



COST-EFFECTIVENESS ANALYSIS OF SOLAR SYSTEMS INTRODUCTION IN HOTEL WELLNESS CASE STUDY: SARUNA WELLNESS CENTER AT CROWNE PLAZA HOTEL

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Abstract:

The hotel industry is currently facing numerous challenges. Although the COVID-19 pandemic is the current top priority, when business starts reopening, hotels will still have to face familiar challenges such as increased competition, sustainability, and energy efficiency. Media reports of frequent natural disasters which are a direct or indirect consequence of climate change affect the public awareness and need for change, especially in reducing energy consumption and choosing new energy sources. It became clear to hotel managers that efficiency must be achieved at every turn and in every area. In this paper, we are arguing that the benefits of investment in heating sanitary hot water and pool water in hotel wellness and SPA centers create savings over an extended period of time. In addition, it supports brand positioning related to renewable energy sources (RES). The paper is using a case study of a wellness center in an upscale hotel in Belgrade, Serbia.

Keywords:

Economic analysis, energy efficiency, renewable energy sources, solar systems, investment profitability

INTRODUCTION

InterContinental Hotels Group (IHG) was one of the first hotel chains that started implementing the latest technological solutions, modern technologies and programs based on environmental protection and implementation of RES. Some of the activities this hotel group applies in the field of environmental responsibility are as follows: a) green roofs – roofs covered with low plants, thereby improving thermal characteristics and sound barriers; b) green facades – the facade is usually covered by ivy, which grows along the surface or with special supports while purifying the air, ensuring cooling and looking good; c) solar systems – installing solar panels on hotel buildings in most cases for providing hot water; d) Rainwater collection system – rainwater collection tanks are located on the roof or the ground and in areas with a large amount of precipitation in these hotels rainwater is used to wash toilets and floors (IHG, 2008; Bradić et al., 2014) A dozen of other similar programs and systems are used in InterContinental Hotels Group, very successfully. Therefore, the idea for further improvement of energy efficiency and the introduction of renewable

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energy sources at Crowne Plaza Belgrade came as a natural continuation of the group's philosophy. Given the number of energy efficiency areas applied at Crowne Plaza Belgrade, it was not easy to find a system that would be of great benefit to both the hotel and the community and all with the idea of economic profitability that both the management of the company and IHG would accept.

ENERGY EFFICIENCY AND RENEWABLE ENERGY SOURCES

The Industrial Revolution and rapid scientific and technological development gave humanity significant prosperity and progress and enabled easier life for a large number of people on the planet. However, it must be noted that this prosperity came with a high price. At the end of the 20th century, limitations and exhaustion of classic energy sources were discovered, on the one hand, and on the other hand, all the limitations of energy supply from renewable sources were discovered as well (Marković, 2010, pp.1 -2). Energy efficiency involves the use of a small amount of energy for different purposes (heating or cooling of space and/or water, lighting, product production, vehicle propulsion, etc.). Energy efficiency should not be presented and seen as energy savings, because savings always involve certain waivers, while efficient use of energy should not impair comfort in work, rest or daily life. In order to improve more efficient energy consumption, we should not only work on technical solutions but also educate people who use these solutions in a conscious and efficient way (Marković, 2010, p.5).

We call renewable energy sources because they are (relatively) inexhaustible, ie. they're being recreated just as quickly as we're using them. Their most important characteristic is that they are "clean", i.e. significantly reduce water pollution of air and soil. RES has a deficiency in terms of usage intensity, but the technology for their use has been significantly improved worldwide in recent years. RES systems used in the entire tourism infrastructure have also been improved.

The term renewable energy (RES) often refers to:

- Sun energy;
- Wind energy;
- Water energy (hydropower - small power plants);
- Geothermal energy;
- Biomass energy;
- Tide and wave energy (Maksin, 2009, p.99).

Solar energy is the most intensively studied type of all types of RES, and today the technologies that enable the use of this form of energy have advanced the most (Maksin, 2009, p. 100).

