

PROCJENA OPERATIVNOG TOKA NOVCA KOD INVESTICIJE U IZGRADNJU PASIVNE KUĆE

ASSESSMENT OF OPERATING CASH FLOW OF THE INVESTMENT IN A CONSTRUCTION OF PASSIVE HOUSES

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Stručni članak

Sažetak: Ovaj članak bavi se upravljanjem tokom novca kućanstva koje je investiralo u štednju energije izgradnjom pasivne kuće. Cilj je potvrditi ili odbaciti hipotezu kako ulaganje većeg kapitala u izgradnju niskoenergetskih kuća dovodi do manjih troškova održavanja kuće u budućnosti i do veće likvidnosti. U članku se predstavljaju mogućnosti štednje energije i metode procjene ekonomske učinkovitosti u građevinskim projektima. Na primjeru investicije u tipske stanove napravljen je izračun operativnog toka novca za pasivne i standardne kuće te su napravljeni zaključci.

Ključne riječi: ekonomska efikasnost, ušteda energije, operativan tok novca, pasivna kuća, standardna kuća

Professional paper

Abstract: The paper deals with operating cash flow of a household that invested in energy saving with building a passive house. The aim is to confirm or refute the hypothesis that higher capital expenditure for the construction of low-energy building houses in the future reduce operating costs and lead to higher liquidity. In the paper are introduced the possibilities of energy savings and methods for assessment of economic efficiency in construction projects. On an example of a model housing investment it is calculated an operating household cash flow for passive and standard house and conclusions are drawn.

Key words: economic efficiency; energy savings; operating cash flow; passive house; standard house

1. INTRODUCTON

Words such as low energy, environmentally friendly, energy saving are widely used in modern terminology. Media, government statements, entrepreneurs, companies and non-governmental organizations are almost competing in their use. But purpose is often different. One independent reports or draw attention to the deteriorating state of the environment and the need for lifestyle changes, others want to sell their products and proclaim apart form a controversial matter on the environment also saving money or declare the results of international agreements and preparing legislation. Practically, however, often households are finding that more energy efficient and more environment friendly products are more expensive products. One of the most important investment decisions of households is living. Many people decide to build their own house. This decision entails, inter alia, the large investment costs. They are in most cases solved through foreign sources that indebted households for long time. It is no exception that the debt takes decades of life.

Repayment of the loan is not only households' expense that is associated with the acquisition of a new building. A considerable part of the family budget goes to a house operation. In the temperate zone of the Czech Republic the highest costs are associated with heating

expenses, which, due to developments in energy prices have not declining character. Households often invest in energy-efficient buildings. Technological progress and development can build buildings with very low energy requirements for heating, the so-called passive houses. These buildings need just a fraction of the heating energy compared to standard buildings that also satisfy valid building norms. The government supports energy-saving construction. According to the lawn a rent or sold building has to inform about its energy performance using so cold "PENB". PENB is a certificate of a building's energy performance, according to them the building is classified into seven classes, which affect not only the selling price of existing buildings, but also influence future investment decisions of households on energy class of new construction [1]. According to the amended Directive of the European Parliament and of the Council 2010/31/EU, only buildings with almost zero energy will be built since 2021 [2]. Draft of the norm for the Czech Republic, which among other things will involve passive constructions after 2020, is currently in commenting.

But are measures that reduce energy needs for heating buildings really cost saving in total as media, builders and interest organizations declare? The following paper is dedicated to the confirmation or refutation the hypothesis that increased investment to

the construction of passive houses in the future reduces operating costs and family budgets lead to higher liquidity.

2. THE ENERGY NEEDS IN THE HOUSEHOLD

Before we tackle the issue of energy consumption of a passive house it is necessary to briefly define the energy needs of the household. Generally, we can divide the energy demand for households:

- Thermal comfort of home.
- Operation of electrical appliances and household items.
- Hot water and lighting.

From the above it is clear that in saving energy not only dwelling itself and its structural design play an important role, but also the number of household members, age, living standards and related behaviours, habits and lifestyle. In the following part of the article we will consider only areas maintaining thermal comfort of home, you can just affect with the structural character of the building [3].

3. POSSIBILITIES OF THE ENERGY SAVINGS IN THE HOUSEHOLD

Ways to save energy in the home and reduce expenditure on maintaining thermal comfort is more. Basically, we can divide the savings related to:

- the behaviour of household members,
- the operation of technical equipment of the house,
- design - house technical solutions,
- the layout of the house.

