

D5.1. KPI definition, monitoring programme and procedures



Deliverable Information Sheet

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V3		Final review	Joana Mundó (ECO), Cristina Ramos (ECO)

List of Acronyms

Acronym	Name
AMB	Barcelona Metropolitan Area
DSS	Decision Support System
EC	Energy Community
ECGF	Energy Communities Governance Framework
ECGT	Energy Communities Governance Toolkit
FES	Final Energy Savings
GDP	Gross Domestic Product
GHG	Greenhouse Gas
KMA	Krakov Metropolitan Area
KPI	Key Performance Indicator
OIS	Operative Integrated Services
PV	Photovoltaic
RE	Renewable Energy

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Keywords list

- Energy Communities
- Citizen-led Energy Initiatives
- Governance Framework
- Energy Communities Governance Toolkit
- Sustainability
- Social Impact
- Economic Impact
- Environmental Impact
- Key Performance Indicators (KPIs)
- Monitoring Program
- Capacity Building
- Stakeholder Engagement
- Innovation
- Gender Equality
- Community Empowerment
- Resource Conservation
- Renewable Energy
- Greenhouse Gas Emissions
- Energy Savings
- Collaboration
- Policy Development
- Vulnerable Consumers
- Local and Regional Governments
- Investment
- Job Creation
- Decentralized Energy
- Environmental Resilience
- Sustainable Energy Practices
- European Union
- Decision Support System (DSS)
- Digital Hub
- Replication Workshops
- Community Engagement
- Innovation Hubs
- Policy Makers
- Legal Expertise
- Energy Experts
- Community Development
- Stakeholder Cooperation
- Project Impact

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1. Executive summary

The COMANAGE project aims to address the governance and management barriers faced by energy communities and citizen-led energy initiatives in the European Union. It seeks to promote sustainable energy practices by creating the Energy Communities Governance Framework (ECGF) and providing the Energy Communities Governance Toolkit (ECGT) to support public authorities. The project envisions two main objectives: fostering the growth and sustainability of existing energy communities and encouraging the establishment of new community-owned energy projects.

The monitoring programme established for the project includes a comprehensive set of Key Performance Indicators (KPIs) that allow for the quantifiable evaluation of the project's impact. These KPIs are organized into three main dimensions: social, economic, and environmental.

In the social impact dimension, the KPIs focus on measuring the project's efforts in supporting energy communities and citizen-led energy initiatives, the capacity building of local and regional governments, stakeholder engagement, and the development of legislation and policies at various governance levels. Additionally, qualitative KPIs have been included to assess the project's impact on community cohesion, environmental awareness, well-being, trust in institutions, and empowerment of women and vulnerable groups. These qualitative indicators provide valuable insights into the project's broader social impact and community outcomes.

The economic impact dimension comprises KPIs that measure the project's contributions to innovation, investment in sustainable energy, female leadership in initiatives, and the participation of vulnerable consumers in energy communities. These KPIs assess the project's effectiveness in mobilizing the local economy, creating jobs, and promoting gender equality.

The environmental impact dimension focuses on KPIs that evaluate the project's success in achieving energy savings, renewable energy generation, and reductions in greenhouse gas emissions. Measuring the project's environmental outcomes ensures that sustainable practices and ecological resilience are promoted.

A list of the KPIs described in the project can be found below:

List of KPI's

Code	KPI definition	Area
SOC01	Number of energy communities and/or other kind of citizen-led energy initiatives supported	Social
SOC02	Number of energy communities and/or other kind of citizen-led energy initiatives launched	Social
SOC03	Number of local and regional governments staff, officials and other relevant market stakeholders with increased skills due to capacity building activities and tools	Social
SOC04	Total number of accesses to capacity building tools • <i>Decision Support System (DSS)</i> • <i>Digital Hub</i> • <i>Local training workshops</i> • <i>Mutual Learning events</i> • <i>Hub managers training</i> • <i>ECGT pamphlet</i>	Social
SOC05	Total number of participants in capacity building activities, including: • <i>Decision Support System (the 3 pilots and 5 replicators will access DSS)</i> • <i>E-learning platform (1.500 accesses from pilots and replicators)</i> • <i>Local training workshops (150 each pilot)</i> • <i>Mutual Learning events (a minimum of 2 per pilot)</i> • <i>DSS webinar (3 Hub managers)</i> • <i>Digital Hub discussions (a minimum of 1 per pilot)</i> • <i>Replication workshop (1 virtual WS at M32 with representatives of the pilots + 5 replicators)</i> • <i>Hub managers training (1 member of each of the 3 pilots)</i>	Social
SOC06	Share of staff members who received the ECGT pamphlet	Social
SOC07	Staff composition (diversity of skills: technical, communication and social science)	Social
SOC08	Number of legislation, policies or strategies created/adapted at any governance levels	Social
SOC09	Number of real-life implementation sites carried out by the project	Social
SOC10	Number of stakeholders reached through media and events during the project	Social

SOC11	Number of OIS Hubs (real life implementation sites) created in the municipalities of the pilot cases and Replicators	Social
SOC12	Number of public-private and public-public partnerships or contracts signed (there is not a specific quantitative target, but the project will monitor it)	Social
SOC13	Number of citizens participating in OIS Hub activities (estimated 20-30 participants each event)	Social
SOC14	Number of participants to the Local hub workshop (Hub kick-off – 80 per event and pilot)	Social
SOC15	Number of OIS Hubs spin-off created in the municipalities of the pilot cases (there is not a specific quantitative target, but the project will monitor it)	Social
SOC16	Number of additional OIS Hubs launched in the Replicators (1 per Replicator)	Social
SOC17	Share of women among the OIS Hubs key stakeholders	Social
SOC18	Share of women among Hub Managers	Social
SOC19	Share of women with a role of leadership among the local governments staff members	Social
SOC20	Share of new initiatives (investments, cooperatives or energy community projects) launched by women leaders	Social
SOC21	Qualitative indicators: • <i>Increased sense of belonging to the community</i> • <i>Increased environmental awareness and energy culture</i> • <i>Increased healthy lifestyle and wellbeing</i> • <i>Increased trust in public institution</i> • <i>Sense of empowerment of women</i> Sense of empowerment among vulnerable groups	Social
ECO01	Number of products (goods or services), processes and methods launched into the market by the project	Economic
ECO02	Investments in local sustainable energy triggered by the project	Economic
ECO03	Economic value of Final Energy Savings (FES)	Economic
ECO04	Share of vulnerable consumers participating in energy communities	Economic
ECO05	Number of new jobs created	Economic
ENV01	Total Primary Energy Savings triggered by the project	Environmental
ENV02	Total Final Energy Savings triggered by the project	Environmental
ENV03	Total reduction of Greenhouse gases emissions triggered by the project	Environmental

