

## Energy Efficiency - Examples of which Less Talk

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*Energy demands, especially electrical, will grow steadily. The need for rational use of energy first emerged globally during the 1973 oil crisis. As a consequence of this crisis, many states have tightened energy regulations to reduce energy consumption, and among them have been regulations related to increasing energy efficiency (EE) in buildings. The interest in energy efficiency has come back into focus when research has shown the great impact of energy consumption on climate change. Generally, when it comes to energy, we distinguish between two categories of energy savings: energy conservation and energy efficiency. These two terms differ significantly. The paper will interpret these two terms in a series of examples.*

*When it comes to the term energy efficiency, the most commonly thought of is energy efficiency in buildings. In the paper we will pay special attention to the areas that are less discussed when it comes to energy efficiency, such as chimney sweeps, Serbian traditional architecture, power plants in healthcare institutions, predictive maintenance (just in time maintenance) of devices and equipment, especially those in healthcare institutions... Energy efficiency also plays a key role in combating energy poverty. Also, the paper will highlight the need to raise the level of knowledge of the Serbian population about the importance of EE through systems of formal and non-formal education.*

*The concept of energy efficiency has two meanings: one refers to technical devices (e.g. electrical machines) - devices are energy efficient if they have a high degree of efficiency (small losses in converting one form of energy into another), and the other - to certain specific measures and behaviors that are applied to reduce energy consumption. However, it should be especially emphasized that energy efficiency should not be viewed as energy conservation, but, as the term itself says, as an efficient use of energy that should not undermine defined standards of working and living environment.*

**Key words:** *energy efficiency, environment, energy poverty, chimney sweeping, predictive maintenance, traditional architecture, education*

### 1. INTRODUCTION

Energy efficiency (EE) is important component of both environmental protection and sustainable development.

The term sustainable development has been around ever since the eighties, mainly in connection with environmental protection. There is no generally

accepted definition of it though. The most widely used one [1] is this: Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

The need for rational energy consumption first appeared globally during the 1973 oil crisis, resulting in more stringent energy regulations aimed at reducing energy consumption; among them have been regulations related to increasing energy efficiency (EE) in buildings. Interest in energy efficiency dwindled when oil crisis subsided, but was revived when research showed significant energy consumption effect on climate change.

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Generally speaking, when it comes to energy, there are two categories:

- Energy Conservation (EC)
  - Meaning everything we do to avoid wasting energy, from turning off lights when leaving an empty room to all manner of recycling (e.g. using recycled aluminum scrap to make new aluminum cans saves about 95% of the energy required to make aluminum cans from bauxite ore). Some every day examples are: shutting down computers or home appliances when not in use, driving car fewer kilometers per day / week / month... It could be say that energy conservation involves using less energy by adjusting people's behaviors and habits...
- Energy Efficiency (EE)
  - As stated above, the term refers to application of certain measures and actions aimed at reducing energy consumption, and use of new advanced technologies that use less energy to perform the same functions. Energy saving LED lamps/light bulbs are a good example – they use up to 90% less energy than conventional ones to give the same amount of light. Another impressive example is that efficiency improvements to electrical machines can have a very large impact on energy consumption, acknowledging the fact that in the world almost all electricity is generated by rotating electrical generators and that more than half of this electricity is used to drive electrical motors (mostly asynchronous ones).

Energy efficiency is tightly linked to sustainable development and environmental protection.

Most frequently measures taken to increase energy efficiency are:

- adequate isolation of areas to be heated or cooled;
- replacing worn out or energy inefficient joinery in rooms to be heated or cooled;
- replacing inadequate heating, air-conditioning or ventilation systems with energy efficient systems;
- buying certified home appliances and equipment;
- installation of measuring and control devices;
- replacing energy-inefficient energy receivers with more efficient ones (e.g. using LED lights);
- replacing non-sustainable fuels with sustainable ones (e.g. replacing fossil fuels with sustainable biomass).

