Importance of Energy Efficiency in Power Engineering

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Abstract. This paper aims to show the importance of energy efficiency in the power engineering, that it is essential to all areas of the economy and society, as well as for the environment. While saving energy always involves certain sacrifices from the usual habits, efficient use of energy has led to increased quality of life, greater competitiveness of companies and the economy as well as energy security. Energy sources that are most in use today are based on the combustion of fossil fuels, and supplies of these fuels have their limitations and should be used more efficiently, thus improving energy efficiency by implementing certain measures in this field.

Keywords: Energy Efficiency, Electrical Engineering, Power Engineering

1. Introduction

Energy efficiency is essential to all areas of the society and the economy, as well as for the environment.

Abundant and economic energy is a key part of modern society. The harnessing of energy, and in particular the use of electrical energy to replace human effort, has led to the high standard of living today in the developed countries. Continued growth in the services that energy can provide will allow for new levels of improved quality of life, particularly in developing countries. Because of these factors, energy is a global and a commercial priority. [1]

In support of raising awareness of the importance for the concept of energy efficiency and achieving the set objectives laid down a series of recommendations, rules, obligations and laws that regulate this area, such as:

- Energy Efficiency Law,
- Energy Efficiency Strategy,
- Energy Efficiency Action Plan,
- A program to improve energy efficiency. [2]

2. Energy Efficiency

Energy Efficiency will be analyzed in these areas:

1. Transformer
2. Energy Efficiency Of Electricel Drives
3. Lighting
4. Air Conditioning
5. Other Electrical Appliances In Households
6. Compensation Of Electricity

2.1 Transformer

According to some estimates, a third of the total losses in the transmission and distribution networks occurs in transformers [3]. The greatest progress in increasing the efficiency transformers was made by reducing the idle running losses, which is directly connected with the properties of magnetic materials for the transformer core. Figure 1 shows the development of magnetic steel core in terms of losses in the transformer core. Around 1900, as a raw material for a core transformers are used hot-rolled steel, while about 1950 in the use its cold rolled steel with silicon and orientation of the grains (Cold-rolled grain oriented silicon steels - 'CCE').[3]

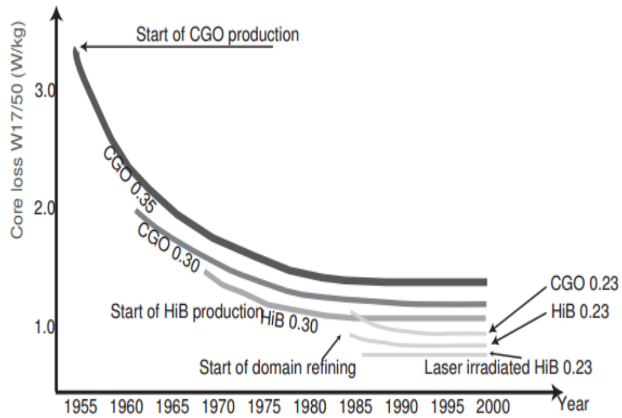

Figure 1: Different types of magnetic steel [3]

The application of different methods of treatment and coating as well as the reduction of the percentage of silicon led to the production of highly permeable steel with grain orientation ("Hib"), and it is now a standard production in Europe

Reference testing standards for transformers are standards: NEMA TP-2 of the United States [1] and the international standard IEC 60076 [1]. Figure 2 shows a comparison of international standards of efficiency transformers at a load of 50%. [3]

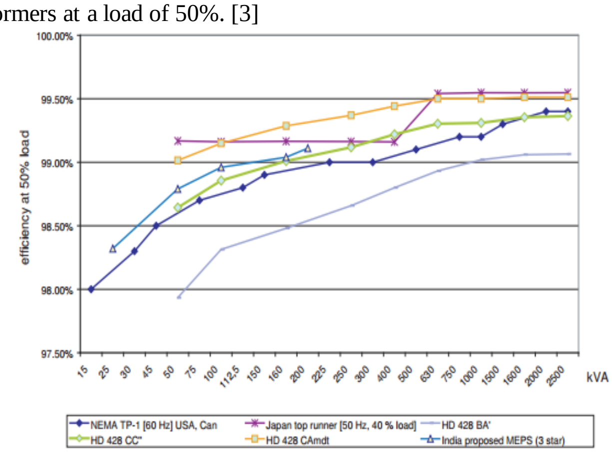

Figure 2: Comparison of international standard efficiencies at 50% of load. [3]

Investing in energy-efficient transformers means reducing energy losses and reduces environmental pollution, thereby reducing operating costs and increasing profits.

