacon	Continuous during Use Case demonstration		Avacon
Average feed in power during use case demo	AP_DER	Measurement	Data collection and documentation via smart metering devices, grid control and smart grid hub	Avacon	Continuous during Use Case demonstration		Avacon
Average demand power during use case demo	AP_FL	Measurement	Data collection and documentation via smart metering devices, grid control and smart grid hub	Avacon	Continuous during Use Case demonstration		Avacon

DEMO Czech Republic							
Data	**Data ID**	**Methodology for data collection**	**Source/Tools/Instruments for Data collection**	**Location of Data collection**	**Frequency of data collection**	**Minimum monitoring period**	**Data collection responsible**
Nominal charging power of EV charging station	CHARGING POWER $_{baseline}$	Datasheet specification	Manufacturer of EV charging station	ČEZd systems	Only once in the beginning of the project	N/A	ČEZd
Charging power of EV charging station in emergency situation (or during field test)	CHARGING POWER $_{baseline\ SG}$	Field test measurements	Meg38 power quality device	ČEZd systems	Every field test or every emergency situation	1 minute values	ČEZd
PV production peak determined as a sum of PV modules power	PV PEAK$_{baseline}$	Datasheet specification	Manufacturer of PV modules	ČEZd systems	Only once in the beginning of the project	N/A	ČEZd
PV production peak after smart charging of home energy storage is implemented	PV PEAK$_{baseline\ SG}$	Field measurements	Meg38 power quality device	ČEZd systems	Once a month	1 minute values	ČEZd

DEMO Netherlands							
Data	**Data ID**	**Methodology for data collection**	**Source/Tools/Instruments for Data collection**	**Location of Data collection**	**Frequency of data collection**	**Minimum monitoring period**	**Data collection responsible**
Power	P	Measurement	DA/Dali	Sub stations	15 min	constant	Enexis
Power	P	Measurement	Local measurement	PV and battery	15 min	constant	Aggregator

DEMO Sweden							
Data	**Data ID**	**Methodology for data collection**	**Source/Tools/Instruments for Data collection**	**Location of Data collection**	**Frequency of data collection**	**Minimum monitoring period**	**Data collection responsible**
RES Power in the system	RES_P		equipment	Substation	5 min	constant	E.ON
Available flexibility	Av_Flex	Aggregation	DSR Platform	Platform	5 min	constant	E.ON

DEMO France							
Data	**Data ID**	**Methodology for data collection**	**Source/Tools/Instruments for Data collection**	**Location of Data collection**	**Frequency of data collection**	**Minimum monitoring period**	**Data collection responsible**
Residential power	Pres	Measurement	Linky Smart Meter	Residential premises	30 min		Enedis
Industrial power	Pind	Measurement	Industrial Smart Meter	Industrial premises	30 min		Enedis

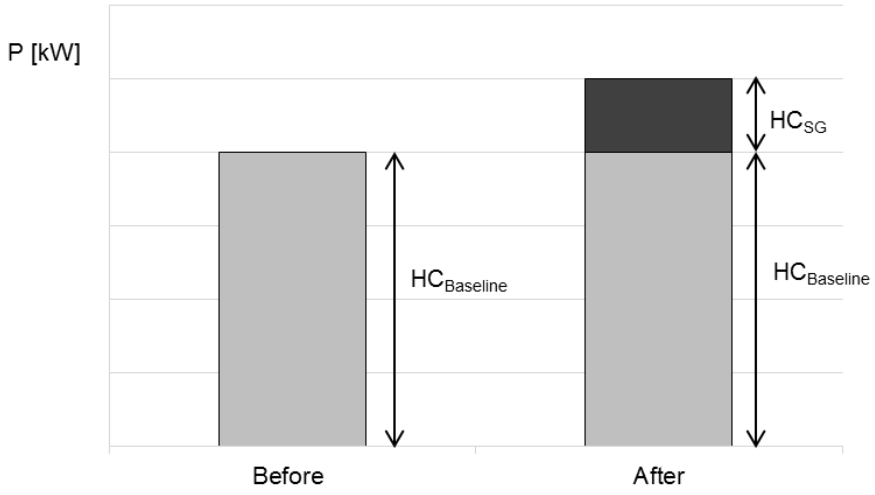
Storage power	Psto	Measurement	Industrial Smart Meter of specific storage meter	Storage system	30 min		ENGIE/ENEDIS

