ENERGY EFFICIENCY ON TO EXAMPLES OF REMOTE HEATING IN SERBIA

Nataša Ćirović, PhD
High Business Technical School of Professional Studies Uzice, SERBIA
e mail: natasa.cirovic@vpts.edu.rs

Milutin R. Đuričić, PhD
High Business Technical School of Professional Studies Uzice, SERBIA
e mail: milutin.djuricic@vpts.edu.rs

Jelena Avakumovic, PhD
High School for Design, Technology and Management Belgrade, SERBIA
e-mail: acedomir@yahoo.com

Abstract: *Energy efficiency is in the focus of the developed world, which this problem imposes on the rest of the world. This problem is very complex and its successful solution requires a well-designed system approach. The main goal of this paper is the energy efficiency researching of remote heating as well as the possibilities of energy savings in Serbia.*

Key words: *Energy efficiency, national security, sustainable development, operating costs, energy management strategy*

1. INTRODUCTION

Energy efficiency occupies the attention of all individuals involved in both production and energy consumption which is very important due to rapidly decreasing of energy reserves and resources. Humanity has faced a dilemma: whether it will rationally use energy, or will soon be left without it. Therefore, in the world, numerous research projects are being implemented, but also projects related to the rational use of energy.

The aim of this paper is to point out the issue of energy efficiency in the area of remote heating in Serbia.

2. ENERGY EFFICIENCY - IMPORTANT COMPONENT OF CORPORATE AND NATIONAL SECURITY

The term ***Energy Efficiency***(EE) includes all the measures in order to reduce energy consumption and which does not disturbe the working and living conditions. It has two possible meanings:

1. on technical devices[1],
2. on to certain measures and behaviors[2].

Significant financial savings are achieved through increased energy efficiency, but direct impact on environmental protection should not be neglected. This is achieved by energy-efficient measures (technical or non-technical) and behavior that is applied in order to reduce energy consumption.

It is an indisputable fact that the economic security of every Business System (BS), Figure 1, and even each country, is a prerequisite for establishing global security, and it is also directly dependent on energy security, because without sufficient quantity of appropriate energy sources there is no national economy. On the other side, the function of corporate security in the domain of its technical and technological capabilities and withinof appropriate legal normative framework, supports running of the business processes of large companies, of which directly depends the preservation of national and global security.[5] "In practice, the economic aspect

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[1]*Devices are energy efficient if they have a high degree of useful effect, respectively small losses during transforming one form of energy into another. The goal is to reduce energy consumption to a minimum without compromising the level of comfort or even with increasing comfort.*
[2]*The essence is to save energy, not to renouncing energy use. Efficient use of energy directly leads to an increase in the quality of life, the competitiveness of the economy and energy security*

of national security is closely connected to trade: the dependence on imports of important products or raw materials is understood as a sign of dependence of the country from the country or countries from which it is imported"[3]. It should be emphasized that the economic security of modern countries is directly related to energy security respectively depending on energy sources as the driving force of the national economy of each country. "Energy security threats can be political instability in the countries that are the world's main energy suppliers, politicalabuse of energy supplies or the competition of major powers around non-renewable energy sources, attacks on energy infrastructure, and natural and industrial disasters."[5]

Energy efficiency is interestingboth for the individual and for the world community. Special interest is shown by business systems where the share of energy costs in total operating costs is between **10%** and **20%**. That requires integrating an energy management strategy within the business strategy for security. It is evident that there is an energy deficit in the world, which is one of the biggest risks for the BS management and their long-term economic sustainability. Considering the Projections of International Organizations that the energy price in the next five years will increase as much as 15% it follows that energy security can be very influential on corporate security, and considering the remote heating and national security, too.[1,2]
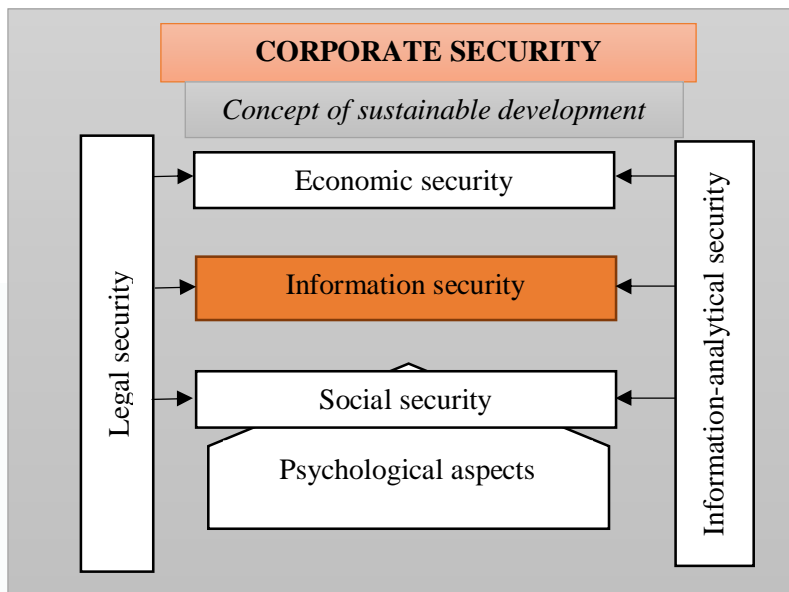

