Recommendations for the preparation and monitoring of energy efficiency program's

For municipalities in Türkiye

Report

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Contents

Abbreviations

EE – Energy Efficiency

GHG – Greenhouse Gas

HVAC - Heating, Ventilation, and Air Conditioning

CPMA – Central Project Management Agency

CoM - Covenant of Mayors

Introduction

These recommendations have been formulated as part of the "EU4 Energy Transition: Covenant of Mayors in the Western Balkans and Türkiye" project. They have been developed by an expert from the Central Project Management Agency (CPMA) and have received direct support from teams representing several Turkish municipalities.

The project is a multi-donor initiative jointly funded by the European Union and the German Federal Ministry for Economic Cooperation and Development. It is being implemented by GIZ in the Western Balkans and by CPMA in Türkiye. The primary focus of the project is to engage local authorities in the Western Balkans and Türkiye to address the energy transition and combat climate change. Specifically, the project aims to assist cities participating in the Covenant of Mayors (hereinafter referred to as CoM) for Climate and Energy Initiative in meeting their energy and climate targets. As an incentive for municipalities to contribute to these targets set by the CoM, the project offers support for the implementation of Sustainable Energy and Climate Action Plans (SECAPs).

Within the project framework, a significant activity involves executing small-scale projects in the realms of energy, climate protection, and transportation within Turkish municipalities. These small-scale projects are expected to introduce innovation and novel approaches at the local level. The anticipated outcomes of these projects should be practical and feasible, focusing on tangibly reducing energy consumption and CO_2 emissions while maintaining or enhancing the current standards of citizen comfort or service delivery.

The integration of alternative energy sources stands as a crucial stride towards fostering sustainable energy practices. Melikgazi and Bagcilar municipality's proactive measures, such as the installation of solar photovoltaic panels and the procurement of an electric vehicle for pilot purposes to fulfill the city's energy needs, not only demonstrates a commitment to renewable energy but also establishes a commendable precedent for responsible energy utilization within the community.

Recommendations for a system for the preparation, implementation, and monitoring of energy efficiency programs for Türkiye municipalities can be highly beneficial for both the community and the environment. This document offers concise recommendations on effectively designing and implementing such programs. The suggestions primarily center on implementing strategies to enhance energy efficiency in municipal buildings and incorporating alternative energy sources. Additional energy efficiency measures can be formulated and executed following similar principles, all of which can substantially support the municipality's objectives in mitigating the effects of climate change.

Principles for the development of municipal energy efficiency programs

Energy consumption in municipalities in Türkiye is substantial due to the operation of various facilities, public services, and infrastructure. Key areas of energy use include municipal buildings, public lighting, water supply and treatment, transportation, and waste management. As urbanization and population growth continue, the demand for municipal services increases, leading to higher energy consumption.

Public buildings and facilities, such as administrative offices, schools, and community centers, contribute significantly to energy usage. Street lighting, water pumping and treatment, and the operation of municipal vehicles also play crucial roles in energy consumption.

Given the unique nature of public transport systems, water supply and waste management in each municipality, these recommendations will focus primarily on implementing measures to enhance the energy efficiency of municipal public buildings and promote the utilization of alternative energy sources.

It is recommended to use the following main stages for the preparation and implementation of municipal energy efficiency programs:

Comprehensive Data Collection: Establish a robust data collection system to gather information on energy consumption across municipal buildings, facilities, and services. This data should include electricity, water, and heating usage, as well as transportation and waste management metrics.

Set Clear Goals and Targets: Define specific energy efficiency goals and targets that align with national priorities and international standards. These goals could include reducing energy consumption by a certain percentage within a specified timeframe or achieving certain energy efficiency ratings for municipal buildings.

Implement Monitoring Tools: Utilize monitoring tools such as smart meters, energy management systems, and data analytics software to track energy usage in real-time and identify areas for improvement. Regularly analyze the data to assess progress towards goals and identify any deviations or anomalies.

Engage Stakeholders: Engage stakeholders including municipal officials, employees, residents, and local businesses in the energy efficiency program. Raise awareness about the importance of energy conservation and encourage active participation in energy-saving initiatives through education, training, and outreach campaigns.

Implement Efficiency Measures: Implement cost-effective energy efficiency measures such as improving insulation in buildings, optimizing Heating, Ventilation, and Air Conditioning (HVAC) systems, upgrading lighting systems to LED, and promoting renewable energy sources where feasible. Prioritize projects based on their potential energy savings and return on investment.

Monitor and Evaluate Performance: Continuously monitor and evaluate the performance of energy efficiency initiatives to ensure they are achieving the desired outcomes. Conduct regular audits and assessments to identify areas for improvement and adjust strategies as needed to maximize energy savings and cost-effectiveness.

Promote Transparency and Accountability: Maintain transparency and accountability in the energy efficiency program by regularly reporting progress and results to the public and relevant

stakeholders. Provide opportunities for feedback and input from the community to ensure the program remains responsive to their needs and priorities.

By following these recommendations, municipalities in Türkiye can effectively implement energy efficiency program monitoring systems to reduce energy consumption, lower carbon emissions, and promote sustainable development in their communities.

Stage 1. Comprehensive Data Collection for Municipal Energy Efficiency Programs

A comprehensive data collection effort is essential for municipalities preparing energy efficiency programs. This data lays the necessary foundation for informed decision-making, effective planning, and the successful implementation of energy efficiency initiatives. Collecting data allows municipalities to establish a baseline assessment of current energy consumption, expenditure, and performance in municipal public buildings and facilities. This baseline serves as a reference point for measuring progress and evaluating the impact of energy efficiency measures over time.

Detailed data collection helps identify opportunities for improving energy efficiency and reducing energy waste. By analyzing energy consumption patterns, identifying inefficiencies, and pinpointing areas of high energy use, municipalities can strategically prioritize investments and target interventions where they will have the greatest impact.

Data collection enables municipalities to set realistic and achievable targets for energy savings and greenhouse gas emissions reduction. By understanding current energy consumption levels and the potential for improvement, municipalities can establish meaningful goals that align with their sustainability objectives and resource constraints.

Access to accurate and up-to-date data empowers decision-makers to make informed choices regarding energy efficiency investments, policies, and strategies. Adopting a data-driven approach ensures that resources are allocated efficiently, risks are minimized, and desired outcomes are achieved. It is also crucial to note that comprehensive data collection strengthens municipalities' ability to secure funding for energy efficiency projects and initiatives. Well-documented data on energy consumption, cost savings potential, and environmental benefits enhances credibility and supports grant applications, financing proposals, and stakeholder engagement efforts.

Collected data serves as the foundation for monitoring and evaluating the performance of energy efficiency programs and projects. By tracking key performance indicators, analyzing progress against targets, and assessing outcomes, municipalities can measure success, identify areas for improvement, and demonstrate accountability to stakeholders. Data transparency and accessibility facilitate stakeholder engagement and collaboration. Sharing data with building occupants, community members, utility providers, and other stakeholders fosters awareness, participation, and support for energy efficiency initiatives, thereby enhancing their effectiveness and sustainability.

