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APPLICATION OF RENEWABLE ENERGY SOURCES IN CENTRAL HEAT SUPPLY SYSTEMS

ZASTOSOWANIE ODNAWIALNYCH ŹRÓDEŁ ENERGII W SYSTEMACH CENTRALNEGO ZAOPATRZENIA W CIEPŁO

Odpowiedzialność za poprawność językową ponoszą autorzy

Abstract

One of priority tasks of the Slovak Republic to boost the use of domestic energy potential and thus to decrease Slovakia's dependence on imported fossil fuels is to increase utilisation of renewable energy sources in heat and electricity generation. Heat pumps offer the most energy-efficient way to provide heating and cooling in many applications, as they can use renewable heat sources in our surroundings.

Keywords: heat pump, renewable energy, central heat supply system, economy

Streszczenie

Zwiększenie wykorzystania odnawialnych źródeł energii w produkcji ciepła i energii elektrycznej jest jednym z priorytetowych zadań Republiki Słowackiej do zwiększenia wykorzystania krajowego potencjału energii i tym samym zmniejszenia zależności Słowacji od importowanych paliw kopalnianych. Pompy ciepła oferują najbardziej energooszczędny sposób do ogrzewania i chłodzenia w wielu zastosowaniach, wykorzystując odnawialne źródła ciepła z naszego otoczenia.

Słowa kluczowe: pompy ciepła, energia odnawialna, centralny system zaopatrzenia w ciepło, ekonomia

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1. Introduction

Many different studies regarding financial and economy crisis are devoted mainly to processes in banking and financial sector and pointed out that a lack of risk management and other bad practices on the market lead to a largest market crash since 1929 [1]. However few new analysis appeared recently which showed that financial and economy crises is more probably a consequence to energy crises very similar as we know it from 70's last century. [2] In that time the price of oil doubled and caused large economy crises. To explain the market behavior during 70's was impossible within the mainstream economy framework. It was Schumacher [3] who discovered that it is not correct to treat fossil energies as income and the full earnings from it allow for consumption. Since this stock of fossil energy provide by the nature is limited and finite it is necessary at least part of the income capitalize. The best of the all solution is to invest this part of the money into projects which will produce forever the same good – renewable energy. The answer of the society to the crises in 70's was doubling the output per energy units. However the society still till these days use fossil energy and produces more and more greenhouse emissions. During 70's the production of the greenhouse emissions crosses the biocapacity of the earth. The produced emissions were not all absorbed and recycle via earth bio systems. Extra emissions are stored in atmosphere as it is a global common store. This process slowly creates a biocapacity depth which exceeds about 30% of the biocapacity of the earth.

Some of the analyst of the present economy crises goes further. Based on the data taken from technical analysis of the oil price volatility and correlated with inflation rate volatility claims that the data clearly shows that a knowledgeable and initially small number of insiders causes new pattern of volatility which emerges shortly on oil market after the year 2000 [4]. It is noteworthy to say that the facts given by Alan Greenspan [5] disclosed that amount of business used various finance instruments backed by oil like futures and options grew from 300 billions USD contracts concluded during the year 2002 up to 2000 billions USD signed in the year 2006. These investors both oil not as a commodity to use but as financial asset. As Greenspan stressed out until 1971 the price has been regulated by USA companies controlling more than 50% of daily production of the oil. In 1971 OPEC took over and used the same principles to control the price on the world market. Dramatic change could be seen during last few years when price went up with the peak in 2008 and go back down within short period of time. In March 2008 commodity index trading funds held quarter trillion USD worth of futures contract. The amount of oil behind this financial asset could be used as a flexible vehicle for regulation purposes of the oil market. The price of the oil is not under control of producers anymore and is not regulated as a result of production supply in order to fulfill demand from the market. Now financial investors dictate the price of the oil to the market with an unprecedented flexibility of price, volume and time.

The other serious crises we are facing are climate change. The long term discussions regarding regulating greenhouse emissions has till now no practical solution. Trading system cap and trade do not fulfill expectation. Market is not able keep the prices on the level which will allow invest money into business and will be drive force for reduction of emissions. The discussion is held whether simple greenhouse tax as it is in Norway is not better solution. Some skeptics said that dealing with greenhouse emissions we are dealing with the property rights problem on global scale. And this is the reason why there will be

no solution which will fulfill basic expectations of all nations. The other arguments coming from the reality that human is prepared to spend even more money when the problem became real contrary to situation in which he is asked to spend less money in order to avoid the rise of the problem.

It is interesting to say that renewable energies could be the synergy solution for both problems: lack of cheap energy and necessity to decrease production of the greenhouse emissions.

