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Methodology for impact assessment of INTERPRETER tools

Deliverable D7.1

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Methodology for impact assessment of INTERPRETER tools

Version 2.0

INTERPRETER

Organisation: CERTH/CPERI

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Date (17/08/2021)

DELIVERABLE 7.1 – VERSION 2

WORK PACKAGE N° 7 – Testing and validation for selected use cases

TASK N° 1 – Definition of Key Performance Indicators for INTERPRETER solution validation

Nature of the deliverable		
R	Document, report (excluding the periodic and final reports)	X
DEM	Demonstrator, pilot, prototype, plan designs	
DEC	Websites, patents filing, press & media actions, videos, etc.	
OTHER	Software, technical diagram, etc.	

Dissemination Level		
PU	Public, fully open, e.g. web	X
CO	Confidential, restricted under conditions set out in Model Grant Agreement	
CI	Classified, information as referred to in Commission Decision 2001/844/EC	

Documents history			
Date	Version	Reviewer	Nature of the revision
29/07/2021	1.0	Jorge Rueda Quintanilla (CUERVA)	Revision of the text and the KPI tables.
17/08/2021	2.0	Alfonso Bernad Hans Bludszuweit	Final Quality Review

Disclaimer of warranties

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This document has been prepared by INTERPRETER project partners as an account of work carried out within the framework of the EC-GA contract No 864360.

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Executive summary

The present deliverable defines the Key Performance Indicators (KPIs) for the evaluation of the INTERPRETER solution. For this purpose, three major categories of KPIs are introduced: a) the grid improvement KPIs, which are related to the technical, environmental and economic assessment of the INTERPRETER solution, b) the accuracy/efficiency KPIs per tool, which basically evaluate the degree of compliance to the use case requirements of each tool and c) the Information Technology (IT) KPIs for the whole INTERPRETER platform.

The deliverable contains a literature review regarding the categories of KPIs in general as well as an extensive analysis of each proposed KPI, in terms of calculation methodology, data sources, business interpretation, target values, etc.

Task 7.1 is included in WP7, which aims to test and validate the grid modelling tool, the various applications for efficient management and effective planning of the grid and the overall solutions with the support of the Distribution System Operators (DSOs) involved in the INTERPRETER project. The outcome of this Task will contribute to the rest of WP7 by providing the indicators according to which the results of the INTERPRETER platform shall be evaluated.

List of abbreviations

Abbreviation	Full name
BaU	Business as Usual
CAPEX	Capital Expenditure
CED	Cumulative Energy Demand
DSO	Distribution System Operator
EPT	Energy Payback Time
GmT	Grid Modelling Tool
IT	Information Technology
KPI	Key Performance Indicator
LOO	Line Overload Occurrence
LV	Low Voltage
NER	Net Energy Ratio
NTL	Non-Technical Losses
OPEX	Operational Expenditure
RES	Renewable Energy Sources
SAIDI	System Average Interruption Duration Index
SAIFI	System Average Interruption Frequency Index
TSO	Transmission System Operator
WP	Work Package

Partners short names

CIRCE: FUNDACIÓN CIRCE CENTRO DE INVESTIGACIÓN DE RECURSOS Y CONSUMOS ENERGÉTICOS

RDN: CENTRO DE INVESTIGACAO EM ENERGIA REN - STATE GRID SA – R&D NESTER

CERTH: ETHNIKO KENTRO EREVNAS KAI TECHNOLOGIKIS ANAPTYXIS

DTU: DANMARKS TEKNISKE UNIVERSITET

CARTIF: FUNDACION CARTIF

ATOS: ATOS SPAIN SA

ATOS IT: ATOS IT SOLUTIONS AND SERVICES IBERIA SL (LTP ATOS)

ORES: OPERATEUR DE RESEAUX D’ENERGIES

CUERVA: MONTAJES ELECTRICOS CUERVA S.L.

TT: TURNING TABLES S.L. (LTP CUERVA)

EQY: EUROQUALITY SARL

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1. INTRODUCTION

This deliverable is the outcome of T7.1 of WP7. The purpose of this deliverable, D7.1, is to define a set of KPIs that shall evaluate the INTERPRETER solution. The proposed KPIs aim to validate the Low Voltage (LV) grid modelling tool and the software applications developed in INTERPRETER considering the improvement of the distribution grid in terms of technical, environmental and economic aspects, the accuracy/efficiency of each tool separately, but also the performance of the whole INTERPRETER platform, altogether. In this context, this deliverable defines the necessary KPIs, their calculation formula, the tools that contribute to their calculation, etc. Also, it defines each KPI's target value and explains its business interpretation.

Since D7.1 aims to evaluate the performance of the INTERPRETER platform, it is related to WP3 (Tool for low-voltage grid modelling), WP4 (Software applications for efficient operation and maintenance of the grid) and WP5 (Software applications for an effective rid planning), which include the development of the INTERPRETER tools that shall be evaluated. Furthermore, the outcome of D7.1 shall contribute to the rest of WP7 (Testing and validation for selected use cases), by providing guidelines, target values, etc. for the validation of the INTERPRETER solution in three demo sites, operated by ORES, CUERVA and DTU.

2. LITERATURE REVIEW

The transition towards a low-carbon economy is significantly transforming the electricity distribution grid. The traditional unidirectional, centralised, fossil fuel-based architecture seems unable to efficiently reduce the energy footprint of the grid whereas bidirectional, non-centralised and renewable-based architectures challenge its dominance [1], [2].

In this context, Distribution System Operators (DSOs) face issues which did not occur before, including complex grid operations, reverse power flows, grid stability issues, etc. The aforementioned challenges are often solved with the assistance of especially designed platforms that comprise tools which support the DSOs' transition towards an active system management approach. The developed software applications provide the DSOs with the capability to design, operate and plan the electricity grid optimally, with special focus on the rapid deployment of Renewable Energy Sources (RES), stability issues and other growing concerns [3].

Once a new platform related to the modernization of the electricity grid is introduced, it is critical to be validated before its wider adoption. In this way, its performance in all aspects, regarding all promised solutions, can be assessed and possible advantages or even drawbacks can be highlighted. For this purpose, Key Performance Indicators (KPIs) are developed, which quantify the impact of the proposed solutions and compare it to respective target values.

In the worldwide literature there is a variety of KPIs related to the assessment of platforms that provide solutions for the improvement/optimization of the electricity grid. These KPIs can be sorted in three main categories, i.e. the grid improvement KPIs, the individual tool accuracy/efficiency KPIs and the overall platform Information Technology (IT) KPIs, as presented in Figure 1 [4], [5].

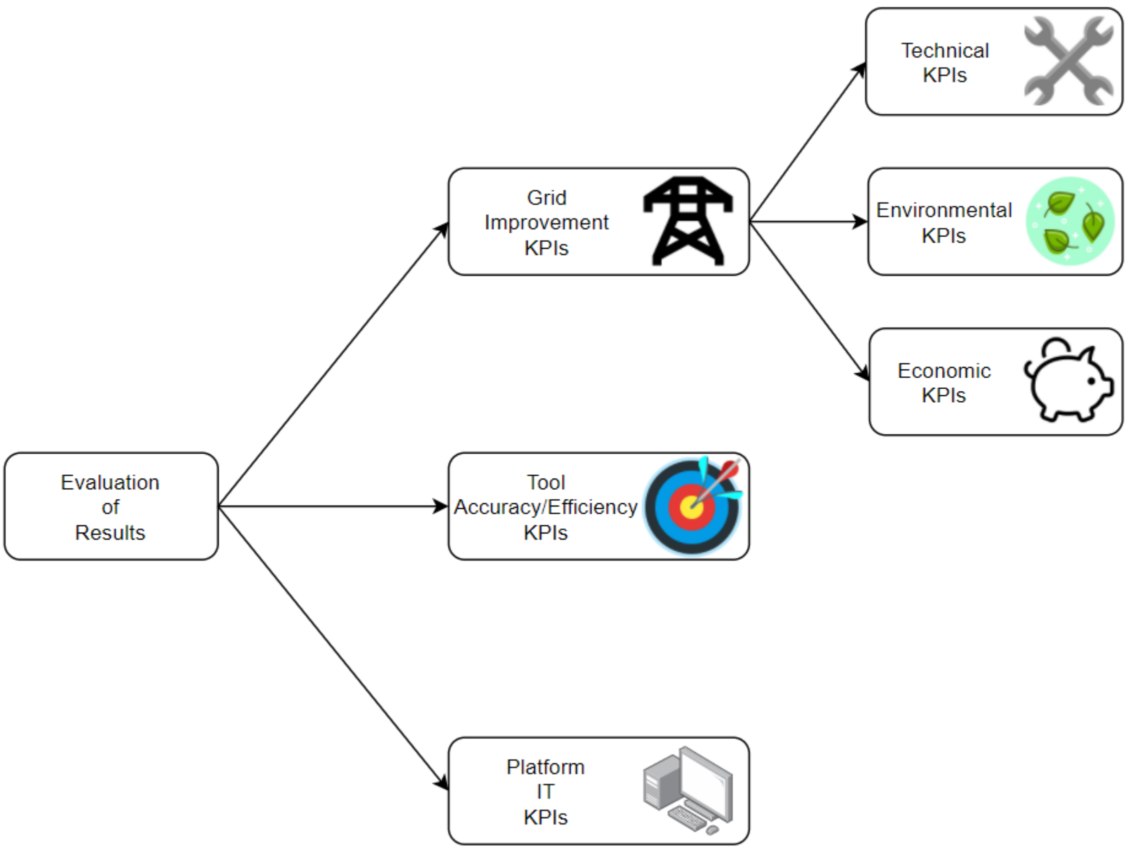

FIGURE 1: EVALUATION OF RESULTS.

The **grid improvement KPIs** refer to the results achieved in terms of design, planning, operation and maintenance of the electricity grid. They can be divided into three main sub-categories, as presented in Figure 1, i.e. technical, environmental and economic KPIs. The technical KPIs refer to the practical aspects of the distribution grid. They mostly deal with issues related to stability, blackouts, congestion, maintenance requirements, energy losses, non-technical losses (NTL), etc. In this sense, such indicators usually aim to secure the quality and reliability of the proposed solution. The environmental KPIs refer to the impact of the distribution system to the environment. They mostly deal with the reduction of the energy footprint, CO_2 emissions, etc. achieved through the integration of RES-based power supply and the reduction of energy consumption and losses. Such indexes have gained much attention over the past few decades due to the ascending need for reduction of fuel-based consumption. Finally, economic KPIs are related to the cost of the whole distribution system for the DSO and the consumers. The cost of energy, the Operational Expenditures (OPEX), the Capital Expenditures (CAPEX), etc. are some of the aspects that are usually investigated by economic KPIs, in order to secure the economic sustainability of the grid. It should be noted that the aforementioned sub-categories, in some cases, contradict each other. For example, a grid with high RES penetration may provide satisfactory results in terms of environmental KPIs but may not provide as satisfactory results in terms of stability and power quality, which are related to technical KPIs. Furthermore, a highly flexible and reliable distribution grid may satisfy many technical indicators, but may also reduce its cost sustainability. Overall, the grid improvement KPIs are considered to be the main focus in a number of research and development studies, as presented in [6], [7].