In summary, comprehensive data collection is vital for municipalities preparing energy efficiency programs. It provides critical insights, informs decision-making, supports goal setting, and enables effective monitoring and evaluation. By leveraging data effectively, municipalities can maximize the impact of their energy efficiency efforts, advance sustainability objectives, and contribute to a greener, more resilient future.

Comprehensive data collection is recommended to be carried out by analyzing at least the following data:

Energy Consumption in Public Buildings

Collect data on energy consumption in municipal public buildings such as offices, schools, libraries, and community centers. This includes electricity, natural gas, and water usage. Monitor energy usage patterns over time to identify trends and areas for improvement. Assess the energy efficiency of building systems including HVAC, lighting, and appliances.

Energy Sources

Identify the sources of energy used in municipal public buildings and facilities, including electricity, natural gas, and renewable energy sources such as solar or wind. Track the proportion of energy obtained from renewable sources and monitor progress towards increasing renewable energy usage.

Building Technical Condition

Assess the technical condition of municipal public buildings to identify their technical stability, resistance to seismic influences and opportunities for increasing energy efficiency. Conduct technical and energy audits and building assessments to assess insulation, windows, doors, roofing, and other components of building envelopes. Identify potential upgrades or modifications to improve energy performance, such as installing energy-efficient windows, upgrading insulation, or replacing outdated HVAC systems.

To facilitate the collection of certain data regarding municipal public buildings, it is suggested to utilize the standard form designated for municipalities in the Annex 1 of this report *(Standard form for the data collection in the process of auditing of public buildings).*

Additionally, when drafting the Program, it would be beneficial to assess other energy-consuming sectors, such as:

Engineering Infrastructure (for example - street lighting, etc.):

Collect data on street lighting infrastructure, including the number and type of streetlights, their energy consumption, and operational efficiency. Evaluate the efficiency of existing street lighting systems and explore opportunities for upgrading to energy-efficient LED technology and the ability to automate lighting processes. Monitor street lighting usage patterns and adjust lighting schedules or brightness levels to optimize energy efficiency while ensuring public safety and security.

Water and Wastewater Management

Track energy consumption associated with water supply, treatment, and distribution systems, as well as wastewater collection and treatment facilities. Identify opportunities for energy efficiency improvements in water pumping, treatment processes, and distribution networks. Explore renewable energy options for powering water and wastewater facilities, such as solar-powered pumping systems or biogas generation from wastewater treatment.

Transportation

Gather data on municipal transportation systems, including public transit vehicles, fleet vehicles, and infrastructure. Monitor fuel consumption, mileage, and emissions from municipal vehicles to identify opportunities for fuel efficiency improvements and alternative fuel adoption. Promote initiatives such as carpooling, cycling infrastructure, and electric vehicle charging stations to reduce energy consumption and emissions from transportation. It would also be appropriate to assess the possibilities for the municipality to switch to more efficient fuel cars, i.e. by changing diesel cars to less fuel-intensive or electric cars.

Etc..

To effectively utilize the collected data and develop an energy efficiency program, a comprehensive energy audit of municipal buildings is essential. This audit should evaluate the current condition of the buildings and engineering systems, compare energy consumption data with similar buildings, and identify requirements for newly constructed buildings. Such an audit will facilitate the identification of areas of inefficiency, the most energy-consuming systems, and buildings with the greatest potential for improvement.

When prioritizing energy efficiency measures, it is important to consider their potential impact, economic efficiency, and feasibility. Factors such as the amount of energy saved, initial investments, and implementation complexity should be considered. Initiatives that are inexpensive and easily implementable, such as installing energy-efficient lighting, optimizing heating and cooling systems, and encouraging simple behavioral changes like turning off lights and equipment when not in use, should be prioritized.

Additionally, potential technological solutions and upgrades that can yield significant energy savings should be considered. This may involve investments in energy-saving measures like wall insulation, installation of more efficient windows, and upgrades to high-performance HVAC systems. The installation of smart building automation systems can also help control and optimize energy usage. Furthermore, the integration of renewable energy sources such as solar, wind, or geothermal energy should be explored. It is beneficial to learn from the experiences of other municipalities, such as Bagcilar and Melikgaze, which have successfully implemented solar PV systems to supply a portion of their energy needs with green electricity.

In preparing the Program, it is crucial to assess the feasibility of onsite renewable energy generation. Solar PV systems could be installed on the roofs of municipal buildings or on underutilized land plots. Given Türkiye's abundant sunlight, solar energy utilization can serve as a highly effective alternative energy source, with investments potentially paying off in a relatively short time frame (4-5 years, based on preliminary estimates).

Improving building envelopes to enhance energy efficiency should also be considered. This could involve measures such as adding insulation to walls and roofs, updating windows and doors, sealing air leaks, and optimizing building orientation and design to maximize natural lighting and ventilation. For instance, a simple measure like painting a flat roof white can yield tangible results by reducing overheating of the premises during the summer.

Implementing energy-efficient lighting upgrades, such as replacing traditional incandescent or fluorescent bulbs with LED fixtures, can result in significant energy savings. LED lighting consumes less energy, lasts longer, and provides better quality light, thereby improving visual comfort. Upgrading HVAC systems to enhance efficiency and performance, for example, by installing high-efficiency boilers, chillers, and heat pumps, can also yield substantial energy efficiency gains. Utilizing programmable thermostats, zone controls, and HVAC scheduling can further optimize temperature settings and reduce energy consumption while maintaining occupant comfort.

In all cases, technical and energy audits of buildings should be conducted by qualified specialists with the appropriate qualifications, experience, and certifications. These specialists will be capable of assessing the current technical and energy status of the buildings and selecting effective energy efficiency measures that align with the municipality's requirements. Furthermore, after evaluating the required funding for implementing the measures and the expected payback period, these specialists can propose a feasible implementation plan for the Program to the municipality

Building occupants can play a pivotal role in promoting efficient energy use. Therefore, they, along with other stakeholders, should be engaged in energy-saving efforts through education and awareness-raising programs. Encourage energy-saving behaviors, such as setting thermostats to optimal temperatures, turning off electronics when not in use, and adopting energy-efficient lighting practices. By adhering to these guidelines and systematically selecting energy efficiency measures tailored to the specific needs and characteristics of the municipality, as well as maximizing the use of alternative energy sources, significant energy savings can be realized. This will reduce environmental impact and enhance overall operational efficiency.

The energy efficiency program developed and implemented by the municipality can serve as a model for other organizations, companies, and private residents, encouraging them to adopt more efficient energy consumption practices and implement exemplary measures.

Setting Goals and Targets of the Program

The goals and targets of the Program must be consistent with the objectives set by the municipality when preparing the Sustainable Energy and Climate Action Plan (SECAP) or similar Municipal plans or programs. However, in this section we will give some specific examples that could be used to achieve the objectives of the programme.

