Upscaling Energy-efficiency in Municipalities:

Sourcebook on Project Bundling

COPENHAGEN CENTRE ON ENERGY EFFICIENCY
SEforALL EE HUB

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Sourcebook on Project Bundling

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Disclaimer:

This book is intended to assist municipal governments and practitioners to speed up their energy efficiency implementation via project bundling. The findings, suggestions, and conclusions presented in this publication are entirely those of the authors and should not be attributed in any manner to DTU, UNEP, the Copenhagen Centre on Energy Efficiency, or the UNEP DTU Partnership.

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Preface

Climate change is one of the greatest threats humanity faces today. At the UN Climate Action Summit in September 2019, 66 countries and over 100 cities pledged to be carbon neutral by 2050[1]. As of May 2020, the UN Framework Convention on Climate Change (UNFCCC) platform on climate change actions had registered climate change actions by over 10,000 cities around the world[2]. This commitment complements the 2030 Agenda for Sustainable Development, adopted by all United Nations Member States in 2015, which provides a shared blueprint for peace and prosperity for people and the planet, now and into the future.

At its heart are the 17 Sustainable Development Goals (SDGs), which are an urgent call for action by all countries – developed and developing – in a global partnership. Through the SDGs they recognize that ending poverty and other deprivations must go hand-in-hand with strategies that improve health and education, reduce inequality and spur economic growth – all while tackling climate change and working to preserve our oceans and forests.

The global urbanization rate reached 55 per cent in 2018, and UN projections indicate that by 2050 the rate will increase to 68 per cent, adding another 2.5 billion people to the global urban population. Ninety per cent of urban population growth is expected to take place in Africa and Asia (United Nations, 2019)[3]. People move to cities searching for job opportunities, higher quality of life and greater access to public services such as healthcare and education.

Energy efficiency (EE) can bring multiple benefits to municipalities, including saving energy and costs, creating local jobs, reducing local air pollution, improved indoor comfort and productivity and better health for local people. The International Energy Agency (IEA) calls EE the "first fuel". It is the top line principle of the EU's Clean Energy Package and Energy Union Governance Regulation. It is often identified as the cheapest mitigation option and cleanest fuel. It is natural for society to expect municipal governments to lead with EE actions in their activities.

Against this background, the Copenhagen Centre on Energy Efficiency (C2E2) has been focusing its recent work on EE improvements in developing countries and municipalities, with numerous activities and initiatives being undertaken in the various regions. One of these is accelerating and scaling-up the implementation of EE improvement projects and programmes. C2E2 aims to provide streamlined, structured and aggregated expertise on technical and business model aspects related to the development of and investment in EE projects and initiatives. C2E2 can assist municipalities, as well as other interested parties, with technical support to implement EE interventions by bundling projects from different locations with similar context and within specific thematic areas through the "Project Bundling" approach. The technical assistance is provided by international energy experts with knowledge and experience of EE project implementation in all regions. C2E2 can thus help to develop project ideas, which can be developed into a feasible investment-grade project, as well as a vast variety of resources to increase local capacity for project assessment, design and implementation.

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[1] IISD. 2019. 77 Countries, 1 00+ Cities Commit to Net Zero Carbon Emissions by 2050 at Climate. Available at: Summithttps://sdg.iisd.org/news/77-countries-100-cities-commit-to-net-zero-carbon-emissions-by-2050-at-climate-summit/
[2] Available at: https://climateaction.unfccc.int/views/stakeholders.html?type=cities
[3] United Nations, Department of Economic and Social Affairs, Population Division . 2019. World Urbanization Prospects: The 2018 Revision (ST/ESA/SER.A/420). New York: United Nations.

Acronyms

In alphabetical order:

AHU- Air handling unit

C2E2- Copenhagen Centre on Energy Efficiency

CAPEX- Capital expenditure

CBA- Cost-benefit analysis

CER- Carbon emissions reductions

CDM- Clean Development Mechanism

DC- Direct current

DG set- Diesel generator

DX- Direct expansion

EE- Energy efficiency

EMS- Energy management system

EPC- Energy performance contracting

ESA- Energy services agreement

ESCO- Energy service company

ESPCs- Energy saving performance contracts

EPI- Energy performance index

EU- European Union

FAD- Free air delivery

FO/LSHS- Low sulphur heavy stock

GHG- Greenhouse gas

GFA- Guarantee facility agreement

GMF- Green municipal fund

HSD- High Speed Diesel

IEA- International Energy Agency

IFI- International financial institutions

IRR- Internal rate of return

LED- Light-emitting diode

MCA- Multi-criteria analysis

MDB- Multilateral development banks

MRV- Measurement, Reporting and Verification

MVA- Mega volt ampere

NDCs- Nationally Determined Contributions

NPV- Net present value

OBF- On-bill financing

O & M- Operation and maintenance

OLTC- On-load tap changer

OSS- One-stop-shop

PAYS- Pay as you save

PPP- Public-private partnership

RF- Revolving fund

RH- Relative humidity

ROI- Return on investment

QFMs- Quantitative financial metrics

QPMs- Quantitative process metrics

QTMs- Quantitative technical metrics

SDGs- Sustainable Development Goals

SMARTER – Specific, Motivating, Achievable and Agreed, Relevant, Time-bound, Evaluation, and Readjustment

SWOT- Strengthen Weakness Opportunities and Threats

TR- Tonnes of refrigeration

U4E- United for Efficiency

UN- United Nations

Tables

Boxes

Figures

Contents

Introduction

Jorge Rogat Castillo

Rationale

Energy efficiency (EE) is widely recognized as one of the most effective ways of achieving reductions in CO_2 emissions and supporting the accomplishment of Sustainable Development Goal 7 (SDG7): ensuring access to affordable, reliable, sustainable and modern energy for all, and aiming to double the global rate of improvement in EE by 2030. Nevertheless, despite the considerable investment potential in EE , it has been largely untapped. The likely reasons lie in barriers, which are hindering investments in EE interventions, and, perhaps most importantly, the absence of comprehensive and well-designed EE strategies.

Municipalities have the authority and resources to take the required action at a local level. Hence, they play a key role in the implementation of EE projects and programmes aimed at carbon-mitigation targets alongside attaining the SDGs. However, more often than not, EE projects proposed by municipalities are very small and therefore not interesting to financiers. This results in projects not being implemented. The implementation of programmes and projects emanating from a well-structured city/municipal EE strategy could be facilitated by the Project Bundling approach. This approach could, besides helping to scale up EE interventions through the aggregation of smaller projects into larger portfolios, help to remove barriers.

Combining projects or elements of projects into a single project or portfolio of projects with the aim of achieving economies of scale could be a significant contribution to scaling up EE initiatives. Components such as administration, tendering, contracting and procurement, project design, deliveries and others can be streamlined, which significantly increases efficiency and decreases transaction costs. The financial component can, in a similar way, be bundled, thus making the financing requirement larger and more attractive to financiers. Because of all these benefits, Project Bundling is an efficient instrument to promote and enable investments in EE projects and thereby scale up EE project implementation.

Objective

This Sourcebook has been developed by the Copenhagen Centre on Energy Efficiency (C2E2). Its objective is twofold. Firstly, to provide streamlined and structured guidance on how to develop a comprehensive EE strategy for cities and municipalities. Secondly, to provide guidance on the technical, operational and financial aspects related to the Project Bundling approach, which could significantly facilitate the implementation of programmes and projects emanating from EE strategy plans. Although the Project Bundling approach can be applied to projects in several areas of intervention – such as construction, road infrastructure, water provision and public transport services – the Sourcebook focuses on Project Bundling in three main areas: public buildings (heating and cooling), street lighting and water supply. For this, the Sourcebook presents a methodology in which the Project Bundling approach is described in a step-by-step process.

Scope

The content described in the Sourcebook focuses on scaling up EE projects by municipalities. In this respect, a municipality is understood as an administrative division that may be a city, town or a grouping of towns. The difference between a city and a municipality is that a city is an urban settlement that is planned and has a large population. While cities are divisions of a state or province, municipalities are divisions of a place that are so divided for local self-governance.

In this Sourcebook, EE refers to the amount of energy input required to get a certain amount of useful energy output through a transformation or conversion process. Thus, improved EE means using less energy input to get the same (or better) service or product, while renewable energy introduces environmental sustainability through the replacement of conventional fossil fuels or non-renewable energy sources by renewable energy sources on the energy supply.

Target audience

The Sourcebook is intended for municipality majors, their advisors and other parties interested in preparing EE strategy plans that could be put in place and implemented in developing country municipalities through Project Bundling. The Sourcebook is kept simple and as short as possible, since the target audience might not have the time to read extensive documents. Even though the Sourcebook has been developed with municipalities in developing countries in mind, by taking into consideration the prevailing differences regarding local conditions, it can also be used by mayors and decision-makers in developed countries.

How to use the Sourcebook

The Sourcebook is composed of seven modules, written in the form of booklets. Although the modules of the Sourcebook can be used independently of one another depending on the needs of the user, it is recommended that the Sourcebook be read in its entirety and sequentially. This is because the Sourcebook is developed and presented in a cohesive way, with modules linked to each other. Going through the whole Sourcebook will allow the reader to get a thorough understanding of the methodology, and what is required for it to be successful.

This Sourcebook builds on existing literature and adapts it to the municipal public sector. It provides useful references at the end of the Sourcebook, as well as further information and reading sources at the end of each module.

Content and structure of the Sourcebook

The Sourcebook is composed of six modules. Module 1 starts with guidance on how to develop an EE strategic plan for municipalities, and how its implementation could be facilitated through the Project Bundling approach. Module 2 presents an introduction and definition of concepts in Project Bundling. Module 3 provides key elements and steps in the development of an energy rapid assessment to foster EE at a municipal level. Module 4 shares a synthesis of the business models for implementing EE bundling projects in the public sector. Module 5 elaborates on the financing of Municipal EE Project Bundling. Module 6 defines key actions in creating a measuring, reporting and verification system (MRV).

Module 1. Energy efficiency strategic planning for municipalities

The lack of EE strategic plans at the city and municipal level may have hindered new EE initiatives from being implemented. Having developed a well-designed long-term EE strategic plan, from which programmes and projects aimed at achieving the goals set in the strategic plan are actually implemented, is crucial. This module will, in a step-by-step process, guide the development of an EE strategy plan. The guidance will be generic and can be used for the development of an EE strategic plan in any of the energy sectors of the economy. The Project Bundling approach will focus on the three energy areas mentioned above.

Module 2. Project Bundling: introduction and steps

This module provides an introduction to EE Project Bundling, to be developed and implemented by municipalities when combining several small projects into one single and larger project in the areas of public buildings, street lighting and water supply. A short background to the issues and concepts of why bundling is key to unlocking finance is provided. An attempt to contextualize the issue and the importance of achieving a greater scale in EE improvements is made. This is done with reference to overall expectations of EE potential and potential contribution to climate goals, the breadth of already stated EE ambitions, and the gap between current and required levels of financing for EE projects.

The module also briefly discusses why investments in EE are not yet at the desired level and why Project Bundling in EE projects is difficult to finance. This is a good point to also bring in some behavioural and socio-political references around the disconnect between government ambitions and reality, and why EE is often under-prioritized, rather than taking a more rational/neoclassical approach as is often done when covering the barriers discussion. The module also introduces some background on why and how much Project Bundling might help to reduce transaction costs, why and how it can unlock new and greater investment opportunities, the need for creating standardized models, aspects of standardization to consider, data required to achieve a viable bundle and so on. The module outlines barriers specific to the three areas of intervention, and therefore what needs to be in place for successful Project Bundling in the area of EE.

Guidance on how C2E2 can assist municipalities in the process of preparing and implementing Project Bundling is also presented.

Module 3. Rapid assessment of energy efficiency projects for municipalities

This module guides municipality mayors, their advisors and other decision-makers on the role of technical analysis of EE projects. This analysis can be further applied during aggregation of EE projects under the Project Bundling scheme, which the Sourcebook talks about. It provides an explanation of the role of standardized procedures for reducing transaction costs, and the need and role of online tools for data collection and project registration, if eligibility is cleared, for municipalities to create efficient Project Bundles. It also presents quick checklists for municipalities to use when examining project development readiness and their ability to register an EE project.

The module provides guidance on how to use tools that have been developed for expressions of interest and project registration by municipalities – through standardized data collection forms with key data, to establish the dimensions of a potentially technically feasible bundled project. Though the module primarily focuses on buildings, water supply systems/units and street lighting projects, it can be adopted for other sector projects with additional suitable templates. These registrations will enable standardized data analysis for each bundling area and the presentation of key parameters in a prefeasibility report for the bundled project

Module 4. Business models for energy efficiency Project Bundling

This module describes the principles of EE bundling business models and financing schemes that make project aggregation feasible. The module describes the characteristics of these business models, their advantages and barriers and how municipalities and building owners can use them in different scenarios. It also addresses the questions that will be most likely raised by investors about each of these models, including:

- Financing structures and their connection to bundling business models
- Market regulation and policy schemes
- Barriers and opportunities to EE bundling business models

A checklist tool for municipalities to work through the options, select a preferred project structure and present the right information to potential financiers will be developed. This will draw on the experience of innovative business models in the European Union and developing, allowing a wider spectrum of practical opportunities for public officials.

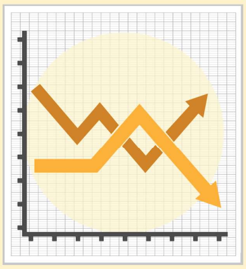
Module 5. Financing energy efficiency Project Bundles for municipalities

This module examines the various financing options for municipal EE Project Bundles, including how they work and their advantages and disadvantages, with some concrete examples.

Funding options include the municipalities' budget funding, grants from national or state level governments and international donors (including climate finance mechanisms), public-private partnerships or commercial sources, or off-balance sheet finance. Except for a municipality's funding and grants, which can be used for social purposes, any other external funding requires a minimum return rate from the project, and a low technical and financial risk. The minimum return rate can vary from country to country, depending on project type, the borrowers' creditworthiness, the project risk levels and the maturity of the loans.

The module provides some of the factors municipalities should consider when choosing between different funding options. It also includes a section on long-term institutional and financial arrangements and actions needed to ensure continuous municipal EE project funding and implementation.

Module 6. Assessing the performance and impacts of Project Bundles



This module will guide municipalities on tracking the climate impact of projects using the bundling approach and how a Measurement, Reporting and Verification (MRV) system conceived at the outset and operating on a continuous basis can serve this purpose.

A description of the likely structures and practices that can be used in making sure MRV frameworks are robust and applicable to the three types of EE projects selected for this sourcebook is also included, and can be shared among other municipality majors around the world interested in Project Bundling.

This module also includes a suggested approach for calculation and reporting of main indicators for municipalities to establish baselines and track progress, in order to report back to corresponding authorities and donors.

MODULE 1

Energy efficiency strategic planning for municipalities

Energy efficiency strategic planning for municipalities

Xianli Zhu, Rahul Raju Dusa, Jorge Rogat Castillo

1.1. The importance of energy efficiency actions in the municipal public sector

Governments are responsible for significant energy demand in public buildings, transportation infrastructure and utilities as they deliver municipal public services (see Table 1.1). It is in the interest of local governments and populations that municipalities provide publicly funded services as efficiently and cost-effectively as possible[4].

On this basis, this module aims to provide a brief systematic guide on how to create robust and operable strategic energy efficiency (EE) plans for the municipal public sector. It focuses on the municipality's functions as an energy consumer and how municipalities can lead by example and improve EE in their own activities. It first explains what a municipal EE strategy is and why it is necessary and relevant to develop one. It then provides a six-step guide on how to prepare a municipal strategy based on existing studies and practices.

There is extensive literature on how to conduct EE planning at national and sub-national levels, often also including the private sector, renewable energy and other climate mitigation and adaptation actions. The sources used in this module are marked as footnotes and sources for further readings can be found at the end of this module.

1.2. About strategic planning, its contents and use

1.2.1. Public-sector strategic planning and its key features

The roots of public-sector strategic planning are originally military and tied to statecraft. Governments at all levels make many different plans in their activities. What special features does strategic planning have that makes it different from other routine and non-strategic planning activities?

Table 1.1 The municipal public sector and its energy demand

Municipal public sector		Energy service
Public buildings	Offices	Lighting, appliances and equipment, space heating and space cooling, mobility and hot water
	Educational facilities	
	Health care facilities	
	Public/social housing	
	Other: sports, culture and entertainment facilities, such as libraries, theatres, museums and sports centres	
Transportation	Public vehicle fleets	
	Transport infrastructure: mass transit facilities	
Utilities	Heat and hot water supply	
	Centralized cooling	
	Power and public lighting	
	Water supply and wastewater treatment	
	Waste removal and disposal	

Based on Energy Charter Secretariat, 2008[5]

[4] The Regional Environmental Center for Central and Eastern Europe (REC) 2018. LEDS-EEP City Energy Planning Toolkit. 2018. Available at: http://documents.rec.org/publications/LEDSToolkitFinal.pdf
[5] Energy Charter Secretariat 2008. Energy Efficiency in the Public Sector - Policies and Programmes in ECT Member Countries.

Box 1.1. Differences among vision, strategy, strategic planning, roadmap and action plan when addressing EE at the municipal level.

Vision, Strategy, Strategic Planning, Roadmap and Action Plan

Governments around the world are using different terms for actions developed to achieve their goals. These are normally covered in a strategic document composed of a vision, strategic plan, roadmap and action plan. When integrating energy actions in the municipal agenda, it is important to first understand the differences between each of them and how each of these should address different aspects.

A **vision** is a description of outcomes that the municipality will strive to achieve. Related to EE, this typically refers to the outlook on how much energy and carbon emissions the municipality aims to reduce.

A **strategic plan** is a document that is used to communicate the municipality's goals and how it will achieve those goals. It can be used to create consensus among different stakeholders, secure resources and continuous efforts and hold relevant organizations accountable for achieving the goals. In this way, it is important that the energy system and its potential efficiency is included in the strategy plan from an early stage.

A **roadmap** normally covers one decade or longer and includes detailed steps to achieve certain objectives. To address EE aspects, the roadmap should make a distinction among the various sectors, including potential synergies among them.

An **action plan** addresses the schedule of actions to be taken to achieve certain goals. In recent years, many countries and local governments have issued their climate action plans. It is important that these plans set clear and quantifiable actions to reduce energy use.

On the basis of a comprehensive literature review, Bryson and Edwards (2017)[6] identified the following features that make public sector planning strategic:

- *Alignment with context*. Paying close attention to context and tailoring the strategic planning approach to the context, even though the planning typically aims to change the context. At a municipal level this might refer to demographic developments, local employment or pollution.
- *Specific purposes and goals*: Careful thinking about purposes and goals, including attention to situational requirements (e.g., political, legal, administrative, ethical and environmental requirements). For instance, municipalities should ensure sustainable development of their jurisdiction from an environmental as well as social perspective.
- *Prioritization*: An initial focus on a broad agenda and later moving to a more selective action focus. Some municipalities might face pressing issues on particular topics, such as local job creation.
- *An emphasis on systems thinking*. Strategic planning is based on understanding the dynamics of the overall system being planned for as it functions – or ideally should function – across space and time, including the interrelationships among constituent subsystems. To ensure EE improvements, it is important to take into consideration the complete energy systems perspective.
- *Stakeholder engagement.* Typically, multiple levels of government and multiple sectors are explicitly or implicitly involved in the process of strategy formulation and implementation. Key stakeholders at a municipal level are local and regional administrations, financial suppliers/investors, energy suppliers, sector representatives, citizens, government, property developers, etc.
- *SWOT analysis.* A focus on strengths, weaknesses, opportunities and threats, and a focus on competitive and collaborative advantages. In the context of EE at a municipal level this needs to assess what is most beneficial for most civilians without taking any risks for future generations.
- *Future-oriented thinking:* A focus on thinking about potential futures and then making decisions in light of their future consequences. Particularly at a national and

[6] Bryson, J. and Edwards, L. H., 2017. Strategic Planning in the Public Sector. Oxford Research Encyclopedias. DOI: 10.1093/acrefore/9780190224851.013.128

sub-national level, it is important to not lose perspective and outlook on any relevant prospects.

- *Emphasis on implementation and operability*. The strategy needs to be operable. To this end, a solid analysis of necessary and available resources needed to implement the actions should be undertaken at a very early stage in the process.
- *Pre-determined strategy and flexibility in implementation.*The strategy combines both stability and flexibility in goals, policies, strategies and processes to manage complexity, take advantage of important opportunities and advance public purposes, resilience and sustainability in the face of an uncertain future. At a municipal level there are many variables and agents that need to converge. Not every plan can be implemented as initially conceived and some flexibility will be required, especially during the implementation phase.

Although many of these actions were conceived for a national level, they can still be applied on a municipal scale. In practice, strategic plans often cover five years or longer, to provide some certainty over multiple years. During the implementation process, it needs to be reviewed regularly to assess effectiveness, make further adjustments and adapt in an iterative way. Due to rapid technology and market changes, it is advised to review the strategy at least every three years.

1.2.2. The contents and benefits of strategic energy efficiency planning for municipalities

Municipalities, in their role as a municipal public resource managers and public interest protectors, need to mainstream EE in their operations and investments and be a model to the residential and business sector in EE actions.

Strategic EE planning for municipalities is necessary and beneficial for multiple reasons. It:

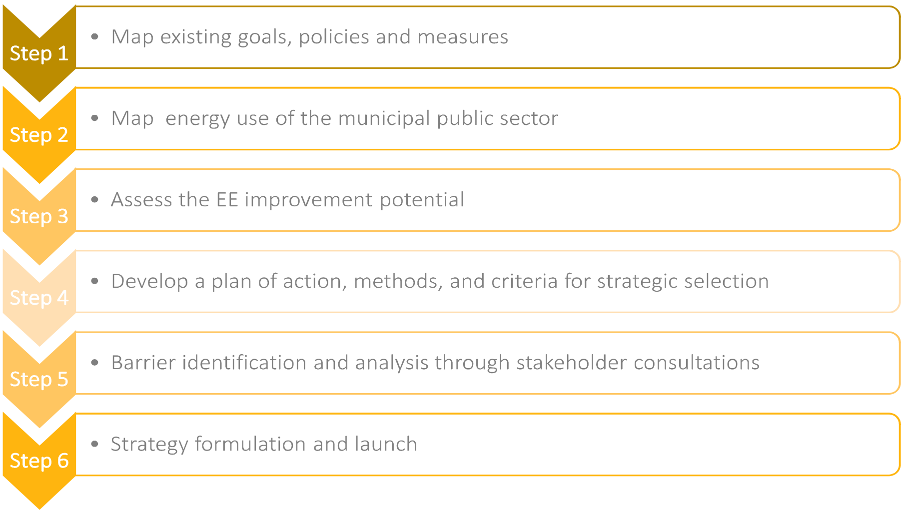
- engages various stakeholders and raises the awareness on EE among them,
- creates a common understanding and on EE actions,
- creates certainty and enables long-term investment.

The size and contents of the public sector's energy consumption vary from one municipality to another. However, given the size of the public sector, municipal public energy consumption is substantial; cities are the centres of economic activity and energy consumption. For example, the public sector in Kazakhstan consumes 15 per cent of electricity and 30 per cent of the heat generated[7]. Ireland has set a target to improve the EE of its public sector by 33 per cent from the 2009 basis by 2020. One key measure was the enactment of a Public Sector EE Strategy in 2017. By the end of 2018, the country's public sector had improved 27 per cent from 2009, resulting in EUR 1.3 billion in energy savings and 4.6 million tonnes of CO_2 emissions avoided since 2009[8]. To effectively coordinate actions to tap into the enormous opportunities for EE improvement in the public sector, it is necessary to carry out strategic planning for EE-focused actions ats a municipal level.

1.3. Steps in strategic planning

To initiate the strategic planning, the core team, various key actors involved and overall terms of references for the task are developed, including the duration of the strategy, expectations for the strategic planning, timeframe, budgeting and work plan. This section presents a comprehensive approach to developing strategic planning for EE actions by municipal public sector based on six key steps (Figure 1.1).

Figure 1.1 Steps for EE strategic planning



[7] World Bank, 2018. Synthesis Report Unlocking Energy Efficiency Potentials in Cities in Kazakhstan. Available at: http://documents.worldbank.org/curated/en/267161521612788850/pd-f/124484-ESM-PUBLIC-P130013-Synthesis MarchFinal.pdf

[8] Sustainable Energy Authority Ireland, 2019. Annual Report 2019 on Public Sector Energy Efficiency Performance An SEAI Report prepared for the Department of Communications, Climate Action & Environment.

Step 1 consists of a mapping of the existing goals, policies and measures to make sure that the strategy for municipal EE actions is aligned with existing policies and strategies. Step 2 involves mapping the municipal public sector's energy use – identifying how the municipal public institutions use their energy, in which forms and for what purposes (creation of baselines). Step 3 deals with estimating the technical potential for EE improvements in different energy uses and in different public institutions, with the aim of creating a strategy. Step 4 encompasses the development of a plan of action. It prioritizes the various EE improvement opportunities, based on cost and benefit analysis, and stakeholder consultation, as well as taking into account the various social, economic and environmental benefits from such actions. Step 5 is barrier analysis, stakeholder consultation and the creation of a measuring, reporting and verification (MRV) system, which allows the tracking of progress and results of any given intervention included in the strategic plan. The last step, Step 6, is about formulating, revising, finalizing and launching the strategy. The module ends with a conclusion section, on the implementation and review of the strategy.

1.3.1. Step 1 - Mapping the existing goals, policies and measures in the municipal context

Energy performance is an integrated aspect of public sector operations and investment. Implementation depends on public support and resource availability. To make the energy strategies practical and operable, it is key to analyse the municipality's framework conditions, such as mapping the existing goals, development strategies, plans and policies (especially those related to EE, low-carbon development, and green growth). Mapping the existing policies and context for the strategic mapping consists of three aspects: relevant national/regional policies, municipal policies and context, and background and expectations for the strategic planning exercise (Figure 1.2). This step helps to put the strategy in the local context and align it with existing policies and strategies to reduce the barriers to implementation.