ENV04	Total generation of Renewable Energy triggered by the project
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Environmental

Table 1. List of KPI's

2. Introduction

Over the past years, several projects boosting energy communities have seen the light around the EU. The launch and implementation of these initiatives carried out -among others- by projects in which the members of the COMANAGE partnership participate, has made it evident that once started energy communities' projects often struggle to take-off. The COMANAGE proposal originates from this experience, with the aim of tackling and counteracting the main governance and management barriers - including a series of legal, administrative, financial, social, and organizational hurdles - faced by citizen-led and public-participated energy communities' projects.

It will do so by creating a methodological and operational **Energy Communities Governance Framework (ECGF)**, and by equipping public authorities involved in energy communities' projects with a set of integrated services, supporting mechanisms and tools aimed at facilitating the management and governance of energy communities and other forms of citizen-led energy initiatives, ensuring their growth and sustainability in the medium and long term: the **Energy Communities Governance Toolkit (ECGT)**.

The final goal of the project will be twofold: first, to ensure that energy communities' projects that have already been set-up can take-off and grow in the medium and long term. Second, to encourage and stimulate the uptake of new community-owned energy projects. With these goals in mind, the project will on one hand operationalize a transnational network of knowledge and competence providers; on the other, it will mobilize, engage, and operationalize key stakeholders around three Operative Integrated Services (OIS) Hubs to be established in three Pilot Cases across the EU represented in the consortium by the Metropolitan Area of Barcelona in Spain (AMB), the Krakow Metropolis Association in Poland (KMA), the Lazio National Association of Italian municipalities in Italy (ANCI LAZIO).

The purpose of this deliverable is to establish a **monitoring programme** through the identification of quantitative and qualitative Key Performance Indicators – KPIs to monitor the performance of the deployed Pilot Executive Plans, in order to provide quantifiable evidence of the potential of the Energy Communities Governance framework and toolkit for the uptake, management and long-term sustainability of energy communities' projects.

3. Indicators: concept and definition

This section provides an overview of indicators in the context of the COMANAGE project. It explains the concept and definition of indicators, highlighting their role in measuring and monitoring specific aspects of sustainability. It may also include information on the importance of well-defined indicators for assessing social, economic, and environmental impacts.

The list of indicators to monitor and evaluate the impact of the tools developed during the project was drawn up with the input of all the partners involved during the proposal preparation phase. This initial list has been revised and updated as part of the work carried out during the elaboration of the deliverable.

The Metropolitan Area of Barcelona has recently been developing a series of indicators to monitor the impact of actions aimed at creating energy communities. These indicators have the ability to analyse different types of energy communities and, based on different variables, it is possible to calculate qualitatively and quantitatively the value that allows the responsible entities to assess whether the objectives are being met.

An adjusted definition of what an indicator is:

An indicator is a representative figure of a magnitude. It is the result of a measurement expressed in numerical terms and it is necessary to do so, when magnitude cannot be expressed in numbers, the information about it becomes “dubious”. An indicator is thus a piece of data or a set of data that helps to objectively measure the evolution of a process or an activity.

3.1. Social impact

This subsection focuses on the social dimension of sustainability and outlines the indicators that will be used to assess the social impact of the COMANAGE project. It covers areas such as community engagement, social equity, livelihoods, cultural heritage, and social well-being. The inputs may include a description of specific social indicators, their metrics or units of measurement, and the rationale for their selection.

The reason why these indicators have been selected to measure the social impact of the project was to achieve the following objectives:

- Measuring the project's impact in **providing support**, resources, and guidance to energy communities and citizen-led energy initiatives. By supporting these initiatives, the project aims to facilitate their development, growth, and overall success.
- Indicating the project's **effectiveness** in inspiring and enabling communities to take action and become actively engaged in sustainable energy projects.
- Assessing the project's success in **enhancing the skills and knowledge** of key stakeholders involved in local and regional governments.

- Reflecting the project's **ability to disseminate** knowledge and resources to stakeholders.
- Revealing the understanding of energy community **governance principles** and practices among relevant stakeholders.
- **Promoting diversity** within the project's staff composition, particularly in terms of skills.
- Measuring the project's **outreach and engagement** with stakeholders

The KPIs that will be used for this section are the following:

- **SOC01 - Number of energy communities and/or other kinds of citizen-led energy initiatives supported:** quantity of energy communities and citizen-led energy initiatives that receive support from the project. It reflects the project's efforts in providing resources, guidance, and assistance to promote the development and growth of such initiatives.
- **SOC02 - Number of energy communities and/or other kinds of citizen-led energy initiatives launched:** actual number of new energy communities and citizen-led energy initiatives that are established and launched as a result of the project's activities. It demonstrates the project's impact in fostering the creation of these grassroots initiatives.
- **SOC03 - Number of local and regional governments' staff, officials, and other relevant market stakeholders with increased skills due to capacity building activities and tools:** number of individuals from local and regional governments, officials, and other relevant stakeholders who have improved their skills and knowledge through capacity building activities and tools provided by the project. It reflects the project's contribution to enhancing the capacity of key actors in the energy sector.
- **SOC04 - Total number of accesses to capacity building tools:** This KPI represents the cumulative number of times the project's capacity building tools are accessed by stakeholders. The tools include the Decision Support System (DSS), Digital Hub, local training workshops, mutual learning events, Hub managers training, and the ECGT pamphlet. It measures the utilization and reach of these resources.
- **SOC05 - Total number of participants in capacity building activities:** This KPI captures the overall number of individuals participating in capacity building activities facilitated by the project. It includes participants accessing the Decision Support System (DSS) and the e-learning platform, attending local training workshops, mutual learning events, DSS webinars, digital hub discussions, and replication workshops.
- **SOC06 - Share of staff members who received the ECGT pamphlet:** This KPI indicates the proportion of staff members who have received the ECGT pamphlet. It highlights the dissemination of relevant information and knowledge among the project's target audience.
- **SOC07 - Staff composition (diversity of skills: technical, communication, and social science):** This KPI focuses on the diversity of skills among the project's staff members. It assesses the range of expertise, including technical, communication, and social science skills, which contributes to a well-rounded and multidisciplinary team.