Figure 1. Corporate security (Đuričić R.M., 2017)[2]

2. ENERGY EFFICIENCY OF REMOTE HEATING IN SERBIA

The remote heating system (RHS) is a heating system for households and industrial buildings from one center (city system or system of thermal energy supply of more populated places). This system represents a unique technical and technological system of interconnected energy facilities, which is used for the production, transmission and distribution of heat energy.

RHS exists in 56 cities (settlements) in Serbia. According to a study conducted by the Serbian Chamber of Engineers in 2013 for the World Bank, there are 3 million residential and business units in Serbia. Objects were built in different time periods and energy efficiency was not always taken into account. Until the eighties, there was no legal regulation covering this area.

The study also confirmed that the average final energy consumption in Serbia is 150 kWh/m^2 per year, while in Europe is around 70 - 80 kWh/m^2, which is twice less.

The Serbia belongs to countries with extremely low energy efficiency and the reasons are found in the use of outdated, energy-inefficient technologies in industry, construction and infrastructure, inadequate legal regulations in this area, low living standards and insufficiently developed environmental awareness of the population. The scope and structure of Serbia's energy reserves and resources are very unappropriate. Reserves of high-quality energy sources, such as oil and gas, are symbolic and make up less than 1% in the total balance reserves of Serbia. The remaining 99% of energy reserves are refer to various types of low-quality coal, dominated by lignite with an estimated share of around 90% of total balance reserves.[4] The total annual final energy consumption in Serbia, in 2013, is around 26.9 TWh (Republic Institute for Statistics, 2014). 21.2 TWh (teravatsat = 10^{12}Wh) is related on buildings (78.9%), of which 14.1 TWhto housing sector (66.6% of the construction sector, or 52.6% of total consumption). Total heat consumption is 8.3 TWh and4.37 TWh is related

on the housing sector (52.65%). Finaly, the total energy consumption in the building industry in Serbia is 29.5 TWh (83.8% of the total consumedenergy).

The heating mode of buildings in Serbia are as follows: 26% of the total surface is heated from the remote heating system and local boiler rooms with central heating (14% from the remote heating systems and 12% from the local boiler rooms), 14% from the electricity system, 10% gas and 50% of the total area uses solid fuels in local furnaces (coal, firewood, biomass from agriculture, waste, etc.), Figure 2.

Installed heat capacity of these plants is about 6,600 MW. About 400,000 apartments are connected to the remote heating network, which makes up about 17% of apartments in Serbia, and in Belgrade this percentage is about 44%. According to the data from "Indicators of remote heating in the heating plants of the members of the business association" Heat of Serbia ", 2013, 2014 and 2015[6,7,8], Figure 3, the relationship between the number of households that are connected and which are not connected to the RHS, on average, are 47% and 53%, respectively.
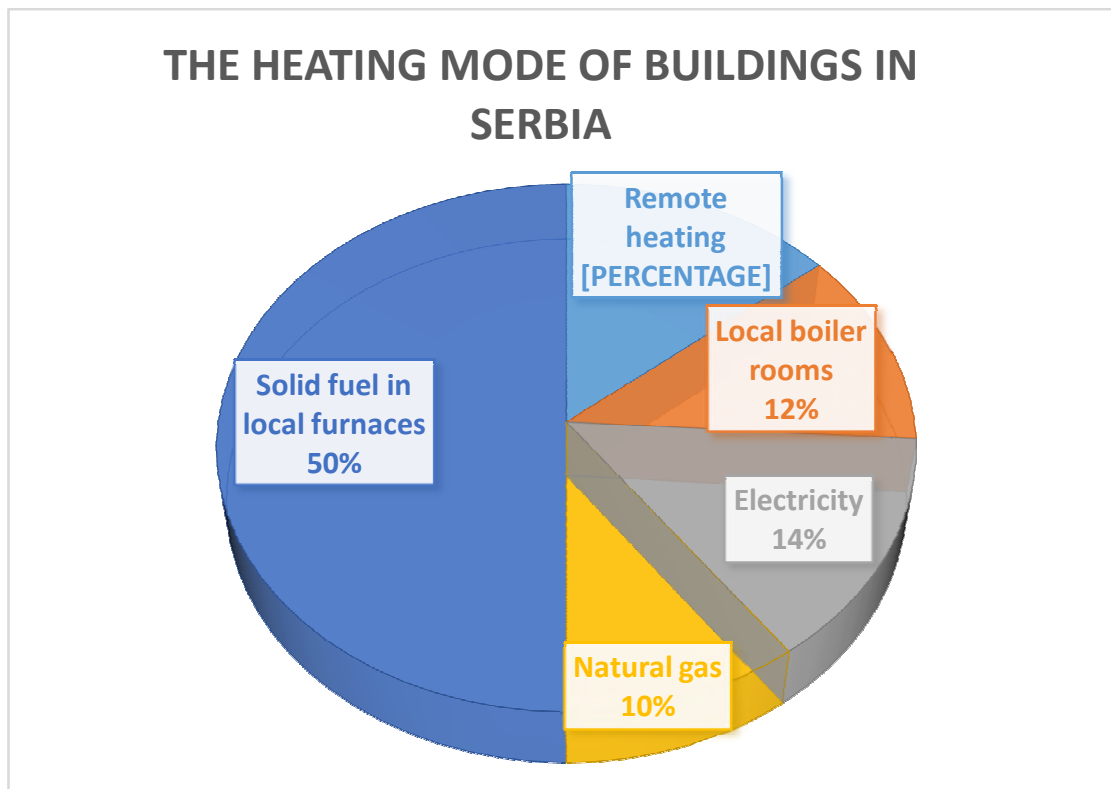