2.2 Energy Efficiency Electric Drive

Electrical drives account for about 65% of electricity consumption in the global industry. It is estimated that the application of high-efficiency motors in the European Union could lead to savings of over 200 billion kWh per year [4].

The efficiency of electric motors is divided into four energy efficiency class IE1, IE2, IE3 and IE4 [4], where class IE4 represents the most efficient engines. Class IE1 motors includes engine efficiency

up to 87.6%, class IE2 from 89.8%, class IE3 of 91.4%, while class IE4 motors reach efficiency values up to 97.0%, of course, all depending on the power of the concrete engine.
High motor efficiency is also more expensive because of the higher quality of their production and the cost of the material used. The Difference in price between the engine class of the IE1 and IE2 is from about 10% to 15%, or between the IE2 and IE3 an additional 10% to 15%.
The diagram in Figure 3 illustrates the possible savings of power (in percentage) depending on the engine power during the upgrade of the engine from the lower energy class to a higher.

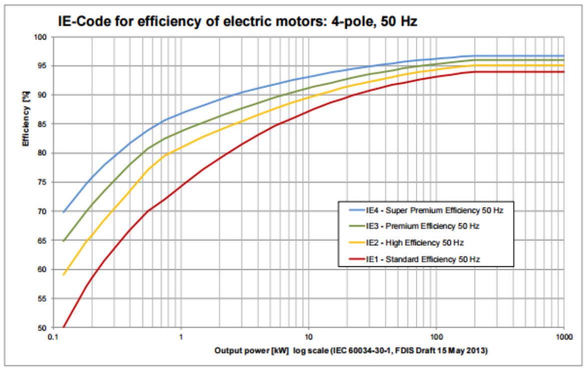

Figure 3: Motor energy efficiency classes at 50 Hz [4-5]

2.3 Lighting

Energy efficiency of light sources is typically measured in lumens per watt (lm/W), meaning the amount of light produced for each watt of electricity consumed. This is known as luminous efficacy. DOE's long-term research and development goal calls for white-light LEDs producing 160 lm/W in cost-effective, market-ready systems by 2025. [6]
The theoretical maximum efficiency, in which all energy is converted into visible light is 683 [lm / W], whereas in reality, these values are much smaller, and may range from 10 to 150 lm / W.
Although extremely inefficient, incandescent bulbs are currently the most widely used light source in the world, and despite the positive features of this type of bulb, the decision was made on their withdrawal from the market of the European Union.
Increasingly favoring the use of compact fluorescent lamps with integrated electronic ballast (aka. Energy-saving bulbs).
Currently available LED drivers are typically about 85% efficient. So LED efficacy should be discounted by 15% to account for the driver. For a rough comparison, the range of luminous efficacies of traditional and LED sources, including ballast and driver losses as applicable, are shown below in table 1. [6]

Table1. Comparison of range of luminous efficacies of traditional and LED sources. [6]

Light Source	Typical Luminous Efficacy Range in lm/W (varies depending on wattage and lamp type)
Incandescent (no ballast)	10-18
Halogen (no ballast)	15-20
Compact fluorescent (CFL) (incl. ballast)	35-60
Linear fluorescent (incl. ballast)	50-100
Metal halide (incl. ballast)	50-90
Cool white LED >4000K (incl. driver)	60-92*
Warm white LED <4000K (incl. driver)	27-54*

*As of Spring 2009

The only currently commercially available alternative to compact fluorescent light bulbs are LEDs. [6]

2.4 Air Conditioning

In the world, 50 million air-conditioners are set up every year. It is important to save the power consumed by air-conditioners.
The consumption of electricity will be less if air-conditioners have higher energy efficiency. Lower energy consumption leads to a reduction in the emissions of CO2 leading to a reduction in global warming. Better servicing of air-conditioners have also leads to a reduction of emission of HCFC-22, resulting in reduction of ozone depletion and global warming. [7]
As the definition indicates, the important actions involved in the operation of an air-conditioning system are:

- Temperature control
- Humidity control
- Air filtering, cleaning and purification
- Air movement and circulation

The more energy efficiency of the device directly depends on the efficiency of the compressor or its management. The most effective type of air conditioners is those that contain embedded inverter.
The number of rotations of the compressor and the external fan is electronically changed and is continuously blowing necessary amount of air, the temperature deviations are smaller and you will get up to 30% more economical operation [8].

