

D8.1

Key Performance Indicators: Definition and Methods

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Executive summary

The GRETA project aims to understand what the necessary conditions are for supporting people in changing their energy citizenship behaviours towards behaviours that are positive and potentially more active in the context of the European Union's decarbonization agenda. New knowledge will be co-created on energy citizenship, by engaging with key stakeholders in six case studies, which reflect distinct types of energy communities framed at different geographic levels and contexts.

GRETA will utilize various types of key performance indicators (KPIs) to monitor the fulfilment of its main and sub-objectives.

This deliverable provides the final set of project KPIs via which GRETA will be monitored throughout its duration. Its specific objectives are:

1. To verify and revise the set of project KPIs that have been preliminarily identified at the proposal preparation stage.
2. To identify and adopt additional project KPIs, if necessary or useful to GRETA.
3. To develop further the consolidated set of final project KPIs, in order to provide context and guidance for their utilization.
4. Provide initial guidance as to the creation of case study KPIs and CLIs throughout the duration of the project.

Section 2 of the deliverable provides a survey of generic and domain-specific methodologies for KPI identification, categorization, development, and management. Overall, the desk research has found that most KPI methodologies share common practices, such as clustering KPIs into thematic groups or subdividing it into domains.

Section 3 feeds from the findings from Section 2 to develop the KPI framework for GRETA. The consortium had already adopted international good practices for defining the preliminary project KPIs at proposal stage. This section completes the KPI analysis, consolidating its selection and producing the remaining descriptive characterization of each of the project KPIs. The final framework has a flexible and hybrid nature, merging KPI identification, selection, and monitoring approaches from multiple generic and domain-specific literature. All listed preliminary KPIs have been formalized as final project KPIs, while its features have been optimized based upon the CIVITAS framework criteria. Furthermore, one additional KPI was introduced, which resulted in GRETA now totalling 12 project KPIs. Annex 1 provides detailed description tables for each of the final project KPIs.

The creation of case study KPIs and CLIs was also addressed, about which initial guidelines related to KPI clustering, categorization, and spatio-temporal scales were provided. These specific KPIs will be produced at later stages of the GRETA project.

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Summary (for dissemination)	This deliverable assesses the range of preliminary project-level KPIs produced at proposal stage. The analysis offers a generalized check for suitability and a comprehensive characterization of each of the KPIs. A KPI framework is defined for GRETA based on the international good practices from generic and domain-specific literature. The finally selected KPIs are described into dedicated KPI description tables, annexed to this deliverable.
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Abbreviations and acronyms

BSI: Balanced Scorecard Institute

CLI: Community-level Indicator

CSOP: Consumer Stock Ownership Plan

CTP: Community Transition Pathway

DER: Distributed Energy Resources

DSO: Distribution System Operator

ECC: Energy Citizenship Contracts

EU: European Union

EV: Electric Vehicle

ICT: Information and Communication Technologies

KPI: Key Performance Indicator

MCDM: Multi-criteria Decision Making

OPCE: (GRETA's) Open Portfolio for Civic Engagement

RES: Renewable Energy Sources

ROI: Return on Investment

V2G: Vehicle-to-grid

1 Introduction

The GRETA project aims to understand what the necessary conditions are for supporting people in changing their energy citizenship behaviours towards behaviours that are positive and potentially more active in the context of the European Union (EU)’s decarbonization agenda.

GRETA will co-create new knowledge about energy citizenship by engaging with key stakeholders in six case studies, which reflect distinct types of energy communities framed at different geographic levels and contexts. Within each case study, GRETA will identify individual and collective citizen actions that can be taken to support the green energy transition, as well as work with communities to design and test novel mechanisms for change, which are called Community Transition Pathways – CTPs (Figure 1). Lastly, GRETA will create a set of guidelines to equip policymakers in advocating for energy citizenship at a European level and internationally.

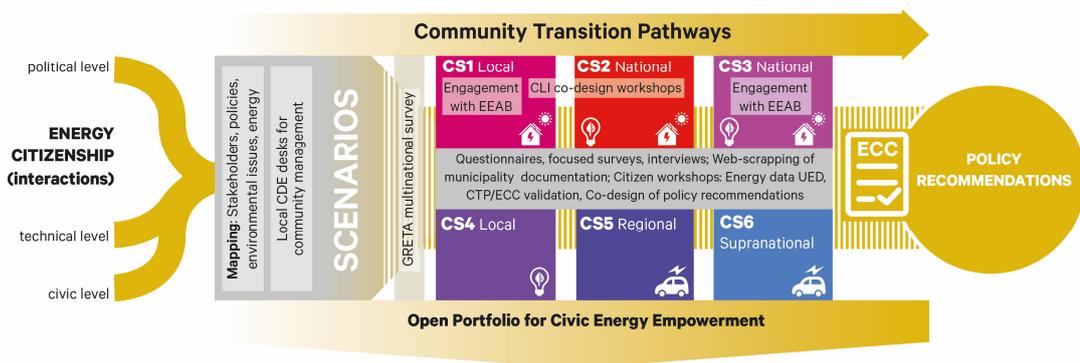


Figure 1: Overall view of the GRETA project activities: Community Transition Pathways assisting GRETA’s case study (CS) communities in the energy transition.

1.1 Key Performance Indicators

GRETA will utilize different types of Key Performance Indicators (KPIs) to monitor the fulfilment of its main and sub-objectives. KPIs could be generally defined as quantifiable indicators of the degree to which an intended result has been achieved, providing an analytical basis not only for performance evaluation and related decision making, but also for driving cross-the-board performance improvements (Cambridge Dictionary, 2021; BSI, 2021).

It is important to make reference to the fact that due to a lack of international consensus on a universal terminology, terms that have been used interchangeably with

the term “KPI” have been at least “performance metric” and/or “performance measure”, even though not all people agree on their equivalency (Barr, 2018).

In what concerns the concrete functional role of KPIs, Parmenter (2015) argues that they:

- Link daily operational activities to broader strategic objectives.
- Offer a glimpse of direction to often dysfunctional collectives.
- Assure more balanced performance.
- Drive ownership, empowerment, and alignment among the work teams.

Figure 2 highlights the process under which, according to Parmenter (2015), pursuing KPI measurement actions supports reaching long-term strategic project objectives, even though such actions take place in operational-level “action plan (AP) silos” characterized by substantially shorter-term foresight.

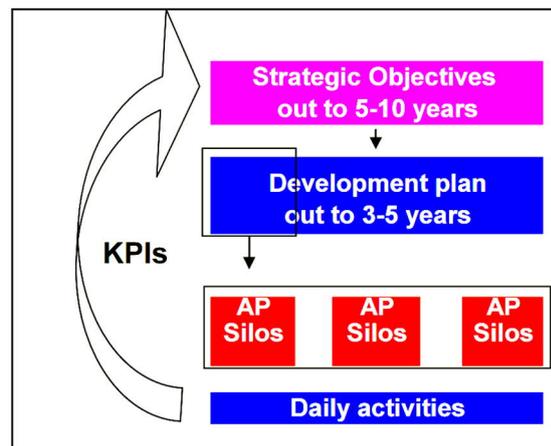


Figure 2: The link between KPIs with strategic goals (Parmenter, 2015).

1.2 The multifaceted KPI approach of GRETA

The KPIs utilized in the GRETA project have three scopes (three kinds of KPIs):

1. KPIs designed to measure success of the whole project, directly measured against fulfilment of GRETA’s main/sub-objectives (GRETA’s “project KPIs”).
2. KPIs designed to monitor the level of fulfilment of the project’s goals through the lens of each of the project’s case studies, thus being transversal to its different contexts (mid-level KPIs, or GRETA’s “case study KPIs”).
3. KPIs that take an explicitly local viewpoint and are co-created within the communities, being thus called “community-level indicators” (CLIs).

Project KPIs have been preliminarily identified at the proposal preparation stage, and their further validation and definition lie within the auspices of Task 8.1, being materialized in the present deliverable.

Case study KPIs align project-level monitoring with the monitoring at case study-level and are expected to be developed within the activities of WP3, in close coordination between LUT and the case study leaders (TNO, UNIBO, FhG, VPS, and TEC). The case study reports (D3.1 – D3.6) will present the final results on case study KPI monitoring.

CLIs are the subject of Task 2.2 and will be finalized only in deliverable D2.3 (M16). A replicable scheme for deriving such indicators via co-creative processes with stakeholders will be delivered earlier as D2.2 (M10). These indicators will be tailored to the local context, depending on what is identified as being relevant in each locality.

While to a degree both case study KPIs and CLIs are out of the scope of this deliverable, different types of guidance are offered on the creation of these KPIs along this report.

1.3 Objectives of the deliverable

The present deliverable will produce the final set of project KPIs through which GRETA will be monitored throughout its duration. Its specific objectives are:

1. To verify and revise the set of project KPIs that have been preliminarily identified at the proposal preparation stage.
2. To identify and adopt additional project KPIs, if necessary or useful to GRETA.
3. To develop further the consolidated set of final project KPIs, in order to provide context and guidance for their utilization.
4. Provide initial guidance as to the creation of case study KPIs and CLIs throughout the duration of the project.

The above objectives are approached mostly through desk research work, based on which existing general and domain-specific methodological frameworks for identifying and describing project KPIs (especially for projects in the same topic areas) are duly analyzed. From these, a suitable framework will be adopted, in order to appropriately describe the final KPIs.

2 Survey of selected KPI frameworks

A KPI framework is a performance measurement methodology used to identify and utilize KPIs. Contrarily to more often used unstructured approaches, such as brainstorming, buying KPIs, or building them from internal or external sources, a KPI framework offers a deliberately designed system that is comprehensive, dedicated, consistent, and verified, helping achieve a project's goals sooner and with less effort.

In order to identify an appropriate methodological framework for GRETA, this deliverable examines a selection of KPI frameworks, classified into:

- “Generic” frameworks, which have a wide and transversal range of applications, being typical of the business and management world.
- “Domain-specific” frameworks, which fall mostly within the scope of research and academia, having in this deliverable a particular focus on the broad clean energy transition context in which GRETA lives.

This task is not intended to be exhaustive, its main goal being to identify a suitable methodology to the context and preliminary KPI analysis performed for GRETA.

2.1 Generic methodologies

KPI methodologies have been promoted and adopted by many businesses worldwide. This has led to a wealth of information available on the web on good practices for identifying, developing, and monitoring KPIs, which can also be useful to consider when developing project KPIs. The desk research in this task has revealed that there is noticeable convergence among these methodologies, in that many of the principles and recommendations offered are shared. For example, most literature acknowledges that in order to identify one or more KPIs, it is firstly necessary to clearly define what the intended results are (i.e., a KPI must be defined in relation to a well-defined objective) and secondly to ascertain the best way to measure the progress towards those results. If these two steps are achieved, then the KPIs can fulfil the requirements of supporting informed decision making and of ensuring that the project focus remains on activities that contribute to reaching its objectives.

2.1.1 KPI identification and categorization

In his reference book on KPIs' development, Parmenter (2015) argues that measures commonly referred to as KPIs could be split into 1) Result indicators – which measure results that have been collectively achieved from an objective perspective – and 2) Performance indicators – which measure performance in a way designed to effectively improve it, and are tied down to processes of the project, some being deemed as “key” and others not. In his work, Parmenter (2015) argues that for years, KPIs have been

largely mislabelled and misused, resulting in lack of focus, adaptability, innovation and profitability, which had been intended goals in the first place. He also identifies the following seven characteristics that KPIs should follow:

1. Being non-financial.
2. Being measured frequently.
3. Being acted upon.
4. Clearly indicating what action is required.
5. Tying responsibility to a particular team (WP or task leaders).
6. Have significant and transversal impact, affecting one or more objectives.
7. Encourage appropriate action, impacting positively on other indicators.

An article published in *Performance Magazine*, published by the KPI Institute, leads a discussion on the different kinds of KPIs, attempting to establish a general KPI typology by compiling the most commonly found definition criteria (Mihăiloaie, 2015). Grouping KPIs based on such criteria provides clarity as to what is being measured in relation to the objectives assigned. The output to this analysis is shown in Figure 3.

