

ECO – EFFICIENCY ANALYSIS OF RESIDENTIAL GREEN BUILDINGS IN ROMANIA

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Abstract

In the European economy weakened by financial crisis and increasing global competition in business the sustainable business approach is considered to be the best solution. For many Romanian companies growing green is still a challenge. A main objective of energy policies is to make all levels of the society, from governments to citizen, interested in increasing the energy efficiency of buildings. One of the most important barriers in implementation of energy policies is that the cost of potential energy savings, typically considered being the only financial benefit, does not sufficiently motivate investments.

In this respect, the study's aim is to draft a model of green investments approach having in view sustainable development drivers and the underlines the implications of the green investments approach.

Keywords: *residential green building, eco-efficiency investment, sustainable buildings, energy costs, financial analysis, property value.*

JEL classification: E22, L85, Q5.

1. INTRODUCTION

Climate change is already affecting wildlife and human lives and their future. Due to natural causes, such as slight changes of solar radiation, volcanic eruptions, and natural climate variability, the climate is constantly changing. However, natural causes can explain only a small part of such a climate change. The main cause is the effect on the environment by greenhouse gases related to human activity. People use fossil fuels, which formed from oxygen millions of years ago and now release CO₂.

Currently, 75% of total global energy demand is supplied by the burning of fossil fuels. But with increasing air pollution, global warming concerns, diminishing fossil fuels and their increasing cost have made it necessary to

look towards renewable sources as a future energy solution.

One of the main goals for today's humans is to protect the planet's environment and find ways to reduce pollution and energy consumption, as well as increase the use of sustainable energy sources.

The construction sector has become energy-intensive and a serious source of pollution. Today, houses use more energy and fossil fuels than ever before. In fact, buildings currently consume more than one-third of all energy and two-thirds of all electricity used in the United States and the European Union (EU). Ideas of efficient energy use in buildings are being developed to solve these problems, noticed almost three decades ago. Many ideas have already in the construction of low-energy, super insulated, passive, zero energy, and other types of eco-friendly buildings.

The development of green buildings crucial for achieving the goal of a green society. The literature has documented that the construction and operation of buildings accounts for about 40% of the worldwide consumption of energy. At the same time, many members of the public are skeptical as to whether energy-efficiency investments for developing "green" buildings are financially sustainable

Research aims to estimate the investments required to construct a block of flats and to determine the future perspectives of zero energy houses in general.

The part dealing with investment estimation considers a block of 18 flats in Bucharest and forecasting cash-flows who will be added to firm value.

Currently, many people's awareness about green buildings is not enough comprehensive and accurate, they think that green buildings require high investment and high cost, and do not want to develop or purchase green buildings, which hinders the development of green buildings in Romania.

Hence, it is very necessary to construct the theoretical method system of green building cost-benefit analysis from a technical and economic point of view, which has important theoretical value and practical significance for the healthy development of green buildings.

2. LITERATURE REVIEW

2.1. Theoretical

Sustainable development is a term that is in the public opinion very little time and people do not know how to define it more precisely. In the articles I have chosen as documentation, I found many definitions of the term, such as: "Sustainable development is a multidimensional process that integrates economic growth, social and natural environment" (Radu et al, 2013, p. 399).

Analyzing as described above we can summarize in a few words as bringing humanity center, which is forced by his actions that protect the environment. Also, World Commission on Environment and Development (WCED), in the report "Our Common Future", also called Brundtland Report, defined sustainable development as that "ensuring the needs of the present without

compromising the ability of future generations to ensure their own needs".

Jerry Yudelson, who first held the event called "Earth Day" and one who first promoted solar energy, the architecture defines sustainability as related to the adoption of various usage models that promote quality and stimulate the senses, which would lead to the joy offered by housing in that building.

Ligny in 2009 stated that sustainable construction can be defined by "special creation of the highest possible quality and at the same time with the lowest impact on the environment".

Another term used in this analysis is eco-efficiency. OECD states that "the effectiveness of the use of natural resources to meet human needs" is the core concept of eco-efficiency.

European Environment Agency (EEA) addresses another expression: "eco-efficiency is a concept and a strategy to meet human needs and enable present and future generations equitable access to natural resources in terms of natural resource cleavage economic growth" .

Industry Canada defines eco-efficiency as "the art of doing more with less, to minimize costs and maximize the value" (Cote et al., 2006).

