ENERGY MANAGEMENT IN THE CITY

Toolkit

DUET

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Prepared by: The Association of Municipalities Polish Network „Energie Cités"

In cooperation with: City of Bydgoszcz, Energy Management Team

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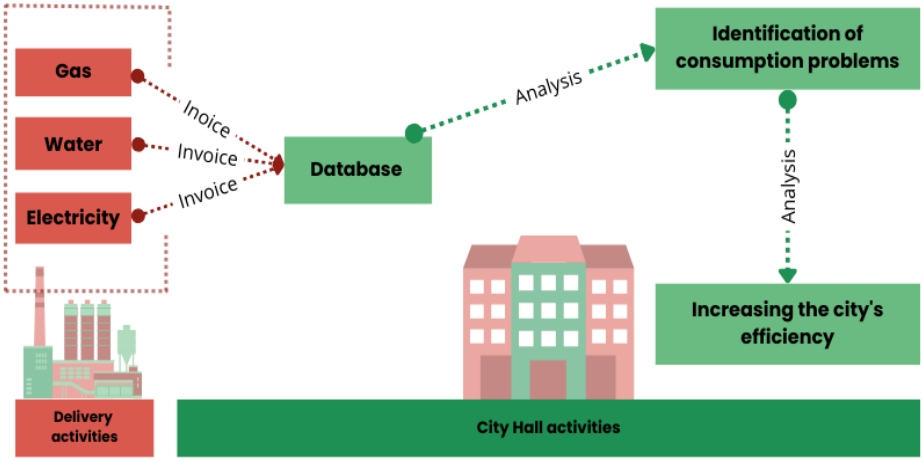
Effective energy management in cities is crucial for sustainable development, cost optimization, and improving the quality of life for residents. This process relies on analysing energy consumption data and identifying areas that require intervention, such as sectors with high consumption or neighbourhoods with low energy efficiency.

Supporting the energy management processes in a city involves developing strategies and utilizing appropriate technologies that enable the sustainable and efficient use of energy, while simultaneously optimizing costs and considering the well-being of residents.

1.1 What does such a process look like?

The city's energy management process requires the collection and analysis of a variety of data. Based on these, cities identify areas that require intervention, such as sectors with high energy consumption or neighbourhoods with low energy efficiency (Figure 1).

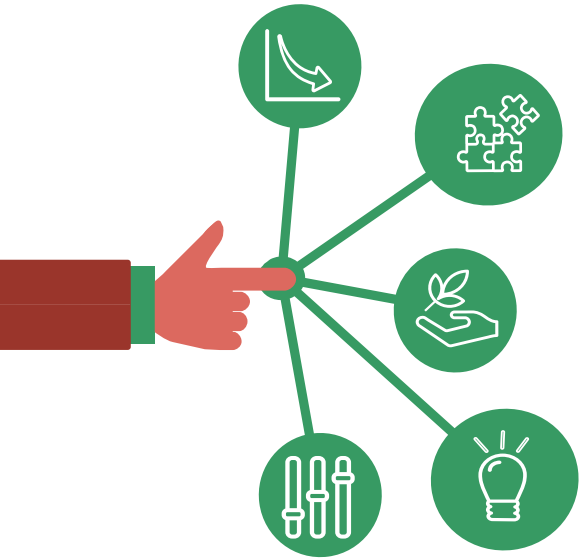
The most extensive and tedious part of the process, performed by the authority's employees, is the collection and processing of relevant data. This involves interfering with the circulation of many documents (including energy invoices, Point of Consumption (PCP) data, emissions monitoring data, and data on city resources) that are delivered to city buildings and institutions.



Supporting the energy management processes in a city involves developing strategies and utilizing appropriate technologies that enable the sustainable and efficient use of energy, while simultaneously optimizing costs and considering the well-being of residents.

1.2. Why is it worth implementing smart energy management system?

An effective energy management system allows the office to work more efficiently, easily analyse available data in order to catch any shortcomings and implement improvements enabling effective energy management in a later date. These improvements are an important step towards a more sustainable city development and enable taking the right path in climate and energy policy.



Although the implementation of a smart energy management system requires the involvement of many stakeholders (local authorities, energy companies and public institution workers), the benefits of taking such measures are tangible, so it is worth investing time and resources into their implementation:

LOWERING THE COST OF ENERGY

Energy management system unification allows for monitoring and optimization of the energy consumption in buildings and street lighting. This can lead to significant cost savings or easily noticing the aspects that need improvements. Thanks to that data can be easily analysed on an ongoing and yearly basis to identify areas where energy consumption is bigger than it is needed in order to implement improvements.