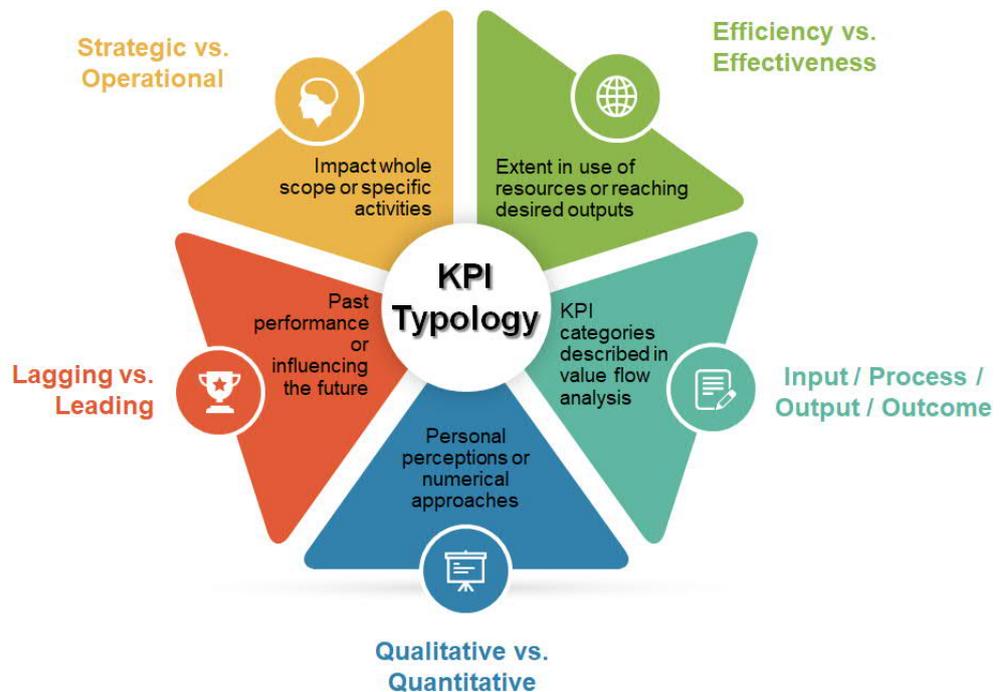


Figure 3: A general KPI typology based on some of the most commonly adopted definition criteria (Mihăiloaie, 2015).

Identified customary definition criteria for KPIs include the following:

- Efficiency vs. Effectiveness: Effectiveness KPIs are linked to whether the outputs of a process were generated as desired. Efficiency has to do with the amount of resources used in order to achieve that process output. These criteria are then both entirely process-related (Mihăiloaie, 2015).
- Strategic vs. Operational: Operational KPIs help measure the short-term performance of specific activities in the project, thus having a smaller scope, whereas strategic KPIs help measure the implementation of a long-term strategy, and generally have a wider scope. However, any KPI can become strategic if identified as an important value driver for a project. To the interpretation of the authors, strategic KPIs are rather similar to what Parmenter (2015) would call “result indicators” (or “key result indicators”), and operational KPIs to what he would simply call “performance indicators” (or “key performance indicators”).
- Lagging vs. Leading: Lagging KPIs show how successful the project was at achieving its intended results, measuring what’s already passed, thus indicating past performance. Leading KPIs, on the other hand, are predictive measurements indicating the direction a project is likely to take, being precursors of future success, and allowing for early corrective action (BSI, 2021).
- Qualitative vs. Quantitative: KPIs that measure personal traits and perceptions/opinions i.e., that are not measured by numbers are considered qualitative. Quantitative indicators, on the other hand, can be measured numerically, and correspond to the most common and most straightforward of KPIs. Quantitative KPIs can be continuous or discrete. Typically, a qualitative KPI is a characteristic of a process or a decision, focusing more on the “why” than on the “how” (McCluney, 2020).
- Input/Process/Output/Outcome: Deploying a value flow analysis for each objective provides added insights into measuring the KPIs, allowing for differentiating what is produced from what can only be influenced. KPIs can be identified into four sequential stages (BSI, 2021; Wilsey, 2017; Mihăiloaie, 2015).
 - Input KPIs measure the amount, time, and quality of resources involved in achieving the objectives (i.e. consumed in processes that produce outputs). Indicators could be related to human capital, costs, etc.
 - Process KPIs focus on the efficiency, quality, and consistency of the processes used to produce a specific output and required to achieve the expected outcomes.
 - Output KPIs refer to either the quality or the quantity of the goods produced, or the services created (i.e. indicate how much work is done and define what is produced).
 - Outcome KPIs focus on accomplishments, measuring the impact achieved through the provision of goods and services.

The value flow-based KPI analysis adopted by Mihăiloaie (2015) has been expanded in BSI (2021) and Wilsey (2017) into a more comprehensive framework for describing KPIs called the “Logic Model” (Figure 4). This approach, adopted by the Balanced Scorecard Institute (BSI), considers an additional KPI family – Project KPIs – which measure the status of deliverables and the progress of milestones in a given project. Within the project KPI’s one can find sub-categories of KPIs, such as employee-related KPIs and implementation risk-related KPIs.

The Logic Model is also helpful for separating between elements that are more operational versus those that are more strategic in nature, effectively enabling the mapping of the range of available measures into operational and strategic KPIs. As a result, Input, Process, Output, and Project KPIs are placed into the operational domain, whereas Outcome KPIs are placed into the strategic domain (Figure 4). In addition to this, Outcome KPIs can still be divided into intermediate and end outcome KPIs.

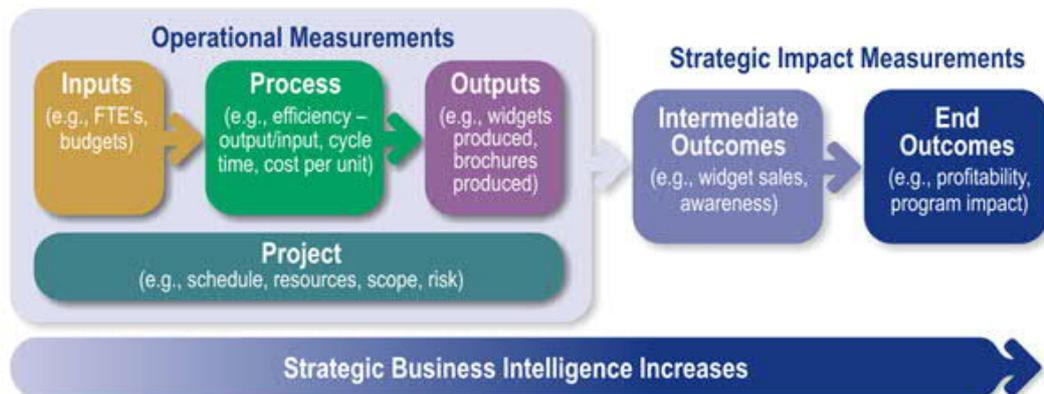


Figure 4: The Logic Model framework for describing KPIs (BSI, 2021; Wilsey, 2017).

This survey intends to highlight only the most commonly found types of performance measures, albeit many more (of less prevalent use) have been adopted in recent literature. For example, McCluney (2020) makes reference to the existence of:

- Practical indicators, which are specific and unique KPIs that take into account existing project processes and explore their effects.
- Directional indicators, which evaluate specific trends within the project, for example to understand if performance is improving or declining, thus being useful for establishing benchmarking analyses.
- Actionable indicators, which include a broad category of measures reflecting the commitment and effectiveness in implementing change processes.

Lastly, Mihăiloaie (2015) argues that KPIs could also be deemed as “active” vs. “inactive” (depending on if they’re monitored or not), “primary” vs. “secondary” (depending on their reliance on another KPI), “public” vs. “internal” (depending on

the nature of the target audience), and “human” vs. “technological” (depending on whether data is exposed to human or system errors).

2.1.2 KPI development and management

The “PuMP Blueprint” performance measurement approach seeks to demystify performance measurement and KPIs by eliminating “bad KPI habits”. The goal is to substitute generalized KPI practices with meaningful and engaging performance measures that drive effective improvement (Barr, 2019, 2014). The methodology follows a sequence of eight steps one should consider when creating and/or utilizing KPIs (Figure 5). The eight steps in PuMP could be briefly described as 1) Diagnosing needs and purpose for the measurement; 2) Clarifying goals and their measurability; 3) Choosing feasible and relevant KPIs; 4) Engaging with others to avoid lack of interest; 5) Comprehensively describe the selected KPIs; 6) Learn on how to properly collect insights from measurements; 7) Developing impactful performance reports; and 8) Reaching the relevant and meaningful targets set for each objective.

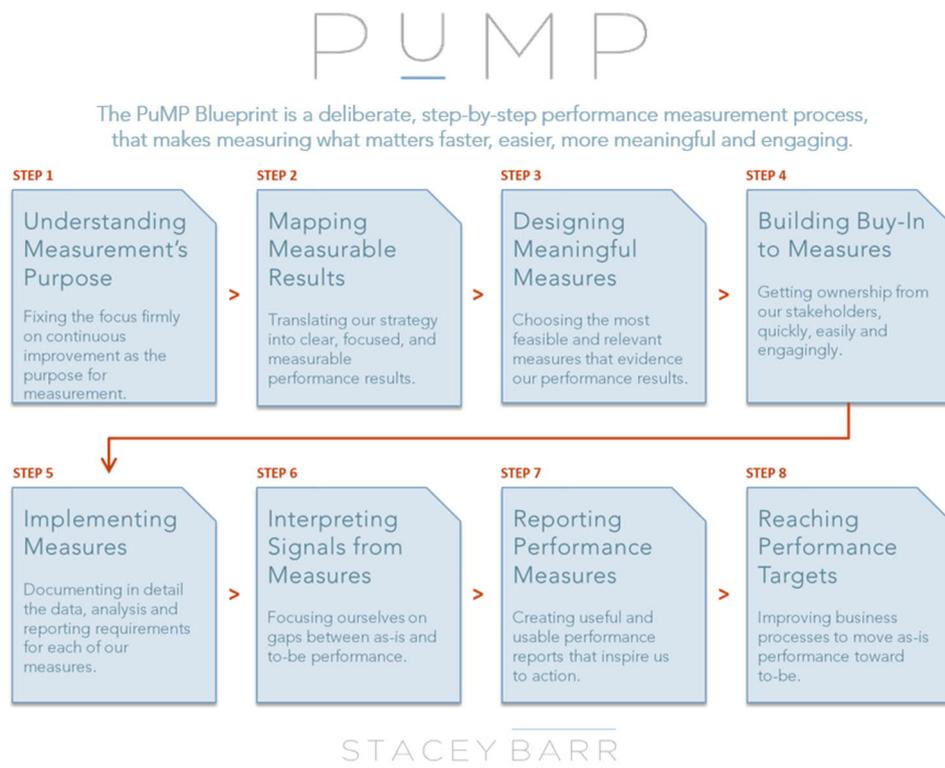


Figure 5: The PuMP Blueprint’s eight steps to choose, implement and utilize quantitative KPIs (Barr, 2019, 2014).

The PuMP Blueprint’s “4-Step Recipe” for writing quantitative KPIs includes:

1. The statistic: Choosing what the best form of summary statistic is for turning the raw data into the values of your measure (e.g. totals, unit count, average, range, share, etc.).

2. The performance attribute data item(s): Clearly identifying the data item, or data items, the statistic is being applied to (e.g. kg. of sand collected, kg. of sand transported...).
3. The scope data item(s): Defining the extent of the performance area that the measure should relate to, while clarifying exclusions (e.g number of new customers that are *referred to by existing customers*).
4. The temporal data item(s): Choosing the frequency of calculation for the measure, which should be included in the description (e.g. number of journals sold *per week*). Interestingly, this methodology strongly disavows aligning measuring frequency with reporting time frames. Accordingly, the frequency of the measure should be frequent enough to detect signals as soon as possible, but not so frequent that the signals may “drown in noise”.

Partially in line with the PuMP Blueprint methodology, the KPI selection advice from BSI-sponsored KPI.org (BSI, 2021a) establishes that before KPIs are set, it is important to articulate the project objectives and determine a strategy for achieving them. The framework follows six fundamental steps to take in when defining KPIs, which are:

1. Describing intended results: If the objectives are clearly articulated they are easier to define measurements for.
2. Understanding alternative measures: This should include the gaining the understanding of how the intended result could be measured directly and based on how many measures (is there a clear way to capture the entire intended result in one or more measures?). Suitable indirect measurements should be identified if no direct measurement is possible. The Logic Model framework can be used to support this type of analysis.
3. Selecting the right measures for each objective: If there are different options for measuring, identify appropriate criteria to choose those that have most relevance. Criteria could include to choose metrics that:
 - (i) Provide information needed to make better strategic choices.
 - (ii) Are valid and verified for measuring what is intended.
 - (iii) Encourage desirable behaviour.
 - (iv) Avoid undue data collection burden or other intended consequences.
4. Defining composite indices as needed: Whenever possible and applicable, two or more KPIs could be grouped into specific indices, to aid the analysis. Composite indices are mostly useful when single indicators aren't meaningful by themselves or don't “tell the whole story” about the performance on an intended result.
5. Setting targets and thresholds: In this important step, the boundaries for good and bad performance should be defined, in order to aid the interpretation and analysis of results.

6. Defining and documenting selected performance measures: This methodology uses a specific table for documenting KPIs - the “Performance measure data definition table”.

Largely inspired by the methodologies and foundational guidelines from PuMP (Barr, 2019, 2018, 2014) and BSI (BSI, 2021a, 2021b), Intrafocus, a UK strategic planning consultancy and training organization, as well as KPI management software provider, established its own KPI framework. This framework provides guidance through the process of developing clear objectives and KPIs to support a strategy, describes processes to ensure KPIs have targets and owners, and shows how to build KPIs that provide clear evidence of whether or not objectives are being met (Intrafocus, 2014).

