Energy-Saving Devices

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Abstract

Energy is classified into two types; nonrenewable and renewable. There is a global interest to benefit and switch to renewable energy sources such as wind and solar energy, and also to create and develop energy saving methods which can limit the consumption of nonrenewable energy. This transition has happened as a reaction to many important issues such as global warming and the rapid increase of oil prices reaching $145 a barrel. Energy saving is a method that can be used to decrease energy consumption. The reduction of energy usage should not affect power efficiency and the outcome services. Energy saving is important because it leads to the increase of environmental value, human comfort, and financial capital. Consumers would want to reduce the energy consumption to reduce the costs.

On the other hand, industrial and commercial users want to increase energy efficiency to maximize their profit. Energy saving will decrease the demand for energy and it is considered a better solution for energy shortages, which will decrease energy production and consumption of nonrenewable energy resources. We have to be a part of the solution instead of the problem. Energy saving may mainly concentrate on the energy saving devices. In this paper, we will study some home electrical devices which are big contributors to residential and industrial energy consumption. Furthermore, the paper will explain replacing standard electrical devices with energy saving devices that do the same task with less energy. Some techniques will be discussed that can help minimizing electrical power consumption. Eventually details of how to use affordable alternative energy sources to reduce energy consumption from the national grid will be explained.

1. Introduction

Energy consumption has a great impact on the environment and economy since it is produced. That's why today Environmental and economic issues are taken in consideration in building power plants, transmission lines and electrical devices. Efforts are made to develop energy saving technology and alternative energy sources to meet environmental and economic restrictions. Energy saving is considered to be a good concept for reducing energy costs and pollution. It is used to decrease energy consumption, while achieving same objectives. Energy saving is developing rapidly to create more efficient and compatible devices. These devices are called saving energy devices. Saving energy devices reduces consumption of energy by approximately 15 %. Although this is a significant reduction in energy consumptions, energy saving devices do not affect output power quality.

A part of energy management is using alternative energy sources. Examples of alternative energy sources can be solar energy, wind power and hydro power. These alternative sources will produce nonpolluting energy and minimize the use of energy produced by nonrenewable sources. For example, using solar energy can reduce environmental pollution from burning coal. In addition, it can generate large amount of power that can be use in industries and homes. Alternative energy sources could be used to develop energy saving devices, which will decrease the dependence on nonrenewable sources. Although energy saving technologies will provide the same power quality, some electronically switched energy saving loads will usually have highly distorted demand current. This high current will generate losses in the distribution system. These losses are translated into unnecessary costs to the electric utility company due to energy loss and increased peak demand.

In this paper, comparisons between energy saving devices and standard devices for both residential and industrial will be stated and explained. These explanations will reflect the benefits of energy saving devices and how they will have a positive impact on bills, energy consumption, power efficiency and pollution. The paper will then be concluded by recommendations about developing new saving technologies.

2. Examples of Energy Saving Devices

2.1 Residential

"The wonderful thing about saving energy is that, in addition to saving the environment, you save money [2]". Many of the saving energy appliances available cost higher than standard ones. However, the extra cost is repaid in energy saving in a few years. To understand the energy consumption inside residents or homes, see Figure 1. The following text explains two examples of energy star qualified devices (energy saving devices). Furthermore, these examples include comparison between energy star qualified devices and standard devices based on tests analysis. This should support the general idea that energy star qualified devices are better than standard devices.

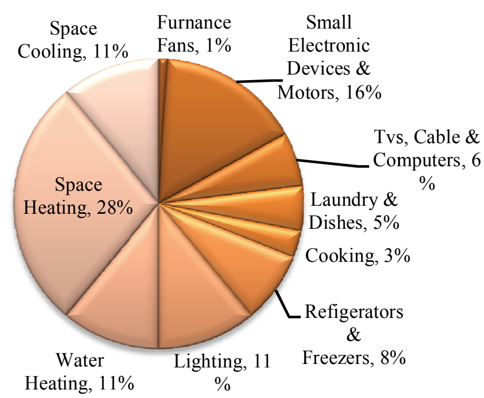

Figure 1. Typical home energy consumption distribution [2].