- **SOC08 - Number of legislation, policies, or strategies created/adapted at any governance level:** This KPI measures the quantity of legislation, policies, or strategies that have been developed or modified at various governance levels as a direct result of the project's influence and advocacy efforts. It reflects the project's impact on shaping energy-related governance frameworks.
- **SOC09 - Number of real-life implementation sites carried out by the project:** This KPI represents the number of physical sites or locations where the project's activities, initiatives, or interventions have been implemented. It indicates the geographical reach and scope of the project's practical implementations.
- **SOC10 - Number of stakeholders reached through media and events during the project:** This KPI measures the number of stakeholders who have been engaged, informed, or influenced through media channels (such as publications, press releases, or social media) and events organized by the project. It assesses the project's ability to reach a broad audience and create awareness.
- **SOC11 - Number of OIS Hubs (real-life implementation sites) created in the municipalities of the pilot cases and Replicators:** This KPI counts the number of OIS Hubs that have been established in the municipalities of the pilot cases and Replicators. It reflects the project's efforts in creating physical Hubs for collaboration and innovation.
- **SOC12 - Number of public-private and public-public partnerships or contracts signed:** this KPI measures the quantity of partnerships or contracts established between the project and private entities (public-private partnerships) or between different public entities (public-public partnerships). It reflects the project's success in fostering collaboration and formal agreements with external stakeholders to achieve common goals.
- **SOC13 - Number of citizens participating in OIS Hub activities:** This KPI counts the number of citizens actively engaged in activities organized by the Operational Integrated Services (OIS) Hubs. It estimates that each event or activity attracts around 20-30 participants. It demonstrates the level of community involvement and the project's ability to mobilize and empower local residents.
- **SOC14 - Number of participants in the Local Hub workshop (Hub kick-off):** This KPI represents the number of individuals attending the Local Hub workshop, specifically the kick-off event. The target is set at 80 participants per event. It highlights the level of interest and participation from stakeholders in the initial stages of the Hub's establishment.
- **SOC15 - Number of OIS Hubs spin-off created in the municipalities of the pilot cases:** This KPI tracks the number of new OIS Hubs that are established as spin-offs or extensions of the project's activities in the municipalities of the pilot cases. While there is no specific quantitative target, the project monitors and encourages the creation of these additional hubs to promote sustainable innovation.
- **SOC16 - Number of additional OIS Hubs launched in the Replicators:** This KPI measures the number of new OIS Hubs that are launched in the Replicator municipalities. The target is set at one Hub per Replicator, indicating the project's aim to expand its impact and activities to these additional locations.

- **SOC17 - Share of women among the OIS Hubs key stakeholders:** This KPI represents the proportion of women among the key stakeholders involved in OIS Hubs. It highlights the project's commitment to gender equality and inclusivity by assessing the representation and involvement of women in decision-making and leadership roles within the Hubs.
- **SOC18 - Share of women among Hub Managers:** This KPI measures the proportion of women among the Hub Managers responsible for overseeing and managing the OIS Hubs. It indicates the project's efforts to promote gender diversity and equal opportunities in leadership positions.
- **SOC19 - Share of women with a role of leadership among the local government staff members:** This KPI assesses the proportion of women holding leadership positions among the staff members of local governments. It reflects the project's focus on empowering women and encouraging their active participation and influence in local governance structures.
- **SOC20 - Share of new initiatives (investments, cooperatives or energy community projects) launched by women leaders:** ratio of the number of initiatives such as investments, cooperatives or energy community projects that are led by women, over the total number of initiatives in the same time frame. It reflects the effectiveness of the project's approach towards mitigating gender barriers.

To measure the social impact of the COMANAGE project 21 KPIs are used, as previously described. The set of KPIs provided covers a wide range of aspects related to the project's objectives and desired outcomes. Each KPI serves a specific purpose and contributes to assessing the project's progress and impact. However, certain KPIs may have greater importance or significance based on the project's priorities and focus. To social KPIs are listed in order of priority, being the first half (**SOC01 to SOC11**) **considered crucial for the analysis of the project results.**

Finally, the following **qualitative indicators (SOC21)** added to the COMANAGE project serve to capture and assess the project's broader social impact and community outcomes. These indicators go beyond the traditional quantitative metrics and focus on the intangible but vital aspects of community development and well-being. Let's examine the reasons for including each of these qualitative indicators:

- **Increased sense of belonging to the community:** This indicator measures the extent to which individuals involved in the project experience a stronger sense of connection, identification, and engagement with their local community. It reflects the project's impact on fostering a deeper sense of belonging and community cohesion.
- **Increased environmental awareness and energy culture:** This indicator assesses the level of awareness and understanding among individuals regarding environmental issues, particularly in relation to energy consumption and sustainability. It reflects the project's success in promoting knowledge and attitudes that contribute to a more environmentally conscious and responsible community.
- **Increased healthy lifestyle and well-being:** This indicator reflects the project's impact on improving the overall health and well-being of individuals within the community. It measures the positive changes in behaviours, habits, and lifestyle choices that lead to improved physical and mental well-being.