2.2. Empirical

The first article¹ which I have studied presents an assessment of the renewable energy potential in Romania using a clustering based data mining method. The case study of the work was the exploitable potential and needs assessment was conducted on a database containing approximately 2,000 projects in the stage of "Technical Approvals Connection", only after working there were only 960. Due view this large database, the authors concluded that Romania is a country with great potential for renewable energy resources, including Bucharest is considered a region that can take almost all sources related to this field. My research used to establish a good relationship

¹ "An assessment of the renewable energy potential using a clustering based data mining method. Case study in Romania"¹, Publicația Energy 81, autori: Gheorghe Grigoras și Florina Scarlatache, ianuarie 2015, pag. 416-429

of dependency between variables like: renewable installed capacity, geographical position and to determine whether the Municipality of Bucharest is an environment fit for the adoption of elements related to the concept of sustainability.

The second starting point² in the analysis that I realized it is an article in which researchers studied the developers perspective regarding the price difference between a standard and a green building, and is based on data from the Singapore Green Mark which assesses the sustainability and energy efficiency of buildings after obtaining A certificate . After analyzing the financial statements of the developers listed on the stock exchange, the authors concluded that there is no evidence that involvement in energy efficient investments, significantly improves the financial performance of residential developers in Singapore. This view can be due to the fact that developers collect only some of the benefits of these investments if sales do not change their strategy with the rental of buildings. Therefore, the higher cost of energy-efficient investments can discourage both developers and buyers, but combining the interests of these two groups can make emerging market of green property investments in Singapore, a very developed.

Another article³ examines the issue of cost-benefit analysis of the application of energy efficiency technologies for green buildings in China. Its empirical analysis leads to the conclusion that energy efficiency technologies could benefit the elementary economic and environmental benefits. Taking into account only the economic side, the authors state that financial assessment indices that have examined shows that green building in China has no investment potential. By ranking of factors influencing the financial results of the evaluation of green buildings,

² "Economic returns to residential green building investment: The developers' perspective", Publicația Regional Science and Urban Economics, Autori: Yongheng Deng, Jing Wu; 2014; pag. 35-44

³ "Cost-benefit analysis on green building energy efficiency technology application: A case in China"; Publicația: Energy and Buildings, nr. 82; Autori: Yuming Liu, Xia Guo, Feiling Hu; 2014; pag. 34-46

Chinese researchers have shown that the power price is the factor most sensitive, followed by additional expenses.

3. RESEARCH METHODOLOGY

In this work i created two databases, one for estimating the cost of capital, and the second for the calculations contained in the case study.

Estimated cost of capital required to turn two stages: getting data from theNBR website on the annual interest rate on bonds and annual returns of the BET index during 2001-2014, to calculate risk premium on Romanian capital market and daily returns of the BET index and company actions addressed during 04.01.2010-13.05.2015. For regression run the program Eviews econometric modeling to find out the beta coefficient of the equity cost was estimated following formula:

$RIMP = a + b \cdot RBET$; where $b = \text{regression slope} = \text{cov}(RIMP, RBET) / \sigma_m^2$

The second database contains financial data (quarterly) on the last five years the company Impact Developer & Contractor database purchased from Thomson Reuters form of balance sheet, profit and loss account and cash flow situation s.

The program used to perform calculations pertaining to the research itself was Excel, a component of Microsoft Office.

The actual research work required in Excel using the following instruments:

-Financial functions: PV, NPV, IRR, PMT, DURATION, etc.

-Statistical functions : AVERAGE, CORELL, VAR, COVAR, STDEV, etc.

-Mathematical and conditional functions: SUM ROUND, SQRT, LN, EXP, IF, etc.

-Text functions: CONCATENATE

- Tables and sensitivity functions and data analysis: Data Table, Goal Seek, Solver and Data Analysis

- Graphics: Chart Wizard XY (scater) etc.

The key assumptions underlying the study are:

- 1) The company owns the land on which construction is to be conducted;
- 2) The project duration is 5 years and the linear depreciation method, all investment duration
- 3) At the end of the five years the building will be sold.

4) The year following the implementation of the investment income is from rental fees. The price for a standard apartment in the Floreasca, according Imobiliare.ro is 930 euro/ apartment. Regarding apartment rent for green, as no data, we increased the price for a standard apartment with 26%, which means the percentage difference between the investment costs. Thus, the monthly rent for an apartment considered green 1210 euro.

5) Annual Cash-flows were considered to remain constant over the entire period, only adjusting them for inflation.

6) The inflation rate of 2% was considered to cover possible fluctuations

7) The exchange rate used was: 4413 euro/ leu.

8) The tax rate is 16% done

9) The interest rate on loans: 14%.