The notion of insolation (INcoming SOLar radiation) represents the energy of total radiation obtained from the sun (directly and diffusely) and which, when it passes through the atmosphere in a unit of time, reaches the earth's surface (Ilić and Lepotić, 2013, p.19).

As Ilić and Lepotić say and according to the principle of operation and use of the spectrum of solar electromagnetic radiation, two types of devices that convert the energy of the sun into other types of energy can be extracted. The first type is a device that collects and converts the thermal energy of the sun's radiation (infrared spectrum) into thermal energy for heating water or other mediums. These devices are called solar thermal collectors (STC). The second type is a device that collects the light energy of the sun's radiation (ultraviolet and visible spectrum) and that device converts the energy of light directly into electricity by the photovoltaic effect. These devices are called solar cells, where groups of cells are connected in solar modules (panels) also called solar panel receivers (Ilić and Lepotić, 2013, p.24).



Figure 1. Solar panels



Source: <http://www.bbsolar.me/index.php/o-nama/ponuda/solarni-paneli>

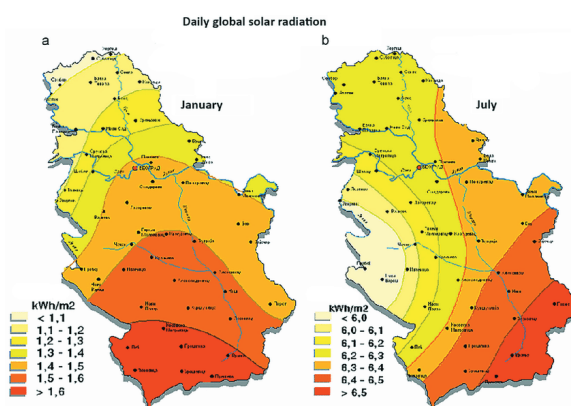
It should be noted that there is a possibility of using solar energy in all tourist facilities in general. In particular, in hotel facilities, it is most commonly used to heat water for showering, cooking, laundry and sports recreational and wellness facilities.

The sun is an energy source that has the greatest energy potential and is a reservoir of both light and thermal energy. The power of the sun's radiation is:

$$P(S) = 3,83 \cdot 10^{26} \text{ W} = 3,83 \cdot 10^{14} \text{ TW} \quad (\text{Radićević et al., 2009})$$

and this power the sun will have for around $5 \cdot 10^9$ years or 5 billion years (Radićević *et al.*, 2009). Serbia is in such a position that the values of the intensity of solar radiation are among the most important in Europe, and in the most favourable areas of our country, a really large number of sunny hours have been recorded. Cities in southern Serbia such as Niš, Vranje, Kuršumlija and Priština have the greatest opportunities for benefiting from solar energy. On average in Serbia, solar radiation is 1,1 kWh/m² per day in the north of the country (in Vršac) up to 1,85 kWh/m² per day in the south (in Priština) – during the winter period, where January is most critical. Average sun radiation is 5,90 kWh/m² per day on Zlatibor up to 6,35 kWh/m² per day in Vranje – during the summer period, where the sunniest month is July (Marković, 2010, p.184).

Figure 2. Daily global solar radiation



Source: Potić, I., Golić, R., & Joksimović, T. (2016). Analysis of insolation potential of Knjaževac Municipality (Serbia) using multi-criteria approach. *Renewable and Sustainable Energy Reviews*, 56, 235-245.



If we look at solar radiation annually, the values ranges are from 1200 kWh/m² per year in northwestern Serbia to 1550 kWh/m² per year in southeastern Serbia. It should be noted that the level of solar radiation use depends on multiple parameters and one of the key is receivers of thermal energy. For Serbia, the average value of available useful energy is 700 kWh/m² per year (Marković, 2010, p.184).

It can be said that the interesting fact that the energy emitted by the sun on 1 m² roof surfaces of houses and buildings in Serbia is equal to the energy that can be obtained by consuming 130 liters of oil (Maksin, 2009, p.115). How favourably the sun's energy can be is clear from the fact that the price of solar energy is incomparably lower than the price of oil, not to mention the ecological dimension.