Experts on energy to households that want to save on heating and do not have the option of larger investment advice in particular:

- Short and intense wind, so not cool down the house wall.
- Closing the door to the cold rooms and drag the window blinds to reduce the heat loss.
- Keep the recommended temperature in the living room and in rooms that are not use to housing (e.g. pantry or laundry) only temper.
- Divide the day into the thermal regime, i.e. the set of thermal comfort in a time when members of a household are in the house or lower the temperature at night.
- Periodically check the condition of the heating system. To install thermostats for thermal control.
- Do not dry clothes on radiators.

Among the economies affected by the layout of the house can be included:

- Location of the radiator, which should be freely in space, i.e. nothing uncovered. They have to be regularly cleaned.

- Technical facilities and residential rooms should be separated.

Among the economies affected by the technical equipment of the house can be included:

- To have a condensing boiler as a household equipment.
- Installation of forced ventilation system with heat recovery.
- Installation of solar or photovoltaic panels for heating,
- Installation of thermal insulated windows and doors.
- Installation of small wind turbines or water micro power plant.
- Installation of micro-cogeneration units.

Among the economies affected structurally- technical solution of the house can be included:

- Thermal insulation of external walls and roof of the house, insulation ceiling constructions separating accommodation and other parts of the house.
- Surface minimizing of exterior walls of the house, i.e. choosing the compact closed shapes without unnecessary segmentation. Globe is energetically the most appropriate shape.
- Consideration of the geographical sitting, i.e. windows oriented mainly to the south, etc.

In simple terms, if all of this will be incorporated in a new building, so the building is called passive or low-energy house [4].

4. PASIVE HOUSE

Meaning passive in general means "idle, unresponsive or just passive". People may this nature wrongly assessed, but passivity in building construction is appreciated in a view of environmental friendliness. For passive houses the passivity is hidden in reducing the energy need from external power supplies. The houses use passive heat gains functionally and treat them effectively. The main source of heat gains is the solar radiation that is accompanied by internal heat gains commonly used for the building operation. These internal heat sources are mainly consisted of electrical appliances (computer, TV, washing machine), activities associated with the operation of the household (cooking, ironing, etc.), but also warm-blooded animals or persons residing in the building. Such use of heat gains requires of course a well - insulated wall and hole fillings.

Thanks to the efficient management of these heat gains in passive houses is not necessary to install classical heating system. The small proportion of heat loss is to be covered with an additional source of heat. The required amount of heat delivered not according to exceed 15 kWh/m² heated area per year [5]. In order to achieve the desired values, you must meet additional technical criteria:

- Specific heat demand for heating < 15 kWhm⁻²a⁻¹.
- Heat output: max 10 W/m².

- The heat transfer through peripheral construction $U < 0.15 \text{ Wm}^{-2}\text{K}^{-1}$.
- The heat transfer through hole fillings $U < 0.8 \text{ Wm}^{-2}\text{K}^{-1}$.
- Coefficient of air tightness $n_{50} < 0.6 \text{ h}^{-1}$.
- Controlled ventilation system with heat recovery with efficiency greater than 75%.
- Annual contribution of primary energy (heating, water heating, ventilation and electrical appliances) $< 120 \text{ kWhm}^{-2}\text{a}^{-1}$.

5. CHARACTERISTICS OF MODEL CASE STUDIES AND IDENTIFICATION OF TARGETS

Confirmation or refutation of the above mentioned hypothesis is done with the help of a following case study. One household of three members occupies two identical buildings (the same shape and shape and layout). Footprint of the building is 460.25 cubic meters and both buildings meet the applicable standards ČSN 73 0540-2 „Thermal protection of buildings” [5]. One house is structurally adapted to the passive standard. Geographic location and sitting of buildings are the same. The subject of the case study is to quantify the operating household cash flow with regard to the expected different investment costs and different construction costs to maintain thermal comfort in the building. As the two building models inhabit the same household the influence of the different behaviour and economic household status were eliminated [6]. This has to be occurred in a study providing in a real environment.

Characteristics of input data:

- Building land in private ownership.
- Construction financing done with the help of a mortgage loan. Own capital is 500 000 CZK from a construction saving.
- Home has 3 members, 2 of them are economically active, 3rd member is a dependent child.
- The gross household income is 55 000 CZK per month. Net income, taking into account the tax credit for child is 43 152 CZK.
- An analysis is carried out at constant prices without taking into account inflation.

6. SOLUTION METHODS

Achieving the goal requires to answer the following key questions?

- What are the investment costs of construction of both houses?
- What is the amount of mortgage payments?
- What are the costs for heating both buildings?