INCREASE IN ENERGY EFFICIENCY

These systems help cities in identifying and eliminating energy losses. Such mapping can become a basis for future investments leading to long term benefits, such as improving building insulation, modernising HVAC systems (heating, ventilation and air conditioning systems) and implementing of more energy efficient devices. Smart energy management helps to identify and eliminate energy losses in energy infrastructure, which leads to lowering the energy demand and improving the network reliability.

LOWERING THE GREENHOUSE GASSES EMISSIONS

Energy consumption is strictly tied to the emission of greenhouse gasses (GHG). Energy management systems can play a crucial role in combating climate change. Units managing their energy consumption more efficiently can lower GHG emissions, which contributes to improving air quality and protecting the environment.

According to International Energy Agency (IEA), implementing the energy management systems on a city level can help in lowering their energy consumption by 10-20% by 2050. This in turn can lead to a global GHG emissions reduction by 14 gigatons of CO_2 annually, which is about 20% of the current annual emissions related to the energy sector.

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INCREASING THE ENERGY SECURITY AND ENSURING THE RELIABILITY OF ENERGY SUPPLY

Energy management system enables better monitoring of the energy grid, identifying potential problems and responding to any system failures faster. This in turn affects the energy supply reliability for municipal entities, companies, as well as the residents. Additionally, proper energy management allows more efficient energy source diversification through integration of all energy sources, including renewable sources such as solar, wind and geothermal. This reduces the municipality's dependence on fossil fuels, which are prone to price fluctuations and supply disruptions.

Energy management system also allows identifying of a potential for the implementation of energy storage systems that store surplus energy produced by renewable energy sources and use it during periods of peak energy demand. This improves the flexibility of the Energy system and reduces the risk of power outages.

Properly implemented systems make it possible to implement demand-side management programs that encourage residents and companies to save energy during the periods of peak demand. These programs can include pricing schemes based on dynamic tariffs and programs incentivising energy savings.

IMPLEMENTING SMART TECHNOLOGIES

Energy management systems integrate autonomous technologies, such as smart energy grids, buildings and smart devices that allow the user to optimise energy usage and automate energy processes. Smart technologies play a key role in increasing energy efficiency of the energy management systems and making them more capable.

An example of the implementation of such technologies is the installation of an IoT (Internet of Things) sensor network e.g. in buildings, municipal infrastructure and devices in order to monitor energy consumption, temperature or even humidity. This data is sent to a central unit for analysis and visualization.

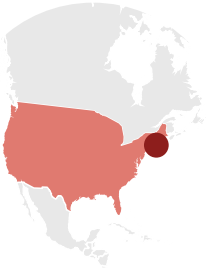
Smart energy grids are another example of this. They use information and communication technologies for a two-way flow of energy and information between energy producers, distributors and consumers. This enables better energy resources management, renewable energy sources integration and real – time response in energy demand changes.

1.3 Energy management systems around the world - examples

COPENHAGEN, DENMARK

Copenhagen is undeniably a great example for other cities in the world, showing how integrated approach to energy management can lead to significant cost savings and improvements in the resident's quality of life. The city has implemented an energy management system based on digitalization of the real – time energy consumption data. Thanks to smart meters the city monitors electricity, heat and water consumption in municipal buildings. All data is collected and analysed in a single platform, making it easy to manage and plan buildings modernisation. Energy management system covers most municipal buildings in Copenhagen. Around 90% of these facilities send hourly updated on Energy and water consumption. In the future it is planned to expand the system to larger private buildings[1].

The system brings both economic, as well as environmental benefits. It is estimated, that after a full implementation of the system, it will allow savings of up to 6 million USD annually. In 2016, thanks to these technologies, the city was able to save 6500 MWh of heat and 1345 MWh of electricity. Additionally, lowering the energy consumption contributes to achieving the city's climate goals, such as emissions neutrality by 2025.



