Innovative financial schemes for buildings’ energy renovation

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Abstract. Building energy renovation is a key issue to tackle the high energy consumption of the building stock. Many countries - especially the Mediterranean ones - have been strongly hit by the financial crisis of 2008 which has affected national economies and resulted in market uncertainty. On one hand, the financial resources are very limited and on the other hand, the energy efficiency policy of the European Union (EPBD recast and Energy Efficiency Directive) has become stricter with more ambitious goals in terms of energy efficiency and CO₂ emissions, especially of the public building stock. Public authorities are not ready to implement them. Administrative and regulatory obstacles help to maintain an unsuitable environment for this kind of initiatives. The majority of public buildings can significantly improve their energy performance, but to mobilize these investments new financial instruments are necessary (such as Energy Performance Contracting – EPC) that will be negotiated with new market actors (Energy Services Companies – ESCOs).

The current work tries to facilitate the decision to implement energy renovation measures in public buildings by the use of a tool. The Subsidy Evaluation Tool (SET) carries out an energy and financial evaluation of Energy Conservation Measures (ECMs) for buildings energy renovation and can be used for various types of public buildings. The main aim of the tool is to find innovative financing schemes that combine public resources with private investments and to create conditions for deep investments in energy efficiency actions for public buildings considered bankable by the market. The paper presents the structure of the tool, its layout, the parameters and formulas utilized, so as to provide with the most appropriate solution for energy retrofitting of buildings from a techno-economic point of view.

1. Introduction
The European energy policy is clear: achieve maximum energy conservation in existing buildings. More challenging targets for less energy needs in buildings are constantly set (2030 targets, 2050 targets) [1]. Latest trends combine energy efficiency plans with specialised financial schemes to facilitate the increase of energy efficiency measures in the existing European building stock. In this way the energy measures are supported by appropriate loan and grants mechanisms.

The current work presents a tool that supports the implementation of energy renovation measures in public buildings through an energy and financial evaluation of Energy Conservation Measures (ECMs), taking into account combination of financing schemes. The tool is an outcome of a European funded project to facilitate financial viable energy renovation actions in the Mediterranean area [2].

2. Energy efficiency interventions on buildings
Sound energy efficiency interventions on buildings, especially on envelopes and glazing systems, generally require long payback times and yield low IRRs (Internal Rate of Return) thus financial
indicators of EPCs (Energy Performance Contracting) for the energy refurbishments of buildings are on average below the minimum levels required by the market. This is the reason why long term investments in building renovation through EPCs, especially in the Mediterranean countries, are not being implemented on a large scale.

The minimum IRR percentage “required by the market” is not a precise measure but rather an empirical figure based on the risk reward profile of these kinds of interventions. In other words only direct contacts with Energy Service Companies (ESCOs), financial institutions and other stakeholders can provide evidence of the market threshold in terms of the IRR which needs to be met to make a project bankable.

In the case that a specific project does not yield a sufficient IRR, calibrated public funding shall be needed to make it profitable. The Subsidy Evaluation Tool enables Public Contracting Authorities (PCAs) to calculate the exact amount of subsidy needed minimizing public spending.

3. Optimising funding for energy efficiency investment projects

The economic & financial assessment of a project goes beyond understanding whether an investment is convenient or not, it also provides a method to understand how to select the best investment in the case of different projects and different financing schemes, and is always a fundamental support for the general understanding of the project.

Once cash flows related to an energy efficiency investment project (-Io = Initial Investment, +CFj = annual savings in the form of avoided costs from reductions in energy bills) have been assessed, the IRR method involves finding the interest rate - R which, used to discount the cash flows expected from the investment, will produce a NPV (Net Present Value) of zero where the total Present Value (PV) of the sequence of cash inflows is equal to the present value of the cash amount invested.

