AN EMPIRICAL STUDY ON LOAD MANAGEMENT TECHNIQUES TO ELIMINATE USAGE OF STANDBY ENERGY SOURCES

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ABSTRACT *–Electricity crisis in Pakistan is mounting day by day. From 2007 onwards, Businesses and consumers alike wonder each year if there will be enough electricity to go around. It continues throughout the year but the period of concern, referred to as times of "peak electric load", is a real threat as the demand for electricity exceeds the supply. Results are blackouts, crippling businesses and household activities within a sector, city, state, and unquestionably in entire region. Load management is the process of balancing the supply of electricity on the network with the electrical load by adjusting or controlling the load rather than the power station output. This can be achieved by direct intervention of the utility in real time. This paper discusses a management plan for distribution of electricity. The idea of the research is to create such a balance in the load distribution to avoid total shutdown in any region. Power is distributed in such a way that all users can at least enjoy basic household devices in all times of the day without the use of personal energy producing (generators) and energy storing (Uninterrupted Power Supply) devices. In this paper,systematic empirical investigation of data was performed. Moreover the disadvantages of alternative energy devices are explored and alternates are identified.*

Index Terms –Load Management, Load Shedding, Uninterrupted Power Supply (UPS), Generators, Peak Load Hour

1. INTRODUCTION

Energy resources and their availability are extremely significant for every country. Energy is considered to be an important component in the social, industrial, technological, economic, and sustainable development of any country. Among all forms of energy, electrical energy is regarded as high grade energy and has been the major driver for technological and economic development.

In the past 150 years or so, electricity has gradually evolved from a scientific curiosity, to an extravagance for the rich, to a modern requisite. You can't imagine living without electricity. The demand of electricity is increasing in every part of the world. Electricity plays a vital role in development and progress of any nation. As people tend to develop economically and socially, the first thing they require is electricity. Any single industry cannot run without electricity. Even small instruments of daily use consume electricity. From a wrist watch which tells you accurate time to an alarm clock which awakes you on specific time, all runs on electric current. Although the world has developed that much and importance of electricity is not furtive, still some countries in the world are facing blackouts. Pakistan is one of those where rolling blackouts are a common affair[1].

Blackout is the applied as a final tactic by an electricity provider to avoid a total breakdown of the power system. There are basically two major of reasons of a blackout: First is Inadequate Capacity to Generate and secondly the Insufficient Infrastructure for Transmission of Electricity from Power Plant to the Consumer [2].

Electric Load Management (LM) or Demand Side Management (DSM) is one of the obvious solutions to match demand with supply. It manages the peak load and reduces the power consumptions when generation capacity is not enough to meet requirements. The other reason for which demand side management is implemented is to reduce the cost of electricity production. Its cover all the technical and economic policies to reduce electricity consumption [3].

Alvarez elaborates the two ways to deal with the growing demand of electricity, "Supply-Side Policy" & "Demand-Side Policy" [4]. According to Alvarez, the supply side policy is to expand the power generation capacity in order to meet the increasing requirement of the country, i.e. installation of new power plants and up gradation of old ones. Otherwise changing the consumption behavior and reducing the needs, will make current capacity sufficient.

All the developed countries in the world are exercising extensive programs for reducing the demand of energy by increasing its efficiency and load management. These programs have played their part in reduction of the demand, hence fulfilling the objective. Industrial and domestic users both are using these policies for many years. This concept started in 1970s and gain popularity in 1980s. Since then all the countries are working on that in order to reduce their peak load. Since there are supply constraints in Pakistan as well, thus load management techniques can play a vital role here as well [5].

This paper is organized as follows: Section 2 discusses the Methodology of research; Section 3 presents the qualitative results based on public survey. In section 4, a new system is proposed for the effective use of load management. Section 5concludes theresearch.

2. RESEARCH METHODOLOGY

This study is a mixture of exploratory and explanatory research. It explains the load shedding problem of Pakistan, alternates used in this regard and load management techniques in details whereas explores the ways to handle that load shedding monster as soon as possible.