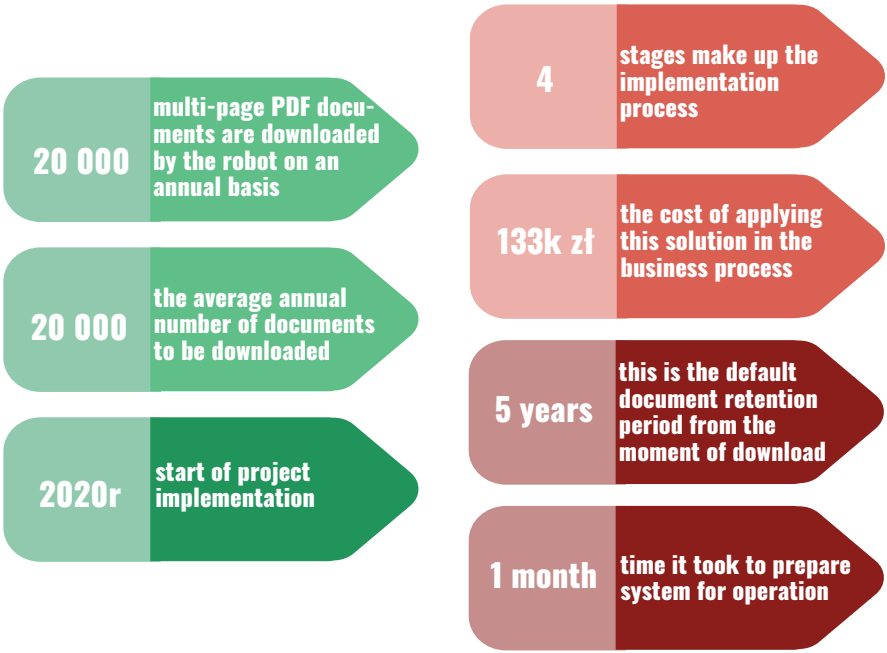
BOSTON, USA

In a project MIT Sustainable Design Lab and MIT Lincoln Lab along with the City of Boston developed a detailed map that monitors hourly energy consumption of buildings, which allows for energy demand pattern analysis and assessing the local energy production capabilities. The map tracks hourly energy consumption in commercial buildings, apartments and critical facilities, such as shelters and food storage, in Boston. The map also includes hypothetical engineering solutions and assesses the feasibility of the local clean energy generation. Using this information, the City Hall is able to efficiently assess the impact of planned investments[2].

YOKOHAMA, JAPAN

In 2010 the city of Yokohama, Japan initiated the Yokohama Smart City Project (YSCP), as a five--year pilot program covering three districts. Currently YSCP is being realised in the whole city populated by 3,7 million residents. This program uses smart energy management grids in homes, buildings and local communities, supports the renewable energy development on a large scale and promotes green solutions in transportation. Thanks to YSCP 4200 households were equipped with energy management systems, reducing the energy consumption by 20% through consumption visualisations and incentives to reduce power consumption. In offices and commercial buildings these systems have also contributed to a 20 % reduction in peak energy demand [3].

2. Energy management system in Bydgoszcz



The City of Bydgoszcz implemented a system called Energy Management Base (EMB). Appropriate units of the Bydgoszcz City Hall, i.e. the IT Department and the Energy Management Team implemented robotization of one of the processes previously carried out entirely by the Energy Management Team. This system has been developed and implemented in such a way as to allow for maintenance-free downloading, distribution and archiving of documents concerning payments for utilities (i.e. electricity, heat, water and gas fuel).

The application allows for:

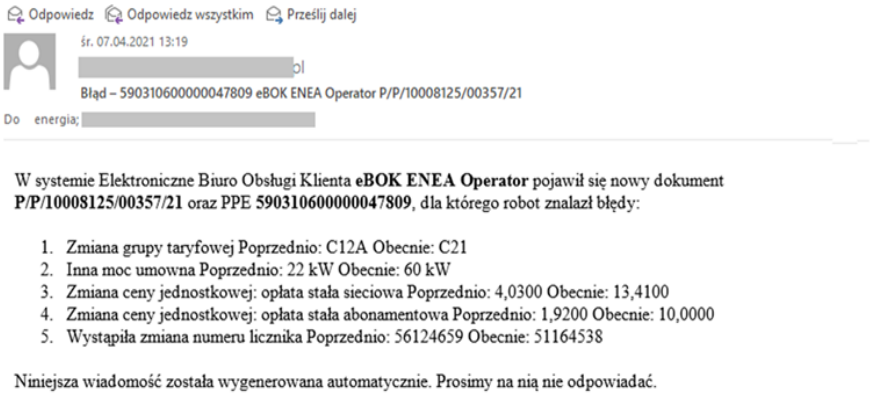
- obtaining source documents, such as:
  - Data from invoices, i.e.: unit price of energy, commercial fees, fixed network fees, fees for over-contractual consumption of reactive energy, meter number.
  - Data on Power Consumption Points (PCP), i.e.: identification and assignment of PCP to appropriate units, changes in tariff groups, changes in contracted capacity, energy consumption in a given settlement period.
  - Data related to CO_2 emissions, i.e. calculation of CO_2 emissions based on energy consumption, monitoring of emissions related to individual buildings.
  - Financial data, i.e. costs related to energy consumption, budgeting based on costs and energy consumption, generation of financial reports and budget analyses on urban resources, i.e. the area of buildings, the number of users, the year of construction of facilities.
- reading data from them, saving them in a central repository and analysing them,
- sending a given document in electronic form to the appropriate unit (final recipient).