Figure 1.2 Mapping existing policies and context for the strategic planning

National/regional policy context

- National policies and targets on EE
- National development strategy and priorities
- National regulations on municipal governments' roles and responsibilities in local EE, public sector operation costs and investment

Municipal policies and context

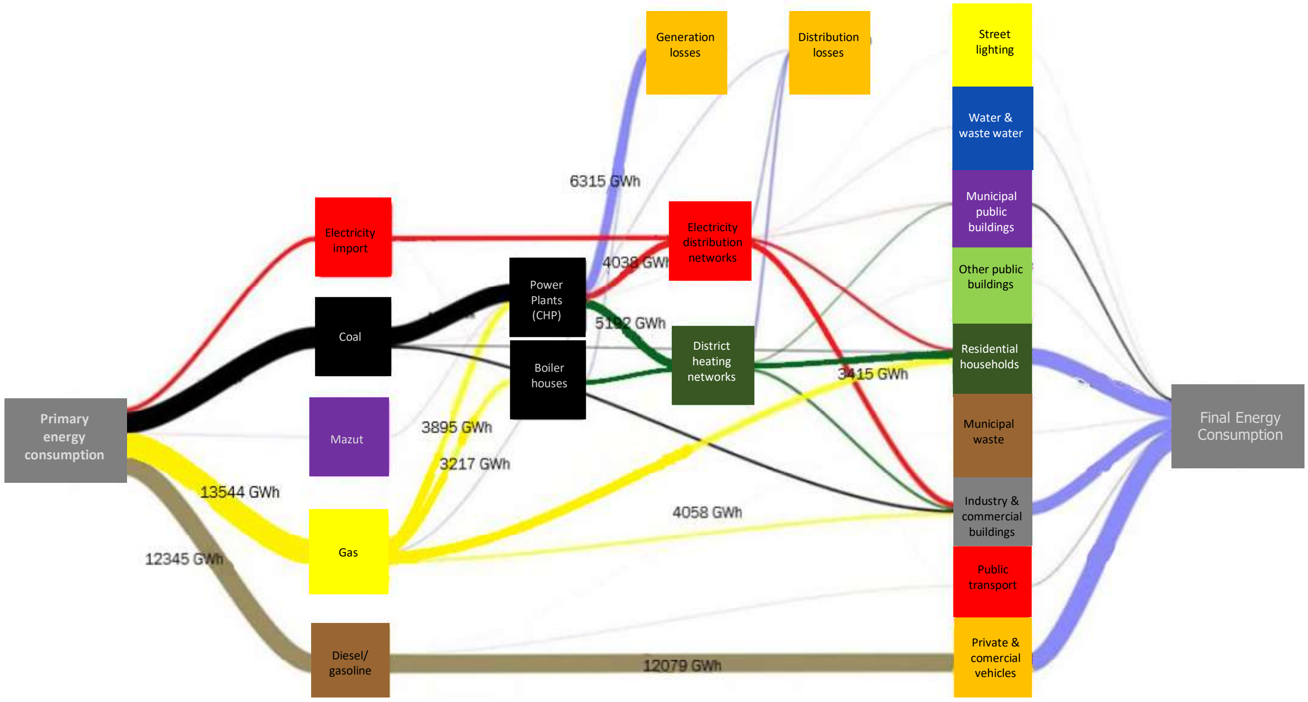
- Development of strategy and priorities
- Local energy supply and demand
- Municipal EE targets and priorities
- Local municipal EE institutional setup and stakeholders

Another preparatory piece of work is mapping the stakeholders for municipal public sector EE, as well as their roles and responsibilities in the strategic planning process. This can include the technical and expert team, which is responsible for data collection and drafting of the strategic plan, the stakeholders to be consulted and the final decision-makers.

1.3.2. Step 2 - Mapping the energy use of the municipal public sector

Identifying the type of energy sources available is the primary step for the municipality to take informed decisions with respect to sustainable energy use, competitive economics, long-term trouble-free maintenance and operations. The decisions inevitably depend on factors such as (not limited to) geography, climatic conditions, political stability and its impact on relevant policies, market maturity of available technologies, type of energy use and availability of trained professionals to carry out all these activities. For example, while the municipalities that are catered for by fossil fuel-based electrical energy of thermal power plants, the fast-paced introduction of renewable energy and other sustainable modes of energy are expected to change the dynamics of the energy markets. This will force the municipalities to assess, understand and act accordingly with respect to efficient operations in most economical conditions. This can be presented in a Sankey diagram as shown in Figure 1.3.

Figure 1.3 Sankey Energy Flow Diagram for Almaty City in 2015 (GWh/year)



Source: World Bank's Energy Sector Management Assistance Program (ESMAP), 2017[9]

Unlike **the factors** mentioned in the previous paragraph, on which the decisions are dependent upon, mapping of energy use is often well within the reach of municipal sector. In line with the three focus areas (street lighting, municipal water supply systems and public buildings) being discussed in this Sourcebook, municipalities more likely have enough in-house resources to take different available energy infrastructure into account and cater to **the needs** of the end energy users.

The main objective is for the municipality to know and understand how much energy is used, where and, if possible, at what time. This may be provided through the analysis of desegregated energy bills, conventional metering and smart metering for all the energy sources available (electricity, gas, biomass, etc.). This way it would be possible for the municipalities to create baselines and map out the biggest energy users in their territory.

Energy mapping is a holistic approach, with the end goal being to define and integrate energy solutions across as many end users as possible[10]. Energy mapping is applicable at different scales (national, municipality level or even system level). It gives an understanding of the types and quantum of energy used for different types of end-use application based on strategic steps with reference to planning, implementation, operations and economics of related activities. While some level of mapping is available at national or even municipal level with reference to the flow of energy supply and demand, the crux of challenge lies in understanding this at a facility and system level.

Box 1.2 Key recommended steps in the energy mapping approach

- Identify high energy intensity facilities through a gate-to-gate defined boundary approach
- Develop each facility's process/system layout
- Define technology used in each section within the facility
- Determine the energy used

[9] ESMAP, 2017. Kazakhstan: Energy Efficiency Transformation in Astana and Almaty https://openknowledge.worldbank.org/bitstream/handle/10986/28927/121463-ESM-P130013-PUBLIC-KEEPAlmatyEE-PlanNovengfinal.pdf?sequence=1&isAllowed=y
[10] The City of Edmonton Energy Transition Plan, Energy Mapping Feasibility Study, Edmonton. 2014. Available at: https://www.edmonton.ca/city_government/documents/PDF/Report_3_-_Energy_Mapping.pdf

A generic approach on how it may be carried out is available in “Annex I. Guide to develop an energy mapping on a municipal level”.

1.3.3. Step 3 - Assess the energy efficiency improvement potential

Several countries have included energy conservation under their legislative acts and policy instruments, mandating EE regulations to achieve their NDC mitigation targets[11]. As these national targets trickle down to sectorial targets, municipalities are one of the key stakeholders in driving city- or community-level targets.

In addition to addressing increasing GHG emissions, rising energy prices, burgeoning populations, uncontrollable growth in energy consumption and rising water demand makes it inevitable for municipalities to adopt EE measures.

EE potential scale

Box 1.3. Examples for municipal-level EE potential achieved/identified

1. Energy efficiency interventions by the Ministry of Regional Development, Construction, Housing and Municipal Economy of Ukraine and Federal Ministry for Economic Cooperation and Development (BMZ) has resulted in 5-10 per cent reduction of the annual energy cost of the municipalities. ((BMZ), 2015)[12]
2. Energy audit studies of municipal water systems in India have indicated at least 25 per cent energy and monetary savings potential. ((IFC), 2008)[13]
3. Energy conservation measures in water utilities of Sharjah Electricity Water Authority have resulted in more than 56 per cent energy savings. (TERI, 2016)[14]
4. An estimated 80 per cent of economically viable energy savings in buildings are untapped. (ESMAP, 2019)[15]
5. Local technological improvements of street lighting systems in Timeri, Guyana resulted in a 29.7 per cent lighting energy consumption reduction. (TERI, 2014)[16]

Though some countries and regions are advancing on EE technologies, as seen in the above examples, there is still significant unrealized EE potential. This calls for relentless efforts by all stakeholders.

The gap in some countries and the success stories in other countries also indicate the abundance of energy and business opportunities that exist to create and manage a sustainable environment. Further deep dive exercises shall reveal gaps at technological and operational level.

Methodology and approach

At a national, regional, municipal or city level, strategies to tackle EE activities generally use a top to bottom approach, which predominantly relies on energy and production data. The outcomes from these results are policies and mandates that are enforced upon users and suppliers. Often these parameters are also influenced by changes in their volumes and the characterstics of the economy (Abeelen, 2013)[17].

While the approach may seem acceptable, the impact of external factors directs us to also consider a bottom-up approach, in which policies are framed based on ground data. The strategies formed are more customized to sector, technology or monetary challenges, where feasible business models such as bundling of projects may make investments in EE projects more attractive and results oriented.

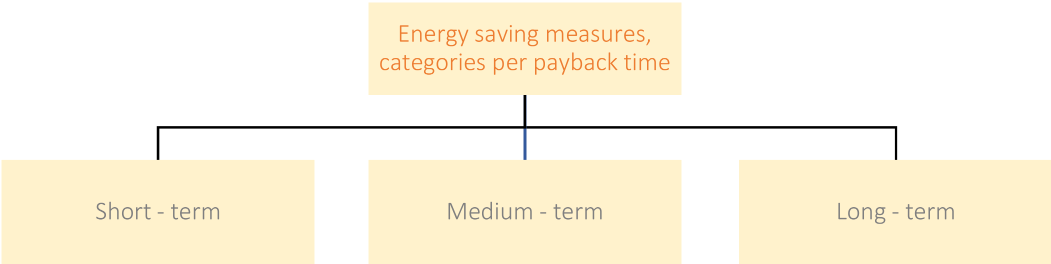
For any entity to improve their energy quality and optimize energy costs, it is invariably important to take an additional step beyond mapping, such as energy audits. Energy audits are key to a systematic approach for decision-making in the area of EE and management, which is comprehensively defined as “the strategy of adjusting and optimizing energy, using systems and procedures so as to reduce energy requirements per unit of output while holding constant or reducing total costs of producing the output from these systems” (Bureau of Energy Efficiency)[18].

The EE process starts with a review of the baseline to provide critical inputs to the energy policy for planning and developing an energy management strategy. The key interventions, entailing operational and technical measures identified in the plan, are implemented. The EE potential at system level, facility level or at a larger national level are checked, if possible, with a monitoring and auditing system followed by a

[11] Available at: https://www.wri.org/indc-definition
[12] BMZ, 2015. Energy efficiency in municipalities. Bonn: GmbH, Deutche Gesellschaft für Internationale Zusammenarbeit (GIZ)
[13] IFC, 2008. India Manual for the Development of Municipal Energy Efficiency Projects. Retrieved from Bureau of Energy Efficiency, Government of India, Ministry of Power. Availble at: https://beeindia.gov.in/sites/default/files/ctools/ManualfortheDevelopmentofMunicipalEnergyEfficiencyProjects.pdf
[14] TERI, 2016. Comprehensive Energy Audit Falaj Pumping Station SEWA. Sharjah: TERI.
[15] ESMAP, 2019. Energy Efficiency. Retrieved from ESMAP. Available at: https://www.esmap.org/energy_efficiency
[16] TERI, 2014. Energy Efficiency omprehensive Energy Audit Falaj Pumping Station SEWA. Sharjah: TERI.
[17] Abeelen, C., 2013. From top-down to bottom-up: two ways to monitor energy-efficiency in Dutch voluntary agreements. Europeon Council for an Energy Efficiency Economy. Netherlands.
[18] Bureau of Energy Efficiency, Govt. of India. 2020. Energy Management and Audit,. Available at: https://beeindia.gov.in/sites/default/files/1Ch3.pdf

review to provide further feedback to the planning stage. A brief ten-step methodology for identifying the EE potential in any system or facility is in "Annex II. Identifying EE potential through detailed energy audits". The identified energy saving measures may be further categorized as follows to justify decisions.

Figure 1.4 Energy saving measure categorization.

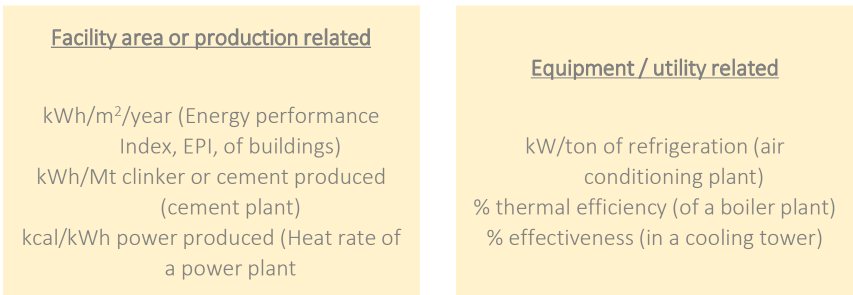


Detailed strategic selection criteria for EE projects are discussed in the module as well as in modules 4 and 5 of this Sourcebook.

Benchmarks and standards

For any EE activities to be successful, and for any energy saving potential to be estimated, benchmark figures and pre-set standards, be it at facility level or equipment level, are essential. These are intended as a reference for the end user and all other applicable stakeholders in relation to existing policies and technologies.

Figure 1.5 Sample Benchmark unit parameters.



There are different EE studies, energy benchmarking reports and standards for energy-intensive sectors.

Box 1.4 Sample energy and GHG benchmarking rating systems

Depending on the location type and applicability, there are energy and GHG benchmarking rating systems, such as:

- Energy Star in the US (http://www.energystar.gov/index.cfm?c=business.bus_index)
- Energy Performance Certificates in the EU (https://ec.europa.eu/energy/eu-buildings-factsheets-topics-tree/energy-performance-certificates_en)
- National Australian Build Environment Rating Systems (NABERS) in Australia (https://www.nabers.gov.au/)
- Asia Pacific Economic Cooperation (APEC) Energy Standard Information System (ESIS) (http://www.apec-esis.org/)
- Greenhouse Gas Emission Baselines and Reduction Potential from Buildings in Mexico (https://www.unenvironment.org/resources/report/greenhouse-gas-emission-baselines-and-reduction-potentials-buildings-mexico)
- Emission Baselines and Reductions Potentials from Buildings in South Africa (https://www.unenvironment.org/resources/report/greenhouse-gas-emission-baselines-and-reduction-potentials-buildings-south-africa)
- Energy Conservation Building Code in India (https://beeindia.gov.in/sites/default/files/BEE_ECBC%202017.pdf)

The key resources in this EE process, which continuously drive the technical, financial and operational aspects, are human resources – basically qualified energy managers, energy auditors and sectorial policy analysts. Hence, building in-house capacities at national and regional level for energy auditing and management expertise is critical for municipalities.

Though international expertise is required from time to time for the municipalities, particularly in low income and other developing countries, to stay updated with international standards, frequent use of such services may turn out to be very costly and hence not sustainable at times for EE activities. In the long run, local expertise at national, regional and municipal body level needs to be developed and enhanced to carry out energy management and audits.

EE has dramatically improved through capacity-building and energy audit programmes implemented either under externally aided programmes or by private energy consultants. Such programmes have resulted in significant savings in energy and corresponding costs. In many countries, certification schemes at national level have been formulated and implemented. This has, in a few cases, led to successful market-based mechanisms in the field of EE.

Box 1.5. Example of a successful EE market mechanism[19]

The certification of energy auditors and managers in India has enabled successful implementation of Perform Achieve and Trade Mechanism (PAT) which resulted in 8.67 Mtoe/year savings, which is 30 per cent above the targeted savings from eight energy intensive sectors in the PAT Cycle-I alone.

Source: Ministry of Power, Government of India.

With the database of possible energy conservation potential and associated measures, municipalities may develop implementation strategies based on the outcomes of the energy economic feasibility studies. These are briefly introduced in the following section.

[19]Bureau of Energy Efficiency, India, n.d. Available at: https://beeindia.gov.in/content/pat-cycle

1.3.4. Step 4 - Development of an action plan, methods and criteria for strategic area selection

The prioritization of the area or areas of energy intensive facilities/production/operational units to be included in the EE strategic plan of the municipality is an important first step in the process of developing an EE strategy. It is equally important that the prioritized areas, besides being the most important areas from the point of view of energy users, are also the areas in which there is potential for new policies, programmes or projects that can help to meet the EE target set by the municipality. Regardless of the level of ambition of the EE target, achieving it will not be possible without the implementation of one or several sound programmes or projects aimed at achieving the target. For this, financial resources and existing capacity must be in place. It is therefore crucial that the prioritized areas have been selected through a systematic and thorough process, and that the benefits outweigh the costs. It is also crucial that they contribute to achieving the target for the specific area within a reasonable payback period.

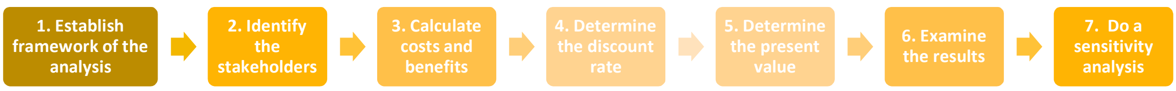
Several methodologies can be used in the prioritization process, with some of them more complicated than others, and requiring more expertise, time and resources. Two of the most-used methodologies are the cost-benefit analysis (CBA) and the multi-criteria analysis (MCA). Both methodologies have their advantages and disadvantages. Their accuracy will depend on the reliability of the data used, particularly in CBA. In both cases, the identification of relevant stakeholders to be involved in the discussions is very important. There is extensive literature on the two methodologies (see for example Oscar A. Preciado-Perez, 2017, D.W. Pearce, 1983, Robert J. Brent, 2017, Dodgson et al. 2009). Therefore, in this module we will limit ourselves to a brief introduction to these two methodologies. This will give the reader enough understanding of the methodologies and allow decision-makers to make the right choice.

Cost-benefit analysis (CBA)

The CBA is a tool that helps to evaluate, in monetary terms, the benefits against the costs of a given intervention, project or programme. If the benefits outweigh the costs, the intervention is normally justified. For this, a list of all the expenses and benefits the intervention is expected to give rise to should be created; this will allow a decision on whether the intervention is worth or not. From the estimated result, return on investment (ROI), internal rate of return (IRR), net present value (NPV) and the payback period can be calculated. In this context, it is very important that the data collected is accurate. It is also important that the same currency is used for the calculations, i.e., all the expenses and benefits should be converted to the same currency, thus making the comparison fair (apples to apples). Below is a suggestion of seven steps that can be followed in a CBA (see Figure 1.6):

1. Establish the framework for the analysis. Here, existing plans, municipality development priorities, baseline and EE improvement potential should be identified. This information should be distributed to the stakeholders to be involved once identified.
2. Identify the stakeholders to be involved in the discussions. All relevant stakeholders should be identified and listed from the very beginning. Involving them early will give the intervention more legitimacy and thereby greater acceptance.
3. Calculate the costs and benefits across the expected life span of the project or programme.
4. Determine the discount rate. This will express the amount of interest as a percentage of the balance at the end of a given period. See afterwards how the result could be affected by using different discount rates.
5. Determine the present value. This is a measurement of profit that is calculated by subtracting the present values of cash outflows from the present values of cash inflows over a period of time.
6. Examine the results and use them as the basis for a decision or recommendation.
7. Conduct a sensitivity analysis. Costs, benefits and risks are often not known with certainty. This allows the possibility of adapting/changing some of the key parameters to potentially mitigate some of the risks.

Figure 1.6 Sequence of the seven steps in developing a CBA.



Source: Adapted from 10 Steps to the process of Cost Benefit Analysis. Project Management Controls[20]

[20] Landau, P., 2018. Cost Benefit Analysis for Projects – A Step-by-Step Guide. Available at: https://www.projectmanager.com/blog/cost-benefit-analysis-for-projects-a-step-by-step-guide

As mentioned earlier, there are advantages and disadvantages with both methodologies. One of the advantages of the CBA, which is essentially a data-based decision-making tool, is that if reliable data is used, it can give a relatively accurate evaluation on whether a project or programme is worth implementing. Among disadvantages are the one related to the exogenous factors like interest rate and inflation, which are beyond the control of the planners and can affect the result of the evaluation.

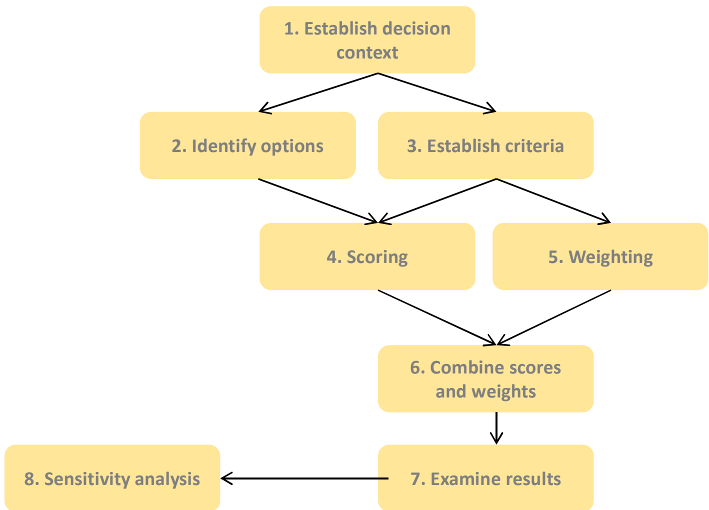
Multi-criteria analysis (MCA)

The MCA is a methodology that, in a systematic way, identifies the preferred options to achieve a specific objective or target that the corresponding municipality has set. It uses a weighting system in which different options are given numerical scores that are ranked based on predetermined criteria. The ranked options are short-listed for a subsequent evaluation. This can be done by a team of experts or/and in consultation with relevant stakeholders. The last relies on the judgements of the stakeholders or experts, thus making the MCA a more participatory approach compared to the CBA. This may give the results from the decision-making process more legitimacy when a consensus among involved stakeholders is reached and, therefore, greater public acceptance. As with the CBA, there is extensive literature on the topic; therefore, we will limit ourselves to providing a brief introduction to the methodology. For a detailed description of how the MCA works, see, for example, Dodgson et al., 2009.

Below are the eight steps that can be followed when using the MCA (see Figure 1.7).

1. *Establish the decision context*. Similar to the CBA, it is important to assess the current situation (baseline), the potential for EE improvements and what the municipality wants to achieve (target).
2. *Identify options*. Review existing EE plans and other national documents and discuss with the involved stakeholders, thus identifying the various options (programmes or projects) that can help to achieve the target.
3. *Establish criteria*. To compare and evaluate different options, which projects or programmes are more appropriate to achieve the target, criteria must be defined.
4. *Scoring*. The identified options are evaluated based on the selected criteria and given a numerical score (for example 1-100) based on performance. To see how well they meet the previously established criteria, a performance matrix is created, where preferred options are given a higher score.
5. *Weighting*. The level of importance among selected criteria to be used for the evaluation of the options may vary; therefore, numerical weights are given to each criterion. This allows scores to be converted to a common scale that can be used to judge the importance of each criterion.
6. *Combine scores and weights.* Scores and weights of each option (project or programme) are combined to calculate an overall value, thus getting the weighted score of each option. The total weighted score of an option (project or programme) is the sum of its scores for each criterion multiplied by the corresponding weights.
7. *Examine the results.* The ranking of the options is given by the weighted average of all the scores. Examining the results gives an indication of how much better one option is over another.
8. *Conduct a sensitivity analysis.* This allows an examination of to what extent the accuracy of the inputs or disagreements between stakeholders may affect the final result.

Figure 1.7 The eight steps to conduct the MCA suggested in this module



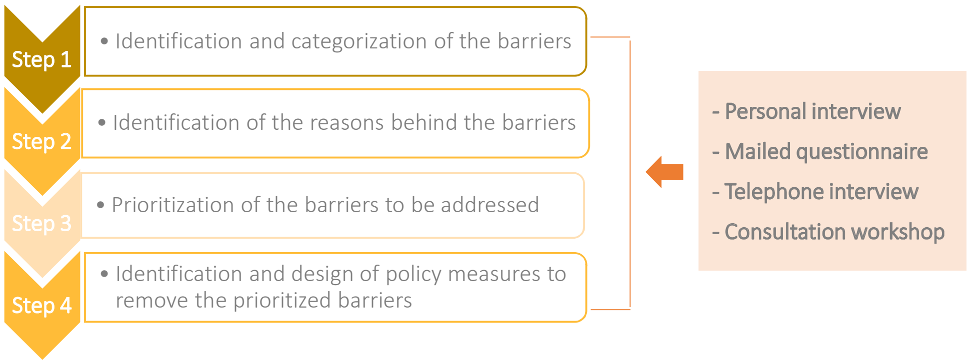
Source: Adapted from TNA step by step Guidebook, 2019[21]

[21] Haselip, J., Narkevičiūtė, R., Rogat, J. and Trærup, S., 2019. TNA Step by Step- A guidebook for countries conducting a Technology Needs Assessment and Action Plan. Available at: https://tech-action.unepdtu.org/wp-content/uploads/sites/2/2019/04/2019-02-tna-step-by-step-guide.pdf

1.3.5. Step 5 - Barrier identification and analysis through stakeholder consultations

Barriers to investing in EE can be understood as the reasons hindering or preventing investments in EE initiatives or projects from taking place. The reasons may be of varying types and degrees of importance, and vary from country to country depending on local circumstances, such as energy prices, structure of the market, regulatory frameworks, incentives/disincentives, culture, etc. Barriers may also depend on external factors, which may be beyond the control of local authorities, low global oil market prices or political unrest being some of them. Barriers constitute a hindrance not only for investors, but in many cases an impediment for energy planners in municipalities to develop long-term EE strategic plans. It is therefore important for municipality mayors and other decision-makers at the local level to identify these barriers and understand the reasons for their existence, thus being able to address them in the best possible way before developing any EE strategy plan. In this module, a four-step process is suggested for the analysis, including the methodology to be used for the analysis (see Figure 1.8).

Figure 1.8 Barrier analysis: four-step process



The identification and categorisation of the barriers is a crucial first step in that it will help to understand the nature of the barriers and thereby, how they can be addressed. Table 1.2 shows an example of some sub-categories and the category of barrier they belong to.