2.1.1 Lights

In Table 1, a comparison between two types of light bulbs is shown according to their energy consumption. The first type is the energy star qualified light bulb, which is supposed to be energy saving while the other type is a standard light bulb. These lights are usually used in living rooms, toilets, kitchens, bedrooms and outdoor.

According to Table 1, saving energy light bulbs consume about 75% less than standard light bulbs. This significant reduction of energy consumption will reduce energy cost of each bulb replaced. In addition, heat is reduced, which means energy star lights are safer and can also save bills from using cooling devices. Furthermore, energy saving light bulbs last ten times more than standard light bulbs [1].

2.1.2 Room Air Conditioners

Room air conditioners are widespread home appliances. According to [1] in U.S.A. only, energy star qualified room air conditioners would stop 1.3 billion pounds of greenhouse gas emissions, which is the same emissions from 115,000 cars. Energy star qualified room air conditioner uses at least 10% less energy than a standard model. Usually it contains timers and automatic adjustment system for better temperature control, consuming minimum amount of energy to cool the room. Energy star qualified air conditioners should have a high specific energy efficiency rate (EER). Table 2 describes the difference between an energy star qualified air conditioner and a standard one based on the minimum EER [2]. An energy star air conditioner has more efficiency than a standard one. Higher efficiency means less loss, which will reduce energy consumption, bills and pollution.

Table1. Lights output power [1].

Output Power (watts)	
Standard light bulb	**Energy Star qualified light bulb**
40	**9 - 13**
60	**13 – 15**
75	**18 – 25**
100	**23 – 30**
150	**30 – 52**

Table 2. Minimum energy efficiency rate (EER) of air conditioners [2].

Minimum EER		
Capacity (Btu/Hr)	**Standard minimum EER**	**Energy Star minimum EER**
Less than 6000	9.7	10.7
6000 to 7999	9.7	10.7
8000 to 13999	9.8	10.8

Table 3. Energy savings in industrial fields [3].

Savings achievable through the use of drives in selected industries					
Company	Industry	Application	Installed	Confirmed	Saved
			Power [KW]	Saving [KWh]	[%]
Pena Colorada	Mining	Fan in palletizing plant	1250	2’423’750	35%
China Steel, Taiwan	Metals	Booster pumps	672	3’030’720	61%
Cruz Azul, Mexico	Cement	Kiln ID fan 1+2	1470	5’309’640	54%
Repsol YPF, Argentina	Petrochemical	Blower (system turbine replacement)	3000	7’560’000	43%
Daqing Plastic Factory, China	Petrochemical	Mixer	1300	2’600’000	31%

2.2 Industrial

There are two main goals that are challenging the industry, financial triumph and environmental responsibility [3]. These goals seem to be contradictory. But when it comes to energy, saving it will achieve both goals. There are many ways to save energy in industrial fields, with examples provided in Table 3.

2.1.1. The lack of System Standards

A lack of system standards for energy efficiency can lead to wasted energy. A study done by the American Council for an Energy Efficient Economy (ACEEE) were they analyze the routine of a leading chemical company and of two major engineering contractors showed that 90% of pumps were not correctly sized. Here a question rises, if 90% of pumps are incorrectly installed in this company, how many are there in companies elsewhere?

2.1.2. Energy Saving for Medium Voltage Drives

The World Energy Outlook 2006, Chapter 2, Global Energy Trends states that “global primary energy is projected to increase by 53% between 2004 and 2030 – an average annual increase of 1.6%. Over 70% of this increase comes from developing countries.” So how can we reach the targets of energy saving?

Fortunately, there are fields in which a massive energy saving exist. A few successful examples from industry are shown in Table 3. The data in this table shows that the energy consumption reduced by an average of 42%. A third to three quarters of the all MV drives (motors, fans, pumps, compressors, etc.) has an adjustable speed in order to accomplish the best operation and make them well matched for drives. An estimation of the possible savings is given in Table 4. The current calculation considers only the MV motors which mean that the installed LV motors power is close to 10 times that of MV motors.