- **Increased trust in public institutions:** This indicator evaluates the level of trust and confidence that community members have in public institutions, such as local governments or relevant authorities involved in the project. It reflects the project's ability to enhance transparency, accountability, and effectiveness in public service delivery.
- **Sense of empowerment of women:** This indicator focuses on the empowerment of women within the community, highlighting the project's efforts to promote gender equality and women's empowerment. It measures the increased confidence, agency, and opportunities that women experience as a result of their involvement in project activities.
- **Sense of empowerment among vulnerable groups:** This indicator assesses the extent to which vulnerable groups within the community, such as marginalized or disadvantaged individuals, experience a sense of empowerment through their participation in the project. It measures the project's effectiveness in addressing social inequalities and empowering these groups to actively contribute to decision-making and community development processes.

Including these qualitative indicators in the COMANAGE project allows for a more holistic evaluation of its social impact. These indicators provide valuable insights into the project's success in fostering community engagement, promoting sustainability values, and empowering individuals and groups to create positive and lasting change within their localities.

Each qualitative indicator addresses important dimensions of the project's impact, such as community cohesion, environmental awareness, well-being, trust in institutions, and empowerment of women and vulnerable groups. They provide valuable insights into the project's social and behavioural outcomes, however, qualitative KPIs are more difficult to measure due to their subjective nature and lack of standardized metrics.

3.2. Economic impact

This subsection addresses the economic dimension of sustainability and describes the indicators to be used for assessing the economic impact of the COMANAGE project. It encompasses indicators related to economic viability, employment generation, income distribution, cost-effectiveness, and economic diversification. The inputs may include a discussion of specific economic indicators, their calculation methods, data sources, and their relevance to the project's objectives.

Below is the list of indicators selected to measure the economic impact of the project:

- **ECO01 - Number of products (goods or services), processes and methods launched into the market by the project:** number of goods or services, processes and methods launched into the market by the project. It reflects the innovation-fostering efforts of the project.
- **ECO02 - Investments in local sustainable energy triggered by the project:** total amount of investment in local sustainable energy triggered by the project. It reflects the project's impact on the mobilization of the local economy towards the consecution of sustainability goals.
- **ECO03 - Economic value of Final Energy Savings (FES):** economic impact associated with the FES triggered by the project. It reflects the economic dimension of the energy savings verified.
- **ECO04 - Share of vulnerable consumers participating in energy communities:** ratio of the number of vulnerable consumers participating in energy communities over the total number of consumers participating in energy communities. It reflects the project's impact on the mobilization of the vulnerable consumers collective towards the consecution of sustainability goals.
- **ECO05 - Number of new jobs created:** total number of direct jobs created by ECs (new and existing) connected to the project. It reflects the creation of conditions for long-term sustainability induced by the project.¹

¹ Taking into account that the majority of ECs has a long-term goal of employing at least one full-time person, the consecution of this goal constitutes proof of long-term maturity.

3.3. Environmental impact

This subsection focuses on the environmental dimension of sustainability and outlines the indicators to be used for assessing the environmental impact of the COMANAGE project. It encompasses indicators related to resource conservation, pollution prevention, biodiversity conservation, greenhouse gas emissions, and ecological resilience. The inputs may include details on specific environmental indicators, their measurement techniques, data requirements, and their alignment with relevant environmental frameworks or standards.

Below is the list of indicators selected to measure the economic impact of the project:

- **ENV01 - Total Final Energy Savings (FES) triggered by the project:** primary indicator that is based on the solutions executed throughout the Pilot Executive Plan implementation and will account mainly for the activities of energy management and building refurbishment.
- **ENV02 - Total generation of Renewable Energy (RE) triggered by the project:** primary indicator that is based on the solutions executed throughout the Pilot Executive Plans implementation and will account for the new Renewable Energy Generation facilities carried out by energy communities in the pilot areas.
- **ENV03 - Total Primary Energy Savings triggered by the project:** secondary indicator based on FES and RE. Refers on the reduction of primary energy sources. Primary energy sources are the natural resources directly harvested or extracted from the environment, such as fossil fuels (coal, oil, natural gas).
- **ENV04 - Total reduction of Greenhouse gases emissions triggered by the project:** secondary indicator based on FES and RE, refers to the efforts and actions taken to decrease the release of greenhouse gases into the atmosphere. Greenhouse gases (GHGs) are gases that trap heat in the Earth's atmosphere, contributing to the greenhouse effect and global warming. The most common greenhouse gases include carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), fluorinated gases and water vapour.

The following paragraphs explain how these indicators will be calculated.

The **Final Energy Savings** will be calculated by comparing households' energy consumption during Pilot Executive Plan implementation with a reference baseline consumption. The baseline should represent a reference year of households involved, providing monthly electricity and thermal consumption for at least one year. The reference baseline consumption will be set according to national or regional statistics for residential energy consumption.

When available, consumption data can be retrieved from energy management or monitoring systems, smart meters data, building energy performance certificates or energy bills of households involved in ECs participating in Pilot activities. This information will be analysed to provide a more detailed estimation of the baseline consumption and the energy savings obtained. The amount of monitored data required to reach a representative sample has yet to be defined.

According to the Grant Agreement, the Final Energy Savings are expected to be around 10% for those households implementing energy management good practices and around 35% for those undergoing a building energy retrofit. These values will be revised and adjusted for each Pilot, providing reference values of Final Energy Savings per household to be used for the

calculation. **Total Final Energy Savings** will be calculated by multiplying the reference Final Energy Savings per household by the number of households directly engaged in a Pilot Executive Plan.

The **Renewable Energy generated** will be extracted as annual production curves of the Renewable Generation installations set up by the ECs involved in a Pilot Executive Plan.

The **Primary Energy Savings** will be calculated by multiplying the total amount of Final Energy Savings and Renewable Energy (RE) generated by the corresponding national primary energy factor.

Similarly, the **Greenhouse gases (GHG) Emissions Savings** will be calculated by multiplying the Primary Energy Savings by the corresponding national CO₂ Emission factor.