In Serbia, the largest number of spa settlements is located in zones that are very favourable when it comes to the intensity of sunlight. Another positive fact remains that spas have still low population density and individual facilities suitable for the installation of equipment for the exploitation of energy of the sun for both heating and hot water production (Maksin, 2009, p.116).

INVESTMENT ACTIVITIES IN HOTEL FACILITIES

According to the United Nations Organisation's definition, investment represents only one part of the social income that remains when all personal and general spending is met (Čerović and Čomić, 2020, p. 7). That part can be used to replace everything that has been spent and exploited, as well as to build new potentials. If we look more closely at tourism and hotel management, investments are most commonly used for replacements, expansions, adaptation and modernization of existing buildings and construction of new facilities, trades and roads, as well as in the construction of facilities that do not belong to these activities but participate in the formation of the entire service.

OECD (Organisation for Economic Co-operation and Development), according to Čerović and Čomić (2020, p.8) classifies all investments in tourism into three groups:

- ◆ Investments in accommodation facilities;
- ◆ Investments in a sub-sector different than the hotel;
- ◆ Investments in building or expanding infrastructure

The same authors (Čerović and Čomić, 2020, p.10) emphasize that the main economic indicators of the success of certain investments are:

- ◆ Efficiency coefficient;
- ◆ Profitability ratio;
- ◆ Reproduction coefficient.

The efficiency ratio of an investment is calculated (Čerović and Čomić, 2020, p.11) :

$$E = \frac{I}{D}$$

where E – efficiency ratio, I – investment rate and D –rate of income increase.

The authors further explain the calculation of profitability ratio of an investment using the formula:

$$R = \frac{D}{I}$$

where is R – profitability ratio. (Čerović and Čomić, 2020, p.11)

The reproduction coefficient of an investment is actually the time it takes to return the investment to the community as income (Čerović and Čomić, 2020, pp.10-11).

Investments in contemporary hotels often involve investments in recreational facilities, regardless of hotel type or tourist destination. Looking at the size and category of the hotel, it's fair to say that low-quality hotels and motels and middle-class hotels generally feature a small pool or a small fitness center. Larger hotels, with higher categorization, are mostly adjusted for business guests and often operate with a swimming pool and wellness and fitness center. Hotels in resorts, where guests stay for an extended period and where fewer resources are used for land and construction, have a lot of additional outdoor facilities (Čerović and Čomić, 2020, pp.269-270).



The pool at Crowne Plaza hotel Belgrade is 17 x 7 m in size, with a depth range from 1,25 m to 2,4 m. The pool has a system that performs automatic water filtration and the water is heated up to 28 °C. Investments in wellness and fitness centres in hotels are just as important as investments in the pool. Very often business people don't have the time for swimming pool recreation, but they are making sure to take time out on the treadmill, a short stay in the sauna or a relaxing massage after a hard day's work. When planning and designing wellness and fitness centers hotel developers are paying special attention to the:

- a) Position – that guests in bathrobes and bathing suits do not pass through the lobby of the hotel and that members of the wellness and fitness club, who are not guests of the hotel, can pass directly to desired facilities;
- b) Service facilities – reception of the wellness center, locker rooms, showers, toilets, exercise rooms, sauna, steam bath, jacuzzi, tepidarium, massage and facial and body treatment rooms, etc.;
- c) Space – there must be a complex that has a control position (Čerović and Čomić, 2020, p.274).

ECONOMIC ANALYSIS OF INVESTMENTS IN SOLAR SYSTEMS: CASE STUDY OF CROWNE PLAZA HOTEL BELGRADE

Disposable hot water, whether it's the residential buildings or hotels, requires a relatively low temperature (40-60°C), so the system that uses the energy of the sun's radiation is perfectly suitable for these needs. This analysis of the solar heat system is calculated on the case of Crowne Plaza Hotel Belgrade. The hotel itself has 420 rooms and 14 apartments. The hotel has eight floors and a total area of 37.000 m², and the large spa & wellness center "Saruna" with 1.650 m² and the largest hotel indoor pool in Belgrade. Heating of sanitary hot water in the hotel is done in two zones:

- a) Low-pressure zone – water heats in two boilers volume 8.000 liters;
- b) High-pressure zone – water is also heated in two boilers with a volume of 8.000 liters.