The IRR therefore is that particular value of the discount rate R that makes a NPV equal to zero. Formally:

\[ \text{NPV} = \sum_{j=1}^{n} \frac{CF_j}{(1+R)^n} - Io \text{ (Initial Investment)} = 0, \text{ when } R = \text{IRR} \]

in other terms, NPV is zero when:

\[ \sum_{j=1}^{n} \frac{CF_j}{(1+IRR)^n} = Io \text{ (Initial Investment)} \]

One of the major problems with subsidies in general and specifically in the field of energy efficiency measures of buildings is calibrating their amount. Namely, if a subsidy is needed then it should be optimised (providing the minimum amount to make an investment financially feasible) and not based on a general flat rate, fixed percentage or defined as a certain amount of the energy measure investment. The fundamental question is how do we minimise subsidies in this context? A starting point is that the cost of a defined set of energy efficiency measures may be known in advance with reference to local standard costs. Baselines and savings from energy efficiency measures may also be calculated, what will really make a project financially feasible is its IRR (Internal Rate of Return) that must reach the market threshold.

Subsidies are minimised when their amount, given the total investment needed and all savings calculated over the considered period, enable the project to yield an IRR equal to the market threshold (IRR* minimum interest rate “required by the market”).

Taking into consideration basic financial maths, the optimal subsidy may be seen as the dependent variable that given all the other known values (Investment amount (-Io), CFj annual savings) makes the project’s NPV (Net Present Value) equal to zero.

Therefore, given the following values:

- Io (Initial Investment);
- CFj (annual savings for n years);
IRR* discount rate = minimum IRR interest rate required by the market.

Then the minimum S (Subsidy) for project feasibility will have to make the project’s NPV equal to zero, formally:

\[
\text{NPV} = \sum_{j=1}^{n} \frac{CF_j}{(1 + IRR^*)^n} - Io(\text{Initial Investment}) + S(\text{Subsidy}) = 0
\]

That may also be written as:

\[
S(\text{Subsidy}) = Io(\text{Initial Investment}) - \sum_{j=1}^{n} \frac{CF_j}{(1 + IRR^*)^n}
\]

When \(\sum_{j=1}^{n} \frac{CF_j}{(1 + IRR^*)^n} \geq Io(\text{Initial Investment})\) then no subsidy is needed.

Cash flows stemming from an energy efficiency project are available and based on the technical characteristics of the energy efficiency measures, market prices and on a sound baseline that leads to reliable savings. When calculating the project’s IRR, if it is \(\geq IRR^*\) then no subsidy is needed because the project is doing better than the minimum required by the market and any subsidy would be redundant.

When evaluating a specific project, the subsidy calculation process may be summarised as follows:

Start by calculating the project’s IRR with the SET (Subsidy Evaluation Tool) spreadsheet, as stated in the paragraph above, if IRR \(\geq IRR^*\) then no subsidy is needed and it is possible to pass on to the next phase; if IRR \(\leq IRR^*\) then a subsidy is needed, the optimised amount (that will make the project’s IRR reach the IRR* minimum level) may be easily found in the SET spreadsheet.

The subsidy is a total amount in Euro that may be provided through a single funding measure or as a combination of several financial instruments that include one or more of the following funding possibilities:

- Grants from local and national authorities;
- European funds;
- Incentives local and national;
- Technical assistance.

Subsidies should not only cover investment expenses (intervention on the building with all the Energy Conservation Measures) but also:

- Technical costs (building design and construction fees, building site security costs etc.);
- IREE-Investor Ready Energy Efficiency certification costs (implementation of an ICP-Investor Confidence Protocol that leads to an IREE certification, thus expenses for the ICP developer, Quality Assurance Provider, M&V-Measurement and Verification activities and other costs related to the IREE certification);
- VAT (Value Added Tax) in the case of public bodies that cannot recover VAT it should be considered as part of the total financial amount needed to complete the investment.

Figure 1 represents the logical framework of the subsidy process.

4. SET general information

The SET carries out an energy and financial evaluation of ECMs (Energy Conservation Measures) and can be used for four types of public buildings: schools, gyms, office buildings and health care structures (nursing homes/rest homes).

