Guideline: Energy efficiency strategy for municipal buildings

Best Practices

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Index

List of figures

List of tables

List of abbreviations

CO_2	Carbon dioxide
CBS	Capacity Building Scheme
CoM	Covenant of Mayors
EE	Energy Efficiency
EED	Energy Efficiency Directive
EPBD	Energy Performance of Buildings Directive
EPC	Energy Performance Contracting
EnMS	Energy Management System
EPC	Energy Performance Contracting
ESCo	Energy Service Company
EU	European Union
EU28	European Union (EU) consisting of a group of 28 countries before Brexit
GDP	Gross Domestic Product
GHG	Greenhouse Gas
TWh / GWh	Terra Watt hours / Giga Watt hours
IPCC	Intergovernmental Panel on Climate Change
LEEG	Local Energy Efficiency Group
NECP	National Energy and Climate Plan
PPP	Public Private Partnership
SEAP	Sustainable Energy Action Plan
SECAP	Sustainable Energy and Climate Action Plan
SWOT methodology	Strengths, Weaknesses, Opportunities, Threats methodology

1. Basic information about this guideline

This guideline "Energy efficiency strategy for municipal buildings" serves as a support material for municipalities in the process of developing their local energy efficiency strategy for municipal buildings.

This guideline is made to report best practices on optimal energy efficiency strategies found for municipal buildings by the support of an organized and structured self-assessment tool. The tool helps to define capacity constraints in energy management in municipalities. At best, this leads to defining specific Capacity Building Schemes.

The starting point is the evaluation of the current strategic local energy plans (in terms of SEAP, SECAP or energy plans in municipalities). Further steps are dedicated to an organizational and process analysis at the administrative level in order to re-arrange workflows and municipal energy management systems. In this context, it is beneficial to build retrofitting strategies including either building refurbishment actions or IT solutions for energy monitoring which is harmonized with potential investments in energy efficiency projects.

The guideline is created for local policy-makers, planners and experts contributing to the development and implementation of building energy efficiency strategies, policies and projects in municipalities. It is intended for representatives at various levels of local government: heads of local governments, heads and specialists of technical and development departments, heads and technical directors of municipal companies, as well as cooperating institutions and companies or other groups in society, eventually including citizens.

This Annex includes reports of the best practices form the implementation of the Guideline "Energy efficiency strategy for municipal buildings" according to the *Act Now!* project. Specific best practices have been identified according to the practical scheme as reported guideline (download the guideline from www.actnow-baltic.eu/learning)

Within the *Act Now!* project several key areas have been identified from the implementation of the self-assessment tool and the SWOT analysis covering several action areas is presented. These will be more in-depth presented in the section 7, but can be summarized in the following main areas (also see figure 1):

- implementation of an Improved Energy Management system (e.g. proposal of smart metering systems);
- strategic reorganization of the Municipal decision making facing with EE strategies;
- diffusion of technological innovation within also favouring cooperation among municipality, academia and local stakeholders;
- strengthening the local stakeholders engagement;
- strengthening PPP and link with EE in private building sector (download the guideline from www.actnow-baltic.eu/learning);
- promote behavioural change and raise awareness; and
- training of municipal employees.