If the Government of the Republic of Serbia should back up these measures with affordable loans and non-repayable financial support, we would be sitting pretty!

However, this would call for experienced multidisciplinary expert teams to make laws and (especially) sub-legal acts.

In other words, energy efficiency equals use of less energy (fuel) to perform *same* tasks (heating/cooling of spaces, lighting, industrial production, providing services, driving vehicles, transportation...). Or: energy efficiency means efficient use of energy in all sectors of end usage: industries, health care, education, trade, services, agriculture, households ...

## 2. BASIC LEGISLATION ON ENERGY AND ENERGY EFFICIENCY (EE) IN THE REPUBLIC OF SERBIA

Most countries in the world have enacted their own laws and regulations that encourage and stimulate a constant increase in energy efficiency in the economy and households.

Serbia is also aware of vital importance of energy efficiency (EE), and therefore has enacted appropriate laws and sub-legal acts, including Strategy for energy development in the Republic of Serbia. Some of them are as follows:

- Law on Efficient Use of Energy (Off. Herald of RS, No. 25/13)
- Energy Law (Off. Herald of RS, No. 145/14)
- Planning and building act (Off. Herald of RS, Nos. 72/2009, 81/2009 - correction, 64/2010 - decision of the CC, 24/2011, 121/2012, 42/2013 - decision of the CC, 50/2013 - decision of the CC, 98/2013 - decision of the CC, 132/2014, 145/2014, 83/2018, 31/2019 and 37/2019 - other act);
- Law on Public Procurement (Off. Herald of RS, Nos. 124/2012, 14/2015 and 68/2015)
- The Proposal of Law on Public Procurement, November 2019, [Internet], <https://www.paragraf.rs/dnevne-vesti/021019/021019-vest13.html>.
- Law on Housing and Building Maintenance (Off. Herald of RS, No. 104/16)
- Rulebook on energy efficiency of buildings (Off. Herald of RS, No. 61/2011);
- Rulebook on the Conditions, Content and Manner of Issuance of Certificates of Energy Performance of Buildings (Off. Herald of RS, No. 69/12)
- Regulation on Minimal Energy Efficiency Requirements Imposed on New and Revitalized Facilities (Off. Herald of RS, No 112/17);
- Rules for Minimal Criteria Regarding Energy Efficiency in Public Procurement of Goods (Off. Herald of RS, No 111/15);
- Regulation on the Types of Products that Affect Energy Consumption for which Energy and other

Resources are required to be Labeled (Off. Herald of RS, No. 92/13);

- Regulation on Programme of Financing Activities and Measures for Improving Efficient Energy Usage in 2019 (Off. Herald of RS, No. 4/19);
- Energy Sector Development Strategy of the Republic of Serbia for the period by 2025 with projections by 2030 (Off. Herald of RS, No. 101/15)

The following document should also be mentioned here: Karamarković V, Matejić M, Ljiljana Brdarević Lj, Stamenić M, Ramić B. Guidelines for preparing Energy Efficiency Projects in Municipalities, Ministry of Mining and ENERGY of the Republic of Serbia, Belgrade, 2008, important for the systematic improvement of energy efficiency in municipalities in Serbia.

In the process of accession to the European Union (EU), Serbia is obliged to accept and implement certain energy requirements and EE defined in the relevant directives and other documents of the European Commission. An extensive overview of EU legislation and intentions related to energy, electricity and energy poverty can be found in [2-18].

### 3. ENERGY EFFICIENCY - AREAS OF APPLICATION AND EXAMPLES OF WHICH WE DON'T TALK ENOUGH IN SERBIA

The promotion and implementation of EE in construction and other industries is the subject of many papers and studies in Serbia and abroad, and we do not intend to discuss these topics here.