KPI BASELINE			
DEMO Germany			
Source of Baseline Condition	LITERATURE VALUES ☐	COMPANY HISTORICAL VALUES ☐	VALUES MEASURED AT START OF PROJECT ☐
Details of Baseline			
Responsible			
DEMO Czech Republic			
Source of Baseline Condition	LITERATURE VALUES ☑	COMPANY HISTORICAL VALUES ☐	VALUES MEASURED AT START OF PROJECT ☐
Details of Baseline	Baseline PV module power values under Standard Test Conditions and baseline EV charging stations charging power values could be simply checked from manufactures datasheets.		
Responsible	Stanislav Hes, ČEZd		
DEMO Netherland			
Source of Baseline Condition	LITERATURE VALUES ☐	COMPANY HISTORICAL VALUES ☑	VALUES MEASURED AT START OF PROJECT ☑
Details of Baseline			
Responsible			
DEMO Sweden			
Source of Baseline Condition	LITERATURE VALUES ☑	COMPANY HISTORICAL VALUES ☑	VALUES MEASURED AT START OF PROJECT ☑
Details of Baseline	Depending on the source of flexibility, the baseline calculation will be done differently: UC1_multifamily building thermal inertia, company historical values and literature will be used. UC2_low temperature heating/cooling grid thermal inertia, literature will be used. UC3_single family house thermal inertia, literature will be reviewed. UC3_hot tap water boiler, values measured throughout the project will be used to improve the baseline by using machine learning. UC3_battery systems, values measured from the project.		
Responsible	E.ON/RWTH		

DEMO France			
Source of Baseline Condition	LITERATURE VALUES ☐	COMPANY HISTORICAL VALUES ☐	VALUES MEASURED AT START OF PROJECT ☐
Details of Baseline			
Responsible			

GENERAL COMMENTS
DEMO Czech Republic - KPI Flexibility will be evaluated for use cases WP6_3 and WP6_4. DEMO Sweden - KPI Flexibility will be evaluated for use cases WP8_1, WP8_2 and WP8_3. *KPI for use case WP8_3 depends on recruited flexibility: quoted KPI assumes recruitment of 5% of flexible heat demand. KPI estimations are based upon simulation of a representation of the DEMO energy system, using internal estimates of the flexibility accessible from each of the available technologies and illustrative demand and generation profiles.

4.1.2. Hosting Capacity

<table>
<tr><th colspan="6">BASIC KPI INFORMATION</th></tr>
<tr><td>KPI Name</td><td colspan="3">Percentage increase of network hosting capacity for DER</td><td>KPI ID</td><td>WP2.2_KPI_2</td></tr>
<tr><td>Strategic Objective</td><td colspan="5">Increased DER integration in distribution grids</td></tr>
<tr><td>DEMO where KPI applies</td><td>GERMANY ☑</td><td>CZECH REP ☑</td><td>NETHERLANDS ☐</td><td>SWEDEN ☑</td><td>FRANCE ☐</td></tr>
<tr><td>Owner</td><td colspan="5">Germany – Thorsten Gross (Avacon)
Czech Republic – Stanislav Hes (ČEZ Distribuce)
Sweden - Anna Eriksmo, Luis Hernandez (E.ON)</td></tr>
<tr><td>KPI Description</td><td colspan="5">This KPI will measure the potential increase hosting capacity for distributed energy resources with Smart Grid solutions compared to the baseline situation where no “smart” actions are performed on the network. The indicator will give a statement about the additional DER that can be installed in the network thanks to Smart Grid solutions without the need for conventional reinforcements (i.e. new grid lines).
 
</td></tr>
<tr><td>KPI Formula</td><td colspan="5">$$HC_{\%} = \frac{HC_{SG} - HC_{Baseline}}{HC_{Baseline}} \times 100$$
HC_{SG} Hosting Capacity for DER with Smart Grid solutions (kW). This hosting capacity should measure DER that can be connected to the grid after the Smart Grid solution is implemented.
$HC_{Baseline}$ Hosting Capacity for DER in Baseline situation (kW). This hosting capacity should measure DER that can be connected to the grid before the Smart Grid solution is implemented.
<u>Note:</u>
Positive value: HC gain
Negative value: HC loss</td></tr>
<tr><td>Unit of measurement</td><td colspan="5">% percentage base</td></tr>
</table>