4. CASE STUDY

Research itself is represented by an investment project which consists of a residential building comprising 18 apartments in the Floreasca area, located north of the capital, with a very good reputation. The construction meets all the criteria set out in Romania Green Building Council requirements, obtaining maximum points among others for easy transport means as well as many pedestrian areas situated in the neighborhood.

The project represents a sustainable building which provides inter alia maximum energy efficiency and comfort finish. Also we have delivered a sustainable strategy by the presence of a waste recycling. As regards energy efficiency, the roof will be installed numerous photovoltaic solar panels.

The interior design is top quality and it being carried out only with paints and adhesives with low VOC content, playing a natural ventilation system and water consumption efficiency, by installing batteries that meet the standards set out in Romania Green Building Council requirements.

To demonstrate that this type of building involves a cost slightly higher, but the yield obtained is far superior to any other type of building, this project will analyze compared to an identical investment project, only that the building would be one standard without meet any standard of sustainability.

	STD ap.	GREEN ap.
Construction materials	500 €/mp ⁴	575 €/mp ⁵
Total Cost	543 €/mp	631 €/mp
Monthly rent	870 €/mp ⁶	1200 €/mp
Current sale price	1900 €/mp ⁷	2270 €/mp
Resale price (5 years)	1500 €/mp	2000 €/mp

Table 4.1. Investement

The company that I have chosen to implement this project is Impact Developer & Contractor, as it is known to be one of those promoting joint concern for the environment with financial benefits earned from investment projects adopted and the one of the objectives they want to achieve is "Increasing environmental performance".

Analyzing the situation and financial performance of the company I have concluded that the company is sustainable for the implementation of such investment project.

to perform calculations that I have proposed me, I need to know the cost of capital estimate is the opportunity cost of capital which is actually financing the cost of investment in equity and will be appreciated as a rate of return demanded by investors on this project.

The cost of capital has two components: the cost of borrowing and the cost of equity. The first component is fully explicit and measure the interest payment while the second is more difficult to assess and not limited to highlighting dividends. The cost of debt and cost of equity underlying the determination of weighted average cost of capital.

$$k = kCPR \cdot CPR / AE + kDAT \cdot DAT / AE$$

To estimate kCPR we used the CAPM model which has the formula:

$$k_{cpr} = R_f + \beta_i (R_M - R_f)$$

Risk free interest rate (Rf) is assimilated rate of return on government securities and which in this case is set to 3.2%.

4 According General association of Romanian engineers

5 According Romanian Green Building Council

6 According www.imobiliare.ro

7 According www.imobiliare.ro

The risk premium represents the excess capital market received percentage points over the risk-free rate and remunerate investors who placed their capital in the capital market portfolio. To calculate it got annual returns year BET and yield of bonds from 2001-04.2015, given that we calculate averages, and their difference is the first Romanian market risk capital.

Beta coefficient was estimated in the model CAPM by obtaining a regression in EViews between IMP and portfolio returns market shares (by the BET prox) using daily data for the period 04.01.2010-13.05.2015. Therefore, the beta value is 0.72. Replacing the CAPM relationship, kCPR is 14.03% and given a cost of debt of 14%, cost of capital of the company's 15.23% .

4.1 EVALUATION CRITERIA OF INVESTMENT

NPV	343.785	GREEN
	6.645	STD
IRR	21%	GREEN
	18%	STD
IRR AMENDED	19%	GREEN
	18%	STD
RECOVERY TIME	3,84	GREEN
	4,12	STD
PROFITABILITY INDEX	9,82%	GREEN
	0,22%	STD

Table 4.2 Evaluation criteria of investment

There will be investment projects with maximum NPV. Criterion $NPV > 0$ and the maximum is built on the assumption that the financial market is unlimited in attracting and placing money at interest rate k and the assumption of reinvestment of annual cash-flows at this rate k .

Best selection criteria for effective investment projects is the net present value, the added value of new investment projects "promise" that they bring to the existing value of the company. The selection of the best investment projects will be done so in relation to maximizing the net present value.

NPV is positive for both projects, so it could be implemented only when you have a choice between two investments, we choose the one that gives us a maximum net actualized value.

Indicator green building is far superior notes that the investment project for a standard building.

Based on this evaluation criterion is chosen project that includes the construction of sustainable buildings.