The previous process of processing and distributing energy data was so tedious and complicated that it was not possible to download documents and build a database on an ongoing basis. The lack of documents resulting from problems with the postal shipment was a significant problem. Traditional paper invoices can get lost or not arrive on time, making it difficult to process payments on time and control costs. The digitization of invoices and documents within EMB eliminates this risk. In the case of document distribution by the City Hall, thanks to the solutions introduced, it was possible to replace the traditional method of document distribution with a more modern method – electronic – replacing the paper form of documents with electronic files. This saved time for employees and the city for the costs associated with sending documents. Thanks to the introduced solutions, it was also possible to reorganize work in local government units, thanks to which the speed of tasks performed and work efficiency increased.

The City of Bydgoszcz has been undertaking numerous activities that are innovative on a national and European scale for years. Robotization processes, which are the only solution of this type in the country, are the best example of this. Due to the potential for replication of the project, this topic is very popular among other local government units

2.1 Operation of the Energy Management Base

The robot automatically logs in to the indicated energy distributor and seller portals, and then downloads source documents from predefined pages. Then, from the downloaded invoices, it rewrites the data to EMB and distributes the downloaded documents to the appropriate e-mails of municipal units on the basis of the connection of the power consumption point (PCP) with a given unit (Figure 2). During the process, deviations from fixed data are monitored, such as: rates and fees for energy and energy distribution, commercial fee, contracted capacity, meter number, lack of energy consumption and the occurrence of the same billing period being charged twice for a given consumption point (Figure 3).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Błąd – 590310600000047809 eBOK ENEA Operator P/P/10008125/00357/21

Do energia;

W systemie Elektroniczne Biuro Obsługi Klienta **eBOK ENEA Operator** pojawił się nowy dokument **P/P/10008125/00357/21** oraz PPE **590310600000047809**, dla którego robot znalazł błędy:

1. Zmiana grupy taryfowej Poprzednio: C12A Obecnie: C21
2. Inna moc umowna Poprzednio: 22 kW Obecnie: 60 kW
3. Zmiana ceny jednostkowej: opłata stała sieciowa Poprzednio: 4,0300 Obecnie: 13,4100
4. Zmiana ceny jednostkowej: opłata stała abonamentowa Poprzednio: 1,9200 Obecnie: 10,0000
5. Wystąpiła zmiana numeru licznika Poprzednio: 56124659 Obecnie: 51164538

Niniejsza wiadomość została wygenerowana automatycznie. Prosimy na nią nie odpowiadać.

Figure 2. Distribution of data to the indicated e-mails of the analysed units.

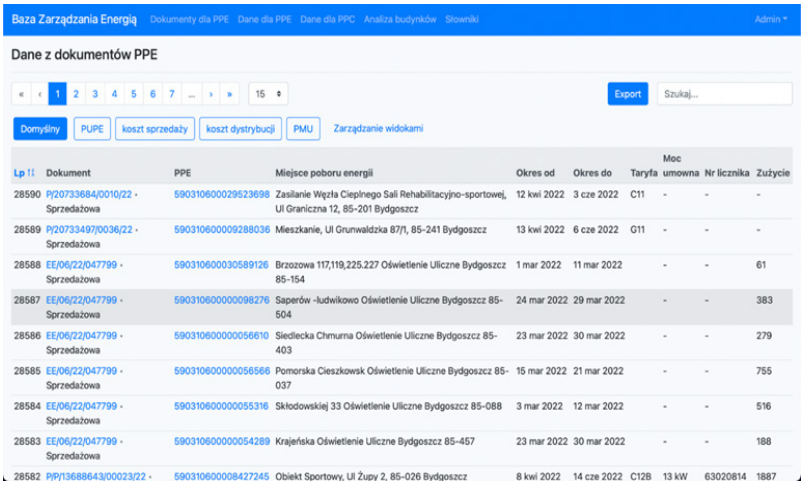


Figure 3. Energy Management Database view – types of data collected.