We will only touch upon some significant references that detail the importance of EE for sustainable development and environmental protection [21-43]. We will also not elaborate on the evident fact that energy efficiency is an inherent part and a key component of Industry 4.0. In this paper, we will try to draw attention to some areas important for the promotion and implementation of EE, to which have not been given sufficient attention in Serbia, or at least not sufficiently. Here we primarily think of: chimney sweeps, Serbian traditional architecture, power plants in healthcare institutions, just in time maintenance of devices and equipment, especially those in healthcare institutions, the elimination of energy poverty, education about the EE (raising the level of knowledge of the population of Serbia, especially young one, on the importance of EE through systems of formal and non-formal education)...

#### 3.1. Chimney sweeping [44-61]

The profession of chimney sweep has been around for hundreds of years and it is one of the professions

that will survive in the era of digitalization and artificial intelligence. In Ref. [48] it is stated: „When you paint a picture of Old England, it would never be complete without the good old chimney sweep. This tells you just how long this profession has been around. And it proves its timelessness because even today chimney sweeps are needed more than ever to assure the maintenance of every household's winter necessity – the chimney“.

Chimney sweeps and chimney companies [45] are extremely important today for improving energy efficiency and environmental protection, not only in Serbia but around the world. For example, maintenance of the heating, ventilation, and air conditioning (HVAC) systems in industrial and medical institutions is also performed by a modern chimney company, using complex equipment. The area of cleaning and maintenance of industrial chimneys is a particularly complex one and we will not discuss it broadly in this paper.

Public Utility Law [57] states that „chimney sweeps include cleaning out and inspection of chimney flues and fuel-burning installations and devices and ventilation ducts and appliances, extraction and burning of soot in chimney flues, inspection of newly constructed and upgraded flue and combustion facilities and appliances and measurement flue gas emissions and determining the degree of utility of the combustion plant, except in cases where the said activities are performed by officials or entrepreneurs authorized in accordance with the law governing the field of pipeline transport gaseous and liquid hydrocarbons and distribution of gaseous hydrocarbons, as well as the law governing the field of energy efficiency.“

Chimney sweeping is highly regarded in all EU countries, with special attention being paid to the education of chimney sweepers [49, 52-55]. In Germany, for example, a chimney sweeper can choose between more than 40 specialist courses and get promoted to the title of Master of Chimney Sweep [53]. The situation is similar in Sweden [54] and Norway [55].

#### *Purpose of modern chimney sweeping*

- Protection of public health and property:
  - Reducing number of fires and protection against fires (Inspection and regular maintenance of smokestacks, fireplaces and ventilation ducts and devices. Even 20-30% of all fires in Serbia are caused by fires in chimneys, due to their irregular maintenance, lack of professional control...);
  - Healthier food preparation (Cleaning and maintenance of greasy ventilation);

- Reduced diseases outbreaks (Supply of cleaner air in work places and homes; reduced environmental pollution);
- Protection against carbon-monoxide (CO) poisoning resulting from inhaling noxious carbon-monoxide concentrations (Numerous cases of poisoning due to CO leakage from chimneys and fireplaces);
- Environmental protection and increased energy efficiency:
  - Reduced air pollution (Reduced emission of harmful burning by-products by regular system maintenance and reduced fuel usage);
  - Environmental protection (Managing soot resulting from properly burning fuels);
  - Increasing energy efficiency of devices/systems (Energy consumption is reduced by regular cleaning and maintenance of chimneys, fireplaces and thermal power plants).

For example, regular chimney sweeps can reduce fuel consumption by at least 10% simply by removing 1mm deposits on smoke side in fireplaces!

Out of the total of two and half millions households in Serbia one and half million (about 60%) use solid fuels for heating. Annually, that is million and three hundred thousands m<sup>3</sup> of wood felled for heating. By organizing a professional chimney sweeping service throughout Serbia, at least one hundred thirty thousands m<sup>3</sup> of firewood could be saved, which means that at least thirteen hundred hectares of forest would be saved from felling every year.