Expectations	Increase of DER hosting capacity Germany – Increase of DER hosting capacities > 0 Czech Republic – WP6_1: +25%, WP6_2: +25%, WP6_4: +5% Sweden - Flexibility from responsive technology (WP8_1: 12%, WP8_2: 19%, WP8_3*: 4%, WP8_5: 10%)			
Reporting Period	Germany – At the end of each use case demonstration Czech Republic – At the end of each use case demonstration Sweden - At the end of each use case demonstration			
Relevant Standards	EN 50438:2013, EN 50160, BDEW MS-Richtlinie, VDE-4105			
Connection / Link with other relevant defined KPIs	Linked with KPI Flexibility for use case WP6_4 (which evaluate decrease of PV production peak caused by PV + storage systems) and WP8_N5 which is called increase of renewable penetration.			
Reporting Audience and Access Rights	PUBLIC ☑	INTERFLEX PARTNERS ☐	DEMO PARTNERS ☐	OTHER (please specify) ☐
OTHER (please specify)				

KPI CALCULATION METHODOLOGY		
DEMO Germany		
KPI Step Methodology ID [KPI ID #]	**Step**	**Responsible**
WP2.2_KPI_2_AVA_1	Determine hosting capacity in grid area before deployment of Smart Grid Hub by simulation in PowerFactory and with reference to technical guidelines (VDE – AR – 4105, DIN EN 50160)	Avacon
WP2.2_KPI_2_AVA_2	Determine hosting capacity in grid area after implementation of Use Case 1 by simulation in PowerFactory and with reference to technical guidelines (VDE – AR – 4105, DIN EN 50160)	Avacon
WP2.2_KPI_2_AVA_3	Determine hosting capacity after implementation of Use Case 2 by simulation in PowerFactory and with reference to technical guidelines (VDE – AR – 4105, DIN EN 50160)	Avacon
WP2.2_KPI_2_AVA_4	Determine hosting capacity after implementation of Use Case 3 by simulation in PowerFactory and with reference to technical guidelines (VDE – AR – 4105, DIN EN 50160)	Avacon
DEMO Czech Republic		
KPI Step Methodology ID [KPI ID #]	**Step**	**Responsible**
WP2.2_KPI_2_CEZd_1	Evaluation of baseline DER hosting capacity by simulation in DNCalc software by using baseline grid topology data from GIS system according to the standard rules for calculation of DER hosting capacity (standard approach).	ČEZd
WP2.2_KPI_2_CEZd_2	After smart solution implementation - evaluation of DER hosting capacity by simulation in DNCalc software by using grid topology data from GIS system (standard approach) and with new rules for calculation of DER hosting capacity or installed power of DER physically connected to the grid after smart solution implementation.	ČEZd
DEMO Sweden		

KPI Step Methodology ID [KPI ID #]	Step	Responsible
WP2.2_KPI_2_EON_1	Determine hosting capacity in grid by simulation.	E.ON
WP2.2_KPI_2_EON_2	Determine hosting capacity after implementation of Use Case 1 by simulation.	E.ON
WP2.2_KPI_2_EON_3	Determine hosting capacity after implementation of Use Case 2 by simulation.	E.ON
WP2.2_KPI_2_EON_4	Determine hosting capacity after implementation of Use Case 3 by disaggregation of measured data.	E.ON
WP2.2_KPI_2_EON_5	Determine hosting capacity after implementation of Use Case 5 disaggregation of measured data.	E.ON
WP2.2_KPI_2_EON_6	Determine hosting capacity of different levels of penetration after implementation of Use Case 1-3 and 5 by simulation.	E.ON

KPI DATA COLLECTION

DEMO Germany

Data	Data ID	Methodology for data collection	Source/Tools/ Instruments for Data collection	Location of Data collection	Frequency of data collection	Minimum monitoring period	Data collection responsible
Current hosting capacity	$HC_{baseline}$	Calculation of hosting capacity in kW under guideline VDE - AR - 4105	Grid model in PowerFactory, standard scenarios	Avacon	Once during each use case demonstration		Avacon
Additonal hosting capacity	HC_{SG}	Calculation of hostig capacity in kW after deploament of Smart Grid Hub	Grid model in PowerFactory, standard scenarios	Avacon	Once during each use case demonstration		Avacon

