iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 9 Issue: VII Month of publication: July 2021

DOI: https://doi.org/10.22214/ijraset.2021.37110

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 9 Issue VII July 2021- Available at www.ijraset.com

Demand Side Management Applied to a Sub Station for Energy Conservation

M. Anmisha[1], CH. Laxmi Srilekha[2], E. Reshma[3], M. Naveen Kumar[4], Dr. P. Ravi Babu[#5]
[1, 2, 3, 4]U.G Students, [5]Professor, Dept. of EEE, Sreenidhi Institute of Science and Technology

Abstract: Electrical energy is an essential ingredient for the industrial and all-round development of anycountry. The per capita consumption of electrical energy is a reliable indicator of a country'sstate of development. It has been estimated that there are two billion people who still lack electricity today and the world demand in developing countries is doubling every eight years. To meet this ever-growing demand, generating plants of all types are being installed.

Unfortunately, the sources of electrical energy are depleting and hence the gap between the supply and the demand is continuously increasing. Under such circumstances the only option left is optimal utilization of available resources. Initially in this direction Load Management and Energy Conservation methods were adopted to overcome the problems. But these two methods concentrate only on the problems faced by supplier alone and do not take into account the problems of consumer. To overcome this problem in 1980's, a concept of DEMAND SIDE MANAGEMENT has emerged and is being applied throughout the world. The concept of DSM has vital role in power system planning and management. The main idea of DSM technique is to discuss the mutual benefits for both supplier and consumer for minimum inconvenience. DSM is broader in scope than either Load Management or Energy Conversation. The need for Power System Planning and Management has increased enormously today. Resources crunch have made availability of power meagre to meet the demand. Powershortage is not only endemic in India but also in the world. as demand always lags with respect to supplya time factor also plays a role in bridging the gap between demand and supply. To bridge this gap the random load shedding is the usual method adopted by the supplier of electrical energy, which discourages the consumer's interest. To overcome this problem recently the concept of Demand Side Management technique has emerged and is being applied throughout the world. This paper deals with the DSM technique of Resized and Revised operation Schedule taking into consideration the load curve of a transformer. The increase in the energy efficiency of equipment is quantified in terms of Transformer Utilization Factor. A considerable increase in the energy efficiency and reduction in core losses has been observed. The work presented in this project gives the results of application of DSM technique to 33/11 KV substation in Palvancha. It has two incoming transmission lines and one 33KV outgoing transmission line and four 11KV outgoing feeders (Burgampadu, Velur, Nanprolu, Sompally). The study indicates the improvement in the energy efficiency of the system. In addition, the consumer also gets a small savings of reduction in the energy billdue to lowering of core losses/ iron losses.

I. INTRODUCTION

The most flexible, unsustainable and unavoidable form of energy in the recent times is electrical energy. It is a coveted form of energy because it can be generated centrally in bulk and transmitted economically over long distances. It has been a critical resource for all nation building activities, which keep the country's wheels on progress and economy to prosper. So, demand for electricityis on the ever increasing side. As this electrical energy can be easily converted into other forms of energy and ease of its control has led to the increase in demand in both the industrial and domestic sectors. Due to this over increase in demand for electrical energy the demand for high quality, reliable power supply has compelled the power engineers to focus their attention on the new technological developments in the power sector operation and improvement

Load management is designed to influence the timing and magnitude of consumer's use of electricity.This method mainly includes peak clipping during the system critical conditions, valley filling and load shifting. This load management includes the use of energy storage, load cycling and modification of process characteristics changing the pattern of demand. Energy conservation is concerned with those actions which reduce the total energy consumption. Examples of energy conservation include the use of more or better loss prevention method, better efficiency and the curtailment of activities to reduce the overall consumption of electrical energy. Load shedding is the procedure by which parts of power system are interrupted according to a predetermined schedule to prevent overall block out of the entire system due to overloading, without considering the inconvenience caused to the customer.

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 9 Issue VII July 2021- Available at www.ijraset.com

The methods discussed above will take care of the interest of the supplier side only without considering the problems of the consumers into account, which is not acceptable, because the ultimate aim of any advancement in technology is to satisfy the consumer. This has forced the power engineers to think of other innovative technological developments to meet the consumer demand either partially or fully, this led to much advancement in the power sector.

