EURO elecs 2015

LATIN AMERICAN AND EUROPEAN CONFERENCE ON SUSTAINABLE BUILGINGS AND COMMUNITIES

21-23 July | 2015 | Guimarães | PORTUGAL

VOL I

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EURO-ELECS 2015

LATIN-AMERICAN AND EUROPEAN CONFERENCE ON SUSTAINABLE BUILDINGS AND COMMUNITIES

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ISBN 978-989-96543-8-9

Printed by Multicomp

1st edition, July 2015

Legal Dep. 395402/15

FOREWORD

Euro-ELECS 2015 is the first Latin American and European conference on sustainable buildings and communities. This international event is organized by UMinho, UFMS, Ufes, ANTAC and iiSBE_PT in Guimarães, Portugal, from the 21st till the 23rd of July 2015.

This event is the evolution of the several previous ELECS (Encontro Latinoamericano sobre Edificações e Comunidades Sustentáveis), which started in 1997 and were held biannually since 2001.

Euro-ELECS 2015 is an innovative scientific event targeted on "Connecting People and Ideas" and aiming to bridge the gap between the academic environment, society, theory and practice, connecting European countries and the countries of Latin America. The conference is focused on the themes of Sustainable Buildings and Sustainable Neighborhoods and in the contributions to achieve these targets.

Building sector uses, globally, about 40% of energy, 25% of water, 40% of natural resources and emit approximately 1/3 of greenhouse gas emissions (the largest contributor). Residential and commercial buildings consume approximately 60% of the world's electricity. Existing buildings represent significant energy saving opportunities because their performance level is frequently far below the current efficiency potentials. Energy consumption in buildings can be reduced by 30 to 80% using proven and commercially available technologies. Investment in building energy efficiency is accompanied by significant direct and indirect savings, which help offset incremental costs, providing a short return on investment period. Therefore, buildings offer the greatest potential for achieving significant greenhouse gas emission reductions, at least cost, in developed and developing countries.

On the other hand, there are many more issues related to the sustainability of the built environment than energy. The building sector is responsible for creating, modifying and improving the living environment of the humanity. Construction and buildings have considerable environmental impacts, consuming a significant proportion of limited resources of the planet including raw material, water, land and, of course, energy. The building sector is estimated to be worth 10% of global GDP (5.5 trillion EUR) and employs 111 million people. However, in developing countries, much of the large amount of the generated jobs does not necessarily imply decent work and quality of life as informal and/or degrading jobs are numerous in construction. Furthermore, many people remain excluded, economically and socially, living in informal housing and in unplanned urban areas.

The building construction sector has the responsibility to contribute to the sustainable development and, subsequently, contribute to diminish inequity, hunger and disease. These issues are not new, but did not change too much in the last decades and we still have the challenge of driving the cultural and environmental richness of these countries to a more sustainable scenario. New sustainable construction opens enormous opportunities because of the population growth and because of the search for wealthy environments. Construction stimulates the urbanization and the construction activities represent up to 40% of GDP. Therefore, building sustainably will result in healthier and more productive environments.

The sustainability of the built environment, the construction industry and the related activities are a pressing issue facing all stakeholders in order to promote the sustainable development of the world.

The conference topics cover a wide range of up-to-date issues and the contributions received from the delegates reflect critical research and the best available practices in the field of sustainable buildings and communities.

More than 500 abstracts were received from which resulted 332 full papers. After the evaluation process 212 papers were approved for oral presentation, all being published in its full version in these proceedings.

The received contributions are distributed by the following 12 major themes:

- Innovation and improvement of sustainable construction materials or systems (low and high tech solutions)

- Sustainable design solutions (low cost, reuse, eco efficiency, renovation, retrofitting, urban renovation)
- Sustainable building technology and management
- Technical knowledge for materials, buildings, neighborhoods and building sector
- Policies and strategies for a sustainable built environment
- Governance for a sustainable built environment
- Empowerment and participation processes for sustainability
- Social housing and buildings affordable to all
- Assessment tools (life cycle analysis, rating tools and monitoring) for materials, buildings, neighborhoods and building sector
- Education for sustainability
- Urban mobility and accessibility
- Resources (water and energy) and residues management

In addition, a relevant number of contributions were received to the following 9 Special Sessions organized by some colleagues that collaborated closely with the organizing committee:

- Earth architecture and construction
- BIM and sustainable construction
- Sustainable construction sites
- Spatial patterns of urban ecosystems
- Open spaces system for a sustainable built environment
- Acoustics applied to buildings and sustainable environments
- Integrated design of renewable energy systems in buildings
- Rural housing, technologies and building cultures
- Building integration of solar thermal systems

All the papers selected for presentation at the conference and published in these Proceedings, went through a refereed review process and were evaluated by, at least, two reviewers.