What is the amount of other operating expenditure in both household models?

6.1. Calculation of Investment Cost

The amount of investment in the construction of the standard house in classification according to JKSO (so called „Uniform classification of buildings”) is determined using financial ratios of a company „RTS” specialized in pricing and costing in construction in the price level of 2013 [7]. Financial ratio expresses the average investment cost of construction per m^3 from the sample of completed buildings classified according to JKSO (see table 1 and equation 1).

$$IC = RU * O_p \quad (1)$$

Table 1 Residential buildings (price in CZK per m^3 of enclosed space) [7]

JKSO	Average	Construction material characteristics				
		1	2	3	5	8
803 Residential buildings	4712	4401	6756	5703	4712	6756

For determination the amount of investment in the construction of a passive house it cannot be used methods of the financial ratios, because there is no definition of the passive house standard and calculation of financial ratios that are available on construction market of Czech Republic. One of the reasons for this is a small market with passive houses in the country. A number of these houses in the Czech Republic is currently estimated in the hundreds. The amount of investment costs in a passive house is therefore based on expert estimates. These are compared with studies that have been processed on the German market in 2010, where the market with passive houses is already fully established [8]. Results of the study showed the difference in price +9%. This difference does not differ from the opinion of experts dealing with this issue in the country. The case study was considered the difference +10% (see Table 2).

The main differences reflected higher investment costs in passive house are:

- Thicker layer of thermal insulation of the building envelope.
- Average performed sandwich construction compared to single-layer construction.
- More work involved in order to achieve higher quality and solution of structural details.
- The air tightness of the building envelope, pressure test Blower -door test.
- Thermally insulated windows and doors.
- Installation of heat recovery units.

On contrary lower investment costs are achieved with no need of high efficiency of the heating system.

Table 2 The difference between investment expenditure for passive house and standard house [Own elaboration]

Type of house	Investment expenditure
The standard house	2 494 003 CZK
The passive house	2 743 297 CZK
Difference	249 294 CZK

6.2. Calculation of Mortgage Payments

There are more ways how to pay in investing expenditures. Own finances in a high of millions are not available in a majority of young households. That's why the most frequently used financing forms are building savings and mortgage loans [9]. There is also the possibility of a combination of a bridging loan from a savings and a mortgage loan. Points for wide using mortgage loans are currently low interests and the possibility of coverage of all planned expenditures. For achieving a higher savings households can use grant funds. There is a program "Zelená úsporám" ("Green Savings") in Czech Republic, which allows to partially cover spending's on the construction of houses with very low energy consumption [10]. At present, however, allocated funds are exhausted and the next challenge is expected.

For the purposes of case study a simple way of financing through a mortgage from "Mortgage Bank" was elected. The mortgage loan conditions are following:

- The product "Mortgage loan up to 85 %" due to the partial coverage of investment expenditure from construction savings.
- Annuity payments, i.e. the same total amount of payments with the changing structure of interest and redemption.
- Fees associated with the loan are:
 - Risk analysis and ensure value CZK 4,500
 - Mortgage loan processing 0.4 % of the loan amount (min. CZK 2,000, max 10 000 CZK)
 - The account management 150 CZK/month.

Interest paid on a mortgage is tax deductible expenditure (2013 to 300 000 CZK/household, from 2014 to 80 000 CZK/household) for determining the tax base. The tax shield arising from paid interests appears in the operating cash household flow one year later.

Table 3 Calculation of loan [Own elaboration, data source: 11]

Item	Standard house	Passive house
Property price	2 500 000 CZK	2 750 000 CZK
Own resources	500 000 CZK	500 000 CZK
Loan amount	2 000 000 CZK (80% LTV)	2 250 000 CZK (80% LTV)
Fixture time	5 years	5 years
Repayment period	20 years	20 years
Amount of interest	3,09 % p.a.	3,09 % p.a.

Item	Standard house	Passive house
The monthly loan payment	11 182 CZK	12 580 CZK
The monthly loan payment inc. maintaining an account	11 332 CZK	12 730 CZK
Difference	1 398 CZK	

6.3. Calculation of Expenditures for Heating

The calculation of expenditure for heating buildings is based on theoretical assumptions about the heat needs according to a standardized energy category [5]. Given standard for the energy consumption for heating in the passive house must be less than or equal to $15 \text{ kWh}\cdot\text{m}^{-2}\cdot\text{a}^{-1}$. At standard home construction the situation is more complicated. The standardized energy category is in interval from 80 to $150 \text{ kWh}\cdot\text{m}^{-2}\cdot\text{a}^{-1}$. Based on data companies engaged in issuing energy performance certificates called PENB the most frequently energy classification of homes is energy classes C and E. On the basis of this information for the calculation of expenditures for heating is used the value $115 \text{ kWh}\cdot\text{m}^{-2}\cdot\text{a}^{-1}$.

