

## Improvement of Energy Efficiency in Housing Sector of Pakistan

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### Abstract

Pakistan is in the grip of worst energy crises of her history that is not only affecting all sectors of economy but also various segments of the society. Major causes of energy crises include economic and political instability, inefficient and faulty distribution system, poor management of energy resources, lack of energy conservation practices and last but not least the lack of accountability on the part of those who stay at the helm of affairs.

Electricity has a wide range of uses in residential as well as in commercial sector in Pakistan. Residential consumption of electricity has the highest share of 45.6% followed by industrial consumption of 28.4%. Households mainly use electricity for refrigerating, cooling, heating, washing and lighting etc. This paper identifies potential areas in the household sector of Pakistan where employing efficient energy use will reduce energy consumption and will present unwanted energy loss. The study specially focuses on the patterns of household electricity consumption to identify the barriers which are preventing from achieving energy efficiency goals.

### Keywords

Electricity, Household, Efficiency, Energy, Lights, Appliances

### 1. Introduction

According to industry experts Pakistan's economic growth rate is at an average of 5% per annum [Integrated Energy Plan 2010-2025, EAC, Ministry of Finance]; while during the same period energy growth will be at 6.25% per annum. Pakistan will double its demand for energy every 12 years like other developing countries. Energy efficiency and energy conservation will play a key role in development of Pakistan.

Among the various other sources of energy, electricity is the most important sources of energy in Pakistan. In spite of having strong potential in coal, wind and solar, presently Pakistan is generating electricity by only three modes which includes thermal 65%, Hydel 33% and nuclear 2%. Having a wide range of uses in residential as well as in commercial sector, the household sector had been the highest consumer of electricity accounting for 45.5% of total electricity consumption.

#### Consumption of Electricity

Sector	Percentage Share
Household	45.5
Commercial	7.6
Industrial	26.9
Agriculture	13.2
Street Light	0.7
Other Govt	6.1

Pattern of domestic energy use are closely linked to agro climatic, socio economic conditions such as the level of user's having standards, education, financial states, family size, etc. Energy consumption in household sector is divided as lighting, space cooling, cooking and other appliances, we obtains light from tube lights, bulbs, energy savers and we made food for ourselves through toaster, microwaves, boiler, oven and range. Other appliances involve television, washing machines, cloth dryer, computer, printer, ceiling fans, iron, electric geysers etc. Electricity consumptions should be studied in terms of electrical appliances their applications and efficiency to overcome energy gap in household sector,

For example: an energy efficient compact fluorescent bulb (CFL) uses 85% less energy than a conventional incandescent bulb to produce same amount of light.

Proper energy planning even till house level is necessary to reduce energy requirement of society. The society can limit or reduce energy consumption through improving the energy efficiency and also by changing consumption patterns.

## **2. REVIEW OF LITERATURE**

Becchis, L.S and D.R.,(2009) determined the microeconomic of end use energy saving as result of efficiency measures or frugality (refer to the behavior that is aimed at energy conservation. Energy efficiency refers to the technical ratio of input energy and output energy services which can be modified by technical improvement. The purpose of this paper was to find the relation between economic variables to find behavior towards energy efficiency. Moreover energy saving is analyzed at microeconomic level to make parameters which are important enough for determining outcome of energy efficiency policies. Change in behaviors along with technology alteration need to be undertaken side by side so that an effective public energy policy is formulated.

Waheed and Yasin, (2009) deals the problem of energy conservation at household level which consume major portion of Pakistan electricity consumption. The basic problem in our society is the missing of energy efficient policy and by changing consumption pattern. Lot of energy is wasted by unnecessary lighting and inefficient cooling arrangement at household sector. They recommend certain minute measures like replacing bulbs with energy savers, controlling line losses and use standard appliances at household level which result in saving money as well as reduce the overall consumption. They have also suggested Government to focus on formulating efficiency standards and also implement it. By formulating laws for manufacturer to follow standard set for production of energy efficient appliances.

Linda Stag.,(2008) relate the energy conservation at household level with the behavior changes in the society. Individuals need to be educated on the energy savings due to which they usually under estimate consumption of various appliances. Certain strategies are recommended, strategic and structured strategies may be employed for energy conservation at household sector. Energy use should always be studies side by side with personal factors like attitude, customs, norms, habits, which implies that interdisciplinary approaches is require getting a full understanding of energy use. Also a dedication is needed from political leadership to understand the energy conservation themselves and communicate the same to the public being idealistic figure in society.