- Percentage Reduction in Energy Consumption: Set a target to reduce overall energy consumption in public buildings by a certain percentage over a specific timeframe. For example: Goal: Achieve a 20% reduction in electricity and natural gas consumption across all municipal buildings by 2030 compared to baseline levels in 2020.
- Renewable Energy Integration: Set targets for increasing the use of renewable energy sources to power municipal buildings.
  For example: Install solar panels on 50% of municipal buildings by 2030, generating at least 20% of total electricity consumption from renewable sources.
- Carbon Emission Reduction: Establish goals for reducing greenhouse gas emissions associated with energy consumption in public buildings.
  For example: Achieve a 30% reduction in carbon emissions from municipal buildings by 2030 compared to baseline emissions in 2020.
- Energy Performance Benchmarking: Set targets to achieve specific energy performance benchmarks or standards for municipal buildings.
  For example: Ensure that all new municipal buildings constructed after 2024 meet LEED Gold certification standards for energy efficiency and sustainability or similar standards used in Türkiye (LEED, which stands for Leadership in Energy and Environmental Design, is a globally recognized

green building certification program developed by the U.S. Green Building Council (USGBC). LEED certification provides a framework for designing, constructing, operating, and maintaining buildings in a sustainable and environmentally responsible manner.)

- Operational Efficiency Improvements: Establish targets for improving the operational efficiency of building systems and equipment.
  For example: Implement energy management systems in 80% of municipal buildings by 2025 to optimize HVAC operations, lighting schedules, and equipment usage.
- Public Awareness and Engagement: Set goals to raise awareness about energy conservation and encourage public participation in energy-saving initiatives.
  For example: Increase community engagement in energy conservation efforts by hosting educational workshops, outreach events, and energy-saving challenges, aiming to reach 50% of residents by 2027.
- Financial Savings: Establish targets for achieving cost savings through energy efficiency measures.
  For example: Realize a cumulative cost savings of TRY 5,000,000 annually from reduced energy expenses in municipal buildings by 2027 through the implementation of energy efficiency upgrades.

By setting clear and measurable goals and targets, municipalities can effectively track progress, prioritize actions, and demonstrate commitment to achieving energy efficiency and sustainability objectives in public buildings.

Implementing Monitoring tools

Implementing monitoring tools for an energy efficiency program involves deploying systems and technologies to track and analyze energy consumption data, evaluate program performance, and identify opportunities for improvement. Here's are some options of implementing monitoring tools for such a program:

- *Energy Management Software:* Utilize energy management software platforms to collect, store, and analyze energy consumption data from various sources, including utility bills, smart meters, and building automation systems. These software solutions often offer features such as real-time monitoring, data visualization, and automated reporting to help identify trends, anomalies, and potential energy-saving opportunities.

  Here are presented some examples of energy management software platforms:

  i) *EnergyCAP* is a comprehensive energy management software designed to streamline the process of tracking and analyzing energy usage data. It offers features such as bill entry, meter management, budgeting tools, and reporting functionalities. *EnergyCAP* allows municipalities or their organizations to identify energy-saving opportunities, track sustainability goals, and manage utility expenses effectively.

  ii) *BuildingIQ* is an advanced energy management platform that utilizes predictive analytics and machine learning algorithms to optimize building energy usage. It integrates with building automation systems to dynamically adjust HVAC settings based on occupancy patterns, weather forecasts, and other factors to maximize energy efficiency while maintaining comfort levels.

iii) *Schneider Electric's EcoStruxure* is a cloud-based energy management platform that offers a suite of solutions for monitoring, controlling, and optimizing energy usage in buildings and facilities. It provides real-time insights into energy consumption, equipment performance, and environmental conditions, allowing organizations to identify energy-saving opportunities and improve operational efficiency.

iv) Etc…

- *Smart Meters and Submetering:* Install smart meters and submetering devices to monitor energy usage at the building level, floor level, or individual equipment level. Smart meters provide detailed insights into energy consumption patterns, allowing for more accurate tracking of energy use and identification of areas for improvement. Submetering enables the disaggregation of energy data, helping to pinpoint energy-intensive processes or equipment. Here are presented some examples of smart meters and submetering devices:

  i) *Aclara* offers a range of smart metering solutions for utilities and administrative or commercial buildings. Their smart meters provide real-time data on electricity, water, and gas consumption, enabling more accurate billing and better management of energy resources. *Aclara's* meters also support advanced features such as remote monitoring, outage detection, and demand response capabilities.

  ii) *Siemens* offers a comprehensive portfolio of smart metering and submetering solutions for administrative, commercial and industrial applications. Their smart meters provide detailed insights into energy usage at the building or equipment level, allowing for more informed decision-making and proactive energy management strategies. *Siemens'* submetering devices enable the disaggregation of energy data, helping identify energy-saving opportunities and optimize building performance.

  iii) *E-Mon* specializes in submetering solutions for commercial, industrial, and residential buildings. Their submetering devices measure electricity usage at the circuit, panel, or equipment level, providing granular insights into energy consumption patterns. *E-Mon's* meters integrate with energy management systems and software platforms to enable real-time monitoring, data analysis, and reporting capabilities.

  iv) Etc…

By implementing monitoring tools as part of an energy efficiency program, municipalities can gain valuable insights into energy consumption patterns, optimize building performance, and drive continuous improvement in energy efficiency and sustainability efforts.

Engaging stakeholders

Engaging stakeholders involves actively involving various individuals and groups who have a vested interest or influence in the success of the energy efficiency program. Here's we try to present it how to do it effectively:

Identify Stakeholders: Begin by identifying all relevant stakeholders who may be impacted by or have a role to play in the energy efficiency program. This may include municipal officials, facility managers, building occupants, community members, local businesses, utility providers, and energy efficiency experts.

Communicate Program Goals and Benefits: Clearly communicate the goals, objectives, and expected benefits of the energy efficiency program to stakeholders. Explain how energy efficiency measures can lead to cost savings, environmental benefits, improved comfort, and enhanced quality of life for the community. Here's are presented some actions could be used for effectively communicating the goals, objectives, and expected benefits of an energy efficiency program to stakeholders:

- Organize presentations and workshops to engage stakeholders directly and provide detailed information about the energy efficiency program. Use slides, videos, and interactive activities to illustrate key concepts, showcase success stories, and demonstrate the potential benefits of energy efficiency measures. Encourage active participation and address any questions or concerns raised by stakeholders during these sessions.
- Develop educational materials such as brochures, fact sheets, and newsletters to disseminate information about the energy efficiency program to a wider audience. These materials should clearly outline the goals, objectives, and expected benefits of the program in a concise and easy-to-understand format. Include visual aids, infographics, and real-life examples to make the content more engaging and accessible to diverse audiences.
- Create a dedicated website or online portal for the energy efficiency program to serve as a central hub for information and resources. Include sections highlighting the program's goals, key initiatives, success stories, and upcoming events. Provide downloadable materials, links to relevant resources, and interactive tools such as energy calculators or efficiency tips to empower stakeholders to act and learn more about energy efficiency.
- Leverage social media platforms such as Twitter, Facebook, LinkedIn, and Instagram to raise awareness about the energy efficiency program and engage with stakeholders in real-time. Share updates, news, and success stories related to the program, and encourage stakeholders to participate by sharing their own experiences and insights. Use hashtags, polls, and contests to generate excitement and foster community involvement around energy efficiency initiatives.
- Host community events, workshops, and outreach activities to connect with stakeholders on a personal level and build relationships. Attend local fairs, markets, and festivals to reach a broader audience and share information about the energy efficiency program. Collaborate with community organizations, schools, and businesses to co-host events and reach diverse groups within the community.
- Schedule regular stakeholder engagement meetings to provide updates on the progress of the energy efficiency program, solicit feedback, and address any concerns or challenges encountered. Create opportunities for stakeholders to participate in decision-making processes, volunteer for working groups, or contribute ideas for new initiatives. Foster a collaborative and inclusive environment where stakeholders feel valued and empowered to actively contribute to the success of the program.