The **tool accuracy/efficiency KPIs** refer to each tool separately and aim to assess its accuracy and efficiency in order to evaluate the degree of compliance to the use case requirements. It is important that the solutions provided are applicable in real-life conditions, meaning that the forecasted/proposed outcome, once the proposed actions (provided by the tool) are applied, shall be effective and not deviate significantly from the measured/actual outcome [5].

The **platform IT KPIs** refer to the overall operation of the platform, as experienced by the user (in this case: the DSO). These KPIs aim to evaluate the interface between the platform and the user, in terms of user friendliness, usability, quality of exchange, connectivity, etc. They also aim to evaluate the impact of the platform's operation in terms of memory usage, computational speed, etc. [8], [9].

Overall, the task of developing the appropriate KPIs which shall validate a platform that aims to support the DSO's decisions incorporates many challenges, as it needs to address many aspects. Since there is no standard methodology for the assessment of such platforms, the recommended practice is to develop a wide variety of KPIs, the results of which may give an inclusive image to the possible user.

3. CATEGORIES OF INTERPRETER KPIS

The INTERPRETER project aims to develop a platform consisting of a set of ten (10) software applications for the optimal design, planning, operation and maintenance of the electricity grid, with special focus on the distribution network, based on the developed grid modelling tool (WP3), as presented in Table 1. The developed tools shall be offered to grid operators through an open-source interoperable platform.

INTERPRETER TOOLS		
Serial Number	Tool	Task
1	Detection of non-technical losses tool	T4.1
2	Grid congestion and voltage balancing tool	T4.2
3	DSO/TSO service coordination tool	T4.3
4	Predictive maintenance strategies for grid assets tool	T4.4
5	Optimal grid reconfiguration and self-healing tool	T4.5
6	Optimal reactive power compensation tool	T5.1
7	Planned phase balancing tool	T5.2
8	Nodal capacity allocation tool	T5.3
9	Optimal location of dispersed storage tool	T5.4
10	Environmental and economic assessment tool	T5.5

TABLE 1: LIST OF INTERPRETER TOOLS.

As described in the literature review, the INTERPRETER solution needs to be assessed through a) grid improvement KPIs, b) tool accuracy/efficiency KPIs and c) platform IT KPIs, which shall be calculated throughout the demo campaigns. For this purpose, CERTH/CPERI circulated a list of proposed KPIs, questions and notes addressed to all relevant partners, i.e. CIRCE, DTU, CUERVA, CERTH/ITI, CARTIF, RDN, ATOS and ORES. The resulting grid improvement KPIs are presented in Table 2. The resulting tool accuracy/efficiency KPIs are presented in Table 3. Finally, the resulting platform IT KPIs are presented in Table 4.

GRID IMPROVEMENT KPIS	
Technical	
Serial number	Name of the KPI
1	Reduction of System Average Interruption Frequency Index (SAIFI)
2	Reduction of System Average Interruption Duration Index (SAIDI)
3	Self consumption rate
4	Line overload occurrence (LOO)
5	Reduction of energy consumption (only technical losses)
6	Reduction of non-technical losses in distribution networks
7	Reduction of total energy losses (including technical + non-technical losses)
8	Energy recovered due to INTERPRETER
9	Exploitation of the available flexibility assets
10	Blackouts due to congestion issues
Environmental	
Serial number	Name of the KPI
1	Cumulative energy demand (CED)
2	Net energy ratio (NER)
3	Energy payback time (EPT)
4	RES lifetime CO_2 emissions

GRID IMPROVEMENT KPIS	
5	CO_2 payback time
6	Reduction in direct CO_2 emissions
7	CO_2 emissions avoided
8	Reduction of environmental footprint for electrical grid
9	Increase of RES exploitation
10	Increase of RES exploitation (percentage)
11	Reduction of RES potential curtailment
Economic	
1	Deferred capacity investments due to peak demand reduction
2	Percentage reduction in Operational Expenditure (OPEX)
3	Percentage reduction in Capital Expenditure (CAPEX)
4	Cost reduction for the system operator
5	Annual cost reduction per customer
6	Savings of consumers (related to ancillary services)
7	Reduction of maintenance cost
8	Recovered revenue to the system operators due to reduced outages

TABLE 2: LIST OF GRID IMPROVEMENT KPIS.

TOOL ACCURACY/EFFICIENCY KPIS	
Serial number	Name of the KPI
1	Accuracy of WP3 tool
2	Accuracy/Efficiency of T4.1 tool
3	Efficiency of T4.2 tool
4	Accuracy of T4.3 tool
5	Efficiency of T4.4 tool
6	Efficiency of T4.5 tool
7	Efficiency of T5.1 tool
8	Efficiency of T5.2 tool
9	Efficiency of T5.3 tool
10	Efficiency of T5.4 tool
11	Accuracy of T5.5 tool

TABLE 3: LIST OF TOOL ACCURACY/EFFICIENCY KPIS.

PLATFORM IT KPIS	
Serial number	Name of the KPI
1	Average response time
2	Error rates
3	Average CPU usage
4	Average memory usage
5	User interface friendliness
6	User satisfaction

TABLE 4: LIST OF PLATFORM IT KPIS.

The aforementioned grid improvement KPIs, tool accuracy/efficiency KPIs and platform IT KPIs shall be individually presented in Sections 4, 5 and 6 respectively, with special attention to their calculation specifications, data sources, target values and business interpretation.

4. GRID IMPROVEMENT KPIS

The INTERPRETER grid improvement KPIs may be a) technical, b) environmental or c) economic. In order for them to be thoroughly defined, the following datasheet, presented in Table 5, has been developed:

Grid Improvement KPI Datasheet			
General Information			
Index:			
Name:			
Description:			
Category of KPI:	Technical ☐	Environmental ☐	Economic ☐
Type of KPI:	Value ☐	Difference from BaU ☐	Percentage difference from BaU ☐
Calculation Specifications			
Calculation formula:			
Unit:			
Sources			
Data source:			
Type of data:			
Time horizon:			
Tools			
Relevant tools: Tools contributing to the achievement of the KPI			
Target			
Target value:			
Business Interpretation			
Impact:			
Relevant Literature			
References:			

TABLE 5: GRID IMPROVEMENT KPI DATASHEET.

The datasheet contains a number of fields that address all main aspects of a grid improvement KPI, including its description, its calculation formula, the INTERPRETER tools which are related to it, etc. More specifically the included fields are the following:

A. **General Information:** The general information of a KPI are **a) its identification index**, (for example, Tech.05 identifies the 5th technical KPI), **b) the KPI's name**, **c) the KPI's description**, **d) the category of the KPI**, which may be technical, environmental or economic and **e) the type of the KPI**, which may be a simple value, a difference between the INTERPRETER solution and the Business as Usual (BaU) approach or even a percentage difference from BaU.
B. **Calculation Specifications:** The calculation specifications of a KPI are **a) its calculation formula** and **b) the unit** in which it is expressed, such as %, MWh, €, etc.
C. **Sources:** In this section, the required data and the way to obtain them are defined. More specifically, it is critical to define **a) the data source**, meaning the source from which the data for the calculation of the KPI could be obtained (in this case, the potential INTERPRETER tools from (at least one of) which the proposed KPI could be calculated or the input data needed for the calculation formula could be supplied), **b) the type of data**, which may be simulation results, measurements, etc. **and c) the necessary time horizon** for the calculation of each KPI, which may be equal to a year, a month, etc.
D. **Tools:** In this field the tools which may contribute to the achievement of the proposed KPI are identified. The tools may contribute directly or indirectly to the improvement of an indicator, without necessarily providing the value of the KPI or the data needed for its calculation.
E. **Target:** Apart from the identification and calculation of each KPI, it is critical to define the **target value** that needs to be achieved in order to claim that the INTERPRETER solution is satisfactory.
F. **Business Interpretation:** Each improvement calculated by the proposed KPIs has an **impact** in terms of business. For example, the reduction in direct CO_2 emissions in a distribution grid means the achievement of a lower environmental impact.
G. **Relevant Literature:** The proposal of a KPI needs to be supported by literature (review papers, research papers, outcome of other projects' deliverables, etc.).

The completed datasheets for the technical, environmental and economic KPIs are presented in the following Subsections 4.1, 4.2 and 4.3 of this deliverable, respectively.

4.1. TECHNICAL KPIS

The technical KPIs are presented in Table 6 - Table 15:

<table>
<tr><th colspan="4">Grid Improvement KPI Datasheet</th></tr>
<tr><th colspan="4">General Information</th></tr>
<tr><td>Index:</td><td colspan="3">Tech.01</td></tr>
<tr><td>Name:</td><td colspan="3">Reduction of System Average Interruption Frequency Index (SAIFI)</td></tr>
<tr><td>Description:</td><td colspan="3">Comparison of SAIFI between BaU and INTERPRETER. SAIFI expresses the average number of interruptions that a customer would experience.</td></tr>
<tr><td>Category of KPI:</td><td>Technical
X</td><td>Environmental
☐</td><td>Economic
☐</td></tr>
<tr><td>Type of KPI:</td><td>Value
☐</td><td>Difference from BaU
☐</td><td>Percentage difference from BaU
X</td></tr>
<tr><th colspan="4">Calculation Specifications</th></tr>
<tr><td>Calculation formula:</td><td colspan="3">$$\frac{SAIFI_{BaU}(number) - SAIFI_{INTERPRETER}(number)}{SAIFI_{BaU}(number)} * 100\%$$
where:
$$SAIFI = \frac{\text{Total number of customer interruptions}}{\text{Total number of customers served}}$$</td></tr>
<tr><td>Unit:</td><td colspan="3">%</td></tr>
<tr><th colspan="4">Sources</th></tr>
<tr><td>Data source:</td><td colspan="3">Output of T4.2, T4.4, T4.5, T5.3, T5.4</td></tr>
<tr><td>Type of data:</td><td colspan="3">Simulation result</td></tr>
<tr><td>Time horizon:</td><td colspan="3">Annual</td></tr>
<tr><th colspan="4">Tools</th></tr>
<tr><td>Relevant tools: Tools contributing to the achievement of the KPI</td><td colspan="3">• Grid congestion and voltage balancing tool (T4.2)
• Predictive maintenance strategies for grid assets tool (T4.4)
• Optimal grid reconfiguration and self-healing tool (T4.5)
• Nodal capacity allocation tool (T5.3)
• Optimal location of dispersed storage tool (T5.4)</td></tr>
<tr><th colspan="4">Target</th></tr>
<tr><td>Target value:</td><td colspan="3">25%</td></tr>
<tr><th colspan="4">Business Interpretation</th></tr>
<tr><td>Impact:</td><td colspan="3">Reduced interruptions per customer and reduced grid operation and maintenance costs due to improved grid stability and lower outage frequency.</td></tr>
<tr><th colspan="4">Relevant Literature</th></tr>
<tr><td>References:</td><td colspan="3">[10]</td></tr>
</table>

TABLE 6: REDUCTION OF SYSTEM AVERAGE INTERRUPTION FREQUENCY INDEX (SAIFI).