The internal rate of return is the rate of return specific investment project analyzed. Is that discount rate (discounting) of future cash-flows that would equalize the current value (V_0) initial investment (I_0). Under the implicit assumption of reinvestment of cash-flows at a rate equal to the IRR, internal rate of return is determined as the solution of the equation of higher degree (n) $V_0 = I_0$ equality or equation $V_0 - NPV = 0$. The investor $I_0 = He$ wants to compare the return on investment they get through with minimum acceptable rate of return. This rate of return released by the investment project is called internal rate of return, and is only solution of the equation: $NPV = 0$.

Under the IRR criterion will be selected investment projects with higher IRR as the rate of interest k chosen as the reference rate (average performance). Assuming more realistic cash-flows to reinvest future rate of return on a specific enterprise as a whole, we have calculated IRR changed.

The current analysis of the IRR and IRR amended, return values greater than the cost of capital investment, therefore, both projects could be implemented in the design of that criterion. How all investors want to get a rate as high *retabilității* adopted for the building project will be green.

Profitability index is the size of the investment related gains from implementing monetary unit of capital invested. Calculations have returned a value of this indicator is given for green building design, substantially higher than the standard building. Therefore, and according to this criterion, the construction of green buildings is more profitable.

Recovery period is the period in which the initial capital is recovered from future revenues generated by the project. Therefore, sustainable design project value exceeds the standard here.

In conclusion, the project was selected based on the evaluation criteria is to construct a green building apartments. We will devote its next part of this paper.

4.2 SENSITIVITY ANALYSIS

Sensitivity analysis involves building the model for determining the cash flow available sites and consideration of different values than originally projected determinants that affect cash flows. The result of this analysis is the matrix sizes VAN, which took into account three situations (optimistic, neutral and pessimistic) and each factor.

Δ	Matrix NPV for different variations from baseline			
	baseline	unit price	Unit var. costs	fixed costs
-10%	35141	343883	345427	345964
-5%	189463	343834	344606	344875
0%	343785	343785	343785	343785
5%	498107	343706	342964	342696
10%	652429	343657	342143	341607
Variation	617288	226	3284	4357

Table 4.3. Sensitivity analysis

Sensitivity analysis reveals changes VAN volatility of the 4 influencing factors: unit price, fixed costs, variable costs per unit, during rotation ACRnete.

From this analysis it appears that the most important factor is the price VAN change. This is an exogenous factor enterprise, it depends on supply-demand ratio and can not be influenced by the manufacturer.

The other three factors have less impact on the NPV of the project and does not cause negative values NPV.

4.3 SCENARIO ANALYSIS

This analysis involves both changes correlated determinants of the size of the CFD and credible probability that these changes take place in the two scenarios.

The difference from the sensitivity analysis is that in a scenario may change suddenly all the determinants of CFD.

In the optimistic scenario was considered a potential increase in the unit price by 10%, with the decrease variable expenses, fixed and rotary duration of ACRNete by the same percentage. The pessimistic scenario assumes a decrease in price by 10% and increasing

variable costs, fixed and rotating ACRNete duration by 10%.

	SCENARIO		
	Pessimistic	Neutral	Optimistic
Unit price	-10%	0%	10%
Unit var. costs	10%	0%	-10%
Fixed costs	10%	0%	-10%
Dur.rot.A CR	10%	0%	-10%
NPV	-602.388	343.785	3.660.822
IRR	10%	21%	29%

Table 4.4. Scenario Analysis

The big difference between the three scenarios of NPV is due to changes in price, which we established in the sensitivity analysis that has the largest impact on net present value.

4.4 DECISION TREE

The decision tree provides a graphical representation of sequential decision-making. It provides the opportunity to have a complete picture of all the decisions that are expected to be adopted in the future, what the possible consequences may occur and what the potential results will be achieved. These decisions may be further: extension, continuation, waiting or abandonment of investment.

Decision Tree analysis enables us NPV based investment intercorrelations while the annual cash-flows and real options that can be taken in this context of enlargement, still, waiting or abandonment of the investment.

Following estimates, we obtained the following values of VAN's:

- VAN originally assessed = 592.424
- Abandonment option, NPV was estimated at 591.818, and abandonment option value was equal to -606. Option unacceptable.
- Deferment option, NPV was estimated at -71.651, which led to a deferment option value -664.075. Option unacceptable.
- Extension option, the NPV was estimated at 43.999, NPV dropping to initially only expansion option value is created 106.006. So this option is possible for acceptance.

4.5 MONTE CARLO SIMULATION

Monte Carlo simulation is a much more thorough sensitivity analysis that takes into account a lot (finite) states the factors likely CFD model selected by a random number generator process. From the normal distribution is calculated $E(NPV)$, $\sigma(NPV)$ and risk associated with this investment the $\sigma(VAN) = 359.308$.