The Data Management Database allows for quick access to this information by generating reports on demand. This allows for monitoring the energy consumption and costs in real time without having to manually search through the documentation. If the system detects irregularities in the master data, the system issues an automatic alert that allows the supervisory team to react quickly and optimize energy consumption. The system also detects changes in data such as tariff groups, contract capacities or fixed fees and informs the supervisory team of any non-compliance.

All collected data goes to a central repository, i.e. a database of historical energy consumption (Figure 4). By centralizing data, all information is gathered in one place, eliminating the problem of dispersion and enabling easier access to complete and accurate energy data. Thanks to this, the City of Bydgoszcz can more effectively manage energy costs and make decisions based on reliable and up-to-date data.

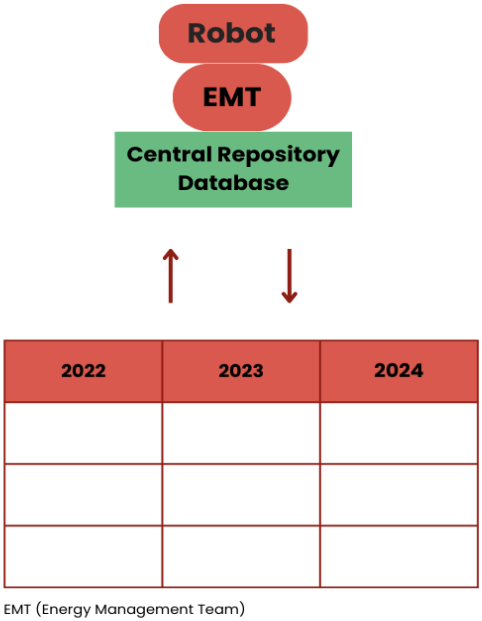


Figure 4. Creation of a central repository in which data is collected, on the basis of which energy consumption forecasts are made.

The introduction of robotization processes is one of the most effective activities introduced to the city's structure in recent years. The costs of purchasing the system were „recouped" after 6 months from the date of purchase. Despite the initial financial outlays, the investment allowed for more effective energy management, relieving employees and more effective optimization.

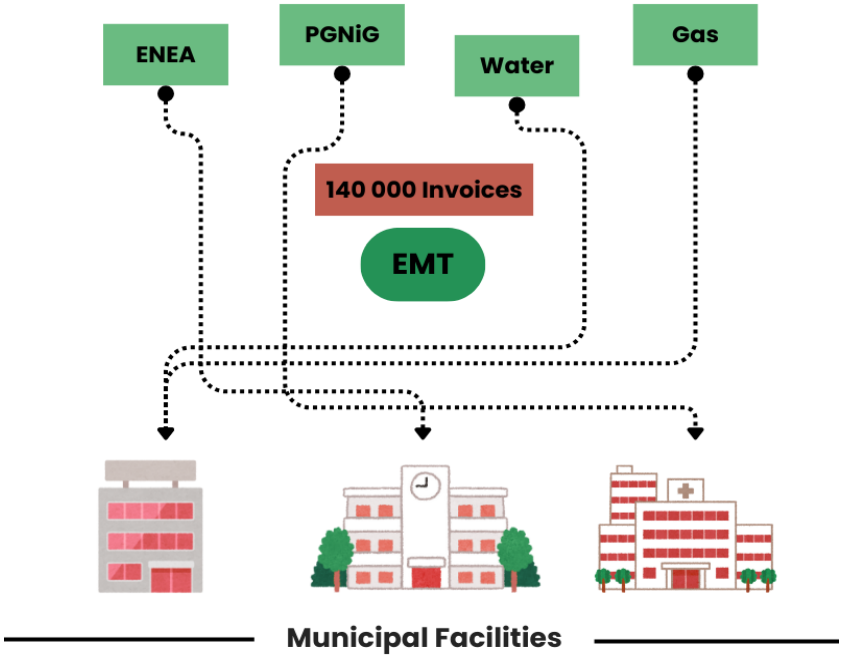


Figure 5. Circulation of documentation in the city without the use of an energy management system. The competent municipal authority for energy is often bypassed by the flow of information. It does not control it.