1) End Use Equipment Control
2) Load Priority Technique
3) Peak Clipping& Valley Filling
4) Differential Tariff
5) Re sizing Operation

II. CONCEPT OF DEMAND SIDE MANAGEMENT

There are several reasons why utilities manage demand through special programs. The entire nation became aware of the scarcity of fuel resources the 1970's. The Utility's reaction was the the introduction of Demand Side Management programs to over come all these problems. The concept ofDSM program in power systems is to bring both supplier and consumer around a common platform for effective utilization of available electrical energy with minimum inconvenience and maximum profits.

The first DSM program known together in conservation program was officially launched to the publicon September 20, 1993, the date coinciding with 109th anniversary of electrification in Thailand. Whatactually DSM means is a measure taken by utilities to influence the amount or timing of customer energy demand in order to utilize scarce energy resources most efficiently.

To manage energy demand utilities offer DSM programs. These programs try to shift electrical demand from peak to off peak hours. DSM strategies fall into five categories. These categories are

1) Energy efficiency
2) Conservation
3) Load management
4) Fuel substitution
5) Load restriction Examples of DSM programs in each of the categories are listed below.

A. *Energy Efficiency*

1) Cash incentives offered to consumers for purchase of efficient appliances.
2) Cash incentives offered to customers for efficient building construction.
3) Energy audits, surveys, seminars and publications.
4) Advanced technology demonstrations.

B. *Conservation*

1) Incentives and rebates for use of alternative energy appliances or equipment.
2) Conservation incentives.

C. *Load Management*

1) Time of use rates
2) Load shifting incentives.
3) Interrupt able service options.
4) Customer emergency generation incentives.

D. *Fuel Substitution*

Fuel substitution incentives.

E. *Load Restriction*

Direct assistance programs. From supplier's point of view DSM includes those supplier activities that are designed to influence consumer so as to use electricity and to achieve a desirable system loadshape. To achieve these objectives supplier can offer the following to the consumer.

1) Differential Tarrif.
2) Penalty for crossing max demand.
3) Higher changes for higher slabs of energy consumption etc.From consumer's point of view DSMincludes the activities, which are carried out by consumer.

a) To increase off-peak use of electricity better utilization of electricity.
b) Better utilization of available power.
c) Rescheduling of loads etc.

DSM program focuses on the actions that change the load shape, so that the consumer demand forelectricity can be met more efficiently. Within this context five broad categories of load shape objectives can be distinguished as listed below.

- Peak Clipping
- Valley Filling
- Load Shifting
- Strategic Conservation
- Strategic Load growth

III. DRIVING FORCES BEHIND DSM

The concept of Demand Side Management in power systems [1] & [2] is gaining momentum worldwide and presently it is developing very rapidly. The causes for this are

1) The rate of generation of electric power is not at all meeting the present day requirements.
2) The continuous rise in the cost of electricity.
3) Activities by consumers to gain more control of their electricity bills.
4) Environmental barriers to site new generating plants.
5) Huge capital investment for building new generating plants. Since the demand for electricity is expanding as well as DSM concept is gaining momentum, it is expected that in near future both supplier and consumer will make better use of DSM techniques to deal with these factors.

A. *Benefits From DSM*

In 1978, the Public Utility Regulatory Polices Act (PURPA) was enacted to address energy issues. This act directed state public utility commission to consider the most effective use of utilities generating power. An example of rate structures are time of day rates and allow utility to generate electricity more cost effectively and and efficiently and reduces traffic on the transmission and distribution system. Most importantly shifting load prevents utilities from building new generating facilities to meet peak demand. Most DSM programs are planned in an integrated resource planning frame work in which utilities compare the benefits and costs of DSM with the cost of additional generation. DSM in power systems involves a mutual understanding between consumer and supplier. For these consumers and suppliers can act with mutual consultation to alter the pattern of demand on consumer side and hence that on the supplier side. The benefits derived from DSM can be either short term or long term. From the consumer's perspective, the benefits are

1) A better quality of supply in terms of voltage and frequency.
2) There is a great reduction in unscheduled interruptions.
3) There is a considerable reduction in energy bills.
4) Helps to maintain lifestyle.
5) Helps to smoothen load shape.
6) Reduced production cost. (as for as industrial consumer is concerned)

From the Supplier's perspective the benefits are

a) Load shape benefits derived from DSM alternatives which prove valley filling and clipping ofpeak, shifting of Loads to off-peak hours etc.
b) Strategic conservation to reduce demand for power as well as energy.
c) Reduced capital investment, operating costs and use of critical fuels

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 9 Issue VII July 2021- Available at www.ijraset.com

d) Improved system efficiency
e) By avoiding unscheduled outages, a continuous supply will be provided.
f) A reliable and better quality of supply in terms of Voltages magnitude and frequency will beprovided from supplier.
g) Energy efficiency of the supplier's equipment i.e, transformers in terms of load factor andtransformers utilization factors are improved.