Claudia and EneDir (2008), main objective is to assess the impact of household energy-efficient appliances on the electricity consumption by using end-use data. The major cause of wasted energy in household sector is because of inefficient electric appliances. Certain measures suggested for conservation of electricity in household sector in Brazil are explained in details. The most productive potential for electricity savings is the replacement of incandescent lamps by fluorescent ones. Secondly, the replacement of electric heaters with solar water heating systems. Refrigerators and freezers consume maximum energy need proper management of power. The methodology involves assessing the impact of using energy efficient appliances over the existing one. Two scenarios were evolved in assessing the performance. Scenario 1 is based on prediction of electricity consumption on existing appliances and scenario 2 on energy efficient household appliances. After mathematical calculations by using empirical formulae to determine consumption of each appliances at current and after change to energy efficient

appliances. A remarkable saving up to 27% was observed by just replacement with energy efficient appliances.

Sifat, M.K.L (2009), gap between supply and demand is increasing day by day in the absence of any long term energy planning based on forecast. 10-12 years forecast is worked out by using empirical relationship. Alternative energy sources based on wind and coal are also accounted for to enhance the electricity production. The increase in consumption of electricity in household sector is mainly due to increase in population. Solutions suggested in the paper are categorized as short and long term. In short term measures like reducing of line losses from 24% to 10% will help in saving 300 MW of energy and increasing production of IPPs and WAPDA from 50% to 80% of its installed capacity along with clearing of circular debt of fuel supply companies. In long / middle term steps towards construction of dams, nuclear power plant. Pakistan is blessed with numerous alternative energy sources such as solar, windmill etc. which can produce quick and cheap electricity. In longer term coal potential to produce electricity cannot be ruled out as practiced in various other countries. Policy makers are advised to take up long term planning and incorporate measures as suggested above well in time otherwise the crisis will further worsen, resulting in affecting growth of our country.

Tahir, Fawad (2011) before solution to energy crisis in Pakistan, it is important to identify the causes of the problem. Lack of competent leaders, absence of proper planning, weak institution full of corruption, lack of public awareness and mismanagement accompanied by no one taking the responsibility are the few causes of current energy crisis. Residential sector consumes 32282 GWh electricity (Pakistan Energy Year Book, 2009). Residential sector consists of more than 24 million households with available access to 70% population. More than 30% electricity is wasted due to lack of awareness on account of using low efficient appliances. Government should take necessary steps to have check and balance on industries which produce non standard appliances. We are using inefficient lights, water pumps, air conditions, fans, etc. Government needs to apply tangible rules and regulations in Mid-stream and Down-stream level. To overcome from these issues, we can apply some management tools and make it possible to finish all the existing problems. Due to poor law and order situation in the country, FDI is not coming in power sector in spite of being highly profitable. Forecasting and proper planning is the missing element in our country which is not addressed at all, needs improvement at high level. The authors concluded that we should focus on regional cooperation in the field of energy. Deals with Iran and China in energy field be finalized in the interest of public without any delay.

Engr Faiz, considers climate change, urbanization and global warming are the causes behind increase in energy demand. Pakistan is energy deficient due to its inadequate energy power supply mix, rising energy gap between demand & supply, lack of energy efficiency legislation and its implementation. Instead of conventional some alternative ways be used to save and generate electricity. Process of conservation of electricity is too slow due to lack of implementation of legislation. Along with changing of incandescent lights with compact fluorescent lighting (CFL) insulation of building, use of glazed glass, use of energy efficient material and control of interior and exterior lights. Replacement of electric water heater with solar one and use of LED lights be exempt from custom duty and be available to public on cheap rates. Appointment of sole energy administrator is very important so that proper legislation be made in this sector.

Munawar (2010), Pakistan is blessed with both conventional and renewable energy sources but unfortunately no significant importance given to the later one. Renewable energy sources comprising of solar, wind, microhydel, biogas and geothermal. Currently, Pakistan is unfortunately producing only 1% of energy from micro/mini renewable energy installation. In spite of day to day decrease in production from conventional sources no significant steps taken by the Government to promote the renewable sources. In Pakistan excellent conditions available on south western parts of Baluchistan and north eastern parts of Sindh for solar energy but so far only small scale test projects are launched. Similarly coastal areas of Sindh and Baluchistan provide ideal conditions for installation of wind turbine to cash this renewable source of energy. Alternate Energy development board (AEDB) is working on small scale projects with

slow pace which needs to be enhanced at an advanced level. Presently the environment in Pakistan is not suitable for foreigners to invest in the energy sector in Pakistan due to multiple issues. Pakistan needs to address all the reservations of investors and should restructure its energy policies mainly focusing on the renewable sources of energy.