Hot water heating is done through heat exchangers of 232 kW and 103 kW, which use thermal energy from a plant for energy production. The heating of the pool is done via a heat exchanger of 180 kW, where warming is also made from the plant for energy production. In the plant for energy production there are 2 x 3,7 MW gas boilers that have very low efficiency levels. The level of consumption of sanitary hot water varies throughout the period: due to different levels of hotel occupancy, season, etc.

Table 1 provides sanitary water consumption per month in hotel during 2016. Because it is taken as representative and this year the average consumption is 793,30 m³ of waters (Pištinjat, 2017).

Table 1. Consumption of sanitary hot water during 2016.

Month	January	February	March	April	May	June
sanitary water consumption (m ³)	880,26	739,79	747,28	659,75	716,90	907,50
Month	July	August	September	October	November	December
sanitary water consumption (m ³)	687,83	591,66	715,14	920,91	1052,65	899,89

Source: Pištinjat, 2017



Table 2. provides a view of the necessary thermal energy and the actual energy that is consumed (Pištinjat, 2017).

Table 2. The necessary and actual energy consumed for the specified quantities

Month	r	sanitary water con- sumption	C	T1	T2	Q _{swc} (required)	Q _{swc} (used)	Q (Losses)
(measures)	(kg/m ³)	(m ³)	(kJ/kgK)	(°C)	(°C)	(kWh)	(kWh)	(kWh)
January	1000	880,26	4,186	10	60	51.177,34	101.550,00	50.372,66
February	1000	739,79	4,186	10	60	43.010,57	90.840,00	47.829,43
March	1000	747,28	4,186	10	60	43.446,03	92.500,00	49.053,97
April	1000	659,75	4,186	10	60	38.357,13	82.070,00	43.712,87
May	1000	716,90	4,186	10	60	41.679,77	83.670,00	41.990,23
Juni	1000	907,50	4,186	10	60	52.761,04	76.570,00	23.808,96
July	1000	687,83	4,186	10	60	39.989,67	67.030,00	27.040,33
August	1000	591,66	4,186	10	60	34.398,46	61.430,00	27.031,54
September	1000	715,14	4,186	10	60	41.577,45	65.100,00	23.522,55
October	1000	920,91	4,186	10	60	53.540,68	88.320,00	34.779,32
November	1000	1.052,65	4,186	10	60	61.199,90	99.650,00	38.450,10
December	1000	899,89	4,186	10	60	52.318,60	96.890,00	44.571,40
Pros./ Pickup	1000	793,30	4,186	10	60	553.456,64	1.005.620,00	452.163,36

Source: Pištinjat, 2017

From this table, you can see that the actual thermal energy consumed (Q_{used}) is almost twice the amount of heat needed to heat these amounts of water (Q_{required}). It is clear that the losses are enormous, and they arise not only because of the branched network of hot sanitary water but also because of the power production plant and the substation. Namely, gas boilers are of high power, but their level of utilization is extremely small. The thermal energy consumption for pool heating at the year level (2016) can be seen in the following table (Pištinjat, 2017).