Grid Improvement KPI Datasheet			
General Information			
Index:	**Tech.02**		
Name:	**Reduction of System Average Interruption Duration Index (SAIDI)**		
Description:	Comparison of SAIDI between BaU and INTERPRETER. SAIDI expresses the average outage duration for each customer served.		
Category of KPI:	Technical X	Environmental ☐	Economic ☐
Type of KPI:	Value ☐	Difference from BaU ☐	Percentage difference from BaU X
Calculation Specifications			
Calculation formula:	$\frac{SAIDI_{BaU}(minutes) - SAIDI_{INTERPRETER}(minutes)}{SAIDI_{BaU}(minutes)} * 100\%$ where: $SAIDI = \frac{\text{Sum of all customer interruption durations}}{\text{Total number of customers served}}$		
Unit:	%		
Sources			
Data source:	Output of T4.2, T4.4, T4.5, T5.3, T5.4		
Type of data:	Simulation result		
Time horizon:	Annual		
Tools			
Relevant tools: Tools contributing to the achievement of the KPI	• Grid congestion and voltage balancing tool (T4.2) • Predictive maintenance strategies for grid assets tool (T4.4) • Optimal grid reconfiguration and self-healing tool (T4.5) • Nodal capacity allocation tool (T5.3) • Optimal location of dispersed storage tool (T5.4)		
Target			
Target value:	25%		
Business Interpretation			
Impact:	Reduced interruptions per customer, reduced grid operation and maintenance costs due to improved grid stability and lower outage frequency.		
Relevant Literature			
References:	[10]		

TABLE 7: REDUCTION OF SYSTEM AVERAGE INTERRUPTION DURATION INDEX (SAIDI).

Grid Improvement KPI Datasheet			
General Information			
Index:	**Tech.03**		
Name:	**Self consumption rate**		
Description:	Amount of energy supplied by local RES and consumed on site/locally.		
Category of KPI:	Technical X	Environmental ☐	Economic ☐
Type of KPI:	Value X	Difference from BaU ☐	Percentage difference from BaU ☐
Calculation Specifications			
Calculation formula:	$\frac{\text{RES Generation (MWh)}}{\text{Energy Consumption at a specific point (MWh)}} * 100\%$		
Unit:	%		
Sources			
Data source:	Output of T4.2, T4.5, T5.3.		
Type of data:	Simulation result		
Time horizon:	Annual		
Tools			
Relevant tools: Tools contributing to the achievement of the KPI	• Grid congestion and voltage balancing tool (T4.2) • Optimal grid reconfiguration and self-healing tool (T4.5) • Nodal capacity allocation tool (T5.3)		
Target			
Target value:	20%		
Business Interpretation			
Impact:	Increase of renewable energy share in the grid, lower environmental impact and reduction of primary energy consumption.		
Relevant Literature			
References:	[11] (target value), [12]		

TABLE 8: SELF CONSUMPTION RATE.

Grid Improvement KPI Datasheet			
General Information			
Index:	**Tech.04**		
Name:	**Line overload occurrence (LOO)**		
Description:	Number of line overloading events within a year.		
Category of KPI:	Technical X	Environmental ☐	Economic ☐
Type of KPI:	Value X	Difference from BaU ☐	Percentage difference from BaU ☐
Calculation Specifications			
Calculation formula:	$\sum$ Line overload events/year		
Unit:	events/year		
Sources			
Data source:	Output of T4.2,T5.3, T5.4.		
Type of data:	Simulation result		
Time horizon:	Annual		
Tools			
Relevant tools: Tools contributing to the achievement of the KPI	• Grid congestion and voltage balancing tool (T4.2) • Nodal capacity allocation tool (T5.3) • Optimal location of dispersed storage tool (T5.4)		
Target			
Target value:	Maximum 2 events/year		
Business Interpretation			
Impact:	Reduction of congestion issues, increased lifetime of grid components. New approaches for electricity grid planning, monitoring and maintenance.		
Relevant Literature			
References:	[13] (target value), [14]		

TABLE 9: LINE OVERLOAD OCCURRENCE (LOO).

Grid Improvement KPI Datasheet			
General Information			
Index:	**Tech.05**		
Name:	**Reduction of energy consumption (only technical losses)**		
Description:	Reduced energy consumption (related only to technical losses) due to INTERPRETER tools.		
Category of KPI:	Technical X	Environmental ☐	Economic ☐
Type of KPI:	Value ☐	Difference from BaU X	Percentage difference from BaU ☐
Calculation Specifications			
Calculation formula:	Energy consumption$_{BaU}$(MWh) - Energy consumption$_{INTERPRETER}$(MWh)		
Unit:	MWh		
Sources			
Data source:	Output of T4.5, T5.1, T5.2, T5.4.		
Type of data:	Simulation result		
Time horizon:	Annual		
Tools			
Relevant tools: Tools contributing to the achievement of the KPI	• Optimal grid reconfiguration and self-healing tool (T4.5) • Optimal reactive power compensation tool (T5.1) • Planned phase balancing tool (T5.2) • Optimal location of dispersed storage tool (T5.4)		
Target			
Target value:	395,093 MWh (ORES demo), 1,212 MWh (CUERVA demo), 9,442 MWh (DTU demo)		
Business Interpretation			
Impact:	Reduced primary energy consumption, lower environmental impact and reduced OPEX.		
Relevant Literature			
References:	[2]		

TABLE 10: REDUCTION OF ENERGY CONSUMPTION.

Grid Improvement KPI Datasheet			
General Information			
Index:	**Tech.06**		
Name:	**Reduction of non-technical losses in distribution networks**		
Description:	Non-technical losses (NTL)		
Category of KPI:	Technical X	Environmental ☐	Economic ☐
Type of KPI:	Value ☐	Difference from BaU ☐	Percentage difference from BaU X
Calculation Specifications			
Calculation formula:	$\frac{NTL_{BaU}(kWh) - NTL_{INTERPRETER}(kWh)}{NTL_{BaU}(kWh)} * 100\%$		
Unit:	%		
Sources			
Data source:	Output of T4.1		
Type of data:	Simulation result		
Time horizon:	Annual		
Tools			
Relevant tools: Tools contributing to the achievement of the KPI	• Detection of non-technical losses tool (T4.1)		
Target			
Target value:	50%		
Business Interpretation			
Impact:	Reduced primary energy consumption and reduced OPEX due to effective detection of non-technical losses.		
Relevant Literature			
References:	[15]		

TABLE 11: REDUCTION OF NOT-TECHNICAL LOSSES IN DISTRIBUTION NETWORKS.

<table>
<tr><th colspan="4">Grid Improvement KPI Datasheet</th></tr>
<tr><th colspan="4">General Information</th></tr>
<tr><td>Index:</td><td colspan="3">Tech.07</td></tr>
<tr><td>Name:</td><td colspan="3">Reduction of total energy losses (including technical + non-technical losses)</td></tr>
<tr><td>Description:</td><td colspan="3">Amount of electrical energy lost either on grid's conductors, transformers, etc., or due to non-technical losses.</td></tr>
<tr><td>Category of KPI:</td><td>Technical
X</td><td>Environmental
☐</td><td>Economic
☐</td></tr>
<tr><td>Type of KPI:</td><td>Value
☐</td><td>Difference from BaU
☐</td><td>Percentage difference from BaU
X</td></tr>
<tr><th colspan="4">Calculation Specifications</th></tr>
<tr><td>Calculation formula:</td><td colspan="3">$$\frac{\text{Total energy losses}_{\text{BaU}}(\text{kWh}) - \text{Total energy losses}_{\text{INTERPRETER}}(\text{kWh})}{\text{Total energy losses}_{\text{BaU}}(\text{kWh})} * 100\%$$
where:
$$\text{Total energy losses} = \sum (\text{energy supply} - \text{energy consumption})$$</td></tr>
<tr><td>Unit:</td><td colspan="3">%</td></tr>
<tr><th colspan="4">Sources</th></tr>
<tr><td>Data source:</td><td colspan="3">Output of T4.1, T4.2, T4.5, T5.1, T5.2, T5.4.</td></tr>
<tr><td>Type of data:</td><td colspan="3">Simulation result</td></tr>
<tr><td>Time horizon:</td><td colspan="3">Annual</td></tr>
<tr><th colspan="4">Tools</th></tr>
<tr><td>Relevant tools: Tools contributing to the achievement of the KPI</td><td colspan="3">• Detection of non-technical losses tool (T4.1)
• Grid congestion and voltage balancing tool (T4.2)
• Optimal grid reconfiguration and self-healing tool (T4.5)
• Optimal reactive power compensation tool (T5.1)
• Planned phase balancing tool (T5.2)
• Optimal location of dispersed storage tool (T5.4)</td></tr>
<tr><th colspan="4">Target</th></tr>
<tr><td>Target value:</td><td colspan="3">13%, in order to match the cost reduction of the system operator (13%, see Econ.04 KPI below), as contributing to reduced OPEX.</td></tr>
<tr><th colspan="4">Business Interpretation</th></tr>
<tr><td>Impact:</td><td colspan="3">Reduced grid operation and maintenance costs, reduced primary energy consumption, lower environmental impact and reduced OPEX due to combined reduction of technical losses and effective detection of non-technical ones.</td></tr>
<tr><th colspan="4">Relevant Literature</th></tr>
<tr><td>References:</td><td colspan="3">[4]</td></tr>
</table>

TABLE 12: REDUCTION OF TOTAL ENERGY LOSSES.