B. Scope Of The Present Work

The present work is based on the application of only a few DSM techniques. For this purpose, a local major industrial consumer having various categories of loads has been considered. Existing power consumption pattern has been recorded prior to the application of DSM techniques. From this load pattern, it is observed that the power consumption is beyond permitted maximum demand during some hours of the day and also there are deep valleys during certain other hours. Thus, load curve is found to be highly uneven, which is undesirable from both supplier as well as the consumer point of view. Load curves with production schedules for a period of six days, including the typical day which recorded the maximum demand for that particular month are collected from the industry. For such load pattern, DSM techniques have been applied. The priorities of various sections of loads are identified in consultation with the the concerned superintendents. Software has also been developed in'C language in graphics mode illustrating the modified curves along with the results. The improved load curve is highly desirable feature from supplier's point of view. Even, the consumer will be happywith the improved load pattern because his maximum demand charges are reduced, quality of supply is improved and life style is maintained. In addition, the supplier's equipment efficiency i.e., transformer is also very much improved after re-sizing operation.

IV. TECHNIQUE ADOPTED FOR CASE STUDY

A. Introduction

Selection of most appropriate Demand Side Management techniques is perhaps the most crucial question both the supplier and the consumer face. The problem is difficult since the number of available DSM techniques from which to select is so large. In addition, because the relative attractiveness of alternative techniques depends upon specific utility characteristics such as load shape, peak demand, duration of peak, consumer mix, load characteristics etc. The one of the DSMtechnique is re-sizing operation.

B. Resizing Operation

It is a well known fact that any electrical equipment will have maximum efficiency near its rated capacity and will have relatively low efficiency under lightly loaded condition. It is not advisable to keep any electrical equipment in the system with low load on it. In this case study it is observed that there are three large capacity transformers one of 950kVA and two each of 500kVA which are also 27working under lightly loaded condition giving rise to inefficient operation. It is suggested to resize therating of lightly loaded transformers by replacing two 500kVA transformers with three transformers of 250kVA, 100kVA and 50kVA. The improvement in the efficiency of the transformers is indicated in terms of Transformer Utilization Factor (TUF) as given in equation (3.2)

V. TERMS USED

The energy of the supplier equipment i.e. transformer has been quantified in terms of Load Factor ofconsumer and the Transformer Utilization Factor as given in equations (3.1) & (3.2).

Load factor =Average load / Maximum load in a given period (3.1) TUF = Actual energy delivered by the transformer in one hour/Energy that the equipment can deliver had if it had been loaded equal to its rating (3.2)

Transformer Utilization Factor is directly proportional to the energy delivered. This implies higher the Transformer Utilization Factor greater is the energy delivered and hence increased energy efficiency of the system in terms of energy delivered. The L0 Transformer Utilization Factor of power transformer is calculated each hour.

The DSM Technique involves the following steps

1) Substation loading data.
2) Data Analysis.
3) Application of DSM technique.
4) Payback period
5) Rate on InvestmentF.

A. *Substation Loading Data*

Table shows the loading data of the three Power Transformers on a particular day for 24 hours asobtained from the substation daily log sheets.

Time in hours	Load current in Amps	Time in hours	Load current inAmperes
00-01	243	12-13	150
01-02	243	13-14	206
02-03	230	14-15	170
03-04	170	15-16	105
04-05	170	16-17	80
05-06	205	17-18	120
06-07	158	18-19	170
07-08	208	19-20	190
08-09	170	20-21	193
09-10	130	21-22	197
10-11	130	22-23	153
11-12	120	23-24	153

Table 1. Load Data of a Sub Station

B. *Data Analysis*

Defining a new term called 'Transformer Utilization Factor' does the analysis of this data, and theenergy efficiency of the system has been quantified in terms of this new term. TRANSFORMER UTILITY FACTOR (TUF) .

The load current at every hour for a week is taken and calculation of TUF is carried out as given in equation (4.1).