DEMO Czech Republic

Data	Data ID	Methodology for data collection	Source/Tools/Instruments for Data collection	Location of Data collection	Frequency of data collection	Minimum monitoring period	Data collection responsible
Number of DER which are possible to connect to the grid before smart solution implementation	$HC_{baseline}$	Download from ČEZ Distribuce systems	GIS data	ČEZ Distribuce systems	Only once in the beginning of the project	N/A	ČEZd
Number of DER connected physically to the grid after smart solution implementation or hosting capacity calculated with new rules for DER hosting capacity calculation	HC_{SG}	Download from ČEZ Distribuce systems	GIS data	ČEZ Distribuce systems	Only once at the end of the project	N/A	ČEZd

DEMO Sweden							
Data	**Data ID**	**Methodology for data collection**	**Source/Tools/Instruments for Data collection**	**Location of Data collection**	**Frequency of data collection**	**Minimum monitoring period**	**Data collection responsible**
RES Power in the system	RES_P		Measurement equipment	Substation	5 min	constant	E.ON
Flexibility dispatched	Dis_Flex	Aggregation	DSR Platform	Platform	5 min	constant	E.ON
System Load	Load_P	Measurement	Measurement Equipment	Substation	5 min	constant	E.ON

KPI BASELINE			
DEMO Germany			
Source of Baseline Condition	LITERATURE VALUES ☐	COMPANY HISTORICAL VALUES ☑	VALUES MEASURED AT START OF PROJECT ☐
Details of Baseline	VDE-AR-4105 allows a maximum voltage rise on critical feeder of 2% nominal voltage.		
Responsible	Thorsten Gross		
DEMO Czech Republic			
Source of Baseline Condition	LITERATURE VALUES ☐	COMPANY HISTORICAL VALUES ☐	VALUES MEASURED AT START OF PROJECT ☑
Details of Baseline	Baseline grid topology for use cases WP6_1, WP6_2 and WP6_4 downloaded from GIS system.		
Responsible	Stanislav Hes, ČEZ Distribuce		
DEMO Sweden			
Source of Baseline Condition	LITERATURE VALUES ☐	COMPANY HISTORICAL VALUES ☐	VALUES MEASURED AT START OF PROJECT ☑
Details of Baseline	Based on measured values from the project, a baseline model will be created for the energy system. This will represent the case that when RES surplus is higher than a set value, the RES would be curtailed. Hence, reducing the penetration of renewables into the grid. This KPI will use this baseline and will compare against how much RES was not curtailed by the activation of different sources of flexibility.		
Responsible	E.ON		
GENERAL COMMENTS			
DEMO Czech Republic - KPI Percentage increase of network hosting capacity for DER will be evaluated for use cases WP6_1, WP6_2 and WP6_4. DEMO Sweden - KPI hosting capacity will be evaluated for use cases WP8_1, WP8_2, WP8_3 and WP8_5.			

4.1.3. Islanding

BASIC KPI INFORMATION					
KPI Name	Capacity of an islanding to last			**KPI ID**	WP2.2_KPI_3
Strategic Objective	Evaluation whether islanding were successful				
DEMO where KPI applies	GERMANY ☐	CZECH REP ☐	NETHERLANDS ☐	SWEDEN ☑	FRANCE ☑
Owner	France – Thomas Drizard (Enedis) Sweden – Luis Hernandez (E.ON)				
KPI Description	This KPI will measure the capacity of an islanding to last as long as required.				
KPI Formula	$$I_{capacity} = \frac{\sum D_{isl}}{\sum D_{req}} \times 100$$ Where: $I_{capacity}$: the capacity of demo's islanding to last as long as required. D_{isl} : the duration of a single islanding. D_{req} : the required duration of an islanding, after an intentional or unintentional disconnection from the grid.				
Unit of measurement	% percentage base				
Expectations	France – 100% Sweden – 100%				
Reporting Period	Once a year				
Relevant Standards	/				
Connection / Link with other relevant defined KPIs	/				
Reporting Audience and Access Rights	PUBLIC ☑	INTERFLEX PARTNERS ☐	DEMO PARTNERS ☐	OTHER (please specify) ☐	
OTHER (please specify)	/				

KPI CALCULATION METHODOLOGY		
DEMO ENEDIS		
KPI Step Methodology ID [KPI ID #]	**Step**	**Responsible**