Heat pump system has been first time used in 1928 in Zurich. Famous professor Aurel Stodola born in Liptovsky Mikulas, Slovakia, developed and introduced heat pump in order to supply heat to Zurich Town Hall. Why heat pumps attract still in present days so many investors into renewable energies?

One of the main sources of the energy consumptions are buildings. In European Union they are responsible for consuming as much as 40% energy. The problem is not only in heating but also in cooling the building during hot summer. Besides energy consumption problems extra high temperature during the summer 2003 killed only in EU more than 30 000 persons. The black out in Italy occurred during the summer. This happened as a consequence of installation and switching in too much of air conditions. In 2006 European Union define energy intelligent near zero building as a building where ratio between fossil energy and renewable energy should be 20% to 80%. As we shall show further on the heat pump system based on water combined with microcapillar heating/cooling system could reach the limits for renewable energy given by EU in terms of heat and cool. What is also very interesting is that heat pump system could extremely reduce greenhouse emissions.

2. Heat

The office building as large as 4000 m² has been step by step reconstructed since 1996. The heat consumption of the building in 1996 was about 3200 GJ per year. Following technical improvements has been done:

- Reconstruction of the original energy source.
- Window exchange and outside shield heat protection.
- Thermostatic regulation.
- Zone regulation.
- Heat pump system introduction.

The figure 1 shows the effect of the above technical improvements on heat consumption. From the figure 2 it is possible to say that the main improvement in heat reduction has been reached via reconstruction of the energy source and better regulation either zone regulation or thermostatic regulation. The heat consumption went down from the level of 3200 GJ to 934 GJ per year. This numbers are calculated as numbers adjusted to day degrees. From the data collected through the years till 2009 it is possible to say that almost 68% of the heat consumption per year has been saved. What is important is that the construction of the building is based on use direct ventilation system through windows. This avoids installing many energy consuming ventilation systems and has no problem with the problem known as building sick syndrome.

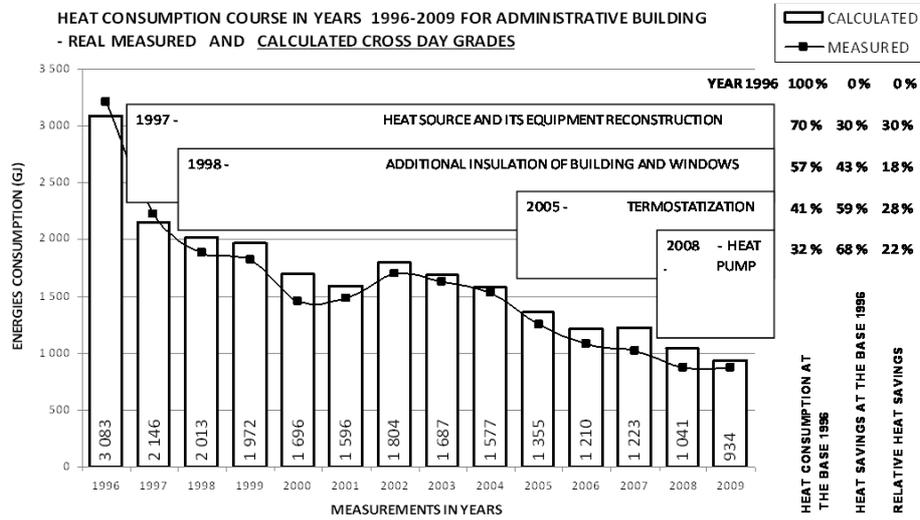


Fig. 1. Heat consumption of the office building

Rys. 1. Zużycie ciepła w budynku biurowym

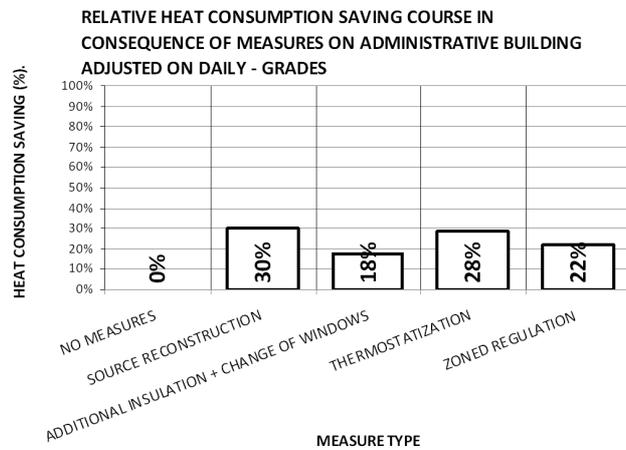


Fig. 2. Relative effects of various improvements on heat saving

Rys. 2. Względne efekty wariantów poprawy energooszczędności

2.1. Primary Energy

The chart on figure 3 shows the same problem from the point of view of primary energy consumption. Comparing the data given in the figure 1 and 3 it is the same until 2008 when the heat pump system has been introduced. SPF 3,04 and 3,16 has been reached in the year 2008 and 2009 respectively. This reduced the consumption of primary energy by the factor of SPF. On top of 22% savings due to the – zone regulation also another 53% of the

primary energy has been saved as a consequence of the introduction of the heat pump system as it is given in the figure 4.