Grid Improvement KPI Datasheet			
General Information			
Index:	**Tech.08**		
Name:	**Energy recovered due to INTERPRETER**		
Description:	Recovery of energy by the implementation of INTERPRETER tools due to the reduction of SAIDI.		
Category of KPI:	Technical X	Environmental ☐	Economic ☐
Type of KPI:	Value ☐	Difference from BaU X	Percentage difference from BaU ☐
Calculation Specifications			
Calculation formula:	$\frac{\text{Total energy (MWh)*SAIDI reduction (p.u.)*}SAIDI_{BaU}\text{ (h)}}{8760\text{ (h)}}$		
Unit:	MWh		
Sources			
Data source:	Output of tools related to the reduction of SAIDI: T4.2, T4.4, T4.5, T5.3, T5.4.		
Type of data:	Simulation result		
Time horizon:	Annual		
Tools			
Relevant tools: Tools contributing to the achievement of the KPI	• Grid congestion and voltage balancing tool (T4.2) • Predictive maintenance strategies for grid assets tool (T4.4) • Optimal grid reconfiguration and self-healing tool (T4.5) • Nodal capacity allocation tool (T5.3) • Optimal location of dispersed storage tool (T5.4)		
Target			
Target value:	226.5 MWh (ORES demo), 2.23 MWh (CUERVA demo), 2.17 MWh (DTU demo)		
Business Interpretation			
Impact:	Reduced duration of interruptions per customer, reduced OPEX due to improved grid stability and lower outage frequency.		
Relevant Literature			
References:	[10]		

TABLE 13: ENERGY RECOVERED DUE TO INTERPRETER.

Grid Improvement KPI Datasheet			
General Information			
Index:	**Tech.09**		
Name:	**Exploitation of the available flexibility assets**		
Description:	Maximization of flexibility.		
Category of KPI:	Technical X	Environmental ☐	Economic ☐
Type of KPI:	Value ☐	Difference from BaU ☐	Percentage difference from BaU X
Calculation Specifications			
Calculation formula:	$\frac{\text{Storage exploitation}_{\text{INTERPRETER}}(\text{kWh}) - \text{Storage exploitation}_{\text{BaU}}(\text{kWh})}{\text{Storage exploitation}_{\text{BaU}}(\text{kWh})} * 100\%$		
Unit:	%		
Sources			
Data source:	Output of T5.4		
Type of data:	Simulation result		
Time horizon:	Annual		
Tools			
Relevant tools: Tools contributing to the achievement of the KPI	• Optimal location of dispersed storage tool (T5.4)		
Target			
Target value:	12%		
Business Interpretation			
Impact:	Increased self-consumption and RES utilization. Reduced grid infrastructure upgrading costs.		
Relevant Literature			
References:	[16]		

TABLE 14: EXPLOITATION OF THE AVAILABLE FLEXIBILITY ASSETS.

Grid Improvement KPI Datasheet			
General Information			
Index:	**Tech.10**		
Name:	**Blackouts due to congestion issues**		
Description:	Annual number of blackouts due to congestion issues.		
Category of KPI:	Technical X	Environmental ☐	Economic ☐
Type of KPI:	Value X	Difference from BaU ☐	Percentage difference from BaU ☐
Calculation Specifications			
Calculation formula:	$\sum$ number of blackouts due to congestion issues within a year		
Unit:	-		
Sources			
Data source:	Output of T4.5		
Type of data:	Simulation result		
Time horizon:	Annual		
Tools			
Relevant tools: Tools contributing to the achievement of the KPI	• Optimal grid reconfiguration and self-healing tool (T4.5)		
Target			
Target value:	0		
Business Interpretation			
Impact:	Self-healing of the grid. Reduced interruptions and reduced OPEX due to improved grid stability and lower outage frequency.		
Relevant Literature			
References:	[17]		

TABLE 15: BLACKOUTS DUE TO CONGESTION ISSUES.

4.2. ENVIRONMENTAL KPIS

The environmental KPIs are presented in Table 16 - Table 26:

Grid Improvement KPI Datasheet			
General Information			
Index:	**Env.01**		
Name:	**Cumulative energy demand (CED)**		
Description:	The energy needed for the manufacturing of the components of a smart grid. The goal is to compare alternative scenarios of the planning tools.		
Category of KPI:	Technical ☐	Environmental ☒	Economic ☐
Type of KPI:	Value ☒	Difference from BaU ☐	Percentage difference from BaU ☐
Calculation Specifications			
Calculation formula:	$\sum$ CEDmanufacturing (kWh)		
Unit:	kWh		
Sources			
Data source:	Output of T5.5 with the aid of necessary Demo input data.		
Type of data:	Simulation result		
Time horizon:	Once manufactured		
Tools			
Relevant tools: Tools contributing to the achievement of the KPI	• Nodal capacity allocation tool (T5.3) • Optimal location of dispersed storage tool (T5.4) • Environmental and economic assessment tool (T5.5)		
Target			
Target value:	The lowest possible value.		
Business Interpretation			
Impact:	Reduced grid infrastructure upgrading costs and increased renewable energy share in the grid. Reduced grid operation and maintenance costs.		
Relevant Literature			
References:	[7]		

TABLE 16: CUMULATIVE ENERGY DEMAND (CED).

Grid Improvement KPI Datasheet			
General Information			
Index:	**Env.02**		
Name:	**Net energy ratio (NER)**		
Description:	The overall ratio of the total energy generated to the total energy invested (CED) for the RES components of a smart grid.		
Category of KPI:	Technical [ ]	Environmental [X]	Economic [ ]
Type of KPI:	Value [X]	Difference from BaU [ ]	Percentage difference from BaU [ ]
Calculation Specifications			
Calculation formula:	$\frac{\text{Lifetime generation (kWh)}}{\text{Cumulative energy demand (kWh)}}$		
Unit:	-		
Sources			
Data source:	Output of T5.5 with the aid of necessary Demo input data.		
Type of data:	Simulation result		
Time horizon:	Lifetime of the RES components		
Tools			
Relevant tools: Tools contributing to the achievement of the KPI	• Nodal capacity allocation tool (T5.3) • Optimal location of dispersed storage tool (T5.4) • Environmental and economic assessment tool (T5.5)		
Target			
Target value:	The highest possible value.		
Business Interpretation			
Impact:	Implementation of energy efficient renewable systems, leading to lower environmental impact, increase of renewable energy share in the grid, reduction of grid infrastructure upgrading costs, operation and maintenance costs.		
Relevant Literature			
References:	[7]		

TABLE 17: NET ENERGY RATIO (NER).

Grid Improvement KPI Datasheet			
General Information			
Index:	**Env.03**		
Name:	**Energy payback time (EPT)**		
Description:	The time needed for the RES components of a smart grid to make up for all of the energy that was expended for their set-up.		
Category of KPI:	Technical [ ]	Environmental [X]	Economic [ ]
Type of KPI:	Value [X]	Difference from BaU [ ]	Percentage difference from BaU [ ]
Calculation Specifications			
Calculation formula:	$\frac{\text{Lifetime (years)}}{\text{Net energy ratio (number)}}$		
Unit:	years		
Sources			
Data source:	Output of T5.5 with the aid of necessary Demo input data.		
Type of data:	Simulation result		
Time horizon:	Lifetime of the RES components		
Tools			
Relevant tools: Tools contributing to the achievement of the KPI	• Nodal capacity allocation tool (T5.3) • Optimal location of dispersed storage tool (T5.4) • Environmental and economic assessment tool (T5.5)		
Target			
Target value:	The highest possible value.		
Business Interpretation			
Impact:	Implementation of energy efficient renewable systems, leading to lower environmental impact, increase of renewable energy share in the grid, reduction of grid infrastructure upgrading costs, operation and maintenance costs.		
Relevant Literature			
References:	[7]		

TABLE 18: ENERGY PAYBACK TIME (EPT).

Grid Improvement KPI Datasheet			
General Information			
Index:	**Env.04**		
Name:	**RES lifetime CO_2 emissions**		
Description:	Total greenhouse gas emitted by the RES components of a smart grid in order to fully environmentally express the manufacturing process (their operation CO_2 is considered 0).		
Category of KPI:	Technical ☐	Environmental ☒	Economic ☐
Type of KPI:	Value ☒	Difference from BaU ☐	Percentage difference from BaU ☐
Calculation Specifications			
Calculation formula:	$\sum CO_2\_eqmanufacturing\ (kgCO_2)$		
Unit:	$kgCO_2$		
Sources			
Data source:	Output of T5.5 with the aid of necessary Demo input data.		
Type of data:	Simulation result		
Time horizon:	Once manufactured		
Tools			
Relevant tools: Tools contributing to the achievement of the KPI	• Nodal capacity allocation tool (T5.3) • Optimal location of dispersed storage tool (T5.4) • Environmental and economic assessment tool (T5.5)		
Target			
Target value:	The lowest possible value.		
Business Interpretation			
Impact:	Implementation of energy efficient renewable systems, leading to lower environmental impact and increase of renewable energy share in the grid.		
Relevant Literature			
References:	[7]		

TABLE 19: RES LIFETIME CO_2 EMISSIONS.

Grid Improvement KPI Datasheet			
General Information			
Index:	**Env.05**		
Name:	**CO_2 payback time**		
Description:	The amount of time that the RES modules of a smart grid must produce energy to recover the energy it took to produce the modules initially.		
Category of KPI:	Technical [ ]	Environmental [X]	Economic [ ]
Type of KPI:	Value [X]	Difference from BaU [ ]	Percentage difference from BaU [ ]
Calculation Specifications			
Calculation formula:	year when $\sum RDCO_2 * (1\text{-degrate})^{year}$ = Lifetime CO_2 emissions		
Unit:	years		
Sources			
Data source:	Output of T5.5 with the aid of necessary Demo input data.		
Type of data:	Simulation result		
Time horizon:	Annually until the sum of reduced $RDCO_2$ reaches the CO_2-eqmanufacturing		
Tools			
Relevant tools: Tools contributing to the achievement of the KPI	• Nodal capacity allocation tool (T5.3) • Optimal location of dispersed storage tool (T5.4) • Environmental and economic assessment tool (T5.5)		
Target			
Target value:	The lowest possible value.		
Business Interpretation			
Impact:	Lower environmental impact through the implementation of RES, exploiting their zero emissions with a view to recovering as soon as possible in the operating phase the energy footprint incurred during their manufacturing phase.		
Relevant Literature			
References:	[7]		

TABLE 20: CO_2 PAYBACK TIME.