Since the study is qualitative and induction approach is used, thus the research is distributed into two parts. The first part was un-structured interviews and the second part was survey questionnaire which is discussed here in detail. The unstructured interviews were done with the personals related to the field to get the real know how of the system, its

condition and future. Detailed discussions were carried out with them in order to find the solution of the problem as well. Second part of the research was based on the research questionnaires. Through this part the information was collected from the people about load shedding, their alternative energy devices and its consequences on the basis of their life style.

3. EMPERICIAL STUDY BASED ON QUANTITATIVE ANALYSIS

A systematic investigation of statistical or numerical data is called Quantitative Research [6]. This research was conducted on the city of Lahore with the help of survey questionnaires.

The sample size derived should be 384. Thus Lahore was divided into different sectors so that the response from each part of Lahore can be achieved. 450 questionnaires were distributed from which 425 responses were received. 27 of them were either blank or were not properly filled, thus regarded as in valid. So the analysis was conducted on the remaining 398 questionnaires which were still 14 more than the required for reliable results.

TABLE I
QUESTIONNAIRES DISTRIBUTED

	Number of Questionnaires	Percentage
Distributed	450	100%
Valid	398	88.44%
Invalid	27	6%
Not received	25	5.56%

3.1 LOAD SHEDDING HOURS

The objective was to identify the number of hours for which people are not enjoying electricity. Questions were asked regarding that how much electricity shortage is faced by people. Research revealed that there are even people who are facing load shedding of 21 hours. On the other hand some people are enjoying electricity 24 hours. This shows that the amount of blackouts is not evenly balanced. Most of the people said that they are facing a blackout of 12 hours whereas the average blackout was calculated of about 14 hours a day (June 2014).

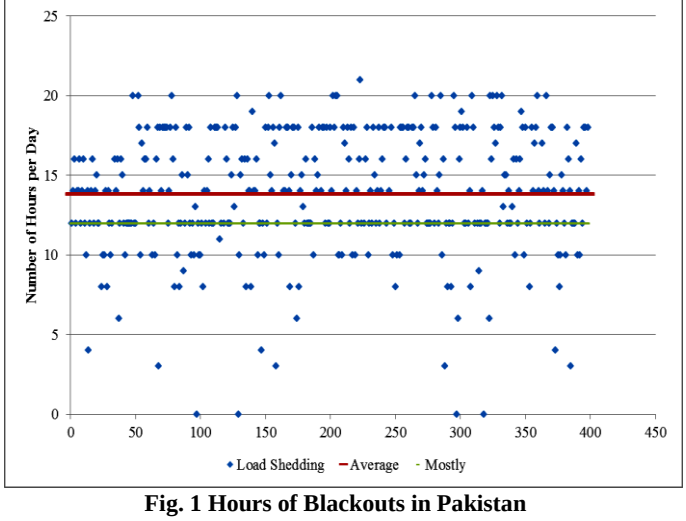

Fig. 1 Hours of Blackouts in Pakistan

3.2 TYPE OF ALTERNATE ENERGY SOURCES USED

The first objective was to identify that which source of energy people are using in the absence of electricity (Load Shedding). The idea was to find out that which device is used by people and of how much power.

