

TOOLS TO HELP ENERGY EFFICIENCY IN PUBLIC BUILDINGS

Velizar Petrov

*Regional development agency with Business center for support of small
and medium-size enterprises, Plovdiv, Bulgaria*

University of agribusiness and rural development, Bulgaria

Abstract: Energy efficiency is the goal of every investor, owner or user of buildings amid the trend of increasing energy prices worldwide. Often this understandable drive goes hand in hand with quite unrealistic expectations.

Achieving energy sustainability and efficiency in public buildings usually has a much greater social and economic impact.

Before we take the first important step towards energy efficiency, we need to know a few things: where are we on the energy efficiency scale, can we improve it and by what means? How much will it cost and how long will the investment pay for itself?

The PRO-ENERGY project aims at promoting Energy Efficiency in public buildings in the Balkan Mediterranean territory and to create a practical framework of modelling and implementing energy investments interventions, through specific ICT monitoring and control systems, as well as through energy performance contracting. The current “Joint cost-benefit analysis modeller” aims at supporting decision-making for retrofits, renovations, etc., which lead to increased energy efficiency in public buildings. It was tested for piloting public building of UARD (University of Agribusiness and Rural Development), Plovdiv, Bulgaria.

Keywords: energy efficiency, public buildings, sustainability.

The context

In the Energy Union, five dimensions are closely intertwined to contribute to achieving greater energy security, sustainability and competitiveness:

- (1) energy security, solidarity and trust;
- (2) an integrated European energy market;
- (3) energy efficiency;
- (4) decarbonization of the economy;
- (5) research, innovation and competitiveness.

European goals have been developed, which are also reflected at the national level.

Energy efficiency is the goal of every investor, owner or user of buildings amid the trend of increasing energy prices worldwide. Often this understandable drive goes hand in hand with quite unrealistic expectations.

Before we take the first important step towards energy efficiency, we need to know a few things: where are we on the energy efficiency scale, can we improve it and by what means? How much will it cost and how long will the investment pay for itself?

What does energy efficiency depend on?

Let's not forget that the energy efficiency of buildings is a relative concept. The expression itself shows a ratio between consumed energy, the costs incurred for it and the benefits received in return. The latter are individual to each business and building and are the most difficult thing to measure. But the ratio between the first two, other things being equal, can give some idea of where our existing or planned building is on the scale of energy efficiency.

In terms of technology, here are the categories that contribute most significantly to energy consumption and relate to the energy efficiency of the building.

It is evident that the largest and most expensive of these also have the greatest potential for cost savings. However, they are also the ones that are the most static and, accordingly, the most difficult subject to significant renovation and modernization in the direction of energy efficiency. Therefore, with a building already designed or built, the only system that can be integrated and change the energy picture remains the building automation system. If the existing building technical installations allow connection to a building automation system, this can seriously change the game in a positive direction in terms of efficiency.

In terms of technology, here are the categories that contribute most significantly to energy consumption and relate to the energy efficiency of the building.

It is evident that the largest and most expensive of these also have the greatest potential for cost savings. However, they are also the ones that are the most static and, accordingly, the most difficult subject to significant renovation and modernization in the direction of energy efficiency. Therefore, with a building already designed or built, the only system that can be integrated and change the energy picture remains the building automation system. If the existing building technical installations allow connection to a building automation system, this can seriously change the game in a positive direction in terms of efficiency.

The common challenge of PRO-ENERGY is to improve energy efficiency of public buildings (municipal/provincial/regional buildings, schools, universities, health centers, hospitals, museums, sports facilities etc.). This is a common problem faced by the territories participating in the project characterized by old facilities, outdated/degraded building façades, materials and equipment (insulation, electrical appliances, cooling/heating systems etc.), lack of skilled civil servants, etc. all leading to high energy consumption and CO₂ emissions

Target groups/stakeholders include local/national/regional public authorities, sector agencies and regulators, infrastructure and service providers, interest groups and NGOs, higher education and research institutes, training centers and schools, business and enterprise support organizations in the project areas. They were include in the formulation of the Joint Strategy and Action Plan through public consultation and other formal/informal meetings and events.