When it comes to district heating plants - where gas and fuel oil, and sometimes coal, are used as energy products, also significant savings of at least 10% can be achieved. For example, in Serbia, about seven hundred thousand households (about 27%) are heated by district heating plants, and, depending on the price of energy products in the market, about € 300 million is spent on energy products every year. If the boilers in these plants were cleaned and maintained regularly and in an effective manner, energy costs would be at least € 30 million less with the same heating effects.

It should be emphasized that it is necessary to arrange the chimney service in Serbia in the way it is arranged in developed EU countries. In Germany, for example, chimney companies measure emissions from fireplaces/combustion plants and make their readings available to local authorities.

In this way, each local government has sufficiently accurate data on the emission of pollutants into the air in its territory and, accordingly, takes measures to comply with the protocols on the permissible amount of pollutant emissions.

It would be crucial for Serbia to pass a modern Law on Chimney sweeping which would significantly improve energy efficiency and environmental protection in Serbia. Right now, each town/municipality in Serbia make their own Chimneysweep Decision [58, 59]. Also, chimneysweepers' training should be significantly improved, preferably modelled on the German education system for chimneysweepers [53].

One of the chimneysweepers' jobs might be installing chimney filters. Ref. [47] states that „chimney filters are able to remove 96% of all particles stemming from wood firing.“

And to end this part of the paper with a quote from Ref. [48]: „Today, we see that chimney sweeps have come such a long way. There has been a lot of sweat and blood put into the research and education of proper chimney maintenance. Professional chimney sweeps take their job very seriously and they ensure safety above all else. So long as we have fireplaces and chimneys to warm our houses, chimney sweeps will always be there to help keep them at their best.“

### 3.2. Predictive Maintenance (PdM) [62-77]

Preventive maintenance of devices/equipment can be planned and predictive (i.e. Just-In-Time Maintenance – JITM). Planned preventive maintenance is carried out in keeping with maintenance schedule for a certain period recommended by devices/equipment manufacturer in technical specification. Keeping up to date records of activities carried out is of vital importance here.

Predictive or Just-In-Time Maintenance (PdM/-JITM) helps troubleshoot and solve problems and unpredictable circumstances by means of Just-In-Time intelligent monitoring and analyzing devices/equipment condition which stipulate optimal time for intervention so maintenance is done only when necessary. The main purpose of PdM/JITM is to predict need for maintenance so that devices/equipment do not break down, i.e. reduce non-functioning time to minimum.

Advantages of PdM/JITM [62]:

- Increase availability and prolong equipment life;
  - Enable preventive intervention based on constant monitoring of equipment condition;
  - Reduce delays in working processes;
  - Reduce costs of spare parts and maintenance work;
  - Increase product quality;
  - Increase health and safety;
  - Boost work ethic; save energy;
  - Provide at least 10% saving compared to planned preventive maintenance.
- Disadvantages of PdM/JITM [62]:

- Costly investment in diagnostic equipment and workers training;
- Costly investment in maintenance personnel training;
- Savings not immediately visible to managers.

In production systems, especially those that are automatically controlled, but also in service systems, PdM/JITM is increasingly being applied instead of classic maintenance approaches. PdM/JITM is based on maintenance based on the real state of a production or service system. Investments in diagnostic equipment and on-going training for maintenance personnel are paid off over a short period of time. At the same time, PdM/JITM increases the quality of products and services performed and boosts the energy efficiency of the production/service system [75]. PdM/JITM is especially important in healthcare institutions that use complex medical devices, as it provides better patients' care and is important for increasing the self-reliance of medical and nursing staff. Also PdM/JITM of HVAC health care facilities improves energy efficiency in hospital buildings.