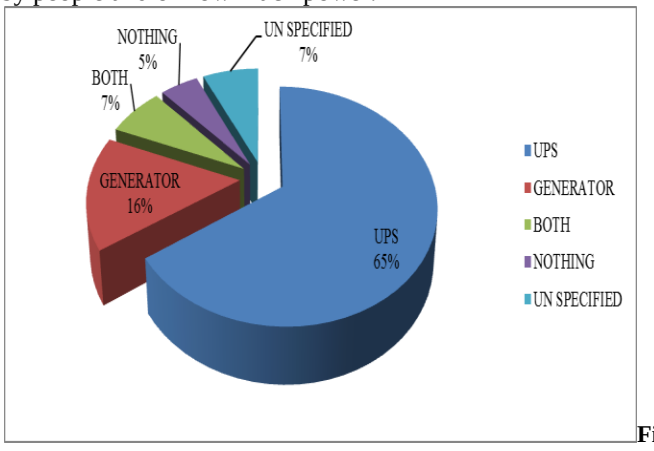

Fig. 2 Alternative Devices used by People

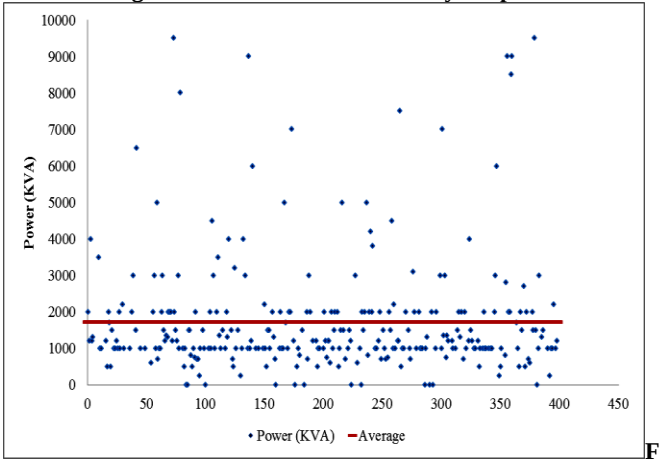

Fig. 3 Power of Alternate Devices used by People

3.3 RUNNING COST OF ALTERNATE DEVICES

Analysis showed that expenditures are double than even the cost of device is purchased to keep it in running position. The amount estimated for that is:

TABLE II: RUNNING COST OF DEVICES

	ANNUALLY	MONTHLY
UPS	74358.37	6196.531
GENERATOR	114200.1	9516.675
BOTH	303002.4	25250.2
COMBINED AVERAGE	163853.6	13654.47

3.4 DAMAGE CAUSED BY SUBSTITUTE DEVICES

As it is known that UPS and generators are not good for appliances, so the objective was to know the amount of damage they cause.

TABLE III
DAMAGE BY ALTERNATE DEVICES

Damage(PKR)	Frequency	Percentage
0	76	19.1%
1-1000	82	20.6%
1001-5000	97	24.37%
5001-10000	11	2.76%
10000+	59	14.82%
UNSPECIFIED	73	18.34%

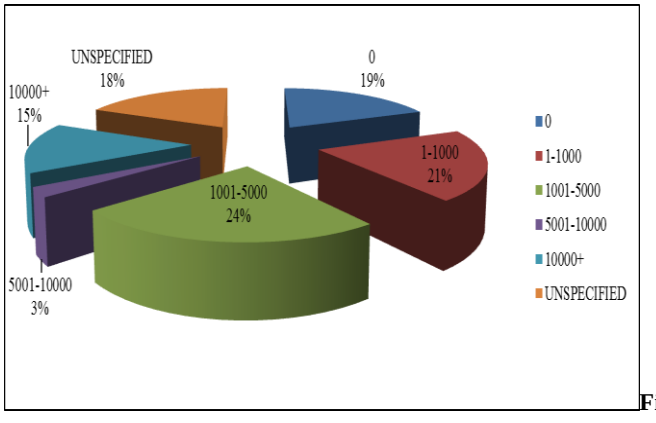

Fig. 4 Damage by Alternate Devices

3.5 PRACTICING LOAD MANAGEMENT TECHNIQUES BY USERS

There are some load management techniques which are advertised and implemented by WAPDA. The objective was to investigate that if people are implementing them or not

Table IV shows that what kind of lighting device is used by the people. Results shows that 50% of the population prefer tube lights

TABLE IV: TYPE OF FLORESCENT LIGHT

Type	Frequency	Percentage
TUBE	197	49.50%
ENERGY SAVOR	148	37.18%
BULB	20	5.02%
UN SPECIFIED	33	8.29%

Most of the people don't know where to set the temperature of air conditioner for cooling purpose. They believe that lower the temperature they set, shorter will be the time taken to reduce the room temperature. Study indicates that only 26% people know the optimal temperature to set the AC as shown in figure 5.