Grid Improvement KPI Datasheet			
General Information			
Index:	**Env.06**		
Name:	**Reduction in direct CO_2 emissions**		
Description:	The amount of CO2 that would be emitted if the lifetime electricity generation of the RES units of the smart grid was produced by conventional means, without considering the CO2 emitted for the set-up of the RES components.		
Category of KPI:	Technical [ ]	Environmental [X]	Economic [ ]
Type of KPI:	Value [X]	Difference from BaU [ ]	Percentage difference from BaU [ ]
Calculation Specifications			
Calculation formula:	$\sum(\text{RES lifetime generation (kWh)} * \text{Emission factor} \left(\frac{kgCO_2}{kWh}\right))$		
Unit:	$kgCO_2$		
Sources			
Data source:	Output of T5.5 with the aid of necessary Demo input data.		
Type of data:	Simulation result		
Time horizon:	Lifetime of the RES components		
Tools			
Relevant tools: Tools contributing to the achievement of the KPI	• Nodal capacity allocation tool (T5.3) • Optimal location of dispersed storage tool (T5.4) • Environmental and economic assessment tool (T5.5)		
Target			
Target value:	The highest possible value.		
Business Interpretation			
Impact:	Lower environmental impact through the increase share of RES in the smart grid. Increase of autonomy and reduction of primary energy consumption.		
Relevant Literature			
References:	[7]		

TABLE 21: REDUCTION IN DIRECT CO_2 EMISSIONS.

Grid Improvement KPI Datasheet			
General Information			
Index:	**Env.07**		
Name:	**CO_2 emissions avoided**		
Description:	Amount of CO_2 emissions avoided due to INTERPRETER solution implementation.		
Category of KPI:	Technical ☐	Environmental ☒	Economic ☐
Type of KPI:	Value ☐	Difference from BaU ☒	Percentage difference from BaU ☐
Calculation Specifications			
Calculation formula:	$CO_2 emissions_{BaU}(kgCO_2) - CO_2 emissions_{INTERPRETER}(kgCO_2)$ where: Annual CO_2 emissions due to the operation of the electrical grid = $(\text{Production by non-RES in the demo (kWh)}) * \left(\text{Fuel emission factor}\left(\frac{kgCO_2}{kWh}\right)\right)$ + $(\text{Injection from grid to the demo site (kWh)}) * (\text{Country emission factor}\left(\frac{kgCO_2}{kWh}\right))$		
Unit:	$kgCO_2$		
Sources			
Data source:	Platform user, when running the 2 scenarios in T5.5 tool.		
Type of data:	Simulation result		
Time horizon:	Annual		
Tools			
Relevant tools: Tools contributing to the achievement of the KPI	• Environmental and economic assessment tool (T5.5)		
Target			
Target value:	219,477 tons (ORES demo), 698 tons (CUERVA demo) and 6,331 tons (DTU demo)		
Business Interpretation			
Impact:	Lower environmental impact through the increase of RES in the grid.		
Relevant Literature			
References:	[18]		

TABLE 22: CO_2 EMISSIONS AVOIDED.

Grid Improvement KPI Datasheet			
General Information			
Index:	**Env.08**		
Name:	**Reduction of environmental footprint for electrical grid**		
Description:	Reduction of environmental footprint for both manufacturing and operational phase. The environmental footprint is related to the manufacturing of the grid components and to the grid usage for a specific time period.		
Category of KPI:	Technical [ ]	Environmental [X]	Economic [ ]
Type of KPI:	Value [ ]	Difference from BaU [ ]	Percentage difference from BaU [X]
Calculation Specifications			
Calculation formula:	$$\frac{\text{Environ. footprint}_{BaU}(kgCO_2) - \text{Environ. footprint}_{INTERPRETER}(kgCO_2)}{\text{Environ. footprint}_{BaU}(kgCO_2)} * 100\%$$ where: Environmental footprint takes into consideration both manufacturing and operational phase.		
Unit:	%		
Sources			
Data source:	Platform user, when running the 2 scenarios in T5.5 tool.		
Type of data:	Simulation result		
Time horizon:	Lifetime		
Tools			
Relevant tools: Tools contributing to the achievement of the KPI	• Optimal reactive power compensation tool (T5.1) • Planned phase balancing tool (T5.2) • Environmental and economic assessment tool (T5.5)		
Target			
Target value:	20%		
Business Interpretation			
Impact:	Lower environmental impact considering not only the operation but also the manufacturing of the grid's components.		
Relevant Literature			
References:	[19]		

TABLE 23: REDUCTION OF ENVIRONMENTAL FOOTPRINT FOR ELECTRICAL GRID.

Grid Improvement KPI Datasheet			
General Information			
Index:	**Env.09**		
Name:	**Increase of RES exploitation**		
Description:	Increase of RES production due to INTERPRETER (in MWh).		
Category of KPI:	Technical [ ]	Environmental [X]	Economic [ ]
Type of KPI:	Value [ ]	Difference from BaU [X]	Percentage difference from BaU [ ]
Calculation Specifications			
Calculation formula:	Energy from RES $_{INTERPRETER}$ (MWh) - Energy from RES $_{BaU}$ (MWh)		
Unit:	MWh		
Sources			
Data source:	Platform user, when running the 2 scenarios in T5.5 tool.		
Type of data:	Simulation result		
Time horizon:	Annual		
Tools			
Relevant tools: Tools contributing to the achievement of the KPI	• Grid congestion and voltage balancing tool (T4.2) • Optimal grid reconfiguration and self-healing tool (T4.5) • Nodal capacity allocation tool (T5.3) • Environmental and economic assessment tool (T5.5)		
Target			
Target value:	375,000 MWh (ORES demo), 1,975 MWh (CUERVA demo) and 14,450 MWh (DTU demo)		
Business Interpretation			
Impact:	Increase of renewable energy share in the grid, leading to increased autonomy and reduction of primary fuel-based energy consumption.		
Relevant Literature			
References:	[20]		

TABLE 24: INCREASE OF RES EXPLOITATION.

Grid Improvement KPI Datasheet			
General Information			
Index:	**Env.10**		
Name:	**Increase of RES exploitation (percentage)**		
Description:	Comparison between the amount of electricity generated from renewable sources with INTERPRETER and with BaU (percentage).		
Category of KPI:	Technical [ ]	Environmental [X]	Economic [ ]
Type of KPI:	Value [ ]	Difference from BaU [ ]	Percentage difference from BaU [X]
Calculation Specifications			
Calculation formula:	$\frac{\text{Energy from RES}_{\text{INTERPRETER}}\text{(MWh) - Energy from RES}_{\text{BaU}}\text{(MWh)}}{\text{Energy from RES}_{\text{BaU}}\text{(MWh)}} * 100\%$		
Unit:	%		
Sources			
Data source:	Platform user, when running the 2 scenarios in T5.5 tool.		
Type of data:	Simulation result		
Time horizon:	Annual		
Tools			
Relevant tools: Tools contributing to the achievement of the KPI	• Grid congestion and voltage balancing tool (T4.2) • Optimal grid reconfiguration and self-healing tool (T4.5) • Nodal capacity allocation tool (T5.3) • Environmental and economic assessment tool (T5.5)		
Target			
Target value:	20%		
Business Interpretation			
Impact:	Increase of renewable energy share in the grid, leading to increased autonomy and reduction of primary fuel-based energy consumption.		
Relevant Literature			
References:	[1]		

TABLE 25: INCREASE OF RES EXPLOITATION (PERCENTAGE).

Grid Improvement KPI Datasheet			
General Information			
Index:	**Env.11**		
Name:	**Reduction of RES potential curtailment**		
Description:	Reduction of RES potential curtailment after INTERPRETER tools' implementation.		
Category of KPI:	Technical [ ]	Environmental [X]	Economic [ ]
Type of KPI:	Value [ ]	Difference from BaU [ ]	Percentage difference from BaU [X]
Calculation Specifications			
Calculation formula:	$\frac{\text{RES curtailment}_{BaU}(\text{kWh}) - \text{RES curtailment}_{INTERPRETER}(\text{kWh})}{\text{RES curtailment}_{BaU}(\text{kWh})} * 100\%$		
Unit:	%		
Sources			
Data source:	Output of T4.5.		
Type of data:	Simulation result		
Time horizon:	Annual		
Tools			
Relevant tools: Tools contributing to the achievement of the KPI	• Optimal grid reconfiguration and self-healing tool (T4.5)		
Target			
Target value:	>0		
Business Interpretation			
Impact:	Lower environmental impact through the increase of RES actual exploitation in the grid, which are maximally exploited, without limitations.		
Relevant Literature			
References:	[1]		

TABLE 26: REDUCTION OF RES POTENTIAL CURTAILMENT.

4.3. ECONOMIC KPIS

The economic KPIs are presented in Table 27 - Table 34:

Grid Improvement KPI Datasheet			
General Information			
Index:	**Econ.01**		
Name:	**Deferred capacity investments due to peak demand reduction**		
Description:	The money saved because of the peak demand reduction during the project.		
Category of KPI:	Technical [ ]	Environmental [ ]	Economic [X]
Type of KPI:	Value [X]	Difference from BaU [ ]	Percentage difference from BaU [ ]
Calculation Specifications			
Calculation formula:	Peak demand reduction due to energy savings and/or peak load shifts (MW) * Incremental cost of peak demand ($\frac{€}{MW}$)		
Unit:	€		
Sources			
Data source:	Output of T5.5, T4.2, T4.5, T5.1, T5.2 and T5.4 with the aid of necessary Demo input data		
Type of data:	Simulation result		
Time horizon:	Annual		
Tools			
Relevant tools: Tools contributing to the achievement of the KPI	• Grid congestion and voltage balancing tool (T4.2) • Optimal grid reconfiguration and self-healing tool (T4.5) • Optimal reactive power compensation tool (T5.1) • Planned phase balancing tool (T5.2) • Optimal location of dispersed storage tool (T5.4) • Environmental and economic assessment tool (T5.5)		
Target			
Target value:	>0		
Business Interpretation			
Impact:	Deferred capacity investments due to energy savings and/or peak load shifts. Reduced CAPEX.		
Relevant Literature			
References:	[3]		

TABLE 27: DEFERRED CAPACITY INVESTMENTS DUE TO PEAK DEMAND REDUCTION.

Grid Improvement KPI Datasheet				
General Information				
Index:		**Econ.02**		
Name:	**Percentage reduction in Operational Expenditure (OPEX)**			
Description:	Reduction of expenditures for operating the DSO's usual line of business—expenditures that are not capital spending in a year. This KPI is related to the reduction of total energy losses.			
Category of KPI:		Technical [ ]	Environmental [ ]	Economic [X]
Type of KPI:		Value [ ]	Difference from BaU [ ]	Percentage difference from BaU [X]
Calculation Specifications				
Calculation formula:	$\frac{OPEX_{BaU}(€) - OPEX_{INTERPRETER}(€)}{OPEX_{BaU}(€)} * 100\%$ where: OPEX = Operational expenditures of the DSO (€)			
Unit:	%			
Sources				
Data source:		Output of T5.5, T4.1, T4.2, T4.5, T5.1, T5.2 and T5.4, with the aid of necessary Demo input data.		
Type of data:		Simulation result		
Time horizon:		Annual		
Tools				
Relevant tools: Tools contributing to the achievement of the KPI	• Detection of non-technical losses tool (T4.1) • Grid congestion and voltage balancing tool (T4.2) • Optimal grid reconfiguration and self-healing tool (T4.5) • Optimal reactive power compensation tool (T5.1) • Planned phase balancing tool (T5.2) • Optimal location of dispersed storage tool (T5.4) • Environmental and economic assessment tool (T5.5)			
Target				
Target value:		>0		
Business Interpretation				
Impact:		Reduced OPEX for the DSO of the smart grid.		
Relevant Literature				
References:		[6]		

TABLE 28: PERCENTAGE REDUCTION IN OPERATIONAL EXPENDITURE (OPEX).