Mirza Majid (2011), Due to inefficient policies by the Government on electricity production and proper management is the root cause of the energy crisis in Pakistan. We have not paced our electricity production with our industrial growth. Moreover, rapid increase in demand, power theft, line losses due to outdated infrastructure, and seasonal variations in the availability of hydropower have further worsened the situation. Consequently, the demand and supply gap is increasing and resultantly causing load-shedding. The other reason for this ongoing energy crisis is lack of future planning. The government has completely failed to plan and forecast for the future. With the upcoming demand of electricity, the government should have planned to overcome the energy crisis in the future. The Government should also pay focus on alternate energy resources like coal, wind and solar, so that cheap and uninterrupted supply of electricity be provided to household and domestic sector. Uneconomical transmission lines should be changed so that line losses can be prevented. Conventional sources of energy must be reinforced with renewable and alternate sources of power generation. Recommendations consist of using energy efficient appliances, control of line losses, and awareness campaigns on energy saving, employing an efficient work force and formulating effective regulation to improve the energy crisis of Pakistan.

Maqbool, Shayan, Nadeem 2011, Pakistan is facing the worst energy crisis mainly due to inadequate power generation capacity in comparison with demand. In spite of controversial major hydro projects, we should be focusing on small hydropower plants with multiple advantages as low cost and reliable. Other renewable sources like solar, wind, geothermal must be brought into use to increase the production of electricity. This study highlights the use of Renewable Energy Resources on a small scale at the household level which will be more reliable, cost effective, independent of the national grid and adaptable by the general public. An average household in Pakistan requires energy to operate a Refrigerator, 2 to 3 Ceiling Fans and 4 to 6 LEDs, Iron and washing machine. 2-3KVA IEUs are sufficient to provide electricity for these devices simultaneously except the washing machines and Iron. These devices only be used at a time by keeping the lighting and fans off during day time. China is manufacturing Small Scale Hydropower, Wind Energy and Solar Power Units at very low prices, which can be obtained and installed at various locations to achieve desired output. Bold and timely decisions are required to be made by the Government, Investors, business analysts and End-Users for incorporating alternate energy sources so that demand be fulfilled with electricity produced from these sources.

### **3. The household Energy Efficiency and Conservation Strategy**

Any home improvement performed will reduce your overall energy consumption or prevent unwanted energy loss contribute to better home energy efficiency. An energy efficient home will keep your family comfortable while saving considerable money. The 180 million residence in Pakistan today collectively use 45.5% of total electricity produced.

Unfortunately a lot of energy is wasted through leaky ducts, windows or old and inefficient appliances and careless attitude towards electric conservation. We throw away our money by wasting energy at our home. Average household in Pakistan spend more than Rs 40000/- a year on electricity bill, which can be easily reduced to 75% (Rs 32000 a year). Energy efficient households in Pakistan can contribute 240 Billion a year by just applying simple energy conservation practices. Thus saving total amount of Rs:192 Billions (24 M x 8000) by 24 M of households by adopting simple energy techniques.

According to CRCP survey lighting and space cooling are two major electrical end uses categories amongst households in Pakistan. Bulbs and tube lights are generally used for lighting, whereas fans, air coolers and air conditioners are used for space cooling. These two basic end uses account for two thirds of the total household electricity. [12]

Residential sector consumes 32282 GWh electricity [Pakistan Energy Year Book, 2009]. This sector consists of more than 24 million household. Out of which 70% have an excess of this source. The given amount of electricity is utilized by 29% (9362GWh) for general appliances (water pumps, irons, television etc), 36% (11622GWh) for space cooling (fans, room cooler air conditioner etc) and 35% (11299GWh) for lighting -Incandescent bulbs, florescent tube lights and compact candescent lamps etc. [Asian Development Bank, 2009].