Most organizations are good at *defining strategy* but very few are good at successfully *implementing strategy*. Accordingly, the Intrafocus methodology is centered around ensuring accurate presentation and interpretation of defined KPIs, being based on seven key steps (Intrafocus, 2014):

1. Create objective: A KPI should not exist unless it contributes to an objective.
2. Describe Results: It is essential to create a result for each objective using a results-oriented language, and not to fall in the common mistake of focusing on defining activities instead.
3. Identify Measures: This should be done following three crucial activities, which are clearly describing the measure, rating the measure in terms of importance, and providing details as to KPI calculation and ownership.
4. Define Thresholds: To be valuable, a KPI needs to be compared to something.
5. Upload Structure/Data into a System: At this stage objectives and metrics can be loaded into a dedicated performance management system (this is related to the type of services that Intrafocus offers).
6. Interpret Results: Once there is historical data, it will be possible to effectively interpret the results via appropriate reporting and visualization means (also linked to the functionalities of the software products offered by Intrafocus).
7. Take Action: This could take place by developing mitigating activities when problems occur or creating initiatives to promote change.

2.2 Domain-specific methodologies

While the previous section has outlined general good practices for categorizing, creating, and monitoring KPIs, this section focuses on exploring approaches applied within specific domains. The collective of literature reviewed pertains to smart cities (Angelakoglou et al., 2020; Angelakoglou et al., 2019; Bosch et al., 2017) and low carbon energy communities (Moghadam et al., 2020; Lien, 2019).

Overall, the desk research has found that domain-specific KPI methodologies take “bits and pieces” from general methodologies, and that the following practices are common:

- Clustering KPIs into broad groups, labelled differently depending on the study.
- Subdividing KPIs into specific domains, also named differently according to the approach followed in each study.
- Compilation of KPIs into composite indices, to facilitate interpretation.
- Mapping key stakeholders for each one of the KPIs defined.

2.2.1 Frameworks for KPI selection and management

Bosch et al. (2017) describe and use a framework for creating smart city indicators aimed at tracking the progress towards city and project objectives. This framework has been produced in the context of the EU project CITYkeys. In developing its KPI selection, CITYkeys has collaborated with the TRIAGULUM, REMOURBAN and SMARTER TOGETHER projects, which also produced smart city KPIs. The approach followed by Bosch et al. (2017) subdivides KPIs into five “impact categories” or “themes”: People, Planet, Prosperity, Governance, and Propagation. Each theme is then allocated subthemes reflecting different policy ambitions. By focusing the indicators on impacts instead of sectors, implicit focus on isolated, sector-specific solutions will be avoided, even though cross-sectoral solutions can be easily evaluated.

In their work, Bosch et al. (2017) used an adaptation of the BSI’s Logic Model framework to create the different types of indicators, as Input, Process, Output, and Outcome KPIs, even though a fifth type of indicator was added – Impact KPIs. This type of indicator measures the quality and quantity of long-term results (e.g. measurable change in quality of life or improved air quality), being a primary focus of the CITYkeys project (Bosch et al., 2017 took a step further in this consideration, since outcome KPIs already measure some level of impact).

According to Bosch et al. (2017), a disadvantage of impact indicators is that these only become apparent after the project has been implemented, which could take years. Also, numerous contextual factors can influence final impact. However, in CITYkeys, this is deemed the only feasible measure for reaching policy goals. To arrive at a shortlist of indicators, the CIVITAS framework set of KPI criteria was used (Engels, et al., 2017):

1. Relevance: Importance for the evaluation process.
2. Completeness: Considering all aspects of implementation of the project.
3. Availability: Data for indicators should be easily made available.
4. Measurability: Measure indicators as objectively as possible.
5. Reliability: Be clear and not vague to avoid different interpretations.

6. Familiarity: Easy to understand by the users.
7. Non-redundancy: Avoiding measuring the same things.
8. Independence: Indicators should not double-count impact; for example, there is a relationship between reducing fossil fuels and reducing CO₂.

In 2019, Lien et al. developed a methodology for selecting cross-scale KPIs for informing smart, low carbon, urban energy communities and further monitor their transition. The methodology consists of four main steps (Figure 6):

1. Identifying project objectives and relevant goals across all scales, if applicable.
2. Conducting a literature review to extract a list of potential KPIs to assess performance towards the previously identified project objectives and goals.
3. Selecting the most relevant KPIs through multiple attribute or multi-criteria decision making (MCDM), suitable for problems that involve multiple conflicting criteria, where it is necessary to narrow down a long list of options. Using this method, all KPIs are ranked based on multiple attributes, and decision criteria are established (similar to those used in the CIVITAS framework). Only non-redundant KPIs complying with minimum decision criteria are selected, whereas other KPIs are discarded.
4. Obtain user feedback on the outputs of Step 3 and perform the process iteratively between steps 2 and 3, refining KPIs until agreement is reached on their suitability to measure progress towards the project’s goals and targets.

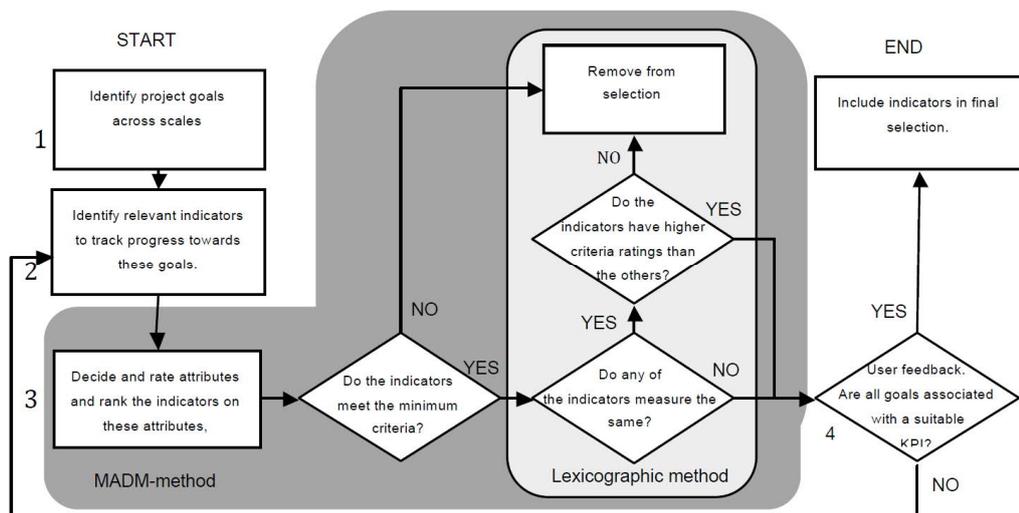


Figure 6: A multi-criteria methodology for selecting key performance indicators suitable to low carbon energy community projects (Lien, et al., 2019).

In Lien et al. (2019), objectives/KPIs have been sorted by so-called “themes” (e.g. green mobility in the energy system, smart energy management...) and allocated to spatial scales (building, neighbourhood, region, city, country). The proposed KPI framework

was applied to two case study Norwegian energy communities and 11 KPIs were selected. The methods for obtaining user feedback were stakeholder group qualitative interviews and workshops. It turned out that some of the KPIs were not as available or measurable as initially expected, which led to a reassessment and defining new KPIs.

Angelakoglou et al. (2019) created their own six step framework for creating KPIs to evaluate smart city technologies and services. This has been mostly based on the assessment of various KPI methodologies developed in the context of EU-funded research on smart cities. The framework requires (Angelakoglou, et al., 2019):

1. Clustering the technologies into different “*transition tracks*”, for example:
 - a. Smart renewables and closed-loop energy positive districts.
 - b. Smart energy management and storage for grid flexibility.
 - c. Smart e-mobility sector.
 - d. City innovation platform.
 - e. Citizen engagement and co-creation.
2. Identifying key stakeholders, such as Distribution System Operators (DSO)s, consumers/citizens, service providers, and policy makers.
3. Defining KPI dimensions, such as:
 - a. Technical Performance: e.g. energy consumption, peak load reduction.
 - b. Environmental Performance: e.g. CO₂ emissions reduction.
 - c. Economic Performance: e.g. average cost of energy consumption.
 - d. Social Performance: e.g. degree of user satisfaction.
 - e. Performance of ICT: e.g. people utilizing energy monitoring apps.
 - f. Legal Performance: e.g. measuring barriers against use of biofuels for energy exploitation.
4. Defining a KPI repository, such that it is possible to evaluate selected technologies not just against the identified KPIs but also using those same KPIs against other solutions with similar characteristics. In creating the repository, KPIs should be *narrowed down and filtered to the most suitable ones* potentially using the CIVITAS framework criteria (as in Bosch et al., 2017).
5. Defining levels of evaluation per KPI, that are related to the element of scale. For example, *building, set of buildings, energy supply unit, set of energy supply units, neighbourhood, and city*.
6. Defining a threshold per KPI, setting quantified objectives of the project with respect to that KPI.

In Angelakoglou et al. (2020), the authors significantly extend their review of smart city KPI frameworks from Angelakoglou et al. (2019) to a detailed analysis of dozens of frameworks and initiatives linked to several research projects and academic literature. In this exercise Angelakoglou et al. (2020) survey almost 2000 smart city KPIs, which helped substantiate some of the categorization already advanced in Angelakoglou et al. (2019). KPIs have been identified in the dimensions “Energy”, “Environmental”,

“Economic”, “ICT”, “Mobility”, “Social”, “Governance”, and “Propagation”. Based on this comprehensive approach, the authors reiterate the framework from Angelakoglou et al. (2019) while further depicting aspects of KPI “clustering” based on orientation and temporal and spatial scales. This work’s key outcome is the 63-strong final list of KPIs for the EU-funded POCITYF project, which deals with the development of positive energy districts in eight historic cities of Europe.

Lastly, just like in Lien et al. (2019), Moghadam et al. (2020) used a type of MCDM analysis to select and evaluate KPIs aimed at monitoring the transition of energy communities to a low-carbon future. This was done in the context of energy community establishment through a broader legal framework called Consumer Stock Ownership Plans (CSOPs). In this project, KPI selection is done in three stages:

1. Literature review: In the first step, a wide range of KPIs is identified based on a comprehensive review of existing literature.
2. KPI filtering: In the second step, KPIs are narrowed down as a result of internal discussion rounds among relevant experts.
3. KPI selection: In the third step, the final set of KPIs is selected through a participatory workshop with the community. Finally, the MCDM is employed to optimize this selection and produce a final ranking and listing of indicators. Thus, contrarily to the approach followed in Lien et al. (2019), multi-criteria analysis is performed here *after* the users’ feedback, rather than ahead of it.

In their work, Lien et al., (2019) followed the common practice of grouping KPIs into environmental, economic, technical, and social indicators. Other than that, KPIs were straightforwardly categorized as either qualitative or quantitative.

2.2.2 Listing of KPIs found in domain-specific literature

This section describes some of the KPIs that have been identified in academic smart city and low-carbon energy communities’ literature. The goal is exclusively to provide an overview of final KPIs adopted in other projects and initiatives and not to produce any analysis of the appropriateness of such KPIs or of their specific categorization.

Firstly, Angelakoglou et al. (2019) have derived a KPI list via application of their proposed framework in various “domains”. Some selected examples of KPIs within each of these domains are presented in Table 1 (full details of definition, formula, unit, level, stakeholders, and threshold/targets can be found in Angelakoglou et al., 2019):

Table 1: Example KPIs within various domains from Angelakoglou et al. (2019).