Table 3. Heat energy used to heat the pool

Month	January	February	March	April	May	June
thermal en.consumation (kWh)	17.140,00	18.960,00	15.150,00	13.170,00	13.580,00	8.640,00
Month	July	August	September	October	November	December
thermal en.consumation (kWh)	5.480,00	8.000,00	10.850,00	14.020,00	16.060,00	20.050,00

Source: Pištinjat, 2017



The actual heat energy needed to heat the water in the pool is smaller than the thermal energy shown because there are losses on the heating pipes and the boiler has a very low level of efficiency. The actual value was calculated with a ratio of 0,6. Thus, the final heat energy consumption Q (total) will look like in the following Table 4:

Table 4. Total actual thermal energy

Month	Q _{swc} (required)	Q _{pool} (required)	Q (total)
(measures)	(kWh)	(kWh)	(kWh)
January	51.177,34	10.284,00	61.461,34
February	43.010,57	11.376,00	54.386,57
March	43.446,03	9.090,00	52.536,03
April	38.357,13	7.902,00	46.259,13
May	41.679,77	8.148,00	49.827,77
June	52.761,04	5.184,00	57.945,04
July	39.989,67	3.288,00	43.277,67
August	34.398,46	4.800,00	39.198,46
September	41.577,45	6.510,00	48.087,45
October	53.540,68	8.412,00	61.952,68
November	61.199,90	9.636,00	70.835,90
December	52.318,60	12.030,00	64.348,60
Annually	553.456,64	96.660,00	650.116,64

Source: Pištinjat, 2017

The solar collectors adopted in this calculation are plated thermal collectors of horizontal type. Collectors are oriented directly to the south and with a tilt of 40°. The total area on which collectors can be installed is 418,32 m². Since the gross area of a collector is 3,312 m², a total of 126 collectors can be installed. Based on the thermal energy generated by sunlight, the number of collectors needed for heat energy needs can be determined to heat the sanitary consumable water and water in the pool (Pištinjat, 2017).



Table 5. Ratio of the number of needed collectors according to the adopted number of collectors

Month	Q (Total)	Q (collector daily unit)	Q (collector unit)	collector surface required	collector surface unit	collector number required	number of collectors adopted
(measures)	(kWh)	(kWh)	(kWh)	(m ²)	(m ²)	(com)	(com)
January	61.461,34	1.215,94	37,69	1.630,71	3,15	517,7	126,00
February	54.386,57	1.813,84	54,42	999,39	3,15	317,3	126,00
March	52.536,03	3.070,08	95,17	552,02	3,15	175,2	126,00
April	46.259,13	3.573,93	107,22	431,44	3,15	137,0	126,00
May	49.827,77	3.782,18	117,25	424,97	3,15	134,9	126,00
June	57.945,04	3.929,98	117,90	491,48	3,15	156,0	126,00
July	43.277,67	4.111,36	127,45	339,57	3,15	107,8	126,00
August	39.198,46	4.064,34	125,99	311,12	3,15	98,8	126,00
September	48.087,45	3.338,80	100,16	480,11	3,15	152,4	126,00
October	61.952,68	2.740,91	84,97	729,11	3,15	231,5	126,00
November	70.835,90	1.760,09	52,80	1.341,59	3,15	425,9	126,00
December	64.348,60	1.021,12	31,65	2.033,13	3,15	645,4	126,00
Pros./Pickup	650.116,64	2.868,55	1052,67	813,72	3,15	258,3	126,00

Source: Pištinjat, 2017

From Table 5., it can be clearly seen that the number of collectors that can be placed on the available surface of the hotel is not sufficient for all energy required. This calculation showed that the physical predispositions of an already built hotel cannot always satisfy all the needs when it comes to installing solar collectors. It should be noted that the use of RES is very important and that such calculations are always better performed at the beginning of planning and design and building of the hotel and all systems in it. Based on the necessary total energy for heating sanitary hot water and water in the pool and the total available energy from collectors, one can determine for every month of the year the share that the solar system can provide, as well as the share of the annual level.