The SET is a simplified tool that does not require in-depth energy expertise for its compilation. The input data, divided into thematic blocks, includes:

- General information;
- General building information;
• Energy consumption measures divided in:
  o Heating energy consumption and - if necessary - hot water;
  o Electricity consumption, excluding the part of electricity used for heating;
• Interventions and estimated investments;
• Energy prices;
• Energy calculations with 2 options (A or B), where:
  o Option A for a simplified energy assessment within the SET requiring some basic
data on the energy measures (surfaces affected by the new insulation, part of the
building affected by the interventions, possible change of fuel if foreseen, power
of the photovoltaic system when installed);
  o Option B is based on a detailed and sound energy audit for savings calculation and
reference data for energy baseline;
• Parameters for the financial calculation;
• Company financial data.
Companies/providers/ESCOs can fill in specific cells of the SET spread sheet indicating the
amount, duration, and interest rate of the loan (part of the project investment covered by the funds
borrowed from the bank) whose remaining parts have been completed by the Public Contracting
Authority. Once companies have provided their basic data, the SET model calculates the financial
fundamentals related to the project (assessment) providing income statements, cash flows, Debt
Service Cover Ratio (DSCR), Loan Life Coverage Ratio (LLCR).
The SET can also be used by Public bodies to choose the building on which prioritize
interventions/investments; when carrying out an analysis on several buildings where no energy audits
are available, option A (simplified energy assessment) enables, with little data, to get a first technical-
financial estimation of the interventions where the building with the most convenient intervention in
terms of a Subsidy/Investment ratio may be identified so that the expenditure for the energy audit shall
take place only once avoiding the cost of an energy audit for each building.

5. How SET works
SET is an Excel® file organized with spread sheets divided into 5 groups [3]. Normally, only the
sheets with a green label are visible, numbered from 1 to 7, and contain the data entry blocks for the
user. These sheets are already set in A4 vertical page format ready to be printed out.
The other spread sheets are hidden and include:
• 2 sheets with red label where data for translation into multiple languages is collected;
1 sheet with yellow label, which collects all parameters and calculation variables;
1 sheet with a light green label that contains the energy assessment calculations;
3 sheets with blue label for the financial calculations.

Figure 2. The SET tool.

5.1. Technical notes to the energy and financial calculations
For the standard use of the SET it is sufficient to fill in the sheets numbered from 1 to 7. The objective of the SET is to allow a first financial assessment of the energy efficiency measures, based on data easy to retrieve and quick to fill in.

The need to reduce the number of input data for energy and financial calculation to a minimum has led to the definition of a simplified calculation algorithm that uses a set of pre-established and standardized parameters. The expert user can eventually customize the energy and financial calculation parameters based on local peculiarities by accessing the "Parameters" sheet. At the foot of the "Parameters" sheet there are also two tables for a customised calculation of deductible interest expenditures (deductible debt service) and specific national or regional taxation rates for the correct compilation of the project financial assessment.

The simplified energy calculation consists of four phases, collected in a spread sheet called "T-Calc option A", which addresses:
- Calculation of the building geometry starting from simplified data input;
- Calculation of the thermal dispersions of the building with and without energy efficiency measures;
- Calculation of electromechanical installations losses, possible improvements and the value in Euro of the thermal energy savings provided;
- Calculation of electricity savings and the respective value in Euro.

If an energy audit is available, the simplified energy calculation (option A) is replaced by the calculation of the audit itself, the results of which must be reported in the “option B”.

The financial calculation is divided into two parts:
• The "F-Calc Subsidy" sheet calculates the amount of the subsidy based on the inflation and expected project IRR;
• The "F-Calc Cash flow" and "F-Calc Mortgage loan" sheets contain the data needed for the assessment of the cash flows of the Financial Plan, also considering mortgage payments, the investment amortization plan and other relevant financial indicators.

5.2. Data input
In sheet "1" it is possible to select various languages. SET can be used in the following languages: Bosnian, English, French, Greek, Italian, Slovenian and Spanish.

In sheet "2", general data of the building and energy consumption data are required. Location and type of the building, latitude, Heating Degree Days (HDD), floor area, fuel type, thermal consumption, electricity consumption are some indicative data.

In sheet "3", costs and investments’ data are required and energy prices data are optional. A list of the most common energy conservation measures is displayed. By entering the estimated cost of the selected intervention, a simplified calculation of achievable energy savings is activated.