To determine the energy performance of buildings it has to be determine the unit price for the unit of energy consumption. Determination of unit price depends on the choice of energy. For standard home it is considered the option of heating with natural gas or electricity. All rates are inclusive of VAT. The most common source of heating in the Czech Republic for standard homes is a natural gas, which also comes as the cheapest source of heating.

The decline in prices of heat pumps and their extensions especially in low-energy structures leads to the fact that a significant portion of new buildings is not connected to natural gas or does not use it. In the event that the building is heated by a supplement heat source connected to electricity, the household fare is better. For this reason, it is considered electricity heating in the passive house.

Table 4 The Heating cost [Own]

Item	Standard house	Passive house
Natural gas	21 016 CZK	
Electric heaters	28 469 CZK	
Electric storage	29 433 CZK	
Heat pump		3 585 CZK

Table 5 Input data into the calculation [12]

Item	Standard house	Passive house
Specific heat consumption	$115 \text{ kWh}\cdot\text{m}^{-2}\cdot\text{a}^{-1}$	$15 \text{ kWh}\cdot\text{m}^{-2}\cdot\text{a}^{-1}$
Heated area	$96,1 \text{ m}^2$	$96,1 \text{ m}^2$
Annual requirements	11 052 kWh	1 442 kWh
Price of gas – RWE Standard	1,64 CZK/kWh	-
Price of electricity - ČEZ	2,17 CZK/kWh	2,17 CZK/kWh

6.3. Calculation of Other Operating Expenditures

The amount of household operating expenditure is determined by the CZSO (Czech statistical office) statistics. It collects and publishes data obtained from representative samples of households in the country. For the study the input data are from the expenditure classification "Employees Households with Children" [13] (see table 6). This statistics testify about pure money expenditures provided to a person in a household with children in CZK/person/month. The amount of consumer spending's is considered the same for both test homes. Numerical treatment consists in a quantifying

the different costs for heating buildings and repayment of the mortgage loan.

Table 6 Consumption expenditure per person [Own elaboration, data source 13]

Average per person per month in CZK/month in 2013					
Total consumption expenditure per person (CZ-COICOP)					
8 493,- CZK					
01	02	03	04	05	06
Foodstuffs and non-alcoholic drinks	Alcoholic drinks and tobacco	Clothing and footwear	Housing, water, electricity, fuels	Furnishings, household equipment, repairs	Health
1 647	181	446	1597	416	168
07	08	09	10	11	12
Transportation	Post and telecommunications	Recreation and culture	Education	Food and accommodation	Other goods and services
1 143	376	831	90	595	1 003

7. CALCULATION OF OPERATING CASH FLOW

Household cash flow is cash expenses and income for the calendar year. Positive cash flows are net disposable income from employment and tax savings from the paid mortgage interest. Conversely, negative cash flows are expenditures on heating and operation of buildings, other consumer expenditures and repayment of the mortgage loan.

Table 7 Household CF per month [Own elaboration]

Item	Standard house	Passive house
Net employment income	43 152 CZK	43 152 CZK
Consumption expenditure without heating	22 932 CZK	22 932 CZK
Expenditure on heating – gas / electricity, TC	1 751 CZK / 2 372 CZK	299 CZK
Expenditure – repayment of the loan	11 332 CZK	12 730 CZK
Total expenses per month	36 015 CZK / 36 636 CZK	35 961 CZK

Table 8 Cash flow – Standard house [Own elaboration]

Item	2014	2015	2019	2020
Net employment income (+)	517 824	517 824	517 824	517 824
Consumption expenditure without heating (-)	275 184	275 184	275 184	275 184
Expenditure on heating (-)	21 016	21 016	21 016	21 016
Expenditure – mortgage Loan (-)	135 984	135 984	135 984	135 984
Tax savings from mortgage loan (+)	9 115	8 770	7 277	6 875
Disposable CF (+/-)	94 755	94 410	92 917	92 515
Item	2024	2025	2034	2035
Net employment income (+)	517 824	517 824	517 824	517 824
Consumption expenditure without heating (-)	275 184	275 184	275 184	275 184
Expenditure on heating (-)	21 016	21 016	21 016	21 016

heating (-)				
Expenditure – mortgage Loan (-)	135 984	135 984	0	0
Tax savings from mortgage loan (+)	5 133	4 664	0	0
Disposable CF (+/-)	90 773	90 304	221 624	221 624