Table 1.2 Barriers to EE projects on a municipal scale

Category	Sub-category
Economic and Financial	• Lack of budgetary autonomy on a municipal level • Financing restrictions, e.g. some municipalities might have caps on the amount of debt they can assume • Low global and/or local energy prices • High upfront capital expenditure (CAPEX) • High cost of capital (high interest rate) • Lack of access to financing • Long payback times, i.e. return on investment • Higher transaction costs for public sector projects
Market structure	• Few suppliers (oligopoly) of technologies/services or one single supplier (monopoly) • Limited municipal incentives to save energy and try new approaches
Legal and Regulatory	• Subsidies to existing technologies/services or energy • Highly controlled/regulated markets • Political instability
Institutional, inter-organizational and administrative	• Lack of a designated department, either in line ministries or in branch ministries, (e.g. environmental or energy department) • Lack of collaboration among institutions to bring projects forward (e.g. urban planning and energy department) • Lack of training at all levels, particularly of technical in-house competence to assess and develop EE projects • Intricate and/or inefficient bureaucratic processes • Lack of managerial skills and resources to develop EE projects • Weak monitoring and enforcement mechanisms
Awareness, information and related social barriers	• Asymmetric information on EE potential • Lack of, or distorted, information on the performance of EE technologies • Lack of, or distorted, information on the multiple benefits of EE technologies (e.g. improved energy security and economic benefits) • Lack of environmental awareness • Aversion to new solutions and technologies • Lack of technical capacity to implement, operate and maintain new EE technologies
Technological barriers	• Incompatibility between new and existing technology solutions • Technical/performance risk of the technology • Unpredictability of performance and respective energy savings • Higher maintenance requirements

To obtain the best possible results from the surveys, it is important to identify the most relevant stakeholders. This is mainly because different stakeholders will have different levels of understanding, different interests, and even a different level of influence on the institutional system and other stakeholders. Knowing which stakeholders to interview means an advantage in the sense that the responses can be considered more accurate and reliable, which will in turn give more legitimacy to the whole analysis. It is therefore important to map all relevant stakeholders before the interview process, or at least have discussions regarding the selection of the stakeholders to be interviewed.

The information elicited from the surveys, either through interviews or consultation workshops, can now be analysed by the corresponding city or municipality authority and the possibilities for different policy measures be considered. The categorization and analysis of the reasons behind the barriers and prioritization of the barriers will enable the process of identifying and designing the corresponding policy measures to address those more effectively. It is very important that the categorization of the different barriers has been correctly done, since different categories of barriers will most likely require different measures. Also, some of the categories, for example financial barriers, will be more difficult to address and may require acceptance or endorsement at a higher political level, while measures like awareness-raising campaigns about the benefits of investing in EE projects may be less dependent on political acceptance and approval. In any case, the information with suggestions for policy options obtained in the surveys must be assessed by the decision-makers who can implement the appropriate options or the ones that need to be designed. Below are some examples of the most common policy measures (Table 1.3):

Table 1.3 Policy measures to overcome barriers to EE

Category	Policy measure
Financial measures	• Investment subsidies • Grants and loans • Loan guarantees • Taxation and other fiscal benefits • Use charges (e.g. congestion charges)
Non-financial measures	• Mandate to provide electricity from energy-efficient technologies • Disincentivizing the use of energy from fossil fuels (e.g. increased taxation on fossil fuels) • Information and awareness-raising campaigns of the multiple benefits of EE • Minimum Energy Performance Standards and labelling technologies • Sustainable public procurement • Promoting research and development • Training and capacity-building • Promoting public-private partnerships

Here it is important to consider the possibility of combining measures instead of addressing the barrier with only one type of measure. For instance, a good option is to combine a financial measure with a non-financial measure. One example is to combine an investment subsidy with a campaign aimed at raising awareness about the multiple benefits of EE.

Measuring, Reporting and Verification (MRV) System

MRV systems include a measurement component that refers to the collection of information that allows monitorting of implementation progress and impacts associated with a given mitigation action included in the strategic plan. The reporting component makes it possible to provide information to the corresponding authorities in a transparent manner. The verification component allows the evaluation of information that is reported in terms of its completeness, consistency and reliability by a qualified third party. Thus, the MRV system serves to ensure transparency, that the results of the implementation of a mitigation actions are occurring and that their impacts are being properly quantified and reported. More detailed information about the MRV systems is found in Module 6 (Assessing the performance and impacts of Project Bundles).

1.3.6. Step 6 - Strategy formulation and launching

All the previous steps are preparatory work for the strategic plan formulation. Normally, the strategic planning process include the high-level policymakers, the stakeholders and the formulation group, which normally consists of a few technical experts who do the actual drafting and then revise the drafts based on feedback from stakeholders. After the final version is approved by the municipal council, the mayor's office, or other municipal decision-making body, it is formally issued for implementation by the relevant responsible organizations.

A typical strategic plan includes the following contents:

1) Official approval/endorsement.
2) Background.
3) Strategy goals (see Table 1.4).
4) The strategies and action plans for their implementation.
5) Cross-cutting issues: some strategic plans also include cross-cutting issues that are relevant for the implementation of multiple strategic goals, such as an adjustment in existing roles and responsibilities, institutional setup for coordination, funding mechanism, public procurement etc.
6) Risk management. The risk management part evaluates the risks to the achievement of each strategic goal. For each risk, the probability and impacts, as well as mitigation measures, are identified to reduce the risks.
7) Measuring, Reporting, and Verification (MRV). In practice, all municipal government agencies have some recording and auditing system on their expenses and investment. When international funding or technical support is needed, or commercial funding or private investment is utilized, there can be additional requirements on the MRV side.

Table 1.4 Example of a strategy summary table.

Strategic Goal	Strategy	Actions	Responsibility	Cost/investment estimation	Resource allocation	Timeline
Goal 1	1. The first strategy to reach Goal 1 2. The second strategy to achieve Goal 1	Underlying actions for First Strategy	Responsible agencies/organizations		Any funding plan/resource allocation	When to do what?
Goal 2	......		...			...

Some strategic plans also contain contents on the strategy development process, including the different actors involved and the stakeholders consulted. The strategic plan needs to be SMARTER (Specific, Motivating, Achievable and Agreed, Relevant, Time-bound, Evaluation, and Readjustment).

Once the strategy is finalized, it needs to be launched online or during an event, which can be used to promote public awareness of the strategy and be used to motivate confidence and interests in EE actions among the private sector and the residential sector. Once launched and released, the strategy enters the deposit of municipal policies and needs to be made available for public access and be integrated into the work plans of relevant stakeholders and municipal government agencies.

1.4. Conclusions

Strategic planning is a process of building consensus among municipal leaders and all stakeholders. In times of rapid changes and competing needs for public resources, a strategic plan creates some stability and certainty for government efforts regarding the duration of the planned period. An agreed and well-formulated strategic plan can help to improve the understanding of available resources and enhance support from key stakeholders. Like other planning processes, a good plan is only useful when it is implemented. The strategic plan needs to be SMARTER. Moreover, there needs to be corresponding resource allocation, authorization, and other enabling and motivation mechanisms so that the relevant government agencies or public bodies can carry out the implementation activities. Clear division of roles and responsibilities, sufficient allocation of resources, as well as a strong commitment and effective support from the municipal leaders are key to the successful implementation of municipal EE strategies.

1.5. Further reading

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MODULE 2

Project Bundling: introduction and steps

Project Bundling: introduction and steps

Jorge Rogat Castillo, Gabriela Prata Dias

Energy efficiency (EE) is part of Sustainable Development Goal 7, namely ensuring access to affordable, reliable, sustainable and modern energy for all, under which the energy efficiency global rate of improvement should be doubled by 2030[22]. The targets for emissions reductions set forth in the Paris Climate Agreement have put EE high on the political, industrial and civil society agenda as an essential strategy for emissions reductions[23]. Even though both EE and renewable energy decrease emissions, it is very important, as explained in the introductory module of this Sourcebook, to be clear about the difference between the two. While renewable energy introduces environmental sustainability through the replacement of conventional fossil fuels or non-renewable energy sources in the energy supply, EE promotes energy savings by reducing the amount of energy demand. The definition of EE is further clarified by the example below (see Box 2.1).

The development of national policy measures to promote and accelerate EE improvements is gaining pace around the globe, encompassed in the Nationally Determined Contributions (NDCs) and in policy and regulatory initiatives of individual countries, regions and cities. Nevertheless, the progress made so far is still not enough to position EE as the significant contributor to emissions reductions it has the potential to be. Investments in EE improvement projects need to be significantly increased.

BOX 2.1. Example of EE measure– LED versus incandescent lights

Incandescent light bulbs have an EE of 35 per cent, whereas equivalent light emitting diodes (LED) solutions are in the range of 80 per cent efficiency. Furthermore, LED lights last up to 3 to 26 times longer. Upgrading existing incandescent lamps with mature LED technology could bring energy savings of up to 90 per cent.

BOX 2.2. United for Efficiency (U4E) initiative

The United for Efficiency (U4E) initiative brings together public and private organizations to support the transition to high efficiency appliances and equipment. It suggests that authorities should start by using an Integrated Policy Approach to accelerate adoption of energy-efficient products, applying: (i) Standards and Regulations, specifying EE and other requirements for a product to be sold in the market, (ii) Supporting Policies for labelling and support standards by ensuring that requirements are clearly and consistently conveyed, (iii) Monitoring, Verification and Enforcement for overseeing products sold in the market, (iv) Environmentally Sound Management and Health aimed at ensuring products do not cause any harm and, (v) Finance and Financial Delivery Mechanisms that support consumers to offset the higher purchase price of efficient products (see https://united4efficiency.org/).

EE projects are often small, scattered, invisible other than on the energy bill, and sometimes technically complicated. Moreover, heavily subsidized energy tariffs, non-cost-reflective of their real value, bring additional difficulty in making the economic case for energy efficiency's feasibility, and thus constitute a barrier. However, EE is generally non-controversial and therefore, politically easily accepted. The fact that frequently the investment volumes associated with EE projects are not big enough creates a

[22] United Nations (n.d.). Available at: https://www.un.org/sustainabledevelopment/sustainable-development-goals/
Target 7.3 of Sustainable Development Goal 7: "Ensure access to affordable, reliable, sustainable and modern energy for all" is to double the global rate of improvement in energy efficiency by 2030.
[23] IEA, 2016. Energy Efficiency Market Report 2016. OECD/IEA, Paris.

difficulty in bringing them to the attention of financial institutions, which have to cope with high transaction costs. Several strategies have been tested to overcome the economic volume barrier. Bulk procurement associated with bundling several small projects seems to be helping EE advance. In this way, Project Bundling can make investing in EE more attractive for financing institutions, regional investment banks and other financiers, and thereby make a significant contribution to bring investments up to a desirable volume and impact level. However, for this to happen, existing barriers need to be identified, analysed and overcome. Project Bundling can be defined as a structure that, through standardization, can bring together several relatively small-scale EE improvement projects or activities to form a single thematic portfolio above a certain investment threshold, thus making it more attractive for financiers. Standardization of similar small-scale EE improvement projects or activities at the local level (e.g. municipal or district) could bring an opportunity to achieve volume and upscale EE implementation through a coordinated approach.

Targeted technical assistance, including financial structuring assistance at the proposal development stage, paired with long-term support to local authorities based on training, communications and awareness raising, an organized and standardized methodology for data collection, and consolidated project analysis, could bring economies of scale and form a supply pipeline of EE investments to existing financing structures. Some of the main benefits of Project Bundling are:

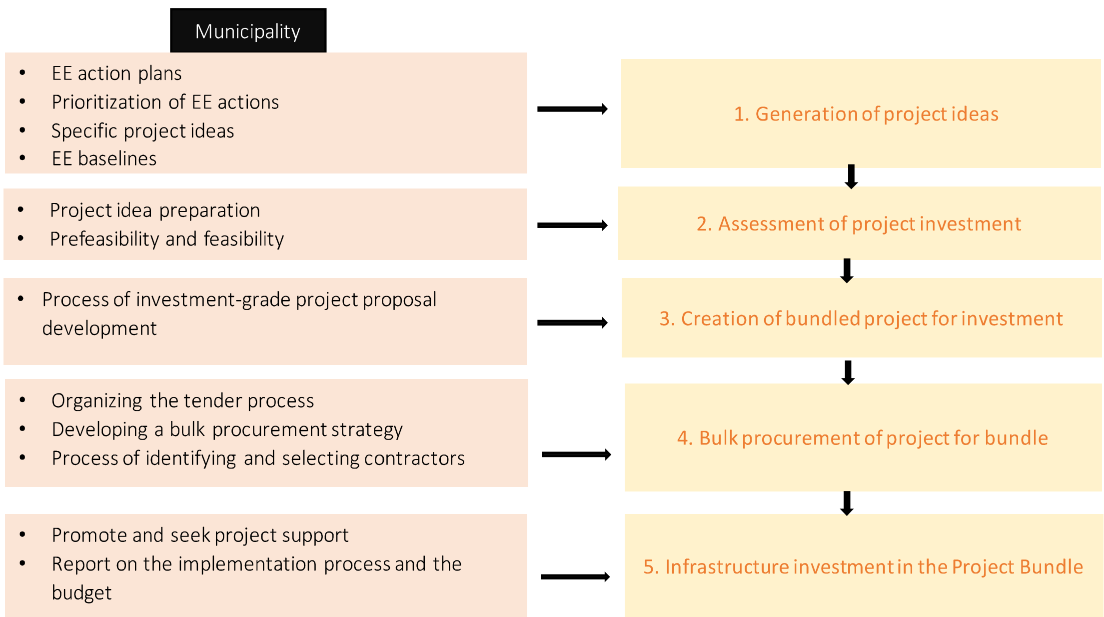
- *It enables access to high-level technical expertise.* Bundled projects are more attractive to high level, local or international experts since they allow them to apply their knowledge in the implementation of new and larger projects. The use of standardized analysis tools (as described in the next modules) for project technical prefeasibility and sizing also helps creating a common baseline and eases the project's economic and technical impact assessment.

- *It accelerates the process of intervention design, implementation, upscaling and replication*. Similar interventions included in a Project Bundle allow for standardization of various activities and procedures before and during the intervention cycle (e.g. expressions of interest, idea evaluation, design, financing and procurement). It mitigates risks through a thorough evaluation and selection of technically feasible projects. Furthermore, it speeds up the process of obtaining the required financing and enables dissemination of lessons learnt and further replication.

- *It increases the attractiveness of projects for potential financiers.* EE interventions are often fragmented across different areas, technological solutions and locations, which determines their high complexity for implementation and relatively small size in the eyes of potential investors. Bundling the interventions reduces transaction costs and increases the attractiveness for investment, as the financiers invest in the overall Project Bundle and not in small individual initiatives.

The Project Bundling approach can be applied to multiple sectors such as buildings (e.g. for heating, cooling and lighting), public street lighting, water supply systems, municipal mobility solutions (municipal fleets, car and other vehicle sharing) and others. The approach for Project Bundling by a city or municipality[24] can be structured and implemented in five steps, as shown in Figure 2.1.

Figure 2.1 The five steps in Project bundling



[24] Available at: https://www.oecd.org/cfe/regional-policy/THE%20EU-OECD%20DEFINITION%20OF%20A%20FUNCTIONAL%20URBAN%20AREA.pdf

Project Bundling, however, faces a number of barriers that hinder its implementation and scale up. Therefore, it is crucial before starting the bundling process that potential barriers are identified and analysed, and policy measures to overcome them identified and assessed. In addition to the barriers mentioned in module 1, there are other barriers such as economic, lack of technical capacity related to operation and maintenance and lack of awareness of the multiple benefits of Project Bundling. These will be analysed, with a focus on the three areas covered in this Sourcebook, in subsequent modules.

2.1. Key steps in Project Bundling

2.1.1. Step 1 - Generation of project ideas

It is envisaged that municipalities will work to translate their EE improvement commitments into action and prioritize their initiatives based on a range of aspects, such as needs in the various sectors, knowledge, tools and platforms that are currently available. In this process, it is also important that municipalities gather the required information and data about national EE plans and priorities, which are in line with, for example, the Nationally Determined Commitments (NDCs) under the Paris Agreement on Climate Change. Information about the interests of local and national partners and other relevant stakeholders, and networks at the local, national and even regional level is also very important. Having identified all relevant stakeholders interested in EE, the possibility of involving them in the discussions regarding needs and project design should be considered. In this context, organizing stakeholder consultations may prove very productive and result in enabling the realization of the discussed project ideas into concrete project proposals for financing. Information regarding EE baselines is crucial and should be included, since this allows the measurement of gains from the determined intervention over the baseline. Having information about the baseline also allows the estimation of improvements that can be achieved by the planned project. Being able to present all this information, including the gains and the multiple benefits of these interventions, makes the project ideas more attractive for financiers.

2.1.2. Step 2 – Technical and economic assessment of project investment.

The development of the project idea into a bundled project proposal requires, besides the information described in Step 1, a mapping of the available local capacity to conduct the assessment, including prefeasibility and feasibility studies. Aspects such as technical specifications, anticipated energy savings and quantified investment amount must be included. Not having the required local capacity to conduct a thorough assessment to provide these details will make the elaboration of a robust and convincing project proposal less likely to be financed. Therefore, a mapping of the existing capabilities is suggested. If they are not in place, a capacity-building component or training should be included at the very beginning, in conjunction with project design.

2.1.3. Step 3 - Business models and financing options

EE interventions are often fragmented across different areas, technological solutions and locations, which determine their high complexity for implementation and relatively small size in the eyes of potential investors. Bundling the interventions reduces transaction costs and increases attractiveness for investments, as the financiers invest in the overall Project Bundle and not in small, dispersed initiatives. This allow for the possibility of accessing larger-scale financing and ensuring actual implementation. Another important component when developing the project proposal is the way it is structured and presented. Funding organizations and other financiers often struggle with obtaining key data and indicators, which can allow for easy screening and judgement of the project potential and its financial attractiveness. It is therefore important to develop and use a standardized format that is familiar to funding organizations and other financiers.

Once proposed EE initiatives have gathered sufficient data, the bundling process between different locations will be possible. To aggregate projects of a similar kind, the creation of a specific structure to be the main bulk procurer and borrower will be needed. For this, there are three options, which are briefly explained below.

- *Special Purpose Vehicle (SPV)*: A type of company or entity that is established for a specific project purpose and whose holders are the different small project owners.
- *ESCO (Energy Services Companies) model*[25]: Considered to be an effective mechanism for EE delivery, which maximizes the provision of energy resources. ESCOs essentially act as project developers as they integrate a series of components, such as project design, procurement, financing, implementation and operation. Its economic model essentially means they do the bulk procurement and, for example, retain the benefits of a decreased energy bill. It is, however, recommended that

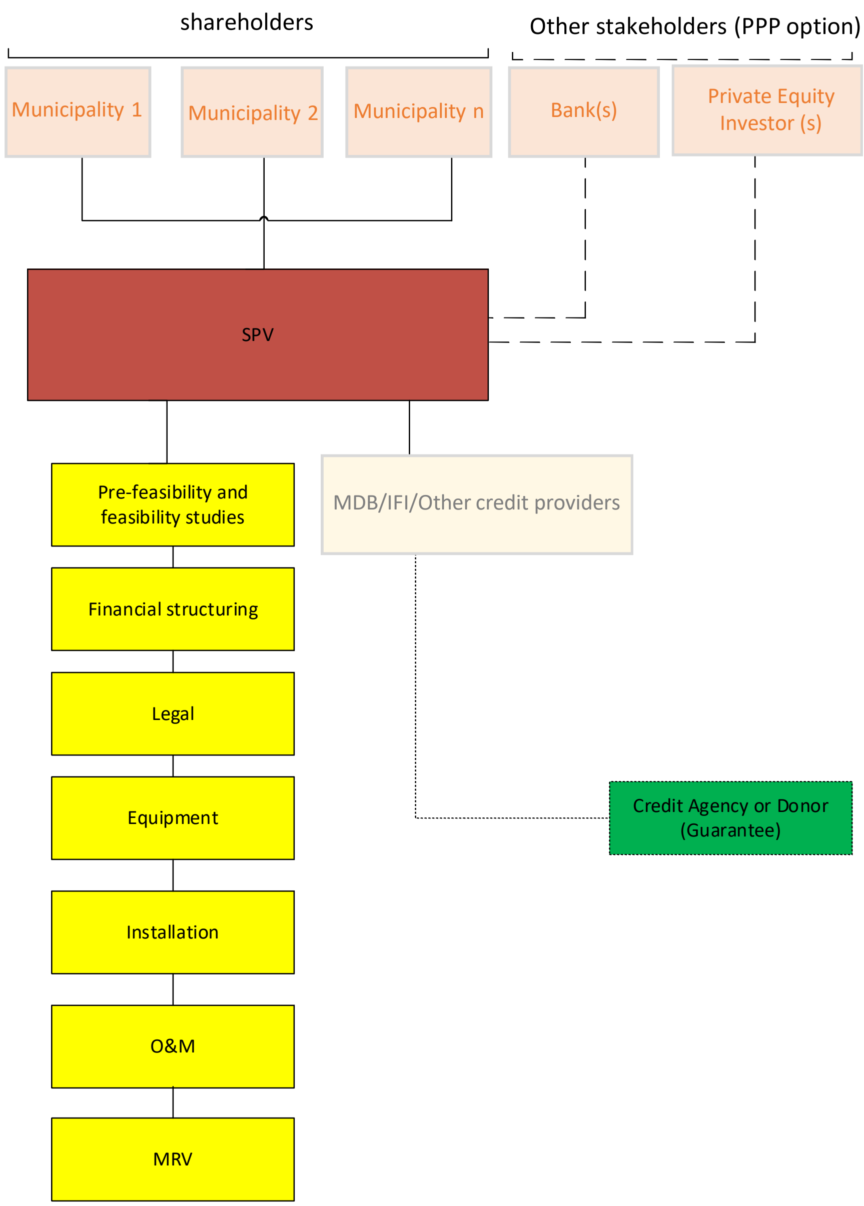
[25] See for example EESL- Energy Efficiency Services Limited of India and the bulk procurement for lighting appliances.

the reader adopts these models after having evaluated their applicability to the final user end areas.

- *Trust Fund or Revolving Fund*: Investments and funding are channelled through this mechanism and return to the structure. A trust fund is set up by a person or entity known as a grantor, for the benefit of another person/entity, known as a beneficiary. A trust fund can contain cash, investments, real estate and other assets. It can be a valuable tool in estate planning and ensuring financial security.

These three options are explained more in detail in module 4. An example of how an SPV model can be created is shown in Figure 2.2

Figure 2.2 SPV model for investment in a bundled project on municipal energy efficiency



2.1.4. Step 4 – Bulk Procurement for the Project Bundle

As several projects are developed to the point of technical and financial feasibility, the next step is to mount procurement and tender issuance by cities or municipalities to implement the projects and realize the anticipated energy savings. As with any project, for implementation to be successful a well-defined and effective procurement strategy should be used. Since the procurement process refers to the acquisition of components or/and services by the city or municipality, it is important it is managed in the most effective way. Aspects such as market conditions – including existing suppliers, best minimum energy performance standards applicable, delivery time, project objectives and timelines, available budget and resources – are very important. It is also worth mentioning that, after bundling, multiple projects will be aggregated and function like a single project during the financing and implementation stage.

When pursuing EE, it is important that the necessary policies and guidelines are in place, together with the testing facilities and product registration systems, so that the products of the new projects comply with the best market solutions available.

In conclusion, an integrated policy and market approach would include the definition of policies, standards and regulations, finance and delivery mechanisms, monitoring verification and enforcement and finally an environmentally sound management and health system[26].

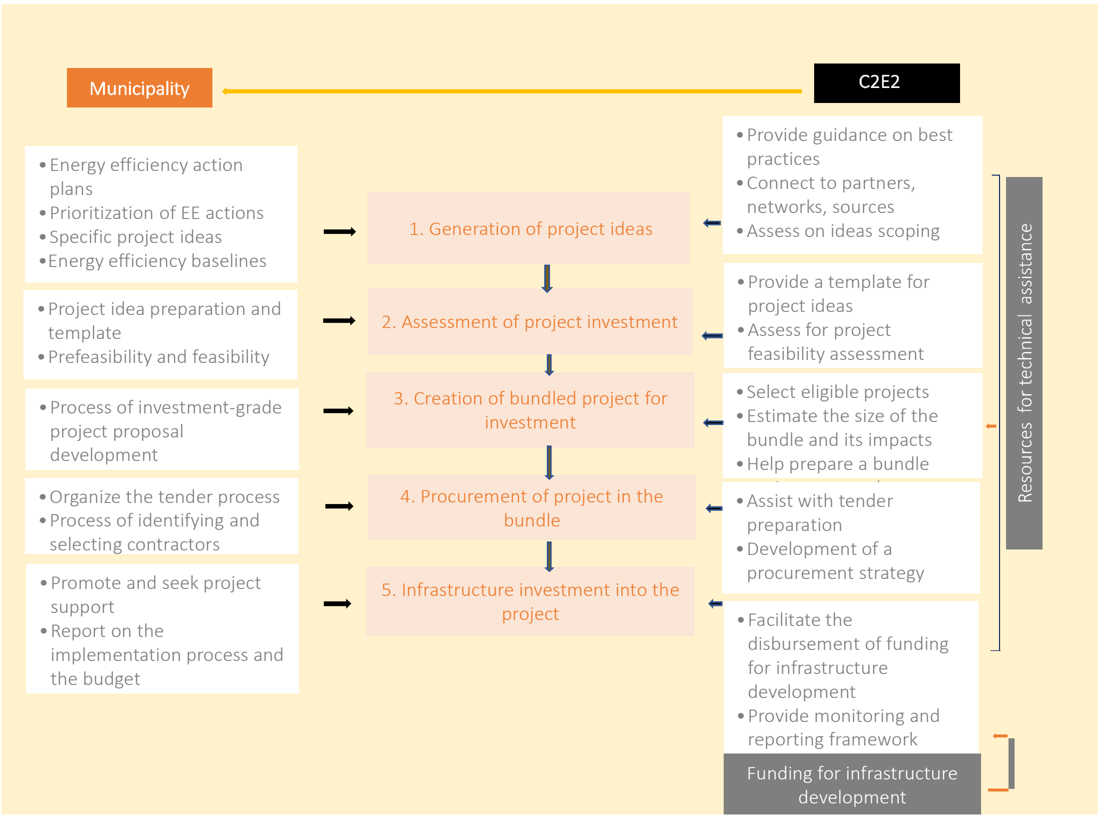
2.1.5. Step 5 - Infrastructure investment in the bundle

At this point, projects will execute the investment into the bundle implementation through engagement of larger-scale investors and development infrastructure financiers. A transparent procedure is required for the disbursement of funds to the individual projects within the bundle; this is in accordance with the projects' budgets. In this process, it is advised that the city or municipality promote the individual projects and seek local co-funding to grow local capability of the finance sector to fund EE projects. Monitoring and reporting is an important component of the bundle approach, therefore a monitoring and reporting framework through which the implementation progress of each of the projects within the bundle can be easily tracked, verified and adjusted is needed. The reporting is very important for the local authorities and the financiers of the project, so that it can be verified and check if revenues are returning according to expectations.