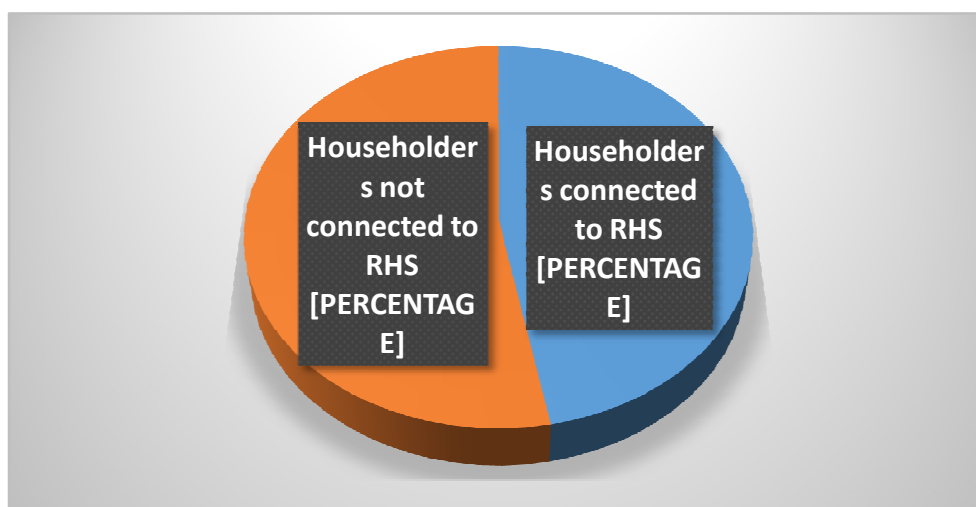**Figute 2.**The heating mode of buildings in Serbia[6,7,8]

Figure 3. Presentation of remote heating system in Serbia for the years of 2013., 2014.and 2015.[6,7,8]

About 6750 kWh is spent per heating season for heating the 45m^{2}apartment (according to the Energy Agency source: 150 kWh/m^2 is the average estimated consumption in Serbia at 20°C, for 16 hours a day in the whole apartment, 180 days in the heating season). The price of this quantity of heat varies depending on the type of energy source, the efficiency of the furnace, the isolation of space and other factors, but certainly the deciding factor is the type of used fuel.[4]

For example: according to the official report of the Republic Agency for Energy, the energy cost for heating of 45 m^{2}living space,in the heating season of 2016/2017 is required:

After the multiple reduction of prices, it is necessary to allocate about 30 000 dinars for the season for heating on natural gas. The heating costs for coal are about 33 000 dinars. Higher costs, about 43 000 dinars, will have households that use expensive firewood, with a price of 5.900 dinars per m^3 and have lower efficiency furnaces, as well as householders that use pellet and more efficient stoves designed for this fuel, whose annual costs are around 45 000 dinars.

Households using the TA furnace will have the energy costs of 35 000 dinars, but only if cheaper night electricity is used exclusively. Using the more expensive electricity only for two hours a day increases costs by as much as 44%, to about 50 000 dinars, which is more expensive than most alternative fuels.