Seek Input and Feedback: Solicit input and feedback from stakeholders throughout the planning, implementation, and evaluation phases of the energy efficiency program. Encourage open dialogue and collaboration to ensure that diverse perspectives and needs are considered in decision-making processes.

Encourage Participation: Encourage active participation and involvement from stakeholders in energy-saving initiatives and activities. Empower building occupants to adopt energy-saving behaviors, such as turning off lights, adjusting thermostats, and reducing water consumption. Collaborate with local businesses to implement energy efficiency upgrades and share best practices.

Form Partnerships and Alliances: Forge partnerships and alliances with relevant organizations, industry associations, non-profit groups, and academic institutions to leverage resources, expertise, and networks in support of the energy efficiency program. Collaborate on joint initiatives, research projects, and outreach campaigns to amplify impact and reach a wider audience.

Address Concerns and Barriers: Listen to the concerns and address the barriers that stakeholders may have regarding energy efficiency measures. Provide support, resources, and incentives to overcome obstacles and encourage participation. Address issues related to affordability, accessibility, and technical feasibility to ensure inclusivity and equity.

Celebrate Achievements and Successes: Recognize and celebrate achievements and successes of the energy efficiency program, highlighting the contributions and efforts of stakeholders. Share success stories, case studies, and testimonials to inspire and motivate continued engagement and support.

By actively engaging stakeholders throughout the energy efficiency program, municipalities can build consensus, foster collaboration, and create a sense of ownership and commitment towards achieving shared goals for a more sustainable and resilient community.

Energy Efficiency Measures Implementation

Organizing the implementation of an energy efficiency program involves establishing effective structures, processes, and roles within the municipality to support the Program's goals. Below are some recommendations regarding the organization and management of the Program.

Firstly, assemble a dedicated team comprising representatives from relevant departments and stakeholders to oversee the planning, implementation, and evaluation of the energy efficiency program. This team should include staff from facilities management, engineering, finance, sustainability, and administration to ensure diverse perspectives and expertise. It is also advisable to appoint managers within the municipality or organizations where projects are being implemented to lead and coordinate energy efficiency efforts. These individuals should have the authority, resources, and support to promote initiatives, engage stakeholders, and monitor progress towards the program's objectives.

The development of a robust energy efficiency plan involves defining objectives, strategies, and actionable plans aimed at achieving energy efficiency targets. This plan should clarify the roles and responsibilities of stakeholders, outline specific actions, objectives, and deadlines, and allocate resources for implementation efforts.

Very important to ensure effective communication and coordination among internal stakeholders, external partners, and the broader community. For this purpose establish regular meetings, workshops, and reporting mechanisms to facilitate information sharing, decision-making, and collaboration.

At the launch of the Program, implementing training programs, seminars, and educational resources is invaluable for strengthening the capacity of staff and stakeholders involved in energy efficiency initiatives.

Provide technical training on the management of planned measures, energy management practices, energy-saving technologies, and Program implementation strategies to enhance skills and knowledge.

Forge partnerships with external organizations, government agencies, other municipalities that have already implemented similar programs/projects, utilities, nonprofits, and industry associations to leverage resources, share best practices, and support Program implementation.

It is essential to implement monitoring and evaluation mechanisms in the Program's implementation to assess the timeliness and effectiveness of the implementation and ensure accountability. Regularly review progress towards goals, conduct performance evaluations, and seek feedback from stakeholders to identify successes, challenges, and opportunities for improvement.

By addressing these organizational aspects, municipalities can enhance their capacity to implement and maintain energy efficiency programs, maximize impact, and achieve the goals outlined in the municipal SECAPs or other related programs.

Procurement organizations

The Municipality must procure the necessary works and services for the implementation of the Program through public procurement procedures established by law. Organizing public procurement involves several main stages.

First, procurement needs are identified. Based on the approved energy efficiency program and proposed implementation stages, the municipality specifies the energy efficiency measures to be implemented. These may include upgrades to lighting systems, HVAC systems, insulation, renewable energy installations, or other improvements aimed at reducing energy consumption and costs. As mentioned earlier, proposals for measures and implementation stages should be provided by energy specialists conducting building audits.

Detailed technical specifications are prepared for the identified works. Comprehensive specifications for each energy efficiency measure are prepared, outlining technical requirements, performance standards, and all regulatory or environmental aspects. Recommendations for structuring the technical specifications for procuring renewable energy installation (solar PV) are detailed in Annex 2. Similar structures can be utilized for drafting technical specifications for procuring other energy efficiency measures.

When announcing procurement, the Municipality requests proposals from qualified contractors, vendors, or service providers capable of implementing the specified energy efficiency measures. Therefore, the municipality must clearly specify the qualifications of contractors, vendors, or service providers it finds acceptable. Proposals received are evaluated based on criteria such as economic efficiency, technical experience, past performance, compliance with specifications, and other important factors before the deadline set by the municipality.

Contracts are concluded with selected suppliers or contractors based on proposal evaluations. Contracts may be awarded separately for each energy efficiency measure or grouped together, depending on the public procurement strategy. While selecting one contractor for all types of work may simplify contract administration for the municipality, but it may compromise the quality of work. Therefore, when organizing procurement of works, the municipality is advised to carefully evaluate the types of work being procured and the specialization of potential contractors. It might be more beneficial to purchase work from several specialized contractors rather than one, as this can attract more qualified contractors for different

specializations. *For example, one contractor could install solar PV systems, while another could handle wall and roof insulation works.*

Throughout the entire public procurement process, transparency, fairness, and compliance with applicable laws and other regulations are crucial to ensuring successful implementation of energy efficiency measures and effective use of public funds. Therefore, municipalities must pay special attention to this aspect.

After signing the contract, selected contractors or suppliers implement energy efficiency measures according to the contract terms. The municipality monitors progress to ensure compliance with specifications, quality standards, and project schedules. Upon completion of the implementation phase, the municipality verifies whether the energy efficiency measures have been installed and function as intended. Acceptance of the work is officially documented, and any necessary adjustments or corrections are addressed. Payment is made to suppliers or contractors based on contract terms and satisfactory completion of the work. Contract closeout procedures, including final documentation, warranties, and financial reconciliation, are completed to finalize the entire process outlined in the contract.

Monitor and Evaluate Performance

Proposed monitoring methodology ensures the effective maintenance and evaluation of such projects, encompassing energy efficiency enhancements in public buildings, solar PV installations, procurement of electric vehicles, establishment of electric vehicle charging stations and other energy efficiency measures. The proposed monitoring methodology includes a systematic approach involving the collection, analysis, and evaluation of data to monitor the performance and efficiency of the measures implemented, as well as the reduction of fossil fuel-based CO_2 emissions.