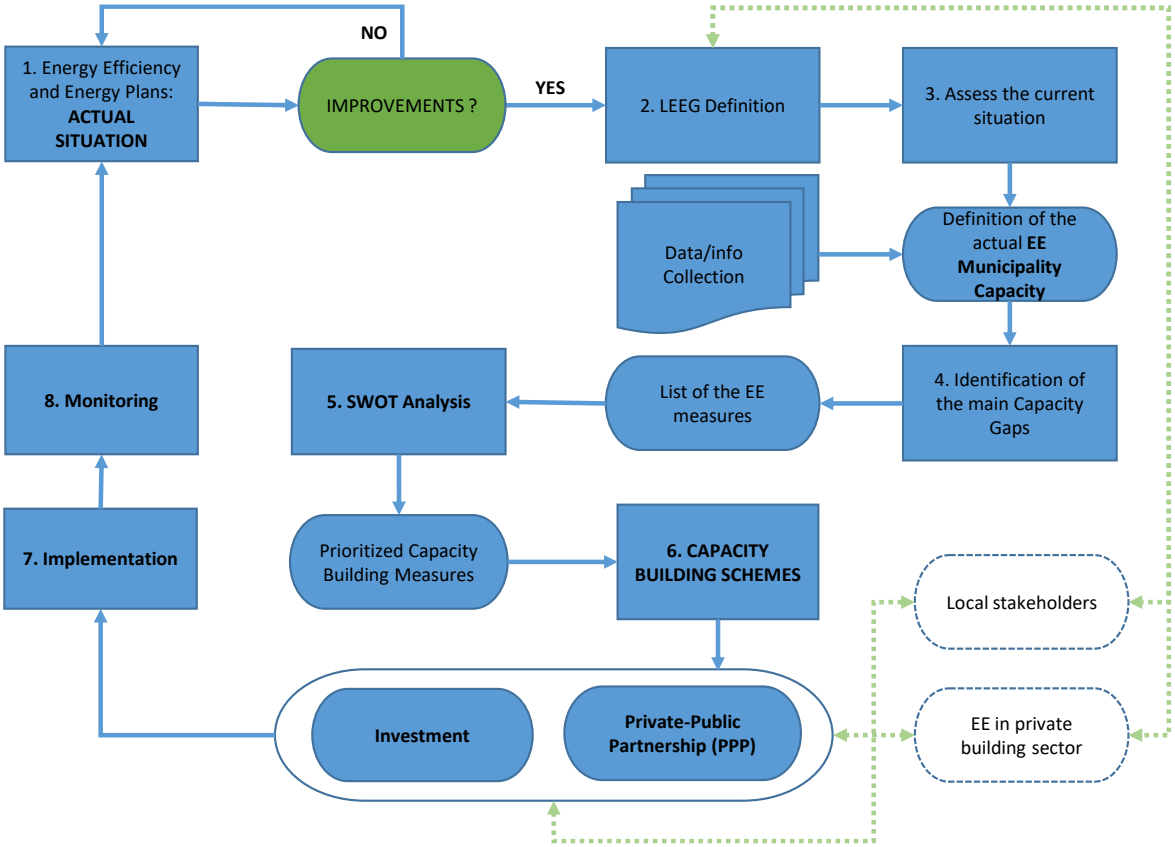

Figure 1. Act Now! project practical approach to implement municipal building energy efficiency measures.

This propose best practice for each parts of the methodology based on each partners experience developed within the framework of the *Act Now!* project.

For each pilot case practices are proposed considering the identified topical aspects emerged during the project development in connection to the implementation of the CBS with a focus on energy efficiency for buildings:

- Delineate Energy Efficiency Strategy and set clear targets from the *Act Now!* prioritization process.
- Set ambitious goal towards energy efficiency standards for municipal buildings.
- Implementation of new energy management systems including tools and/or technologies.
- Develop new SEAP/SECAP or strengthening existing SEAP/SECAP.
- Technology diffusion to promote markets for energy efficiency in buildings.
- New key role of LEEG on energy efficiency strategies for building within the Municipal council.
- Stakeholders and expert engagements.
- Raise awareness and strengthening energy use habits.

2. Best case practices

2.1 The actual situation of energy efficiency and energy plans

2.1.1 Municipality of Sievi (Finland) – the use of the capacity assessment tool from Act Now! project

Summary: The Act Now! project capacity assessment tool was used to determine to current status of the energy efficiency capacity in the Sievi municipality. The tool made the employees of small municipality to rethink all the aspects of energy efficiency and helped them to organize the actions that needs to be taken in order to increase the capacity. The plan is to fill the capacity assessment tool again after 1.5 – 2 years to revise the current situation in the municipality.

Results: The results of the capacity assessment were used to revise and update the municipality's SEAP since the lacks found with the tool helped to see the missing parts. One missing part was the involvement of stakeholders to the municipality's EnMs. This was corrected by establishing a LEEG that had members from different important stakeholders in the municipality.

Success reasons vs drawbacks:

Success: Establishment of municipality local energy efficiency group was one of the success followed by use of the capacity assessment tool. The LEEG has several members from outside the municipality organization; from the industry and other stakeholders important to the municipality.

Drawback: The tool gives a score to all different dimensions of capacity; however, the score might not give the real situation from the state of capacity since the tool is a self-assessment tool and therefore is affected by the opinions and attitudes of the persons filling it. This could lead to a situation that although the municipality has improved their capacity the score will not increase since the self-criticism as also increased.

2.2 Experience from LEEG towards setting EE strategy for Buildings

2.2.1. Municipality of Bremerhaven: central role of LEEG on energy efficiency strategies for building within the Municipal council

Summary: Bremerhaven's LEEG originates from Bremerhaven's Energy Policy Work Program (EPAP). The processing and updating of the EPAP is handled according to the licensed methodology of the European Energy Award. Due to political change and formal decisions of the Magistrat Bremerhaven the LEEG structure has changed since December 2019.

Since 2020 the LEEG in Bremerhaven is the "Arbeitskreis (AK) Klimaschutz" and consists of an inner circle (core LEEG, actively driving and managing the process) and an outer circle (enhanced LEEG, consulting, influencing, securing wider participation). Management and the presidency of "Arbeitskreis (AK) Klimaschutz is at the climate city office.

Results: Since 2020 the new structure of the LEEG in Bremerhaven is consisting of 43 participants ("Arbeitskreis (AK) Klimaschutz"), of these 10 are from the municipality and 33 are not. Out of the 43 participants 14 are members of the inner-circle-LEEG (sub-circle of specialists called "Fachkreis"). Out of these 14 participants are 8 municipal participants and 6 non-municipal.