The largest heating energy costs will have households using electricity directly in heating bodies and boilers for remote heating, propane butane gas and fuel oil. For the purchase of energy sources that are needed for heating throughout the season, they have to allocate 93 000 dinars for electricity, 84 000 dinars for propane butane gas, or 71 000 dinars for fuel oil, Table 1.

Since gas is shown as the most cost-effective energy source, this is exactly the most common source of heat energy.[1,4]

Table 1. The energy cost for heating of 45 m^2 living space, in the heating season of 2016/2017

TYPE OF HEATING	COSTS(DIN)	
Natural gas	30 000	
Coal	33 000	
Firewood(cost 5.900 din/m3)	43 000	
Pellet	45 000	
TA furnace (cheaper night electricity)	35 000	
TA furnace (expencive electricity, only two hours reheating)	50 000 (44%)	
Households using electricity directly inheating bodies and boilers for remote heating, propane butane gas and fuel oil.)	electricity	93 000
	propane butane gas	84 000
	fuel oil	71 000

The latest information about energy efficiency in buildings (residential, commercial, industrial) in Serbia shows that average energy consumption in buildings exceeds 150 kWh/m^2 per year, while in developed European countries it is below 50 kWh/m^2. This fact obliges engineers of all specialties to intensify activities to achieve standards applicable in the EU countries, Table 2.

The energy efficiency in buildings in relation to European countries is very different and it is evident from the period of the early 1990s. The confirmations are: average final energy consumption in residential buildings of the EU for heat purposes is 138 kWh/m²; in Denmark, in buildings connected to remote heating systems, the specific heat consumption for heating is 96kWh/m² and in buildings using fuel oil or gas are 131 kWh/m² and 106 kWh/m², respectively. In buildings built according to new regulations in Poland, a country with a harsher climate than ours, the specific energy consumption is 90-120 kWh/m². In Sweden, with colder and longer heating seasonal consumption, this amounts is 120 kWh/m², and in the latest buildings with the lowest energy requirements it does not exceed 60-80 kWh/m², Table 2.

According to the same source, the average annual specific energy consumptions in buildings heated from the remote heating system and local boiler rooms in Serbia are:
- for residential buildings - 171 kWh/m²,
- for non-residential buildings - 194 kWh/m²,
- for the preparation of hot water
- in residential buildings - 55 kWh/m² and
- in non-residential buildings - 12 kWh/m².

The average specific heat consumption for heating and hot water in residential and non-residential buildings, considering 1 m² of net residential area, is 228 kWh/m², Table 3.

The average annual specific energy consumptions in heating objects using other heating methods are:
- for electrically heated objects -130 kWh/m²,
- natural gas - 230 kWh/m² and
- local furnaces with solid fuel - 57 kWh/m².

Table 2. Average annual heat consumption in Serbia and EU countries

The average annual heatconsumption in Serbia and EU countries:		
EU:	138 kWh/m²/year	
Denmark:	96 kWh/m²/year	- remote heating
	131/138 kWh/m²/year	- heating the oil well
Sweden:	120 kWh/m²/year	
	60-80 kWh/m²/year	- the latest requirements
Poland	90-120 kWh/m²/year	- buildings built according to new regulations
Serbia	171 kWh/m²/year	- long-distance heating and 55 kWh/ m²/year - hot water preparation - residential buildings
	194 kWh/m²/year	- long-term heating and 12 kWh/ m²/year - preparation of hot water - non-residential buildings

Table 3. Total average specific consumption of heat energy

228	kWh/ m²/year	- for remote heating and hot water preparation
130	kWh/ m²/year	- electric heating
230	kWh/ m²/year	- heating with natural gas
57	kWh/ m²/year	- local solid fuel stoves

According to the latest data, more than 95% of the energy facilities in Serbia are waiting for reconstruction. Most of them use worn-out technology that disturbs the environment and also operates inefficiently considering the energy point of view. It is necessary to invest in clean technologies that will be safe for both the staff and the environment. As a consequence, there will be an inevitable increase in the prices of generated energy from reconstructed facilities, and the main goal will be to keep energy prices in spite of all investments at an acceptable level. Every potential investor in the region of Southeast Europe will have to face this issue.

The crucial barrier in the implementation of energy efficiency enhancement programs is the unrealistic relation of energy prices and inconsistency. Under these circumstances, users have no economic interest in investing in energy efficiency projects.