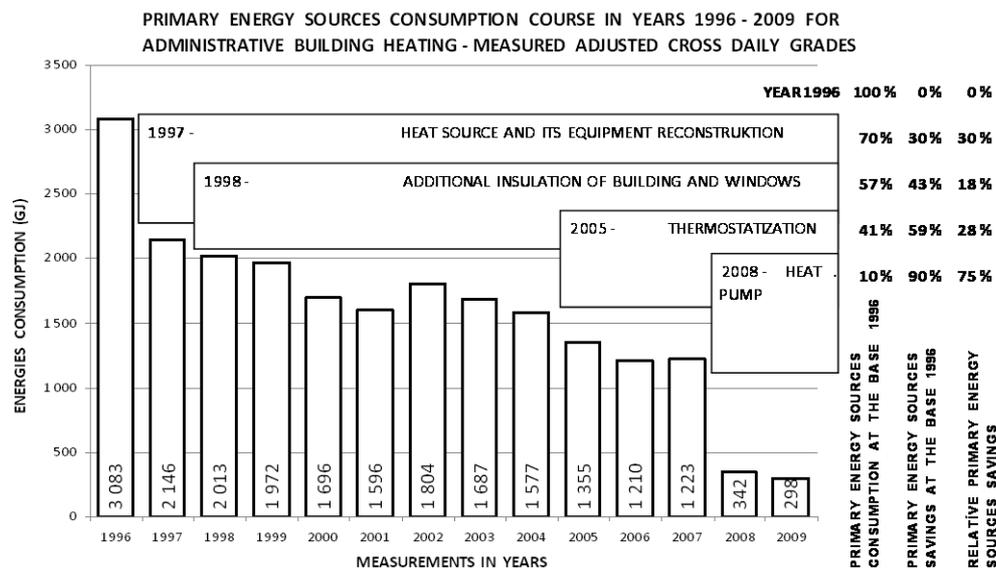


Fig. 3. Primary energy consumption of the building during the years 1996 till 2009

Rys. 3. Zużycie energii pierwotnej w budynkach wybudowanych w latach 1996–2009

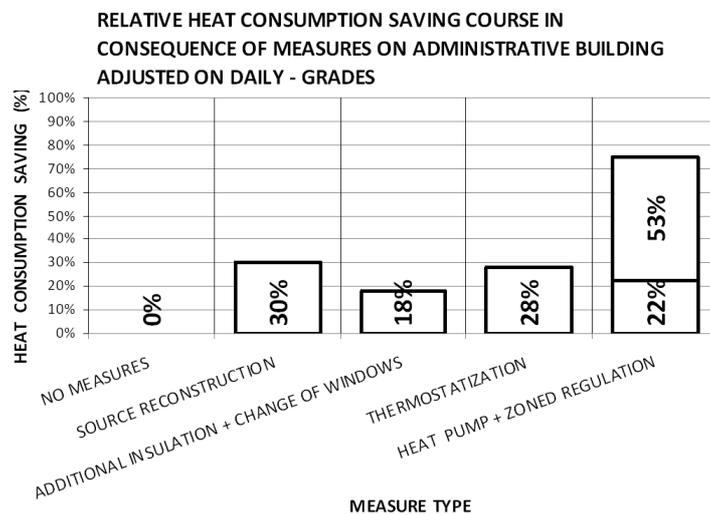


Fig. 4. Relative effects of various improvements on primary energy saving

Rys. 4. Względne efekty wariantów poprawy oszczędności energii pierwotnej

2.2. Greenhouse emissions CO₂

A very similar chart to chart of primary energy is observed regarding saving emissions. However the sharp decrease of the emission produced as side product of the primary energy production is observed when heat pump system has been introduced. Total decrease of the emissions comparing the year 1996 has been reached up to 96%. 59% of the reduction could be attached to the heat pump system. From the relative point of view a reduction of up to 86% of the emissions produced before installation heat pump systems.

