IGREENGrid Recommendations to EEGI regarding the Key Performance Indicators

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Short Description (Max. 50 words):

This document provides an overview of the recommendations made to EEGI team regarding the evaluation of their Key Performance Indicators on practical solutions tested by IGREENGrid demonstrators.

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1 Introduction and scope of the document

The European Electricity Grid Initiative sets general guidelines and roadmaps that are followed by several European projects. The goals identified by EEGI and the definition of their Key Performance Indicators (KPIs) are proposed with an external approach since these decisions are made separately and prior to the development of projects. As a result, the feedbacks concerning the use of their KPIs on projects are important for EEGI in order to see if their guidelines are in line with the realities of the field situation.

1.1 Objective

The objective of the document is to provide an analysis of the applicability of EEGI KPIs on real demonstration projects by highlighting the main problems encountered during the calculation of these indicators on IGREENGrid demonstrators. The final aim is to use this analysis to make a list of recommendations to the EEGI team through the form of simple precautions in order to make the calculation of KPIs possible on real R&I scenarios.

1.2 Organisation of the document

The document is structured as follows:

- Section 2 presents an analysis of the applicability of the EEGI KPIs calculation of the real solutions by identifying the main problems encountered on field;
- Section 3 presents a conclusion summarizing the recommendations issued to EEGI team for improving their KPIs.

1.3 Notations and Acronyms

EEGI	European Electricity Grid Initiative
DER	Distributed Energy Resources
DRES	Distributed Renewable Energy Sources
KPI	Key Performance Indicators
HC	Hosting Capacity
BAU	Business as Usual
R&I	Research and Innovation
SUT	Solution Under Test
SAIDI	System Average Interruption Frequency Index
SAIFI	System Average Interruption Duration Index

Table 1 (Acronyms)

2 Applicability analysis

IGREENGrid project has selected three KPIs from the list defined by the EEGI team. This first category of indicators evaluates technical aspects of the solutions related to the main expected benefits of IGREENGrid solutions.

In addition, from the whole list of EEGI KPIs, the applicability of other relevant KPIs has been investigated because related to technical aspects tested by some IGREENGrid demonstrators (but not common to all of them). As we focus on profitable feedbacks from the calculation of KPIs, all the EEGI KPIs applicable to IGREENGrid will be considered, whether they are used in IGREENGrid evaluation or not. The recommendations of this document are related to the EEGI KPIs in
Table 2.

EEGI KPI	Used for IGREENGrid Evaluations
Increased RES and DER Hosting Capacity	X
Reduced Energy Curtailment of RES/DER	
Power quality and quality of supply	X
Increased Flexibility from energy players	
Reduction of Energy Losses[1]	X

Table 2 (EEGI KPI concerned by the recommendations)

The applicability of these five KPIs has been analyzed according to the difficulties encountered (or expected) in their calculation on IGREENGrid demonstrators. Each considered KPI presents different problems that are detailed in the next paragraphs.

2.1 Increased RES and DER Hosting Capacity

From the integration of DRES in distribution systems, the hosting capacity indicator is the most relevant KPI for the evaluation of the solutions benefits. Multiple methodologies are proposed in literature for the calculation of the maximum connectable generation in distribution grid and, from their analysis, the main aspects to be considered for an accurate estimation of the hosting capacity are:

- The time profiles of loads, generators and other devices;
- The stochastic nature of power consumption and generation;
- The (future) position of generators within the network;
- Model accuracy of the network components.

[1] This indicator is not considered in the final list of EEGI KPIs (GRID+ project) but it is explicitly mentioned in the latest released Roadmap (2013-2022)

Often, the available data from the field-tests on demonstrators does not allow a precise evaluation of these four points and the current state of the art does not include alternative procedure able to guarantee the same level of accuracy with a lower amount of data. According to this, the resulting hosting capacity will be affected by a noticeable uncertainty. In order to provide a meaningful performance evaluation, the effect of the resulting inaccuracy has to be taken into account, defining a range of values in which the KPI is expected to be, instead of a single indication.