The primary energy factors and CO₂ emission factors will be retrieved by national open data, standards or reports on the energy sector. The calculations will consider separately electricity and thermal energy sources.

$$Pr i m a r y \text{ Energy Savings} = [Final \text{ Energy Savings} + RE \text{ Pr o duction}] * Pr i m a r y \text{ Energy factor}$$

$$CO_2 \text{ Emissions Savings} = Pr i m a r y \text{ Energy Savings [MWh]} * CO_2 \text{ Emission factor}$$

All four environmental indicators defined will be calculated on a yearly basis, not taking into consideration the dynamic character of energy management activities, and other Greenhouse gases different of CO₂

In the aim of estimating the energy savings resulting from the action, the average annual energy consumption is used. The baseline scenario considers that households will not increase their energy demands in the next 5 years. The level of ambition accounts for energy savings either thanks to improvements in energy management or to building refurbishment. The level of ambition put in place for AMB and ANCI LAZIO only includes energy management good practices, which are assumed to lead to 10% in energy savings. The level of ambition implied for KMA passes through energy refurbishment and is assumed to lead to a 35% reduction in carbon footprint. The target for KMA was chosen in accordance with the lowest level of ambition developed under the H2020 CITYinvest project methodology, which considers CO₂ savings of up to 35%, 50%, 75%, or the reach of carbon neutrality. The same levels of ambition were associated with investment costs of up to 50, 200, or 1.200 €/m² or above 1.200 €/m². To sum up, the chosen ambition target for KMA is level 2 (up to 35% and up to 50 €/m²), while for other actors is level 1, the minimum level of ambition which ensures a high probability of calculation reliability. The reference-rated power and load factors of residential PV installed are extracted from regional and national databases.

The first are assessed to be 3.94kW for AMB, 3kW for KMA and 3.73kW for Lazio. It is assumed that each participant in an energy community will be assigned a fraction of the reference rated power equal to 30% per household on average. The cost of the PV installation has been calculated per each household proportionally with the assigned rated power, considering a reference investment of 7.000 € for the installation of a 3kW PV plant.

Based on the experience of the completed H2020 CITYinvest project and other energy communities running projects, it is accepted as feasible and realistic to engage in energy projects 0.2 % of the citizens living in pilots' and Replicators' municipalities. Of these, it has been assumed that 20% of the households directly engaged in project activities will participate in the installation of a PV plant.

4. Pilots' context

Each pilot should consider their unique context and tailor their focus accordingly. This includes understanding the specific social, economic, and environmental aspects that are particularly relevant to the pilot site. By aligning the indicators and data collection efforts with the specific context, the pilots can accurately assess the impact and outcomes within their particular setting.

4.1. KMA

Krakow Metropolitan Area (KMA) consists of the city of Krakow and the 14 municipalities related to it in terms of functionality. The KMA includes 1 urban municipality, 10 rural municipalities and 4 urban-rural municipalities. The scope of KMA is smaller than the optimal scope of the Urban Functional Area of Krakow. The KMA is inhabited by approximately 1,07 million residents. The total area of the KMA is 127.500 habitants. The population density of the entire area is 811 people per km². However, there are significant differences: in the city of Krakow, it is 2.384 residents per km², while in the suburban area, it is 313 residents per km² (on average). The median for the area is 267 people per km². In most municipalities of the KMA, an upward trend in population density can be observed.

According to the Krakow Metropolis Strategy 2030², adopted in December 2021, one of KMA's major goals is to transform into an environmentally friendly region oriented toward climate neutrality, ensuring a high quality of life. The specific objectives of the strategy include efficient energy management and improvement of air quality by 1) effective energy management and improving the energy efficiency of buildings, 2) development of renewable energy sources and embracement of modern technologies for energy efficiency, 3) implementation of joint actions and tools to improve air quality.

A negative phenomenon occurring in the KMA are unfavourable changes in the structure of the demographic – the ratio of working age to non-working age people is decreasing. In terms of the wealth of local government units, the KMA could be classified as wealthy. The average income achieved in 2019 per capita amounted to 635 euro (in Krakow it is 1.084 euros). In the last period, there was constant positive dynamic recorded. Due to the changes caused by the coronavirus pandemic and numerous systemic legislative changes, it should be assessed that the state of local government finances may weaken over the next decade. Nevertheless, the municipalities of KMA maintain a relatively high capacity to absorb external funds.

A significant problem in energy management in KMA, is the dispersion of competencies and responsibilities among various units. The process of energy management takes place at the level of individual entities but not at the municipality level. Thus, on a limited scale, municipalities use the opportunity offered by cooperation, e.g. within energy cooperatives.

² <https://metropoliakrakovska.pl/metropolia/publikacje/strategia-metropolia-krakowska-2030>

The KMA has experience in supporting municipalities in the implementation of investments related to the thermal modernization of public buildings or renewable energy. As part of the Integrated Territorial Investments Strategy ³ for 2014-2020, thermal modernization projects were implemented, under which 144 buildings were subjected to thermal modernization by 2022.

TECHNICAL ASSUMPTIONS	KMA
Population (M)	1,07
Residents per dwelling	2,7
Total dwellings (K)	519
Unitary Dwelling area (m ²)	90
Number of municipalities ⁴	15
Number of staff members and stakeholders	183
Average annual energy consumption kWh/m ² *y	120,00
Average household annual energy consumption MWh/hh*y	10,80
Level of ambition – Energy management/Refurbishment	0,35
Estimated costs energy management/refurbishment (€/m ²)	150
Estimated energy savings (MWh/hh*y)	3,78

³ <https://metropoliakrakowska.pl/metropolia/publikacje/strategia-zintegrowanych-inwestycji-terytorialnych>

⁴ The figure differs from the one in the Grant Agreement due to a mistake in the draft of the proposal, this change does not affect the other KPIs defined: <https://metropoliakrakowska.pl/metropolia/o-metropolii>

Energy residential PV power (kW)	3,00
Load factor	0,14
Energy residential PV power for single household - 30% (kW)	0,90
PV energy produced for a single household (MWh/year)	1,10
Citizens directly engaged (0,2%)	2800
Households directly engaged	1037
Households participating in PV installation (20%)	207
Estimated cost of 3kW PV installation (€)	7000
Estimated costs for PV installation (€/household)	2100
Carbon emissions (gCO ₂ eq/kWh)	340