KPI domain	Example KPIs
Technical	<ul style="list-style-type: none"> • Degree of energetic self-supply by RES • Reduced energy curtailment of RES and DER

	<ul style="list-style-type: none"> • Average number of electrical interruptions per customer per year • Average length of electrical interruptions (in hours) • Energy demand and consumption • Energy savings • Smart storage capacity • Battery degradation rate • Storage energy losses • Maximum hourly deficit • Energy consumption data aggregated by sector fuel • Yearly km made through the e-car sharing system instead of conventional cars • Number of efficient vehicles deployed in the area • Number of EVs charging stations and solar powered V2G charging stations deployed in the area
<p>Environmental</p>	<ul style="list-style-type: none"> • Carbon dioxide emissions' reduction • Increase in local renewable energy generation • Increased efficiency of resources consumption • Reduction in annual final energy consumption • Decreased emissions of particulate matter • Decreased emission of nitrogen oxides (NOx) • Noise pollution
<p>Economic</p>	<ul style="list-style-type: none"> • Payback • Return on Investment (ROI) • Reduction of energy cost • Financial benefit for the end-user • Grants • Fuel poverty • Stimulating an innovative environment • Awareness of economic benefits of reduced energy consumption
<p>Social</p>	<ul style="list-style-type: none"> • Consumers' engagement • Professional stakeholder involvement • Social compatibility (fit to people's frame of mind, does not challenge values) • Ease of use for end-users of the solution • Advantages for end-users • Advantages for stakeholders • People reached • Thermal comfort

	<ul style="list-style-type: none"> • Increased environmental awareness • Increased consciousness of citizenship • Increased participation of vulnerable groups • Local job creation • Local community involvement in the implementation phase • Increased citizen awareness of the potential of smart city projects • Number of city officials and urban experts trained to conduct meaningful and ethical engagement of citizens • Provision of a localized multi stakeholder co-creation and co-production Field Guide for Citizen Engagement activities • Participation of citizens, citizen representative groups and citizen ambassadors in the co-creation of local/micro KPIs for Citizen Engagement for Smart Cities
<p>Legal</p>	<ul style="list-style-type: none"> • Green building self-consumption legal framework compatibility • Symbiotic waste heat legal framework compatibility • Energy flexibility policies legal framework compatibility • Smart EVs legal framework compatibility • City platform legal framework compatibility • Changes in rules and regulations • Measure extent to which privacy by design is ensured
<p>ICT</p>	<ul style="list-style-type: none"> • Peak load reduction • Number of customers that are positive about how energy systems are controlled • Reliability • Increased system flexibility for energy players • Increased hosting capacity for RES, EVs and other new loads • Impact of ICT apps into mobility • Developer engagement • Data safety • Data loss prevention • Usage of open source software • Expiration date of open data • Quality of open data • Platform downtime • Open data based solutions • Number of active “touch points” identified

Moghadam et al. (2020) also generated a list of indicators, as discussed earlier categorized as environmental, economic, technical and social, as well as quantitative and qualitative. There are many overlaps with the indicators of Angelakoglou et al. (2019). A few additional indicators include:

- Local PM₁₀ emissions’ reduction (quantitative, environmental).
- Public incentives (quantitative, economic).
- Increase of plan system efficiency (quantitative, economic).
- Architectural impact (qualitative, social).

The CITYkeys indicator framework (Bosch et al., 2017) assesses performance in five “themes”: people (e.g. social), planet (e.g. environmental), prosperity (e.g. economic), governance (e.g. legal) and “propagation” (which appears to relate to *impact potential*) as well as considering the different levels of the indicators. The authors have created a number of indicators within these themes which are demonstrated to be generalized in a way that could be mapped to all different types of typical smart city indicators, which therefore can be used to cover a number of different projects. Bosch et al. (2017) demonstrate their approach by mapping these core indicators against some existing examples from real smart city projects.

Table 2 presents selected CITYkeys indicators from across the categories described above, organized into specific “sub-themes”, some of which have been found from other indicators’ lists already.

Table 2: Example KPIs within various sub-themes from Bosch et al. (2017).

KPI sub-theme	Example KPIs
Energy and mitigation	<ul style="list-style-type: none"> • Reduction in annual final energy consumption (by buildings) • Reduction in life cycle energy use • Reduction of embodied energy of products and services used in the project • Carbon dioxide emission reduction • Reduction in lifecycle CO₂ emissions • Local freight transport fuel mix
Pollution and waste	<ul style="list-style-type: none"> • Decreased emissions of Nitrogen dioxides • Reduction in the amount of solid waste collected
Economic performance	<ul style="list-style-type: none"> • Financial benefit for the end-user • Payback period
Materials, water, and land	<ul style="list-style-type: none"> • Increased efficiency of resources consumption

	<ul style="list-style-type: none"> • Share of recycled input materials • Share of renewable materials • Share of materials recyclable
Factors of success	<ul style="list-style-type: none"> • Changing professional norms • Changing societal norms
Climate resilience	<ul style="list-style-type: none"> • Climate resilience measures

3 KPI framework for GRETA

The GRETA project includes three types of KPIs: project KPIs, case study KPIs, and CLIs. From these three, the present deliverable will focus on project KPIs the most, of which a preliminary list was produced already at proposal stage.

The GRETA consortium has adopted international good practices (e.g. BSI, 2021a; Moghadam et al., 2020; Barr, 2019, Angelakoglou et al., 2019; Lien, 2019; Bosch et al., 2017) for defining preliminary project KPIs, by:

1. Defining high-level project objectives.
2. Reshaping higher-level objective sub-components into clear intended results.
3. Identifying respective measures, following commonplace KPI criteria, such as relevance, completeness, measurability, independence, etc.

This section will thus complete and finalize the KPI analysis and selection, as well as produce the remaining descriptive characterization of each of the project KPIs, by:

4. Rechecking for suitability of intended results and KPIs, while considering whether there is a need for using additional KPIs (or for filtering out any existing ones) and/or need for creation of composite indices.
5. Perform typology analysis and assess KPI selection for category balance.
6. Clustering KPIs and defining KPI relevant dimensions.
7. Allocating ownership to goals and KPIs.
8. Clarifying KPI measurement thresholds to enable future monitoring.
9. Mapping responsible stakeholders per KPI.
10. Compiling characterization into KPI tables.

In practical terms, the GRETA consortium adopted a flexible and hybrid framework that merges KPI identification, selection, and monitoring approaches from multiple generic and domain-specific literature.

3.1 Suitability of preliminary KPIs

GRETA has five high-level objectives with nine respective sub-objectives. Each sub-objective has at least one preliminarily identified KPI, as presented in

Table 3. In the table, together with most KPIs, there are also potential units and a range of results, reflecting the minimum and maximum expected outcomes for that KPI.

These KPIs have been advanced jointly by the consortium along the preparation of the project proposal. However, while this contribution is collective, each partner devoted more effort to developing indicators that were linked to their expertise and experience,

and thus to the objectives associated to their contribution to GRETA (e.g. LUT to SO2.1-KPI 2.1, TNO to SO2.3-KPI 2.3, UNIBO to SO3.2-KPIs 3.2a and 3.2b, etc.).

Table 3: List of objectives, sub-objectives and preliminary project KPIs defined for GRETA.

Objective	Sub-objective (intended result)	Project KPI/Unit/Outcome
Objective 1 TO UNDERSTAND WHO ENERGY CITIZENS ARE and clarify concepts, definitions, and evolving perspectives on energy citizenship	SO1.1. Increasing the understanding of energy citizenship amongst stakeholders	KPI 1.1 Increased level of understanding from case studies stakeholders indicated by no. of case study stakeholders declaring they better understand energy citizenship as an operative concept (Range 6-18)
Objective 2 TO UNDERSTAND HOW ENERGY CITIZENS ACT AND INTERACT individually and collectively, within energy communities, and whether and how exclusion from this process happens	SO2.1. Creation of EU survey database containing data from across Europe on energy citizenship practices	KPI 2.1 No. of responses within EU survey database (Range 9000-10000)
	SO2.2. Identification of principles to support participation of energy citizens, by combatting exclusion and improving utilization of energy-related data and other sources of information to mediate communications and knowledge-building	KPI 2.2 A set of recommendations to support application of principles in different contexts (Range 5-10)
	SO2.3. Develop framework for energy citizenship emergence	KPI 2.3 Framework produced and accepted by case study stakeholders (Range 6-18)
Objective 3 TO DEVELOP AND TEST BEHAVIOURAL STRATEGIES, APPROACHES AND MODELS FOR FACILITATING ENERGY CITIZENSHIP leading to new strategies for achieving decarbonization	SO3.1. Testing and validation via case studies of models for classification and prediction of energy citizenship phenomena to support understanding of energy citizenship behaviour	KPI 3.1 No. of (diverse) participants to case study workshops and co-design (Range 60-180)
	SO3.2. Creation of roadmaps for case studies to transition along decarbonization pathways and Energy Citizenship Contracts (ECC) to support implementation of roadmaps	KPI 3.2a No. of new case study decarbonization pathway roadmaps (Range 4-6) KPI 3.2b No. of new Energy Citizenship Contract Drafts prepared for signature (>2)

Objective	Sub-objective (intended result)	Project KPI/Unit/Outcome
	SO3.3. Evaluation of GRETA approach for decarbonization via ECCs, by identifying and utilising community-level indicators (CLIs) within case studies	KPI 3.3a Creation of community-level indicators (Range 6-12) KPI 3.3b No. of indicators showing positive trend according to the metric defined by case study community (Range 4-8)
Objective 4 TO REALIZE IMPACT BY SCALING APPROACHES from local case study to regional, national and supranational levels leading to generalizing and formalizing project outputs for further use	SO4.1. Repository of open source materials based on project outputs	KPI 4.1 Access and downloads from repository during final year (> 50)
Objective 5 TO IMPROVE THE POLICY MAKING PROCESS towards a more favourable governance, policy, political, legal, and financing framework for the emergence of energy citizenship in the EU	SO5.1. Guidelines for establishing policies and regulations that favour civic energy engagement	KPI 5.1 Policy briefs drafted and ready to disseminate (6)

The above set of preliminary indicators has been re-checked for suitability, based on the individual and collective assessment of the KPIs, using the CIVITAS framework. The result of this analysis is presented in Table 4.

Table 4: Preliminary KPI list's suitability analysis based on the CIVITAS framework.

Defining criteria	Analysis' comments
Relevance	The partners are aligned in that there is relevance to each of the 11 indicators advanced for GRETA, and that collectively, these indicators support both the intended results and the five main goals of the project. Yet, the latter has been optimized by addition of one KPI pertaining to Objective 5. KPI naming has also been improved to reflect concerns with diversity aspects.
Completeness	Project KPIs have been defined that cover its various implementation stages. The analysis of the set of KPIs for completeness was performed based on the Logic Model framework, which will be further depicted in the KPI typology analysis (Section 3.2).

Defining criteria	Analysis' comments
Availability	This analysis was made challenging at the onset of GRETA. However, LUT and case study leaders are developing the means for assuring that all KPI data will be easily gatherable. Moreover, there is no indication at this stage that data availability will become a challenge for monitoring of any of the KPIs.
Measurability	Most KPIs are quantitative and of simple measurement. Some other KPIs have a qualitative nature (KPI 1.1 and KPI 2.3), which requires indirect measurement approaches. For those cases, approaches were developed to allow the reporting in numerical terms. Thus, all 11 KPIs are capable of being measured as objectively as possible. For most KPIs, a measurement unit had not been added to the proposal. These units were now added in Table 6. For two of the original KPIs (KPI 1.1 and KPI 3.3b), new units were defined with view of improving measurability. A 12 th KPI has been added, which has also a quantitative nature.
Reliability	With the exception of KPI 3.3a, the advanced KPIs were re-written for better clarity and to avoid varied, ambiguous interpretations (Table 5).
Familiarity	As typical in social sciences' projects, most KPIs were described in a non-technical language, purposely easily understandable by a general audience. This is particularly relevant for GRETA, given the wide range of citizens the project will engage in the case studies. The naming of the KPIs and the units was further optimized for familiarity in the naming revision performed and also considered in the new KPI added.
Non-redundancy	All KPIs were successfully checked for uniqueness and to avoid redundancy. This was reinforced during the course of re-writing of the KPIs for reliability.
Independence	All the KPIs have a unique nature. However, there are relations between some of them, which are difficultly avoidable. For example, the accounting for successfully signed energy citizenship contracts (KPI 3.2b) is linked to accounting of decarbonization pathway roadmaps (KPI 3.2a). Following the precedent from Bosch et al. (2017), the consortium has knowingly opted for including these KPIs due to its policy relevance. Aspects of KPI independence will be monitored along the project and any double counting will be avoided.

While the GRETA team considered the CIVITAS framework to be the most appropriate and practical, this selection of KPIs is also compliant with requirements set by other authors. For example, referring to the work of Parmenter (2015):

- All the advanced KPIs have significant impact and are non-financial.

- The KPIs are clear as to their actionability and measurability (even though for most KPIs, measurement units have only been added in this deliverable). Measurability has also been improved by better clarifying measurement units.

Other criteria proposed in Parmenter (2015) will also be addressed in the next sections, such as transversal impact across the project (see Section 3.2) and monitoring responsibility (see Section 3.4, albeit this was already addressed earlier in this section when making mention to preliminary KPI preparation at proposal stage).

As mentioned above, KPIs were renamed for reliability and familiarity purposes. The list of renamed KPIs is presented in Table 5.

Table 5: Original and revised naming of GRETA's project KPIs.