Main activities:

- Existing situation analysis - energy efficiency
- Good practices selection and benchmarking
- Joint strategy and action plan for increasing energy efficiency through behavioural change
- Joint criteria for selecting pilot public buildings
- Energy audits in pilot public buildings
- Design and implementation of activities on Capacity Building for Energy Managers
- Installation of smart sensors in pilot public buildings
- Design and development of a joint pilot platform for monitoring and improving energy efficiency in public buildings
- Designing and implementing a joint benefit analysis mode

- Three types of pilot actions are foreseen:
- 1) Design & development of an open-source Joint ICT Platform,
- 2) The design & development of the Joint Cost-Benefit Analysis

Modeller &

- 3) The joint preparation of Energy Performance Contracts.

Joint Cost-Benefit Analysis Modeller

Joint cost-benefit analysis modeller aims at supporting decision-making for retrofits, renovations, etc., which lead to increased energy efficiency in public buildings. The tool can be used in two main cases: assessment of the performance of an already existing and operating building and virtual assessment of the energy efficiency of a future building that is currently being designed, built or renovated. In both cases, the generated data can serve not only as a reference and assessment of the current state of the building, but also as a basis for making decisions about future improvements. Calculations are made on the basis of entered output data for available building systems such as heating, cooling, ventilation, lighting, etc. The assessment begins with the introduction of basic data about the user and the building, as well as a choice of currency in which the potential future investments and their benefits will be measured. The next steps require entering detailed data about the

available systems in the building and the levels of automation in them. After entering all the information, the tool can generate a report. The tool has a specialized financial module that allows choosing between different energy sources and entering price information. In this way, if the value of the planned energy efficiency investment and the annual consumption of the building are entered, we will get the time for its repayment and the saved costs in 10 years. This assessment can answer the question: should we invest in a building automation system or what will we lose if we don't. Of course, this estimate is approximate, especially in financial terms, but it can give a good indicative idea of the potential for increasing energy efficiency.

The cost-benefit analysis modeller (CBA) is composed of the following key features (sheets):

- Cover: Title page, including disclaimer. It also includes four (4) buttons for navigation to the additional model sheets.
- Operating Guide: The present sheet provides a manual on using the CBA tool.
- Dashboard: A simplified and snapshot presentation of the Key Inputs inserted, the CBA Key results and the Project's Financial Structure. Furthermore, the "Dashboard" sheet presents the main Operating and

Investment Flows during both construction and operation periods, concluding to the Free Cash Flow per period examined.

- Inputs: The “Inputs” sheet has mainly to do with data entry. The user has to insert its estimations in this sheet.

- CBA analytics: It is a financials output sheet, thus presenting both the occurring financial KPIs of the analysis conducted.

The cost-benefit analysis modeller (CBA) is composed of the following key features (sheets):

- Cover: Title page, including disclaimer. It also includes four (4) buttons for navigation to the additional model sheets.

- Operating Guide: The present sheet provides a manual on using the CBA tool.

- Dashboard: A simplified and snapshot presentation of the Key Inputs inserted, the CBA Key results and the Project’s Financial Structure. Furthermore, the “Dashboard” sheet presents the main Operating and Investment Flows during both construction and operation periods, concluding to the Free Cash Flow per period examined.

- Inputs: The “Inputs” sheet has mainly to do with data entry. The user has to insert its estimations in this sheet.

- CBA analytics: It is a financials output sheet, thus presenting both the occurring financial KPIs of the analysis conducted.

Joint CBA Modeller Inputs

The input data:

- Annual Energy Cost Savings: The estimated annual energy savings to be triggered by the project's accomplishment, in currency terms.

- Total Capital Expenditure: The amount of the total capital expenditures for project's construction, in currency terms

- Subsidy/Grant Amount: The grant to be received for financing the project's construction.

- Debt: The debt % to be used to cover own financing.

- Loan inputs: Interest rate (the loan's interest rate), Maturity years (the loan's maturity period), Loan type, Grace period (if applicable), Total Operating Expenses (automatically calculated the sum of total operating expenses).

- Financial and Fiscal inputs: Inflation rate (according to the national CPI index), Energy Inflation rate, Tax rate, Discount factor.

- Environmental Inputs: Reduction in Electricity Consumption (kWh/y), Reduction in Diesel Consumption (kWh/y), Operations Period (the project's estimated operational period in years).