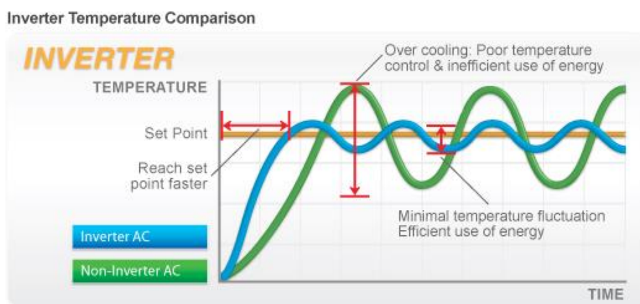

Figure 4: Inverter Temperature Comparison. [9]

2.5 Other Electrical Appliances In Households

With the increase of the types and numbers of the household appliances, electrical appliances' standby energy consumption has attracted more and more people's concern. To reduce the energy waste of the household appliances, a method for the energy-saving control of the standby household appliances.
Size share on household appliances (refrigerators, freezers, washing machines, as well as for food preparation: stoves, ovens) in total electricity consumption are 35% and points to the fact that a large number of old, energy inefficient, electrical appliances, are still in use. [10]
There are studies that show that it is possible to achieve significant energy savings, where consumers when replacing or purchasing new appliances, opt for purchasing the new generation, who have a higher purchase price, but they use less electricity during its service life.
Standardization of energy labels has enabled customers to rationally make decisions about selecting devices based on all parameters. Showing such a label located on Figure 5.

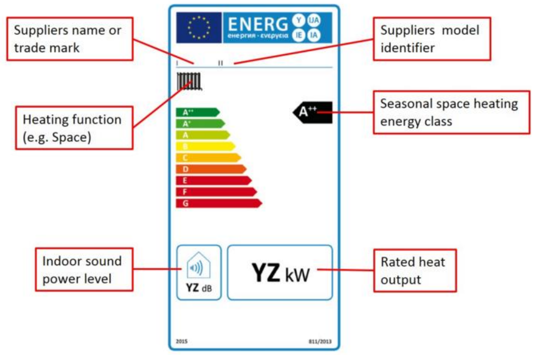

Figure 5: Energy Manufacturing Model. [11]

Also, there are the newest presented method where it is possible to divide the indoor electrical circuits into two parts, one of which is the circuit that can be powered down while the other cannot be turned off. An algorithm that fuses the detected current information and the pyroelectric infrared sensor information is put forward to assure that the circuit will be cut off when the household appliances in the circuit that can be powered down are at the standby status and nobody is at home. [10]

Taking in consideration that total electricity consumption in this area is 35% by using developed system is reliable and has great importance on energy conservation.

2.6 Compensation of Electricity

Compensation of electricity (power) presents a series of activities being implemented to control the production and consumption of reactive power, in order to realize better technical and economic characteristics of operation of the power system.

In case of expansion, a larger investment is required in the equipment needed to increase distribution capability of the installation, such as oversized transformers and switchgears.

Transformers For an installation which requires 800KW, the transformer should be approximately: 800KVA for power factor = 100% 1000 KVA for power factor = 80% 1600 KVA for power factor = 50%.[12]

Large size conductors

The Figure 6 shows a variation of a cross section of a conductor as a function of the power factor for a given useful power. This illustrates that

when the power factor of an installation is low, the surcharge on the electricity bill is only part of the problem. For instance, in an installation where no correction has been made and which has a power factor of 70%, the cross-section of the conductor must be twice as large as it would be if the power factor were 100%. [12]

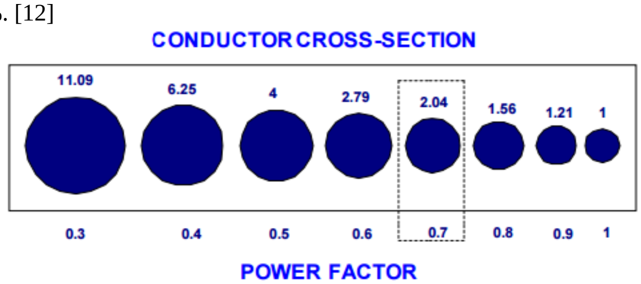

Figure 6: Variation of a cross section of a conductor. [12]

Good governance consumption of reactive energy brings economic benefits.