Project KPI code	Original naming	Revised naming
KPI 1.1	Increased level of understanding from case studies stakeholders	<i>Level of understanding of practical aspects of energy citizenship by diverse case study stakeholders</i>
KPI 2.1	No. of responses within EU survey database	<i>Participation of diverse stakeholders in GRETA's multinational survey</i>
KPI 2.2	A set of recommendations to support application of principles in different contexts	<i>Degree of project contribution to fomenting better utilization of energy-related data and other sources of information</i>
KPI 2.3	Framework produced and accepted by case study stakeholders	<i>Acceptance of GRETA's energy citizenship framework by diverse case study stakeholders</i>
KPI 3.1	No. of (diverse) participants to case study workshops and co-design	<i>Participation of diverse case study stakeholders in co-design and testing/validation workshops</i>
KPI 3.2a	No. of new case study decarbonization pathway roadmaps	<i>Level of realization of decarbonization roadmaps within the case studies</i>
KPI 3.2b	No. of new Energy Citizenship Contract Drafts prepared for signature	<i>Level of realization of energy citizenship contracts within the case studies</i>
KPI 3.3a	Creation of community-level indicators	<i>(unchanged)</i>
KPI 3.3b	No. of indicators showing positive trend according to	<i>Positive trends in community-level indicators</i>

Project KPI code	Original naming	Revised naming
	the metric defined by case study community	
KPI 4.1	Access and downloads from repository during final year	<i>Stakeholder access to open, digitally-available, semi-structured project outputs</i>
KPI 5.1	Policy briefs drafted and ready to disseminate	<i>Degree of project contribution to improving policy making on energy citizenship</i>

The KPI units were also revised. The list of renamed KPIs is presented in Table 6.

Table 6: Original and revised units for each of GRETA's project KPIs.

Project KPI code and name	Original unit	Revised unit
KPI 1.1 <i>Level of understanding of practical aspects of energy citizenship by diverse case study stakeholders</i>	No. of case study stakeholders declaring they better understand energy citizenship as an operative concept	<i>Average (between all the case studies) share of total case study stakeholders inquired declaring that they understand practical aspects of energy citizenship (%)</i>
KPI 2.1 <i>Participation of diverse stakeholders in GRETA's multinational survey</i>	No. of responses within EU survey database (indicated as same as KPI)	<i>No. of survey responses registered</i>
KPI 2.2 <i>Degree of project contribution to fomenting better utilization of energy-related data and other sources of information</i>	(none indicated)	<i>No. of recommendations on citizen participation in different contexts produced</i>
KPI 2.3 <i>Acceptance of GRETA's energy citizenship framework by diverse case study stakeholders</i>	(none indicated)	<i>Average (between all the case studies) share of total case study stakeholders inquired with a score above 4 on a 5-point Likert scale for user acceptance (%)</i>
KPI 3.1 <i>Participation of diverse case study stakeholders in co-design and testing/validation workshops</i>	No. of (diverse) participants to case study workshops and co-design (indicated as same as KPI)	<i>Total (between all the case studies) no. of case study stakeholder participants in co-design and</i>

Project KPI code and name	Original unit	Revised unit
		<i>testing/validation workshops</i>
KPI 3.2a <i>Level of realization of decarbonization roadmaps within the case studies</i>	No. of new case study decarbonization pathway roadmaps (indicated as same as KPI)	<i>Total (between all the case studies) no. of decarbonization roadmaps produced</i>
KPI 3.2b <i>Level of realization of energy citizenship contracts within the case studies</i>	No. of new Energy Citizenship Contract Drafts prepared for signature (indicated as same as KPI)	<i>Total (between all the case studies) no. of energy citizenship contracts signed</i>
KPI 3.3a <i>Creation of community-level indicators</i>	(none indicated)	<i>Total (between all the case studies) no. of community-level indicators created</i>
KPI 3.3b <i>Positive trends in community-level indicators</i>	No. of indicators showing positive trend according to the metric defined by case study community (indicated as same as KPI)	<i>Share of the total (between all the case studies) no. of community-level indicators showing a positive trend (%)</i>
KPI 4.1 <i>Stakeholder access to open, digitally-available, semi-structured project outputs</i>	(none indicated)	<i>No. of registered downloads from the GRETA Open Portfolio for Civic Energy Empowerment (OPCE)</i>
KPI 5.1 <i>Degree of project contribution to improving policy making on energy citizenship</i>	(none indicated)	<i>No. of energy citizenship policy briefs produced</i>

The GRETA consortium decided to add one single project KPI to GRETA. This addition is in objective 5 "To improve the policy making process towards a more favourable governance, policy, political, legal, and financing framework for the emergence of energy citizenship in the EU". The naming and unit adopted for the new KPI are specified in Table 7.

Table 7: Project KPIs added to GRETA.

Project KPI code	KPI naming	KPI unit
KPI 5.1	Participation of EU-level and national diverse stakeholders in policy maker workshops	<i>No. of stakeholder participants in policy maker workshops</i>

The newly added KPI is to be monitored ahead of the original and revised KPI 5.1 “Degree of project contribution to improving policy making on energy citizenship”. Thus, the new enumeration of project KPIs pertaining to objective 5 is:

- KPI 5.1 Participation of EU-level and national diverse stakeholders in policy maker workshops, measured by No. of stakeholder participants in policy maker workshops.
- KPI 5.2 Degree of project contribution to improving policy making on energy citizenship, measured by No. of energy citizenship policy briefs produced.

3.2 KPI typology

This section analyses the typology of the KPI selection. Ideally, the range of KPIs adopted in the project would reflect a good balance between the different KPI types.

The section focuses on three specific “typology dualities” deemed of greater relevance:

- Typology duality 1: “Operational” or “Strategic”?
- Typology duality 2: “Lagging or “Leading”?
- Typology duality 3: “Qualitative” or “Quantitative”?

Table 3, Table 8, Table 9, and Table 10 perform the typology analysis for each of the three dualities.

Table 8: Analysis of the KPI typology duality 1 for the selected KPIs.

Project KPI code and name	KPI typology duality 1	
	Operational	Strategic
KPI 1.1 <i>Level of understanding of practical aspects of energy citizenship by diverse case study stakeholders</i>		✓ To increase awareness of energy citizenship within communities is a key goal for GRETA
KPI 2.1 <i>Participation of diverse stakeholders in GRETA’s multinational survey</i>	✓	
KPI 2.2 <i>Degree of project contribution to fomenting better utilization of energy-related data and other sources of information</i>		✓ To provide means and tools that allow citizens and communities to increase engagement

Project KPI code and name	KPI typology duality 1	
	Operational	Strategic
		in energy citizenship action has strategic relevance in GRETA
KPI 2.3 <i>Acceptance of GRETA's energy citizenship framework by diverse case study stakeholders</i>	✓	
KPI 3.1 <i>Participation of diverse case study stakeholders in co-design and testing/validation workshops</i>	✓	
KPI 3.2a <i>Level of realization of decarbonization roadmaps within the case studies</i>	✓	
KPI 3.2b <i>Level of realization of energy citizenship contracts within the case studies</i>		✓ To establish new policy frameworks to accelerate local decarbonization is absolute key for GRETA
KPI 3.3a <i>Creation of community-level indicators</i>	✓	
KPI 3.3b <i>Positive trends in community-level indicators</i>	✓	
KPI 4.1 <i>Stakeholder access to open, digitally-available, semi-structured project outputs</i>		✓ To realize impact through cross-pollination of energy citizenship knowledge and tools openly provided in GRETA is a strategic objective
KPI 5.1 <i>Participation of EU-level and national diverse stakeholders in policy maker workshops</i>	✓	
KPI 5.2 <i>Degree of project contribution to improving policy making on energy citizenship</i>		✓ To improve energy citizenship policy making at intergovernmental level is one of the most important outcomes of the GRETA project

Table 9: Analysis of the KPI typology duality 2 for the selected KPIs.

Project KPI code and name	KPI typology duality 2	
	Lagging	Leading
KPI 1.1 <i>Level of understanding of practical aspects of energy citizenship by diverse case study stakeholders</i>		✓
KPI 2.1 <i>Participation of diverse stakeholders in GRETA's multinational survey</i>		✓
KPI 2.2 <i>Degree of project contribution to fomenting better utilization of energy-related data and other sources of information</i>	✓	
KPI 2.3 <i>Acceptance of GRETA's energy citizenship framework by diverse case study stakeholders</i>		✓
KPI 3.1 <i>Participation of diverse case study stakeholders in co-design and testing/validation workshops</i>		✓
KPI 3.2a <i>Level of realization of decarbonization roadmaps within the case studies</i>	✓	
KPI 3.2b <i>Level of realization of energy citizenship contracts within the case studies</i>	✓	
KPI 3.3a <i>Creation of community-level indicators</i>	✓	
KPI 3.3b <i>Positive trends in community-level indicators</i>		✓
KPI 4.1 <i>Stakeholder access to open, digitally-available, semi-structured project outputs</i>		✓
KPI 5.1 <i>Participation of EU-level and national diverse stakeholders in policy maker workshops</i>		✓
KPI 5.2 <i>Degree of project contribution to improving policy making on energy citizenship</i>	✓	

Table 10: Analysis of the KPI typology duality 3 for the selected KPIs.

Project KPI code and name	KPI typology duality 3	
	Qualitative	Quantitative
KPI 1.1 <i>Level of understanding of practical aspects of energy citizenship by diverse case study stakeholders</i>	✓	
KPI 2.1 <i>Participation of diverse stakeholders in GRETA's multinational survey</i>		✓
KPI 2.2 <i>Degree of project contribution to fomenting better utilization of energy-related data and other sources of information</i>		✓
KPI 2.3 <i>Acceptance of GRETA's energy citizenship framework by diverse case study stakeholders</i>	✓	
KPI 3.1 <i>Participation of diverse case study stakeholders in co-design and testing/validation workshops</i>		✓
KPI 3.2a <i>Level of realization of decarbonization roadmaps within the case studies</i>		✓
KPI 3.2b <i>Level of realization of energy citizenship contracts within the case studies</i>		✓
KPI 3.3a <i>Creation of community-level indicators</i>		✓
KPI 3.3b <i>Positive trends in community-level indicators</i>		✓
KPI 4.1 <i>Stakeholder access to open, digitally-available, semi-structured project outputs</i>		✓
KPI 5.1 <i>Participation of EU-level and national diverse stakeholders in policy maker workshops</i>		✓
KPI 5.2 <i>Degree of project contribution to improving policy making on energy citizenship</i>		✓

The tables show a very good balance for dualities 1 and 2, i.e. between operational and strategic KPIs, and between lagging and leading KPIs. In total, GRETA includes 7 KPIs that could be categorized as operational, and 5 that could be categorized as strategic. Moreover, the total for lagging KPIs is 5, against 7 leading KPIs, which is very positive.

In terms of duality 3, while GRETA is a social sciences and humanities project prone to abundance of qualitative measurements with indirect measurement units, several quantitative indicators have been selected. Qualitative KPIs are a minority. However, the balance within duality 3 is not as key as in dualities 1 and 2, and thus the higher amount of quantitative measures is not deemed to be prohibitive, but rather considered practical from the KPI monitoring and management perspective.

The second level of analysis for typology of the KPIs selected for GRETA is related to the use of the Logic Model as in BSI (2021) and Wilsey (2017), which is helpful for differentiating what we produce from what we can only influence and adds detail to the categorization into operational and strategic measurements. Correspondingly and ideally, the selected KPIs for GRETA would be well balanced between input, process, output, project, and outcome KPIs. Within outcome KPIs, which are in essence strategic measurements, one can include both intermediate and end outcome KPIs.

Table 11 indicates the placement of the newly revised list of project KPIs for GRETA into the different Logic Model stages.

Table 11: Logic Model-based analysis of the KPI typology categorization for the selected KPIs.

Project KPI code	Operational measurements				Strategic measurements	
	Inputs	Processes	Outputs	Project	Intermediate outcomes	End outcomes
KPI 1.1						✓
KPI 2.1	✓					
KPI 2.2					✓	
KPI 2.3		✓				
KPI 3.1	✓					
KPI 3.2a			✓			
KPI 3.2b					✓	
KPI 3.3a				✓		
KPI 3.3b				✓		
KPI 4.1					✓	
KPI 5.1	✓					
KPI 5.2						✓

As Table 11 shows, for a project with a total of 12 selected KPIs, the balance between the different stages (according to the Logic Model) is very good. All stages have at least one identified KPI, whereas most stages have 2-3 KPIs.

Based on the above analyses, it can be concluded that overall, the revised list of GRETA KPIs is not only suitable but very well balanced from the KPI typology standpoint.

3.3 KPI clusters and dimensions

This section explores the clustering of GRETA KPIs (called “transition tracks”, “impact categories”, “domains” or “themes” in the literature) and its potential segmentation in different KPI dimensions (in the literature also called sub-themes).

3.3.1 Clustering of KPIs

The GRETA project looks into the social and human sides of the EU’s energy transition. Within this transition, GRETA investigates different “pathways”, which are linked to the context of each of the project’s case studies. These transition pathways bear a resemblance to the concept of “transition tracks” from Angelakoglou et al. (2019), in which smart city solutions have been clustered into highly interdisciplinary domains, *in terms of the need they address, and yet under a common umbrella*. The GRETA framework will adopt this approach and its nomenclature (for a matter of consistency), tackling three such domains, or tracks, of the energy transition¹:

- Transition track 1: *Intelligent Renewable Energy Systems*.
- Transition track 2: *Energy Efficient Buildings and Homes*.
- Transition track 3: *Smart Connected and Automated Mobility*.

Figure 7 illustrates how the GRETA case studies are mapped into these domains.

¹ In the GRETA proposal, these domains were called “categories”, being among the key attributes used to demonstrate the complementary nature of the proposed case studies.