The participants of the inner circle ("Fachkreis") will continue to work as a fixed group. The participants of the outer circle are expected to fluctuate slightly, depending on topics and time resources. The combination of overall LEEG and inner-circle LEEG establishes wide stakeholder participation and was driven in 2019/2020 by political intentions.

2.2.2. Municipality of Sondeborg: strengthening the PPP link and role within the decision making process

Summary: Public Private partnership (PPP), Citizen Engagement and learning is the DNA of Sonderborg. Since 2007, the ProjectZero PPP has supported the city councils' ambition of carbon neutrality by 2029. The LEEG approach *within Act Now!* project has helped Sonderborg connect to key stakeholders, not only for creating additional homeowner actions, but also for planning and executing the Roadmap2025 in eight segments focused on achieving 75% carbon reductions by 2025. The LEEG-members are motivated by the ProjectZero-opportunity to co-create the future Sonderborg and in cooperation with the citizens and companies achieve carbon neutrality by 2029.

Results: The almost 100 LEEG-members of the eight working groups are focused on each their segment challenges and opportunities within homeowners, house associations, private flats, personal transportation, businesses, farming, heavy transport, renewable energy production. They have also become important local and national ambassadors for the climate transition of Sonderborg. They are now focused on capacity building as part of the Roadmap2025 execution strategy. 50 bank advisers from various banks have just participated in a course on financing investments in the green transition.

Concrete examples of results in the group of private homeowners:

- Identifying the focus-areas;
- Creating the homeowner strategy for Roadmap2025 and KPIs;
- Creating a strong connection along the Customer journey and between the municipal and the private sector actions;
- Coordination of strategy implementation;

- Creating training programs for craftsmen and local banks;
- Local communication and ambassadorship;
- Events for homeowners in regards to energy renovating their homes.

Success reasons vs drawbacks: Creating and communicating a shared vision for the entire municipal territory as well as maintaining political support is important for success, but also a key challenge.

Transferable value: The participants contribute with experiences, competences, ideas, work and energy to the selected topic/challenge. The Local Energy Efficiency work Group LEEG has an important role in planning and in implementation and execution of the plan. It is essential that the LEEG includes participants from both the municipal admin as well as stakeholders from the private sector, and that they have different job positions and thereby different point of views as well as knowledge on different subjects.

It is worthwhile to establish a LEEG also with stakeholders from the private section, as it becomes a cooperation partner for driving energy efficiency not only in relation to the municipality buildings but to all buildings in the municipality.

2.3. Identification of the main capacity gaps in order to define specific targets

2.3.1. Municipality of Kaliningrad (Russia) - Improving the energy efficiency of heating systems in municipal and private buildings

Summary: The energy efficiency was achieved by reducing heat consumption in municipal and private buildings through the installation or modernization of an automated heating unit in a district heating system. A project was implemented on installation of modernized individual heating units in multi apartment buildings as part of a program funded by the European Bank for Reconstruction and Development during 2019-2020:

- 126 modernized individual heating units were installed;
- equipment was completely replaced in 102 heating units (in places where old hydro-elevator installations where present and where hydro-elevators were previously absent);
- in 24 individual heating units the old tubular heat exchangers of the hot water supply system were replaced with automated hot water supply' units.

Results: As a result of modernization, individual heating units allow the owners of premises in the multi apartment buildings not only to efficiently establish the metering and control of the heat they use, but also to optimize the consumption of this communal resource. As part of the implementation of the municipal energy saving program for 2014-2019, in total 43 thermal systems (boiler houses, heating units, etc.) were modernized.

Success reasons vs drawbacks: Success is the development of the use of PPP financial instruments for the modernization of heat supply systems for apartment buildings based on experience gained from the implementation and financing of similar projects for municipal buildings.

The disadvantages are associated with a low level of awareness of residents, which does not allow to intensify the implementation of projects to modernize heating systems. Another disadvantage is the inefficiency of such projects for small houses, where the cost of maintenance is high, which dramatically increases the payback period of projects.

Transferable value: Proposed projects for the modernization of heat supply systems could be replicated in private and municipal multi apartment buildings.

2.4. How to make a Capacity Building Scheme strategy

2.4.1 Municipality of Gulbene (Latvia): A Capacity Building Scheme focused on SECAP

Summary: The final version of the "capacity self-assessment tool" received from Gulbene municipality for capacity needs and gaps identification as described in the section 4.4. has been deeply investigated by coaching and expert partner Riga Technical University within the *Act Now!* project.

Each Capacity Dimensions have been thus discussed within a tandem approach in order to create a more consistent capacity building action plan to be shared and implemented in Gulbene municipality. The main outcome within this process was oriented towards the creation an optimal synergy among the municipality staff, the formed LEEG and the coaching partner.