Ref. [64] advises: „One way to introduce a predictive maintenance program into your operation in small doses is to use condition-based maintenance (CBM). CBM helps you create an early warning system for predicting failure with real-time asset data. Mastering CBM teaches you to integrate technology, data collection, and change management into your maintenance practices - all things you'll need for a full-blown predictive maintenance strategy. Start small by choosing one or two assets, learn how to run an effective condition-based monitoring program, and test your strategy. Once you've ironed out the process, start spreading CBM around your facility. This will give you a great foundation for advanced predictive maintenance“. At the end of this part of the paper, we must emphasize that Industry 4.0 is everywhere in the maintenance community and that PdM/JITM is driving Industry 4.0 [74, 63-65, 67, 69, 71, 72].

### 3.3. *Improvement of traditional architecture [78-90]*

Most border villages in Serbia are completely empty. In order to restore the villages, it is necessary to create the necessary infrastructures, which includes: revitalization of rural houses, modernization of road infrastructure, availability of communication systems, provision of safe drinking water, reliable supply of electricity (using autonomous pico and micro hydro-power plants, where possible).

Every family who comes to one of these villages should receive a restored and energy efficient home and property of ten or more hectares for free.

Resettlement of the emptied villages would also contribute to solving the key problem in Serbia: birth dearth (low fertility; the colloquial term in Serbia is: bela kuga - white plague).

Houses in traditional architecture in Serbia are usually not adequately isolated and energy-efficient. We would recommend here to initiate a scientific project in Serbia which would aim to solve the problem of thermal isolation using natural materials so that traditional village houses can still be treated as such. The first step of a research project would be to develop a prototype of a thermal insulation material based on natural materials used in traditional architecture, which would have thermal conductivity properties comparable to modern materials. The second step, thermal insulating plates would be manufactured following study results. The third step would be the energy rehabilitation of a village house with prototype thermal insulation plates. That village house would be chosen according to criteria set out during project activities. In order for such a research project to be realized, it would be necessary to amend/supplement some regulations in Serbia in the field of construction.

These thermal insulation plates could be produced by small manufacturers in rural areas.

### 3.4. *Raising public EE importance awareness in Serbia through systems of formal and informal education [91-93]*

Negotiations on Serbia's accession to the European Union are ongoing, covering 35 thematic chapters. The negotiation process so far has shown that in many chapters, Serbian legislation is largely in line with EU legislation. The weak point is the application of laws and regulations in practice. The main problems are: serious lack of adequate human resources, absence of suitable supporting infrastructure, and scarce financial resources.

The negotiating chapter of particular interest to Serbia is Chapter 27 - Environment and climate change. The role of local governments (LGs) and civil society organizations (CSOs) in meeting EU environmental requirements is vital where LG carry most responsibility.

In order to improve the environment in the territory of LG, it is necessary to establish cooperation between LS and CSOs operating in the territory of local self-government. The cooperation between LG and CSOs can be seen as a kind of ecological coalition. An ecological coalition should play an important role in defining and implementing environmental programs in the territory of the LG.

It is essential to extend this coalition to schools in local communities by involving teachers/professors,

students and their families in concrete actions linked to environmental protection and sustainable development, as well as increasing energy efficiency, their important component. To achieve this, all participants in ecological coalition should be educated.

It must be noted that school children and young people in Serbia are not sufficiently included in solving problems of environmental protection and sustainable development. Nowadays it is obvious that educating youths for sustainable development is one of major issues for solving global ecological problems and achieving sustainable development. Ecological awareness raised today will in future, when they grow up, have a major impact on environmental protection and sustainable development.

Therefore we recommend that The Kid's ISO 14.000 Programme be carried out in primary and secondary schools modelled on the eponymous programme designed by Prof. Takaya Kawabe and Mrs Miyuki Koyama, president and general secretary of a well-known Japanese non-government non-profit ArTech carrying out the project [92, 93].

The said programme is supported by the UN and International Organization for Standardization. The main aim of this project is to teach children on environmental protection, sustainable development and increasing energy efficiency as their important component, and to include them in activities carried out to that effect in schools, families and local communities.