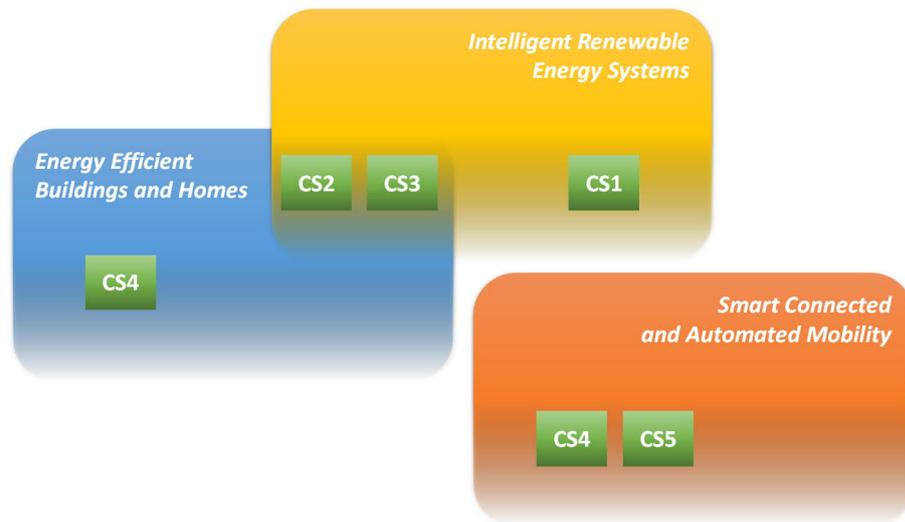


Figure 7: Mapping GRETA case studies into transition tracks ("CS" : Case study).

The objectives of case studies 1 (Bologna Pilastro-Roveri, Italy), 2 (Natural gas-free neighbourhoods, The Netherlands), and 3 (Coopérnico, Portugal) all fall within Transition track 1.

The focus of case study 4 (UR BEROA, Spain) is most substantially on energy efficiency. This is in addition to case studies 2 and 3, which also have that emphasis, albeit in addition to the emphasis on renewable energy. Thus, the goals for these three cases can be mapped to Transition track 2.

Case studies 5 (MobileCityGame, Germany) and 6 (Electric autonomous and connected mobility network) pertain to the field of mobility, thus fitting within Transition track 3.

Because each case study's expected outcomes are transition track-specific, GRETA's case study KPIs should be mapped accordingly. These KPIs are based on the project KPIs, but not all project KPIs will produce case study KPIs. Two example KPIs that can be downscaled from project to local context are:

- KPI 1.1 Level of understanding of practical aspects of energy citizenship by diverse case study stakeholders (here, energy citizenship knowledge becomes transition track-specific).
- KPI 3.2a Level of realization of decarbonization roadmaps within the case studies (roadmaps will be built within the context of each community and its expected transition outcomes).

It is relevant to mention that within the scope of the activities in WP3, some transition track-tailored case study KPIs could end up diverging slightly from the parent project KPIs. However, collectively, these KPIs should establish a clear link to the project goals, allowing an approximate measure of its fulfilment.

Also GRETA’s CLIs, which are tailored-made with communities and focused on local decarbonization goals, should be clustered into transition tracks.

As to the project KPIs, these indicators refer to the high-level goals of the project, not tackling any pathway in particular, but the energy transition broadly. Thus, project KPIs could be mapped to all the three transition tracks, even though this would be of little practical use – in GRETA, clustering of KPIs is relevant exclusively in the scope of the project’s case studies.

3.3.2 KPI dimensions

It is commonplace to categorize KPIs into so-called “dimensions”, an indication of the topic the indicator most explicitly pertains to. Although the KPI categorization literature is rich, GRETA adopts the system utilized in Angelakoglou, et al. (2019).

GRETA being a social sciences and humanities project aimed at improving the policy making around energy citizenship, its project-level KPIs are inevitably of limited scope, having three such dimensions:

- Social dimension (KPIs measuring the level of awareness, engagement, and acceptance within citizens and communities).
- Policy dimension (KPIs measuring the production of recommendations and roadmaps within the scope of project activities).
- Legal dimension (KPIs measuring the number of contracts – ECCs – signed).

As Table 12 shows, roughly 70% of the project KPIs measure performance of some type of social process. Other project KPIs are either mostly policy or legal-related.

Table 12: Identified principal dimensions of selected KPIs.

Project KPI code and name	KPI dimension
KPI 1.1 <i>Level of understanding of practical aspects of energy citizenship by diverse case study stakeholders</i>	Social
KPI 2.1 <i>Participation of diverse stakeholders in GRETA’s multinational survey</i>	Social
KPI 2.2 <i>Degree of project contribution to fomenting better utilization of energy-related data and other sources of information</i>	Policy
KPI 2.3 <i>Acceptance of GRETA’s energy citizenship framework by diverse case study stakeholders</i>	Social

Project KPI code and name	KPI dimension
KPI 3.1 <i>Participation of diverse case study stakeholders in co-design and testing/validation workshops</i>	Social
KPI 3.2a <i>Level of realization of decarbonization roadmaps within the case studies</i>	Policy
KPI 3.2b <i>Level of realization of energy citizenship contracts within the case studies</i>	Legal
KPI 3.3a <i>Creation of community-level indicators</i>	Social
KPI 3.3b <i>Positive trends in community-level indicators</i>	Social
KPI 4.1 <i>Stakeholder access to open, digitally-available, semi-structured project outputs</i>	Social
KPI 5.1 <i>Participation of EU-level and national diverse stakeholders in policy maker workshops</i>	Social
KPI 5.2 <i>Degree of project contribution to improving policy making on energy citizenship</i>	Policy

The categorization of KPI 3.3a and KPI 3.3b deserves special mention: The former measures the creation of other KPIs and could have been categorized under some dimension related to project management. However, in practice, CLIs are entirely community-tailored and are a result of successful stakeholder engagement, so the creation of CLIs can be perceived as a measure of community engagement – hence the social dimension. The latter measures the degree of positive developments in CLIs’ monitoring. Due to the above, a “positive development” in CLIs means, by association, a positive development for the citizens and communities engaged, hence the categorization of this indicator also as a social KPI.

Case study KPIs extend the project KPIs into the local environment. For that reason, these indicators will be mapped to the same dimensions as the project KPIs.

Lastly, CLIs co-created with case study communities could and should belong to a wider range of KPI dimensions. In fact, these KPIs could belong to any dimension, whether economic, technical, environmental, ICT-related, or any other in the interest of the engaged citizen collectives approached in the project. Accordingly, some example indicators found in the literature that could be adopted as CLIs are:

- Reduction in CO₂ emissions (environmental dimension).
- Reduction in NO_x emissions (environmental dimension).
- Reduction in household final energy consumption (technical dimension).
- Reduction in consumption of natural gas (technical dimension).
- Increase in local renewable energy generation (technical dimension).
- Decrease of electrical outages (technical dimension).
- Increased stability of distribution grid (technical dimension).
- Percentage of electric vehicles (technical dimension).
- Number of recharges at EV charging stations (technical dimension).
- kWh recharged in the EV charging stations (technical dimension).
- Share of households with smart meters (ICT dimension).
- Use of smart mobility apps (ICT dimension).
- Novel energy businesses created (economic dimension).
- Financial benefits from energy efficiency upgrades (economic dimension).
- Payback period from solar investments (economic dimension).

3.4 Objective and KPI ownership

To ensure the success of the KPI management activities, it is important that KPIs are clearly allocated to responsible teams and/or individuals. Table 16 indicates the sub-objective and respective project KPI owners (responsible entity/person for KPI measurement) within GRETA. Rather than specifying individuals, in this deliverable, the identification goes as far as allocating a GRETA consortium partner to the objective/deliverable.

In some of the project KPIs, the responsible partner will work with case study leaders for capturing and compiling case study measurement outcomes (KPI 1.1 and KPI 2.3). The same case study leaders will become responsible for monitoring the corresponding case study KPIs, when these are defined within the scope of WP3.

Table 13: List of sub-objectives, project KPIs, and KPI owners in GRETA.

Sub-objective (intended result)	Project KPI code and name	Responsible partner
SO1.1. Increasing the understanding of energy citizenship amongst stakeholders	KPI 1.1 <i>Level of understanding of practical aspects of energy citizenship by diverse case study stakeholders</i>	TNO (although each case study leader will be responsible for the corresponding case study KPI)
SO2.1. Creation of EU survey database containing data from across Europe on energy citizenship practices	KPI 2.1 <i>Participation of diverse stakeholders in GRETA's multinational survey</i>	LUT

Sub-objective (intended result)	Project KPI code and name	Responsible partner
SO2.2. Identification of principles to support participation of energy citizens, by combatting exclusion and improving utilization of energy-related data and other sources of information to mediate communications and knowledge-building	KPI 2.2 <i>Degree of project contribution to fomenting better utilization of energy-related data and other sources of information</i>	LUT
SO2.3. Develop framework for energy citizenship emergence	KPI 2.3 <i>Acceptance of GRETA's energy citizenship framework by diverse case study stakeholders</i>	TNO (although each case study leader will be responsible for the corresponding case study KPI)
SO3.1. Testing and validation via case studies of models for classification and prediction of energy citizenship phenomena to support understanding of energy citizenship behaviour	KPI 3.1 <i>Participation of diverse case study stakeholders in co-design and testing/validation workshops</i>	LUT
SO3.2. Creation of roadmaps for case studies to transition along decarbonization pathways and Energy Citizenship Contracts (ECC) to support implementation of roadmaps	KPI 3.2a <i>Level of realization of decarbonization roadmaps within the case studies</i>	UNIBO
	KPI 3.2b <i>Level of realization of energy citizenship contracts within the case studies</i>	UNIBO
SO3.3. Evaluation of GRETA approach for decarbonization via ECCs, by identifying and utilizing community-level indicators (CLIs) within case studies	KPI 3.3a <i>Creation of community-level indicators</i>	LUT
	KPI 3.3b <i>Positive trends in community-level indicators</i>	VPS
SO4.1. Repository of open source materials based on project outputs	KPI 4.1 <i>No. of registered downloads from the GRETA Open Portfolio for Civic Energy Empowerment</i>	KAS
SO5.1. Guidelines for establishing policies and regulations that favour civic	KPI 5.1 <i>Participation of EU-level and national diverse stakeholders in policy maker workshops</i>	FhG

Sub-objective (intended result)	Project KPI code and name	Responsible partner
energy engagement	KPI 5.2 <i>Degree of project contribution to improving policy making on energy citizenship</i>	FhG

3.5 Spatial and temporal scale

The aspects of scale are also relevant for the KPI characterization, particularly in context of the energy transition. Noticeably, due to its high-level and all-encompassing nature, in GRETA, project KPIs are “spatial scale-agnostic”. However, the element of “geographical scale” has been explicitly considered at proposal level and deemed a key attribute for ensuring complementarity of the case studies. Thus, case study KPIs and CLIs will both have a spatial definition, according to the following:

- Case study 1 – Bologna Pilastro-Roveri, Italy: Local/Neighborhood.
- Case study 2 – Natural gas-free neighbourhoods, The Netherlands: National.
- Case study 3 – Coopérnico cooperative, Portugal: National.
- Case study 4 – UR BEROA cooperative, Spain: Local/Neighborhood.
- Case study 5 – MobileCityGame, Germany: Regional.
- Case study 6 – Electric autonomous and connected mobility network: Supranational.

The above refers to a preliminary level of analysis, one that is based on standard perceptions of what geographical scale “means”. The ongoing activities in GRETA’s work package 5 are defining a taxonomy of geographical levels for the project. These levels may even follow a different system for each case, rather than being systematized. It is likely that GRETA’s case study KPIs and CLIs follow that same taxonomy.

From a temporal perspective, KPIs could be measured during (short-term), at the end (mid-term), or after the project (long-term). As Table 14 shows, in GRETA, most project KPIs are measured during the project, with a few more being additionally measured at the end of the project. The assessment at the end of the project provides information on the project’s overall performance and its effective beneficial impact in the communities.

Some of the KPIs could continue to be monitored in the long-term, through the training and agreement to do so between the project consortium and case study communities (KPI 1.1 and KPI 3.3b). On the other hand, KPI 4.1, could be used to monitor GRETA’s dissemination in the long-term, as this dissemination takes place via the OPCE, which will in principle be managed indefinitely by LUT as project coordinator.

Table 14: Temporal framing of each of the selected project KPIs.