The building segment for the Capacity Building Scheme is addressed to municipal buildings. According to the capacity self assessment tool the definition of the Capacity Building Schemes (CBSs) is involving the following main capacity dimensions identified, namely: Commitment & Management, Energy Planning, Implementation, Resource and Infrastructure.

Results: All the main gaps and criticalities identified from the implementation of the tool are reported in the following table 1 as a summary including the overall score on a normalized 1-10.

Table 1. The main gaps and criticalities identified with the implementation of the tool

Dimension of Capacity - COMMITMENT AND MANAGEMENT	Actual score	Max Score	%
Management Commitment	0	6	0%
Energy Strategy & Action Plan	7	7	100%
Management & Stakeholders	7	14	50%

Dimension of Capacity - COMMITMENT AND MANAGEMENT	0,8
Management Commitment	0,0
Energy Strategy & Action Plan	0,6
Management & Stakeholders	0,3

Dimension of Capacity - ENERGY PLANNING	Actual score	Max Score	%
Regulatory Compliance	4	4	100%
Monitoring and Analyzing Energy Use	7	12	58%
Target Setting	2	7	29%

Dimension of Capacity - ENERGY PLANNING	1,0
Regulatory Compliance	0,6
Monitoring and Analyzing Energy Use	0,3
Target Setting	0,2

Dimension of Capacity - IMPLEMENTATION	Actual score	Max Score	%
Communication	0	3	0%
Documentation	1	3	33%
Operational Control	1	5	20%
Design	2	2	100%
Procurement of Energy Services, Products, Equipment and Energy	3	5	60%
Checking and Management Review	0	2	0%

Dimension of Capacity - IMPLEMENTATION	1,2
Communication	0,0
Documentation	0,2
Operational Control	0,1
Design	0,6
Procurement of Energy Services, Products, Equipment and Energy	0,3
Checking and Management Review	0,0

Dimension of Capacity - RESOURCES	Actual score	Max Score	%
Competence, Training and Awareness	2	6	33%
Financial Resources and Energy Financial Commitment	4	5	80%
Human Resources and Inter-Relationships	4	4	100%

Dimension of Capacity - RESOURCES	1,2
Competence, Training and Awareness	0,2
Financial Resources and Energy Financial Commitment	0,4
Human Resources and Inter-Relationships	0,6

Dimension of Capacity - INFRASTRUCTURE & TECHNICAL DATA	Actual score	Max Score	%
Energy Production Infrastructure	2	4	50%
Buildings (in the focus area)	4	8	50%
Other Public Sectors and Municipal inteventions	4	4	100%

Dimension of Capacity - INFRASTRUCTURE & TECHNICAL DATA	1,1
Energy Production Infrastructure	0,3
Buildings (in the focus area)	0,3
Other Public Sectors and Municipal inteventions	0,6

Capacity Self-Assessment Tool for Local Authorities (Municipality)	
FINAL SCORE	5,4

Among the others important gaps have been identified on the dimension of: "Commitment and management" as well as for the "Implementation". Specifically, evident criticalities have been identified in the following sub indicators: *Management Commitment; Communication; Checking and Management*

Review. While evident lacks have been also found for *Operational Control, Target setting, Documentation and Competence, Training and Awareness*.

The tailored action plan towards the definition of an optimal Capacity Building Scheme has been defined taking into account the following main steps:

1. developing an energy strategy based on SEAP approach and the implementation of a non-certified (at least in the first phase) Energy Management System (EnMS) in line with the requirements from the ISO 50001;
2. Defining the key roles of the LEEG and the interaction with the Municipality Management staff;
3. Defining a specific action plan for increasing Competence, Training and Awareness in the Municipality Management Staff and LEEG.

This was implemented in 6 workshops whose structure is reported in the figure 2 below.

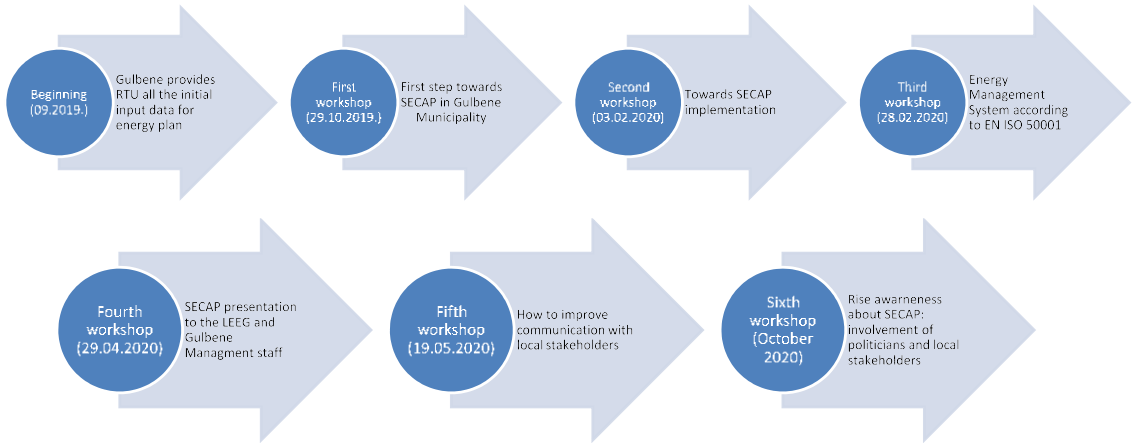

Figure 2. The structure of 6 workshops.