Table 2. Technical assumptions from the pilot KMA

4.2. LAZIO

The Lazio region extends over an area of 17.232 km² with 5.755.700 inhabitants in 2020, divided into 378 Municipalities. The population density is 334 inhabitants/km², with a peak in Ciampino with 2.969 inhabitants/km² and Rome with 2.135 inhabitants/km². It is the second Italian region by number of inhabitants. Rome, in addition to being the capital of Italy and the regional capital, is the largest and most populated municipality on our peninsula, with almost two million eight hundred thousand inhabitants. The other capitals of the respective provinces are Latina, Viterbo, Rieti and Frosinone. The regional Gross Domestic Product (GDP) is more than 200 billion euros and it represents around 10% of the Italian GDP.

Socially, the region thrives on its cultural heritage, with historical landmarks like the Colosseum and the Vatican drawing tourists from around the world. The preservation of this heritage is paramount to fostering a strong sense of identity and community among its residents. Lazio is also a melting pot of diverse populations, embracing both urban centres like Rome and smaller rural communities. Inclusivity and equitable access to resources, such as renewable energy, play pivotal roles in nurturing a cohesive and harmonious society.

Economically, Lazio is a region with multifaceted strengths. The tourism sector stands as a pillar of its economy, with visitors flocking to iconic attractions, picturesque countryside, charming coastal towns and equipped mountain ski resorts. Agriculture, another vital economic sector, thrives in Lazio's fertile lands. From vineyards producing world-renowned wines to olive groves yielding exceptional olive oil, as well as the famous "Pecorino Romano" cheese, the region's commitment to renewable energy integration in farming operations ensures environmental stewardship, reduced costs, and enhanced competitiveness. Environmental considerations are at the forefront of Lazio's priorities. The region's remarkable biodiversity, encompassing national parks and protected areas, demands vigilant preservation efforts. By adopting renewable energy sources and practices, Lazio can minimize its ecological footprint and contribute to the conservation of its diverse ecosystems. Furthermore, air quality concerns prevalent in many urban areas propel the region towards sustainable solutions. In this context, the emergence of energy communities is of utmost importance. ANCI Lazio supports the sustainable implementation of Lazio's energy transition plans by its members. Lazio's energy transition hinges on the active participation of communities in shaping the region's future. Energy communities enable residents to have a say in decision-making processes, access affordable and clean energy, and foster social empowerment. By spearheading the adoption of renewable energy, these communities accelerate Lazio's transition to a low-carbon and sustainable energy system. Moreover, they serve as catalysts for local economic development, generating employment opportunities, attracting investments, and nurturing the growth of renewable energy-related industries. In the Italian context, the framework for energy communities is awaiting the implementing decree.

However, within the scope of the purposes of ANCI Lazio which concern the protection of local autonomies recognized by the Constitution and by national and regional legislations, in the field of energy and energy communities, ANCI Lazio signed an agreement in 2020 with the Lazio Region Administration to concretely favour the Municipalities of Lazio on the subject of energy efficiency and new forms of sustainable mobility in line with the strategy relating to the Regional Energy Plan and the National Strategic Plan for Sustainable Mobility. With this agreement ANCI Lazio and the Regional Administration intend to intercept the needs of the Municipalities in the area of financing and in the structuring of energy efficiency and sustainable mobility policies and provide administrations with the opportunity to use regional funds in the best possible way, both with specialist support with both training and information initiatives.

The pilot action in Lazio provides for a focused and non-exclusive activity on the first energy community created in the Lazio Region, i.e. the Renewable Energy Community of Ventotene on the island of Ventotene born in October 2021. In the same month of October 2021, the Ministry of the Ecological Transition together with the Lazio Region has recognized the merit of being the first Italian island with a community of renewable energy, an innovative example in Europe.

The Lazio Region stands as a beacon of social cohesion, economic prosperity, and environmental sustainability. With a focus on preserving its cultural heritage, embracing renewable energy in key sectors, and empowering local communities through energy initiatives, Lazio paves the way for a future that harmoniously balances the needs of its people, the economy, and the environment.

TECHNICAL ASSUMPTIONS	ANCI-LAZIO
Population (M)	5,88
Residents per dwelling	2,4
Total dwellings (K)	2450
Unitary Dwelling area (m ²)	94,19
Number of municipalities	378
Number of staff members and stakeholders	1236
Average annual energy consumption kWh/m ² *y	101,57
Average household annual energy consumption MWh/hh*y	9,57
Level of ambition – Energy management/Refurbishment	0,10
Estimated costs energy management/refurbishment (€/m ²)	10

Estimated energy savings (MWh/hh*y)	0,96
Energy residential PV power (kW)	3,73
Load factor	0,14
Energy residential PV power for single household - 30% (kW)	1,12
PV energy produced for a single household (MWh/year)	1,37
Citizens directly engaged (0,2%)	11760
Households directly engaged	4900
Households participating in PV installation (20%)	980
Estimated cost of 3kW PV installation (€)	7000
Estimated costs for PV installation (€/household)	2611
Carbon emissions (gCO ₂ eq/kWh)	340

Table 3. Technical assumptions from the pilot ANCI LAZIO

4.3. AMB

The Barcelona Metropolitan Area (AMB) is the public administration of the metropolitan territory of Barcelona, with an area of 636 km² and 36 municipalities with a population of over 3,3 million. It is the largest metropolitan agglomeration in the western Mediterranean and generates half of Catalonia's region GDP. The AMB has powers in the areas of social cohesion, territorial and urban planning, mobility, transport, waste management, water supply, environment protection, social housing, infrastructures, and economic promotion in the metropolitan territory.

Under the Climate & Energy Plan 2030,⁵ the organisation carries out actions to promote a process of transition towards a decentralised energy model based on renewable and sustainable energy with an integrated approach. The organisation has a sound experience in managing and implementing local and European projects in the fields of sustainable development, energy efficiency and economic, social and territorial cohesion, with specific focus on energy transition and fight against fuel poverty.