WP2.2_KPI_3_Enedis_1	The duration of the islanding will be assessed from the moment the switch is opened to the moment the switch closed.	Thomas Drizard
WP2.2_KPI_3_Enedis_2	The duration of a required islanding is calculated as the minimum between: - the duration of a customer's power cut if there were no islanding system. - the maximum duration of an islanding depending on storage capacity.	Thomas Drizard
DEMO E.ON SVERIGE		
KPI Step Methodology ID [KPI ID #]	**Step**	**Responsible**
WP2.2_KPI_3_EON_1	The duration of the islanding will be assessed from the moment the switch is intentionally or unintentionally opened to the moment the switch is closed.	Luis Hernandez
WP2.2_KPI_3_EON_2	The duration of a required islanding is calculated as: - the duration of a customer's power cut i.e. the inability of the overlying power grid to source the village due to a planned or unplanned outage, or the planned duration of an islanding test (intentional disconnection from main grid).	Luis Hernandez

KPI DATA COLLECTION

DEMO ENEDIS

Data	Data ID	Methodology for data collection	Source/Tools/Instruments for Data collection	Location of Data collection	Frequency of data collection	Minimum monitoring period	Data collection responsible
Duration of a single islanding	D_{isl}	Difference between two instants on data	Collected data	At the storage level	For every islanding attempt	/	Thomas Drizard
Required duration of an islanding	D_{req}	Minimum between two durations	Collected data	At the storage level	For every islanding attempt	/	Thomas Drizard

DEMO E.ON SVERIGE

Data	Data ID	Methodology for data collection	Source/Tools/Instruments for Data collection	Location of Data collection	Frequency of data collection	Minimum monitoring period	Data collection responsible
Duration of a single islanding	D_{isl}	Download from cloud storage	Measurement data gathered by the microgrid controller.	Cloud storage	Constant	Event length	Ingmar Leisse
Required duration of an intentional islanding	D_{req}	Download from cloud storage	Data input into test schedules	Cloud storage	Constant	N/A	Ingmar Leisse

Required duration of an unintentional islanding	D_{req}	Elnät outage report	SCADA – OPS room	Report archive	During outage period	Outage period	Demijan Panic

KPI BASELINE			
DEMO ENEDIS			
Source of Baseline Condition	LITERATURE VALUES ☐	COMPANY HISTORICAL VALUES ☐	VALUES MEASURED AT START OF PROJECT ☐
Details of Baseline	Baseline values not applicable to this KPI.		
Responsible			
DEMO E.ON SVERIGE			
Source of Baseline Condition	LITERATURE VALUES ☐	COMPANY HISTORICAL VALUES ☐	VALUES MEASURED AT START OF PROJECT ☐
Details of Baseline	Baseline values not applicable to this KPI.		
Responsible			
GENERAL COMMENTS			

4.2. Social KPIs

4.2.1. Customer recruitment

BASIC KPI INFORMATION					
KPI Name	Customer recruitment rate			**KPI ID**	WP2.2_KPI_4
Strategic Objective	Measure whether demos are managing to recruit enough customer base in order to attain demo objectives				
DEMO where KPI applies	GERMANY ☑	CZECH REP ☐	NETHERLANDS ☐	SWEDEN ☑	FRANCE ☑
Owner	Germany – Thorsten Gross (Avacon) Sweden – Anna Eriksmo, Luis Hernandez (E.ON) France – Thomas Drizard (Enedis)				
KPI Description	Customer engagement is a heuristic for the new energy system. This KPI measures if customers are prone to be more active in the new system and this will have an impact on how new solutions will be designed in a commercialization phase. A prerequisite for this is that they are willing to take part, in the first place.				
KPI Formula	$$CR_{\%} = \frac{CR_{successful}}{CR_{required}} \times 100$$ $CR_{\%}$ - percentage of required customer base that use case was able to recruit $CR_{successful}$ - number of customers (installed capacity, energy volume) actually recruited $CR_{required}$ - number of customers (installed capacity, energy volume) needed to obtain enough flexibility in demo in order to verify use cases				
Unit of measurement	Unit depends on Use Case description, but should be either customer numbers (#), installed capacity (MW), flexible capacity contracted or Energy (MWh)				
Expectations	Germany – 100% Sweden – 100% France – 80%				
Reporting Period	Germany – at the end of the recruitment period Sweden – at the end of the recruitment period France – at the end of the recruitment period				
Relevant Standards	N/A				
Connection / Link with other relevant defined KPIs	This KPI is linked to the KPI of active participation. Recruiting customer is a prerequisite for active participation of customers.				
Reporting Audience and Access Rights	PUBLIC ☑	INTERFLEX PARTNERS ☐	DEMO PARTNERS ☐	OTHER (please specify) ☐	
OTHER (please specify)	Source of the data is not to be published.				
KPI CALCULATION METHODOLOGY					
DEMO Germany					