2.2. The work of the Copenhagen Centre on Energy Efficiency

The Copenhagen Centre on Energy Efficiency (C2E2) has been focusing its work on EE improvements in developing countries. It is undertaking activities and initiatives in various regions. One of these is accelerating the scale up the implementation of EE improvement projects and programmes. C2E2 aims to provide streamlined, structured and aggregated expertise on technical and business models aspects related to the development of and investment in EE projects and initiatives. C2E2 can assist cities and municipalities, as well as other interested parties, with technical support in implementing EE interventions by means of bundling projects from different locations with similar context and within specific thematic areas. The technical assistance is provided by international energy experts with knowledge

Figure 2.3 C2E2 technical assistance to local governments.



[26] See also United for Efficiency for further details on Model Regulations for lighting Appliances and equipment, product registration systems and procurement guidelines at: united4efficiency.org

and experience of EE project implementation in all regions. C2E2 can thus help to develop project ideas into a feasible investment-grade project, and provide a vast variety of resources to increase local capacity for project assessment, design and implementation. Figure 2.3 shows the interaction between C2E2 and cities and municipalities with EE improvement plans, and the type of support it can provide.

2.3. Conclusions

This module has introduced the various steps required for a successful Project Bundling and shown how it can in turn help in the implementation of the interventions outlined in the EE strategic plan. The module has also shown the multiple benefits of Project Bundling, such as economies of scale, reduced transaction costs and increased attractiveness to financiers when similar small-scale projects are bundled into a larger project or intervention.

2.4. Further reading

Dzene, I., Rochas, M., Blumberg, D., 2007. Energy 4 Cohesion Guideline for bundling decentralized energy actions. Energy 4 Cohesion- Deliverable 6.3. August, 2007.

Socks, M., Mosenthal, P., DeCostanzo, D., Gupta, A., 2016. The Energy Efficiency Extra Value Menu: Streamlining Energy Efficiency Delivery. 2016 ACEEE Summer Study on Energy Efficiency in Buildings

United for Efficiency (U4E) initiative, https://www.un.org/sustainabledevelopment/sustainable-development-goals/

MODULE 3

Rapid assessment of energy efficiency projects for municipalities

Rapid assessment of energy efficiency projects for municipalities

Santiago Martínez Santaclara, Jorge Izquierdo Pérez, Gabriela Prata Dias, Rahul Raju Dusa, Clara Camarasa Hernando

3.1. An overview of technical solutions and measures to support Project Bundling

Technical options to improve energy efficiency (EE) at a municipal level are readily available and, in many cases, are economically viable. The purpose of this module is to present viable technical options and tools to develop EE measures, all of which have the potential to be part of a comprehensive intervention to shape a bundled project. It also shares insights of EE potential technical measures, a systematic framework and necessary tools to develop a rapid assessment. Based on their EE potential at a municipal level, the content focuses on key areas: street lighting, water supply systems and public buildings.

3.2. EE potential in street lighting, water supply systems and public buildings

3.2.1. Street lighting

Lighting accounts for 15 per cent of global power consumption and 5 per cent of GHG emissions. In the next decade, lighting consumption is expected to rise by 50 per cent[27]. According to various sources, the share of street lightning consumption can represent a wide range of the public energy used in cities worldwide, from 4 to 40 per cent[28]. This being a notable expenditure, improving the technology's efficiency can bring high mitigation, mainly through the replacement of old equipment with more efficient luminaires (see Table 3.1).

Table 3.1 Efficiency percentage and cost by luminaire type*

	Efficiency (%)	Cost (USD/year)
Mercury Vapour	35%	77.1
Metal Halide	80%	21.1
High Pressure Sodium	80%	17.6
Compact fluorescent Lamp (CFL)	70%	34.4
Incandescent	35%	550.6
Light-emitting diode (LED)	95%	11.5

*Calculations based on the annual energy consumption for a single 160 W mercury vapour lamp and equivalent lamps operating 12 hours a day with an electricity price of 0.11 USD/kWh

When focusing on developing countries in relation to the previous data, two outcomes were observed:

- Street lighting accounts for lower electricity demand in these countries due to a lack of electrification and insufficient street lighting coverage of certain areas.
- Higher expenses are recorded due to extensive use of old, inefficient equipment.

Depending both on the existing technology and on the types of measures to undertake, the electricity savings potential in old systems can range from 40 to 60 per cent of annual energy demand[29]. Two main types of EE measures in street lighting are identified:

- Replacement of luminaries with more efficient technologies, i.e. LED bulbs. Just this measure, by itself, can lead to significant energy savings. Installation of smart luminaries with features such as photovoltaic sensors (to detect natural light) and motion sensors (to detect vehicular and pedestrian movement), etc. These measures are key to maximizing energy savings.
- Allocation of dedicated personnel to ensure efficient operations at optimal costs along the technology's lifetime.

[27] US Department of Energy, 2015. Rise and Shine: Lighting the World with 10 Billion LED Bulbs. Available at: https://www.energy.gov/articles/rise-and-shine-lighting-world-10-billion-led-bulbs.
[28] Available at: www.worldbank.org/energy/led-street-lighting-unburdening-our-cities
[29] European Commission (EC), 2007. Guide for energy efficient street lighting installations. 2007. Available at: https://ec.europa.eu/energy/intelligent/projects/sites/iee-projects/files/projects/documents/e-street_e_street_guide_en.pdf.

3.2.2. Water supply systems

Water is a universal right. However, most of the population with access to it is not aware of its real value, meaning that the waste of a scarce resource such as water will affect future access to it, with financial constraints due to the waste of energy consumed and equivalent emissions.

The water supply system is one of the predominant energy demand sources of municipalities, reaching 30 to 50 per cent of their electricity bill in some cases[30]. On a wider scale, various studies estimate that the whole water cycle (including extraction, treatment, distribution, collection and sanitation) creates 4 to 7 per cent of global energy demand, with significant country variations (from about 2 to 6 per cent in countries like Brazil or Spain to around 20 per cent in California in the US)[31].

Up to 70 or 80 per cent of the energy spent in the water supply process (from source to consumer), and about 50 per cent of the whole water cycle expenses (including wastewater disposition after its use), is associated with the electricity needed for pumping water in its transportation and distribution stages. Some studies have found close to 60 per cent of energy losses in the cycle, which shows the room for improvement of this sector[32]. Several factors have an influence on the magnitude of this demand:

- The geographical characteristics of the system, i.e. the distance from the source to the consumption points and the height difference between them (thus, the significant differences in the electricity share of water supply between regions).
- The so-called energy-water nexus, which addresses the direct relationship between water consumption and energy use. Two types of water expenses are distinguished:
    - Final consumption at the demand side, which has a multiplier effect on energy consumption at the supply side due to all the steps involved in the supply process.
    - Network leakages, which in old systems can represent about 34 per cent of water consumption. This issue has a double negative effect: as leakages increase, the pressure needs to be raised to ensure the water supply, thus both energy consumption and water leakage further increase. Taking into account the technical and economic difficulties of addressing them, leakages can be reduced cost-effectively to levels of 10 to 15 per cent.
- Sizing of the pumping system, especially after changes or reductions of the water demand, e.g. when the leakage issues are addressed.
- System components age and suitability:
- Sedimentation level of the pipes: new low friction piping reduces the resistance considerably.
- Efficiency of pumps and presence of variable speed drives.
- Adjustment of pumping head depending on dynamic and static conditions of the water sources.
- Efficiency of capacitors and transformers.
- Operational practices and frequency of maintenance activities.

3.2.3. Public buildings

When looking at the origin of energy consumption, buildings worldwide account for about 30 per cent of countries' energy consumption, out of which public buildings represent approximately 30-40 per cent of the overall building stock[33]. Furthermore, as populations and developing economies grow, the average floor area per household and the demanded thermal comfort (especially when it comes to air conditioning) grow too, which leads to a severe expected average building consumption increase. For instance, Chile has experienced a 6 per cent growth in the past 10 years[34]. In other countries like Denmark, buildings (as opposed to industry and transport) demand about 40 per cent of energy, of which roughly 15 per cent is associated with the public sector (hospitals, schools, etc.)[35].

In this light, further buildings' efficiency improvement needs to be addressed to flatten this trend, if not reverse it. Some estimates point to a potential compensation of the increasing buildings energy consumption of 30 to 40 per cent by 2050 through improved thermal performance. Since 2014, technical efficiency improvements worldwide led to a reduction of energy consumption of 0.7-0.9 per cent yearly, with a 4 per cent decrease just between 2016 and 2018, which meant avoiding the emissions of about 3.5 Gt of CO_2[36]. Digitalization (smart metering and control) plays an important role, as it is estimated that it can potentially help reducing buildings' consumption up to 10 per cent by 2040.

[30] IEA, 2017. Water Energy Nexus. World Energy Outlook Special Report. Technology report. Available at: https://www.iea.org/reports/water-energy-nexus.
[31] Gustavo, F. and Emilio, L., 2015. Eficiencia energética y regulación económica en los servicios de agua potable y alcantarillado. Available at: https://repositorio.cepal.org/handle/11362/37630.
[32] Copeland, C., 2014. Energy-water nexus: the water sector's energy use. Congressional Research Service. Available at: https://www.everycrsreport.com/files/20140324_R43200_708bce0bc492d24f-c5ee90e7e4902f90e2fde12d.pdf.
[33] UN Environment and International Energy Agency, 2017. Towards a zero-emission, efficient, and resilient buildings and construction sector- Global Status Report 2017 . Available at: https://www.worldgbc.org/sites/default/files/UNEP%20188_GABC_en%20%28web%29.pdf
[34] Silvero, F., Rodrigues, F., Montelpare, S., Spacone, E., Varum, H., 2019. The path towards buildings energy efficiency in South American countries. Sustainable Cities and Society 44(2019), 646-665. Available at: https://www.sciencedirect.com/science/article/abs/pii/S2210670718306929.
[35] Mathiesen, B. V., Drysdale, D., Lund, H., Paardekooper, S., Ridjan, I., Connolly, D., Thellufsen, J.Z., Jensen, J.S., 2016. Future green buildings—a key to cost-effective sustainable energy systems. Available at: https://vbn.aau.dk/ws/portalfiles/portal/234005850/Future_Green_Buildings_A_key_to_cost_effective_sustainable_energy_systems_ENGLISH.pdf.
[36] IEA, 2019. Energy Efficiency. Avilable at: https://www.iea.org/reports/energy-efficiency-2019.

To this end, the building energy performance index (EPI) (kWh/m^2/year) is a primary indicator for quantifying the efficiency characteristics of the building. This, however, varies significantly based on the building typology, location and climatic conditions, which directly influence potential energy savings. Depending on the type and utilization of the building, the following baseline data (not limited to) may be required to understand, assess and plan activities to enhance EE public buildings:

- Building characteristics (usage, location, climatic conditions, age, size, floors, distribution, etc.)
- Current equipment in use, technologies adopted, energy consumption share, design and operating efficiencies, parameters directly and indirectly impacting these efficiencies (occupancy, heating and cooling loads, age, ventilation rates, end use requirements, demand supply gap, etc.)
- Measurement of natural and artificial lighting: illuminance (Lux)
- Desired and available Lux levels through lighting (natural and artificial)
- Consumption of hot water/fuel/electricity
- Operation hours on daily/monthly basis
- Through surveys: preferences on lighting, thermal comfort, air streams, etc.

Some of the potential EE measures per building component or technology are presented in the following table:

Table 3.2 Potential EE measures for buildings

Section / Area	EE measures
Envelope	Reduction of heat transmittance (improvement of insulation), with a potential of about 30 per cent of energy savings • Multiple layer external walls with different insulating material • Roof maintenance/replacement/upgrade (also with different layers, including insulation material) • Floor maintenance/replacement/upgrade (floor heating can be an additional measure) Shadowing: to reduce/maximize direct radiation (for desired/undesired heating and natural lighting) • Smart shadowing (smart blinders) • Shadowing according to position of the sun in each season Building openings • Windows and doors insulation improvement • Double glazing with air chamber (DHC) • Maintenance/replacement/upgrade of windows frames (aluminium or PVC) • Air chambers through doors (sliding, rotating) or intermediate rooms, to reduce the air leakage • Smart windows control (energy savings potential of 10 to 20 per cent[34])
Lighting	• Maintenance/replacement/upgrade of luminaries with LED lights. • Smart lighting: sensors to turn the lights off when they are not being used (energy savings potential: 1 to 10 per cent[34])
Devices and controls	• Timed plugs for devices that do not need to be on permanently (energy savings potential of 1 to 5 per cent[34]) • Acclimatization and control with smart thermostats: optimizing both efficiency and comfort (energy savings potential of 5 to 20 per cent [8]) • Smart zoning (different spaces): potential energy savings of up to 10 per cent [34] • Building management systems
Heating and cooling	• Replacement of old radiators and H&C systems by newer technologies, depending on the municipality infrastructure and the sustainability degree of the energy source in the area • District heating (having low temperature district heating as a goal) • Heat pumps (heating and/or air conditioning) • Use of solar collectors for space heating and domestic hot water • Geothermal heat pumps
On-site energy generation: renewable energies and transmission losses reduction	Solar photovoltaic energy for on-site electricity generation: could cover uses such as lighting and other electric appliances' energy needs.
Social promotion and training of staff and relevant stakeholders	• Training to conduct periodic maintenance of the building components and technologies for optimal reduction of energy consumption • Energy conservation awareness-raising through thematic campaigns • Workshops, capacity-building and seminars on energy conservation and EE measures

3.3. Key steps to develop a rapid assessment

A rapid assessment should analyse the municipality's overall conditions, including the city's geographical location, population, GDP, energy resources, urban planning and development plans, renewable potential (e.g. solar energy), socio-economic environment and energy portfolio. The rapid assessment should prioritize the analysis of technical and economic barriers, as well as challenges ahead in the development of EE measures. It should be done in parallel with the identification of a sound business model and financial instruments (see Modules 4 and 5).

To develop a rapid assessment, concrete resources will be required, such as technical expertise, and energy and financial information. These resources, supported by the tools presented in this section, will provide the municipality with the necessary understanding to develop projects to improve the efficiency of street lighting, water supply systems and public buildings in the municipality – along with other associated benefits, such as reducing GHG emissions, improving energy security, favouring public budgets, reducing local air pollution and creating local jobs.

3.3.1.Preliminary data for the rapid assessment

To create a baseline of the status of energy consumption and study each individual potential improvement, it is required to start from a broader analysis of the municipality. The data required to develop the baseline and indicators on potential savings that will be introduced in further sections are:

- City/municipality population
- GDP (USD/year)
- Climate characteristics on a monthly base (e.g. precipitation, temperature, humidity)
- Total electricity consumption (kWh/month, or if not available kWh/year)
- Consumption of natural gas, oil, coal, etc. (kg/month, toe/month, kcal/month)
- Total electricity bill (USD/month, or if not available USD/year)
- Share of the electricity bill over the overall municipal expenses (USD/month, or if not available kWh/year)
- Shares of the different municipal sectors (e.g. lighting, water supply, etc.) on the overall electricity bill

The share of electricity bill over the municipal expenses and its split by sector are crucial parameters that can help define the current situation at a municipal level, and the potential impact that actions could bring, not only at a sectorial level but at a more holistic municipal level. When bundling several projects, these numbers can potentially be compared to the national electricity consumption, as the actions to consider in the projects might have an influence on this figure.

From here, a split per sector can be done, so that useless data will not be collected if there is no intention of developing a project in some of the proposed areas. This research can be done by reading labels in the components, audits on the utilities, analysing bills, and looking at previous/current projects of retrofit/expansion of the systems.

3.3.1.1. Street lighting

The upgrade of existing non-efficient lighting systems towards highly efficient and available LED solutions can reduce energy consumption by 40 to 60 per cent, depending on the existing lighting technologies in use. LEDs ensure a cost-effective solution that can alleviate the finances of the utilities/municipalities through energy savings, resulting in lower financial constraints that would allow expansion of the system without the need for more capital.

A desk audit for the street lighting sector requires a revision of existing lighting stock. The general information required to develop a rapid assessment of the lighting sector is:

Parameter	Value
Average sunlight during the year (hours)	
Electricity price (USD/kWh)	

The required inventory of existing stock classifies the existing bulbs as follows:

Technology	Lamp power (W)	Stock of fixtures (number)	Local cost of the lamp (USD/lamp) *1
Mercury Vapour	125		
	250		
Metal Halide	70		
	100		
	150		
	175		
High Pressure Sodium	70		
	100		
	150		
	250		
Compact Fluorescent Lamp (CFL)	100		
Linear Fluorescent Lamp (LFL)	70		
Incandescent	100		
LED*2			

*1 Indicate only the local price of the bulb for each technology, without considering any installation costs.
*2 Add as many rows for each of the LED Power lamps available as needed.

End-use application of each lamp technology to develop a regulation for public auctions depending on the end-use of the lamps.

Technology	Street/roadway	Parking lot	Pedestrian walkway
Mercury Vapour			
Metal Halide			
High Pressure Sodium			
Compact Fluorescent Lamp (CFL)			
Linear Fluorescent Lamp (LFL)			
Incandescent			
LED			

Dimming practices for street lighting

Dimming practices are considered one of the most effective energy efficient actions in street lighting. The dimming of the luminaires' output during the hours of less activity in the night help reduce the energy consumed while ensuring the supply of the service. If already present in the municipality, the information required is as follows:

Parameter	Value
Percentage (%) of lamps dimmed	
Hours per year dimmed	
Percentage reduction (%) of light output when dimmed	

Running costs and maintenance

An understanding of the running of street lighting is required, i.e. if it is managed by the municipality or through a contracted company.

A. If the maintenance is done by the municipality:

Parameter	Value
Average number of fixtures replaced (or % if known) per year:	
Average cost of man labour (USD/hour):	
Average cost of equipment* (USD/hour):	

* Equipment costs include the leasing of the truck to lift the personnel, fuel costs, costs derived from security of roads and signals.

B. If the maintenance is done by an external company:

Parameter	Value
Average number of fixtures replaced (or % if known) per year:	
Charges (USD/year):	

3.1.1.2. Water supply systems

A desk audit is required to create a sound baseline for energy consumption and water production that will allow an analysis of the potential savings of specific actions in both areas. The audit will enable a detailed revision of existing devices, system operation and maintenance. The information required to develop a rapid assessment of these systems are split by general information about the utility water production and energy consumption, a stock and technology categorization and efficiency status of the different devices in place.

Parameter	Value
Population served by the utility	
Water production and consumption	
Annual water volume produced (m^3/year)	
Annual water volume authorized consumption (m^3/year)	
Annual water volume billed (m^3/year)	
Energy consumption	
Annual electricity consumption (kWh/year)	
Annual electricity costs (USD/year)	
Electricity Price (in USD USD/kWh)*[1]	
Total utility costs (including non-energy related costs)	

The energy withdrawn from the grid and the electric installation:

Parameter	Value
Power factor of the electricity withdrawn from the grid	

Regarding electro-mechanical components:

Technology	Installed capacity	Stock of fixtures (Number)	Efficiency (%)
Transformer	(in kVA)		
Electric motor	(in kW)		
Pump	(in kW)		

Capacity control technologies/devices:

Technology	Units (numbers)	Range of capacities installed (kW)	Operating Load range variation (% loading)	Manual or feedback control
Variable Speed Drive (VSD)				
Fluid coupling (Scoop control)				

Existing billing mechanisms:

Method	Share of households (%)	Water price (USD/m^3)	Water consumption (m^3/person/year)
Metering			
Fixed tariff			
Authorized non-billed consumption			

Type of implemented maintenance[37]:

Method	YES/NO?
Corrective maintenance (components are changed after failure)	
Preventive maintenance (components are changed before failure)	
Condition based maintenance (action on root causes based on performance warning w.r.t variation between components' estimated lifetime and normal lifetime.	
Predictive maintenance (action based on performance/output warnings before the component's designed hours of operation are reached)	

Also, any energy conservation measures adopted or implemented recently (last 5 years max) should be accounted for (activity, investment, energy saved, cost saved, etc.).

3.1.1.3. Public buildings

Municipalities play a special role in creating awareness of climate change, EE and conservation practices. As the closest cell of the political power to the people, their performance can be used as a lighthouse to influence the local population on such matters. The retrofit of existing public buildings can be done through the implementation of more efficient devices (efficient HVAC and auxiliary systems, lighting systems, electrical systems and drives, various appliances such as computers for offices, control systems, building Management Systems, etc.) by renovating parts of the building that have a direct impact on energy consumption (e.g. insulation materials, windows,

[37] Danfoss Drives, 2020. Webinar on "Conditioning montioring with intelligent drives" by Norbert Hanigovszki, 2020.

rooftops, doors, air curtains, landscaping) and/or by raising the awareness of workers in the use of the resources.

Most of the information that needs to be collected as part of the desk audit is available from the building's operational, maintenance and procurement personnel, in the equipment or appliance manufacturers' labels, architecture plans and/or monthly bills. The information pertaining to building characteristics, equipment and its auxiliary characteristics, energy consumption profile and so on are required as preliminary data to assess their status. A detailed questionnaire containing data to be collected is shared in Annex II. Questionnaire for Rapid Assessment for buildings.

3.3.2. How to analyse the data

Each of the three intervention areas indicated (street lighting, water supply systems and public buildings) requires a tailored analysis that takes into account the characteristics of each sector (e.g. standards and regulation). C2E2 has the required experience in assisting municipalities in the process of developing these analyses and bringing them into bundled projects. By working with developing countries to accelerate the scaling up of the implementation of EE improvement projects and programmes, C2E2 has a series of quantitative self-rapid assessment tools and examples. The methodologies' structures for these tools are based on international best practices, available technologies in the market and policy regulations. If the information required in "3.3. How to develop a rapid assessment?" is available, the C2E2 tools will assess and indicate the potential energy and financial savings as well as equivalent emissions reduction. Examples of similar projects developed with the assistance of C2E2 are available in the Knowledge Management System of the Centre's webpage[38].

Light-touch assessments are intended to analyse and point out potential savings with specific technical actions that are already mature without the need of allocating resources (financial, time, capacity). The tools are designed in such way that they can support both individual and bundled approaches. Apart from the technical opportunities that the tools can provide, there are administrative tasks that can reduce the financial constraints without improving or worsening the energy consumption level (e.g. re-negotiation of electric tariff scheme).

C2E2 can provide technical support on the use of in-house tools and for the transformation of the results into a project preparation to institutions from developing and emerging economies in:

- use of in-house light-touch assessment tools;
- identification of potential partners (capital seekers) to develop Project Bundling to acquire a better negotiation position and preparation of project proposals for investors, such as national and international organizations, with the aim of improving the liveability of cities;
- mitigating the effect of fossil fuel-based energy consumption by reducing related emissions;
- reducing primary energy consumption and increasing EE;
- reducing the financial constraints that hamper local development;
- positive impact of the investment (financial, environmental and social);
- analysing the sustainability risks that the project aims to mitigate by implementing more efficient and sustainable solutions. Better risk control and compliance standards would avoid:
    - damage of property and/or equipment, assets, supply chain of energy-efficient equipment,
    - results of changes in policies, liability, market preferences or technologies to move away from non-sustainable and non-environmentally friendly solutions, which would otherwise would affect the value of the assets.

BOX 3.1 Street lighting EE – The case of Latin America and Canada

Various relevant projects carried out in Latin America in the recent past provide an idea of the costs and energy reduction potential of these actions. All of those projects, where the replacement of 50,000 to 200,000 old luminaires (normally High-Pressure Sodium lamps) was undertaken, have demonstrated economic feasibility.

In Canada and the U.S, the results of eight full-scale LED conversion projects presented energy savings of 30 to 65 per cent, with only 2 projects below 60 per cent. Because higher energy savings and lower maintenance costs than expected were achieved, the projects reduced their payback period from the expected 3 years. In some cases, as in the city of Hamilton, Canada, a payback period of 1.25 years was achieved for the replacement of all of its 10,000 luminaires.

[38] Copenhagen Centre on Energy Efficiency (C2E2). Knowledge Management System (KMS), https://c2e2.unepdtu.org/kms/.

BOX 3.2. Water supply EE – The case of Jordan

Several potential projects aim to reduce the energy consumption of the water supply sector at a municipal level. In Madaba, Jordan, the savings potential of replacing and retrofitting the pumping system was reducing annual electricity consumption by 35 to 50 per cent, thus reducing GHG emissions by 1,000 tons of CO2-eq per year. In this case, water extraction entailed 71 per cent of the water utility's electric energy consumption.

BOX 3.3. Public buildings EE- The case of Brazil

In Brazil, within the National Electricity Conservation Programme (PROCEL), the PROCEL Seal programme was launched. This involved, among other activities, EE programmes targeted at buildings and municipal energy engagement actions, which resulted in 6.16 billion kWh of energy savings in 2010 alone. This and other programmes caused a reduction of Brazil's energy intensity by 2 per cent in the period between 2001 and 2010.

3.4. Conclusions

A deep technical analysis gives an initial picture to stakeholders on the available EE potential for respective technical options and suitable solutions in the process of identifying and implementing EE measures. There is significant EE potential to be tapped into, and the successful stories on EE implementation measures give stakeholders enough confidence on the functionality of the technical analysis process. Identifying EE measures are case specific. However, developing rapid assessments with the help of self-assessment tools or an expert should form the primary step in the process. Eventually, the accuracy of the outcomes of technical analysis trickles down to relevant and successful EE bundling business and financial models, which are discussed in subsequent modules, to implement EE measures aggregated on larger scale.

3.5. Further reading

NYSERDA, 2002. "How-to Guide to Effective Energy-Efficient Street Lighting: For Planners and Engineers." New York State Energy Research and Development Authority (NYSERDA), October 2002. Available at http://www.rpi.edu/dept/lrc/nystreet/how-to-planners.pdf.

Prado-Lorenzo, J.M. and Sanchez, I.M.G., 2007. "Efficiency Evaluation in Municipal Services: an application to the street lighting service in Spain." Journal of Productivity Analysis Vol. 27 No. 3 (June 2007): 149-162.