Table 9 Cash flow – Passive house [Own elaboration]

Item	2014	2015	2019	2020
Net employment income (+)	517 824	517 824	517 824	517 824
Consumption expenditure without heating (-)	275 184	275 184	275 184	275 184
Expenditure on heating (-)	3 585	3 585	3 585	3 585
Expenditure – mortgage Loan (-)	152 760	152 760	152 760	152 760
Tax savings from mortgage loan (+)	10 254	9 866	8 187	7 734
Disposable CF (+/-)	96 549	96 161	94 482	94 029
Item	2024	2025	2034	2035
Net employment income (+)	517 824	517 824	517 824	517 824
Consumption expenditure without heating (-)	275 184	275 184	275 184	275 184
Expenditure on heating (-)	3 585	3 585	3 585	3 585
Expenditure – mortgage Loan (-)	152 760	152 760	0	0
Tax savings from mortgage loan (+)	5 775	5 246	0	0
Disposable CF (+/-)	92 070	91 541	239 055	239 055

8. CONCLUSION

The research shows that total expenditures both model homes are almost identical. It means that the amount of remaining disposable cash is the same. The differences in the costs for heating buildings (significantly lower in passive house) are balanced by the different level of mortgage payments in standard housing (higher payments for passive house due to higher capital expenditures).

Table 10 Heating costs and mortgage [Own]

Item	Standard house	Passive house
Heating	420 320 CZK	71 700 CZK
Mortgage	2 617 116 CZK	2 939 818 CZK
Total	3 037 436 CZK	3 011 518 CZK

Can we completely deny the hypothesis “higher capital expenditure for the construction of low-energy building houses in the future reduce operating costs and family budgets and lead to higher liquidity”? Yes, at least until the end of the repayment mortgage. After finishing repayments the different level of expenditures on heating shows. The passive house in comparison requires about 5 times lower expenditures for heating.

The question is why interest organizations and government pronouncements declare savings? The answer lies in a simple number game. Lower savings on heating costs is a demonstrable and is fixed in construction standards. Financial return on an increased investment is calculated just from gained savings without taking into account external sources of financing. But the household expenses have to be taken into account comprehensively. Otherwise there is no practical impact.

It cannot be ignored the fact that most households do not dispose of own finances for construction and a load of mortgage repayments is a normal part of the operating expenses of the family. In this point of view, the increased investment in housing in low-energy building at first glance appears to be financially neutral decision. Let him break down:

- Saving resources due to heating exists. In the total expenditure it will be seen after the repayment of the mortgage. It can therefore be contemplated with instalments of extraordinary repayments during the setting period for a new fixation mortgage interest. The calculation of the potential amount outstanding repayment and the calculation of the household ability to reduce its standard of living temporarily can be done with the help of living minimum of households.
- Energy prices compared to interest rates have historically more turbulent character and their planning entails greater uncertainty. Therefore, although in recent years due to competition and setting the market position energy prices go down, it is not nonsense in the long point of view to talk about cost savings due to lower energy consumption and projected growth in energy prices.
- Investing in a house is a long term investment. If your building is perceived in the context of the age of its users, then from the perspective of the management of finances in retirement the investment to a passive house appears to be a sensible choice and effective. The question is any expenses due to technical wear of both buildings.
- One cannot ignore demonstrably higher quality of living, which is associated with a constant supply of fresh air, the greater thermal comfort and stability.
- Due to the current issue of energy supply it can be expected ongoing support for low-energy buildings. In this case the using of irreversible grants moves an investment to the passive house in the first place.
- With the development of the market of low-energy buildings there can be theoretically expected some reduction in investment spending, although considering the current minimum price of building construction. Against this argument can be set a planned statutory duty of low-energy construction.
- Due to the legislation of PENB in case of the sale or lease of real estate there can be expected higher market prices of passive houses.
- One has to mention the great unknown. Each household must it consider individually. Even the best low energy building is meaningful only in case of an energy- responsible behaviour of its users.

Sure it would be found other arguments that play for or against the construction of passive houses. Although the research did not accept the hypothesis it cannot be refused at all with an objective consideration of future development scenarios. Quite the contrary, passive houses are good economic choice for household from the perspective of future uncertainties. Hope that in the Czech Republic, the market with passive houses will only expand.

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