Success reasons vs drawbacks: a tailored action plan for towards the definition of an optimal Capacity Building Scheme has been defined taking into account a synergetic approach among the Municipality management Staff, The established Local Energy Action Plan (by LEEG) and the coaching partner (i.e. Riga Technical University). The general scheme is reported in the figure below:

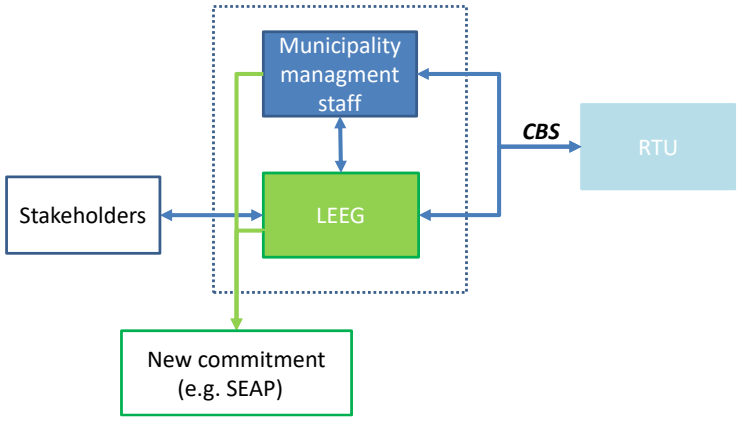

Figure 3. Act Now! Approach for CBS implementation in Gulbene according to a tandem approach with an expert partner within the project.

Transferable value: The tandem approach was the essential part towards the development of a SECAP in Gulbene municipality. Gulbene municipality staff and the LEEG together with the coaching partner RTU set up the implementation of a SECAP and Energy Management System. A tailored capacity building action plan implemented on a framework of 6 workshop was essential to create the ground for a proper knowledge transfer and a more participated decision making process within the Municipality including the LEEG in the major decisions on the direction of Municipal Energy Management Policy.

This approach could be considered applicable for Municipality that wants to have a new SECAP from an existing energy plan. The approach proposed in the *Act NoW!* project can provide the ground to facilitate the exchange of strategic planning in terms of creating the synergy with expert and/or academia towards promoting a sustainable and integrated planning.

2.4.1. Municipality of Sievi (Finland): A Capacity Building Scheme focused on SECAP

Summary: In the case of Sievi municipality, writing the Capacity Building Scheme was started by listing the lacks in capacity found with the capacity assessment tool. The list was expanded with other missing capacity building needs and tasks. Next the lacks were divided in categories according to their subject, or the reason of the lack and prioritized as well as scheduled. The aim of this was to have timetabled task list containing responsible persons and aims.

Results: As the result of the listing and prioritization of the capacity building needs, the municipality had a timetabled action plan for capacity building. This action plan was used to help in the revision of the SEAP. The example of the Sievi municipality Capacity Building Scheme is reported in table 2.

Table 2. Example from the Sievi municipality Capacity Building Scheme.

Subject	From	To	Capacity lacks/capacity building needs/task	Aim	Preknowledge	Performers	Responsible person
Energy management tool - EnMS	2019 summer	Municipal council meeting - August	Lack of energy management tool	Purchase of energy management tool	price	Expert partner; "Energy manager"	"Energy manager" together with top management
	2019 autumn	Continuous task	EnMS revision by top management	Continuous improvement of the quality of EMS	EMS data; realized savings (resources, saved energy, money et.)	Top management+ Local energy efficiency group	Local energy efficiency group
	2019 autumn		Identification of EMS and other energy control training needs	Identification of the lack in knowledge and learning the newest information	Improving the skills and know-how of staff	Local energy efficiency group and "energy manager"	Local energy efficiency group and "energy manager"
	2019 summer	Municipal council meeting - August	Complete monitoring and measurement systems connected to cloud/ software for real-time data visualization			Expert partner, Technical committee	"Energy manager"+ Technical staff, Top management
Human resources	2019 summer	Municipal council meeting - August	Lack of local energy efficiency working group	Set up Municipality's LEEG	Suitable persons and stakeholders	"Energy manager"	"Energy manager", Technical committee, Top management
	2019 autumn		Clear job descriptions and titles. Awareness of EMS in all levels.	Job description of "Energy manager" + LEEG is clear to the staff and municipality's residents. Increase the awareness.			Top management + LEEG + Municipality's communication

The action plan will show what tasks are continuous such as revision of the EnMS or communication with the stakeholders and what tasks needs to done only once e.g. purchase of energy management system.