UNECE, 2017. Overcoming Barriers to investing in Energy Efficiency. http://www.unece.org/fileadmin/DAM/energy/se/pdfs/geee/pub/Overcoming_barriers-energy_efficiency-FINAL.pdf

MODULE 4

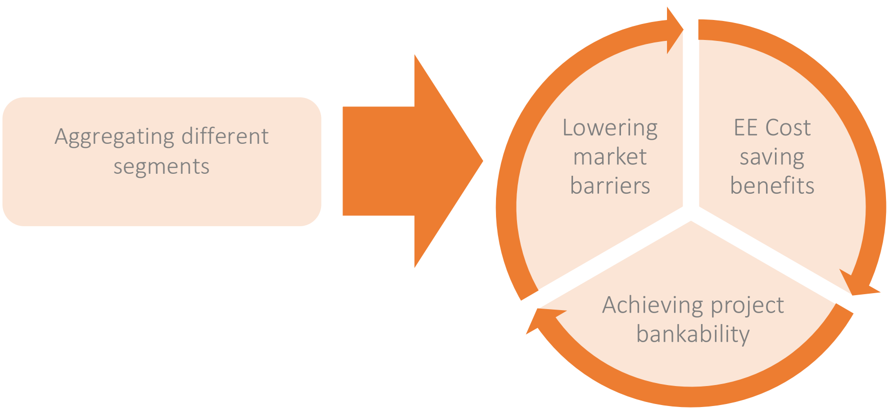
Business models for energy efficiency Project Bundling for municipalities

Business models for energy efficiency Project Bundling for municipalities

Jorge Hinojosa Garza

As explained in previous modules, the concept of Project Bundling brings a new perspective to energy efficiency (EE) by achieving greater performance through the aggregation of different municipalities or large stakeholders as part of the same holistic solution. As shown in Figure 4.1, the bundling process allows projects to navigate through the cycle of lower market barriers, cost-saving benefits and project bankability. This means that several actors can seek financing together and create common business models to unlock larger investments. Through this aggregation, EE technologies that are difficult to replicate and have high upfront costs can be financed through a single framework, which is especially useful for municipalities. This module focuses on emerging business models for the public sector and provides the reader with examples and an analysis that helps different municipalities to expand their scope.

Figure 4.1 EE bundling main goals



4.1. Energy efficiency bundling business models

The concept of Project Bundling brings a new perspective to EE by achieving greater efficiency through the aggregation of different municipalities as part of the same holistic solution[39]. This means that several actors can seek financing together and create common business models to unlock larger investments. One of the primary reasons for this is the use of economies of scale, which directly helps reduce the transaction cost of the projects. Given that projects are bundled into a single investment portfolio, financing becomes less risky for potential lenders[40]. In this sense, municipalities can use a single procurement process for bundled facilities to access more convenient financial leverage and cost-effective business models (See Module 4. Business models for energy efficiency Project Bundling for municipalities).

The need for EE projects to be more financially attractive gives bundling an innovative opportunity to make the case for financing packages that involve public and private actors[41]. Since municipalities have started using different modalities for public buildings, water services and street lighting, it is crucial to discuss the main business models that have been proven to create these comprehensive packages.

4.1.1. ESCO business model

Energy Service Companies (ESCOs) provide EE upgrades through energy savings, retrofitting, risk management and energy infrastructure outsourcing. The goal of ESCOs is to guarantee EE under a

[39] ESMAP. 2013. Financing Municipal Energy Efficiency Investments: Global Experiences and Lessons Learned. Washington, D.C.
[40] Kerstetter, M., 2012. Bundling Solutions for Financing Building Energy Efficiency Retrofit Projects in Residential and Commercial Buildings. Columbia Law School, New York.
[41] Cleary, K. and Palmer, K., 2019. Energy-as-a-Service: A Business Model for Expanding Deployment of Low-Carbon Technologies. Resources for Future, Washington, D.C.

performance-based contract. This means that customers can make repayments for the upgrades as they achieve energy savings. ESCOs, as developers, take care of the project's financing and operational settings, guaranteeing savings at a lower cost. The model allows public buildings to pursue EE upgrades while ESCOs provide the financing and assume the risk. As the building saves energy month by month, customers repay debt and service costs.

ESCOs allow public building and facilities owners to opt for large capital investment EE upgrades without bearing technical and market risks, lowering financial barriers. These features are tied to performance guarantees, given by the ESCO. The advantage of using performance-based contracts is that governments can bundle projects that are outsourced and ESCOS will monitor and verify energy savings and performance of the buildings or facilities[42].

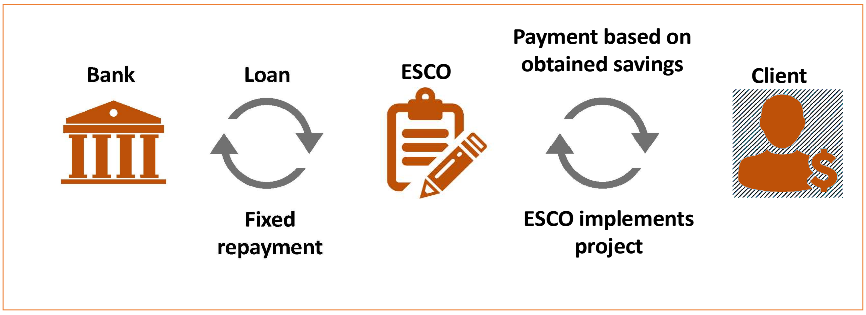
Energy performance contracting (EPC) is a contracting model that allows ESCOs to become service providers and contractors of EE bundling projects. Under EPCs, the main point is to offer building owners or sponsors guaranteed performance and energy savings through a contract with an ESCO. This means that the project is expected to guarantee energy savings that will help the ESCO repay the project investment costs. This contract also allows the end user to borrow money, guaranteed by the ESCO, which assumes the performance risk[43].

Under a **shared savings EPC model**, the ESCO takes care of the financing instruments with financial institutions, which the ESCO uses to finance the client. The savings are used by the client to pay the ESCO, who will finally repay the loan to the bank. One of the main advantages of this EPC model is that while energy savings are being achieved, the ESCO receives performance-based income for the project to operate (see Figure 4.2).

In some cases, ESCOs operate similar to banks, in that they can extend the credit to building owners, which is useful for leveraging EE bundling projects. In the figure below, the case of a simple shared savings EPC model depicts the ESCO as an EE investment financing mechanism, which is used for project aggregation, lowering the risk and capital costs. Therefore, the shared savings model implies that the ESCO assumes both the technical and credit risk.

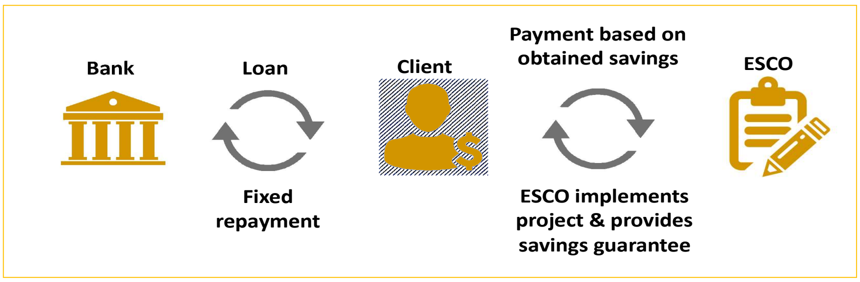
Under the **guaranteed savings model,** shown in the figure below, the purpose of the ESCO is to guarantee savings on the end user's energy bill. In this case, the ESCO assumes technical risks, but the client obtains financing from equity or debt to pay the contractual fees to the ESCO and the financial institution (see Figure 4.3).

Figure 4.2 EPC shared savings model



Source: IEA, 2018

Figure 4.3 EPC guaranteed savings model



Source: IEA, 2018

[42] ESMAP, 2013. Financing Municipal Energy Efficiency Investments: Global Experiences and Lessons Learned. Washington, D.C.
[43] IEA, 2018. Energy Service Companies (ESCOs), IEA, Paris. Available at: https://www.iea.org/reports/energy-service-companies-escos-2

For the EPC guaranteed savings model to work properly, it is crucial that the building owner or client arranges an adequate financing source for the EE upgrade, since the ESCO only guarantees technical performance parameters, but it does not cover any sharing of a payment structuring scheme.

4.1.2. Super ESCO business model

The Super ESCO is an entity that the government creates to function as an ESCO for the public sector specifically. As described in "Module 2. Project Bundling: introduction and steps", the main point of its creation is to unlock project financing potential via project aggregation[44]. Given the numerous barriers traditional ESCOs present when it comes to project implementation and external financing, Super ESCOs use international and local public funds to drive EE programmes in public facilities.

Large-scale implementation and diverse leasing schemes with the public sector are the main strengths Super ESCOs have recently used in EE projects, such as in the cases of Belgium and Croatia, where federal governments created these entities to boost EPC and green leasing for municipalities. In practice, the use of Super ESCOs has evolved into the parent entity of traditional ESCOs, by financing them in an aggregated manner, so that financing access becomes easier and project financing schemes have more leverage to grow.

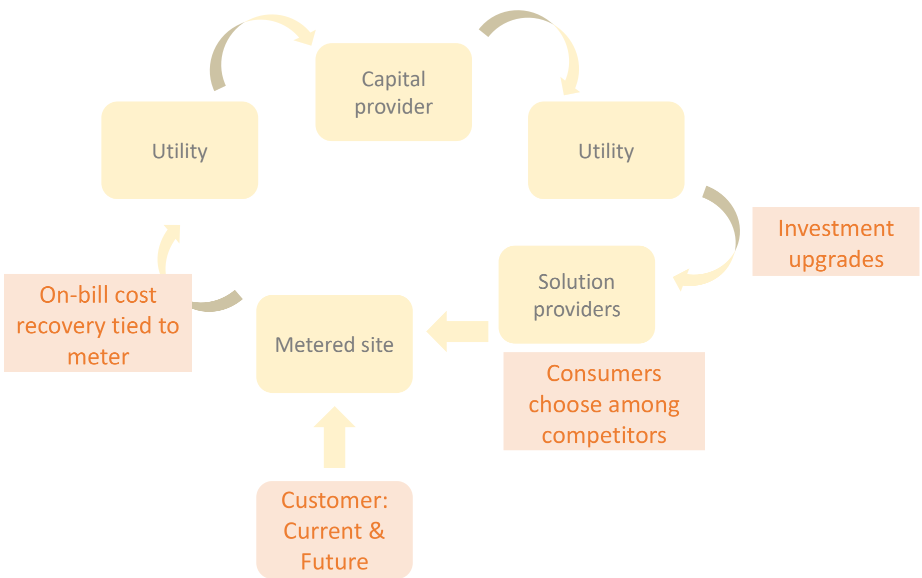
In this sense, Super ESCOs assess, train and finance traditional ESCOs, which continues into a monitoring process, with the purpose of preparing and standardizing the market. The bundling capacity and external financing potential of super ESCOs has led municipalities to design large contracts with these entities for the financing cycle to fully use public incentives and opt for larger EE portfolios.

4.1.3. Pay as you save model

When consumers do not have financial resources to give upfront payments or opt for debt, pay as you save (PAYS) allows them to access cost-effective EE upgrades, as they pay for a tariff through their electricity bills. This modality removes high debt and cost barriers while monthly energy savings are directly tied to the long-term sustainability of this business model. For low-income consumers and remote access residential areas, PAYS has been proven to improve EE step by step without the need for creditworthiness (see Figure 4.4).

In cooperative schemes and municipalities, not having a debt obligation results in an attractive scheme where customers make a joint effort to ensure they will offset tariffs through their bill energy savings. Since PAYS financing relies on an adequate metre and the completion of the occupancy periods of the buildings under contract, consumers increasingly participate as part of bundling projects to lower these uncertainties. In low income areas, publicly owned buildings are increasingly using the advantage of the PAYS model through the on-bill tariff system, which allows them to access resource efficient measures without debt obligation. Moreover, these customers do not need to worry about up-front payments, which means numerous bundling opportunities in developing markets.

Figure 4.4 PAYS financing model



Source: Energy Efficiency Institute, 2011[47]

[44] IEA, 2018. Energy Service Companies (ESCOs), IEA, Paris. Available at: https://www.iea.org/reports/energy-service-companies-escos-2

4.2 Comparison of energy efficiency bundling business models

Comparing these business models allows us to widen the perspective of EE solutions that support building owners and municipalities via smarter financing schemes that enable larger and longer-term projects. For instance, ESCOs facilitate the work to building owners by the energy companies taking over the financing and energy services, thus guaranteeing savings and refinancing schemes. Nevertheless, some property owners need faster access to cash or constant technology upgrades that become capital-intensive. Since the cash flow of EE projects mostly comes from cost savings and not company sales, business models address multi-annual energy improvements and innovative technologies to make projects bankable.

Given the diversity of financial barriers, public-private partnerships (PPPs) enhance the use of these bundling business models, such as the case of lease agreements where equipment is constantly upgraded without necessarily becoming an expensive asset for owners. In the case of ESCOs, guarantees are very helpful for investment cases where small municipalities or actors want to bundle up EE schemes without sufficient knowledge and capacities.

More importantly, partnerships between project owners and companies that allow the use of economies of scale improve competition and transaction costs without the limited access to the financing they had before. In terms of financial support, the government plays a fundamental role via fiscal incentives that combine with bundling business models to detonate these technologies.

4.2.1. Barriers

One of the main points of using bundling business models for EE is to bring transaction costs down and standardize retrofit packages for owners and actors to access simpler EE cost-efficient measures. Nevertheless, certain barriers are inherent to each one of the business models described previously, since they are exposed to diverse financial, technical and behavioural risks, depending on the market and scheme of operation[45]. First, it is essential to analyse the barriers to EE business models, regardless of bundling or aggregated approaches, for a better understanding of this activity. Table 4.1 shows the most typical and relevant barriers to EE business models in municipalities and urban developments.

EE business models in municipalities are exposed to several barriers that need to be tackled through adequate regulatory frameworks and policy incentives that foster the development of more innovative business models, depending on the specific case of each municipality. As the figure above shows, market and financial barriers are a burden for municipalities, since EE investments are risky and highly exposed to market prices, as well as regulatory decisions that might represent more barriers than benefits to the projects.

Moreover, the lack of capacities in municipalities represent one of the most challenging barriers to EE business models, since there is a need to start from scratch in several regions of the developing world. This means that without the right regulatory, pricing and financial signs, EE projects remain a luxury for many municipalities that have limited time and funds.

This is why this module makes the case for EE bundling business models and bulk procurement, where municipalities tackle the barriers through project aggregation, while using business models that widen the spectrum of financing possibilities for innovative EE projects that offer significant energy cost savings, competitive purchasing prices and adequate funding availability. As discussed, lowering the investment risk of EE projects through bundling business models has shown positive results for medium- or long-term

Table 4.1 Key barriers to EE business models in municipalities

Main barriers		
Market	**Financial**	**Technical**
Market organization and price distortion	Limited borrowing capacity	Limited municipal capacities
High transaction costs	Limited creditworthiness	Limited familiarity with EE technologies
Energy prices below costs of supply	High up-front costs	Lack of affordable EE technologies for specific local conditions
Uncertain regulatory framework	Perception of high risk and high transaction costs	Lack of capacity to maintain EE investments
	Perception of high risk and high transaction costs	

Sources: ESMAP, 2017; IEA, 2018

[45] Kerstetter, M., 2012. Bundling Solutions for Financing Building Energy Efficiency Retrofit Projects in Residential and Commercial Buildings. Columbia Law School, New York.

investments where technology upgrades are essential to making the on-bill payments as users save energy.

Nevertheless, bundling business models also have barriers, which are described in Table 4.2 below.

Table 4.2 Barriers per EE bundling business model

Main barriers per bundling business model		
Traditional ESCO model	Super ESCO model	Pay as you Save (PAYS)
Lack of EE knowledge of potential clients	Limited to government availability	Limited familiarity with EE technologies
Unpredictable energy saving benefits for certain projects	Need for large group of projects to aggregate	Lack of access to information
Limited financing access for remote and low-income municipalities	Financing access depends on incentives and policies	Lack of affordable EE technologies for specific local conditions

Source: Own elaboration

Comparing EE bundling business models allows us to identify the main barriers for each of them, depending on the perspective of the investors or municipalities. As aggregating projects involves long-term commitments to a chosen business model, it is crucial that these barriers are considered before pursuing with the investment. For instance, if the end user is a municipality that aggregates with other municipalities for EE upgrades, the adequate business model will be very different from bundling of a few buildings in a commercial district of a city. The municipalities might find EE performance contracts and PAYS business models feasible and adequate, others might depend on Super ESCO modalities, given their financial constraints and risk perceptions. Using the risk-return curve for each project and considering these innovative business models are essential for opportunities – such as PPPs, financial cooperatives, horizontal multi-projects, among other initiatives – that help stakeholders obtain their desired energy savings and environmental benefits without bearing more costs. This brings us to analyse the main opportunities of EE bundling business models.

4.2.2. Opportunities

EE bundling business models represent opportunities for municipalities, since the combination of innovative financing mechanisms and aggregated investments allow stronger cooperation schemes that lead to higher economic benefits for the bundle. In the case of buildings, there are diverse possibilities of integration of innovative technologies for heating, cooling, lighting, devices and other EE upgrades.

For instance, municipal financial guarantees can leverage, from multilateral financial institutions, instruments to incentivize EPC contracts as bundled projects that simplify the cost-effectiveness for building owners. In some cases, the EE measures involve replacing lighting, upgrading to more-efficient water heaters or installing more efficient water systems for buildings. Through PAYS business models, these expensive installations can become more feasible by bundling as horizontal multi-projects in various municipalities at the same time. Therefore, costs and risks are shared and financed in a cooperative scheme by building owners, reaching more EE targets and environmental benefits in a shorter time. With regard to public lighting, there are increasingly efficient opportunities for cities through the use of LED technologies, which have proven to save as much as 70 per cent of energy[46].

As the figure below shows, the ESCO model for public lighting provides innovative interventions for investors and energy service companies with municipalities, which is increasingly translated into aggregated projects, such as the case of Brazil. This is also crucial to understand for the Super ESCO business model, which unlocks the potential of ESCOs in municipalities that do not have access to funds (see Figure 4.5).

The case of EE bundling for water and wastewater utilities also offers numerous opportunities, especially in developing markets, where there are still large gaps in financing and policies that address the problem at a municipality level. It has been found that there are several challenges from the water source to water treatment, distribution and re-use within the whole process, due to weak governance and infrastructure in every single step of the chain[47]. Therefore, implementing lower cost, stable financial return projects is crucial for water EE measures to be better put in place. One of the latest approaches is the water and sanitation EE pilot that led Mexico to obtain national financing for its water utilities.

[46] ESMAP, 2017. Lighting Brazilian Cities: Business Models for Energy Efficient Public Street Lighting. Washington, D.C.
[47] ESMAP, 2012. A Primer on Energy Efficiency for Municipal Water and Wastewater Utilities. Washington, D.C.

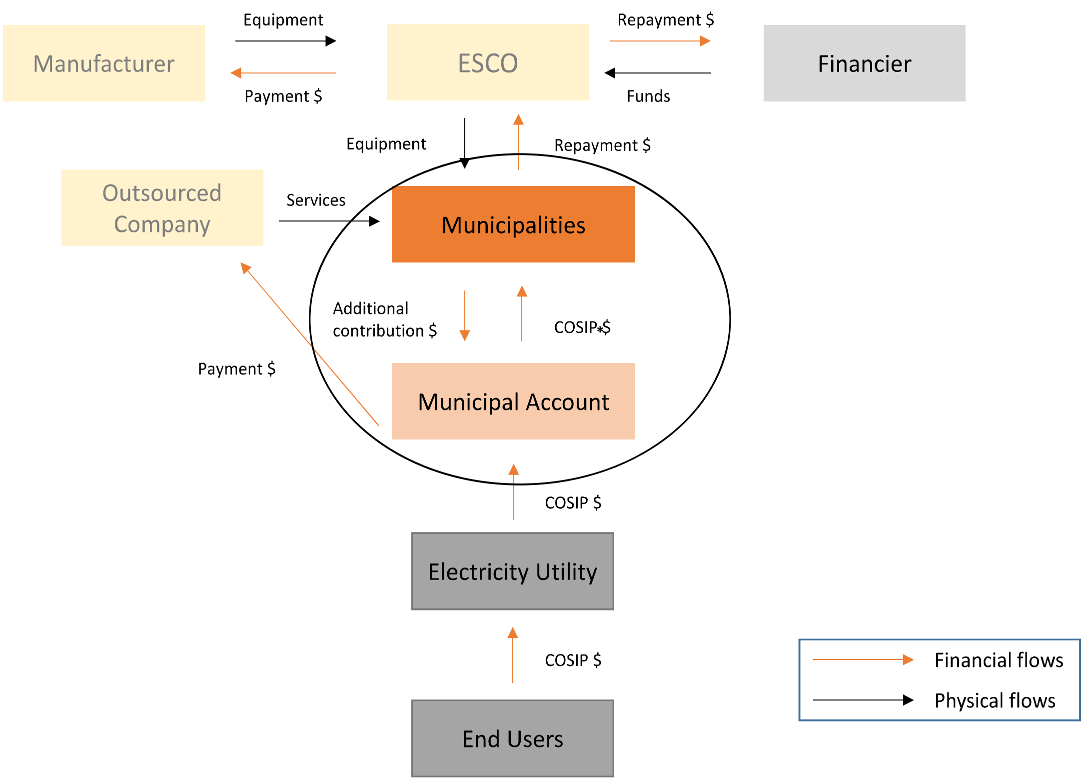
Through this programme, households could access EE improvements that included electricity savings from water, commercial efficiency and physical efficiency, which is being monitored by the government.

BOX 4.1. Public lighting EE – The case of Brazil

In the case of Brazil, given the lack of financial and debt capacities of municipalities, the solution was to aggregate municipalities as a consortium that managed the financing process via an SPV. Using the ESCO model, municipalities could upgrade their lighting and make the repayments, counting on a technical performance guarantee. Financiers were able to provide capital expenditure at a competitive rate for the consortium and the ESCO took care of the management process, as well as the operation and maintenance.

This has led 13 Brazilian cities to use the business model as "payment for the use of the asset", making the replacement of lighting more cost-efficient without bearing risks municipalities were not ready to undertake. The constant evolution of this model into a public-private partnership that delimits the tasks each of the players are bound to deliver has led to rapid public LED lighting modernization in several Brazilian cities. Nevertheless, without sound policies in place and limited municipal capacities, the implementation of such bundling projects remains a challenge in other cities (ESMAP, 2017).

Figure 4.5 Example structure of the ESCO model for public lighting.



Source: ESMAP, 2017 [48]

*COSIP means street lighting charge on consumers bill.

[48] ESMAP, 2017. Lighting Brazilian Cities: Business Models for Energy Efficient Public Street Lighting. Washington, D.C.

4.3 Existing business models for public building deep renovation

The evolution of sustainable business models has brought innovative solutions in Europe, making use of public-private partnerships and stakeholder networks in different ways, depending on the type of buildings or facilities. Based on a preliminary analysis of the renovation market, it was found that several EE upgrade access barriers are tied to the lack of stakeholder integration and the design of business models that are not necessarily the most adequate to each user.

As Figure 4.6 shows, the interrelation of ESCOs and different stakeholders goes beyond traditional financing schemes, since there are numerous opportunities on the building renovation end. These emerging sustainable ideas have been proven in European cities, widening the scope of collaboration between public authorities, installers, investors, contractors, homeowners and other actors that are crucial to EE innovations.

4.3.1. One-stop-shop model

These business models use networks, clusters, PPPs and innovative technologies to solve EE issues in buildings via a holistic approach. They integrate the building owner and define optimal measures and interventions for the renovation project, focused on multi-family buildings, especially social housing. Many of these projects use modern digital technologies for energy-saving measures to be applied in smart manners, depending on the solution that is more adequate to each building. For instance, one-stop-shops are being used by PPPs via EPCs to allow renovations to focus on EE solutions, according to the most updated efficiency standards.

Since these business models are technology-intensive, most of them are financed upfront through green bonds, over periods of around 15 to 20 years. These mechanisms allow disposable income and capital for family EE businesses to operate without budget restrictions.

4.3.2. Innovative financing schemes

As described before in this module, innovative financing schemes are linked to business models, such as on-bill financing, PAYS, energy savings obligations and other solutions that include crowdfunding and home-based financing. This means that participatory investments that promote greener spaces and renovations are gaining momentum in many public-private interventions. For instance, refurbishing packages have brought large multi-property buildings, such as the case of Laguna de Duero, in Spain.

Figure 4.6 Mapping of key stakeholders in the building renovation ecosystem

Source: EU Horizon 2020[49]

[49] EU Horizon 2020, 2020. Sustainable Business Models for the Deep Renovation of Buildings. Stunning, European Union.

In this intervention, the renovation was carried out by a private company and its subcontractor, which was linked to a loan with Triodos Bank. The private company was refunded through a long-term contract with the owners community and the district heating connection was financed by a sustainable long-term scheme.

4.3.3. New revenue models

The innovation of renovation schemes has widened to new revenue models that combine elements of climate policies and in-house value-added business model ideas, such as profiting from rent increases, feed-in schemes of remuneration, green building label certificates and others. For instance, feed-in schemes allow the energy producer to receive payments per unit of renewable energy produced, which is similar to climate policies. Nevertheless, in this case, these schemes result in long-term income sources, which cover financial gaps for the building, combining with other support mechanisms. The case of green building label certificates has evolved into guarantees of building performance that allow premium prices for the certified property to be agreed on a later stage, according to green standards.

4.4. Conclusions

This module provides municipalities and public sector officers a wide perspective on business models for energy efficiency. As bundling diverse projects via innovative financing schemes represents numerous opportunities for public projects, the purpose of this discussion is to identify the main features of each alternative, depending on the user's needs and financial constraints.

The evolution of sustainable business models for EE has been increasingly leading buildings and municipalities to incorporate aggregated projects with the purpose of saving costs and energy. This analysis gives the reader an opportunity to visualize the main barriers and opportunities of these innovative business models with the objective of providing sufficient practical information for new bundling opportunities to emerge.

The leap from traditional ESCO business models to more recent innovative financing schemes, such as public building deep renovation interventions, is bringing the sustainability community together, with circularity and efficiency in mind, to create a more resilient paradigm. There are still practical challenges to be proven in developing countries, considering diverse socio-economic realities and financing access opportunities.

4.5. Further reading

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Energy Efficiency Institute, 2011. *Pay as You Save.* https://eeivt.com/wordpress/pays/

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Kerstetter, M., 2012. *Bundling Solutions for Financing Building Energy Efficiency Retrofit Projects in Residential and Commercial Buildings.* Columbia Law School, New York.