KPI Step Methodology ID [KPI ID #]	Step	Responsible
WP2.2_KPI_4_AVA_1	Determine number of participants needed for successful demonstration	Avacon
WP2.2_KPI_4_AVA_1	Determine KPI based on actual participation	Avacon
DEMO Sweden		
KPI Step Methodology ID [KPI ID #]	**Step**	**Responsible**
WP2.2_KPI_4_E.ON_1(8a)	Estimate necessary installed capacity in order to obtain demo. Calculate in installed capacity (MW)	E.ON Sverige
WP2.2_KPI_4_E.ON_2(8b)	Estimate necessary installed capacity in order to obtain demo. Calculate in installed capacity (MW)	E.ON Sverige
DEMO France		
KPI Step Methodology ID [KPI ID #]	**Step**	**Responsible**
WP2.2_KPI_4_ENEDIS_1	Determine number of participants and flexible capacity needed for successful demonstration	Enedis
WP2.2_KPI_4_ENEDIS_2	Determine KPI based on actual participation	Enedis

KPI DATA COLLECTION							
ALL DEMOs							
Data	**Data ID**	**Methodology for data collection**	**Source/Tools/Instruments for Data collection**	**Location of Data collection**	**Frequency of data collection**	**Minimum monitoring period**	**Data collection responsible**
Numbers of customer/installed capacity/energy volume/flexible capacity needed to obtain enough flexibility in demo in order to verify use cases	$CR_{required}$	Analysis during use case design phase	N/A	N/A	N/A	N/A	Avacon E.ON Enedis
Numbers of customer/installed capacity/energy volume/flexible capacity recruited	$CR_{successful}$	Records from recruitment activities (customer agreements if applicable)	N/A	N/A	N/A	N/A	Avacon E.ON Enedis

KPI BASELINE			
ALL DEMOs			
Source of Baseline Condition	LITERATURE VALUES ☐	COMPANY HISTORICAL VALUES ☐	VALUES MEASURED AT START OF PROJECT ☐
Details of Baseline	Baseline values not applicable to this KPI.		

Responsible	
GENERAL COMMENTS	
DEMO Sweden - KPI customer recruitment will be evaluated for use cases WP8_1, WP8_3 and WP8_4.	

4.2.2. Active participation

<table>
<tr><th colspan="6">BASIC KPI INFORMATION</th></tr>
<tr><td>KPI Name</td><td colspan="3">Active participation of all kinds of flexibility</td><td>KPI ID</td><td>WP2.2_KPI_5</td></tr>
<tr><td>Strategic Objective</td><td colspan="5">Verification whether demos are leveraging all types of flexibility they initially declared. This KPI reflects how versatile the demos are in leveraging flexibility from different technologies.</td></tr>
<tr><td>DEMO where KPI applies</td><td>GERMANY ☑</td><td>CZECH REP ☐</td><td>NETHERLANDS ☐</td><td>SWEDEN ☑</td><td>FRANCE ☑</td></tr>
<tr><td>Owner</td><td colspan="5">Germany – Thorsten Gross (Avacon)
Sweden – Anna Eriksmo, Luis Hernandez (E.ON)
France – Thomas Drizard (Enedis)</td></tr>
<tr><td>KPI Description</td><td colspan="5">The DEMOs aspire to make use of flexibility from different technologies. If and how different types of technologies can actually be accessed and utilized during the DEMO phase depends on the number of different technologies that are available in the region of the DEMO as well as on the general capabilities of the DEMO. DEMOs have declared a number and types of technologies they are targeting during DEMO phase and will be measured against their initial aspirations.</td></tr>
<tr><td>KPI Formula</td><td colspan="5">
$$\text{Participation}_{\%} = \frac{\text{N}_{\text{leverage technology}}}{\text{N}_{\text{target technology}}} * 100$$
<table>
<tr><th colspan="8">Sources of Flexibility: Technologies initially targeted</th></tr>
<tr><th>Demo</th><th>PV</th><th>Wind Generator</th><th>Battery Storage</th><th>Residential Loads</th><th>Industrial, Municipal & Commercial Loads</th><th>Mobility</th><th>Total</th></tr>
<tr><td>Avacon</td><td>X</td><td></td><td>X</td><td>X</td><td></td><td>X</td><td>4</td></tr>
<tr><td>E.ON</td><td>X</td><td></td><td>X</td><td>X</td><td></td><td></td><td>3</td></tr>
<tr><td>Enedis</td><td>X</td><td></td><td>X</td><td>X</td><td></td><td>X</td><td>4</td></tr>
</table>
<table>
<tr><th colspan="8">Sources of Flexibility: Technologies actually leveraged</th></tr>
<tr><th>Demo</th><th>PV</th><th>Wind Generator</th><th>Battery Storage</th><th>Residential Loads</th><th>Industrial, Municipal & Commercial Loads</th><th>Mobility</th><th>Total</th></tr>
<tr><td>Avacon</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>E.ON</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Enedis</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>
$\text{Participation}_{\%}$ - Percentage of technologies leveraged
$N_{leverage\ technology}$ - number of different technologies leveraged in DEMO
$\text{N}_{target\ technology}$ - number of types of technologies initially targeted in DEMO
</td></tr>
<tr><td>Unit of measurement</td><td colspan="5">% of technologies leveraged</td></tr>
</table>