Utilizing dependable monitoring methods, the municipality can track the advancement of the project implementation, identify any deviations or deficiencies that may have emerged, precisely measure, and compare against the planned energy efficiency metrics, evaluate the performance of the installed solar PV system, analyze energy production, and assess its broader impact on the municipality's overall energy consumption and its contribution to climate change mitigation.

The main objectives of the implementation of the monitoring methodology of the energy efficiency projects implemented by the Municipalities:

Evaluation of project planning and implementation: Evaluation of project planning and implementation involves the assessment of planned versus actual investments for project execution, as well as a comparison between the intended and executed technical solutions. Additionally, it encompasses an analysis of the project's implementation timeline and an examination of the challenges and obstacles encountered during the process. These evaluations play a crucial role in enhancing the success of future projects by providing valuable insights for improved planning and execution.

Performance evaluation: This means assessing the effectiveness and efficiency of the measures implemented to ensure that they are in line with or above the planned level of energy efficiency.

Fault Detection and Maintenance: Swift identification of any irregularities, faults, or malfunctions within the system is crucial. Early detection allows for timely maintenance, minimizing downtime and optimizing energy consumption or energy production.

Energy consumption analysis: Energy consumption analysis involves assessing the impact of insulation or other energy efficiency improvements on buildings. This includes comparing the energy generated by the solar PV system with the overall demand for municipal electricity consumption, encompassing lighting, heating, cooling, irrigation, and other necessities. Such an analysis provides insights into solar energy's contribution to fulfilling the municipality's overall energy requirements. By examining these metrics, stakeholders can better understand the effectiveness of energy efficiency measures and the extent to which renewable energy sources like solar power can offset traditional energy consumption.

Data Management and Reporting: Establishing a structured framework for collecting, storing, and interpreting data generated by the monitoring process is essential. Regular reports and analyses facilitate informed decision-making for system optimization and future planning purposes. To effectively monitor the solar PV system, various methodologies and tools can be employed, including:

- *Real-time Monitoring Software*: Utilizing specialized software that continuously tracks and records energy generation, system performance metrics, and environmental factors affecting solar panel efficiency.
- *Remote Sensing and IoT Devices:* Implementing sensors and Internet of Things (IoT) devices to gather data on temperature, irradiance, panel orientation, and other relevant parameters in real-time.
- *Periodic Inspections and Audits:* Conducting scheduled inspections and audits to physically assess the condition of the solar panels, electrical connections, and overall system health.

By establishing a reliable monitoring methodology, the municipality can ensure the successful use and sustainable operation of the solar PV system and the effective monitoring, evaluation and control of other implemented measures and systems.

It is necessary to have a well-structured methodology for monitoring the progress and efficiency of the installation of solar PV and other implemented effective energy-saving measures, as well as the further use of the generated electricity for the needs of the municipality. This methodology was developed to assess the effectiveness of project planning and implementation and includes several monitoring stages:

Stage 1: Evaluation of Project Planning and Implementation

Stage 2: Assessment of Planned and Actual Energy Efficiency and Electricity Generation

Stage 3: Evaluation of Financial and Environmental Benefits

Stage 4: Other Actions Related to the Monitoring

The monitoring process aims to address the following key inquiries:

(i) Have the projected targets for energy efficiency and electricity generation and CO_2 emission reductions been met?

(ii) Was the budget allocated for the project implementation appropriate, and was the project executed within the scheduled timeline?

(iii) What is the anticipated payback period of the implemented project, enabling future financial planning and identification of benefits for subsequent projects' implementation?

Conducting thorough monitoring of the project's implementation allows for a comprehensive understanding of its performance, ensuring alignment with the initial objectives and paving the way for informed decisions regarding future projects and financial planning.

Stage 1. Evaluation of Project Planning and Implementation

In conducting this assessment, the municipality should reassess the planned energy efficiency measures to determine the extent to which they were implemented as intended. It is crucial to evaluate the budget allocated for each measure against the actual costs incurred, as well as to compare the planned project deadline with the actual implementation timeline. This report should outline the achieved results in relation to the initial targets. In cases where the desired outcomes were not fully met or were exceeded, brief explanations along with the main reasons should be provided. Table 1 and Annex 3 of this methodology offer recommendations on preparing such a report. Upon the project's completion, this report, along with conclusions and recommendations, could be submitted to municipal management.

This assessment serves a dual purpose for the municipality: aiding in the planning and execution of similar projects in the future, while also offering valuable insights to other municipalities embarking on energy efficiency improvement initiatives. The report's findings will significantly inform future municipal project planning and serve as a resource for other municipalities engaged in similar endeavors.

Table 1. Form of report on evaluation of project planning

Name of indicators	Results	Explanation (if needed)
1. Planned to install Solar PV plants with a capacity (kWp)		
2. Solar PV plant that has been installed currently has a capacity of (kWp)		
3. Planned Solar PV implementation budget (TRY)		
4. Solar PV implementation budget incurred (TRY)		
5. Planned to implemented (other measure …) m^2, kW,…		
6. Implemented (other measure) m^2, kW…		
7. Planned (other measure) implementation budget (TRY)		
8. Other measure implementation budget incurred (TRY)		
…..		
Planned total project implementation budget (TRY)		
Total project implementation budget incurred (TRY)		
Percentage of investment in terms of the planned budget "+" "-", (%)		

Planned project preparation period (month)		
Project preparation period within (months)		
Planned project procurement period (month)		
Project procurement implemented within (months)		
Planned project implementation period (month)		
Project implemented within (months)		

Stage 2. Assessment of Project Results

2.1. Assessment of Planned and Actual energy efficiency achieved

The assessment of planned and actual energy efficiency and environmental benefits of implemented measures in municipal public buildings involves evaluating the initial objectives set for energy efficiency improvements against the actual outcomes achieved. This assessment considers factors such as energy consumption reduction, cost savings, and environmental impact. It examines the effectiveness of the measures implemented, comparing projected benefits with realized results. Additionally, it analyzes any unforeseen challenges encountered during implementation and identifies opportunities for further optimization. Ultimately, this assessment informs future decision-making regarding energy efficiency projects in municipal buildings and contributes to overall sustainability efforts.

Here's an example of an energy efficiency project evaluation for a municipal public building:

Objective: To assess the energy efficiency improvements made in City Hall over the past year and determine their impact on energy consumption and cost savings.

Data Collection: Gather energy consumption data for City Hall for the previous year. Collect information on energy efficiency measures implemented, such as HVAC upgrades, lighting retrofits, insulation improvements, etc.. Obtain utility bills to assess changes in energy consumption and energy costs.

Analysis: Compare energy consumption before and after the implementation of energy efficiency measures. Calculate the decrease in energy consumption. Where possible, it would be appropriate to assess the reduction in energy consumption achieved by considering each of the measures implemented. This would make it possible to assess the effectiveness of each of the measures implemented. When conducting an analysis on energy consumption, it is necessary to also evaluate the changed comfort conditions (*for example: it used to be too cold / hot, and after the implementation of the project it became comfortable*), as well as different outdoor conditions in different years. These factors influence the assessment of the achieved energy efficiency after the implementation of the project. Therefore, after collecting data on energy consumption before and after the modernization of the building, these data should be recalculated for a normative year. To carry out these recalculations, municipal specialists could enlist the help of engineering consultants, and this would make it possible to assess the achieved energy efficiency much more accurately.