2.1 What does the Energy Efficiency Regulations require?

The first and most important determinant of the Regulation on Energy Efficiency of Buildings is to divide facilities into new and existing facilities. All facilities which have the building permit issued after the date of entry into force of the Regulation are considered new and a minimum requirement of "C" class is prescribed,

which limits the consumption of heating energy in buildings with several apartments to a maximum of 60 kWh/m^2 per year. The achievement of the "C" class does not require specific expertise in the field of construction physics. It is usually enough to "clothe the building in a thicker suit" so that instead of the previous 3cm insulation (it was enough before the new Regulation), its thickness would be 10cm, and the windows will have double glazing and five-chamber frame (instead of the previous single one). Of course, the calculation is not so banal, but in the absence of educational programs it is presented to a wider population on that way.

In Serbia, the average annual specific energy consumption for residential buildings using the remote heating system is 170 kWh/m^2, which is almost triple times higher than maximum permissible amount according to the new Regulation. The "C" class itself sounds great. However, the Regulation is obligated only for new facilities, which represent only a few percent of the total facilities. For all other existing facilities, the improvement of energy performance is required only in the case of "extensive renovation", which implies the construction and other works on the adaptation or rehabilitation of an existing building, when the value of works is greater than 25% of the value of the building (without land) or when the more than 25% of the building envelope was subject to energy recovery. In this case, energy efficiency improvements are required only for the higher class, which means that most objects in their exploitation life will never reach either the "C" class.[9]

2.2 „20-20-20"

Changes resulting from the new Regulation on energy efficiency of buildings are obviously very positive. After 20 years of delay Serbia decided to join global trends, promicing to fulfill by 2020 a series of climate and energy goals, known as "20-20-20" goals:
- Reduction of carbon dioxide emissions by at least 20% compared to 1990 levels,
- 20% of energy consumption should be encouraged from renewable energy sources and
- Reduction by 20% of primary energy consumption, compared to the predicted values, must be achieved by improving energy efficiency, Figure 4.

In achieving these goals, the citizens, owners and users of the facilities, which are connected to remote heating systems, will be important factor.
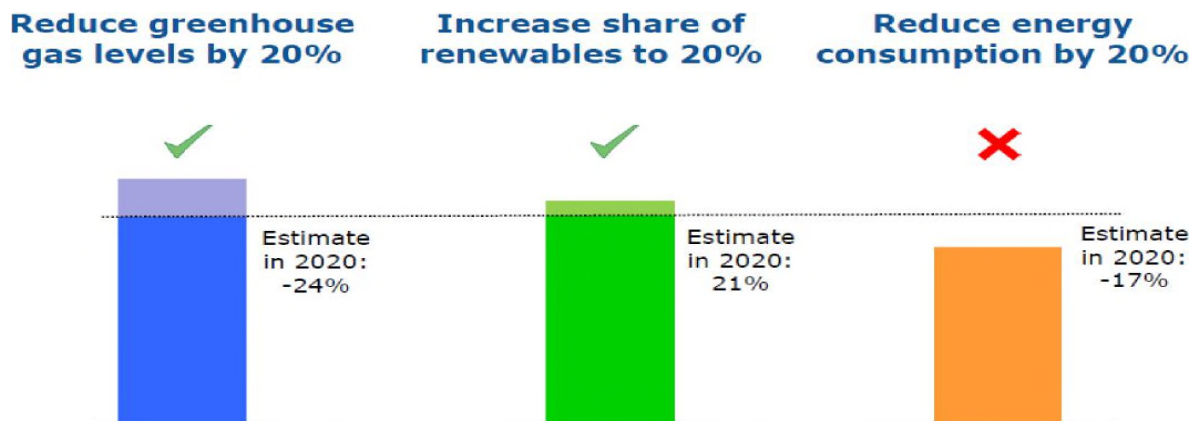

Figure 4. The main goals of "20-20-20" strategy for buildings in EU countries for the period to the year of 2020[9]

A large number of buildings in Serbia, as much as 75%, were built before the 1970s, without thermal insulation, which leads to the loss of large amounts of energy (Insulation in Building and Energy Efficiency - Panel Discussion), Figure 5.

Figure 5. The lost of energy as a result of poor insulation in buildings

An average of 60-70% of the lost energy "goes" through the outer walls and windows, and for every euro invested in the insulation it returns 7.5 euros.

Their energy efficiency can be improved up to 80%, but according to estimates, about 800 million euros would be needed to insulate the buildings. Although there are insufficient funds for this, there are certain ways of financing, and things are expected to change after the acceptance of the relevant laws, and especially after the establishment of the Energy Efficiency Fund and the Development Bank of Serbia.