Grid Improvement KPI Datasheet			
General Information			
Index:	**Econ.03**		
Name:	**Percentage reduction in Capital Expenditure (CAPEX)**		
Description:	Comparison of CAPEX before and after the implementation of INTERPRETER tools.		
Category of KPI:	Technical ☐	Environmental ☐	Economic X
Type of KPI:	Value ☐	Difference from BaU ☐	Percentage difference from BaU X
Calculation Specifications			
Calculation formula:	$\frac{CAPEX_{BaU}(€) - CAPEX_{INTERPRETER}(€)}{CAPEX_{BaU}(€)} * 100\%$		
Unit:	%		
Sources			
Data source:	Output of T4.2.		
Type of data:	Projection simulation result		
Time horizon:	Annual		
Tools			
Relevant tools: Tools contributing to the achievement of the KPI	• Grid congestion and voltage balancing tool (T4.2)		
Target			
Target value:	10%		
Business Interpretation			
Impact:	Reduced grid infrastructure upgrading costs (CAPEX) for the DSO of the smart grid.		
Relevant Literature			
References:	[21]		

TABLE 29: PERCENTAGE REDUCTION IN CAPITAL EXPENDITURE (CAPEX).

Grid Improvement KPI Datasheet			
General Information			
Index:	**Econ.04**		
Name:	**Cost reduction for the system operator**		
Description:	Cost reduction for the system operator by the implementation of Smart Grid approaches compared to BaU. This KPI is obtained from CAPEX and OPEX reductions.		
Category of KPI:	Technical ☐	Environmental ☐	Economic X
Type of KPI:	Value ☐	Difference from BaU ☐	Percentage difference from BaU X
Calculation Specifications			
Calculation formula:	Cost reduction for the system operator considering both OPEX and annualized CAPEX reduction. It is assumed that the annual cost for the system operator is equal to the sum of OPEX and annualized CAPEX. where: $\text{Annualized CAPEX} = \frac{\text{Investment cost}}{A}$ $A = \frac{1-\frac{1}{(1+i)^n}}{i}$ n = number of years (expected lifetime), i = rate of interest		
Unit:	%		
Sources			
Data source:	Output of T5.5, T4.5 and T5.4, with the aid of necessary Demo input data. This KPI is calculated by the platform user for 2 scenarios.		
Type of data:	Projection simulation result		
Time horizon:	Annual		
Tools			
Relevant tools: Tools contributing to the achievement of the KPI	• Optimal grid reconfiguration and self-healing tool (T4.5) • Optimal location of dispersed storage tool (T5.4) • Environmental and economic assessment tool (T5.5)		
Target			
Target value:	13%		
Business Interpretation			
Impact:	Overall cost reduction for the DSO of the smart grid, including both OPEX and CAPEX reduction.		
Relevant Literature			
References:	[21]		

TABLE 30: COST REDUCTION FOR THE SYSTEM OPERATOR.

Grid Improvement KPI Datasheet			
General Information			
Index:	**Econ.05**		
Name:	**Annual cost reduction per customer**		
Description:	Annual cost reduction per customer due to expected potential infrastructure savings.		
Category of KPI:	Technical ☐	Environmental ☐	Economic ☒
Type of KPI:	Value ☐	Difference from BaU ☒	Percentage difference from BaU ☐
Calculation Specifications			
Calculation formula:	Cost reduction for the system operator (%) * fixed part of electricity bill per country (%) * Annual energy consumption of the average customer (MWh) * Price of electricity ($\frac{€}{MWh}$) It is assumed that the cost reduction of the system operator (%), which is calculated in the previous KPI, is translated into cost reduction per customer through the fixed charges of the electricity bill. More information can be found in [22].		
Unit:	€		
Sources			
Data source:	Output of T5.5, T4.5 and T5.4, with the aid of necessary Demo input data. This KPI is calculated by the platform user for 2 scenarios.		
Type of data:	Projection simulation result		
Time horizon:	Annual		
Tools			
Relevant tools: Tools contributing to the achievement of the KPI	• Optimal grid reconfiguration and self-healing tool (T4.5) • Optimal location of dispersed storage tool (T5.4) • Environmental and economic assessment tool (T5.5)		
Target			
Target value:	15-20 €		
Business Interpretation			
Impact:	Reduced cost for the smart grid's costumers, resulted by the cost reduction for the grid operator thanks to both the reduced grid infrastructure upgrading costs (CAPEX) and operating & maintenance costs (OPEX).		
Relevant Literature			
References:	[21]		

TABLE 31: ANNUAL COST REDUCTION PER CUSTOMER.

Grid Improvement KPI Datasheet			
General Information			
Index:	**Econ.06**		
Name:	**Savings of consumers (related to ancillary services)**		
Description:	Percentage of savings of consumers before and after the deployment of INTERPRETER tools thanks to ancillary services.		
Category of KPI:	Technical ☐	Environmental ☐	Economic ☒ X
Type of KPI:	Value ☐	Difference from BaU ☐	Percentage difference from BaU ☒ X
Calculation Specifications			
Calculation formula:	$\frac{\text{Cost of consumers}_{\text{BaU}}(€) - \text{Cost of consumers}_{\text{INTERPRETER}}(€)}{\text{Cost of consumers}_{\text{BaU}}(€)} * 100\%$		
Unit:	%		
Sources			
Data source:	Output of T4.2.		
Type of data:	Simulation result		
Time horizon:	Annual		
Tools			
Relevant tools: Tools contributing to the achievement of the KPI	• Grid congestion and voltage balancing tool (T4.2)		
Target			
Target value:	60%		
Business Interpretation			
Impact:	Profit for the customers by providing ancillary services to the grid operator, leading to overall savings in consumers' bills.		
Relevant Literature			
References:	[23]		

TABLE 32: SAVINGS OF CONSUMERS.

Grid Improvement KPI Datasheet			
General Information			
Index:	**Econ.07**		
Name:	**Reduction of maintenance cost**		
Description:	Percentage of reduction of maintenance cost compared to BaU.		
Category of KPI:	Technical ☐	Environmental ☐	Economic X
Type of KPI:	Value ☐	Difference from BaU ☐	Percentage difference from BaU X
Calculation Specifications			
Calculation formula:	$\frac{\text{Maintenance cost}_{BaU}(€) - \text{Maintenance cost}_{INTERPRETER}(€)}{\text{Maintenance cost}_{BaU}(€)} * 100\%$		
Unit:	%		
Sources			
Data source:	Output of T4.4.		
Type of data:	Simulation result		
Time horizon:	Annual		
Tools			
Relevant tools: Tools contributing to the achievement of the KPI	• Predictive maintenance strategies for grid assets tool (T4.4)		
Target			
Target value:	30%		
Business Interpretation			
Impact:	Reduced grid operation and maintenance costs due to an improved and preventive maintenance strategy.		
Relevant Literature			
References:	[24]		

TABLE 33: REDUCTION OF MAINTENANCE COST.

Grid Improvement KPI Datasheet			
General Information			
Index:	**Econ.08**		
Name:	**Recovered revenue to the system operators due to reduced outages**		
Description:	Monetary value of recovered energy resulted by the implementation of INTERPRETER tools. This KPI is related to the energy recovered due to the reduction of SAIDI.		
Category of KPI:	Technical [ ]	Environmental [ ]	Economic [X]
Type of KPI:	Value [ ]	Difference from BaU [X]	Percentage difference from BaU [ ]
Calculation Specifications			
Calculation formula:	$\text{Annual Revenue } (€) * \frac{SAIDI_{BaU}(h)}{8760(h)} * \text{Decrease in outage time}_{INTERPRETER}(p.u.)$ (=Energy recovered (MWh)*Price of energy (€/MWh))		
Unit:	€		
Sources			
Data source:	Output of tools related to the reduction of SAIDI: T4.2, T4.4, T4.5, T5.3, T5.4.		
Type of data:	Simulation result		
Time horizon:	Annual		
Tools			
Relevant tools: Tools contributing to the achievement of the KPI	• Grid congestion and voltage balancing tool (T4.2) • Predictive maintenance strategies for grid assets tool (T4.4) • Optimal grid reconfiguration and self-healing tool (T4.5) • Nodal capacity allocation tool (T5.3) • Optimal location of dispersed storage tool (T5.4)		
Target			
Target value:	10,562.28 € (ORES demo), 118 € (CUERVA demo), 81.17 € (DTU demo)		
Business Interpretation			
Impact:	Reduced interruptions. Reduced outage revenue losses due to improved grid stability and lower outage duration.		
Relevant Literature			
References:	[25]		

TABLE 34: RECOVERED REVENUE TO THE SYSTEM OPERATORS DUE TO REDUCED OUTAGES.

5. ACCURACY/EFFICIENCY KPIS PER TOOL

The INTERPRETER accuracy/efficiency KPIs refer to each individual INTERPRETER tool [5]. The purpose/business interpretation of these KPIs is to showcase the increased accuracy and/or efficiency of every algorithm used in the INTERPRETER solution individually. In order for these KPIs to be thoroughly defined, the following datasheet, presented in Table 35, has been developed:

Tool Accuracy/Efficiency KPI Datasheet			
General Information			
Index:			
Name:			
Description:			
Category of KPI:	Accuracy ☐	Efficiency ☐	Accuracy and Efficiency ☐
Accuracy/Efficiency Metric			
Metric:			
Sources			
Data source:			
Tools			
Relevant tools: Tools contributing to the achievement of the KPI			

TABLE 35: TOOL ACCURACY/EFFICIENCY KPI DATASHEET.

The datasheet contains fields that address the main aspects of an accuracy/efficiency KPI, including its description, its metric, etc. More specifically the included fields are the following:

A. **General Information:** The general information of an accuracy/efficiency KPI are **a) its serial index**, (for example, Acc&Eff.02 identifies the 2nd tool accuracy/efficiency KPI), **b) the proposed KPI's name**, **c) the KPI's description**, and **d) the category of the KPI**, which may refer to accuracy, efficiency or both, depending on the purpose of the tool.
B. **Accuracy/Efficiency Metric:** This field refers to the metric(s) according to which the accuracy or the efficiency of each tool is evaluated.
C. **Sources:** This field refers to the source from which the data could be obtained (in this case: output of a certain tool and data provided by the demo sites).
D. **Tools:** In this field the tool which is evaluated is identified.