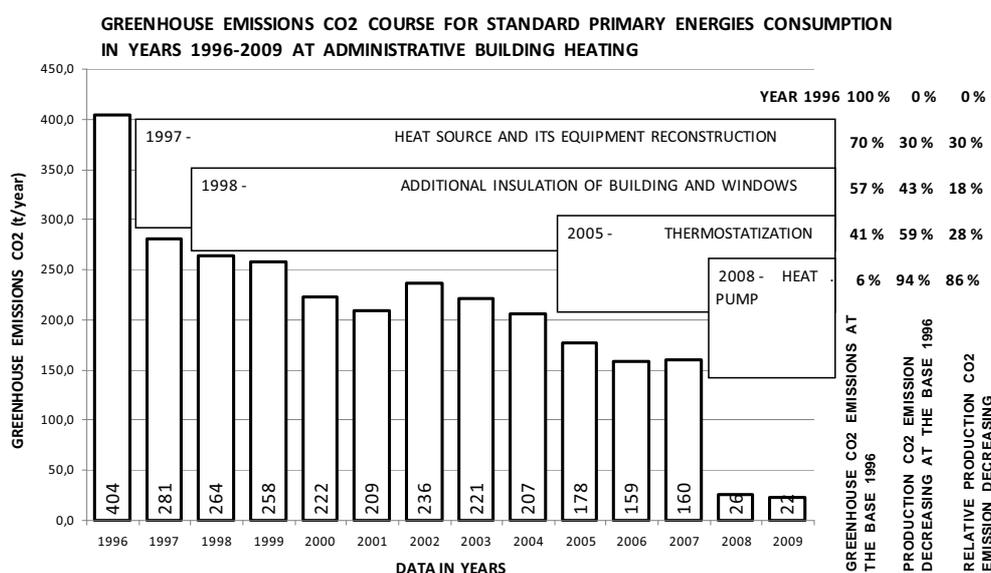


Fig. 5. Greenhouse emissions chart during the years 1996 till 2009

Rys. 5. Wykresy emisji w zielonych budynkach wybudowanych w latach 1996–2009

2.3. Micro capillary systems

Micro capillary systems use for a transport of energy a radiation part. Replacing radiators within the complex systems will shift the working point of the heat pump system and based on the first measurements and further calculation it is possible to reach SPF during heat period as much as 4,22. However micro capillary system allows also cooling buildings with the extremely small energy consumption The calculated SPF has been reached 14,98. If we combine above figures we can reach for the total year SPF as much as 6,91. This ratio is nothing else than 13% of the primary energy and 87% of secondary energy. From the point of view renewable energies it is necessary to stress out that an electricity mix in Slovakia consists 15% of the production from water electricity stations so then we can calculate the ratio for renewable energy as $(SPF+0,15)/(SPF+1)$ which gives us 89%.

3. Conclusions

Heat pump system combined with micro capillary system provides an extremely efficient tool to reduce fossil energy consumption and in the same time also greenhouse emissions CO₂. Our experiments showed that nearly 95% of the greenhouse emissions could be saved. Moreover the heat and cool primary energy can be reduced 80% and better. From the point of view of heat and cool it is possible to say that the system reach the target of EU – energy near zero intelligent buildings. The energy power of the water well allows even to put exceeded energy on the local market so the building could be converted from the energy consumption into the energy supply status. Heat pump system build within the building far exceeds the limit given by EU for SPF in order to be calculated into national renewable energy quotas. The potential of the heat pump system is widely used in Sweden, Germany or Swiss. The potential of water based heat pump system is very attractive not only for heating but for cooling buildings as well as very effective and possible cheaper solution comparing to other possibilities. Combination with the micro capillary system also introduce for the human very comfort heating and cooling system due to radiation based transport of energy. This type of transport of the energy is very convenient to the human. It is expected that it could be a factor which could positively influence the environment within the building and has a potential to influence also the productivity of the work in office space.

The discussion from the first section of this article introduced the very interesting question. Is the main source of the problem of the present day lack of cheap energy or is the problem of contamination of the atmosphere greenhouse gasses? Heat pump systems address both problems. It has a possibility to reduce greenhouse gasses production up to 95% and it could provide renewable energy more than 80% from the energy consumed. To overcome the economy crises will be enough to follow the solution from 70's and reduce fossil energy consumption per GDP to 50% level or we have to in the same time reduce the greenhouse gasses more than 50%? The ecology oriented scientists are given many facts that we have to reduce also greenhouse emission production. Hence the heat pump system addresses both problems.

The experimental workplace of our Faculty “Economic Research Centre for Renewable Energy Sources and Distribution systems” was founded with the purpose of investigating possibilities to reduce the energetic costs of buildings tied to economy. The realized project of the Centre creates real environment for effective implementation research of technologies in laboratory and operative conditions: technologies of co-generative elements, heat pumps, thermal capillaries, and technologies in field of measurement and regulation. The solution is the project with possibility to repeat it on other similar applications as well as the utilization of experience and determination of economical expedience of researched technologies implementation. Next phase of the research will be evaluation of operative behavior of the building, interaction with building constructions and study of inner climate parameters and overall results for central heat supply system.

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