Table 6. The share of the solar system in total energy needs

Month	Q (Total)	Q (availability)	solar system share
(measures)	(kWh)	(kWh)	(%)
January	61.461,34	14.959,16	24,34
February	54.386,57	21.599,30	39,71
March	52.536,03	37.772,97	71,90
April	46.259,13	42.555,62	91,99
June	57.945,04	46.794,51	80,76
July	43.277,67	50.584,91	116,88
August	39.198,46	50.005,43	127,57
September	48.087,45	39.753,50	82,67
October	61.952,68	33.724,59	54,44
November	70.835,90	20.956,32	29,58
December	64.348,60	12.561,89	19,52
Pros./Pickup	650.116,64	417.804,72	64,27
Annually	553.456,64	96.660,00	650.116,64

Source: Pištinjat, 2017



From the table it is clear that the smallest share of the solar system is in meeting energy needs in December and January (19,52% and 24,34%), while in July and August it is over 100% which means that the solar system can provide more energy than necessary. April and May are also very efficient because the solar system provides more than 90% of the needs. On an annual basis, the share of the solar system would be 64,27% (Pištinjat, 2017).

Based on the monthly consumption of gas in the gas boilers, the savings in gas used in gas boilers, both in volume (m³) and in currency (RSD), were calculated after the installation of solar collectors. It is important to note that the current price of gas in 2021 has been taken. Savings based on the access to the gas system and access fees are also current in 2021 (Srbijagas, 2019).

Based on the average monthly consumption of electricity to power high-temperature pumps of RSD 40.000,00 savings were calculated after the installation of solar collectors and the share of the solar system.

Table 7. Partial and total savings from introduction of solar system

Month	solar system share	L gas	gas saving by solar system	gas price	gas saving by solar system	price of access to the system	price of access saving by solar system	saving electricity for pumps	total savings
(measures)	(%)	(m ³)	(m ³)	(RSD/m ³)	(RSD)	(RSD/m ³)	(RSD)	(RSD)	(RSD)
January	24,34	17.880,80	4.352,03	35,50	154.479,76	3,04	13.212,77	9.735,66	177.428,18
February	39,71	19.032,45	7.558,62	35,50	268.300,87	3,04	22.947,98	15.885,76	307.134,61
March	71,9	19.185,90	13.794,50	35,50	489.649,72	3,04	41.880,11	28.759,67	560.289,50
April	91,99	19.282,00	17.738,28	35,50	629.638,01	3,04	53.853,42	36.797,59	720.289,02
June	80,76	12.393,61	10.008,67	35,50	355.267,83	3,04	30.386,33	32.302,69	417.956,84
July	116,88	10.539,54	10.539,54	35,50	374.111,51	3,04	31.998,04	40.000,00	446.109,56
August	127,57	10.147,27	10.147,27	35,50	360.187,50	3,04	30.807,11	40.000,00	430.994,61
September	82,67	11.111,02	9.185,39	35,50	326.044,60	3,04	27.886,84	33.067,67	386.999,12
October	54,44	15.083,69	8.210,97	35,50	291.456,42	3,04	24.928,49	21.774,42	338.159,34
November	29,58	14.673,85	4.341,16	35,50	154.093,78	3,04	13.179,76	11.833,73	179.107,26
December	19,52	16.688,85	3.257,93	35,50	115.643,58	3,04	9.891,08	7.808,65	133.343,31
Pros./ Pickup	64,27	15.328,56	115.874,17	35,50	4.113.069,70	3,04	351.793,99	315.323,74	4.780.187,43

Source: Pištinjat, 2017

Based on Table 7, you can see how much gas and electricity are saved annually and that the amount to the total of RSD 4,780,187.43.

First, we will evaluate the profitability of the investment through a static method:

$$P = \frac{I}{CF} ; \text{ (Spasić and Čerović, 2019, p.276)}$$

In our case, the initial investment is $I = 30.126.113,50$ RSD and cash flow, i.e. savings achieved within one year amount to $CF = 4.780.187,43$ RSD, so the return period is:

$$P = \frac{I}{CF} = \frac{30.126.113,50 \text{ RSD}}{4.780.187,43 \text{ RSD}} = 6,3 \text{ years}$$

For investments of this type, the expected return period is 5 to 7 years, so for this investment we can say it is profitable.