In sheet "4", there are two options for the calculation of the energy savings which are fundamental in the definition of the Financial Plan. Option A is a simplified estimation of savings in relation to the foreseen ECMs. It is suitable for predicting the potential savings and the ranking of buildings according to their cost / benefit ratio when resources for sound energy audits are limited. Option B is the estimation of savings through an energy audit based on a tailored calibrated calculation. This method requires the existence of an accurate energy audit from which estimated savings and reference data on the energy baseline is derived.

In sheet "5", the main parameters for the financial calculation are included. The first part summarises savings and the investment expenditure which are determined by SET. In the second part of the box the following information must be compiled:
• Financial plan duration (20 years maximum);
• General inflation rate;
• Inflation rate of electricity prices;
• Inflation rate of heating energy source;
• NPV (Net Present Value) discount rate;
• IRR* (Internal Rate of Return) the minimum project return required by the market for projects with a similar risk reward profile.

On the basis of the values entered above, the tool determines the subsidy amount (in Euros) that is needed to make the project yield an internal return equal to IRR*.

In sheet "6", the financial plan follows the form commonly used in PPP (Public-Private Partnerships); it is automatically compiled by the tool and it is structured in three parts:
• The first part shows the income statement related to the investment determined by SET, where two selections are available for customisation:
  o eventual incentives or other financial transfers different from the subsidy;
  o administrative, maintenance and other general expenses.
• The second part – cash flow statement - presents the cash flows related to the investment;
• The third part highlights two financial indicators that assess the financial stability of the project:
  o DSCR-Debt Service Cover Ratio (EBITDA / Debt service. Debt service = Loan payment (Current Portion Of Long-Term Debt [CPLTD] + interest). DSCR is an indicator of the project capacity to cover debt service with earnings before interest, tax, depreciation and ammortisation and is calculated on a yearly basis;
  o LLCR-Loan Life Coverage Ratio (NPV - Net Present Value of the cash flow available for loan repayment / total loan) indicates an overall repayment capacity of the project.
In sheet "7", the working team of the tool and general info are displayed (see Figure 3).

Figure 3. The SET tool sheet "7".

5.3. Calculation parameters
The energy assessment implemented in the SET with option A, implies two simplification levels:

- Simplification of the building geometry, so as to define dispersion areas starting from a minimum input data, in order to allow a general energy assessment even in the absence of a project or detailed geometric details;
- Simplification of the building energy calculation through the use of a series of predetermined coefficients defining the climatic context and building use.

The parameters for the simplification of the calculation and, in general, all the variables that influence the energy and financial calculations are defined in the "Parameters" sheet. They can eventually be modified in order to provide users with a tool adapted to national or local requirements. Some of the parameters are energy carrier data, climatic data, irradiation on the horizontal and vertical, thermal performance characteristics of the building, efficiency of the electromechanical installations and calculation of deductible interests and taxes.

If necessary, only parameter values should be modified, neither formulas nor links between cells can be altered.

5.4. Energy calculations
The tool performs simplified energy calculations through “option A”, according to four phases as described below.
Phase 1. Building geometry calculations
Starting from the simplified input data inserted in sheet “2”, the geometry of the building is modelled, determining the floor area and the perimeter. The latter takes into account the maximum size of the short side and the minimum ratio between the sides in the "Parameters" sheet. The window surface is determined as a percentage of the façade areas, depending on the construction period of the building. All dispersion areas are confirmed or adjusted according to the values inserted in sheet "4", in the cases where the intervention affects the entire dispersion area (specified in the drop-down menus of sheet “3”).

Phase 2. Building thermal dispersions
The heat transfer coefficient of the building $H_{tr}$ [W/K] before and after the intervention is applied to the building geometry. Then the respective net energy demand values for heating $Q_{ndH}$, is defined by means of a simplified calculation (with a monthly resolution) according to the EN ISO 13790 [4] and UNI TS 11300-1 standards [5].