Analyze the corresponding cost savings based on reduced energy consumption and changes in utility rates. Assess any unexpected challenges or issues encountered during implementation.

Environmental Impact: Estimate the reduction in greenhouse gas emissions resulting from decreased energy consumption. Calculate the baseline GHG emissions associated with energy consumption in the building before the energy efficiency upgrades. This involves converting energy consumption data (kWh for electricity, therm or cubic meters for natural gas) into CO_2 equivalent emissions using emission factors specific to the energy sources. To calculate CO_2 equivalent emissions from energy consumption in Turkey, we need to use emission factors specific to the energy sources used for electricity generation and heating, such as natural gas. These factors represent the amount of CO_2 emitted per unit of energy consumed and are typically provided by government agencies or international organizations. For example, the emission factor for electricity generation in Turkey varies depending on the energy mix and the efficiency of power plants. However, as a rough estimate which we used in this methodology, it is commonly around 0.555 kg CO_2 per kWh. This means that for every kilowatt-hour (kWh) of electricity consumed, approximately 0.555 kilograms of CO_2 are emitted.

Estimate the reduction in energy consumption resulting from the implemented measures. Calculate the reduction in CO_2 equivalent emissions achieved due to decreased energy consumption by each energy source. Compare the baseline emissions with the emissions after the implementation of energy efficiency measures to determine the reduction percentage.

> *Example Calculation: Before energy efficiency upgrades, the building emitted 1000 kg of CO_2 equivalent per year. After implementing energy efficiency measures, energy consumption decreased by 20%, resulting in emissions of 800 kg of CO_2 equivalent per year. The reduction in emissions is 200 kg of CO_2 equivalent per year, representing a 20% decrease compared to the baseline.*

Interpretation: The evaluation indicates that the energy efficiency measures led to a significant reduction in GHG emissions associated with the municipal building. This reduction contributes to the municipality's environmental goals and commitments to combat climate change. The findings can be used to showcase the effectiveness of energy efficiency investments and to justify further efforts in this direction. In summary, by quantifying the impact of energy efficiency measures on GHG emissions reduction, municipalities can assess the environmental benefits of their initiatives and make informed decisions to promote sustainability and mitigate climate change.

2.2. Assessment of Planned and Actual Electricity Generation and Environmental Benefits

Table 2 suggests that the municipality gather monthly data on electricity production quantities and evaluate their impact on decreasing CO_2 emissions. Subsequently, the municipality can conduct a more comprehensive analysis to explore the potential electricity generation throughout the year. This evaluation will allow for an assessment of the efficiency of the installed solar PV system and based on this analysis, appraise the prospects for integrating new alternative energy sources in the future.

The information outlined in *Table 2* of these recommendations could be supplied by municipal specialists to the municipal management, presenting the achieved project results. Such data provision could substantially enhance the municipality's decision-making processes regarding the planning and execution of future energy efficiency initiatives.

Calculation on CO_2 Emission Reduction

For a calculation of CO_2 emission reduction multiply the amount of displaced grid electricity by the CO_2 emission factor to estimate the CO_2 emissions avoided due to the solar PV system's generation. The formula generally looks like this:

$$CO2\ Emissions\ Avoided = Electricity\ Displaced \times\ CO2\ Emission\ Factor\ (1)$$

On average, Turkey's carbon intensity for electricity generation is approximately 550 grams of CO_2 per kilowatt-hour (gCO_2/kWh). Therefore, for 1 MWh (equal to 1000 kWh), the estimated CO_2 emissions would be around 550,000 grams, or 550 kg of CO_2.

Conversion CO_2 reduction into an equivalent number of trees required to sequester the same amount of carbon.

To convert CO_2 reduction into an equivalent number of trees required to sequester the same amount of carbon, it could be used the concept of carbon sequestration by trees. Trees absorb carbon dioxide during photosynthesis and store it as carbon in their biomass.

Here's a basic method to estimate the number of trees needed to sequester the same amount of carbon dioxide that was reduced due to the solar PV system's generation:

i) Determine Carbon Sequestration Rate per Tree:

The amount of carbon dioxide a tree can sequester varies depending on factors like species, age, size, and environmental conditions. On average, a tree can absorb around 22 kilograms of carbon dioxide per year. This figure might vary, so you may want to use specific data for the tree species common in the area.

ii) Calculate Carbon Dioxide Reduction: Based on the CO_2 emissions avoided by using solar-generated electricity (calculated previously), convert this amount into the equivalent amount of carbon sequestered by trees.

iii) Convert CO_2 Reduction to Trees: Use the carbon sequestration rate per tree to estimate the number of trees needed to absorb the same amount of carbon dioxide. The formula is as follows:

$$\text{Number of trees} = \frac{\text{CO2 Emissions Avoided}}{\text{Carbon Sequestration Rate per Tree}}\ (2)$$

Let's assume we have avoided 10,000 kilograms of CO_2 emissions due to the solar PV system's generation. Next, we'll utilize the carbon sequestration rate per tree in kilograms. For illustration purposes, let's consider a carbon sequestration rate of 22 kilograms of CO_2 absorbed per tree annually.

$$\text{Number of trees} = \frac{10{,}000\ (\text{kg of } CO_2)}{22\ \text{kg (Carbon Sequestration Rate per Tree)}} = 454\ \text{trees}\ (3)$$

Assessment of the planned and actual environmental benefits of an electric vehicle

To compare the CO_2 emissions produced by Electric Vehicles (EVs) and Internal Combustion Engine Vehicles (ICEVs) in municipality, let's consider average emission factors and typical energy sources for electricity generation:

Internal Combustion Engine Vehicles (ICEVs) in Turkey might emit around 180-200 grams of CO_2 per kilometer driven, taking into account the fuel mix and vehicle efficiency. This emission factor is based on the combustion of gasoline or diesel fuel in internal combustion engines. Since in the municipality, ICEVs can use both gasoline or diesel, it is recommended to calculate the average for the assessment, i.e., 190 grams of CO_2 per kilometer.

Electric Vehicles (EVs) produce zero tailpipe emissions during operation as they are powered by electricity. However, to accurately calculate the emissions from EVs, it's crucial to consider the emissions associated with electricity generation.

Calculation of CO_2 Emissions per Kilometer:

Assuming an electric vehicle consumes an average of 0.2 kWh per kilometer.

Using an average emission factor of 190 g CO_2/km for ICEVs, the emissions per kilometer for ICEVs would be 190 grams of CO_2.

Calculating the emissions from electricity consumption: 0.2 kWh/km * 550 g CO_2/kWh (assuming an average emission factor for electricity in municipality) = 110 grams of CO_2 per kilometer driven for EVs.

Comparison:

However, if the municipality charging the electric vehicles at a charging stations, which are supplied with electricity produced by solar pv, the reduction in CO_2 emissions should be calculated by 190 g/ km.

However, if the generated electricity is not enough to charge the vehicle, then the CO_2 reduction in the amount of electricity used from the network should be assessed based on these calculations, in this hypothetical scenario:

An average ICEV might emit approximately 190 grams of CO_2 per kilometer driven.