Success reasons vs drawbacks: The Capacity building scheme made this way will give a clear task list to the responsible persons and can be thought as a notepad containing need-to-be-made tasks.

As drawback, the timetable written into the scheme was too ambitious and therefore started immediately run behind the schedule. This lead to drop of motivation. Therefore, it is important that the tasks scheduling is realistic and it is ensured that municipality has the resources and motivation to keep up with the planned tasks.

Transferable value: When the municipality starts to improve their energy efficiency capacity from the "scratch" the scheme made this way will give concrete action plan ensuring that all the tasks will be made.

2.5. Implementation of the energy efficiency measures

2.5.1 Municipality of Kaliningrad (Russia): Smart building

Summary: One of the key action of the CBS in Kaliingrad developed within the *Act Now!* project was addressed to ensuring synergies in the implementation of energy-saving measures and meeting the requirements for achieving the standard microclimate of rooms in buildings of school and preschool institutions.

Results: It was expected to save of up to 30% of thermal energy consumption.

Success reasons vs drawbacks: The main success was on savings in budget funds, improving the environmental situation and ensuring the necessary level of indoor climate of premises that meets regulatory requirements. The main drawbacks were mostly in connection with the complexity of installation of equipment.

Transferable value: The application of this solution in the municipal buildings with active visits and long-term stay of various social groups (kindergartens, schools, nursing homes, guest houses, hospitals, as well as offices) that are not equipped with forced ventilation systems.

2.5.2 Municipality of Gdynia (Poland): Technology diffusion to promote energy efficiency in buildings

Summary: In order to move towards the zero emission society, new, energy efficient technologies for buildings should be intensively promoted and implemented. These technologies are related to thermomodernization and energy/building management systems (EnMS/BMS). The EnMS systems enable significant reduction of energy consumption in the building (responsible for 40% of final energy use) without compromising the temperature comfort and air quality. Gdynia municipality focusses on increase of energy efficiency in school buildings. Series of energy audits has been conducted by city expert-partner Institute of Fluid-Flow Machinery from Polish Academy of Sciences (IMP PAN). Audits included check of air conditions and energy efficiency challenges. Other sources of knowledge transfer (and diffusion) for the city were IMP PAN partners (Solwena Ltd), municipal trolleybus company (PKT) and Sopot municipality implementing EnMS systems. The gained experiences are shared (diffused) inside OMGGS (Metropolitan Area Gdańsk-Gdynia-Sopot) local energy efficiency work group - LEEG.

Results: Gdynia municipality activities in the field of energy efficiency focus on thermo-modernization and energy management in public (school) buildings. *Act Now!* expert-partner IMP PAN helps to develop alternative energy monitoring systems and preparing energy audits, which included air condition assessment. Audit pointed to temporally high concentration of CO_2 after 2 or 3 lecture and problems with existing ventilation systems. These findings stimulated Gdynia to invest in systems enabling remote control of air conditions and to plan modernization of at least 10 school buildings during next 5 years. These plans include installation of BMS systems or both BMS and thermos-modernization (the latter in PPP formula). Expected energy savings are 15% in the case of BMS alone and 50% when both measures take place. Gdynia was encouraged by results of municipal PKT company implementing EnMS in depot (expected energy savings 20-30%) as well as Sopot municipality thermomodernization effects (energy savings up to 50%). Sopot as one of the first municipality in the region implemented original ESCO/PPP formula can serve to inspire other municipalities of LEEG/OMGGS for EnMS development.

Success reasons vs drawbacks: The performed energy audits in school buildings in Gdynia pointed to challenge related to energy efficiency versus air quality. Performed air quality control has shown that after 2 or 3 lectures CO_2 concentration in the classroom can reach level above 3000 ppm, which might have longstanding consequences.

Transferable value: Large metropolitan LEEG can be a source of inspiration and ***technology diffusion*** for the participating (and other) municipalities in the field of energy efficiency. In the case of OMGGS/LEEG cities concentrated and shared ideas (during series of seminars) on technology issues related to EnMS/BMS systems, thermomodernization and various energy contracts.

2.5.3 Municipality of Gulbene (Latvia): Implementation of new energy management systems including tools and/or technologies for data collection

Summary: According to the state-of-the-art assessment of the Energy management and energy strategies for *Act Now!* project the main identified problems in Gulbene municipality were lack of systematic collection of energy data for all the municipal building stock and a metering systems mostly for the parishes of Gulbene mucipality. Thus, the LEEG set the target to develop a SECAP including the definition of a systematic Energy Management System (EnMS) according to the ISO 50001.