The Organizers want to thank all the authors who have contributed with papers for publication in the proceedings, to all reviewers, whose efforts and hard work secured the high quality of all contributions to this conference and to the organizers of the special sessions that helped to tackle some specific topics very relevant for the sustainability of the built environment.

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Cristina Engel de Alvarez – Federal University of Espírito Santo
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Connecting People and Ideas . Proceedings of EURO ELECS 2015 . Guimarães . Portugal . ISBN 978-989-96543-8-9

Economic aspect of solar thermal collectors' integration into facade of multifamily residential building

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ABSTRACT: The subject of this research is the Life cycle costs analysis of the building in order to assess the economic efficiency and cost-effectiveness of investments in various variants of application of active solar systems in aim to achieve a reduction of energy consumption and environmental pollution.

Different variants of solar thermal collector's application to the existing prefabricated residential building in the settlement Konjarnik in Belgrade, Serbia, are considered from the economic point of view. Cost-effectiveness and feasibility of various scenarios of energy optimization achieved by application of solar thermal collectors into the building envelope are evaluated on the basis of final energy consumption (within the EU-ISO standards).

The methodological approach involves the analysis of the costs of energy consumption for sanitary hot water preparation, financial analysis of costs and cost savings throughout the life-cycle of the existing building in case of application of solar thermal collectors' on the building envelope, as well as a comparative analysis of obtained results. Criteria for the economic analysis include the amount of investment, energy costs and life-cycle costs of the building. According to the adopted criteria, the most suitable models are selected. This methodological approach is generally applicable in the analysis of investments in improvement of building energy performances, while possible technical solutions and the resulting economic benefits must be carefully considered.

Keywords: solar thermal collectors, investment projects, lifecycle costs analyses, life cycle savings, greenhouse gases emissions.

1 INTRODUCTION

New energy-efficient buildings represent a small percentage in relation to the total building stock. Until the seventies of the last century, in Belgrade, buildings were designed without consideration of energy demands and consumption (Krstic-Furundzic & Djukic 2009). According to the data collected by Serbia's Statistical Office, about 55 percent of the total of 583,908 existing housing units in Belgrade were built during this period (Krstic-Furundzic & Bogdanov 2010). These data reveal that Belgrade's building stock has a significant number of buildings whose energy performance has to be improved. It should not be disregarded because significant energy savings and reduction of fossil fuels consumption can be achieved.

In the paper, solutions for reducing energy consumption for water heating in existing housing are examined from economic point of view.

The methodological approach implies the analysis of the costs of energy consumption for sanitary hot water preparation, financial analysis of costs and cost savings throughout the life-cycle of the existing building in case of application of solar thermal collectors' on the building envelope, as well as a comparative analysis of obtained results. Criteria for the economic analysis include the amount of investment, energy costs and life-cycle costs of the building. According to the adopted criteria, the most suitable models are selected. This methodological approach could generally be applicable for building refurbishment, but generalization of technical solutions and possible benefits have to be carefully individually considered.

2 METHODOLOGY

During 1950's up to 1970's, a large number of buildings had been built in the suburban settlements of Belgrade. The residential buildings in the settlement Konjarnik, as a model on which different design variants and possibilities for improvements of energy performances by application of solar thermal collector systems are analysed and discussed from the aspect of energy benefits in a few papers by authors Krstic-Furundzic & Kosoric (2009a, b). Those scenarios are analysed from an economic point of view in this paper.

Figure 1. Location of Konjarnik on the map of city of Belgrade. Figure 2. Typical building with attic annex.