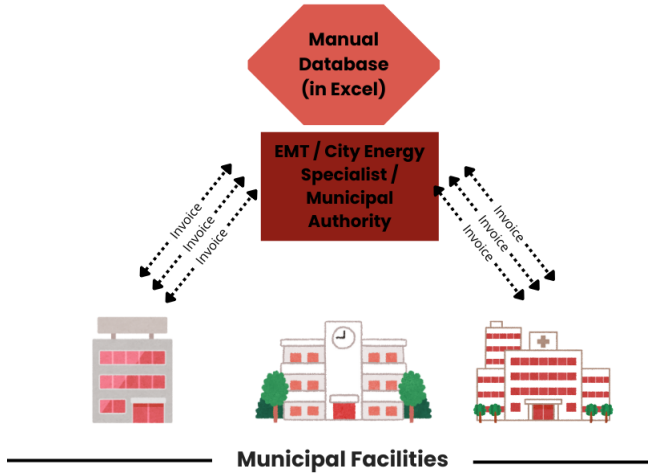


Figure 6. Creating an energy database in a city without using an energy management system. A delegated municipal branch mediates the flow of energy information each time. It puts a lot of work into it, builds a database on its own, which is prone to errors such as missing documentation and errors in data.

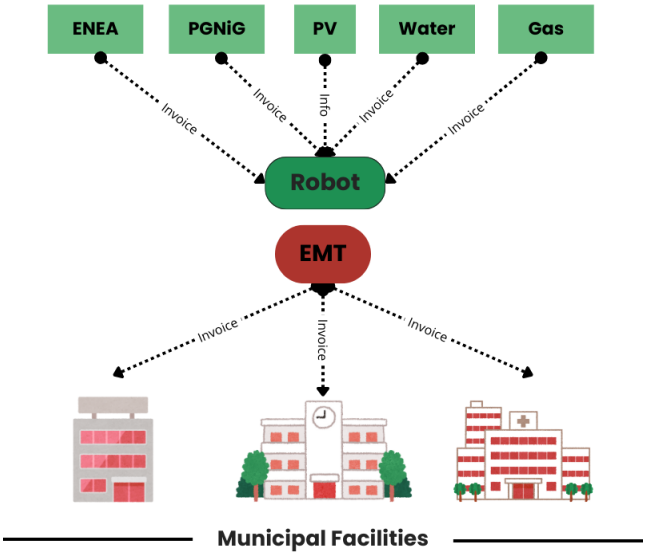


Figure 7. Information flow after the implementation of an energy management system.

2.2 Areas of authority

The implementation of the Energy Management Base has brought the city a number of measurable benefits that have significantly improved the efficiency of energy resource management and facilitated the implementation of strategic energy goals. One of the key achievements was the creation of a central data repository that enables the central management of all contracts covering all utilities. As a result, the municipal administration in Bydgoszcz now has easier access to information and can more effectively monitor and control energy consumption and the associated costs.

Thanks to this improvement, it was possible to comprehensively implement the digitization of document circulation and build a database of the energy management system. Digitizing these processes and collecting data faster enables more effective climate plans. In addition, the city is better able to manage its energy resources and make decisions based on reliable data.

An important element of the implementation was also the creation of conditions conducive to the systematic acquisition of external funds for the energy transition. By developing the competences of civil servants and investing in their education, the city can more effectively apply for funds for energy-related projects. The knowledge gained by specialists translates directly into the city's ability to implement ambitious climate plans and improve energy efficiency.

The new system also carried out a detailed inventory of city's resources, allowing for better coordination of energy management activities. As a result, the city is able to better adapt its activities to the needs of its residents and environmental protection requirements.

2.3 Stages of implementing the Energy Management Database

The process of implementing EMD consisted of four stages:

1

OBTAINING SOURCE DOCUMENTS

The RPA (robotic process automation) robot logs into the portals of the eBOK customer service system of the electricity seller and distributor at least once a day from Monday to Friday and downloads documents that have not been downloaded since the last login. Documents are downloaded, i.e. invoices, requests for payment, contractual penalties, interest notes and other documents available for download. Documents are downloaded in the source format under a unique name containing at least the document number so that they can be further processed and data can be obtained. The average annual number of documents to be downloaded can reach up to 20 thousand.