Limaye, D. and Limaye, E., 2011. *Scaling up energy efficiency: the case for a Super ESCO.*

MODULE 5

Financing energy efficiency Project Bundles for municipalities

Financing energy efficiency Project Bundles for municipalities

Xianli Zhu

Adequate financing solutions are key to deliver the multiple benefits from EE Project Bundles. This module focuses on how to address barriers to financing the EE Project Bundles developed in the previous modules. Like other investment projects, many municipal EE Project Bundles face the issue of high upfront costs, while the revenue from the investment, in the form of energy savings, occurs in small flows during the operation period.

The funding options include using the municipalities' own budget, grants from national or state level governments and international donors (including climate finance mechanisms), public-private partnerships or commercial sources, and off balance sheet finance. Except for a municipality's funding and grants, which can be used for social purposes, any other external funding will require a minimum rate of return from the project, and a low technical and financial risk. The minimum rate of return can vary from country to country, depending on the project type, the borrowers' creditworthiness, project risk levels and the maturity of the loans.

This section describes each type of financing source, including how they work, their advantages and disadvantages, and some concrete examples. It outlines some factors municipalities should consider when choosing between different funding options. It includes a section on long-term institutional and financial arrangement and actions needed to ensure continuous municipal EE project funding and implementation. Finally, it provides a list of existing tools that can support the decision-making on the financing of municipal EE Project Bundles.

5.1 Municipal energy efficiency Project Bundle financing – preconditions and options

5.1.1 Preconditions for successful financing

The economic returns of municipal EE Project Bundles come from the energy bill savings. To be able to attract external financing, especially from commercial sources, a Project Bundle needs to be economically viable, with a stable flow of revenue and profits during its life. Therefore, a few preconditions need to be met, including:

- *A municipality's payments for energy use need to be based on current consumption.* If billing is not consumption-based (as is the case with some district heating systems), energy savings from EE Project Bundles will not yield any cost savings and thereby make financing difficult or impossible.
- *Energy prices should reflect the real costs of energy*. Sometimes energy prices include subsidies and taxes. Heavily subsidized and low energy prices can reduce the profitability of municipal EE Project Bundles and make them less attractive to public facility owners and users, and financial institutions (Ravillard, et al., 2019)[50].
.
- *Stability of energy prices.* Energy price fluctuations directly affect revenue flow and project risks. High price instability, especially on price declines, can reduce investors' interest in EE Project Bundles. Price increases give EE projects more revenue and profits. Clear long-term government policies on future energy prices can reduce the risks of EE Project Bundles and motivate investment in them.
- *The municipal budgeting process must allow a municipality to retain the cost savings resulting from EE projects*. If the municipal budget is reduced when energy costs are lowered, the municipality is unable to repay the financing costs of the EE projects.

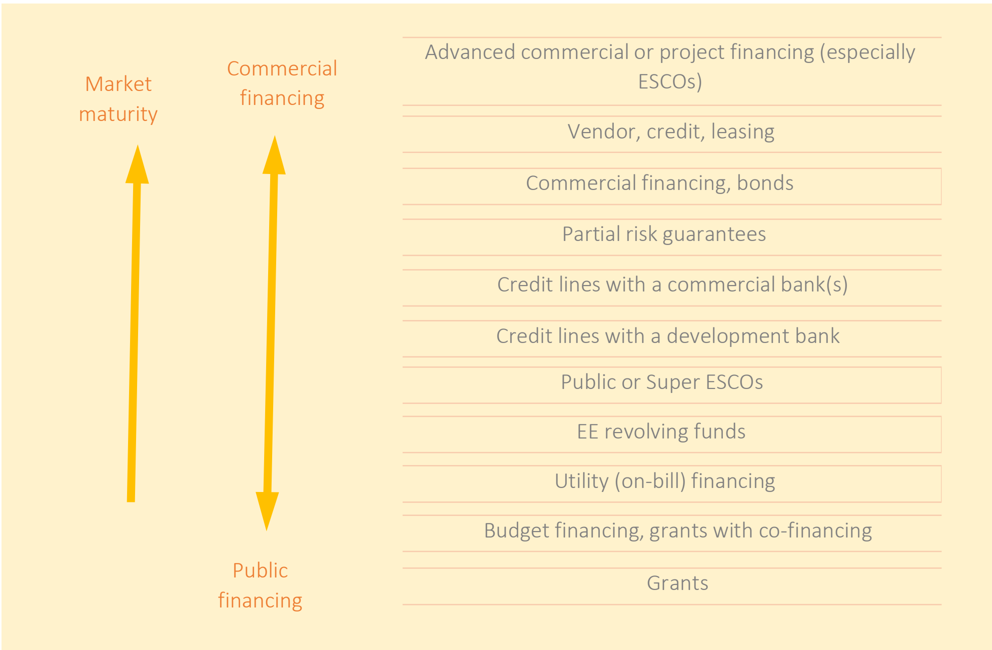
A municipality needs to have good baseline data on energy use and related service levels, such as hours and levels of indoor lighting, comfort levels for heating and cooling and adequate light levels for public lighting. Without such baseline information, it is challenging to measure the energy and cost savings from EE projects (see more on data analysis in "Module 3. Rapid assessment of energy efficiency projects for municipalities" and "Module 6. Assessing the performance and impacts of Project Bundles").

[50] Ravillard, P., Carvajal, F., Soto, D.L., Montuenga, J.E.C., Antonio, K.M., Ji, Y., Hallack, M., 2019. Towards Greater Energy Efficiency in Latin America and the Caribbean: Progress and Policies. Inter-American Development Bank

5.1.2 Financing options for energy efficiency projects

Below is the full spectrum of international funding options for EE projects. As can be seen in Figure 5.1, higher market maturity means more access to commercial credit. Generally, the funding sources can be divided into four major types: 1) municipalities' own funding and budget, and grants from higher levels of government or international donors; 2) external credits, such as loans from banks and financial institutions and municipal bonds; 3) private investment in the form of public-private partnerships; 4) off-balance sheet options, i.e. EE retrofitting projects are financed by private investors, especially ESCOs or leasing companies – in such a situation municipalities keep paying the same energy bills for a certain period of time to the ESCOs or leasing companies. Private businesses and commercial banks fund municipal EE Project Bundles because of profit opportunities. Often a Project Bundle's financing is a combination of different funding sources. Apart from some minimum economic returns from the projects, private investors and commercial banks often require effective risk control measures, such as a certain proportion of funding from project owners, guarantees or collaterals. Like other infrastructure construction projects, municipal EE Project Bundles can also be funded through public-private partnerships.

Figure 5.1 Financing EE- A ladder of options



Source: Lukas, 2018 [51]

[51] Lukas, A., 2018. Financing Energy Efficiency, Part 1: Revolving Funds. Live Wire- A Knowledge Note Series for the Energy & Extractives Global Practice (2018/88). The World Bank Group

5.1.3 Factors influencing the availability of financing mechanisms in different municipalities

Municipalities in different countries and regions can face very different situations when it comes to the available options for funding municipal EE bundles, which can be influenced by multiple factors (see Figure 5.2).

Figure 5.2 Main factors influencing the availability of different financing models

Main factors influencing the availability of financing models

- A municipality's financial strength and creditworthiness
- Predictability of revenues and budget transfers
- Local legal and regulatory framework
- Commercial financing environment
- Nature of the EE Project Bundles
- Local implementation capacity
- Availability of different delivery mechanisms

Most of these factors are influenced by the size of a municipality, with large municipalities facing different challenges to smaller ones[52]. In terms of Project Bundles, the same type of EE actions, such as street lighting and water supply, can be big enough for one or more Project Bundles in a big municipality. Smaller municipalities, due to the smaller volume of EE potential among the same technology or the same type of public facilities, may have to either aggregate actions with greater diversity in the same bundle or be part of a bundle covering multiple municipalities.

5.2 Municipal budget funding and grants

The first situation is that municipalities have enough funding for implementing the EE Project Bundles, either through their own savings or budget funding, through grants from national or regional funding, or from international development agencies.

In such a situation, they can choose between hiring a general energy service provider company – which carries out the product procurement, installation and construction – or hiring several companies for different parts of the activity, such as detailed energy auditing and designing of the project, procurement, and installation. Hiring a general contractor can reduce the workload and technical expertise requirements from the municipalities. However, the overall contract payments may be higher and the municipality loses control of specific aspects of project implementation. During the EE project implementation, municipalities' procurement process must not be limited to selecting the least-cost supplier and allow for certain types of agreements such as Energy Saving Performance Contracts (ESPCs).

5.3 Off balance sheet funding solutions

If municipalities cannot obtain credit, they may need to consider financing models that do not accrue municipal debt and, therefore, do not count against their borrowing capacity (e.g. vendor finance or ESCO project financing).

As EE projects need energy audit and technical capacity, even when municipalities use their own funding or borrow money from banks to finance their EE projects, they normally still need to contract an external technical team to carry out the retrofitting. Such professional services can be provided by ESCOs or other technical companies. The fees can be paid in the form of a pre-negotiated fixed amount, with the ESCO guaranteeing a certain level of energy saving, or in the form of a certain share of the saving. In "Module 4. Business models for energy efficiency Project Bundling for municipalities", there are more details on the engagement of product suppliers, ESCOs, auditors, architects and other service providers in implementing municipal EE Project Bundles.

There are two preconditions for an energy performance contract to work. First, the statutes allow municipalities to retain their original budget for utility costs even though future utility bills will be reduced as a result of the installed energy and water

[52] Novikova, A., Stamo, I., Stelmakh, K., 2017. Guideline on Finding a Suitable Financing Model for Public Lighting Investment.

conservation measures[53]. Second, the public agencies and institutions are ready to share the energy, water consumption data.

5.3.1 ESCOs

ESCOs are energy service companies, which often provide both technical services and finance for EE projects. As ESCOs specialize in EE investments, they are in a better position of risk control, therefore can provide upfront investment for EE projects and recover the investment plus some profits through energy saving and energy cost reduction of the projects. For municipalities, the great advantage of using ESCOs to finance their EE Project Bundles is that there is no need to raise funds for their EE projects, while upon the end of the contract with the ESCOs, municipalities can enjoy continuous energy-saving benefits from the projects, better services for the users and increases in the public building or infrastructure's market value. Please refer to "Module 4. Business models for energy efficiency Project Bundling for municipalities" for further information on ESCOs.

5.3.2 On-bill financing

On-bill financing (OBF), also known as on-bill repayment, refers to a type of loan that can be used to invest in improving the EE of a building. The loan is paid back over time through additional charges on the building's utility bill. This mechanism encourages building occupants and owners to invest in EE measures, which can decrease energy consumption and utility bills[54]. OBF can help municipalities solve the upfront costs of EE retrofits, while the costs are repaid through an additional charge on their energy bills. The advantage of OBF is that customers do not need to fund the EE retrofitting costs. At the same time, due to long-term services and monopoly in the market, utility companies know the customers' performance in terms of energy bill payment and have both the past energy bill information and more leverage to avoid a default of payment by the borrowers. The disadvantage is that OBF also needs an initial public funding injection and most existing programmes try to keep bill neutrality and avoid an increase in the customers' energy bills. Utility companies, as ESCOs, tend to focus on lighting and energy using equipment with a large number of participants and a short payback period. OBF financing is popular in the US.

5.3.3 Vendors' credit

Another form of commercial credit is that offered by suppliers, which allows municipalities to pay for the products or equipment for EE Project Bundles in installments over an agreed duration. Such installment or credit sales can reduce the upfront fundraising needs by municipalities for their Project Bundles. Credit offered by vendors or suppliers is often quicker to get than loans.

5.3.4 Green leasing

Green leasing – also known as energy-aligned, energy-efficient or high-performance leasing – is the practice of realigning the financial incentives of sustainability or energy measures in lease documents. Realigning cost structures through a green lease allows both building owners and tenants to save money, conserve resources and ensure the efficient operation of buildings[55]. A green lease is mainly applied in commercial buildings. In most municipalities, the government agencies and public institutions use public buildings; in some cases, municipal governments and public institutions also rent buildings from a private company or the government body that manages public buildings. In such cases, green leasing can be a way to finance EE projects. One example is the city of Cleveland in the US, which uses green leasing to support city building EE improvement[56].

Green leasing can also be used to finance EE equipment for municipal street lighting, public buildings, water supply systems or other municipal EE Project Bundles.

5.4 Commercial credit and development credit

To access commercial credit for funding, a municipality needs to consider the following preconditions. In case these preconditions are not all met, the municipalities need to consider other funding options.

1) Local commercial banks or financial institutions (lenders) are interested and willing to finance municipal EE projects and have the funds and financial products for municipal EE financing.

2) A municipality needs to be considered creditworthy by commercial lenders, or they can get credit backing or a guarantee from the national or regional government.

3) In many countries, national governments impose borrowing limits on municipalities. A municipality needs to have sufficient borrowing capacity under such a limit to take on additional loans.

4) In addition to a good credit rating and sufficient borrowing capacity, a municipality may need to have collateral that is acceptable to commercial lenders.

[53] DBEDT, 2016. Hawaii State Guide to Energy Performance Contracting (EPC), 2016 Revision. Department of Business, Economic Development, and Tourism (DBEDT), Hawaii.
[54] Zhang, S., 2013. On-bill financing: encouraging energy efficiency. Center for Climate and Energy Solutions.
[55] Feierman, A., 2015. What's in a Green Lease? Measuring the Potential Impact of Green Leases in the US Office Sector. Institute for Market Transformation (IMT).
[56] IMT, 2019. Green Lease Leaders: Spurring Efficiency in Cleveland Businesses and City Buildings. Market Transformation (IMT).

Sometimes multilateral development banks or national development banks or funds also provide low-interest loans or special credit lines for EE projects. Development banks are funded by governments and target support for economic growth. Hence, they often offer loans at lower interest rates and longer maturity.

5.4.1 Getting a project to bankability

The definition of bankability is that the project is robust enough from a revenue and risk perspective to attract finance under the terms of an EPC contract[57]. Although financing is the last, and the key, step between project development and project implementation, bankability is an issue to a large degree determined in project opportunity identification through economic assessment and the selection of business models. The technical and economic assessment is expected to seek Project Bundles with relatively short payback periods, an internal return rate higher than the market interest rate, and low technical, economic and political risks. Such Project Bundles proposals are of high bankability. They are likely to attract the attention of banks and other financial institutions and raise the necessary funding.

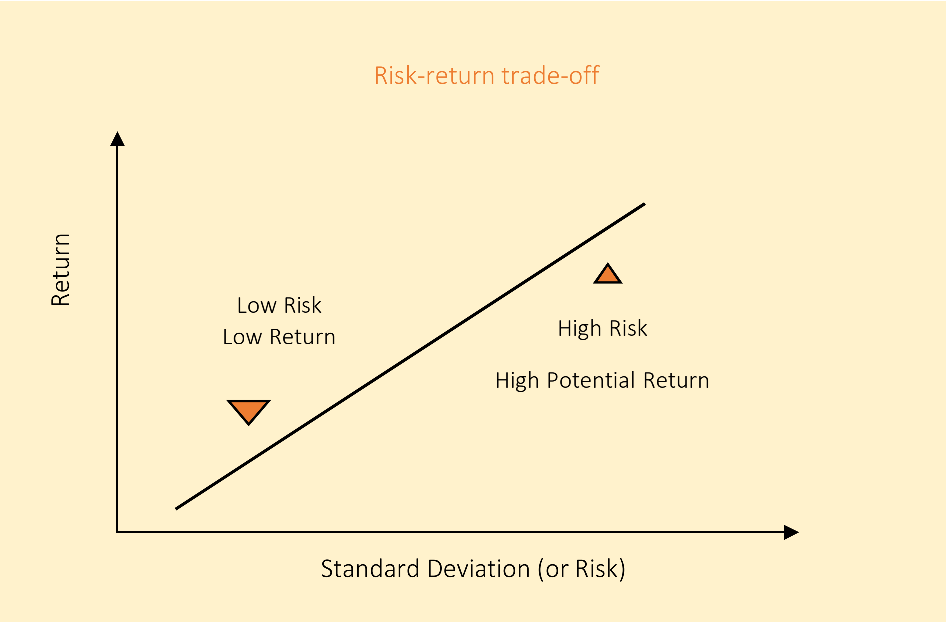
5.4.2. Risk management

As EE improvements are intangible, many EE projects are perceived as complex and granular. In turn, projects struggle with an unfavourable ratio between perceived project revenue and transaction cost. Project Bundling can address the issue of small scale and high transaction costs; they cannot address the problem of perceived financial risks, and sometimes bundling itself appears linked to many difficulties and elevated complexity.

EE projects are "brain-driven", i.e. a considerable share of the project value does not relate to the value of the invested assets, but rather on the know-how behind the optimal application of the assets. The cash flow of EE projects comes from cost savings instead of product sales; the risks are more closely linked to the operation and use of public facilities and occupants' behaviours. Hence, they are often considered higher-risk.

Higher risk is associated with a greater probability of higher return, and lower risk with a greater probability of smaller return. This is called the risk-return trade-off. This means that projects with higher risks often have to offer higher returns to attract external financing (see Figure 5.3).

Figure 5.3 Illustration of the risk-return trade-off



[57] Milne, C., 2019. Bankability Assessment of the new EPC, Deliverable D4.5.

From the perspective of financial institutions, two elements are of utmost relevance in assessing the economic returns and risks of EE projects. Commercial loans can be offered based on the municipalities' own creditworthiness or the EE bundle's bankability. In risk assessment, banks and financial institutions consider the risks related to the project's successful implementation, delivery of the expected energy savings, realization of the expected energy cost-saving and timely repayment of the loans and interests[58]. Table 5.1 and Table 5.2 are the risks of EE projects. Non-quantifiable risks are those that cannot be directly reflected in the project's economic feasibility assessment, while quantifiable risks directly affect the results of economic feasibility assessment.

Table 5.1 Non-quantifiable EE retrofit risks

Risk factor	Risk Type	Description
Product Lifetime	Technology	The uncertain lifespan of installed products; depreciation and sustainable performance; future product replacements.
EE Product Failures	Technology	Failures of products throughout their installation lifetime.
Facility data limitations	Technology	Lack of data to assess facility performance/consumption accuracy.
Technology mismatch	Technology	Installations of sub-optimal products due to lack of technological know-how or the unavailability of resources.
Maintenance control	Technology	The inability of providers to monitor the maintenance of the installed upgrade project and regulate actions for optimal use.
Unproven Technologies/Products	Technology	Lack of information and track record of product performance life cycles.
Negative Utility	Technology	Product maintenance requirements might be very time-consuming and therefore have a higher associated non-monetary cost.
Extreme weather conditions	Physical	Floods, changes in weather.
Product Use	Behavioural	Assumptions on typical use might not be accurate as users might use the retrofitted product sub- optimally.
Rebound Effect	Behavioural	Greater incentive to consume more energy and be less sparing with consumption behaviour given the notion of saving measure instalments.

Source: Stevens et al., 2017 [59]

Table 5.2 Quantifiable EE retrofit risks

Risk factor	Risk Type	Description
Inaccurate Assumptions	Valuation Risk	Inaccurate methods and assumptions to model savings from upgrade projects.
Whole life energy considerations	Valuation Risk	Consideration of time (whole life of energy savings/product lifespan etc. to model investment returns).
Vacancy	Occupancy Risk	Assumed versus the actual vacancy rate, which increases risk over longer periods. Occupancy is not guaranteed to remain stable over long periods.
Fuel Cost/ Energy Price Fluctuation	Energy Price	Unforeseen changes in the cost of fuel within countries.
Tariff Structures	Valuation Risk	Unforeseen changes in the assumed tariff structures, for example from fixed tariff to time-based tariffs.
Required Return	Valuation Risk	EE upgrades producing less than the expected return.
Accuracy of consumption baselines	Valuation Risk	Inadequate estimated volumetric consumption baseline for modelling guaranteed savings.
Interest Rate Fluctuation	Valuation Risk	Unforeseen changes in the interest rate incorporated within the valuation.

Source: Stevens et al., 2017

[58] IEA, 2014. Energy Efficiency Financial Institutions Group 2017, Bleyl et al. 2017
[59] Stevens, D., Brounen, D., de Coo, W., Adan, H., Fuerst, F., 2017. Risks and Uncertainties Associated with Residential Energy Efficiency Investments. Conference Paper.

If some risks with high occurrence probability and high impacts on the project's economic performance are identified, the project owners need to plan effective risk management measures. The risks for commercial banks can also be reduced through collateral or guarantees for the loans.

Apart from directly borrowing money from commercial banks, big municipalities may be able to issue bonds and use the funding raised to finance their EE Project Bundles, which is another form of loans (called debt securities) that investors provide to issuing municipalities.

When the funding is loans or credits from international sources, especially in foreign currency, country risks are an important factor affecting a municipalities' access to international finance. Country risk is a broader concept that encompasses both the potentially adverse effects of a country's political environment and its economic and financial environment. Like other risks, it can also be managed with guarantees and insurance.

5.5 Mechanisms for financing and implementation of energy efficiency Project Bundles

5.5.1 Using Public-private partnership (PPP) to leverage private investment

The public sector can develop policy and regulatory instruments to overcome the barriers and facilitate the scaling-up of investments in EE projects, but project development and commercial financing are necessary to sustain the scaling up of EE investments. PPPs are mechanisms that use public policies, regulations or financing to leverage private-sector financing for EE projects. The IEA identified three top PPP approaches for EE finance. These are dedicated credit lines, risk-sharing facilities and energy-saving performance contracts[60].

These PPP approaches are not only relevant for mobilizing private finance for EE projects from all sectors, including the municipal public sector. Other practices of funding municipal EE projects include establishing dedicated credit lines targeted at public sector EE (as indicated in Table 5.3 above), so that the municipal EE projects can access low-interest loans from the credit lines, to overcome the funding barriers and realize the various social, economic and environmental benefits that the EE actions can bring about. Dedicated credit lines can streamline the procedures and building capacity of a team that is able to evaluate municipal EE project proposals.

Another solution is offering risk guarantees, either directly by the municipal government or by development banks. These can help reduce the risks of municipal EE projects and help attract loans from commercial banks. In this sense, risk-sharing allows the actors involved in the bundle to make their investments safer. Climate and multilateral funds offer risk guarantees and help build capacities to diminish the present barriers. There are also examples of insurance products for energy performance contracts, but they are more available for developed countries.

Table 5.3 PPP mechanisms in the IEA EE policy pathway

Type of PPP	Brief description	PPP features			
		Agreement between public and private entities	Allocation of risk between partners	Mobilization of private sector financing	Payment to private sector for providing services
Dedicated credit lines	Mechanism under which governments or donors provide low-interest loans to LFIs to encourage them to offer sub-loans to implementers of EE projects	Loan agreement between partners	Project financing risk shared between partners	Private partner generally provides co-financing	Local financial institutions earn fee by on-lending funds at higher interest
Risk-sharing facilities	Mechanism where governments or multilateral banks offer guaranteed product to absorb some EE project risks and encourage involvement of LFIs in EE financing by reducing their risk	Guarantee Facility Agreement (GFA)	Public partner absorbs some financial risk	Risk reduction mobilizes additional private-sector financing	LFI earns interest on additional loans mobilised
Energy-saving performance contracts (ESPCs)	ESCO enters into term agreement with public agency to provide services, with payments contingent on demonstrated performance	Energy Services Agreement (ESA)	Performance risk generally borne by ESCO	ESCOs mobilize private-sector financing	Performance-based payment to ESCO

Source: IEA, 2011

[60] IEA, 2011. Joint Public-Private Approaches for Energy Efficiency Finance- Policies to scale-up private sector investment. The IEA Policy Pathway series.

5.5.2 Institutional capacity-building – Public Super-ESCO and Revolving Fund

EE Project Bundle coordination and financing requires technical expertise and trust between the technical team carrying out the retrofitting, maintenance, and operation, and the users of the municipal facilities in such aspects as data access and collection. To maintain continuous EE improvement, ensure resource availability and accumulate expertise and experience in project development and risk control, one effective solution is creating specific funding mechanisms, such as a Super ESCO, revolving fund, development credit line or risk guarantee.

Super ESCOs are governmental entities created to serve the public sector, develop the capacity of private ESCOs and facilitate project financing[61].

With government backing in terms of funding, credit and market demand, public ESCOs can be dominant in the local ESCO market and become super ESCOs. Public ESCOs can be an effective solution for combining technical expertise and public funding to overcome the technical and financial barriers to municipality EE Project Bundles. In recent years, Super ESCOs have been established in India, Saudi Arabia, Armenia, the US, Belgium and the UAE. Typically, the government capitalizes a Super ESCO with sufficient funds to undertake public sector EE projects and to leverage private sector/ commercial financing. The Super ESCO then has a dual role of supporting the capacity development and project development activities of existing private sector ESCOs and helping to create new ESCOs[62].

Revolving Fund. Another approach is setting up a revolving fund to support public sector EE improvement. The government provides the starting capital to the Revolving Fund (RF), which then provides investments in municipal EE projects and recovers its investment through energy saving. In this way, a pipeline of municipal EE projects can be developed, funded and implemented.

Box 5.1. Example of Super ESCO – EESL India[63]

Energy Service Limited (EESL) is a joint venture of four National Public Sector Enterprises – NTPC Limited, PFC, REC and POWERGRID – and was set up under the Indian Ministry of Power in 2009. It is the largest super ESCO in the world. It has distributed 360 million LED bulbs and implemented India's Affordable LEDs for All (UJALA) programme, by distributing LED bulbs, and the Street Lighting National Programme (SLNP), by retrofitting streetlights with LEDs. Today, UJALA is the world's largest domestic lighting project and SLNP is the world's largest streetlight replacement programme.

Under the Buildings Energy Efficiency Programme (BEEP), EESL has completed projects in 10,344 buildings including railway stations and airports. Other areas it has been active include replacing inefficient water pumps with efficient ones, promoting electric cars and public procurement of air conditioners.

EESL is the world's largest energy service company (ESCO) that is driving numerous initiatives considered potential game-changers in building a conducive ecosystem for energy-efficient technologies across geographies. EESL implements EE retrofit projects under the Pay-As-You-Save (PAYS) ESCO. EESL has taken its market transformation business model to the UK, Middle East, South Asia and South-East Asia.

EESL's success in driving public energy efficiency implementation in India has attracted international support. In 2019, the Asian Development Bank (ADB) approved a loan of USD 250 million as part of an assistance package to EESL to expand energy efficiency investments in India.