Within the Capacity Building Scheme definition, the LEEG understood the real need to have a more systematic EnMS in order to reach the goals set in the new SECAP developed during the project.

Results: The municipality management staff in coordination with the LEEG define an action plan for the definition of an EnMS according to ISO50001. This was considered a key aspect in order to create the ground for the definition of the energy consumption baseline scenario in all municipal buildings enabling to evaluate the deviation from the baseline consumption trend either due to a miss energy management or due to improvement of energy efficiency in the building according to a specific implemented strategy.

Success reasons vs drawbacks: The coaching approach implemented within a workshop based concept was essential to ensure a more optimize knowledge transfer among the LEEG and the coaching partner (i.e. Riga Technical University). This enabled a more consistent decision making process towards the selection of more focused investments for the energy monitoring system reconstruction and renovation and more consistent evaluation of the socio-economic benefits.

Transferable value: This approach could be adapted for municipalities that need a more clear understanding on how to make a systematic planning for the renovation of the EnMS.

2.5.4 Municipality of Kaliningrad (Russia): Implementation of new energy management systems including tools and/or technologies for data collection

Summary: The municipality has developed a traditional energy-saving management system: conducting an energy audit of the first level, with the results posted in the state information system "Energy Efficiency" with information on energy consumption for the annual period of all buildings of the municipal institution, technical parameters of buildings and energy saving targets.

At the same time, the institution's energy manager analyses the energy consumption of municipal facilities at the municipal institution level, develops energy-saving measures that are fixed in the institution's energy saving program, and then implements them subject to financing from own funds or from the federal, regional budget and, alternatively, PPPs.

This information is transmitted to the energy manager of the administration of the municipality, which integrates the programs of all municipal institutions into a single municipal program, taking into account the existing development programs of the municipality.

As part of the *Act Now!* project, an expert function has been added to this energy management scheme. Analysis and development of energy-saving measures is carried out by members of the local energy efficiency working group LEEG together with the energy manager of the municipality on the basis of self-assessment and SWOT analysis, ensuring the improvement of the competencies of the energy manager and other involved personnel and the quality of preparation of energy-efficient measures.

Results: It is expected to achieve energy savings of approximately up to 3% and thus reducing the burden on the municipal budget due to lower energy consumption.

Success reasons vs drawbacks: The possibility to have a more constant and more consistent data monitoring, solving the lack of dynamic control over energy consumption and control of the results of energy-efficient measures implemented.

Transferable value: This application can provide the ground on how to exchange experience between municipal institutions based on the results of the implementation of measures and the transfer of necessary technical documentation.

2.6. Monitoring of after implementation of energy efficiency measures

2.6.1. Municipality of Sievi (Finland) - Smart system control technologies within building: opportunity for municipal buildings

Summary: Automation of building can foster energy efficiency in buildings. The prerequisite to make this possible is the provision of a comprehensive information and data collection about building users in order to move from potential to practical use.

Smart and automation systems for space and buildings allow greater energy efficiency in residential and non-residential buildings. Users can control their energy consumption and if well informed minimise energy consumption. Energy Management System is thus a tool that could be used in municipalities to control energy consumption and more promptly identify inefficient energy use.

A key pilot case in the *Act Now!* Project is provided from the Municipality of Sievi in which the biggest municipal buildings in the town centre have a comprehensive Schneider Electric building automation with cloud-based UIs and services. That way also the consumption data can be seen directly in the system.

On the other hand, the buildings in rural areas, the village schools in particular, don't have any monitoring solution so far, only local energy meter for billing purposes. Investments are divided to 2 phases. During phase 1, the movable energy flow metering system was bought, in order to provide deeper understanding of the building behaviour in circuit level. The first measurement campaigns have already been performed, and additional ones are planned together with Sievi technical department.

The phase 2 investment includes then energy monitoring systems for the 6 village schools. The solution is based on COTS-based devices in order to provide continuity and product support also after the project. This solution will be finalized during coming weeks, after which the tendering process can be started. The procurement process is planned to be finished by the end of April at latest.

In Sievi, the idea is to use the project EnMS for analyzing the data during the project.

Results: All planned school buildings were equipped with monitoring system, consisting of the needed set of sensors, programmable logic unit and required cables. In Sievi town hall, a dedicated server was installed and configured to receive measurements from school buildings over internet. That server provides both a local UI as well as interface for sending the data forward to other 3rd party services as well. See the example for one of the schools in figure 3.

Figure 4.. Jokikylä school heating and hot tap water parameters from the year 2020.