The Energy Balance is a document establishing the annual amounts of energy and energy sources required for the regular and safe supply of energy consumers (direct consumers) for the year of 2015, 2016 and 2017. In addition, the document also presents data related to the implementation of the previous two years, respectively the assessment of the previous year. This document was prepared on the basis of monthly and annual data on production, processing and supply of energy and energy sources in accordance with the methodology of the International Energy Agency and Eurostat.

All energy streams are observed within three energy systems:
1. The primary energy system (PE)[3],
2. Primary Energy Transformation System (PET)[4], i
3. Final energy system (FE)[5].

Table 4, 5 and 6 show the RS Energy Balance for a total period of three years, starting from 2013.[6,7,8]

Table 4. The basic energy indicators for the period of 2013 - 2015

REPUBLIC OF SERBIA	2013.	2014.	2015.
EFFICIENCY OF TRANSFORMATION (FE/PE)	0,549	0,608	0,590
Consumption of PE per capita (kg en/capita)	2093,60	2053,96	2275,73
Consumption of energy per capita (kWh/capita)	3778	3779	3968
The share of householdres in energy consumption	53	52	54

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[3]PE shows the structure of total available primary energy for consumption (1. **domestic production** based on the use of its own resources including coal, crude oil, natural gas, hydropower, biomass, wind energy, sun energy, geothermal energy, and 2. **net imports**, which represent the difference between imports and exports of energy products, primary energy, including net imports of electricity).

[4]PET shows the energy sources needed for primary energy transformation processes, energy production (including own consumption, losses in transformation, transmission and distribution of energy to final consumers). The structure of this level consists of thermal power plants, hydro power plants, thermal power plants - heating plants, biogas power plants, solar power plants, wind power plants, heating plants, industrial power plants, oilrefineries, coal processing and high furnaces.

[5]FE combines energy consumption for non-energy purposes (non-energy consumption) and the consumption of final energy for energy purposes. Consumption of final energy for energy purposes is presented in two ways: 1 - includes the structure of the consumption sector, such as industry, transport and others (households, public and commercial activities and agriculture), and 2 - includes the structure of energy sources: solid fuels, liquid fuels, gas fuels, electricity, heat, renewable energy sources.

Table 5. The basic energy indicators for the period of 2014 - 2016

REPUBLIC OF SERBIA	2014.	2015.	2016.
EFFICIENCY OF TRANSFORMATION (FE/PE)	0,575	0,547	0,546
Consumption of PE per capita(kg en/capita)	1853,55	2116,27	2167,85
Consumption of energy per capita (kWh/capita)	3634	3828	3720
The share of householdres in energy consumption	53	52	52

Table 6. The basic energy indicators for the period of 2015 - 2017

REPUBLIC OF SERBIA	2015.	2016.	2017.
EFFICIENCY OF TRANSFORMATION (FE/PE)	0,575	0,547	0,542
Consumption of PE per capita (kg en/capita)	2055,44	2128,99	2138,98
Consumption of energy per capita (kWh/capita)	3761	3752	3807
The share of householdres in energy consumption	52	51	51

3. MEASURES FOR INCREASING ENERGY EFFICIENCY

The increase in the number of residents, who prefer a higher level of comfort, and spend more time in buildings, determines that the trend of energy demand growth will continue in the future. According to the official statistics of the European Union about 40% of the total final energy consumption and about 36% of the total CO_2 emissions go to the buildings. This is the largest final energy consumption sector, followed by traffic (33%) and industry (24%). For this reason, energy efficiency in buildings today represents the main goal of energy policy at the regional, national and international level.

The basic measures for increasing energy efficiency are related to investments in the field of energy efficiency (in industry[6] and in building[7]) and renewable energy sources[8], which are cost-effective and also bring the following benefits: reduction of production costs, improvement of competitiveness and profitability, rehabilitation and modernization of property and reduction of polutted gases emission. On the other side, a major contribution to the improvement of energy efficiency can be given to introduction of energy management in industry and main goals would be related to the application of energy efficiency measures in industrial buildings, halls, business buildings and residential buildings (insulation of walls, roofs and floors, installation of rolling shutters; new energy-efficient windows, installation of new heating and ventilation systems, installation of highly energy-efficient lighting, etc.). Carriers of these activities in Serbia should be experts in energy efficiency and almost 1,600 licensed engineers for energy efficiency. The starting point for their work should be provided by almost 1,500 energy passports for residential buildings.The saving of primary energy of 150,000 MWh and a reduction in CO_2 emissions of about 30,000 tons per year are direct results. All this will not give proper effect if all countries do not provide a quality Energy Management Strategy.