The analysis in the paper is hypothetical and it aims to show the economic benefits of installing system of solar thermal collectors on the buidling envelope in Belgrade's climate conditions. The methodological approach includes description of the model for economic analysis, evaluation of economic efficiency, LCC analysis of variants of solar thermal collectors' application and comparative analysis of achieved results.

2.1 Description of the model for economic analysis

The settlement Konjarnik is 4 km south-east of downtown of Belgrade and stretches about 2km (Fig. 1). This settlement was chosed for analysis because it consists mainly of typical buildings (Fig. 2) which were built during the 1960's and 1970's. The settlement is characterized by large rectangular shaped residential buildings with typical south-north orientation, more precisely, the deviation of 10˚ to the southwest is present (Fig. 3).

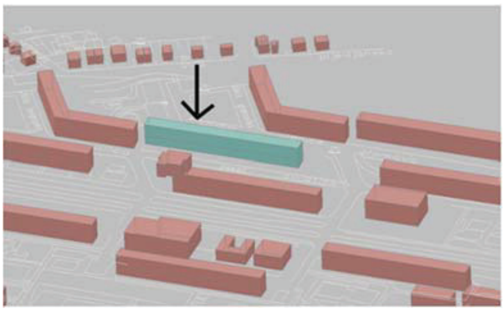

Figure 3. Buildings disposition in Konjarnik settlement

The selected multifamily building, the 8-floors high, has rectangular and compact form and consists of 5 lamellas. It is located within a semi-closed block, on the south oriented hillside. The neighbouring buildings are sufficiently far to prevent overshading. One of the central lamellas, with four one-side oriented flats, is chosen for the analysis. As shown in Figure 2, the facades oriented south and north consist rows of windows and parapets, which represent 70% and loggias, which represent 30% of facade surfaces (Krstic-Furundzic & Kosoric 2009a). Existing refurbishment strategies applying on these residential buildings are transformations of flat roofs into slopping roofs by attic annex, which was action organized by municipality and glazing of loggias, which was illegal action usually carried out by the tenants (Krstic-Furundzic 2010).

As the buildings in the analyzed settlement are consisted of a large number of lamellas, and as in the analysis of possibilities for solar thermal collectors application on south-west oriented facade and roof surfaces was selected central lamella (Krstic-Furundzic & Kosoric 2009a, b), in the paper the evaluation of economic efficiency and feasibility were carried out for the same lamella. Authors of different design variants calculated consumption of thermal energy for water heating (20-50˚C) according to the number of apartments and tenants inside one lamella altogether which presents 251 kWh per day, i.e. 91,618.3 kWh per year for one lamella and the existing water heating system fully based on electricity was substituted with the new system – solar thermal collectors (AKS Doma –manufacturer), with the auxiliary system based on electricity (Krstic-Furundzic & Kosoric 2009a, b). Solar thermal collectors with liquid working medium had been proposed. According to Polysun 4 Version 4.3.0.1., which was used for the analyses of energy contribution of solar thermal collectors, Belgrade is the city with global irradiance of 1341.8 kWh/m^2, and 2123.25 sunny hours per year (Krstic-Furundzic & Kosoric 2009a, b).

Modern architectural concepts, which are based on the rational energy consumption in buildings and the use of solar energy as a renewable energy source, provide the new and significant role to the roofs (Krstic-Furundzic 2006) and facades that become multifunctional structures. By applying the system of solar thermal collectors, multifunctional roofs and facades could be created.