In the bottom left diagram, it is easy to identify the effect of COVID-19, when hot water consumption drops to almost zero from mid-March to mid-May. The holiday break begins in early June. Likewise, the top right figure reveals the effect of hot June period, when heating was practically off, but started again in early July,

when the colder and rainy period started. This service alone gives significant help to everyday energy management activities, as the real-time and cumulative consumption curves can be browsed in the same user interface, instead of gathering the values manually from every remote building.

On the other hand, the aforementioned examples also show the need for technical interpretation. More sophisticated EnMS system is needed to ensure full benefit for the system. As the biggest administration, school and health-care facilities are equipped with Schneider electric system, the most natural option would be to include these measurements to the part of Schneider EcoStruxure EMS system, which includes all needed functions for energy management. Sievi municipality is negotiating with Schneider about this.

Success reasons vs drawbacks: Sievi case reveals the realistic view on the development of EnMS processes in municipality. Existing legacy systems have a significant role in the process, and their integration to the process is critical for the success, but not always easy to execute. On the other hand, technical EnMS hardware and software is only one part of the challenge. Another part is in the transition of practices and work conventions to a new level. In Sievi case, this appeared to be challenging, because the small municipality often has a minimum amount of workforce in administration. One executive role already includes many tasks now, and adding a new time-consuming thread like EnMS to that is not easy without clear incentives. In Sievi case, the employees are eager to improve the energy efficiency in the municipality and are aware of the fact that although integration of new system might take time, the benefits gained from it will in a long run help to ease their workload.

Transferable value: Sievi village school energy measurement system is fully functional and can serve different future EnMS via standard http-based interfaces. Moreover, the installed logic units in schools include free capacity for supplementary connections, as an example if there is need to include room condition monitoring to the system. Therefore, the completed procurement will be beneficial for years.

2.6.2. Municipality of Gdynia (Poland): Technology diffusion to promote markets for energy efficiency in buildings

Summary: In order to realize the zero emission society, new, energy efficient technologies for buildings should be intensively promoted and implemented. These technologies are related to thermos-modernization and energy/building management systems (EnMS/BMS). The EnMS systems enable significant reduction of energy consumption in the building (responsible for 40% of final energy use) without compromising the temperature comfort and air quality.

Gdynia municipality focusses on increase of energy efficiency in school buildings. Series of energy audits hava been conducted by city expert-partner Institute of Fluid-Flow Machinery from Polish Academy of Sciences (IMP PAN). Audits included air conditions check and energy efficiency challenges. Other sources of knowledge transfer (and diffusion) for the city were IMP PAN partners (Solwena Ltd), municipal trolleybus company (PKT) and Sopot municipality implementing EnMS systems. The gained experiences are shared (diffused) inside OMGGS (Metropolitan Area Gdańsk-Gdynia-Sopot) local energy efficiency group - LEEG.

Results: Gdynia municipality activities in the field of energy efficiency focus on thermo-modernization and energy management in public (school) buildings. *Act Now!* expert-partner IMP PAN helps to develop alternative energy monitoring systems and preparing energy audits, which included air condition assessment. Audit pointed to temporally high concentration of CO_2 after 2 or 3 lecture and problems with existing ventilation systems.

These findings stimulated Gdynia to invest in systems enabling remote control of air conditions and to plan modernization of at least 10 school building during next 5 years. These plans include installation of BMS systems or both BMS and thermos-modernization (the latter in PPP formula). Expected energy savings are 15% in the case of BMS alone and 50% when both measures take place. Gdynia was encouraged by results of municipal PKT company implementing EnMS in depot (expected energy savings 20-30%) – see figure 4 (a), as well as Sopot municipality thermos-modernization effects (energy savings up to 50%) – figure 4 (b). Sopot as one of the first municipality in the region implemented original ESCO/PPP formula which becomes inspiration for other municipalities of LEEG/OMGGS.

Figure 5.. Central station of EMS in PKT Gdynia, (b) thermos-modernized public building using PPP/ESCO formula in Sopot.

Presently, Gdynia with OPEC (a municipal company/heat distributor) are planning modernization of heating substations in schools enabling remote monitoring.

Success reasons vs drawbacks: the performed energy audits in school buildings in Gdynia pointed to challenge related to energy efficiency versus air quality. Performed air quality control have shown that after 2 or 3 lectures CO_2 concentration in the classroom can reach level above 3000 ppm, which might have longstanding consequences.

What does 3000 ppm of CO_2 means? Fresh air contains much less than 500 ppm of CO_2, international standards allow up to 1000 ppm. The CO_2 concentration above 3000 ppm may result in headache, problems with attentiveness and sleepiness; educational efficiency fall dawn drastically. Some authors point to lungs diseases and cancers.

Transferable value: large metropolitan LEEG can be a source of inspiration and technology diffusion for the participating (and other) municipalities in the field of energy efficiency. In the case of OMGGS/LEEG cities concentrated and shared ideas (during series of seminars) on technology issues related to EnMS/BMS systems, thermos-modernization and various energy contracts.