CBA Inputs

Annual Energy Cost Savings ▶

Total Capital Expenditure ▶

Subsidy/Grant Amount ▶

Own Financing ▶

Upon Own Financing:

Debt ▶

Equity ▶

Project's Financial Structure

Subsidy/Grant

Debt

Equity

Total

Loan Balance at the end of Grace Period

Interest during Grace Period

Loan Inputs

Interest Rate

Maturity (years)

Loan Type (1/2)

Grace Period (Yes/No)

Grace Period (years)

Total Operating Expenses

Maintenance Costs

Staff Costs

Managerial Fees

Insurance Costs

Other Expenses

Financial & Fiscal Inputs

Depreciation Rate

Inflation Rate

CBA Results

NPV (currency amounts) -

IRR N/A

Payback (years) -

DSCR N/A

Reduction in Energy Consumption (kWh/y) -

Reduction of CO2 Emissions (tns/y) -

[Show me the CBA Results' Analytics](#)

[Get me back to Dashboard](#)

Instructions for "Inputs" sheet

Input cells. Please fill in the data required by the CBA Modeller.

Output cells. The amounts are automatically calculated and are used for CBA purposes.

CBA analysis

The section provides a financial output sheet, thus presenting both the occurring financial KPIs of the analysis conducted, as well as Investor's Profit & Loss statement, Investor's Cash Flow statement, Payback Analysis and Debt Service Cover Ratio Analysis. The very analysis takes place under the Discounted Cash Flows investment valuation framework.

CBA Inputs	UARD Building
Annual Energy Cost Savings (euro)	626
Total Capital Expenditure (euro)	5113
Subsidy/Grant Amount (euro)	-
Debt (%)	-
Interest Rate (%)	0.3%
Maturity (years)	-
Grace Period (years)	-
Maintenance Costs (euro)	0
Staff Costs (euro)	0
Managerial Costs (euro)	0
Insurance Costs (euro)	0
Other Expenses (euro)	-
Inflation Rate (%)	0.5%
Energy Inflation Rate (%)	-
Tax Rate (%)	-

Discount Factor (%)	0
Operations Period (years)	19

CBA Analytics UARD

Proposals	UARD Building
NPV: Net Present Value (€)	6781
IRR: Internal Rate of Return (%)	10.36
Payback Period (years)	9
DSCR (average)	N/A

$$NPV = F / [(1 + i)^n]$$

Where,

PV = Present Value

F = Future payment (cash flow)

i = Discount rate (or interest rate)

n = the number of periods in the future the cash flow is

NPV is calculated by taking the present value of all cash flows over the life of a project. Then, the present value of cash flows is subtracted from the investment's initial investment. If the difference is positive (greater than 0), the project will be profitable.

The internal rate of return (IRR) is a metric used in financial analysis to estimate the profitability of potential investments. IRR is a discount rate that makes the net present value (NPV) of all cash flows equal to zero in a discounted cash flow analysis.

$$NPV = \sum_{n=0}^N \frac{C_n}{(1+r)^n} = 0$$

Conclusions and recommendations

During the survey and analysis of the Energy agency of the pilot building in Bulgaria, two modelers were used - economic and technical. The modeler developed within the project is one and combines economic and technical indicators in one. After the comparison, we found that the results are similar. We have a recommendation to make the interface of the modeler more attractive for end users, as well as to enable graphical representations of the analyzes and the possibility of automatic generation of report forms.

References

1. ЕК (2021), Съобщение за медиите, Европейски зелен пакт: Комисията предлага преобразяване на икономиката и обществото на ЕС за постигане на амбициозните цели в областта на климата, https://ec.europa.eu/commission/presscorner/detail/bg/IP_21_3541?fbclid=IwAR0mf8c-2yTqG2ispU4KC7BtrBEw-ohJhAMl1CFIn95fwTivAs2BhgWST4Y [Accessed: 12/07/22]
2. Р. България, Министерство на енергетиката (2020), „Стратегия за устойчиво енергийно развитие на РБългария до 2030 г. с хоризонт до 2050 г.“, стр. 5.
3. Official Journal of the European Union (2018), REGULATION (EU) 2018/1999 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL, <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018R1999&from=BG> [Accessed: 07/07/22]
4. PRO-ENERGY: Promoting Energy Efficiency in Public Buildings of the Balkan Mediterranean Territory - <https://pro-energy-project.eu/>