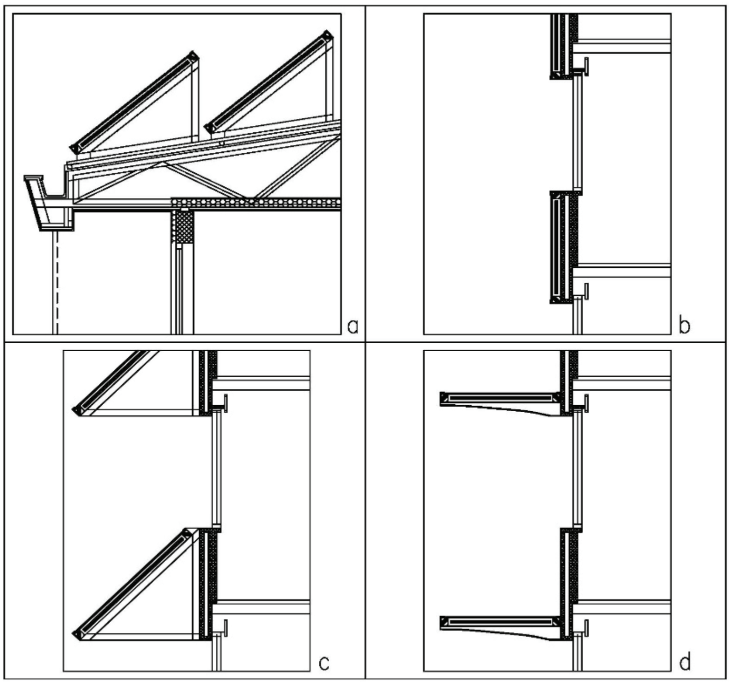

Figure 4. Design variants 1– 4 (a - d) cross-sections.

Four variants of the position of solar thermal collectors on building envelope, designed by Krstic-Furundzic & Kosoric (2009a, b), are taken into consideration in the analysis of economic efficiency and cost-effectiveness of investments (Fig. 4).

The proposed variants of position of solar thermal collectors on building envelope are: 1. variant - solar panels mounted on the roof and tilted at 40˚, area of 100 m^2 (Fig. 4a); 2. variant - solar panels integrated in parapets (vertical position-90˚), area of 90 m^2 (Fig. 4b); 3. variant - solar panels integrated in parapets and tilted at 45˚, area of 120 m^2 (Fig. 4c); and 4. variant - solar panels integrated as sun shadings (horizontal position-0˚), area of 55 m^2 (Fig. 4d); which is described in detail in Krstic-Furundzic, & Kosoric (2009a, b).

2.2 Evaluation of economic efficiency

The goal of this LCC analysis is to evaluate economic efficiency and feasibility of different scenarios of solar thermal collectors' application into the envelope of existing multifamily housing in Belgrade and their impact on the environment.

The economic assessment includes LCC analysis of four scenarios that evaluates feasibility of solar thermal collectors' integration in the building facade and roof in order to reduce electricity demands from public electrical distribution network. Economic efficiency of accomplished energy optimization of presented variants is assessed according to the final energy consumption (Krstic-Furundzic et al. 2013).

LCC analysis are carried out by Net Present Value methodology, which implies present value of investment plus discounting of all future costs to the present value, and is suitable for comparative assessment of several different scenarios (different energy improvements of the same building). The LCC analysis which deals with application of solar thermal collectors for water heating is carried out as cost analysis through whole life-cycle of analysed components (WLC – Whole Life Cycle) (König et al. 2010). In addition to life-cycle costs, this analysis includes also monetary benefits from electric energy feed-in tariff related to exploitation of solar energy.

Selected tool for LCC analysis in this study is BLCC (Building Life Cycle Cost) software, version 5.3-12 (EERE 2012). BLCC software was developed by United State Department of Energy and it is used for calculation of buildings life-cycle energy savings. The LCC calculations are based on the FEMP (Federal Energy Management Program) discount rates and energy price escalation rates which are updated and published every year on April 1. With certain modifications, this software was used in several investment analyses in Serbia which required feasibility study for different models of optimization of facade, building structure, lighting and heating system (thermotechnics) (Plavsic & Grujic 2005).

Criteria for evaluating of the analyses results are divided into two groups (Plavsic 2004):

1. Evaluation criteria for financial efficiency of each scenario include:
- Net Present Value (NPV);
- Adjusted Internal Rate of Return (AIRR);
- Simple Payback Period (in years).
2. Evaluation criteria for external effects include:
- protection and conservation of the environment;
- sustainability of energy resources.

Final efficiency assessment of the design and its scenarios (using computer software BLCC) is expressed in two areas:

- assessment of financial and market efficiency of the design, which determinates feasibility of the investment under real market conditions, measured by accumulation;
- assessment of social and economic efficiency of the design which evaluate the effects on social and economic development of the country.

Design scenarios are ranked by each criterion in final stage of the analysis. BLCC software provides choices such as:

1. design scenario which is the most favourable in terms of the lowest LCC.
2. design scenario with the shortest Simple Payback Period.
3. design scenario with the lowest emission of greenhouse gases.