Project KPI code and name	Temporal frame
KPI 1.1 <i>Level of understanding of practical aspects of energy citizenship by diverse case study stakeholders</i>	In-project (short-term) /End-of-project (mid-term) Could be monitored at a post-project stage (in the long-term) via established agreements with case study stakeholders
KPI 2.1 <i>Participation of diverse stakeholders in GRETA's multinational survey</i>	In-project (short-term)
KPI 2.2 <i>Degree of project contribution to fomenting better utilization of energy-related data and other sources of information</i>	In-project (short-term)
KPI 2.3 <i>Acceptance of GRETA's energy citizenship framework by diverse case study stakeholders</i>	In-project (short-term)
KPI 3.1 <i>Participation of diverse case study stakeholders in co-design and testing/validation workshops</i>	In-project (short-term)
KPI 3.2a <i>Level of realization of decarbonization roadmaps within the case studies</i>	In-project (short-term)
KPI 3.2b <i>Level of realization of energy citizenship contracts within the case studies</i>	In-project (short-term) /End-of-project (mid-term)
KPI 3.3a <i>Creation of community-level indicators</i>	Short-term
KPI 3.3b <i>Positive trends in community-level indicators</i>	In-project (short-term) /End-of-project (mid-term) Could be monitored at a post-project stage (in the long-term) via established agreements with case study stakeholders
KPI 4.1 <i>Stakeholder access to open, digitally-available, semi-structured project outputs</i>	In-project (short-term) /End-of-project (mid-term) LUT could manage open repository at a post-project stage (in the long-term)
KPI 5.1 <i>Participation of EU-level and national diverse</i>	In-project (short-term) /End-of-project (mid-term)

Project KPI code and name	Temporal frame
<i>stakeholders in policy maker workshops</i>	
KPI 5.2 <i>Degree of project contribution to improving policy making on energy citizenship</i>	End-of-project (mid-term)

3.6 KPI measurement thresholds

Describing the boundaries of desired performance around a target, i.e. defining what is good and bad performance and how data is interpreted for a given KPI is a rather important step in KPI development. Performance is based on targets, the desired level of performance, and thresholds. Thresholds create exact points where an indicator displays good, satisfactory, and poor performance.

The preliminary list of KPIs produced in the GRETA proposal offered limited expected outcome information, indicating for most KPIs no more than an approximate desirable target range of outcomes, with the lowest end being the minimum expected outcome and the higher end being the estimated maximum achievement within the project (Table 3).

Table 15 converts the preliminary expected outcome details from Table 3 into concrete measurement threshold information, where the first threshold value – TH1 – represents the limit under which poor, undesirable results are located, and the second threshold value – TH2 – represents the limit over which all results reflect a good performance. The full range of satisfactory results is located between TH1 and TH2.

As Table 15 shows, for some KPIs, the thresholds are a reflection of the preliminary approximate range (no revision of range needed), whereas for some other KPIs, there were adjustments to the potential range of expected outcomes, which results in divergent thresholds from those initially planned in the GRETA proposal.

Table 15: Preliminary and new KPI threshold information for GRETA’s project KPIs; TH1 and TH2 represent the lower and upper thresholds of desired performance.

Project KPI code and name	Preliminary and revised range of outcomes	Threshold information			
		TH1	TH2	TH1	TH2
KPI 1.1 <i>Level of understanding of practical aspects of energy citizenship by diverse case study stakeholders</i>	Prelim.: Range 6-18 (target performance)				
	Revised: 75%-100%	60%	80%		
		TH1	TH2		

Project KPI code and name	Preliminary and revised range of outcomes	Threshold information			
KPI 2.1 <i>Participation of diverse stakeholders in GRETA's multinational survey</i>	Prelim.: Range 9000-10000 (target performance) Revised: N.A.	8000		10000	
KPI 2.2 <i>Degree of project contribution to fomenting better utilization of energy-related data and other sources of information</i>	Prelim.: Range 5-10 (target performance) Revised: N.A.				
KPI 2.3 <i>Acceptance of GRETA's energy citizenship framework by diverse case study stakeholders</i>	Prelim.: Range 6-18 (target performance) Revised: 75%-100%	TH1		TH2	
KPI 3.1 <i>Participation of diverse case study stakeholders in co-design and testing/ validation workshops</i>	Prelim.: Range 60-180 (target performance) Revised: N.A.	TH1		TH2	
KPI 3.2a <i>Level of realization of decarbonization roadmaps within the case studies</i>	Prelim.: Range 4-6 (target performance) Revised: N.A.	TH1		TH2	
KPI 3.2b <i>Level of realization of energy citizenship contracts within the case studies</i>	Prelim.: >2 (target performance) Revised: 4-6 (target performance)	TH1		TH2	
KPI 3.3a <i>Creation of community-level indicators</i>	Prelim.: Range 6-12 (target performance) Revised: N.A.	TH1		TH2	
KPI 3.3b <i>Positive trends in community-level indicators</i>	Prelim.: Range 4-8 (target performance) Revised: 75%-100%	TH1		TH2	
		TH1		TH2	

Project KPI code and name	Preliminary and revised range of outcomes	Threshold information				
KPI 4.1 <i>Stakeholder access to open, digitally-available, semi-structured project outputs</i>	Prelim.: >50 (target performance) Revised: 50-150 (target performance)	50		100		
KPI 5.1 <i>Participation of EU-level and national diverse stakeholders in policy maker workshops</i>	Prelim.: N.A. Revised: 15-25 (target performance)					
KPI 5.2 <i>Degree of project contribution to improving policy making on energy citizenship</i>	Prelim.: 6 (target performance) Revised: 6-20 (target performance)	TH1		TH2		
		4		10		

3.7 Description of project KPIs into tables

The final set of GRETA project KPIs is compiled into Annex 1. The KPIs are described using the template from Table 16, which has been built by combining input from varied literature (BSI, 2021a; Angelakoglou, et al., 2019; and Bosch, et al., 2017). This table, designed to use no more than a single page, corresponds to a first version (v1) of the KPI formal description into a table format and may suffer improvements/updates along the project. Any of the KPI owners in GRETA can suggest such modifications, even though the final adoption decision will be with the project’s Executive Committee.

Table 16: Table template for description of GRETA KPIs (Adapted from BSI, 2021a; Angelakoglou, et al., 2019; and Bosch, et al., 2017).

Details on project objectives	Details on key performance indicator					
High-level objective <i>Describe associated overall project objective</i>	General KPI information					
	Project code and name		<i>Project KPI code and name</i>			
	Description		What the measure is about and why is it relevant			
Sub-objective (intended result) <i>Desired results associated to objective</i>	Ownership		Assign responsible partner for measure and data			
	Dimension		Describe principal KPI dimension			
	KPI typology information					
Sub-objective ownership <i>Assign responsible partner for sub-objective implementation</i>	<i>Typology duality 1</i>		Is KPI operational or strategic?			
	<i>Typology duality 2</i>		Is KPI a lagging or a leading KPI?			
	<i>Typology duality 3</i>		Is KPI qualitative or quantitative?			
	<i>Based on Logic Model</i>		Indicate stage of analysis			
	KPI measurement information					
	Measurement unit		What's being counted			
Collection frequency		How often this data will be collected (e.g. daily, weekly, continuously)				
Reporting frequency		How often this data will be reported (e.g. daily, weekly, continuously)				
Verified by <i>(Data management perspective)</i>		What partner certifies that data is correct, according to existing standards				
Validated by <i>(Project coordination perspective)</i>		What partner certifies that the measure is realistic, understandable, pertinent				
Targets and Thresholds		■	TH1	■	TH2	■

4 Conclusions

This deliverable's main goal was to re-assess and potentially consolidate the preliminary selection of project KPIs that had been preliminarily advanced during the preparation of the GRETA proposal.

Various methodologies for KPI selection and management have been reviewed. The desk research identified many convergent practices that different KPI frameworks follow, both within generic and domain-specific literature. While such practices are often branded differently, they reflect similar general approaches. Examples of such approaches are the use of KPI criteria for suitability analysis, aspects of typology, clustering of KPIs, and its subdivision into content-based dimensions. It is also found that domain-specific literature of an academic nature feeds substantially from different types of generic sources, more typical to the business performance and strategy world.

The KPI framework for GRETA assumes a hybrid nature, following a range of international good practices and combining KPI identification, selection, and monitoring approaches from multiple generic and domain-specific literature. The list of preliminary KPIs have been assessed for several definition criteria (completeness, reliability, measurability...), and substantially optimized in terms of its attributes (description, units, thresholds...). Further analyses have been performed primarily aimed at accessing typology balance within the selection of KPIs. Satisfactory results for these assessments resulted in the formal adoption of the set of preliminary KPIs as final project KPIs. In addition, the analysis retrieved the need for an additional project KPI. As a result, GRETA now totals 12 project KPIs. Annex 1 provides the detailed description tables for each of these indicators.

A secondary goal of the deliverable was to assess the conditions for creating both case study KPIs and CLIs in GRETA. The former result from the adjustment of project-level KPIs to the case study conditions, being created in WP3, whereas the latter will be derived through co-creative processes with the communities under the auspices of WP2. Because these indicators will be created later in the project, this analysis was not produced in detail (especially for the case of CLIs, which can diverge substantially from project KPIs). Yet, initial guidelines were provided that are related to the framing of these KPIs into clusters, their categorization under different topic dimensions, their mapping under temporal and spatial scales, and their allocation to responsible partners.

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Annex 1. GRETA’s project KPI tables

Table A1.1: Description of KPI 1.1 Level of understanding of practical aspects of energy citizenship by diverse case study stakeholders (v1).

Details on project objectives	Details on key performance indicator			
<p>Objective 1 TO UNDERSTAND WHO ENERGY CITIZENS ARE and clarify concepts, definitions, and evolving perspectives on energy citizenship</p> <p>SO1.1. Increasing the understanding of energy citizenship amongst stakeholders</p> <p>SO1.1 ownership: TNO</p>	General KPI information			
	Project code and name	KPI 1.1 Level of understanding of practical aspects of energy citizenship by diverse case study stakeholders		
	Description	This indicator assesses the ability of GRETA to increase the awareness of what energy citizenship means in everyday life among engaged citizens		
	Ownership	TNO		
	Dimension	Social		
	KPI typology information			
	<i>Typology duality 1</i>	Strategic		
	<i>Typology duality 2</i>	Leading		
	<i>Typology duality 3</i>	Qualitative		
	<i>Based on Logic Model</i>	Outcome (End)		
	KPI measurement information			
	Measurement unit	Average (between all the case studies) share of total case study stakeholders inquired declaring that that they understand practical aspects of energy citizenship (%)		
	Collection frequency	Every six months		
	Reporting Frequency	Yearly		
	Verified by	VPS		
	Validated by	LUT		
Targets and Thresholds		TH1 60%		TH2 80%

Table A1.2: Description of KPI 2.1 Participation of diverse stakeholders in GRETA’s multinational survey (v1).

Details on project objectives	Details on key performance indicator					
<p>Objective 2 TO UNDERSTAND HOW ENERGY CITIZENS ACT AND INTERACT individually and collectively, within energy communities, and whether and how exclusion from this process happens</p> <p>SO2.1. Creation of EU survey database containing data from across Europe on energy citizenship practices</p> <p>SO2.1 ownership: LUT</p>	General KPI information					
	Project code and name		KPI 2.1 Participation of diverse stakeholders in GRETA’s multinational survey			
	Description		Indicator aimed at assessing the representativeness of the EU citizen consultation performed in GRETA			
	Ownership		LUT			
	Dimension		Social			
	KPI typology information					
	<i>Typology duality 1</i>		Operational			
	<i>Typology duality 2</i>		Leading			
	<i>Typology duality 3</i>		Quantitative			
	<i>Based on Logic Model</i>		Input			
	KPI measurement information					
	Measurement unit		No. of survey responses registered			
	Collection frequency		Monthly			
	Reporting Frequency		Monthly			
	Verified by		VPS			
	Validated by		LUT			
	Targets and Thresholds		■	TH1 8000	■	TH2 10000
					■	

Table A1.3: Description of KPI 2.2 Degree of project contribution to fomenting better utilization of energy-related data and other sources of information (v1).

Details on project objectives	Details on key performance indicator				
<p>Objective 2 TO UNDERSTAND HOW ENERGY CITIZENS ACT AND INTERACT individually and collectively, within energy communities, and whether and how exclusion from this process happens</p> <p>SO2.2. Identification of principles to support participation of energy citizens, by combatting exclusion and improving utilization of energy-related data and other sources of information to mediate communications and knowledge-building</p> <p>SO2.2 ownership: LUT</p>	General KPI information				
	Project code and name	KPI 2.2 Degree of project contribution to fomenting better utilization of energy-related data and other sources of information			
	Description	This indicator’s goal is to validate the project’s contribution to improving citizen interaction and value creation from different types of data in the context of accelerating the EU energy transition			
	Ownership	LUT			
	Dimension	Policy			
	KPI typology information				
	<i>Typology duality 1</i>	Strategic			
	<i>Typology duality 2</i>	Lagging			
	<i>Typology duality 3</i>	Quantitative			
	<i>Based on Logic Model</i>	Outcome (Intermediate)			
	KPI measurement information				
	Measurement unit	No. of recommendations on citizen participation in different contexts produced			
	Collection frequency	Monthly			
	Reporting Frequency	Monthly			
	Verified by	VPS			
Validated by	LUT				
Targets and Thresholds		TH1		TH2	
		4		8	

Table A1.4: Description of KPI 2.3 Acceptance of GRETA's energy citizenship framework by diverse case study stakeholders (v1).