Phase 3. Electromechanical installations losses and savings on the thermal energy supplied
Heat losses due to the heating system are added to the net heating energy needs, calculated before and after the planned interventions, applying the system efficiency coefficients indicated in the "Parameters" sheet. Heating energy needs are eventually subdivided into two fuel types - if indicated in sheet “2” - in proportion to the consumption entered as baseline.
On the energy supplied to the building - before the intervention - the share of thermal energy for hot water is determined and added (when the production is combined with heating).
The unit energy cost is applied to the savings of each fuel type and, in the case of heating with a heat pump, the self-consumption contribution of the photovoltaic system, if any, is deducted.
On the savings for each type of fuel an energy unit cost is applied and, in the case of heating with a heat pump, the self-consumption contribution of the photovoltaic system is deducted.
Finally, savings are precautionary reduced, before being used in the financial plan. The corrective factor of the savings, indicated in the “Parameters” sheet, was determined through a test run on a group of sample buildings where SET consumption values were compared to the ones obtained with an energy audit.
Phase 4. Electricity savings calculation
Electric energy savings due to improvements of the lighting system are calculated by applying the savings percentages (“Parameters” sheet) to the share of electrical consumption attributed to lighting (“Parameters” sheet) and to the building portion affected by the electromechanical installations indicated in sheet "4". The final result also takes into account the possible installation of a photovoltaic system and the related self-consumption.

5.5. Financial calculations
The parameters for financial calculations are inserted in Sheet “5”.

Project outline data such as duration of the project, general inflation rates of the energy carriers, desired discount rate for the calculation of the NPV and the IRR* are defined. The subsidy displayed in Sheet “5” is automatically calculated and also depends on the above mentioned data.

Once all the data have been inserted, the Financial Plan of the project is automatically available in a separate sheet “6 PEF” with the following information:

- INCOME STATEMENT (on a yearly basis over the entire project period);
- CASH FLOWS (on a yearly basis over the entire project period);
- FINANCIAL INDICATORS addressing loan coverage capacity:
  - DSCR-Debt Service Cover Ratio (EBITDA / Debt service. Debt service = Loan payment (Current Portion Of Long-Term Debt [CPLTD] + interest). DSCR is calculated on a yearly basis);
  - LLCR-Loan Life Coverage Ratio (NPV - Net Present Value of the cash flow available for loan repayment/total loan).

All input data for the financial plan calculations are pre-defined and entered directly by the Public Contracting Authority except for the information on the debt structure of the company which is provided directly. Debt structures may fluctuate between 100% self-financing (all investments covered by own resources) and 100% debt-financing (all resources are provided by third parties). It is evident that different debt structures involve different debt service costs (impact on the income statement) and different effects on cash flows. Each company therefore has its own specific financing structure (specific mix of own resources, loan and subsidy) in order to realize the investment. Inserting mortgage data in Sheet “5”, the mix of mortgage + subsidy + equity is automatically determined, where: mortgage + subsidy + equity = total investment.

Figure 5. The SET tool – Financial Plan sheet.
The definition of the financial data, in addition to the direct processing in Sheet “6 PEF” of the data included in the previous pages, is also based on parameters calculated in the following three sheets of the SET tool:

- Sheet “F-Calc Mortgage loan” (loan calculation sheet) that according to the amount, duration and interest rate of the loan, provides details on: number of loan payments, debt service (interest) and capital composition of each payment;
- Sheet “F-Calc Cash flow” (cash flow calculation sheet) which provides some parameters necessary for the overall definition of cash flows (operating, investments and financing cash flows);
- Sheet “F-Calc Subsidy” (subsidy calculation sheet) provides the amount (in Euros) of the grant that guarantees a minimum return on the project equal to the one required by the market for projects with a similar risk reward profile (IRR*) considering the achievable savings, the investment amount and the above mentioned IRR*.

6. Conclusions
In the present work the features of the Subsidy Evaluation Tool (SET) have been presented. The tool carries out an energy and financial evaluation of Energy Conservation Measures (ECMs) and it is shown that a variety of parameters is needed in order to find the most appropriate solution for energy retrofitting of buildings from a techno-economic point of view. The study highlights the importance of the financial parameters (such as investment costs, subsidies) in the field of energy efficiency measures for buildings. The tool serves as a bridge between financial institutions and building owners/managers to facilitate energy renovation actions and achieve savings from a well computed energy and cost analysis. It also contributes to the global European Union goals to achieve the maximum of the possible energy conservation measures in buildings and reach the EU energy targets for 2030 and 2050.

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