With the assumption that the lowest LCC and the shortest SPP are of equivalent importance, final selection of the best scenario would be the one that best meets both criteria.

2.2.1 Criteria for efficiency evaluation

Criteria for efficiency evaluation include economic efficiency criteria and external effects.

Economic efficiency criteria involve:
Adjusted Internal Rate of Return (AIRR) - represents the discount rate which is investment value reduced to zero. This data indicates optimal ratio of income (savings) and expenses (costs) during economic life-cycle of building.

Net Present Value (NPV) - is the sum of income during building life-cycle which is reduced to its value of the first year of its life-cycle (present value). Net Present Value presents an absolute indicator of profitability of the design taking into account the time preferences and, using discounting technique, it reduces all future design effects to their present value. For practical reasons, the initial investment period of building economic life-cycle (beginning of investment study) is taken as base time for calculation of NPV. Discounting is performed according to previously established discount rate (usually the individual discount rate that makes the weighted arithmetic mean of real interest rates on funding sources). The discount rates of 10-12% are traditionally used by The World Bank for all funded projects. However, as the entire calculation in this study was done in euro currency, the average interest rate in Western Europe was taken into account. In this case, NPV is calculated for savings - as a specific design profit.

Simple Payback Period (SPP) - refers to necessary time (in years) for return of initial investment. Invested funds are returned in the year when the cumulative net effects of economic life-cycle become positive. The aim is to reduce a simple payback period (value SPP), in order to be as short as possible. The acceptable payback time of the initial investment is considered to be before the end of last year of economic life-cycle. Data such as the initial investment, annual costs and balance saving during life-cycle of the design, are used to calculate SPP. Building Life Cycle Cost (BLCC) software operates with simple payback period, which is simple ratio of initial investment increased for all annual costs and savings (as the equivalent of income in one year).

External effects involve:
Different social and economic effects which do not need to be quantified. For improvement of energy efficiency these effects are of great social benefits such as conservation of the environment and non-renewable resources, influence on technical progress, quality of life of the population, increase of consumer surplus, etc.

2.3 LCC analysis of variants of solar thermal collectors‘ application

Comparative LCC analysis of the existing building model and different variants of solar thermal collectors’ integration in the building roof or facade takes into account: (a) capital costs, (b) energy costs - costs of electric energy consumption for water heating (electric water heater) from public network, (c) energy costs/incomes - feed-in tariff for renewable energy sources and (d) operating, maintenance and repair (OM&R) costs of installed solar system.

In this study, feasibility of investment in solar thermal collectors system, which would substitute certain percentage of production of hot water in the building, is estimated according to consumption of final electrical energy (from renewable and non-renewable sources).

2.3.1 Investment

A capital investment is considered as onetime cost in the first year of the economic life-cycle of the project.

In the analysis of solar thermal collectors' integration into the building facade and roof, the value of complete installed system for each scenario is based on the average value per $1m^2$ of solar collector panel. According to manufacturer, the average price of solar collector system for hot water is 700€ per $1m^2$ of solar panel. For four scenarios of solar thermal collectors' integration, total initial capital investments are shown in Table 1.

2.3.2 Energy costs

Analysis of energy efficiency of solar collectors' integration assumes that there is constant electrical energy consumption for sanitary hot water preparation within observed part of residential building. Four selected scenarios, with different solar collectors' positions, result in different capacity for production of electrical energy from renewable sources, and thus different consumption of electrical energy from public electricity network. In the analysis, public network electrical energy price was adopted according to current price list approved by "EPS - Elektroprivreda Srbije" in December 1, 2012, for consumers within the blue zone (351-1600 kWh per month), which represents zone of average household electricity consumption per month. This price is average price for households with two phase measurement of electricity consumption (1/3 of day – lower tariff). The price of 0.06 €/kWh was established as an input for electrical energy costs calculation. The price of 0.23 €/kWh was adopted for electricity from renewable sources (according to feed-in tariff of EPS and Regulation on Incentives for the production of electricity by using renewable energy sources and combined production of electricity and thermal energy).