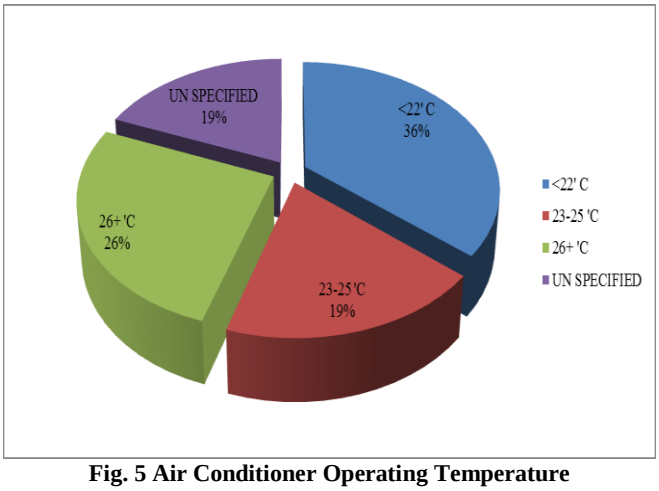

Fig. 5 Air Conditioner Operating Temperature

Table V depicts that very few people know that devices consume power while they are on standby, i.e. they are not completely off from mains [7]. Hardly 13% people switch it off from mains.

TABLE V: STANDBY APPLIANCES

	Frequency	Percentage
REMOTE (ON STANDBY)	313	78.64%
MAINS (COMPLETELY OFF)	50	12.56%
UN SPECIFIED	35	8.79%

In every region, there is some time of peak usage. In Pakistan peak hours are found to be between 7 pm and 11 pm. As shown in figure 6, only 18% people know properly about peak hours, its tariff and reduce their load in that time.

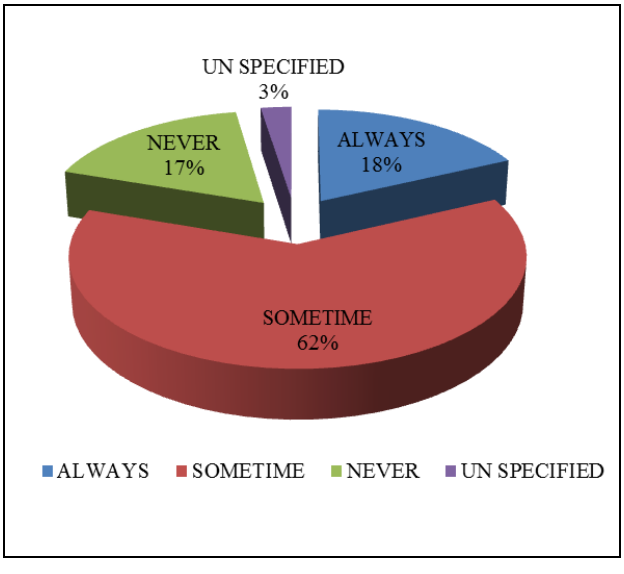

Fig. 6 Peak Hour Usage

4. PROPOSED SYSTEM

After going through the literature and in depth discussions with the technical personals, one thing is evident that rolling blackouts will not end that soon. It will take time and the people of Pakistan will have to bear them for at least 3 to 4 years. The discussions and studies also revealed that alternate methods are neither cheap nor efficient. Their output is way less than their input, thus adding the loss. On the other hand, they also carry the baggage of technical flaws with them which damage the appliances and add insult to injury [8].

Thus there should be a way out so that one should enjoy its basic right of electricity. Since the electricity in the country is not enough that everyone's demand can be fulfilled, so there should be a mechanism that everyone can at least run their basic appliances in all times of the day. The division of electric power should be done in a way that no region of the country would be in complete darkness. Thus using the load management techniques, a new load distribution system is proposed

The conventional way of load shedding followed by WAPDA now days is to shut down the electricity of certain area. In this way they cope with demand supply gap of electricity [9].

To attain the main objective that there shouldn't be any complete blackout in the region, it is proposed that the power is distributed in such a way that everyone can enjoy its basic needs of daily routine at all times. For that purpose, we divide the load into basic and other load. Basic mean that the appliances which are very mandatory in nature and people even use UPS devices to run them, i.e. lights, fans etc. Other means that all the other appliances operational in a house like Fridge, AC, TV, Microwave, Water Pump etc.

For partial load shedding, a device can be used for switching between main (other load) and secondary (basic load) line. Load shedding will be done though that device on the main line. No load shedding will be done on secondary line. Figure 7 shows a block diagram of that limiting device.