2

OBTAINING DATA FROM DOCUMENTS AND ANALYSIS

With the help of a prepared solution for process automation, the contractor recognizes the type of source document and transforms it into a digital data stream through the data mapping mechanism. Data retrieved from documents feed the created database. For invoice documents, a set of data necessary for the process is downloaded.

At the stage of ordering the project, it was assumed that the documents made available on the seller's and distributor's eBOK would have a PDF format in the form of embedded text data in these documents and the process of recognizing the content of the documents (OCR-ing) would not be necessary.

As part of the contract, it was included that substantive institutions would have access to downloaded documents and a database that will contain data from all uploaded documents along with detailed data from invoices and a link to source files. The data downloaded daily is added to the database. Data can be viewed by document type and by all fields. In addition, the system is equipped with a mechanism for exporting data in Excel format. The mechanism allows for filtering by a specific range of data. In addition, the system informs about changes in documents by sending an alert to the indicated e-mail address in the event of deviations from the norm and applicable standards.

DOCUMENT DISTRIBUTION

3

On the basis of a list containing the association of the PCP with an e-mail address, all documents can be sent to the indicated e-mail addresses. In addition, the system must allow for simple editing of PCP - e-mail address relationships. If there is more than 1 PCP number associated with different e-mail addresses on the document, the document is sent to all e-mail addresses indicated in the association.

In the case of documents that do not include the PCP number, but which are linked to another source document, e.g. a summons, a note, the system transfers these documents according to the PCP appearing on the source documents. In addition, a report is generated with information about downloaded documents, documents that have been sent to units and documents that could not be delivered to units.

In the case of non-delivery, the report contains a description of the error allowing for appropriate corrections, and in the case of inability to deliver the document due to the lack of recognition of the PCP, the lack of connection between the PCP and the e-mail, the inability to link the document downloaded without the PCP with the source document from the PCP, after a certain number of attempts, such a document is directed to the e-mail address specified in the configuration.

ARCHIVING DOCUMENTS AND DATA

The system allows for defining the period after which a specific type of documents is deleted both from the database and the files corresponding to the entries in the database are deleted. By default, this period is 5 years from the time of collection.

The system was delivered in the form of a solution installed on the customer's servers - in an environment with specific parameters. All additional services, such as outgoing mail handling, prepared database, must be configured and provided by the Contractor.

2.4 Benefits resulting from the Energy Management Base

The implementation of the Data Management Database brings numerous benefits, improving the efficiency of energy management. One of the key aspects is the automatic creation of an energy database, which in turn enables the central collection and easy access to all information on energy consumption. The system automatically checks the correctness of data on invoices, detecting and correcting errors, which increases accuracy and financial transparency.

Eliminating paper invoices eliminates the associated costs and speeds up document processing. Electronic invoices facilitate archiving and access to payment history. The system generates quick reports on energy consumption and costs, enabling ongoing monitoring of expenses and better budget planning. In addition, thanks to the ability to alter anomalies according to pre-set quantifiers, the system automatically detects and reports any irregularities, which allows for quick response and optimization of energy consumption.

3. Instruments supporting the development of energy management systems in your city

With knowledge of how modern energy management systems work and their benefits, this chapter will show You how to implement such automation in Your city.

EVALUATION OF WORKING TIME IN YOUR CITY

Which of the processes related to energy management takes the most time? Is there any way to speed it up/ automate? What difficulties do office employees encounter in the circulation of information related to energy distribution?

SETTING PRIORITIES AND STAGES OF CHANGE IMPLEMENTATION

Indicate priorities, outline an action plan. Adding functionalities can be done slowly – the most important thing is that the changes are in line with the assumed priorities.

DISCUSSION WITH THE IT DEPARTMENT
Is the IT Department in Your City Hall able to realistically undertake the implementation of the process?