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[6]Examples of energy efficiency projects in the industry are: reconstruction of existing boilers (automatic control, thermal insulation improvement, regenerative burners, etc.); production of heat and electricity (cogeneration); transfer from heating to electricity, heating with direct combustion of fuel as energy sources; improvement of technological processes by introducing control; reconstruction of the steam distribution system, increasing the return of condensate, replacement of worn-out pipelines; installation of waste heat recovery equipment - economizer for secondary air heating, space heating, installation of absorption chillers, improvement of efficiency of existing refrigerators, installation of frequency regulators on selected fan motors, pumps, etc., replacement of preimensional old engines, reconstruction of compressed air system, reconstruction electricity distribution system.

[7]Examples of energy efficiency projects in the building industry are: replacement of boilers with or without change of the basic energy source; application of the microgeneration / trigeneration system; reconstruction of heat substations, balancing of the heating system and installation of individual heat controllers; replacement of windows; insulation of exterior walls, roofs and foundations; insulation of heat pipes, pipes and reservoirs; lighting and installation of a consumer management system.

[8]Examples of renewable energy projects are: wind farms, small hydropower plants, solar power plants, solar thermal systems for heating or cooling water for industrial processes or spaces, solar thermal systems for drying processes, heating or biomass heating systems, cogeneration biogas and the installation of gas engines / turbines for the production of electricity, biogas stations and geothermal heat pumps.

4. NECESSITY OF THE ENERGY MANAGEMENT STRATEGY IN SERBIA

Respecting the importance of energy for human life, it is necessary to make the Energy Management Strategy at the level of business systems (BS), local communities and beyond. This is documented by the South East Europe Institute - SEEI, Figure 6. As world's largest companies, the BS management needs to put energy efficiency into the prime level and make the diversification of the energy mix as one of the priorities in its future development, Figure 7.
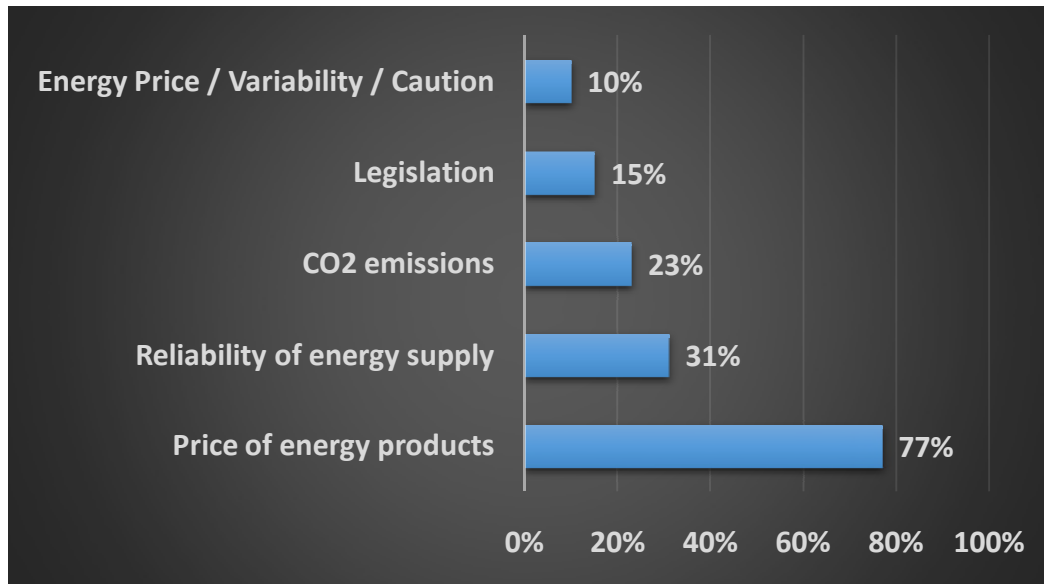