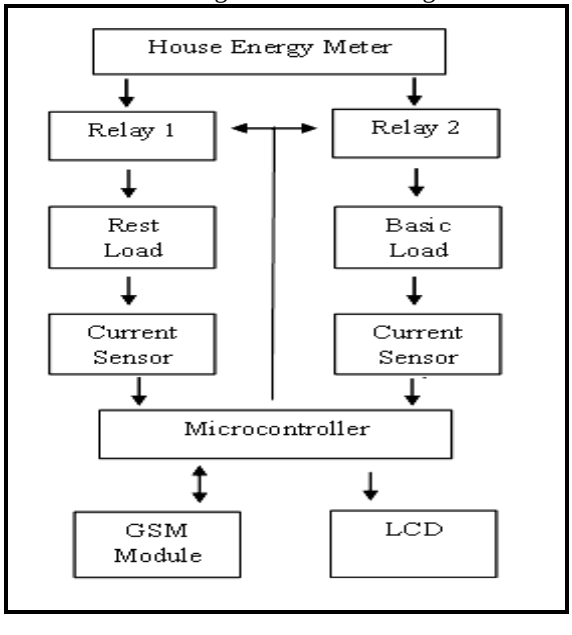

Fig. 7 Block Diagram of Limiting Device

The device will be connected after meter's output and house will get two types of supply. The device will act as a splitter and will split the supply in two parts, "Main Supply" & "Secondary Supply" as shown in Fig 8. The main supply will be connected to all the load of the house except the basic utilities whereas the secondary supply will supply the current to the basic utilities. The device will be nothing more than a relay circuit which will be controlled through the controller. The time of the controller can be preset, and can also be changed by GSM or by wireless technology.

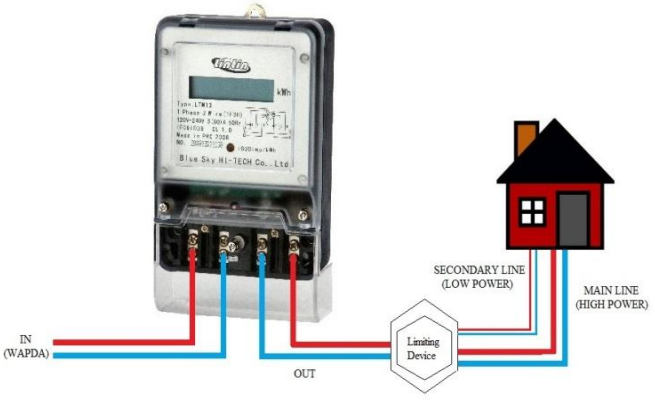

Fig. 8 Proposed System (With Limiting Device)

The idea is that the amount of electricity we waste in UPS charging should be conserved and supplied to the public in times of load shedding. In this way we can eliminate the alternate energy devices which are not only a burden to the pocket but also toxic for the appliances as well.

Furthermore, this system can be introduced within the new meters. Thus the meter will give two separate outputs and do the switching itself. Figure 9 shows how it will look-like.

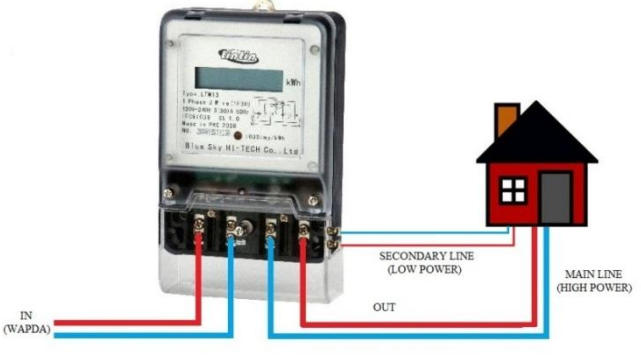

Fig. 9 Proposed System (with Self Switching)

This system will even be useful once when load shedding will end. In that scenario it will be used to reduce the demand in peak times which will reduce the load peaks.

5. CONCLUSION

In this rapidly developing world, electrical energy is a prerequisite for growth. Currently Pakistan is facing severe energy crisis. Alternate energy devices used in this regard are not only in-efficient but also a burden to national grid by themselves. People are not educated about the already implemented load management techniques. Different reforms should be adopted on priority basis in order to improve enforcement of load management techniques in electricity distribution system to reduce the frequent shutdowns.

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