Benefits of Power Factor Correction:

- Reduce Utility Power Bills
– Increase System Capacity
- Improve System Operating Characteristics (Gain Voltage)

- Improve System Operating Characteristics (Reduce Line Losses) [12]

Installation of capacitors for power factor correction enables the consumer to reduce the bill, or to maintain the level of reactive power below the values that are charged.

Conclusion

Investing in energy efficiency in all areas is the cheapest way of providing energy security and environmental protection. In our country that cannot be achieved in equal measure in all areas, and because of the economic feasibility we can't expect significant savings by replacing existing transformers (except in the construction of new plants), as well as replacement of electric motors and drives for the current bad situation in our economy and industry. Kosovo now has the lowest level of energy efficiency in Europe. Countries of Western Europe annually consume less than 90 kWh / m2, whereas in our country's power consumption ranges from 150 to 180 kWh / m2.

Replacing the existing interior lighting with more efficient one, can bring significant savings. The amount of the expected savings is up to 80%, while maintaining the same or even better, lighting conditions. More efficient outdoor lighting usually won't bring as larger energy savings (no more than 50%). The emission of "greenhouse gases" (CO_2, SO_2, NO_x ...) created by burning fossil fuels, is the most worrying issues for the environment. As a developing country, Kosovo doesn't have a developed industrial sector. Thus, in contrast to developed countries, most of the electricity in Kosovo is spent by households.

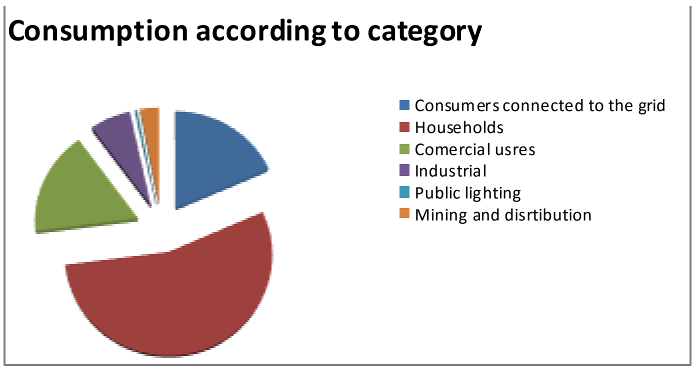

Figure 7: Participation of overall consumption categories in 2011. Annual report 2011. [13]

Since households are the biggest consumers of electricity in Kosovo, unlike in other countries where the industry spends more electricity, the focus of government policy should be energy efficiency in this sector.

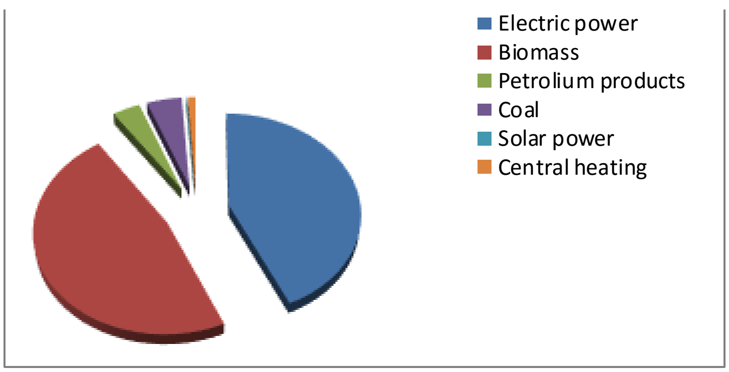

Figure 8: Participation of all energy products in the household sector. [14]

So far, no public policy is focused to adjust the household sector. Moreover, in Kosovo, there is no incentive to use Alternative heating ways, which would significantly reduce the demand for energy.

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