[61] IEA, 2019. Energy Service Companies (ESCOs)- At the heart of innovative financing models for efficiency.
[62] Sarkar, A., Moin, S., 2018. Transforming Energy Efficiency Markets in Developing Countries: The Emerging Possibilities of Super ESCOs. The World Bank Group. Available at: http://documents.worldbank.org/curated/en/536121536259648570/pdf/129781-BRI-PUBLIC-VC-ADD-SERIES-6-9-2018-12-9-31-LWLJfinalOKR.pdf
[63] ADB, 2019. ADB Provides $250 Million to Expand Energy Efficiency Investments in India. News Release, 27 November 2019. Available at: https://pib.gov.in/newsite/PrintRelease.aspx?relid=199549; https://www.adb.org/news/adb-provides-250-million-expand-energy-efficiency-investments-india

Box 5.2. The City of Pittsburgh's Green Initiatives Trust Fund[64]

The City of Pittsburgh's Green Initiatives Trust Fund provides a continuous and secure source of funding from energy-saving measures, which is used to finance future energy-efficiency projects within the city, such as energy audits, aggregated energy purchases, renewable energy generation, efficiency upgrades at city-owned facilities and other green initiatives in the Pittsburgh Climate Action Plan. The city focuses on projects with a payback period of less than half of the operational life expectancy of the equipment or measure. The fund has helped energy projects to be evaluated and approved more quickly through the decision-making bodies of the municipality. Established in 2008, the fund was initially seeded with USD 100,000 and topped up with savings from aggregated energy purchases and energy savings each year. From 2008 to 2012, the fund financed solar thermal installations, a solar photovoltaic installation, installation of 4,000 LED streetlights, and retrofits to various city facilities, including the City-County building, totalling USD 2.45 million.

Box 5.3. Best practice example of revolving fund – Canada's Green Municipal Fund (GMF)[65 66]

The GMF started in 2000 and was created by the Canadian federal government to provide upfront multi-year funding. GMF is a revolving fund administered by the Federation of Canadian Municipalities (FCM). The GMF supports grants, loans and loan guarantees to encourage investment in EE and other environmental municipal projects. By 2016, the fund has received CAD 675 million of funding from the federal government. GMF can provide grant and low-interest loans. Grants of up to 50 per cent of eligible costs are available for plans, studies and field tests, to a maximum of CAD 175,000. Low-interest loans of up to 80 per cent of eligible costs are available for capital projects, to a maximum of CAD 5 million or CAD 10 million for high-ranking projects, typically combined with a grant amount for 15 per cent of the loan, to a maximum of CAD 750,000 or CAD 1.5 million for high-ranking projects.

5.5.3. Education and capacity-building

Three conditions need to be met for EE investment and transactions to take place: marketing and technical assessment, financing and incentives for all market participants[67]. To speed up municipal EE project implementation at scale, it is important to build the capacity of market players, including qualified energy managers and auditors, professionals for data collection and project design, retrofitting, equipment replacement and repair and maintenance.

Energy audits play an important role in investment decision-making for municipal EE Project Bundles. They offer insights into how the energy is used, and solutions for EE improvement, their costs and payback periods. Two types of energy audit are involved in different stages of the project identification and decision-making: preliminary and detailed. A preliminary energy audit involves an analysis of utility billing information, building equipment and operating data and sometimes a visit to the building or facilities in order to identify EE measures and energy-saving opportunities. The detailed audit consists of a site walkover to identify the energy profile of a building or facility by completing surveys, and analysis of energy conservation measures and energy-saving opportunities. An investment-grade detailed audit involves analysis of capital-intensive improvements and required rigorous engineering analysis. They can sometimes take several months to complete and deliver. They normally require more dedicated input from on-site staff and are usually the outcome of less detailed energy audit recommendations.

[64] ICLEI Canada, 2018. On the money: Financing tools for local climate action. Partners for Climate Protection. Available at: https://fcm.ca/sites/default/files/documents/resources/guide/financing-tools-local-climate-action-pcp.pdf
[65] Government of Canada, 2018.Up-front Multi-year funding – Green Municipal Fund. Available at: https://www.nrcan.gc.ca/plans-performance-reports/dpr/2017-2018/21503
[66] The G20 Energy Efficiency Finance Task Group, 2017. G20 Energy Efficiency Investment Toolkit.
[67] World Bank, 2008. Fi<nancing energy efficiency : lessons from Brazil, China, India, and beyond

Evaluating the energy saving from municipal EE Project Bundles involves comparing EE performance before and after the retrofitting measures, which can be influenced by multiple factors beyond the control of ESCO companies, such as activities or behaviour change of the users, energy price changes or even weather fluctuations. Hence it is important to systematically collect data to establish EE benchmarks and clear rules on risk and benefit sharing in energy performance contracts, to avoid contract disputes and keep all participants in EE projects motivated through continuous engagement.

5.6. Designing the right financing solutions for each municipal Project Bundle

Municipalities sometimes face some restrictions in using municipal funding for municipal EE Project Bundles, due to an inadequate revenue base, restrictions on their revenue-raising and borrowing powers, and restrictions on municipal funding use. Municipalities may also find it difficult to access financial credit due to the requirements for collateral and recourse, the difficulty of assessing the creditworthiness of different public institutions and EE retrofitting projects lack of hard cash flows.

Based on their observations from hundreds of municipalities, the World Bank concluded that the main financing options for cities retrofitting municipal buildings are:

- their own budget funds,
- public finance provided by national or regional governments,
- finance provided by international organizations, such as the World Bank or Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ),
- dedicated EE funds,
- commercial financing from banks and private investors, including by issuing local government bonds.

Cities need to conduct or commission analyses to determine the financial vehicles available to them, and the suitability of these options. Large municipalities face different sets of challenges to smaller municipalities and will often need different solutions. The suitability of different financing mechanisms depends, among other factors, on:

- the municipality’s creditworthiness,
- The predictability of revenues,
- Local legal and regulatory frameworks,
- Implementation capacity.

Different types of municipal EE Project Bundling vary in technology complexity and financial returns. Table 5.4 offers a simple assessment of the characteristics and financing options of three types of municipal EE projects: public building retrofits, public lighting, and municipal utilities.

- Public building retrofits. This includes installing insulation, efficient windows,

Box 5.4. Financing of Municipal EE projects - the US practices[68]

In the US, municipalities, universities, schools and hospitals are known together as the 'MUSH' market. In the United States, MUSH EE projects mainly rely on self-funding – the total energy cost saving should at least be able to cover the overall costs of implementing the project. Financial institutions engage directly with the end-user to provide the loans, while the ESCOs are responsible for designing the EE retrofitting projects, installing the equipment and providing the ongoing operation and maintenance services, and taking the performance risks. Private-sector FI engagement in the energy services business is predominantly driven by federal, state or local regulations, which set out the way energy services are financed, including the allocation of risk.

[68] Wilson Sonsini Goodrich & Rosati, 2012., Innovations and opportunities in Energy Efficiency finance. MAY 2012, Second Edition. Prepared by Kim, C., O’Connor, R., Bodden, K., Hochman, S., Liang, W., Pauker, S., Zimmermann, S.

efficient boilers and chillers, and energy management systems.

- Public lighting. This includes replacing mercury vapour and high-pressure sodium lamps with LED lamps, and installing lighting controls. Municipal utilities. This includes reducing losses in district heating and water supply systems, installing efficient pumps and optimizing systems. Depending on the existing conditions of the equipment, paybacks for the replacement of energy-using equipment are often shorter than system-wide renovation. For example, in India, the payment period of replacing inefficient chillers and pumps with efficient ones is usually less than three years or max five years.

Generally speaking, three basic types of delivery mechanism for EE investment projects have been popular in recent years: (i) loan financing schemes and partial loan guarantee schemes; (ii) ESCOs; and (iii) utility demand-side management programmes.

Table 5.4 Illustrative Municipal EE Projects and Related Financing Options

		Project Characteristics Potential				Potential Financing Options for Municipalities
Type of Measure	Examples	Technical Complexity	Investment Needs	Paybacks	Weak Credit, Limited Borrowing Capacity	Strong Credit, Ample Borrowing Capacity
Building Retrofit	Insulation, Efficient Chillers/ Boilers, EMS	Medium	Medium to High	Long	Budget Financing, EE Funds	Budget Financing, EE Funds, Public Support, Commercial Financing
Public Lighting	LED Lamps, Lighting Controls	Low to Medium	Medium to High	Medium		
Utilities	Loss Reduction, Efficient Pumps, System Optimization	Medium to High	Medium to High	Long		

Source: ESMAP, 2014[69] (Note: Indicative Payback Periods: Short (<3 years), Medium (3-6 years), Long (>6 years)

EE measures can be limited to the energy-using equipment and appliances, or cover comprehensive building or system renovation. EE measures that only involve the replacement of inefficient lighting, appliances and equipment with efficient ones can be implemented using budgetary resources and through public procurement. However, when municipal EE Project Bundles cover the comprehensive retrofitting of buildings, street lighting systems or utilities, the enormous investment needed, and longer payback periods, may make it necessary to seek external financing. This is where multilateral development banks, climate funds and development programmes have huge potential, since project financing mechanisms still need capacity-building for later secure operation in developing markets.

Both financiers and end-users must decide to what extent technical assessment work should be outsourced (Table 5.5).

[69] ESMAP, 2014. Financing Municipal Energy Efficiency Projects- Energy Efficient Cities, MAYORAL GUIDANCE NOTE #2

Table 5.5 Decision tree for municipal EE project financing

Situation		Issues/ challenges	Action	Financing mechanism
Does the municipality have sufficient resources to fund the project itself?	Yes	Allocation of funds from the budget	Prepare grant application	General budget financing
No Are grants available from donors?	Yes	Grants may not finance entire project	Prepare grant application	Partial budget financing and partial grant
No Are funds available from national government?	Yes	Funds may only provide partial financing	Apply for national funds	Budget capture
No Is there an EE fund?	Yes	Eligibility criteria for the EE fund	Apply to the EE fund	EE fund
No Are commercial banks willing to offer dedicated credit lines and/or risk-sharing programmes?	Yes	Creditworthiness, collaterals, and borrowing capacity of the municipality	Review eligibility for these mechanisms	Dedicated credit lines or risk guarantee programmes
Is the municipality creditworthy and has borrowing capacity?	Yes	Criteria used by commercial banks to assess creditworthiness	Access credit lines or risk-sharing programmes	Dedicated credit lines or risk guarantee programmes
No options available for financing				
No Are there active ESCOs in the local market?	Yes	Developing EPC	Negotiate EPC with ESCOs	Commercial financing with ESCOs
No Are leasing or vendor financing programmes available?	Yes	Eligibility criteria and terms of financing programmes	Negotiate leasing or vendor financing agreement	Leasing or vendor finance
No Does the municipality have the capacity to issue municipal bonds?	Yes	The market for such bonds, transaction costs	Develop municipal bond programme	Municipal bonds

Source: ESMAP, 2014.

EE measures for efficient indoor lighting and appliances, due to their low cost and short paybacks, may be implemented by municipalities using budgetary resources and through public procurement. However, often such efficient indoor lighting and appliance measures are combined with building retrofit options in a single project. Such bundling may reduce transaction costs and facilitate the implementation of some of the longer payback building envelope and equipment options. However, it may require external financing due to the larger investment needs.

5.7. Conclusions

Municipalities have multiple options to finance their EE Project Bundles. They can use their budget fund and grants from governments at higher levels and international donors, get loans from development banks, as well as resort to innovative off-balance sheet financing mechanisms such as ESCOs, in-bill financing, vendor credit and green leasing. To be able to get commercial loans and private investment, the Project Bundles' risks need to be low while their financial returns need to be above similar projects. Bundling can create EE projects with financing needs above the thresholds of financial institutions and overcome the barrier of high transaction costs for financial institutions. Through Project Bundling, municipal governments can build up their institutional capacity for EE project identification, development and implementation, hence reducing the risks for financial intuitions and private investors. Each municipality has its own specific situation in terms of financing options, and EE Project Bundles can be different in terms of profitability, risk and financing needs. Each municipality needs to evaluate its own Project Bundles and tailor the financing solutions accordingly.

5.8. Further reading

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ESMAP, 2013. Financing Municipal Energy Efficiency Investments: Global Experiences and Lessons Learned (background report). Washington, DC: Energy Sector Management Assistance Program.

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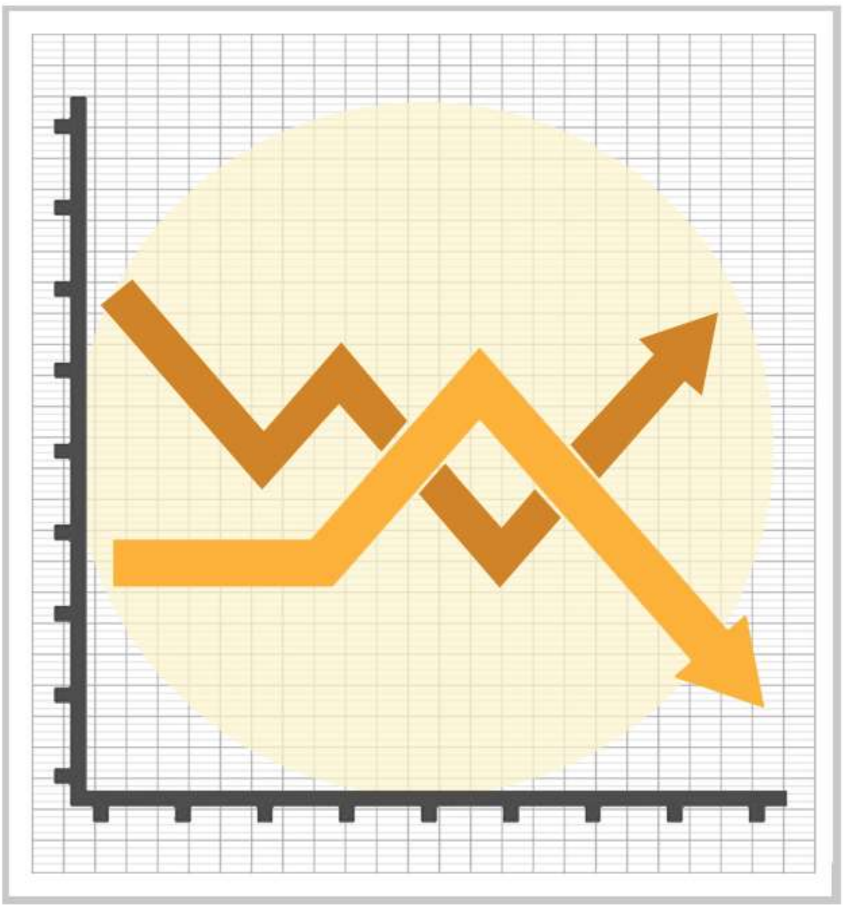
World Bank, 2010. Implementation Completion and Results Report on a Grant from the Global Environment Facility Trust Fund in the Amount of USD 10 million to the Republic of Bulgaria for an Energy Efficiency Project. Washington, DC: The World Bank.

MODULE 6

Assessing the performance and impacts of Project Bundles



Assessing the performance and impacts of Project Bundles

Fernando Farias

6.1. MRV frameworks and tracking of information

Measurement, Reporting and Verification (MRV) systems comprise, briefly, a *Measurement* component that refers to the collection of information to monitor the progress of the implementation and impacts associated with a mitigation action; a *Reporting* component, upon delivery of the measured information in a defined and transparent manner to the corresponding authorities; and a *Verification* component, the evaluation of the information that is reported in terms of its completeness, consistency and reliability by a qualified third party. These systems serve to ensure, in a transparent way, that the results of the implementation of a GHG emissions mitigation actions are occurring and that their impacts are being properly quantified and reported. An MRV system can be part of a more integrated Monitoring system which then can be viewed as periodically measuring progress toward explicit short, intermediate and long-term results. It also can provide feedback on the progress made (or not) to decision-makers, who can use the information in various ways to improve the effectiveness of government policies (Bridging the gap, UNICEF, 2008)[70].

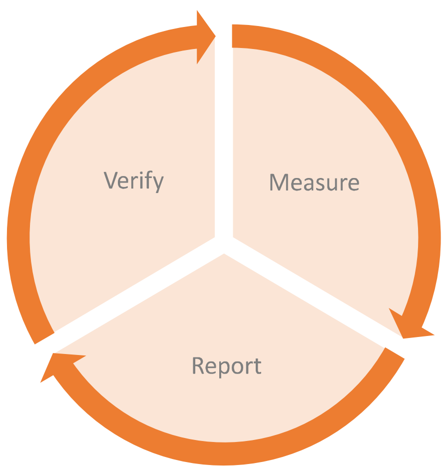
Therefore, the main objective of building MRV frameworks for these bundled EE projects proposed at city and municipal level would be to use a tool that monitors in a dedicated and accurate manner the impact generated by these projects and how they are advancing. This information can become crucial to gain the interest of financiers, attract financial support and contribute to further implementation of these projects. In this case, a solid MRV framework for bundling projects will generate transparency and build trust regarding the effectiveness of projects with regards to their results (e.g. GHG mitigation, SDG contribution).

In the context of bundled EE projects, apart from GHG reporting, MRV systems may provide additional benefits such as constant performance assessment for improving the operation and project performance, and enabling cross-project comparisons and supporting the municipalities' future investment/ procurement decision-making.

As a whole, the components of the MRV system must allow for an adequate monitoring of the bundled project, through a good characterization of its main features, and identify which are the important elements about the project that allow such characterization. In the case of bundled projects, special attention should be given to the internal interactions between the subprojects that make up the bundled project.

Usually, MRV systems are not considered at the beginning of the analysis or preparation of the projects, therefore the data needed to implement them afterwards becomes hard to gather on a regular basis. However, this can be addressed with the initial inclusion of the main MRV concepts at an early stages in the preparation of the projects. Overall, projects using this MRV module are expected to be assessed on a regular basis and improve over time. Once included, they can be assessed and eventually adjusted on a regular basis, allowing for a continuous improvement of the MRV system in relation to the project, as presented in Figure 6.1

Figure 6.1 Implementing MRV on a continuous basis



(Periodic reporting)

[70] UNICEF, 2008. Bridging the gap: The role of monitoring and evaluation in evidence-based policy making. Available at: shorturl.at/frHKN

6.2 The Measurement in the MRV system

In this type of project, an MRV System that serves to track the performance of the project must include an initial *Measurement* stage that, through the evaluation of indicators, can identify the impact (savings) due to the implementation of the project, mainly in terms of the mitigation of GHG emissions, its economic costs and other additional co-benefits. To do this, the identification of what must be measured, who will do this and how the measurements will be taken become crucial. A plan to perform the measurement stage is also needed.

Given the type of activities included in these bundled projects, the indicators are mainly related to projects occurring in the energy sector, in particular associated with energy consumption. In practical terms, a lower energy consumption when these projects are implemented will bring a lower generation of GHGs. For this reason, it is important to be able to appropriately measure energy consumption, which, through evaluation in the appropriate equations, will allow us to better determine the associated GHG emissions that will no longer be emitted. To expand information on the impact of the project to other areas, for example its financial impact or variables that allow the evaluation of some of the SDGs, they need to be included within the group of variables to be identified.

The quantitative (measurement) information to collect as part of the MRV system in these cases would comprise:

- Quantitative financial metrics (QFMs)
- Quantitative process metrics (QPMs)
- Quantitative technical metrics (QTMs)

The *QFMs* refers to those variables that allow the calculation of the financial impacts of the projects, as well as their adequate financing. Generally, through its evaluation, the effectiveness (cost-effectiveness) in the use of the funds associated with the projects can be determined.

The *QPMs* in turn, include the definition of activities that are procedural in nature. They can be identified in terms of actions completed, and their relationships with the expected or achieved goals of the project. QPM are used to keep track of the progress of the project through administrative practices following a Gantt chart or a milestone calendar with the main activities of the programme. They are primarily used to guarantee the efficacy of processes and programmes in conjunction with one or more additional metrics, and to demonstrate that a project is functionally operating as planned. Examples of quantitative process metrics include documenting and reporting on the creation of new institutions or working groups, meetings held or progress in educational programmes.

Finally, the *QTM*s correspond to the variables that allow the calculation of mainly the GHG emissions, to determine the mitigation potential associated with the projects. The project's GHG emissions can be estimated using methodologies that allow determining the GHG emission reduction values when such projects are implemented, in relation to the project's to business-as-usual (BAU). For EE assessment, activity data is also needed, in terms of the energy services created; for example, for public building insulation, the main benefits could be the indoor thermal comfort improved/remaining the same, occupants and use of the buildings, and market value of the buildings.

A summary of typical metrics for a project as part of an MRV system for EE Project Bundling is presented in Table 6.1. Benefits of the implementation of these projects include (1) energy savings; (2) energy cost savings; (3) GHG emission reduction; (4) increased property value; (5) other social/environmental benefits such as air quality and health, access to energy, education, and economic growth. Indeed, such factors are likely to be more pressing at the local scale (UNEP, 2014)[71].

Table 6.1 Examples of Metrics used in an MRV system for EE projects

Quantitative Financial metrics	Quantitative Process metrics	Quantitative Technical metrics
Loans given in a differential rate for EE projects vs expected	Number of efficient pieces of equipment installed in public sector vs. expected	kWh*/y saved in public buildings implemented and verified vs. expected
Public funds spent in energy audits vs number of energy audits completed.	Number of energy audits completed and documented by public sector	USD/y saved in public buildings implemented and verified vs expected
Public funds spent in retrofitting public buildings vs funds available for retrofit in public sector	Number of Energy Conservation Measures (ECM) proposed vs. ECM implemented effectively	GHG/y saved in public buildings through ECM implemented and verified vs. expected
Cost of retrofitting office building per square meter	Number of Certified Measurement & Verification Professionals in Country	Investment vs. GHG saved
		Baseline follow up

Source: adapted from OLADE, 2018[72]

[71] UNEP, 2014. Climate Finance for Cities and Buildings: A Handbook for Local Governments. Available at: https://www.uncclearn.org/sites/default/files/inventory/-climate_finance_for_cities_and_buildings-_a_handbook_for_local_governments-2014carbon_finance_for_cities_and_buildings_3.pdf

[72] OLADE, 2018. MRV Methodology For Energy Efficiency Implementation Measures In Commercial And Public Buildings For Countries Of The Caribbean Region. Available at: http://www.olade.org/publicaciones/mrv-methodology-for-energy-efficiency-implementation-measures-in-commercial-and-public-buildings-for-countries-of-the-caribbean-region/?lang=en

As a source of methodologies to estimate the GHG emission mitigation associated with projects, probably the most comprehensive reference is the CDM (Clean Development Mechanism) Methodology Booklet (UNFCCC, 2019)[73]. This includes over 100 typologies of projects that have been presented to obtain carbon emissions reductions (CER) under the CDM mechanism. If, in the case of the implementation of bundled projects, issuance of CERs is not expected, the proposed methodologies can still serve as a good technical basis for estimating GHG emission reductions associated with specific projects of a variety of typologies. These methodologies are technically robust, internationally known and proven in a variety of projects implemented around the world. They also bring the necessary instructions to develop and implement M&V plans. In spite of the advantages of using CDM methodologies presented here, at some point in the implementation of MRV frameworks, a more comprehensive approach should be considered, including on-site Energy Audits.

Prior to estimating the impact of the project, the accounting methodologies require the definition of a baseline or a baseline scenario. The baseline scenario is a reference case and hypothetical description of what would have most likely occurred in the absence of the project. It should describe the reasonable scenario with regards to anthropogenic emissions as well as sustainable development that would occur without the proposed project activity. There are three generic possibilities for the baseline scenario:

- Implementation of the same technologies or practices used in the project activity;
- Implementation of an alternative technology or practices;
- The continuation of current activities, technologies, or practices that, where relevant, provide the same type, quality, and quantity of product or service as the project activity. (UNEP-DTU C2E2 and the District Energy in Cities Initiative, 2019)[74].

For the three typologies of bundled projects considered in this Sourcebook, four CDM methodologies were selected. The associated baseline and measuring parameters indicated in these methodologies were classified and included in Table 6.2. See CDM methodologies in the CDM Methodology Booklet for more details.

a) AM0020: Baseline/Monitoring methodology for **water pumping** efficiency improvements

b) AMS-II.L: Demand-side activities for efficient outdoor and **street lighting** technologies

c.1) AM0091: Large-scale **EE** technologies and fuel switching in **new and existing buildings**

c.2) AMS-II.E: Small-scale **EE** and fuel switching measures for **buildings**.

Table 6.2 Characterization of bundled projects

Type of bundled projects	Features in energy terms	Baseline parameters	Measuring parameters
a) Delivery of water from a pumping system that has a lower energy demand due to reducing losses or leaks in the pumping system and/or by implementing measures to increase EE	Switch to more energy-efficient technology/measure	• Water volume supplied by the project in baseline period • Electrical energy required to deliver water within the boundaries of the system in baseline period • Grid emission factor	• Water volume supplied by the project • Electrical energy required to deliver water within the boundaries of the system • Pumping equipment and system efficiencies • Annual operating hours • Grid emission factor
b) Efficient lighting replaces less efficient lighting thus reducing electricity consumption and GHG emissions	Replacement of less-efficient lighting by more-efficient technology	• Annual operating hours baseline period • Average project equipment power baseline period • Number of project luminaires	• Annual operating hours • Average project equipment power • Number of project luminaires placed in service and operating under the project activity
c1) Energy efficient project building units result in lower emissions due to lower consumption of fuel, electricity and chilled/hot water	Electricity and/or fuel savings through EE improvement. Use of less carbon-intensive fuel.	• Historical average retail price of the fuel most commonly used in the baseline building units • Emission factors of fuel used in baseline buildings • Electricity and fuel bills	• Fuel consumption, quantity and energy content of hot/chilled water consumed and electricity consumption in project buildings • Total number of efficient appliances of each type used in registered CDM project(s) in the host country • Gross floor area of project buildings • Individual equipment/appliance design and operating conditions and efficiencies • Emission factors and calorific values of fuels
c2) EE and fuel switching measures for buildings. Use of more-efficient and/or less-carbon-intensive equipment in buildings.	Electricity and/or fuel savings through EE improvement. Optionally, use of less-carbon-intensive fuel	• Energy use of buildings before the project implementation • If grid electricity is consumed: grid emission factor	• Specifications of the equipment replaced or retrofitted • Energy use of buildings after the project implementation

Source: adapted from the CDM Methodology Booklet (2019), examples of parameters.