An electric vehicle, considering the average emission factor for electricity generation in municipality, might indirectly emit around 110 grams of CO_2 per kilometer driven due to electricity consumption.

This illustrates the difference in direct emissions from ICEVs compared to the indirect emissions associated with electricity consumption for electric vehicles in municipality, showcasing the potential environmental advantage of electric vehicles in regions with a relatively cleaner electricity generation mix.

Table 2. Data on electricity generation and CO_2 emission reductions

Name of indicators	Amount of electricity produced MWh/ month	Mileage travelled by electric vehicle (km/month)	CO_2 emission reduced (th. tons)	Conversion CO_2 reduction into an equivalent number of trees (number)
January, 20__				
February, 20__				
March, 20__				
April, 20__				
May, 20__				
June, 20__				
July, 20__				
August, 20__				
September, 20__				
October, 20__				
November, 20__				
December, 20__				
Actual amount of electricity produced by the project in a year period (MWh/year)				
Planned amount of electricity produced by the project in a year period (MWh/year)				
Percentage of acquisition "+" "-", (%)				
Actual amount of CO_2 emissions reduced by the project in a year period (th.tons/year)				
Planned amount of CO_2 emissions reduced by the project in a year period (th.tons/year)				
Percentage of acquisition "+" "-", (%)				

Stage 3. Evaluation of Financial Benefits

The municipality needs to designate individuals responsible for the routine collection of data. They could develop a systematic approach for gathering data concerning achieved energy efficiency, electricity consumption required for municipal operations and solar panel-generated electricity by assessing prevailing market electricity prices. This data can be procured through energy meters, utility bills, or monitoring software integrated with the solar photovoltaic system.

According to the form presented in Table 3 of this Methodology, municipal specialists could prepare and systematically provide information to the municipal management. This serves the purpose of acquainting them with the progress of the implemented project and enables informed, data-driven decisions regarding the utilization of alternative energy sources in the future.

Table. 3. Report on data of Financial Benefits

Period of time	Total electricity consumption (including electricity received from the grid) for the needs of the municipality =(MWh)	Average electricity price (TRY/MWh)	Electricity generated by solar PV for the municipality needs (MWh)	Electricity generated by solar PV (%) (4*100/2)	Financial savings due to solar PV (TRY) (3*4)
1	2	3	4	5	6
January, 20__					
February, 20__					
March, 20__					
April, 20__					
May, 20__					
June, 20__					
July, 20__					
August, 20__					
September, 20__					
October, 20__					
November, 20__					
December, 20__					
Total/period:					

Stage 4. Other actions related to the monitoring

In addition to the monitoring measures already mentioned, the municipality is recommended to implement the following monitoring activities of the implemented project:

Technical Inspections and Maintenance Checks: Schedule routine inspections and maintenance checks for the implemented energy efficiency measures and solar PV system to ensure it operates optimally. This includes examining the panels, inverters, wiring, and other components for any issues that might affect performance.

Total Electricity Produced: Measure the total energy output generated by the solar PV system within a specific timeframe (daily, monthly, annually).

Energy Generated vs. Estimated: Compare the actual electricity production with the estimated or expected output based on the system's capacity and prevailing weather conditions.

Stakeholder Engagement and Reporting: Engage with relevant stakeholders, including municipal authorities, energy specialists, and maintenance personnel, to share findings and discuss any necessary adjustments or improvements. Regularly report on the system's performance and the benefits accrued to the municipality using solar energy.

Adaptation and Improvement: Based on the insights gathered from monitoring and evaluations, implement necessary adaptations or improvements to enhance the system's efficiency, address any identified issues, or optimize energy usage further.

Long-term Sustainability Planning: Develop a long-term plan for the sustainable operation and maintenance of the solar PV system. This might involve training municipal staff, budget allocations for upkeep, and strategies for potential expansions or upgrades.

Documentation and Record-keeping: Maintain comprehensive records of all data, reports, maintenance schedules, and any modifications made to the system. This documentation aids in tracking the system's history and informs future decisions.

Monitoring and Reporting

The reporting stage in the implemented project focusing on implemented energy efficiency measures and solar PV monitoring involves the comprehensive assessment and documentation of key data and outcomes gathered during the operation. This stage encompasses the compilation, analysis, and presentation of detailed reports aimed at evaluating the system's performance, energy generation, and impact on the municipality's energy and electricity consumption.

Primarily, this reporting phase involves:

i) Data Collection and Compilation: It begins with the systematic collection of data related to electricity production, consumption, and other relevant parameters. This may involve retrieving information from energy meters, utility bills, and monitoring software integrated with the solar PV system. The collected data is then compiled systematically for analysis.

ii) Performance Evaluation: The gathered data is meticulously analyzed to assess the solar PV system's performance against predefined Key Performance Indicators (KPIs). This includes scrutinizing electricity production levels, energy savings achieved, cost reductions, environmental impact (e.g., reduced carbon emissions), and any other pertinent metrics outlined in the project objectives.

iii) Assessment of Targets and Goals: A comparison is made between the planned targets and the actual achievements of the project. This involves evaluating whether the projected electricity generation, CO_2 emissions reduction, and other goals set at the project's initiation have been met, surpassed, or not achieved.

iv) Documentation and Reporting: The analyzed data and findings are then documented comprehensively in a structured report format. This report includes detailed insights, graphical representations, and an analysis of the observed outcomes. It provides a clear overview of the system's performance over the specified period, highlighting successes, challenges faced, deviations from initial plans, and potential areas of improvement.

v) Presentation and Decision-making Support: The compiled report, along with conclusive data and insights, is presented to relevant stakeholders, including municipal authorities and management. This presentation aims to provide a clear understanding of the project's progress, enabling informed decision-making regarding future steps, such as optimizing the current system, planning future projects, or diversifying energy sources based on the observed performance and outcomes.

Overall, the reporting stage serves as a crucial phase in assessing the effectiveness and success of the implemented energy efficiency and renewable energy projects. It not only offers insights into the achieved results but also forms the basis for strategic planning and informed decision-making for the municipality's sustainable energy initiatives in the future.

Annexes.