Details on project objectives	Details on key performance indicator					
<p>Objective 2 TO UNDERSTAND HOW ENERGY CITIZENS ACT AND INTERACT individually and collectively, within energy communities, and whether and how exclusion from this process happens</p> <p>SO2.3. Develop framework for energy citizenship emergence</p> <p>SO2.3 ownership: TNO</p>	General KPI information					
	Project code and name		KPI 2.3 Acceptance of GRETA's energy citizenship framework by diverse case study stakeholders			
	Description		The goal of this indicator is to measure citizen validation of GRETA's energy citizenship emergence framework			
	Ownership		TNO			
	Dimension		Social			
	KPI typology information					
	<i>Typology duality 1</i>		Operational			
	<i>Typology duality 2</i>		Leading			
	<i>Typology duality 3</i>		Qualitative			
	<i>Based on Logic Model</i>		Process			
	KPI measurement information					
	Measurement unit		Average (between all the case studies) share of total case study stakeholders inquired with a score above 4 on a 5-point Likert scale for user acceptance (%)			
	Collection frequency		Every three months			
	Reporting Frequency		Every six months			
	Verified by		VPS			
	Validated by		LUT			
	Targets and Thresholds		TH1	TH2		
			60%	80%		

Table A1.5: Description of KPI 3.1 Participation of diverse case study stakeholders in co-design and testing/validation workshops (v1).

Details on project objectives	Details on key performance indicator			
<p>Objective 3 TO DEVELOP AND TEST BEHAVIOURAL STRATEGIES, APPROACHES AND MODELS FOR FACILITATING ENERGY CITIZENSHIP leading to new strategies for achieving decarbonization</p> <p>SO3.1. Testing and validation via case studies of models for classification and prediction of energy citizenship phenomena to support understanding of energy citizenship behaviour</p> <p>SO3.1 ownership: LUT</p>	General KPI information			
	Project code and name	KPI 3.1 Participation of diverse case study stakeholders in co-design and testing/ validation workshops		
	Description	This KPI will assess the engagement of case study stakeholders in co-design and validation workshops aimed at improving knowledge on and also at predicting energy citizenship behaviour		
	Ownership	LUT		
	Dimension	Social		
	KPI typology information			
	<i>Typology duality 1</i>	Operational		
	<i>Typology duality 2</i>	Leading		
	<i>Typology duality 3</i>	Quantitative		
	<i>Based on Logic Model</i>	Input		
	KPI measurement information			
	Measurement unit	Total (between all the case studies) no. of case study stakeholder participants in co-design and testing/validation workshops		
	Collection frequency	Weekly		
	Reporting Frequency	Monthly		
	Verified by	VPS		
Validated by	LUT			
Targets and Thresholds		TH1 50		TH2 150

Table A1.6: Description of KPI 3.2a Level of realization of decarbonization roadmaps within the case studies (v1).

Details on project objectives	Details on key performance indicator					
<p>Objective 3 TO DEVELOP AND TEST BEHAVIOURAL STRATEGIES, APPROACHES AND MODELS FOR FACILITATING ENERGY CITIZENSHIP leading to new strategies for achieving decarbonization</p> <p>SO3.2. Creation of roadmaps for case studies to transition along decarbonization pathways and Energy Citizenship Contracts (ECC) to support implementation of roadmaps</p> <p>SO3.2 ownership: UNIBO</p>	General KPI information					
	Project code and name		KPI 3.2a Level of realization of decarbonization roadmaps within the case studies			
	Description		This indicator will monitor the production of community transition pathway roadmaps in the project's case studies			
	Ownership		UNIBO			
	Dimension		Policy			
	KPI typology information					
	<i>Typology duality 1</i>		Operational			
	<i>Typology duality 2</i>		Lagging			
	<i>Typology duality 3</i>		Quantitative			
	<i>Based on Logic Model</i>		Output			
	KPI measurement information					
	Measurement unit		Total (between all the case studies) no. of decarbonization roadmaps produced			
	Collection frequency		Every three months			
	Reporting Frequency		Every six months			
	Verified by		VPS			
	Validated by		LUT			
	Targets and Thresholds		■	TH1 2	■	TH2 4

Table A1.7: Description of KPI 3.2b Level of realization of energy citizenship contracts within the case studies (v1).

Details on project objectives	Details on key performance indicator					
<p>Objective 3 TO DEVELOP AND TEST BEHAVIOURAL STRATEGIES, APPROACHES AND MODELS FOR FACILITATING ENERGY CITIZENSHIP leading to new strategies for achieving decarbonization</p> <p>SO3.2. Creation of roadmaps for case studies to transition along decarbonization pathways and Energy Citizenship Contracts (ECC) to support implementation of roadmaps</p> <p>SO3.2 ownership: UNIBO</p>	General KPI information					
	Project code and name		KPI 3.2b Level of realization of energy citizenship contracts within the case studies			
	Description		The goal of this KPI is to monitor the strategic delivery of case study ECCs			
	Ownership		UNIBO			
	Dimension		Legal			
	KPI typology information					
	<i>Typology duality 1</i>		Strategic			
	<i>Typology duality 2</i>		Lagging			
	<i>Typology duality 3</i>		Quantitative			
	<i>Based on Logic Model</i>		Outcome (Intermediate)			
	KPI measurement information					
	Measurement unit		Total (between all the case studies) no. of energy citizenship contracts signed			
	Collection frequency		Every three months			
	Reporting Frequency		Every six months			
	Verified by		VPS			
Validated by		LUT				
Targets and Thresholds		■	TH1 2	■	TH2 4	■

Table A1.8: Description of KPI 3.3a Creation of community-level indicators (v1).

Details on project objectives	Details on key performance indicator				
<p>Objective 3 TO DEVELOP AND TEST BEHAVIOURAL STRATEGIES, APPROACHES AND MODELS FOR FACILITATING ENERGY CITIZENSHIP leading to new strategies for achieving decarbonization</p> <p>SO3.3. Evaluation of GRETA approach for decarbonization via ECCs, by identifying and utilizing community-level indicators (CLIs) within case studies</p> <p>SO3.3 ownership: LUT</p>	General KPI information				
	Project code and name		KPI 3.3a Creation of community-level indicators		
	Description		This KPI quantifies the total number of CLIs produced in the project		
	Ownership		LUT		
	Dimension		Social		
	KPI typology information				
	<i>Typology duality 1</i>		Operational		
	<i>Typology duality 2</i>		Lagging		
	<i>Typology duality 3</i>		Quantitative		
	<i>Based on Logic Model</i>		Project		
	KPI measurement information				
	Measurement unit		Total (between all the case studies) no. of community-level indicators created		
	Collection frequency		Monthly		
	Reporting Frequency		Every three months		
	Verified by		VPS		
Validated by		LUT			
Targets and Thresholds		TH1	TH2		
		5	10		

Table A1.9: Description of KPI 3.3b Positive trends in community-level indicators (v1).

Details on project objectives	Details on key performance indicator			
<p>Objective 3 TO DEVELOP AND TEST BEHAVIOURAL STRATEGIES, APPROACHES AND MODELS FOR FACILITATING ENERGY CITIZENSHIP leading to new strategies for achieving decarbonization</p> <p>SO3.3. Evaluation of GRETA approach for decarbonization via ECCs, by identifying and utilizing community-level indicators (CLIs) within case studies</p> <p>SO3.3 ownership: LUT</p>	General KPI information			
	Project code and name		KPI 3.3b Positive trends in community-level indicators	
	Description		This indicator offers a general view of the status of CLI monitoring and thus of the decarbonization progress in the case studies	
	Ownership		VPS	
	Dimension		Social	
	KPI typology information			
	<i>Typology duality 1</i>		Operational	
	<i>Typology duality 2</i>		Leading	
	<i>Typology duality 3</i>		Quantitative	
	<i>Based on Logic Model</i>		Project	
	KPI measurement information			
	Measurement unit		Share of the total (between all the case studies) no. of community-level indicators showing a positive trend (%)	
	Collection frequency		Monthly	
	Reporting Frequency		Every three months	
	Verified by		VPS	
	Validated by		LUT	
Targets and Thresholds		<div style="display: flex; align-items: center; justify-content: center;"> <div style="width: 10px; height: 10px; background-color: red; margin-right: 5px;"></div> <div style="border: 1px solid black; padding: 2px;">TH1</div> </div> <div style="display: flex; align-items: center; justify-content: center; margin-top: 2px;"> <div style="width: 10px; height: 10px; background-color: red; margin-right: 5px;"></div> <div style="border: 1px solid black; padding: 2px;">60%</div> </div>	<div style="display: flex; align-items: center; justify-content: center;"> <div style="width: 10px; height: 10px; background-color: yellow; margin-right: 5px;"></div> <div style="border: 1px solid black; padding: 2px;">TH2</div> </div> <div style="display: flex; align-items: center; justify-content: center; margin-top: 2px;"> <div style="width: 10px; height: 10px; background-color: yellow; margin-right: 5px;"></div> <div style="border: 1px solid black; padding: 2px;">80%</div> </div>	

Table A1.10: Description of KPI 4.1 Stakeholder access to open, digitally-available, semi-structured project outputs (v1).

Details on project objectives	Details on key performance indicator					
<p>Objective 4 TO REALIZE IMPACT BY SCALING APPROACHES from local case study to regional, national and supranational levels leading to generalizing and formalizing project outputs for further use</p> <p>SO4.1. Repository of open source materials based on project outputs</p> <p>SO4.1 ownership: KAS</p>	General KPI information					
	Project code and name		KPI 4.1 Stakeholder access to open, digitally-available, semi-structured project outputs			
	Description		This indicator measures the interest of varied stakeholders in GRETA's openly available materials, offering an insight of GRETA's research impact			
	Ownership		KAS			
	Dimension		Social			
	KPI typology information					
	<i>Typology duality 1</i>		Strategic			
	<i>Typology duality 2</i>		Leading			
	<i>Typology duality 3</i>		Quantitative			
	<i>Based on Logic Model</i>		Outcome (Intermediate)			
	KPI measurement information					
	Measurement unit		No. of registered downloads from the GRETA Open Portfolio for Civic Energy Empowerment (OPCE)			
	Collection frequency		Continuously			
	Reporting Frequency		Monthly			
	Verified by		VPS			
	Validated by		LUT			
	Targets and Thresholds			TH1		TH2
				50		100

Table A1.11: Description of KPI 5.1 Participation of EU-level and national diverse stakeholders in policy maker workshops (v1).

Details on project objectives	Details on key performance indicator				
<p>Objective 5 TO IMPROVE THE POLICY MAKING PROCESS towards a more favourable governance, policy, political, legal, and financing framework for the emergence of energy citizenship in the EU</p> <p>SO5.1. Guidelines for establishing policies and regulations that favour civic energy engagement</p> <p>SO5.1 ownership: FhG</p>	General KPI information				
	Project code and name		KPI 5.1 Participation of EU-level and national diverse stakeholders in policy maker workshops		
	Description		This indicator measures the engagement and interest of EU policy makers in GRETA's outputs, offering a perception of meaningfulness of the policy briefs to be later produced		
	Ownership		FhG		
	Dimension		Social		
	KPI typology information				
	<i>Typology duality 1</i>		Operational		
	<i>Typology duality 2</i>		Leading		
	<i>Typology duality 3</i>		Quantitative		
	<i>Based on Logic Model</i>		Input		
	KPI measurement information				
	Measurement unit		No. of stakeholder participants in policy maker workshops		
	Collection frequency		Weekly		
	Reporting Frequency		Monthly		
	Verified by		VPS		
	Validated by		LUT		
	Targets and Thresholds			TH1	
			10		20

Table A1.12: Description of KPI 5.2 Degree of project contribution to improving policy making on energy citizenship (v1).

Details on project objectives	Details on key performance indicator					
<p>Objective 5 TO IMPROVE THE POLICY MAKING PROCESS towards a more favourable governance, policy, political, legal, and financing framework for the emergence of energy citizenship in the EU</p> <p>SO5.1. Guidelines for establishing policies and regulations that favour civic energy engagement</p> <p>SO5.1 ownership: FhG</p>	General KPI information					
	Project code and name		KPI 5.2 Degree of project contribution to improving policy making on energy citizenship			
	Description		This KPI assesses the strategic delivery of thematic policy briefs			
	Ownership		FhG			
	Dimension		Policy			
	KPI typology information					
	<i>Typology duality 1</i>		Strategic			
	<i>Typology duality 2</i>		Lagging			
	<i>Typology duality 3</i>		Quantitative			
	<i>Based on Logic Model</i>		Outcome (End)			
	KPI measurement information					
	Measurement unit		No. of energy citizenship policy briefs produced			
	Collection frequency		Monthly			
	Reporting Frequency		Every two months			
	Verified by		VPS			
	Validated by		LUT			
	Targets and Thresholds			TH1		TH2
			4		10	