The completed datasheets for each tool's accuracy/efficiency KPIs are presented in this Section, in Table 36 - Table 46.

5.1. WP3 TOOLS – GMT

Tool Accuracy/Efficiency KPI Datasheet			
General Information			
Index:	**Acc.&Eff.01**		
Name:	**Accuracy of WP3 tool**		
Description:	How accurate the output of WP3 tool is.		
Category of KPI:	Accuracy X	Efficiency ☐	Accuracy and Efficiency ☐
Accuracy/Efficiency Metric			
Metrics:	Accuracy KPIs: The algorithms of WP3 can only be evaluated based on their accuracy, since they aim to produce a highly accurate grid representation. The grid modelling tool, developed within WP3, predicts the parameters of various grid assets (e.g. Transformers, Cables, PVs), load and generation profiles, network connectivity and voltage states of every network node. Examples of WP3 accuracy KPIs: Voltage difference = V_{real} - $V_{calculated}$ (for magnitudes and angles) Maximum magnitude deviation: 0.006335 pu Maximum angle deviation: 0.0036 degrees Network Connectivity Accuracy: Comparison between the real network graph and the predicted one.		
Sources			
Data source:	Outputs of WP3 vs Data provided by Demo		
Tools			
Relevant tools: Tools contributing to the achievement of the KPI	-Low data availability sub-tool (T3.2) -Medium data availability sub-tool (T3.3) -High data availability sub-tool (T3.4) - Integrated tool coding (T3.5)		

TABLE 36: ACCURACY OF WP3 TOOL.

5.2. T4.1 NTL DETECTION

Tool Accuracy/Efficiency KPI Datasheet			
General Information			
Index:	**Acc.&Eff.02**		
Name:	**Accuracy/Efficiency of T4.1 tool**		
Description:	How accurate/efficient the output of T4.1 tool is.		
Category of KPI:	Accuracy ☐	Efficiency ☐	Accuracy and Efficiency X
Accuracy/Efficiency Metric			
Metrics:	Accuracy KPIs: $\text{Precision} = \frac{TP}{TP+FP}$ where: TP: true positive, number of detected frauds FP: False positives Efficiency KPIs: $\text{Loss reduction}=\frac{\text{Total losses}_{BaU}(MWh) - \text{Total losses}_{INTERPRETER}(MWh)}{\text{Total losses}_{BaU}(MWh)}*100\%$ where: Total losses: Total energy losses (MWh) at Trafo level (balance)		
Sources			
Data source:	Outputs of T4.1, Data provided by Demo		
Tools			
Relevant tools: Tools contributing to the achievement of the KPI	• Detection of non-technical losses tool (T4.1)		

TABLE 37: ACCURACY/EFFICIENCY OF T4.1 TOOL.

5.3. T4.2 GRID CONGESTION AND VOLTAGE BALANCING

Tool Accuracy/Efficiency KPI Datasheet			
General Information			
Index:	**Acc.&Eff.03**		
Name:	**Efficiency of T4.2 tool**		
Description:	How efficient the output of T4.2 tool is.		
Category of KPI:	Accuracy [ ]	Efficiency [X]	Accuracy and Efficiency [ ]
Accuracy/Efficiency Metric			
Metrics:	Efficiency KPIs: Reduction of outages/overloadings/voltage deviations.		
Sources			
Data source:	Outputs of T4.2, Data provided by Demo		
Tools			
Relevant tools: Tools contributing to the achievement of the KPI	• Grid congestion and voltage balancing tool (T4.2)		

TABLE 38: EFFICIENCY OF T4.2 TOOL.

5.4. T4.3 DSO/TSO SERVICE COORDINATION

Tool Accuracy/Efficiency KPI Datasheet			
General Information			
Index:	**Acc.&Eff.04**		
Name:	**Accuracy of T4.3 tool**		
Description:	How accurate the output of T4.3 tool is		
Category of KPI:	Accuracy X	Efficiency ☐	Accuracy and Efficiency ☐
Accuracy/Efficiency Metric			
Metric:	Accuracy KPI: Probabilistic congestion forecast accuracy.		
Sources			
Data source:	Outputs of T4.3, Data provided by Demo.		
Tools			
Relevant tools: Tools contributing to the achievement of the KPI	• DSO/TSO service coordination tool (T4.3)		

TABLE 39: ACCURACY OF T4.3 TOOL.

5.5. T4.4 PREDICTIVE MAINTENANCE

Tool Accuracy/Efficiency KPI Datasheet			
General Information			
Index:	**Acc.&Eff.05**		
Name:	**Efficiency of T4.4 tool**		
Description:	How efficient the output of T4.4 tool is.		
Category of KPI:	Accuracy ☐	Efficiency ☒ X	Accuracy and Efficiency ☐
Accuracy/Efficiency Metric			
Metric:	$$\min_{\eta,c,t \in R^{+}} : \begin{cases} \sum_{i=1}^{n} (w_i * t_i + c_i) \\ -\sum_{i=1}^{n} (\eta_i^{pred} - \eta_i) \end{cases}$$ $$\text{s.t.} \quad \Delta\eta_i = \eta_i^{pred} - \eta_i > 0$$ $$\text{where} \quad \Delta\eta_i = f(t_i , c_i)$$ where n represent the core assets, whose state is under examination, t_i and c_i (€) are the time and cost required for the maintenance, w_i is a weight that represents the total costs when the specific equipment is off (€/time) and η_i is the resulting SoH/HI after the maintenance is performed, while η_i^{pred} is the predicted value of the SoH/HI. The constraints' function $f(t_i , c_i)$ is going to be obtained from a lookup table, which will include maintenance costs, duration of any maintenance action/plan and an estimation of the effect this action will have in the equipment. (As described in D4.7)		
Sources			
Data source:	Outputs of T4.4, Data provided by Demo.		
Tools			
Relevant tools: Tools contributing to the achievement of the KPI	• Predictive maintenance strategies for grid assets tool (T4.4)		

TABLE 40: EFFICIENCY OF T4.4 TOOL.

5.6. T4.5 OPTIMAL GRID RECONFIGURATION

Tool Accuracy/Efficiency KPI Datasheet			
General Information			
Index:	**Acc.&Eff.06**		
Name:	**Efficiency of T4.5 tool**		
Description:	How efficient the output of T4.5 tool is.		
Category of KPI:	Accuracy [ ]	Efficiency [X]	Accuracy and Efficiency [ ]
Accuracy/Efficiency Metric			
Metrics:	Efficiency KPIs: Three objective functions are considered. These objective functions can be expressed in kW, €, % or dimensionless, depending on the case. $h_1=\sum_{i \text{ is not the slack node}} d_i\left(\left(P_i^{load}-P_i^{demanded}\right)^2+\left(Q_i^{load}-Q_i^{demanded}\right)^2\right)+ w_{slack}\left(\left(P_{slack}^{load}\right)^2+\left(Q_{slack}^{load}\right)^2\right)$ Objective function 1: Minimization of the exchanges with the grid (at the slack bus) while satisfying users' demand as much as possible. This function is the weighted sum of the deviation on the delivered power to the users at each node with respect to the power demanded by them plus the energy sold at the slack bus. This objective function is meant to be used in a situation where the user's aim is to be as close as possible to satisfying the customers' demanded loads, prioritizing some consumers to other ones if the weights di are set to be different on them. The last term consisting on the energy sold at the slack bus is used to break ties when different solutions satisfy that the objective function is equal to zero at them, choosing the one that does not generate more power than necessary. $h_2=h_1+\sum_{(i,k)\text{is an edge with a switch}} a_{ik}\ switch_{ik}$ Objective function 2: Objective function 1 plus a cost a_{ik} associated to the use of each line in which there is a switch. This objective function should be used if there is a risk associated to the use of some lines, maybe because the operator has an input coming from the predictive maintenance tool (Task 4.4) concerning the possible fault of some lines in the future, and the operator does not want to use them unless using them is the only possibility to avoid a serious deviation between the power delivered and the power demanded on the loads. If the operator does not want to use these risky lines at all, he should remove them from the model of the grid and then run the Control Optimisation algorithm with Objective function 1. $h_3=h_1+\sum_{i \text{ is a node}} \zeta_i\ \left(\left(P_i^{gen}\right)^2+\left(Q_i^{gen}\right)^2\right)$ Objective function 3: Objective function 1 plus a (possibly different) cost ζ_i associated to the power supplied by each generator. This objective function consists on an economic approach, which is meant to be used if the operator wants to find a compromise between satisfying the power demanded by customers and saving money from energy production. On this approach, the weights defined on Objective function 1 can be seen as virtual costs to the deviation regarding the power demanded. (As described in D4.9)		
Sources			
Data source:	Outputs of T4.5, Data provided by Demo.		
Tools			
Relevant tools: Tools contributing to the achievement of the KPI	• Optimal grid reconfiguration and self-healing tool (T4.5)		

TABLE 41: EFFICIENCY OF T4.5 TOOL.

5.7. T5.1 OPTIMAL REACTIVE POWER COMPENSATION

Tool Accuracy/Efficiency KPI Datasheet			
General Information			
Index:	**Acc.&Eff.07**		
Name:	**Efficiency of T5.1 tool**		
Description:	How efficient the output of T5.1 tool is.		
Category of KPI:	Accuracy [ ]	Efficiency [X]	Accuracy and Efficiency [ ]
Accuracy/Efficiency Metric			
Metrics:	Efficiency KPIs: - Reduced losses (MWh, %) - Reduced peak loads (MW, %) - Reduced OPEX (€, %) - Reduced CAPEX (€, %)		
Sources			
Data source:	Outputs of T5.1, Data provided by Demo.		
Tools			
Relevant tools: Tools contributing to the achievement of the KPI	• Optimal reactive power compensation tool (T5.1)		

TABLE 42: EFFICIENCY OF T5.1 TOOL.

5.8. T5.2 PLANNED PHASE BALANCING

Tool Accuracy/Efficiency KPI Datasheet			
General Information			
Index:	**Acc.&Eff.08**		
Name:	**Efficiency of T5.2 tool**		
Description:	How efficient the output of T5.2 tool is.		
Category of KPI:	Accuracy ☐	Efficiency X	Accuracy and Efficiency ☐
Accuracy/Efficiency Metric			
Metric:	Efficiency KPIs: - Reduced losses (MWh, %) - Reduced peak loads (MW, %) - Reduced OPEX (€, %) - Reduced CAPEX (€, %)		
Sources			
Data source:	Outputs of T5.2, Data provided by Demo.		
Tools			
Relevant tools: Tools contributing to the achievement of the KPI	• Planned phase balancing tool (T5.2)		

TABLE 43: EFFICIENCY OF T5.2 TOOL.