Annex 1. Proposed Form for data collection to evaluate energy consumption in municipal public building

Public Building Energy Consumption Evaluation Form

Date of data collection: _____

Surname, first name, contact details of the specialist who filled out the form:

_____

Building Information	**Data and short explanation**
Building name:	
Address:	
Building type (e.g., office building, school, library):	
Year built:	
Total floor area (m^2):	
Number of floors:	
Occupancy schedule (hours/day, days/week):	
Energy consumption data:	
Electricity consumption:	
Monthly electricity consumption (kWh):	
Annual electricity consumption (kWh):	
Electricity consumption by floor/area (if available):	
Natural gas consumption:	
Monthly natural gas consumption (m^3):	
Annual natural gas consumption (m^3):	
Natural gas consumption by floor/area (if available):	
Water consumption:	
Monthly water consumption (m^3):	
Annual water consumption (m^3):	
Water comsumption by floor/area (if available):	
Building Systems:	
HVAC System:	

Type of HVAC system (e.g., central air, split units):	
Age of HVAC system:	
Heating fuel type (if applicable):	
Cooling fuel type (if applicable):	
Thermostat settings:	
Lighting:	
Type of lighting fixtures (e.g., fluorescent, LED):	
Number of fixtures:	
Average Wattage per fixture:	
Lighting control systems (e.g., occupancy sensors, timers):	
Appliances and equipment:	
Types of appliances and equipment:	
Energy Efficiency Ratings (if available):	
Building envelope:	
Walls insulation type and thickness:	
Window type (e.g., single-pane, double-pane):	
Roofing material and insulation (if any):	
Condition of doors and windows (e.g., seals, weather-stripping):	
Energy efficiency measures implemented:	
List of energy efficiency measures implemented *(date of implementation, estimated energy savings (if available), technical evaluation)*	e.g., - LED lighting retrofit - HVAC upgrades, - insulation improvements …
Building Stability:	
Structural material (e.g., concrete, steel):	
Date of last structural inspection:	
Structural integrity assessment (e.g., good, fair, poor):	
Seismic stability:	
Seismic design category (if known):	
Date of last seismic assessment:	
Seismic retrofit measures implemented (if any):	
Seismic vulnerability assessment (e.g., low, moderate, high):	

Additional notes:	
Comments or observations:	
Recommendations for Energy Efficiency Improvement:	

Based on the evaluation conducted, the following recommendations are suggested for improving energy efficiency in the building:

- Upgrade lighting fixtures to energy-efficient LEDs to reduce electricity consumption and improve lighting quality.
- Install programmable thermostats and implement temperature setbacks during unoccupied hours to optimize HVAC energy usage.
- Enhance insulation in walls, roofs, and windows to minimize heat loss and improve thermal comfort.
- Conduct regular maintenance of HVAC systems to ensure optimal performance and energy efficiency.
- Consider renewable energy options such as solar panels or wind turbines to generate onsite renewable electricity.
- Implement energy management systems to monitor and control energy usage in real-time, identifying areas for further improvement.
- Educate building occupants about energy-saving practices and encourage their participation in energy conservation efforts.

This form can be customized based on specific requirements and the complexity of the building. It serves as a comprehensive tool for gathering data on energy consumption, building systems, and energy efficiency measures to support energy management and optimization efforts in public buildings.

Annex 2. Recommended structure of the terms of reference (TOR) to be developed when organizing the procurement of contract work for the implementation of the measures of the Program (e.g. on renewable energy sources)

A Terms of Reference (TOR) document outlines the scope, objectives, responsibilities, and expectations for a specific project. In the case of a solar PV installation on the roof of a municipality building, the TOR serves as a guide for the contractor responsible for carrying out the installation. Below is a suggested structure for the TOR document:

1. Introduction:

A brief overview of the project, the planned start and end of the project implementation (the planned deadlines for implementation are indicated)

2. Objectives:

Clear statement of the objectives of the solar PV installation project.

Outline how the project aligns with the municipality's goals, such as reducing energy costs, promoting sustainability, and reducing carbon emissions.

3. Scope of Work:

Detailed description of the scope of the project.

Description of the municipality building and its roof where the solar PV system will be installed (the total area of the roof is indicated, the area where it is planned to install a solar PV, the place/ places of installation of converters is planned).

Specifications for the solar PV system's capacity, components, and design.

Requirements for equipment, materials, and installation methods.

4. Responsibilities:

Roles and responsibilities of the contractor, the municipality, and any other relevant stakeholders.

Contractor's responsibilities for design, procurement, installation, testing, and commissioning of the solar PV system.

Municipality's responsibilities, such as providing necessary information, access to the roof, and required approvals.

5. Technical Specifications:

Detailed technical requirements for the solar PV system:

– System Capacity and Configuration:

- Clearly define the total capacity of the solar PV system in kilowatts (kW) or megawatts (MW).
- Specify whether the system will be grid-tied, off-grid, or hybrid.
- Outline any plans for future capacity expansion.

– Specifications for solar panels, inverters, mounting structures, wiring, and any other relevant components:

- Solar Panel Specifications:

Provide details about the type, model, and some technical details of the solar panels to be used, specify the panel's efficiency, wattage, weight limits, and dimensions, indicate any warranties associated with the panels.

- Inverter Specifications:

Describe the type of inverters (string inverters, microinverters, etc.) to be used, specify the capacity, efficiency of the inverters, outline any relevant warranties and monitoring capabilities, standards and certifications that must be met.

– Mounting Structure Design:

Detail the design of the mounting structures for the solar panels on the building's roof. Specify the material, orientation, and tilt angle of the panels. Provide information on wind load calculations and structural integrity considerations.

– Wiring and Connection Design:

Describe the electrical wiring and connections between panels, inverters, and other components. Outline cable specifications, conductor sizes, and routing plans. Ensure compliance with electrical codes and safety standards.

– System Performance:

Define the expected energy output of the system based on its capacity and location.

Specify the performance ratio and degradation rate over time.

Include plans for monitoring and evaluating system performance.

– Safety Measures:

Describe safety protocols for installation, maintenance, and emergency situations. Specify procedures for working at heights, handling electrical components, and securing the installation site.

- Quality Control and Testing:

Outline quality assurance procedures for inspecting components before installation. Specify testing requirements for panels, inverters, and electrical connections.

- Installation Timeline and Methodology:

Provide a clear timeline for the installation process, including milestones and deadlines. Detail the step-by-step methodology for installing the solar PV system, from panel placement to electrical connections.

- Environmental Considerations:

Specify measures to minimize environmental impact during installation, such as waste disposal and protection of local ecosystems.

- Documentation and Reporting:

Describe the documentation requirements for the installation process, including as-built drawings, technical specifications, and test reports. Outline reporting procedures for progress updates and any deviations from the original plan.

– Compliance and Permits:

Specify the need for obtaining necessary permits, approvals, and inspections from relevant authorities. By providing comprehensive and detailed specifications for the solar PV system's capacity, components, and design, as well as clear requirements for equipment, materials, and installation methods, the municipality and the contractor can ensure that the project is executed successfully, meets quality standards, and delivers the expected benefits.

6. Design and Installation Guidelines:

Design considerations for the solar PV system, including panel layout, shading analysis, and electrical design. Installation guidelines covering safety, quality standards, and best practices.

7. Timeline:

Project timeline indicating key milestones, deadlines, and project duration. Provision for any flexibility due to unforeseen circumstances.

8. Budget and Payment Terms:

Detailed breakdown of the project budget, including costs for materials, labor, equipment, and any other expenses. Payment schedule and terms, including any advance payments, milestones, and final payment.

9. Quality Assurance and Testing:

Description of the quality control and assurance processes that will be implemented during and after installation. Testing procedures for ensuring the system's functionality and performance.

10. Health, Safety, and Environmental Considerations:

Safety protocols and guidelines for the construction site to ensure the well-being of workers and the public. Environmental considerations and measures to minimize the project's impact.

11. Reporting and Communication:

Reporting requirements, including progress reports, testing results, and any issues encountered. Communication channels and points of contact for both the contractor and the municipality.

12. Annexes:

Any additional documents, drawings, maps, or technical specifications that support the TOR.