**Distribution of Electricity Consumption in Household sector [6]**

Sector	Percentage Share
Lighting	35.7
Space Cooling	7.4
Industrial	28.4
Agriculture	11.8
Street Light	0.6
Other Govt	6.2

Due to lack of awareness 30% (9684.6GWh) of electricity is smashed .By the introduction of standardized appliances; we can save this huge amount of electricity (Enercon Pakistan, 2009). In industry sector 19330GWh electricity is used (Pakistan Energy Year Book, 2009). From this electricity 6.4% (1237GWh) electricity is consumed by steel and iron, 3% (580GWh) by pulp and paper, 27.6% (5335GWh) textile, 0.8% (155GWh) sugar and 62.2% (12023GWh) for other industries (Asian Development Bank, 2009). Electricity efficiency potential in industrial sector is 25% [Enercon Pakistan, 2009].

**i. Lighting**

According to EEIP baseline domestic lighting survey there are presently approximately 117.4 million residential points in the country, 36% of which are fitted with incandescent bulbs (IBs), 42% with compact fluorescent lamps (CFLs) and 22% with linear fluorescent tube lights. The survey suggest that IB and CFL light points are used for an average 2.9 hours daily and FTL light points are used for an average of 3.3 hours daily. According to Household Energy Strategy Study (HESS) survey finding, residential lighting accounts for 14% of total electricity delivered and for approximately 35.7% of household electricity consumption. The study conducted by Consumer Rights Commission of Pakistan in 2004 showed that on average an inefficient incandescent bulb consumes extra energy equivalent to 2.3watts/8-hours. [12]

**ii. Fans**

It was estimated that every household in Pakistan own a minimum of two to three fans and based on this figure, the total strength of fans was over 40 million. In 2004, a comparative study conducted by the Consumer Rights Commission of Pakistan (CRCP) [12] with support from the Global Environment Facility (GEF)/UNDP showed that none of the ceiling fans tested met efficiency standards, and they consume on an average extra 12.67 watts/8 hours. Same report has also suggested that the quality of copper wire and silicon steel being used and manufacturing of motors should be increased by reviewing the standards developed by the PSQCA.

**4. Promoting Energy Efficiency at high level:**

Government leadership and action from firms and individuals would be needed to substantially improve energy efficiency. People will be more able to make cost-effective choices if they are given the right information when they buy a product. Incentives to encourage people to minimize costs over the lifecycle of their assets, rather than just the initial costs, will also improve energy efficiency.

The easiest solutions for reducing the burden on Pakistan’s economy would be the development of effective National Energy Conservation and Energy Efficiency Policy infrastructure. This would

include the regulatory framework, building codes and educational, demand and supply management programmers.

## **6. Energy conservation Planning (At Household Level)-DIY Home Energy Assessment [11]**

After you know where your home is losing energy, make a plan by asking yourself a few questions:

- i. How much money do you spend on energy?
- ii. Where are your house greatest energy losses?
- iii. Have you ever calculated your line losses?
- iv. Are you using energy efficient appliances at your home?
- v. Are you using energy savers/LED lights?
- vi. How long do you plan to own your current home?
- vii. Do you have energy audit plan for your home and follow some timetable?
- viii. Have you address air leak at your house?
- ix. Have you regularly carryout maintenance of electric appliances?
- x. Do you know simple energy saving tips?

## **7. Energy conservation through Lighting**

An average household dedicates more than 30% of its energy budget to lighting.[13] Switching to energy-efficient lighting is one of the fastest ways to cut your energy bills. Timers and motion sensors save even more money by reducing the amount of time lights are on but not being used in our country. Hence significant savings in electricity consumption can be achieved by replacing existing IBs in the domestic sector with energy efficient CFLs that provide the same lumen output at lower electricity consumption. In addition, CFLs have a longer lifetime as compared to IBs ADB in its technical assistance report has suggested inject of large volume of efficient compact fluorescent lamps into the market at a low price to expedite their use by domestic consumers. This approach has been successful in several countries where it has immediately reduced customer's monthly power bills. ADB report also suggests that the introduction of 15 million high-quality compact fluorescent lamps into Pakistan's domestic market would save customers \$78 million over the lifetime of those bulbs (approximately 2 years). In addition, 880 MW of power demand would be avoided.

LED bulbs are rapidly expanding in household use. LEDs use only about 20%-25% of the energy and last up to 25 times longer than traditional incandescent bulbs.[13] They come in variety of colors, and some offer convenient features such as daylight and motion sensors. In addition to standard screw-in bulbs, you'll find LEDs in desk lamps, kitchen under-cabinet lighting, and even holiday light strings. Many homeowners use outdoor lighting for decoration and security. A variety of products are available from low-voltage pathway lighting to motion-detector floodlights. LEDs work well indoors and outdoors because of their durability and performance in cold environments. Look for LED products such as pathway lights, step lights, and porch lights for outdoor use. You can also find solar powered outdoor lighting. Outdoor Lighting Tips: [10] Because outdoor lights are usually left on a long time, using CFLs or LEDs in these fixtures will save a lot of energy. Most bare spiral CFLs can be used in enclosed fixtures that protect them from the weather.