The supramunicipal vision of AMB is key to the implementation of pilot experiences, with a high potential for replicability among its 36 municipalities, which is conducted through the Metropolitan Board for a New Energy Model, a forum that gathers all the stakeholders of the territory helping to accelerate energy transition all across the metropolitan municipalities.

Renewable energy projects hold a pivotal role within the COMANAGE Indicators' Work Package in the AMB, emphasizing the importance of sustainable energy transition and its impact on social, economic, and environmental dimensions. These projects aim to address the pressing need for clean, renewable energy sources while reducing greenhouse gas emissions and promoting energy independence. By focusing on renewable energy indicators, such as the percentage of energy derived from renewable sources, carbon footprint reduction, and increased energy efficiency, the pilots within the COMANAGE project can assess the effectiveness and progress of their renewable energy initiatives. Through comprehensive data collection, stakeholder engagement, and context-specific indicators, these projects can contribute to the broader goals of sustainable development and pave the way for a more resilient and environmentally conscious future.

In the Catalan context, the framework for energy communities is still in its early stages, with a draft legislation that remains uncertain in its future trajectory. Recognizing this, the AMB has strategically shifted its focus towards installing photovoltaic (PV) systems on their buildings and actively engaging citizens in shared self-consumption projects. By prioritizing these initiatives, the AMB aims to contribute to the promotion of renewable energy and community participation, despite the current limitations in the legal framework. These localized efforts not only foster the adoption of clean energy sources but also empower citizens to actively participate in the energy transition and pave the way for more sustainable and resilient communities.

The proposal envisions the use of Key Performance Indicators (KPIs) as a vital tool for assessing and measuring the progress and effectiveness of the COMANAGE project, specifically for the Barcelona Metropolitan Area (AMB). By employing a carefully selected set of KPIs, AMB aims to monitor and evaluate the impact of its initiatives, identify areas of improvement, and ensure alignment with its sustainability goals. These indicators provide a standardized and systematic approach to assess the success

⁵ Pla Energia i Clima 2030 (<https://www.amb.cat/s/web/ecologia/sostenibilitat/canvi-climatic/pla-clima-energia-2030.html>)

of AMB's efforts, facilitating informed decision-making, and promoting transparency and accountability throughout the project's implementation.

TECHNICAL ASSUMPTIONS	AMB
Population (M)	3,3
Residents per dwelling	2,5
Total dwellings (K)	1280
Unitary Dwelling area (m ²)	92,11
Number of municipalities	36
Number of staff members and stakeholders	141
Average annual energy consumption kWh/m ² *y	71,19
Average household annual energy consumption MWh/hh*y	6,56
Level of ambition – Energy management/Refurbishment	0,10
Estimated costs energy management/refurbishment (€/m ²)	10
Estimated energy savings (MWh/hh*y)	0,66
Energy residential PV power (kW)	3,94
Load factor	0,16

Energy residential PV power for single household - 30% (kW)	1,18
PV energy produced for a single household (MWh/year)	1,66
Citizens directly engaged (0,2%)	6400
Households directly engaged	2560
Households participating in PV installation (20%)	512
Estimated cost of 3kW PV installation (€)	7000
Estimated costs for PV installation (€/household)	2758
<u>Carbon emissions (gCO₂eq/kWh)</u>	340

Table 4. Technical assumptions from the pilot AMB

5. Collection and calculation methodology

This section outlines the procedures and techniques used to gather data and calculate the defined KPIs and provides a transparent and systematic approach to ensure consistency and accuracy in data collection and calculation processes. Below are some key points to keep in mind when establishing the methodology.

Regarding the **data collection process**, some key points to take into account are:

- *Identify the **sources of data** for each KPI. These could include internal databases, surveys, interviews, or external data providers.*
- *Specify the **data collection frequency**, establishing a schedule for monitoring.*
- *Outline the **data collection process**, including data entry procedures, tools, and responsible partners.*
- *Discuss any **data validation and quality assurance** measures implemented to ensure the accuracy and reliability of collected data.*

Another important element when establishing a methodology is the **processing and transformation** of the collected data. In this process, some important points are:

- *To describe any pre-processing steps required for the collected data, such as data cleansing, normalization, or aggregation.*
- *To explain any data transformations or calculations necessary to derive the KPIs from the raw data.*
- *To outline the formulas or statistical methods used for data processing and transformation.*

Regarding the **calculation of the KPIs**, it is very important to provide a clear definition of each KPI, as has been done in section 3, and include the formula used for its calculation, when necessary.

Then, below are the points that have been taken into account for the design of the **project's monitoring programme**:

Parameters/targets to be monitored: the parameters that must be monitored are those that come from the list of indicators, drawn up in the first phase during the preparation of the proposal, and subsequently revised during the preparation of *D5.1 KPI definition, monitoring programme and procedures*. Talking about parameters means both the indicators in the list and the variables needed to calculate any of these KPIs. The parameters can be both quantitative and qualitative, trying to maximize the quantitative since they are the ones that are used to monitor the evolution of the project more precisely. The indicators with the associated parameters are those presented in section 3 of this document.

Target stakeholders to be addressed: there can be different types of stakeholders depending on the particularities of each pilot and their social context. Another important variable to consider when identifying stakeholders is the access to the information necessary to monitor the project. Considering this, the following **types of stakeholders** have been identified:

- **Civil servants:** to be able to have data that is difficult to access and that is necessary for the calculation of some indicators, such as energy consumption data from public administrations participating in energy communities, etc.
- **Elected officials:** legislative responsibility.
- **Energy companies:** different types of energy companies may be necessary to monitor the results of the project, depending on their field of specialization. Some areas of expertise that are needed are: expertise in social dynamization and participatory processes for the creation of energy communities, technical expertise in energy distribution in large-scale energy communities and to have a powerful IT department with advanced management tools.
- **Consumers:** access to many data due to valuable experience in participatory processes with citizens, in the management of different types of energy communities, from the perspective of the private sector.
- **Policymakers:** to monitor the progress of the development of new legislations, policies or strategies, it will be necessary to address the policymakers.
- **Legal experts:** to maximize the results of some indicators presented, it is also necessary to turn to legal experts who can provide experience in the development of regulations, legal advice on legal figures of energy communities or legalization processes of shared photovoltaic installations.
- **Energy experts:** some of the necessary data require technical knowledge in energy matters, such as the tools.