Monte Carlo simulation returns a hope to increase investment value $E(NPV) = 590.485$ lei, and risk associated with this investment the $\sigma(VAN) = 359.308$.

The probability that NPV is less than or equal to zero is 42.42%, which means that there is 42% chance that NPV has negative or zero probability fairly high.

Also $E(IRR) = 28\%$, with a risk $\sigma(IRR) = 3.83\%$.

5. CONCLUSIONS

The construction sector is the largest contributor in terms of emissions seriously affecting atmospheric layer and the greenhouse gases produced numerous climate change. In addition, all this investment sector is responsible for a global resource consumption exceeding one third of the total. Another consequence is a significant contribution to the production of solid waste, estimated at 40% of the total.

To reduce this enormous impact on the environment, the first solution is the construction of green buildings that significant savings can be achieved and at the same time. This would be possible only by raising awareness among the population of the seriousness of the current situation that could lead to an informed and willing only sustainable building projects. For the investors, "waking up to reality" can only occur by demonstrating that green projects bring a higher return, since they care for the environment before the financial interests and the amazing savings in terms of cost, discrepancies occur because developers do not benefit from them, not those who use the buildings constructed.

This paper focused on defining the concept of sustainable development and implementation of investment projects, specifically by presenting an investment project in a green block, which overcomes skepticism of investors who believe that energy efficiency

and sustainability of a building can not be consistent with financial gain.

After practical investigations conducted within the research itself, and an analysis of the results, the following conclusions can be drawn:

- Given the financial aspect, this type of investment requires a slightly higher cost, but also shows high values calculated indicators in the selection criteria in the certain and uncertain, therefore the project can be accepted.

- Even if it costs more investors, the quality offered by them will be far superior to standard projects, which also represents a competitive advantage.

- Developers do not be discouraged as they collect premise just some of the benefits of this investment, the main beneficiaries are the end users.

- Social Survey and the European Directive demonstrates that this type of buildings is a perspective that will be increasingly addressed therefore investment values will remain stable in the future.

- One of the studies presented in the literature review shows that Romania's meteorological situation is conducive to all types of renewable energy technologies.

- The investment project submitted can be successfully adopted.

Recent studies show that energy efficiency and obtaining certificates certifying a building's sustainability produce tangible benefits recognized in the property market, but increased energy efficiency remains a complex blocks. To increase the number of these types of housing should be taken such as:

- Education programs for developers, builders and architects who focus on construction practices and the financial benefits obtained.

- Setting up a database containing information on energy consumption and potential savings, and companies implementing such projects to be promoted.

- Development of methods of funding to achieve Backed concept of sustainability. As part of this effort to provide financial incentives to companies that adopt high performance projects.

- Intensive advertising of these types of buildings to be brought to public attention and educate the population to want sustainable housing.

As demonstrated by the case study, there are many opportunities to enter the Romanian market through the use of products, services and environmental technologies.

In this work we find the answer to the questions outlined in the introduction:

1. What is a green building?

A green building is one which uses the phase of design strategies minimize negative environmental impact should be guided according to this concept in the construction phase and during use. However, an important part of such a building is energy efficiency

2. Why these buildings are important and what it means in the context of sustainable development and environmental protection challenges in the 21st century?

Green buildings are important for the environment and for users, who have the opportunity to improve their quality of life by dwelling in such a building. Challenges in the 21st century are mainly related to destruction of ozone, particulate matter found in the atmosphere and climate change is getting worse by the day. Another issue that raises is consuming the earth's natural resources. Sustainable development concerns mostly the problem, defining it by saying that we must take care to set aside resources for future generations.

3. What is the difference between the benefits of implementing an investment project in a green building compared to a standard?

The benefits from the implementation of an investment project in a green building are superior to those resulting from the adoption of a draft standard building. Green building has been accepted by all criteria for selecting investments, with much better results than the standard. Of course, mention the environmental benefits.

4. In addition to the environmental benefits that are cost savings associated owners that implement such projects?

Economic cost totaling 320 lei per month, which amounts are added to the value of rental apartments.

European Commission amended Energy Performance Directive, which requires a high energy performance, but quite difficult to obtain. It will still find quick solutions because the coming years will require zero energy buildings, and when it will occur at both political and economic, to support such projects.

Green buildings will come to dominate the market with 2020 and with increasing energy prices, when the price will decrease and efficient technologies, and demand for such buildings explode.

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