Another static method is the accounting rate of yield:

$$ARR = \frac{ANP}{AI} ; \text{ (Spasić and Čerović, 2019, p.278)}$$

In our case, the average annual profit is = RSD 4,780,187.43 and the average annual investment is = $30,126,113,50/6 = \text{RSD } 5,021,018.92$, so the accounting rate of the yield is:

$$ARR = \frac{ANP}{AI} = \frac{4.780.187,43 \text{ RSD}}{5.021.018,92 \text{ RSD}} = 0,952$$



For a company that invests, the time value of money is important, so it can be calculated with a formula:

$$V_n = V_s \times (1+i)^n \quad ; \text{ (Spasić and Čerović, 2019, p.281)}$$

where: V_n – value of money at the end of the period, V_s – value of money at the beginning (present value),
and – annual interest rate, n – length of period

$$(1) \quad V_n = 250.000 \text{ €} \times (1 + 3,5\%)^{6,3} = 250.000 \text{ €} \times 1,2420074 = 310.501,86 \text{ €}$$

$$(2) \quad V_n = 250.000 \text{ €} \times (1 + 3,5\%)^5 = 250.000 \text{ €} \times 1,1876863 = 296.921,58 \text{ €}$$

$$(3) \quad V_n = 250.000 \text{ €} \times (1 + 3,5\%)^8 = 250.000 \text{ €} \times 1,3168090 = 329.902,26 \text{ €}$$

It should be noted that the formulas (1), (2) and (3) used an annual interest rate of 3,5%, obtained by specialists of Komercijalna Banka. Formula (1) looks at the value of money after 6,3 years or 74 months of repayment with an interest rate of 3,5%, because the return period method determined that the investment pays out in 6,3 years. However, since such loan repayment times are unrealistic, i.e. loans are not approved for the specified period in formulas (2) and (3) you can see the value of the money after five or eight years.¹

For the Crowne Plaza Hotel, a bank loan repayment plan, or an Annuity Plan, as it is otherwise called, has been designed. According to the offer of Komercijalna banka a.d. Belgrade's interest rate for Crowne Plaza hotel is 3,5%, the loan processing and release fee is 0,5%, the mortgage registration fee is € 510,38 the cost of assessing the value of the property is RSD 65.000 and the annual insurance premium is RSD 40.000. The basic assumption that has been made is that the hotel can settle costs exceeding € 250.000,00 which are:

- ♦ € 6.248,52 for the entire investment;
- ♦ € 1.250,00 amounting to 0,5% of the total loan amount for the loan processing;
- ♦ € 510,38 mortgage fee;
- ♦ RSD 65.000;
- ♦ 5 (8) x RSD 40.000 annual insurance premium that is advocated (for 5 years or 8 years).

The first example is the repayment of a loan for a period of five years with all the conditions specified. The annuity plan will then look:

Table 8. An annuity plan for a loan for five years or 60 months

due date	payment of loans	annuity	principal payment	interest payment
01.08.2021.	250.000,00			
01.09.2021.		4.547,94	3.818,77	729,17
01.10.2021.		4.547,94	3.829,91	718,03
01.11.2021.		4.547,94	3.841,08	706,86
01.12.2021.		4.547,94	3.852,29	695,65
01.01.2022.		4.547,94	3.863,52	684,42
01.02.2022.		4.547,94	3.874,79	673,15
...		...	...	...
01.05.2026.		4.547,94	4.495,27	52,67
01.06.2026.		4.547,94	4.508,38	39,58
01.07.2026.		4.547,94	4.521,53	26,41
01.08.2026		4.547,70	4.534,47	13,23
Total	250.000,00	272.876,16	250.000,00	22.876,16

Source: Komercijalna banka a.d. Belgrade, 2021

¹ Data related to interest rate and loan repayment plans for 60 or 96 months were obtained by specialists in the credit risk analysis department of Komercijalna banka.



The annuity plan was calculated in euros and with complex discounted net cash flow, in which case the total or aggregate annuity is € 272.876,16. The total principal payment, of course, matches the total loan paid out at €250.000 and the total interest paid is € 22.876,16 (Petrović and Straživuk, 2021).

The value of the aggregate annuity according to the bank's repayment plan for a period of five years differs from the value of the money calculated at the end of the five-year period, because the bank calculates with a complex interest rate.