5.9. T5.3 NODAL CAPACITY ALLOCATION

Tool Accuracy/Efficiency KPI Datasheet			
General Information			
Index:	**Acc.&Eff.09**		
Name:	**Efficiency of T5.3 tool**		
Description:	How efficient the output of T5.3 tool is.		
Category of KPI:	Accuracy ☐	Efficiency ☒	Accuracy and Efficiency ☐
Accuracy/Efficiency Metric			
Metric:	Efficiency KPI: Efficiency can be measured checking solution's quality (obtained nodal capacity vs limit value that would generate congestion).		
Sources			
Data source:	Outputs of T5.3, Data provided by Demo.		
Tools			
Relevant tools: Tools contributing to the achievement of the KPI	• Nodal capacity allocation tool (T5.3)		

TABLE 44: EFFICIENCY OF T5.3 TOOL.

5.10. T5.4 OPTIMAL LOCATION OF DISPERSED STORAGE

Tool Accuracy/Efficiency KPI Datasheet			
General Information			
Index:	**Acc.&Eff.10**		
Name:	**Efficiency of T5.4 tool**		
Description:	How efficient the output of T5.4 tool is.		
Category of KPI:	Accuracy ☐	Efficiency X	Accuracy and Efficiency ☐
Accuracy/Efficiency Metric			
Metric:	Efficiency KPI: Percentage of congestion elimination.		
Sources			
Data source:	Outputs of T5.4, Data provided by Demo.		
Tools			
Relevant tools: Tools contributing to the achievement of the KPI	Optimal location of dispersed storage tool (T5.4)		

TABLE 45: EFFICIENCY OF T5.4 TOOL.

5.11. T5.5 ENVIRONMENTAL AND ECONOMIC ASSESSMENT

Tool Accuracy/Efficiency KPI Datasheet			
General Information			
Index:	**Acc.&Eff.11**		
Name:	**Accuracy of T5.5 tool**		
Description:	How accurate the output of T5.5 tool is.		
Category of KPI:	Accuracy X	Efficiency ☐	Accuracy and Efficiency ☐
Accuracy/Efficiency Metric			
Metric:	Accuracy KPIs: Comparison for LCA and LCC results (e.g. in units such as kWh, $kgCO_2$, years, €, €/kWh), based on given data from demos and manufacturers of each component, and the output produced from T5.5 tool (e.g. target of 8%-12% for each LCA and LCC result).		
Sources			
Data source:	Outputs of T5.5, Data provided by Demo.		
Tools			
Relevant tools: Tools contributing to the achievement of the KPI	Environmental and economic assessment tool (T5.5)		

TABLE 46: ACCURACY OF T5.5 TOOL.

6. IT KPIS FOR THE WHOLE INTERPRETER PLATFORM

The IT KPIs for the whole INTERPRETER platform refer to the entire INTERPRETER solution, instead of the accuracy/efficiency KPIs per tool of Section 5. In order for them to be thoroughly defined, the following datasheet, presented in Table 47 has been developed:

Platform IT KPI Datasheet			
General Information			
Index:			
Name:			
Description:			
Type of KPI:	Value ☐	Difference from BaU ☐	Percentage difference from BaU ☐
Input:	Questionnaire ☐	Recording by platform ☐	
Calculation Specifications			
Calculation formula:			
Unit:			
Sources			
Data source:			
Type of data:			
Time horizon:			
Target			
Target value:			
Business Interpretation			
Impact:			
Relevant Literature			
References:			

TABLE 47: PLATFORM IT KPI DATASHEET.

The datasheet contains a number of fields that address all main aspects of a platform IT KPI, including its description, the sort of input it requires from the user, its calculation formula, etc. More specifically the included fields are the following:

A. **General Information:** The general information of a KPI are **a) its identification index**, (for example, Plat.06 identifies the 6th platform IT KPI), **b) the KPI's name**, **c) the KPI's description**, **d) the type of the KPI**, which may be a simple value, a difference between the INTERPRETER solution and the BaU or even a percentage difference from BaU and **e) the input** it requires, which may be a questionnaire that the user answers or a recording by the platform.
B. **Calculation Specifications:** The calculation specifications of a KPI are **a) its calculation formula** and **b) the unit** in which it is expressed, such as seconds/request, MB/request, etc.

C. **Sources:** In this section, the required data and the way to obtain them are defined. More specifically, it is critical to define **a) the data source**, meaning the source from which the data is obtained (in this case, the system monitoring or the platform user), **b) the type of data**, which may be system records or personal opinion expressed by the user **and c) the necessary time horizon** for the calculation of each KPI.

D. **Target:** In this field, the target value of each KPI is proposed, in order to validate the success of the platform.

E. **Business Interpretation:** Each improvement calculated by the proposed platform IT KPIs has an **impact** in terms of business. For example, a user friendly interface has a positive impact on the user experience.

F. **Relevant Literature:** The proposal of a KPI needs to be supported by literature (review papers, research papers, outcome of other projects' deliverables, etc.).

The completed datasheets for the platform IT KPIs are presented in this Section, in Table 48 - Table 53.

6.1. AVERAGE RESPONSE TIME

Platform IT KPI Datasheet			
General Information			
Index:	**Plat.01**		
Name:	**Average response time**		
Description:	Average time that is required for a certain tool to provide the information needed.		
Type of KPI:	Value X	Difference from BaU ☐	Percentage difference from BaU ☐
Input:	Questionnaire ☐	Recording by platform X	
Calculation Specifications			
Calculation formula:	$\frac{\sum \text{All user waiting time (seconds)}}{\sum \text{User requests (number)}}$		
Unit:	seconds/request		
Sources			
Data source:	System monitoring		
Type of data:	System records		
Time horizon:	Duration of demo campaigns		
Target			
Target value:	7 seconds/request		
Business Interpretation			
Impact:	Reduced response time.		
Relevant Literature			
References:	[26], [27]		

TABLE 48: AVERAGE RESPONSE TIME.

6.2. ERROR RATES

Platform IT KPI Datasheet			
General Information			
Index:	**Plat.02**		
Name:	**Error rates**		
Description:	Percentage of user requests that ended in an error (did not provide required results, software failure etc.).		
Type of KPI:	Value [X]	Difference from BaU [ ]	Percentage difference from BaU [ ]
Input:	Questionnaire [ ]	Recording by platform [X]	
Calculation Specifications			
Calculation formula:	$\frac{\sum \text{Failed requests (number)}}{\sum \text{Total requests (number)}} * 100\%$		
Unit:	%		
Sources			
Data source:	System monitoring		
Type of data:	System records		
Time horizon:	Duration of demo campaigns		
Target			
Target value:	5%		
Business Interpretation			
Impact:	Reduced errors.		
Relevant Literature			
References:	[5]		

TABLE 49: ERROR RATES.

6.3. AVERAGE CPU USAGE

Platform IT KPI Datasheet			
General Information			
Index:	**Plat.03**		
Name:	**Average CPU usage**		
Description:	Amount of CPU uptime required per request.		
Type of KPI:	Value [X]	Difference from BaU [ ]	Percentage difference from BaU [ ]
Input:	Questionnaire [ ]	Recording by platform [X]	
Calculation Specifications			
Calculation formula:	$\frac{\sum \text{Uptime for every request (seconds)}}{\sum \text{Requests (number)}}$		
Unit:	seconds/request		
Sources			
Data source:	System monitoring		
Type of data:	System records		
Time horizon:	Duration of demo campaigns		
Target			
Target value:	5 s/request		
Business Interpretation			
Impact:	Minimization of CPU usage requirements for every tool.		
Relevant Literature			
References:	[8]		

TABLE 50: AVERAGE CPU USAGE.

6.4. AVERAGE MEMORY USAGE

Platform IT KPI Datasheet			
General Information			
Index:	**Plat.04**		
Name:	**Average memory usage**		
Description:	Memory required per request.		
Type of KPI:	Value [X]	Difference from BaU [ ]	Percentage difference from BaU [ ]
Input:	Questionnaire [ ]	Recording by platform [X]	
Calculation Specifications			
Calculation formula:	$\frac{\sum \text{Memory required for every request (MB)}}{\sum \text{Requests (number)}}$		
Unit:	MB/request		
Sources			
Data source:	System monitoring		
Type of data:	System records		
Time horizon:	Duration of demo campaigns		
Target			
Target value:	7 MB/request		
Business Interpretation			
Impact:	Minimization of memory requirements for every tool.		
Relevant Literature			
References:	[8]		

TABLE 51: AVERAGE MEMORY USAGE.

6.5. USER INTERFACE FRIENDLINESS

Platform IT KPI Datasheet			
General Information			
Index:	**Plat.05**		
Name:	**User interface friendliness**		
Description:	How easy it is for the user to use the software.		
Type of KPI:	Value X	Difference from BaU ☐	Percentage difference from BaU ☐
Input:	Questionnaire X	Recording by platform ☐	
Calculation Specifications			
Calculation formula:	Likert scale.		
Unit:	-		
Sources			
Data source:	Platform user		
Type of data:	Personal opinion		
Time horizon:	In the end of demo campaigns		
Target			
Target value:	3 (range 1 to 5)		
Business Interpretation			
Impact:	Improved user experience.		
Relevant Literature			
References:	[9]		

TABLE 52: USER INTERFACE FRIENDLINESS.

6.6. USER SATISFACTION

Platform IT KPI Datasheet			
General Information			
Index:	**Plat.06**		
Name:	**User satisfaction**		
Description:	The degree to which measured software performance meets user expectations.		
Type of KPI:	Value X	Difference from BaU ☐	Percentage difference from BaU ☐
Input:	Questionnaire X	Recording by platform ☐	
Calculation Specifications			
Calculation formula:	Apdex score		
Unit:	-		
Sources			
Data source:	Platform user		
Type of data:	Personal opinion		
Time horizon:	In the end of demo campaigns		
Target			
Target value:	0.7 - 0.84 (range 0 to 1)		
Business Interpretation			
Impact:	Improved user experience.		
Relevant Literature			
References:	[28], [29]		

TABLE 53: USER SATISFACTION.

7. CONCLUSIONS

This deliverable provides the KPIs for the assessment of the INTERPRETER solution. The proposed KPIs cover all main aspects of the INTERPRETER solution, including grid improvement KPIs (i.e. technical, environmental and economic KPIs), tool accuracy/efficiency KPIs and platform IT KPIS. Each KPI is presented individually, in a datasheet that contains all valuable information including its description, its calculation formula or its metric, the data sources and the tools that may contribute to its achievement, its target value, its business interpretation, etc. The proposed KPIs shall be calculated during the demo campaigns in the demo sites operated by ORES, CUERVA and DTU in order to validate the INTERPRETER solution.

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