3 RESULTS OF LIFECYCLE COST ANALYSIS

Life-cycle period for scenarios of solar collectors' integration in LCC analysis is 15 years. According to manufacturer, life-cycle of proposed system for hot water is 20 to 25 years, while full capacity of the system is reduced by 20% after 15 years of use. Since energy efficiency analysis was carried out for system's full capacity, period of full system capacity was adopted in this LCC analysis.

Majority of investments that have an impact on energy savings and environment conservation are long term investments and usually have very high capital costs. Since this investment analysis is limited to 15 years (period of full capacity of the system) and the system capacity cannot be determined precisely after this period, all future costs are discounted to present value using a real discount rate of 3.5%, so that the costs in very far future have as less as possible influence on analysis results.

Life-cycle cost analysis is performed for each design variant of solar thermal collectors' integration in the building envelope. Using BLCC software, the Net Present Value (NPV) is determined for each scenario, and the scenario that gives the best results during the life-cycle was chosen. All future costs are discounted to present value using a discount rate of 3.5%.

Basic assumption is that inflation has a neutral effect on building life-cycle if price relations (parity of prices) do not change in life-cycle or if impact of inflation is identical on both income and costs of the building.

Results of LCC analysis, LC savings and greenhouse gases emissions for variants of solar collectors' integration are shown in Table 1, 2 and 3.

3.1 LCC Analysis results – application of solar thermal collectors

From the LCC analysis of variants of solar thermal collectors' integration, the following conclusions can be listed:

- Results of LCC analysis (Table 1) show that Variant 1, scenario with thermal collectors positioned on the roof in the area of 100m^2, is the most favourable variant, because it has the highest incomes from investment in renewable energy sources. Variant 3 also has incomes, but, although the area of solar collectors is bigger in comparison to Variant 1, energy production capacity is reduced as solar collectors are placed on the parapets of the facade. Also, Variant 3 has higher initial investments, so the overall incomes are smaller than in Variant 1.

Table 1. Results of LCC analyses of the four variants (design variants of integration of solar thermal collectors) compared to Reference model (Model of the existing building).

Scenario	Annual Costs			Present Value Costs			LCC
	Annual Electricity Costs (base-year) (public) (€)	Annual Electricity Costs (base-year) (solar collect.) (€)	Annual OM&R* Costs (€)	Total Initial Capital Costs (€)	Discounted Total OM&R* Costs (€)	Discounted Total Energy Costs (€)	
Reference model	5,499.00					63,321.00	63,321.00
Variant 1	2,541.00	-11,332.00	100.00	70,000.00	1,152.00	-101,264.00	-30,112.00
Variant 2	3,570.00	-7,386.00	100.00	63,000.00	1,152.00	-43,959.00	20,193.00
Variant 3	2,653.00	-10,904.00	100.00	84,000.00	1,152.00	-95,051.00	-9,899.00
Variant 4	4,209.00	-4,939.00	100.00	38,500.00	1,152.00	-8,418.00	31,234.00

* Operating, Maintenance, and Repair

- Results of the analysis of LC savings (Table 2) also show that Variant 1 has better financial advantages compared to other variants. First of all, Simple Payback Period (SPP) is the shortest (8.05 years), Savings to Investment Ratio (SIR) is most favourable, as well as Adjusted Internal Rate of Return (AIRR). Shortest Simple Payback Period (SPP) shows that this variant has the highest savings.
- Variant 2 and Variant 4 certainly have positive influence on environment and reduction of energy consumption from non-renewable sources. But, from the investment standpoint, these variants are considered unacceptable, since the Simple Payback Period exceeds LC period of solar thermal collectors (15 years of full system capacity). Variant 2, with SPP of 16.95 years, might be acceptable if we take into account the fact that the real life cycle of solar collectors system is longer than 15 years.
- Variant 1, which has the highest savings in electrical energy consumption from public network, also has the lowest greenhouse gases emission (Table 3).
- From the aspect of LCC analysis the most favourable is Variant 1.
- Combination of Variant 1 and Variant 3 (solar collectors on the roof and facade) would certainly give much better results in the evaluation of the economic efficiency of investment in renewable energy.