SEARCHING FOR SOURCES OF FINANCING

SYSTEM EXECUTION

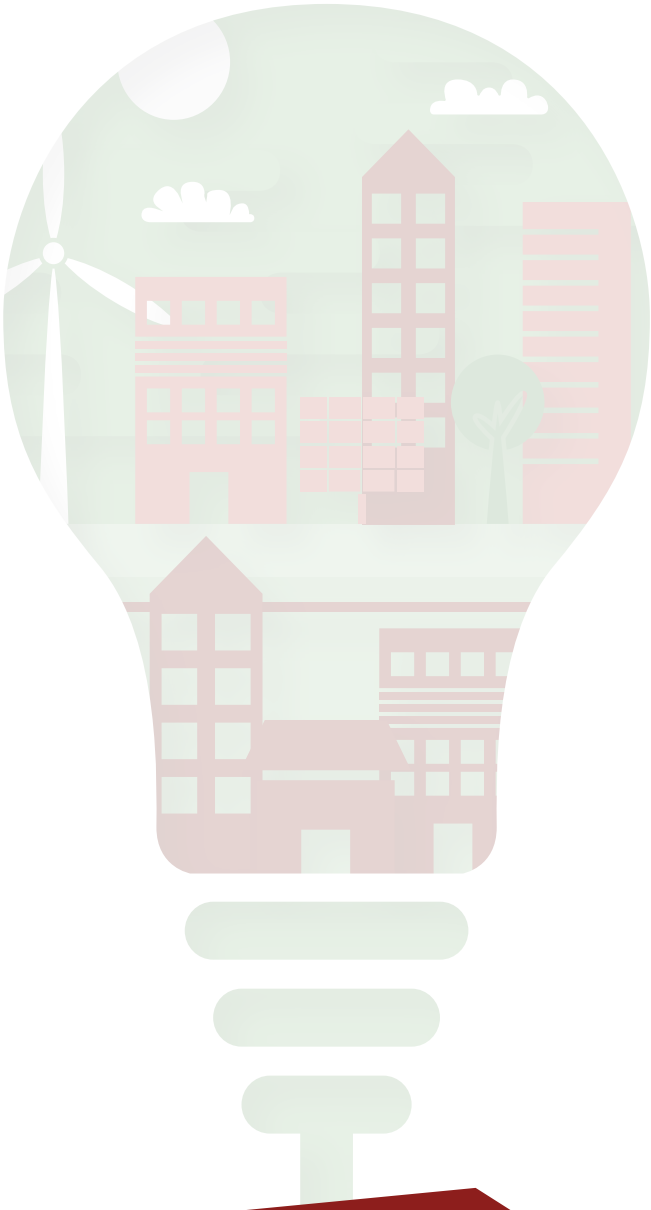
TRAINING FOR EMPLOYEES
Training the office's employees in the operation of the developed system will allow them to be introduced to the program and ensure the proper use of the implemented automations.

AUTOMATION IMPLEMENTATION

ENERGY ANALYSIS AND ACTION PLAN
With an abundant database of energy consumption, You can rely on it to plan measures to improve Your city's energy efficiency.

3.1 Additional materials and sources of information

- [1]https://www.c40.org/pl/case-studies/cities100-copenhagen-mapping-real-time-consumption-to-plan-efficiency-updates/
- [2]https://www.bostonplans.org/planning-zoning/planning-initiatives/boston-community-energy-study
- [3]https://www.c40.org/pl/case-studies/cities100-yokohama-city-wide-rollout-of-smart-energy-management/
- https://zawiercie365.pl/pl/728_samorzad-gminny-powiatowy---wybory/32934_innowacyjny-samorzad-2024-wdrozenie-bazy-zarzadzania-energia-najlepszym-projekt.html
- https://www.bydgoszcz.pl/aktualnosci/tresc/nasz-robot-ponownie-nagrodzony-1/
- https://www.bydgoszcz.pl/aktualnosci/tresc/robot-zarzadza-fakturami-za-prad-zdobyl-1-miejs/
- https://www.bydgoszcz.com/artykul/7802,cyfrowy-urzednik-cenna-pomoca-w-samorzadzie-nagroda-dla-um-bydgoszczy
- https://pfrdlamiast.pl/baza-miejskich-innowacji/robotyzacja-procesow-administracyjnych-w-urzedzie-miasta-bydgoszczy.html
- https://www.c40.org/pl/case-studies/cities100-yokohama-city-wide-rollout-of-smart-energy-management/
- https://www.c40.org/pl/case-studies/cities100-copenhagen-mapping-real-time-consumption-to-plan-efficiency-updates/
- https://www.bostonplans.org/planning-zoning/planning-initiatives/boston-community-energy-study
- https://www.freepik.com/pikaso/explore



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