- CFLs and LEDs are available as flood lights. These models have been tested to withstand the rain and snow so they can be used in exposed fixtures.
- Look for approved / qualified fixtures that are designed for out-door use and come with features like automatic daylight shut-off and motion sensors.

## **8. Energy conservation through Appliances**

Appliances account for about 13% of your household's energy costs, with refrigeration, cooking, and laundry at the top of the list. [9] When you're shopping for appliances, think of two price tags. The first one covers the purchase price—think of it as a down payment. The second price tag is the cost of operating the appliance during its lifetime. You'll be paying on that second price tag every month with your utility bill for the next 10 to 20 years, depending on the appliance. Following can be followed to conserve energy through electric appliances:-

- i. Don't keep your refrigerator or freezer too cold. Recommended temperatures are 37°-40°F for the fresh food compartment and 5°F for the freezer section. If you have a separate freezer for long-term storage, it should be kept at 0°F.
- ii. Make sure your refrigerator door seals are airtight. Test them by closing the door over a piece of paper or a dollar bill so it is half in and half out of the refrigerator.
- iii. Cover liquids and wrap foods stored in the refrigerator. Uncovered foods release moisture and make the compressor work harder.
- iv. Regularly defrost manual-defrost freezers and refrigerators; frost buildup decreases the energy efficiency of the unit. Don't allow frost to build up more than one-quarter of an inch.
- v. Try to minimize the use of oven, as it consumes a lot of energy rather use other means of heating.
- vi. Turn off the TV, VCR, Stereo or radio when not in use.
- vii. Remove old items from refrigerator regularly, so you don't waste electricity keeping them cold all the time.
- viii. Always use the appliances with a full load.
- ix. Un-plug battery chargers or power adapters when equipment fully charged or disconnected from the charger.
- x. Turn off appliances, light and equipment when not in use

### **9. Energy conservation through sealing air leak and insulation**

Improving your home's insulation and sealing air leaks are the fastest and most cost-effective ways to reduce energy waste and make the most of your energy dollars. Be sure to seal air leaks before you insulate, because insulating materials won't block leaks. Air leaks can waste a lot of your energy dollars. One of the quickest energy- and money-saving tasks you can do is caulk, seal, and weather strip all seams, cracks, and openings to the outside. Test your home for air tightness. On a windy day, carefully hold a lit incense stick or a smoke pen next to your windows, doors, electrical boxes, plumbing fixtures, electrical outlets, ceiling fixtures, attic hatches, and other places where air may leak. If the smoke stream travels horizontally, you have located an air leak that may need caulking, sealing, or weather stripping.

### **10. Energy conservation through Heating and Cooling**

Heating and cooling your home uses more energy and costs more money than any other system in your home—typically making up about 54% of your utility bill [11]. No matter what kind of heating and cooling system you have in your house, you can save money and increase your comfort by properly maintaining and upgrading your equipment. By combining proper equipment maintenance and upgrades with recommended insulation, air sealing, and thermostat settings, you can cut your energy use for heating and cooling—and reduce environmental emission from 20 to 50%. Eliminate trapped air from hot-water radiators once or twice a season; if unsure about how to perform this task, contact a professional.

- Place heat-resistant radiator reflectors between exterior walls and the radiators.
- Turn off kitchen, bath, and other exhaust fans within 20 minutes after you are done cooking or bathing; when replacing exhaust fans, consider installing high-efficiency, low-noise models.
- During winter, keep the draperies and shades on your south-facing window open during the day to allow the sunlight to enter your home and closed at night to reduce the chill you may feel from

### **Conclusion**

Pakistan is currently facing a severe electricity crisis in terms of its short fall. This is due to both reduction in supply and increase in demand for electricity. The government must also provide people with alternative appliances along with creating awareness in the general public about it. Secondly, the government should seriously focus upon the population growth rate in the country. It should formulate such policies that could reduce the population growth rate. Moreover a strong dedication is required from the people of Pakistan to follow small measure at their houses / work place to conserve the electricity. The increase in demand portion can be minimized by following simple energy conservation measur

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