Table 2. Results of Life cycle savings analysis of four scenarios (design variants of integration of solar thermal collectors)

Scenario	Annual Energy Consumption			Electrical energy Savings (+) or Cost (−)		Non−Energy Savings or Cost (−)						
	Electricity Consumption (public) (kWh)	Electricity Consumption (solar collec.) (kWh)	Total Investment (€)	Annual Electricity Savings (€)	Discounted Electricity Savings (€)	Annual OM&R* Costs (€)	Discounted OM&R* Costs (€)	First year savings (€)	Simple Payback Period (SPP) (year)	Adjusted Internal Rate of Return (AIRR) (%)	Total Discounted Operational Savings (€)	Savings to Investment Ratio (SIR)
Variant 1	-42,348.80	49,269.50	70,000.00	8,791.00	101,264.00	-100.00	-1,152.00	8,691.00	8.05	6.00	100,112.00	1.43
Variant 2	-59,503.50	32,114.80	63,000.00	3,816.00	43,959.00	-100.00	-1,152.00	3,716.00	16.95	0.87	42,807.00	0.68
Variant 3	-44,208.80	47,409.50	84,000.00	8,252.00	95,051.00	-100.00	-1,152.00	8,152.00	10.30	4.27	93,899.00	1.12
Variant 4	-70,142.80	21,475.50	38,500.00	731.00	8,418.00	-100.00	-1,152.00	631.00	61.03	-7.39	7,266.00	0.19

* Operating, Maintenance, and Repair

Table 3. Analysis of greenhouse gases emissions of four scenarios (design variants of integration of solar thermal collectors)

	Reference Model		Variant 1		Variant 2		Variant 3		Variant 4	
	Annual emissions (kg)	Life-Cycle emissions (kg)	Annual emissions (kg)	Life-Cycle emissions (kg)	Annual emissions (kg)	Life-Cycle emissions (kg)	Annual emissions (kg)	Life-Cycle emissions (kg)	Annual emissions (kg)	Life-Cycle emissions (kg)
CO_2	59,910.57	898,371.49	27,692.51	415,254.97	38,910.22	583,466.92	28,908.79	433,493.37	45,867.42	687,791.54
SO_2	301.89	4,526.86	139.54	2,092.45	196.07	2,940.07	145.67	2,184.36	231.12	3,465.76
NOx	89.41	1,340.74	41.33	619.73	58.07	870.77	43.14	646.95	68.45	1026.47

4 CONCLUSION

Investments in energy production from renewable sources always have a positive effect on the economy (reducing energy consumption costs) and the ecology of a country (reducing greenhouse gases emissions). Life-cycle costs analyses for different variants of integration of solar thermal collectors for water heating show that feasibility of investments in renewable energy sources is based on price difference between standard and feed-in tariff of electricity per kWh.

In this analysis, feasibility of investment in solar thermal collectors system is economically efficient only for scenarios where renewable energy sources meet energy needs in the percentage of about 50% or more. Therefore, whether a system for production of energy from renewable sources results in incomes or costs in life-cycle depends on the policy of the country and values (prices) of feed-in tariff for energy from renewable sources. It is certain that all investments in renewable energy have positive impact on preservation of healthy environment, but their cost effectiveness depends on the goals and policies of economic and energy development.

In surrounding countries of Serbia and EU countries, the values of electricity feed-in tariff per kWh are twice or three times higher than in Serbia (although the price of electricity from public network is significantly higher). Political aspect of feed-in tariff values in Serbia is based on Directive on the promotion of the use of energy from renewable sources (RES Directive 2009/28/EC, 2009) according to which Serbia, as signatory of the Agreement of Energy Community, will be obliged to provide at least 20% of energy consumption from renewable sources. This percentage, which is already reached in Serbia through the production of electricity from hydro-power plants, amounts to about 24% (MERZ, 2012). As long as the target level does not increase above the current production of electricity from renewable sources, there will not be changes in Serbia government's efforts to support investments in other renewable energy sources.

4.1 Acknowledgments

The research is done within the COST Action 1205 ″Building integration of Solar Thermal Systems (BISTS)″ supported by European Cooperation in the field of Scientific and Technical Research and the scientific research project "Spatial, Environmental, Energy and Social Aspects of Developing Settlements and Climate Change – Mutual Impacts" (TP36035), financed by Ministry of Education, Science and Technological Development of the Republic of Serbia.

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