Specific tools to be used: from all the tools available for data collection, a selection has been made of those that, due to the characteristics of the project, have been considered most useful. This selection was made together with the project partners in charge of data collection:

- Questionnaire for data collection
- Interviews
- Methodologies for data processing

Schedule for monitoring: the monitoring process will involve periodic reporting of the KPIs to the European Commission at specific intervals. It is planned that the KPIs will be reported **every 9 months**, allowing for regular updates on the project's performance and outcomes. This periodic reporting will provide the European Commission with timely and relevant information on the project's achievements, challenges, and overall progress towards its objectives.

Additionally, a comprehensive **final report** will be prepared at the end of the project, summarizing the results of the monitoring and evaluation efforts throughout the project's duration. This final report will present a detailed analysis of the KPIs, showcasing the project's overall impact on energy communities, sustainability, social development, and the environment.

By reporting the KPIs to the European Commission every 9 months and with the final report at the project's conclusion, the project partners will ensure **transparency and accountability** in project implementation. The regular updates will enable the European Commission to monitor the project's performance and provide feedback, while the final report will serve as a comprehensive assessment of the project's achievements and outcomes. Through this monitoring and reporting process, the project aims to demonstrate the effectiveness of the Energy Communities Governance Framework and Toolkit and its contributions to the uptake, management, and long-term sustainability of energy communities' projects across the EU.

5.1. Main obstacles to calculate the impact

Below are the **main obstacles** that have been detected to be able to carry out the monitoring programme described above:

- Data availability: not having the necessary data to calculate the indicators is a real risk and for which contingency measures must be prepared. Regarding this, the pilots will have to ensure that the data necessary for the calculation of the indicators are collected, and just in case that any of the data is very difficult to collect, the validity of the indicator will have to be reconsidered.
- Data consistency and comparability: once the data has been collected, the pilots will be responsible for making an initial assessment to determine its consistency and comparability. The consistency of the data is fundamental to ensure a good implementation of the monitoring plan, so it is very important that this phase is well executed. Not having consistent or easily comparable data can derail the entire monitoring plan. As a contingency measure, it will be necessary to implement robust data validation processes to ensure data integrity at the point of entry. This must include checks for data types, ranges, and logical consistency, and a protocol to regularly monitor data quality and perform data cleansing to identify and rectify any inconsistencies.
- Comparability and standardization of available data: this obstacle refers to the process of making data from different sources or entities more comparable and consistent by applying common standards and formats. This is essential for ensuring that data can be effectively analysed, aggregated, and used to calculate the different types of indicators.
- Stakeholder cooperation and engagement: stakeholders engagement strategy described in WP3 is very important to ensure the success of the monitoring programme implementation. The correct application of this strategy depends on all the partners participating in WP5. The information provided by the detected stakeholders is essential to be able to measure the impact of the project.
- Time lag and delayed effects: impact assessment often involves measuring changes over time. However, there might be a time lag between the implementation of the monitoring programme and the observable impact. Additionally, some effects might be delayed or only become apparent after a significant period, making it challenging to attribute them accurately to the programme.

6. Conclusions

The implementation of the monitoring programme is a crucial step in assessing the project's impact and ensuring its success in promoting sustainable energy communities and citizen-led initiatives. The comprehensive set of Key Performance Indicators (KPIs) developed for the project allows for the systematic measurement and evaluation of its social, economic, and environmental outcomes.

In the social impact dimension, the identified KPIs enable the project to measure its support for energy communities and citizen-led energy initiatives, capacity building of local and regional governments, stakeholder engagement, and the development of relevant legislation and policies. The inclusion of qualitative indicators further enriches the evaluation by assessing community cohesion, environmental awareness, well-being, trust in institutions, and the empowerment of women and vulnerable groups. These qualitative indicators provide valuable insights into the project's broader social impact, demonstrating its commitment to fostering inclusive and empowered communities.

In the economic impact dimension, the selected KPIs effectively measure the project's contributions to innovation, investment in sustainable energy, female leadership in initiatives, and the participation of vulnerable consumers in energy communities. These indicators highlight the project's role in mobilizing the local economy, creating job opportunities, and promoting gender equality and social inclusion.

The environmental impact dimension is effectively assessed through KPIs that quantify energy savings, renewable energy generation, and greenhouse gas emissions reductions. By monitoring these environmental outcomes, the project demonstrates its commitment to promoting resource conservation, pollution prevention, and ecological resilience.

Throughout the monitoring programme, several key KPIs emerge as particularly important indicators of the project's success. These include the number of energy communities and citizen-led energy initiatives launched, the number of stakeholders with increased skills through capacity building activities, and the total number of accesses to capacity building tools. These KPIs prove to be valuable in measuring the project's ability to facilitate community engagement, enhance stakeholders' knowledge, and effectively disseminate information and resources.

The monitoring programme's comprehensive approach, combined with the selected KPIs, provides a robust framework for evaluating the COMANAGE project's impact. The project's pilot partners, represented by the Metropolitan Area of Barcelona (AMB), the Krakow Metropolis Association (KMA), and the Lazio National Association of Italian Municipalities (ANCI LAZIO), demonstrate a commitment to achieving the project's objectives and fostering sustainable energy practices across the European Union.

As the project continues, the ongoing monitoring and evaluation of the KPIs play a crucial role in guiding decision-making, identifying areas for improvement, and ultimately ensuring the successful growth and sustainability of energy communities and citizen-led energy initiatives. By leveraging the insights gained from the monitoring program, the COMANAGE project leaves a lasting positive impact on the European energy landscape, paving the way for a more sustainable and community-driven future.