[73] UNFCCC, 2019. CDM Methodlogy Booklet.Available at: https://cdm.unfccc.int/methodologies/documentation/meth_booklet.pdf
[74] UNEP-DTU C2E2 and The District Energy in Cities Initiative, 2019. District Energy Projects: MRV Framework Guidance. Available at: http://www.districtenergyinitiative.org/sites/default/files/publications/guidance-des-mrv-frameworkfinal-11092019539.pdf

In each of these CDM methodologies, the general equation to calculate the savings reductions in greenhouse gas emissions associated with bundled projects (Equation 1) combines information on electrical parameters, with activity data and emission factors which as a whole allow to determine the GHG emissions associated with the implementation of the project.

Equation 1:

Where:

PEy: Project Emissions savings in year y (tCO_2eq)

ESy: Energy Saved by the project in year y (MWh)

GEFy: Grid Emission Factor in year y (tCO_2eq / MWh)

TLy: average technical losses in the grid in year y (%)

In the case of more efficient lighting projects, the lower annual electricity consumption of the most efficient lighting system is represented by ESy in Equation 2, whereby its calculation is presented in more detail in Annex IV.

In order to assess how GHG emission mitigation is progressing effectively in the project, the set of variables for monitoring the project can be determined through the equations and methodologies previously identified.

Considering that bundled projects can be built from information from different smaller-scale projects, it may be necessary to define an intermediate system that allows compiling and systematizing the information associated with the projects that make up the complete bundled project, in addition to the integrated system that comprises the set of projects.

6.3. Reporting in the MRV system

Reporting in the MRV system allows publicizing and disclosing in a standardized and periodic way, to different stakeholders, what the performance of the bundled project is in each year, by presenting the evaluation of indicators. If the performance of the project is not what was expected, the information stated in the report and its conclusions can be used to take corrective measures.

Depending on who receives the report, there may be different approaches to compiling and presenting the information to disclose. It could be that someone is more interested in the economic performance of the project rather than in GHG emissions, for example. In such a situation, it is possible to consider including more economic indicators in the report, or to carry out a more detailed analysis of the financial issues associated with the bundled project. An example, in this case, could be to identify the differences that may exist at the financial level between the different individual subprojects that make up the bundled project.

Additionally, the quality of the report (in terms of completeness and transparency) is of prime importance for a subsequent process of verifying the information presented as part of the bundled project.

Regarding the contents of a report of this type, the information it usually contains includes:

- A description of the organization of the information presented in the report, including sources and institutional arrangements used to obtain it, as well as legal frameworks that allow this information to be collected from its sources;
- A description of the technical approach used to obtain the information included in the report, which allowed the associated calculations to be performed;
- A description of how the quality of the information used in the report was verified, and if it was used to make calculations that allow the evaluation of some of the previously defined indicators.

6.4. Verification in the MRV system

Verification is generally performed at the national level and consists of external reviews of the information obtained by the implementation of the mitigation measure. It mainly comprises two elements:

- The participation of third parties to carry out this verification stage, such as external technical experts who were not involved in the generation of the data or the preparation of the report to be verified;
- The definition and application of verification provisions through the use of checklist-type revision procedures and cross-checking of data and information, in order to assess the degree of compliance.

Generally it is an authority (public institution) that is in charge of the global verification process, which for reasons of agility can be referred to a specialist verification process company (energy auditors with knowledge of MRV for example). Verification also serves as technical feedback between national and local officials.

Different from other families of projects, in the case of energy related projects, there is a range of available opportunities for performing Verification of high quality, mostly associated with the existence of experts with more formal competences and established systems at international level to conduct these verification processes, through Energy Audits and related third party accreditation processes.

6.5. Organization of information in the MRV system

Considering the importance of the data within an MRV system, when the variables that characterize the project are known, it is also important to have available not only the numerical value associated with these data, but also a scheme that allows the capture of this information periodically, to subsequently be reported and its validity verified.

It is also important to be clear about the origin of the data used for tracking the projects, who provides these data, in what format they are presented and with what periodicity. In the case of bundled projects, it is necessary to know which projects will be included within the bundled scheme, and to identify their main characteristics throughout the operation of the bundled projects. Supporting the adequate transfer of data and information, a combination of control operations should be available, including the availability of a team of inspectors who can check on-site the energy data subsequently reported, as well as provide technical advice to companies to perform a good measuring and reporting, on a regular basis.

To ensure proper sustainability in the MRV system, it will always be appropriate to have an instruction manual that may help to properly determine the data needed to perform the calculations, the templates to use in the report and the ways of verification most used. It is also suitable to agree with government authorities on the definition of an official binding regulatory framework, which facilitates the handling and exchange of information and defines the institutional arrangements that allow the identification of which institutions should carry out special activities as part of the operation of the MRV system. All this information can be organized to facilitate the monitoring processes. Table 6.3 indicates the application of the MRV system for monitoring the public lighting mitigation action previously presented.

Table 6.3 MRV for projects installing more energy efficient street lighting systems

MRV	What	Who	How	When	Observations
Measurement	Data: Electric Power Consumption of the improved lighting system in KWh	Local government, which compiles the data from the municipalities	Considering the installed capacity of the lighting projects installed and in operation	Yearly basis	Establish a protocol for the delivery of information between the local government and the municipalities
	Data: luminaire types of the improved lighting system, associated power and their effective operating hours				
	Data: Emission Factor of the National Electric System in tCO_2/MWh.			Yearly basis	National authority
	Additional calculations: * GHG emissions avoided, corresponding to each year of operation of the most efficient lighting system	Local Government	Using the CDM methodology and spreadsheet	Yearly basis	n/a
Report	* Report with annual data on the results of municipal mitigation actions	Local Government	Preparation of report based on standardized template	Yearly basis	n/a
	* Periodic report of the municipality on mitigation actions in the framework of its PEACC	Local Government	Preparation of periodic update report	Periodic	Identify update frequency
Verification	Verification Report of the results reported with the measure	Third part, as designated by the national environmental authority	Checklist application	Yearly basis, once a report is received for verification	n/a

6.6. Conclusions

In summary, including an MRV system in the bundled project will improve the strength of the project and make explicit the associated savings in terms of energy consumption avoided and mitigation of GHG emissions. It will also serve to identify how the project is advancing and if there are any problems during the operation of the bundled project, so that corrective measures can be taken as part of a continuous improvement process. Overall, projects running with MRV support are expected to be assessed on a regular basis, and improve in time through adequate monitoring. The initial Measurement stage allows the evaluation of indicators that can identify the impact (savings) due to the implementation of the project, whereas the Reporting stage allows the disclosure, in a standardized and periodic way, the performance of the bundled project to to different stakeholders. Finally, the Verification stage, consisting of external reviews of the information obtained by the project implementation, will ensure the quality of the project outputs and credibility of the information provided.

6.7. Further reading

CEPAL/GTZ, 2010. Indicadores de políticas públicas en materia de eficiencia energética en America Latina y el Caribe, (in Spanish), available at https://repositorio.cepal.org/handle/11362/3763

GIZ, 2012. Nationally Appropriate Mitigation Actions: A technical assistance Sourcebook for practitioners. Available at https://www.adelphi.de/en/system/files/mediathek/bilder/nama_source_book.pdf

IEA, 2014. Energy Efficiency Indicators: Fundamentals on Statistics, OECD/IEA, 2014 (https://webstore.iea.org/energy-efficiency-indicators-essentials-for-policy-making)

SEEAction, 2018. SEE Action Guide for States: Energy Efficiency as a Least-Cost Strategy to Reduce Greenhouse Gases and Air Pollution and Meet Energy Needs in the Power Sector. Available at https://www4.eere.energy.gov/seeaction/system/files/documents/pathways-guide-states-final0415.pdf

Annexes

Annexes

Annex I. Guide to developing energy mapping on a municipal level

1. Identify the high energy intensity facilities through a gate-to-gate defined boundary approach.

2. For a given facility, a pre-defined boundary is fixed and thereby includes all energy consumption against total output or reference (material, energy, area, etc.). It is important as it gives an idea/a record of all types of energy going into the boundary and all types of energy or outputs going out of the boundary (a balance). In simpler terms, evaluating specific energy consumption. For buildings (also referred as Energy Performance Index) it is in kWh/m^2/year or toe/'000m^2/year (if multiple fuels are included). For water stations kWh/l, etc.

Defining and fixing a boundary is important to set a baseline with respect to:

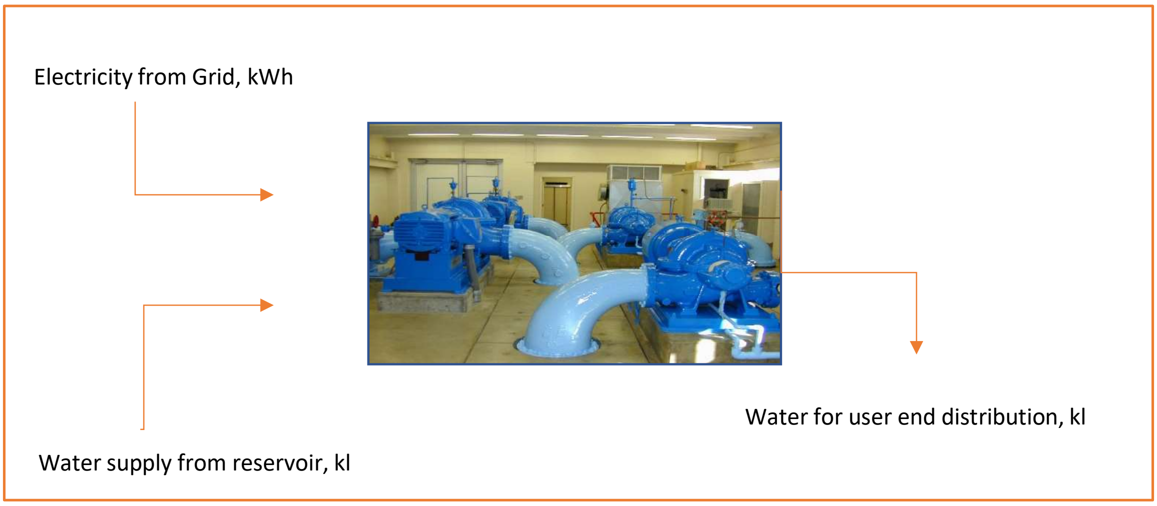
a. The energy consumption of the facility,

b. The technology and operational characteristics and conditions of the facility within the boundary that impact the energy consumption of the facility,

c. Technology and policy regulations in place during the baseline formulation.

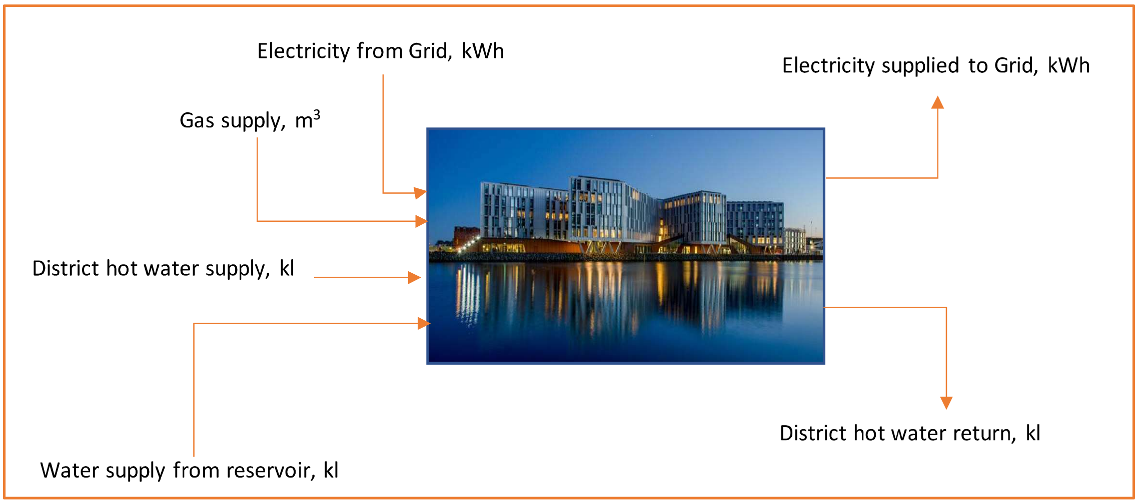
This baseline set in the defined boudary will be more relevant to compare, monitor and report the impacts of EE measures.

Figure A1.1 Example of a boundary approach for water utility distribution station[75]



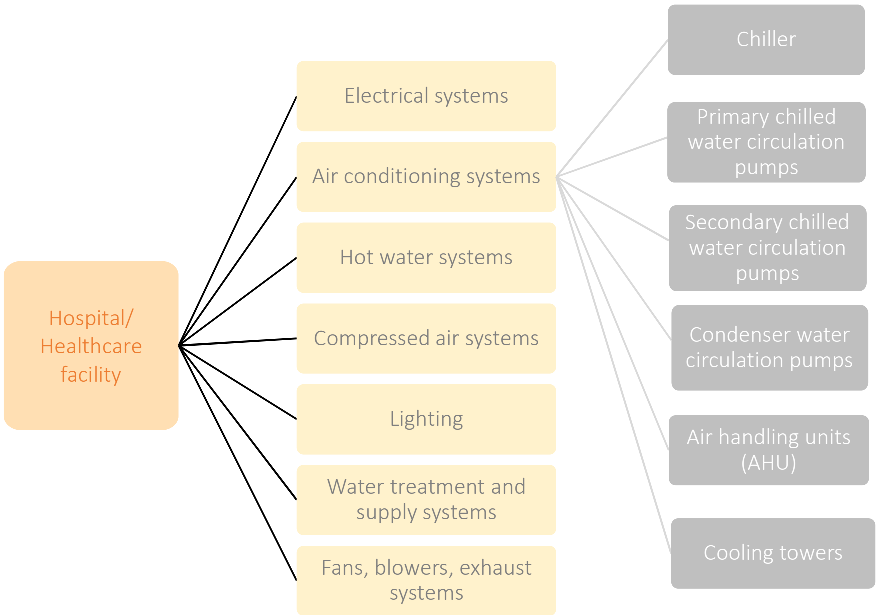
[75] Image source: https://images.app.goo.gl/nNUENtD2naw3xgQBA

Figure A1.2. . Example of a boundary approach for buildings[76]



3. Develop each facility's process/system layout
    a. Identify sections in the layout – macroscopic view
    b. Deep dive analysis on targeted section – microscopic view

Figure A1.3. Example of a public building Air-Conditioning system illustrating for macroscopic and microscopic layout



[76] Image source: https://images.app.goo.gl/nNUENtD2naw3xgQBA

4. Defining technology used in each section.

a. Identify what technologies are already in place to investigate the applicability of relatively efficient technology.

Figure A1.4. Example for section wise technology catalogue

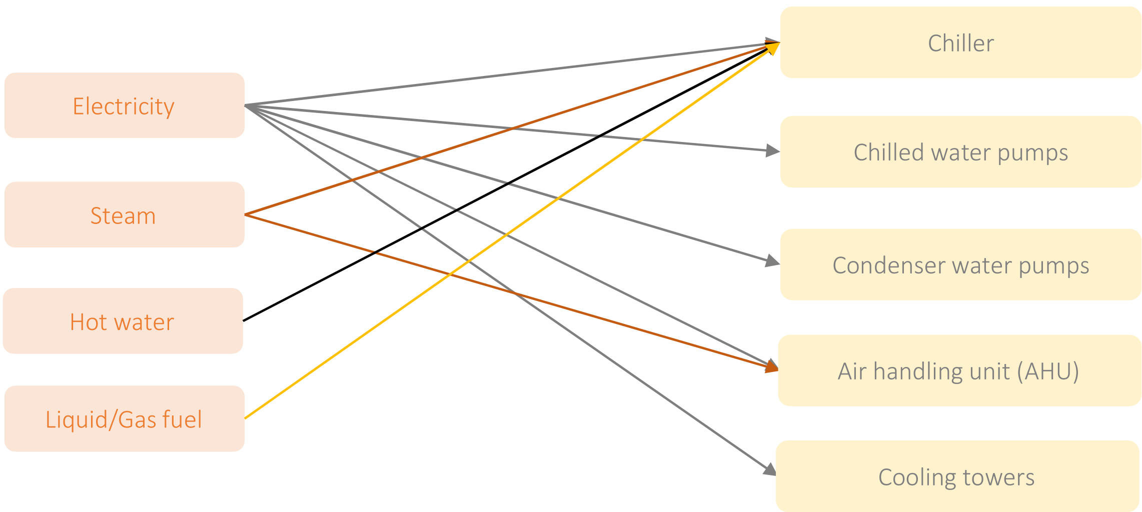
Chiller	Chilled water pumps	Condenser waer pumps	AHU	Cooling towers
• Electricity (Vapour compression system) • Steam (Vapour absorption machine - VAM) • Hot water (VAM) • Liquid/Gas fuel (Direct fired VAM)	• Electricity (electric motor driven centrifugal pump sets)	• Electricity (electric motor driven centrifugal pump sets)	• Electricity (electric motor driven fans and blowers) • Steam (for integrated dehumidifiers and RH control)	• Electricity (electric motor driven fans) • No energy input (Natural Draft) • Not applicable (Air cooled chillers)

5. Determine the energy used

a. What are the types of energy inputs available and where they are used?

b. Are there suitable meters located in required points to measure, record, store the data and make it readily available on Energy Management Systems for result oriented actions?

Figure A1.5. Example for linking end use input energy



Note: The above figure illustrates possible major (not limited to) energy use options for various sections of the centralized air conditioning system

6. Categorize personnel accountable for managing the operations/process, technology and energy.
    a. Personnel allocation for data collection and monitoring.
    b. Have timelines in place for different types of section wise data gathering.
    c. Collating and mapping energy use beneficial for the facility.
7. Study of data collected for potential optimization of resources and operations.
    a. Involve workforce from other departments for energy map discussions.
    b. Find issues at various levels that may have direct or indirect influence on energy intensity.
    c. List engineering and maintenance opportunities
    d. Identify possible room for changes in operational practices that may enhance the energy intensity.

Annex II. Identifying energy efficiency potential through detailed energy audits

Table A2.1. Methodology for Identifying EE Potential through detailed Energy Audits. (Bureau of Energy Efficiency)

Step No	Plan of Action	Purpose/Results
Step 1	<u>Phase I – Pre-Audit Phase</u> • Plan and organize • Walk through Audit • Informal Interview with energy manager, production/plant manager	• Resource planning, establish/organize an energy audit team • Organize instruments and time frame • Macro data collection (suitable to type of facility) • Familiarization of process/plant activities • First-hand observation and assessment of current operation and practices
Step 2	• Conduct brief meeting/awareness programme with all divisional heads and persons concerned (2-3 hours)	• Build cooperation • Issue questionnaire for each department • Orientation, awareness creation
Step 3	<u>Phase II – Audit Phase</u> • Primary data gathering, process flow diagrams, energy utility diagram	• Historic data analysis, baseline data collection • Prepare process flow charts • All service utilities system diagram (Example, single line diagram of power distribution, water, compressed air and steam distribution) • Design, operating data and schedule of operation. • Annual energy bill and energy consumption pattern (manual, log sheets, name plates, interview)
Step 4	• Conduct survey and monitoring	• Measurements: Such as motor survey, insulation and lighting survey with portable instruments for collection of more and accurate data. Confirm and compare operating data with design data.

Step 5	• Conduct detailed trials/experiments for selected energy guzzlers	• Trials / Experiments - 24-hour power monitoring (Maximum Demand, Power Factor, kWh, etc.) - Load variation trends in pumps, fans compressors, chillers, etc. - Boiler/efficiency trials - Furnace efficiency trials - Equipment performance experiments, etc.
Step 6	• Analysis of energy use	• Energy and material balance and energy loss/waste analysis
Step 7	• Identification and development of Energy Conservation (ENCON) opportunities	• Identification and consolidation of ENCON measures • Conceive, develop and refine ideas • Review the previous ideas suggested by unit personnel • Review the previous ideas suggested by energy audit, if any • Use brainstorming and value analysis techniques • Contact vendors for new/efficient technology
Step 8	• Cost-benefit analysis	• Assess technical feasibility, economic viability and prioritization of ENCON options for implementation • Select most promising projects • Prioritize by short-, medium- and long-term measures
Step 9	• Reporting & presentation to top management, decision-makers and stakeholders	• Documentation, report presentation.
Step 10	Phase III – Post Audit Phase • Implementation and follow-up	• Assist and implement ECNON recommendation measures and monitor the performance - Action plan, schedule for implementation - Follow-up and periodic review

Annex III. Questionnaire for rapid assessment for buildings

1. Building general information

	Facility	Headquarters
Name & Address of Company		
Phone No.		
Email		
Contact person name		
Designation & phone		
Type of building facility		
Age		
Capacity (further generic details may be customized based on the building type)		

2. Size and distribution characteristics

Orientation:

Number of floors:

Height:

Floor surface area (m^2):

No. of floors:

Space distribution:

- Is it a multi-space building (rooms, offices)?
- Does it consist of an open/ unobstructed interior?

Parameter	Value
Building daily operating hours	
Working days in a week (days)	
Sunlight hours of the locality in a year (hours)	
Maximum occupancy (persons)	
Type of windows and orientation	
Type of construction	
Type of roof	
Blinds installed (Yes/No)	
Insulation and reflective paints used (Yes/No)	

3. Energy source

Source	Year 2017-18		Year 2018-19		Year 2019-20		Major Consumption
	Qty	USD	Qty	USD	Qty	USD	Points with annual quantity
Electricity							Example: Chillers & pumps – 1 lakh units
FO/LSHS							
Coal / LPG / Natural Gas							
HSD							
Others							

Note: All numbers should include units. Monthly details also to be furnished

Electricity

Contract Demand kVA ------------------------------------
Demand Charges USD/kVA ------------------------------------
Unit Charges USD/kWh --------------------------------
Other fuel costs USD/quantity ....

Installations and devices

a. Transformers

No. of transformers & type	Capacity	Location	Incoming Voltage	Supply Voltage	OLTC Details
Example: 3 nos oil immersed type	2.5 MVA	S-11 transformer yard	11 KV	415 V	NA

b. Capacitors

Avg. Plant Power Factor ------------------------------
Total Capacitance provided kVAr* -----------------------------
Location of Capacitors ----------------------------

c. Motors

Application	kW Range	Nos.					Operating
		Squirrel cage induction motors	Slipring	Synchro-nous	D.C	Others	hours/year

d. Air Compressors

Installed capacity m^3/h:
Capacity utilization m^3/h:
Major users:

Compressor Type & Make	FAD capacity m^3/h	Motor rating kW	Comp. Air pressure kg/cm^2g	Approx. energy consumption per year	Annual operating hours

e. Heating Ventilation and Air Conditioning
Air Conditioning System: Centralized/Decentralized

Unit tag number	Installed cooling / heating capacity	Compressor Type and motor power (type and kW)	Make & Model	Application & desired condition	Energy consumption per year	Annual operating hours

* Kilowat-Ampere reactive

Air Handling Units details (Make, cfm, TR, kW) may also be furnished here.

Air handling unit (AHU) tag number	Area catering to	Make	Air flow, cfm *	Cooling Capacity, TR	Rated Power, kW	Annual energy consumption, kWh/year	Annual operating hours

*Cubic feet per minute

Any other water cooled, air cooled, D/X, Brine systems, Heat pumps etc. details to be furnished.

f. Pumps

Type & Nos.	Rated			Type of	Application	Annual operating hours
	Flow m³/h	Pres. * (mmWC)	Motor kW	control		

* Millimeters water column

g. Fans and blowers

Type & Nos.	Rated			Type of	Application	Annual operating hours
	Flow m³/h	Pres. (mmWC)*	Motor kW	control		

* Millimeters water column

h. Cooling towers

Type	Cooling load	Design range	Approach	Pump			Fan		Annual operating hours
	kcal/h	°C	°C	Motor kW	Flow m³/h	Head m	Motor kW	Air flow m³/h	

i. Lighting

Lamp/ Luminaire type	Lamp Watt x Nos.	Type of work	Method of switching	Operating load kW	Power consumption kWh/year

j. Boilers /Furnaces

Type	Fuel used	Capacity	Application areas	Energy consumption per year	Annual operating hours

k. Captive Power generation

Type* & No.s	Capacity	Fuel used	% loading	Units generated	SEGR**	Annual operating hours

* DG Set / Gas turbine / Waste heat boilers / fuel fired boilers etc.
** Specific Energy generating Ratio

l. Appliance details

Parameters	Value		
	Installed power rating (kW)	Daily working hours	Annual working days
Computers			
Desk lamps			
Refrigerators			
Coffee machines			
Vending machines			
Any other electronic devices			

m. Brief description of the facility
Any further details which the building facility may share.

4.Buildings' isolation and EE

Energy rating of the building:
Glazing characteristics:
Envelope characteristics:

5.Previous EE improvement interventions/ campaigns

S.No	Year	Activity/project	Category	Investment (USD)	Cost savings (USD)	Energy savings (quantity/annum)	Fuel savings (quantity / annum)

Annex IV. GHG emission reduction calculation from lower annual electricity consumption of the most efficient lighting system

A detailed calculation of the net electricity saved due to the implementation of the bundled project of a most efficient lighting system can be estimated from Equation 2. This equation is an adaptation of the CDM Methodology: AMS_II.L: Small-scale Methodology: Demand-side activities for efficient outdoor and street lighting technologies (2013). This methodology allows simultaneously an estimation of baseline, the mitigation potential and the definition of elements to be included for an MRV system.

Equation 2:

$$NES_y = \sum_{i=1}^{N} \left(Q^M x\, P_{i,y}{}^M x \frac{1\,kW}{1000\,W} x\, H_{i,y}{}^M\right) - \sum_{i=1}^{N} \left(Q_i{}^B x\, P_{i,y}{}^B x \frac{1\,kW}{1000\,W} x\, H_{i,y}{}^B\right)$$

Where:

NES_y: Net electricity saved in year ***y***
y: year
i: counter for luminaire type
N: Number of luminaires
$Q_i{}^B$: Quantity of baseline luminaries “i” from the original system (units)
$P_{i,n}{}^B$: Rate power of each luminaire type “i” from the original system (W)
$H_{i,n}{}^B$: Annual operating hours from the original system (hours)
$Q_i{}^M$: Quantity of luminaries “i” from the bundled project (units)
$P_{i,n}{}^M$: Rate power of each luminaire type “i” from the bundled project (W)
$H_{i,n}{}^M$: Annual operating hours from the bundled project (hours)

Source: CDM Methodology: AMS_II.L: Small-scale Methodology: Demand-side activities for efficient outdoor and street lighting technologies (2013)

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