The Kid's ISO 14000 Program should be adapted to the nowadays state of environmental education in the world.

#### 4. CONCLUSION

Energy efficiency is also a technical, economic and social issue linked with environmental protection and sustainable development.

In Serbia, public awareness of sustainable energy is very low – its basics should be taught in primary education.

Once again let us emphasize that energy efficiency should not be viewed as saving energy, but rather as efficient use of energy, as the name implies. In other words, carrying out measures of energy efficiency means less energy is used with same end results, e.g. keeping set room temperature.

In order to increase energy efficiency in all sectors of final energy consumption: industry, transport, services, agriculture and construction, existing regulations in Serbia must be significantly amended and professionally applied in practice. In this regard, the knowledge of the relevant supervisory authorities / inspection services should be constantly improved and staffed.

Also, if insufficient attention is paid to increasing energy efficiency in Serbia, and if efficient mechanisms for protecting energy-poor households are not defined and implemented, any increase in energy prices will be drastically increased by the number of energy-poor households. Above all, to increase energy efficiency in Serbia requires knowledge, and this multidisciplinary knowledge. The Government of the Republic of Serbia must create adequate financial mechanisms and incentive measures to increase energy efficiency in all sectors of energy end-use, as well as to eradicate energy poverty. The return on investment shall be manifold. In other words, the investment in Energy Efficiency definitely DOES PAY OFF.

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## REZIME

### ENERGETSKA EFIKASNOST - PRIMERI O KOJIMA SE MANJE GOVORI

*Potrebe za energijom, posebno električnom, neprestano će rasti. Potreba za racionalnim korišćenjem energije prvi put se pojavila na globalnom nivou tokom naftne krize 1973. godine. Kao posledica ove krize, mnoge države su pooštrile propise u oblasti energetike radi smanjenja potrošnje energije, a među njima su bili i propisi koji su se odnosili na povišenje energetske efikasnosti (EE) u zgradarstvu. Interes za energetske efikasnošću je ponovo došao u žižu interesovanja kada su istraživanja pokazala veliki uticaj potrošnje energije na klimatske promene. Generalno, kada govorimo o energiji razlikujemo dve kategorije uštede energije: čuvanje energije (domaćinska briga o trošenju energije) i energetska efikasnost. Ova dva pojma se značajno razlikuju. U radu će ova dva pojma biti tumačena u nizu primera. Kada se pomene pojam energetska efikasnost najčešće se pomisli na energetske efikasnost u zgradama. U radu ćemo posebnu pažnju da posvetimo oblastima o kojima se ređe govori kada je u pitanju energetska efikasnost, kao što su dimničarstvo, narodno staro graditeljstvo, energane u zdravstvenim ustanovama, održavnje uređaja i opreme na vreme, posebno u zdravstvenim ustanovama. Energetska efikasnost ima i ključnu ulogu u borbi protiv energetske siromaštva. Takođe, u radu će biti istaknuta i neophodnost podizanja nivoa znanja stanovništva Srbije o važnosti EE kroz sisteme formalnog i neformalnog obrazovanja. Koncept energetske efikasnosti ima dva značenja: jedno se odnosi na tehničke uređaje (npr. električne mašine) - uređaji su energetske efikasni ako imaju visok stepen iskorišćenja (mali gubici pri pretvaranju jednog oblika energije u drugi), a drugi - na određene mere i ponašanja koja se primenjuju za smanjenje potrošnje energije. Međutim, posebno treba naglasiti da se na energetske efikasnost ne treba gledati kao na očuvanje energije, već, kako sam termin kaže, kao na efikasno korišćenje energije koja ne sme da naruši definisane standarde radnog i životnog okruženja.*

**Ključne reči:** energetska efikasnost, životna sredina, energetske siromaštvo, dimničarstvo, prediktivno održavanje, stara gradnja, obrazovanje