2.1.3. Motor Efficiency

The efficiency of a motor is a measure of how effectively it will convert electrical energy into mechanical power. Energy loss can be noise or mostly heat. These losses must be eliminated in order to increase the efficiency (see Table 4). High efficiency motors can create major savings in energy consumption. However there are many factors to be considered such as designing for efficiency and operational temperature. Making efficient motors as well as minimizing overall lifetime costs for the motors can be achieved by manufacturing high quality motors with high efficiency designs. Designers on ABB’s (Asea Brown Boveri) tried to eliminate the losses by the following. They decrease the Iron losses by using better quality steel and by increasing the length of the core to reduce the magnetic flux density. Windage and friction are reduced by better bearing and seal selection, air flow and fan design. The fan must be large enough to allow sufficient cooling, but not so large that will reduce the efficiency and increase the noise. Stator copper losses are reduced by improving the stator slot design. The stator laminations must be made of low loss steel, and as uniform and thin as possible to maximize the strength of the magnetic fields. Rotor losses are reduced by increasing the size of the conductive bars and end rings to produce a lower resistance. Stray load losses are decreased by developing the slot geometry. All this development and reduction of energy loss led to a high efficiency motor which is called M3BP by ABB.

3. Analyses

3.1 Test Analysis (Motor)

In Table 6, we try to demonstrate how high efficient industrial motors can save energy and money as well. For example, the normal motors generally have a rated voltage of 415V and power 2KWH. Assuming that the motor is working for 12 hours a day and the energy saving potential of 40 % [3]. This study is about a single high efficiency industrial motor. Now imagine the effect of implementing the energy saving methods on the entire industrial sector.

Table 4. High efficiency motor [3].

Medium voltage drives can deliver global savings of 227 TWh per year		
Installed MV motors (world estimation based on 20 year motor lifespan)	500,000	Pcs
Motors used for square torque loads (at least)	333,000	Pcs
Installed power used to drive square torque loads (average power, 1500kw per MV motor)	500,000,000	KW
Less than 4 percent MV motors have a frequency converter, remaining at least	300,000	Pcs
Assuming that only 30 percent of these motors have an energy saving potential in the same order of magnitude as the sample testimonies above	90,000	Pcs
These 90,000 motors consume*	569	TWh
Assuming the energy saving potential of 40% (similar to the testimonies above)	277	TWh
The EU-15 share can be estimated to be 20%	45 TWh	

*Assumptions: 2/3 of teh motors operate 7500h/yr and 1/3 operate 1850h/yr.
Average load 75 percent of teh rated power

Table 5. Distribution of motor losses [3].

Distribution of losses in an ABB M3BP motor		
No-load losses	Iron losses in core	18%
	Widage and friction losses	10%
Load losses	Stator copper losses	34%
	Rotor loses	24%
	Stray load losses	14%

Table 6. Bill calculation [4].

Bill Calculation			
Type	**Normal motor**	**High efficiency motor**	
Power consumed	2000	2000* 40% =800	KWh
Power saved	-	1200	KWH
Bill according to Slab tariff [DEWA]	400	160	AED
	108.99	43.59	USD

3.2 Test Analysis (Lights)

In the United Arab Emirates (U.A.E.), lights are considered to be one of the most energy consuming devices. Changing standard lights to energy saving lights will save energy and bills dramatically. According to Table 1 a standard light with 150W will be reduced by 30W to 52W, which is approximately 80% to 65% saved energy. Each saving energy light bulb saves 30$ for lifetime, which will save much more money for each home [1]. For example, 60 light bulbs are installed in one home, so according to [1] saving bills will be about 1800$. Furthermore, since the U.A.E. is considered to have hot weather most of the year, 75% less heat produced by lights will obviously save bills and energy using cooling devices.

4. Conclusions

Demand for energy is ever increasing. It is necessary to preserve energy. In this paper several methods of saving energy are explained. Residential systems and Industrial system which consume bulk parts of the energy are considered. Different approaches and simple methods which aid energy saving in day to day life in residential systems are explained. These are simple methods and do not require much capital investment to avoid energy wastage. Similarly two major approaches for energy saving in industrial systems are explained. It is very important to note that energy saving also improves the system reliability which results in reduced break down and improved plant performance. In addition to these indirect advantages, the energy saving also has direct advantages such as very good payback period in terms of energy saving through reduced energy bills and improved reliability.

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