Figure 6. The main reasons forthe introduction of an energy management (source: SouthEast Euoropean Institute)
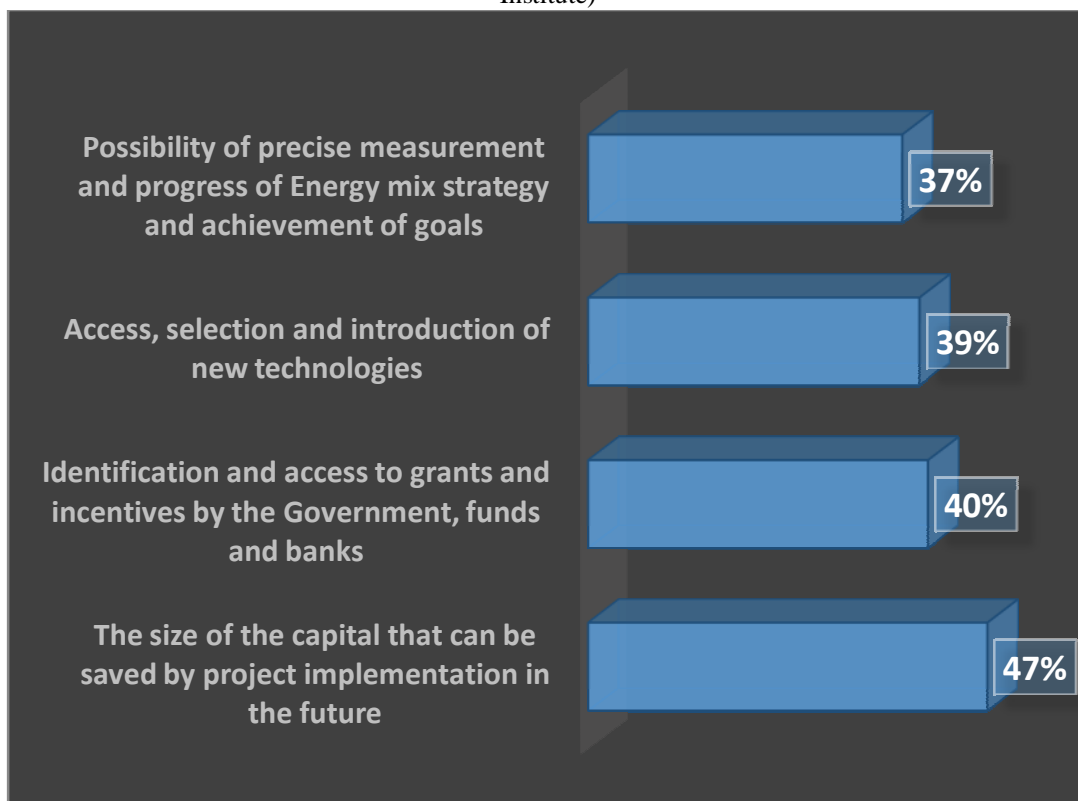

Figure7. The main reasons for investing in the energy mix strategy of the world's leading companies (source: SouthEast Euoropean Institute)

Considering energy, BS management should determine whether the BS is doing the right thing and, if itworking, whether it is working in the right and good way. If the answer to any of these questions is "No", it is necessary to take appropriate corrective measures in order to increase energy efficiency, Figure 8.
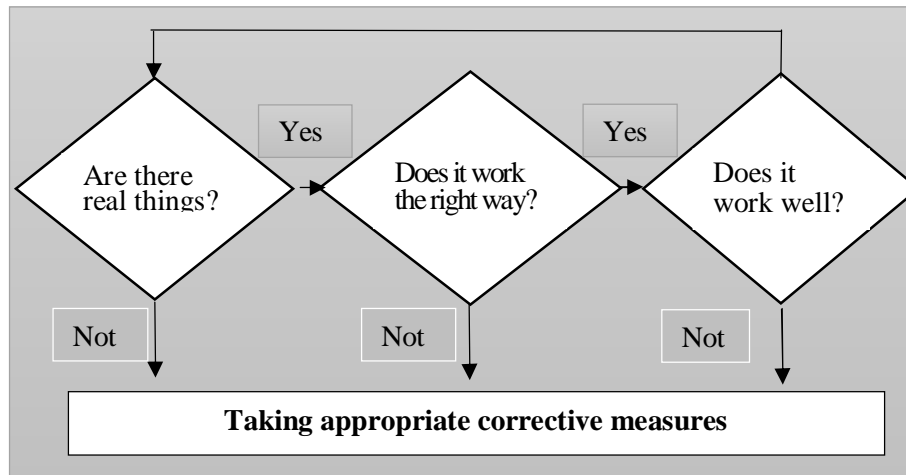
Figure 8. The principles of energy efficiency improvement

5. CONCLUSION

Energy efficiency is gaining worldwide attention.

Increasing energy efficiency by technical or non-technical measures and behavior, significant financial savings from households, business systems and the state in general are implemented.

Increased energy efficiency directly affects both the preservation of the environment and the concept of sustainable development.

Serbia can have significant effects on energy efficiency.

The goal of the state is to create an environment for Serbia's inclusion in the EU's energy efficiency goals.

A well-designed Energy and Measures Management Strategy can make significant savings.

Remote heating system is a great opportunity for raising energy efficiency in Serbia.

Reducing energy losses and increasing energy efficiency can be achieved by the following measures: replacing non-renewable energy sources with renewable energy, replacing energy-inefficient consumers with more efficiently, isolating space which is heated or cooled, replacing worn-out or ineffective joinery which are heated or cooled, installing measuring and regulating devices, replacing or installing efficient systems for heating, air conditioning or ventilation etc.

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