2.2 Reduced Energy Curtailment of RES/DER

DRES energy curtailment represents the amount of energy that is effectively available from DRES but couldn't be injected in the network in order to release the network constraints. A high amount of curtailed energy indicates unfavorable conditions for distributed generation integration and, its reduction, determines higher energy contributions from renewable-based power source. The calculation of this KPI is obtained by evaluating the energy "saved" from curtailment.

This KPI is evaluated comparing the real generation profile obtained by field measurement to a predictable generation profile based on forecast. The typical predictable generation profile of renewable based generators is hard to evaluate. As a result the estimation of the curtailed energy amount is not always accurate.

According to this, this KPI can be effectively applied when the generation profile can be precisely reconstructed. Otherwise, the effectiveness of smart grid solutions can be evaluated only by means of dedicated simulations (in which generation profiles are known *a priori*).

2.3 Power Quality and Quality of supply

Power quality and quality of supply are fundamental aspects that have to be considered for a robust operation of the grid. The EEGI team has proposed three separate indicators based on the monitoring of:

- Voltage time profile fulfilling grid nominal voltage;
- Quality of service;
- Identification and isolation of faults.

The evaluation of all these aspects presents some difficulties when the related indicators have to be applied on physical demonstrators. In particular, taking into account the data that can be normally collected from real networks, the following issues for the use of EEGI KPIs (but also for the definition of possible alternatives) have been encountered:

- Definition of voltage profile performance, taking into account the nominal voltage value. Indeed some smart grid solutions can intentionally increase (or decrease) the voltage spread;
- Limited observation intervals for an accurate evaluation of statistic indicators (such as

SAIDI and SAIFI);

- On-field difficulties for testing protection devices and for evaluating their performance in faults identification.

According to these aspects, the limitations imposed by the real network (in which real customers and generators are connected) seem to prevent the application of the proposed KPIs. Again, the possibility to use simulations can be a possible solution for the evaluation of the performance in terms of power quality and quality of supply. In fact, all the considered issues can be solved by simulating the critical situations and, from the obtained results, evaluate the impact of smart grid technologies on their mitigation.

2.4 Increased Flexibility from energy players

The flexibility of generation and consumption is going to play a fundamental role in the future grid, especially when large penetration of renewable based and intermittent generation will take place in distribution networks. The EEGI team has proposed two separate indicators that can be connected to the flexibility of energy players:

- Increase of load/generation capacity participating in network management;
- Reduction of peak load.

Both these indicators do not feature insuperable issues in terms of applicability on real networks. In fact, the input quantities for an accurate evaluation of the flexibility KPIs can be easily measured (consumption and generation profiles basically).

However, from a more accurate analysis of their definition, IGREENGrid consortium agrees on the fact that, especially the peak load, cannot be considered as a performance indicator in several situations. In fact, it has emerged that the necessity of a time variant consumption is often more beneficial than a smoothed profile, in particular when intermittent generation is connected to the selected grid.

2.5 Reduction of Energy Losses

IGREENGrid experience focuses on the practice of innovative solutions for the operation of the distribution systems in presence of deep penetration of DRES. The energetic aspect, such as the impact of these solutions on the technical losses, has been considered a relevant performance indicator. The evaluation of the energy efficiency of a distribution network, in theory, does not represent a critical task. Indeed a simple energy balance can be performed. However, it has to be considered that real networks are subjected to:

- Synchronization mismatch of the energy meters;
- Presence of nontechnical losses (e.g. frauds).

As a result the calculation of the grid efficiency can be affected by large uncertainty. Therefore, again, a possible solution can be represented by the evaluation of the energetic impact of smart

grid solution from the computation of simulation data.

3 Conclusions and Recommendations

The previous section provides feedbacks of several months of exploitation on the IGREENGrid demonstrators regarding the calculation of EEGI KPIs.

A common problem identified is the difficulty to gather large amount of data and to overtake the issues introducing uncertainty in KPI calculation procedures.

The main recommendation made by the IGREENGrid team to overcome the encountered problems is to rely on adequate simulations to reconstruct realistic situations of network operation. Other recommendations have been issued to change the definition of some KPIs in order to make them more relevant according to the realities of the situation.