The monthly annuity, as seen from the table, is € 4.547,94 and the average monthly saving is € 3.388,30. Based on this, we conclude that an average of € 1.159,64 is required per month for annuity costs. Another simulation was designed for a loan for an eight-year period with all the conditions listed. The annuity plan would then look as follows:

Table 9. An annuity plan for loan for eight years or 96 months

due date	payment of loans	annuity	principal payment	interest payment
01.08.2021.	250.000,00			
01.09.2021.		2.989,51	2.260,34	729,17
01.10.2021.		2.989,51	2.266,94	722,57
01.11.2021.		2.989,51	2.273,55	715,96
01.12.2021.		2.989,51	2.280,18	709,33
01.01.2022.		2.989,51	2.286,83	702,68
01.02.2022.		2.989,51	2.293,50	696,01
...		...	...	...
01.05.2029.		2.989,51	2.954,88	34,63
01.06.2029.		2.989,51	2.963,50	26,01
01.07.2029.		2.989,51	2.972,15	17,36
01.08.2029.		2.989,86	2.981,16	8,70
Total	250.000,00	286.993,31	250.000,00	36.993,31

Source: Komercijalna banka a.d. Belgrade, 2021

The annuity plan was calculated in euros and with discounted net cash flow, in which case the total or aggregate annuity is € 286.993,31. The total principal payment, of course, matches the total loan paid out at € 250.000 and the total interest paid is € 36.993,31 (Petrović and Straživuk, 2021).

The value of the aggregate annuity according to the bank's repayment plan for an eight-year period differs from the value of the value calculated at the end of the eight-year period, as the bank calculates at the complex interest rate.

The monthly annuity, as seen from the table, is € 2.989,51 and the average monthly saving is € 3.388,30. Based on this, we conclude that on average, more is saved monthly by installing the solar system than is necessary for annuity costs. If we look in detail for months of the year only during four months, the annuity costs are greater than the savings.

CONCLUSION

It should be noted that the electro-mechanical project for the construction of the solar system was done by the renowned company Master Solar Ltd in cooperation with Misteco ltd. The equipment provided in the project is of the highest quality. Solar collectors have a Solar Keymark certificate with a report and an addition to the report according to EN ISO 9806:2013. The manufacturers of all equipment are certified according to ISO 9000 and ISO 14001 and originate from Austria, Germany and Italy.



Economic analysis of investments in this system has shown that installing solar systems for water heating is cost-effective in a short period of time because the method of the return period shows that the investment is cost-effective after 6.3 years. If we look at dynamic methods or include a time dimension of money, it is clear that based on an offer from one of the banks in Serbia for such an investment, one can talk about a period of five or eight years. It is important to say that each of these offers has its advantages and that it is always up to hotel management to make a final estimation.

The first offer for a five-year loan shows that, as we have already argued, the monthly annuity is € 4.547,94 and the average monthly saving is €3.388,30. In this case, it is clear that an average of € 1.159,64 (RSD 136.334,24) for annuity costs should be added on average. For a hotel with capacities such as Crowne Plaza Belgrade, a specific amount can be provided from the current business cash flow. On the other hand, the investment will be disbursed in just five years and the total interest payment for that period will be € 22.876,16.

In addition, a different eight-year loan simulation shows that, as we have already argued, the monthly annuity is € 2.989,51 and the average monthly saving is €3.388,30. In this case, it is clear that on average, more is saved per month by installing the solar system than is necessary for annuity costs. On the other hand, the investment will be disbursed in eight years and the total interest payment for that period will be € 36.993,31, up about 60% from the interest paid over a period of five years. The advantage of an eight-year loan decision is that the monthly difference between annuity and savings can be used for other investments.

We conclude by arguing that investments as such are more than favorable for hotels for a number of reasons:

1. IHG brand reputation related to RES is supported;
2. Sustainable social practice is supported;
3. Acceptable investments stimulate substantial savings of funds for a long period of time.

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