Expectations	Germany – 100% Sweden – 100% France – 100%			
Reporting Period	End of DEMO			
Relevant Standards	/			
Connection / Link with other relevant defined KPIs	/			
Reporting Audience and Access Rights	PUBLIC ☑	INTERFLEX PARTNERS ☑	DEMO PARTNERS ☑	OTHER (please specify) ☐
OTHER (please specify)				

KPI CALCULATION METHODOLOGY		
ALL DEMOs		
KPI Step Methodology ID [KPI ID #]	**Step**	**Responsible**
WP2.2_KPI_5_all_1	Define number and type of technologies to be leveraged during DEMO	WPL
WP2.2_KPI_5_all_2	Determine number and type of technologies actually leveraged during DEMO	WPL
WP2.2_KPI_5_all_3	Determine KPI in [%] based on the numbers given above	WPL

KPI DATA COLLECTION							
DEMO Germany							
Data	**Data ID**	**Methodology for data collection**	**Source/Tools/ Instruments for Data collection**	**Location of Data collection**	**Frequency of data collection**	**Minimum monitoring period**	**Data collection responsible**
Number of flexibility technologies targeted	$N_{target\ technology}$		Project planning	Avacon	End of each use case		Avacon
Number of flexibility technologies actually leveraged in demo	$N_{leverage\ technolog}$		Technical information from participants	Avacon	End of each use case		Avacon
DEMO Sweden							

Data	Data ID	Methodology for data collection	Source/Tools/ Instruments for Data collection	Location of Data collection	Frequency of data collection	Minimum monitoring period	Data collection responsible
Number of flexibility technologies targeted	$N_{target\ technology}$		Project planning	E.ON	End of each use case		E.ON
Number of flexibility technologies actually leveraged in demo	$N_{leverage\ technolog}$		Technical information from participants	E.ON	End of each use case		E.ON
DEMO France							
Data	**Data ID**	**Methodology for data collection**	**Source/Tools/Instruments for Data collection**	**Location of Data collection**	**Frequency of data collection**	**Minimum monitoring period**	**Data collection responsible**
Number of flexibility technologies targeted	N_{target}		Project planning	Enedis	End of each use case		Enedis
Number of flexibility technologies actually leveraged in demo	N_{levera}		Technical information from participants	Enedis	End of each use case		Enedis
KPI BASELINE							
DEMO							
A baseline for this KPI is not applicable.							
GENERAL COMMENTS							
DEMO Sweden - KPI active participation will be evaluated for use cases WP8_1, WP8_2 and WP8_3.							

5. REFERENCES

5.1. Project Documents

[GA] Grant Agreement (list of all demo KPIs)
[D6.1] Design of Solution

5.2. External Documents

[1] Standard EN 50160 - Voltage Characteristics in Public Distribution Systems
[2] EN 50438:2013 - Requirements for micro-generating plants to be connected in parallel with public low-voltage distribution networks
[3] BDEW MS-Richtlinie - Technische Richtlinien für Erzeugungsanlagen am Mittelspannungsnetz
[4] VDE-4105 - Power generation systems connected to the low-voltage distribution network