TUF= Rating of the transformer in MVA for each hour V3xVoltage on LV side x Current on LV side100

Transformer Utilization Factor (TUF) can be defined as "The Ratio of Actual Energy delivered by thetransformer to the energy that the equipment can deliver had it been loaded with a constant load equalto its rated capacity for a selected period, say 24 hours. TUF is directly proportional to the energy delivered.This implies higher the TUF greater is the energy delivered and hence increases energy efficiency of the system in terms of energy delivered. The TUF's of all the three power transponders are calculated in each hour. The Transformer Utilization Factor of the Transformers is calculated using the data and formula fromequation 1. The TUF of the transformer for each hour of operation has been calculated and tabulated in table 2

TUF = ($\sqrt{3}$ *Voltage on LV * Current on LV) / (Rated VA of LV Transformer)

Time inhours	TUFB	Time in hours	TUFB
00-01	55.50	12-13	34.25
01-02	55.50	13-14	47.03
02-03	52.50	14-15	38.81
03-04	38.81	15-16	23.97
04-05	38.81	16-17	18.26
05-06	46.80	17-18	27.40
06-07	36.07	18-19	38.81
07-08	47.50	19-20	43.38
08-09	38.81	20-21	44.06
09-10	29.70	21-22	45.00
10-11	29.70	22-23	34.93
11-12	27.40	23-24	34.93

TUF before DSM

- *Observations:* From the TUF calculations it is observed that the utilization factors of Power Transformers are very low indicating that the energy capacities of transformers have been utilized to a low extent. This low capacity utilization is because of iron losses and hence higher cost of operation. From the calculation of TUF it is seen that the transformers are loaded unevenly throughout the day and hence the TUF arcless than 50% for most of the time and also from data collection it is seen that the transformers are connected throughout the day (even though they are lightly loaded). That means core losses are being supplied throughout the day,irrespective of the load on the powertransformer and hence the energy efficiency of the system is poor.Thus there is a lot of scope for improving the energy efficiency of the system .And this is done by the DSM technique adopted without affecting the quality of supply to the consumers.

C. Application of DSM Technique

The DSM technique selected is "Re sizing & Revised Operation Schedule (R&ROS). Instead of having one high capacity transformer, two or three transformers of low ratings are suggested to be installed. This Re sizing & Revised Operation Schedule helps to load each transformer to its ratedcapacity, when- ever it is connected, resulting in higher energy efficiency.

The following suggestions are made by DSM for the power transformer.

Instead of having one 10/16 MVA Transformer. Three transformers each of rating 40 MVA, 10 and 10 MVA respectively are suggested to be installed. For the given load pattern on these transformersthe Revised Schedule of Operation is suggested below.

00 hrs - 03 hrs - [40+10+10] MVA Transformer to be connected.03 hrs - 09 hrs - [40+10] MVA Transformer to be connected.

09 hrs - 13hrs - 40 MVA Transformer to be connected

13 hrs - 24hrs- [40+10] MVA Transformers to be connected

Based on the above suggestions TUF have been recalculated for each of the re sized transformers asexplained earlier and have been tabulated in table 3.

Table3 . TUF After DSM

Time in hours	TUFA
00-01	92.60
01-02	92.60
02-03	87.06
03-04	77.73
04-05	77.73
05-06	93.73
06-07	72.24
07-08	95.11
08-09	77.73
09-10	74.30
10-11	74.30
12-13	85.73
13-14	94.20
14-15	77.73
15-16	48.00
16-17	36.58
17-18	54.84
18-19	77.73
19-20	86.87
20-21	88.25
21-22	90.00
22-23	69.96
23-24	69.96

D. Core Losses

The reduction in core losses is given as the difference between the actual transformers used before re sizing operation and the transformers are used after re sizing operation.

Power losses that is core losses in the power transformer before DSM technique are 7, 77,600 kWh per year, after resizing the power transformer the core losses are 466560 kWh per year. Therefore total energy savings or reductions of core losses after DSM technique are 311040kWh per year and the core losses are reduced to 40% and TUF are improved to maximum extent.

E. Payback Period (PP)

Payback period is normally defined as the ratio of capital investment to net returnsPayback Period= A/ (C*D-B)
A=Capital cost of energy conservation equipment including installation ChargesB = Annual operation cost
C = Annual energy savings in kWh per year D = Projected energy price per kWhD=Projected energy price per kWH
A = Rs.98, 00,000;B = Rs.20, 000;
C = 311040;D = Rs. 6.
Payback Period (PP) = 5 years and 4 months

F. Rate on Investment (ROI)

Rate on Investment is defined as the ratio of Net annual returns to Capital investment ROI= (Net Annual returns *100) /(Capital Investment)
=18.835% per year
A=Capital cost of energy conservation equipment including installation ChargesB = Annual operation cost
C = Annual energy savings in kWh per year D = Projected energy price per kWhD=Projected energy price per kWh
A = Rs.98, 00,000;B = Rs.20, 000;
C = 311040;D = Rs. 6.
Payback Period (PP) = 5 years and 4 months

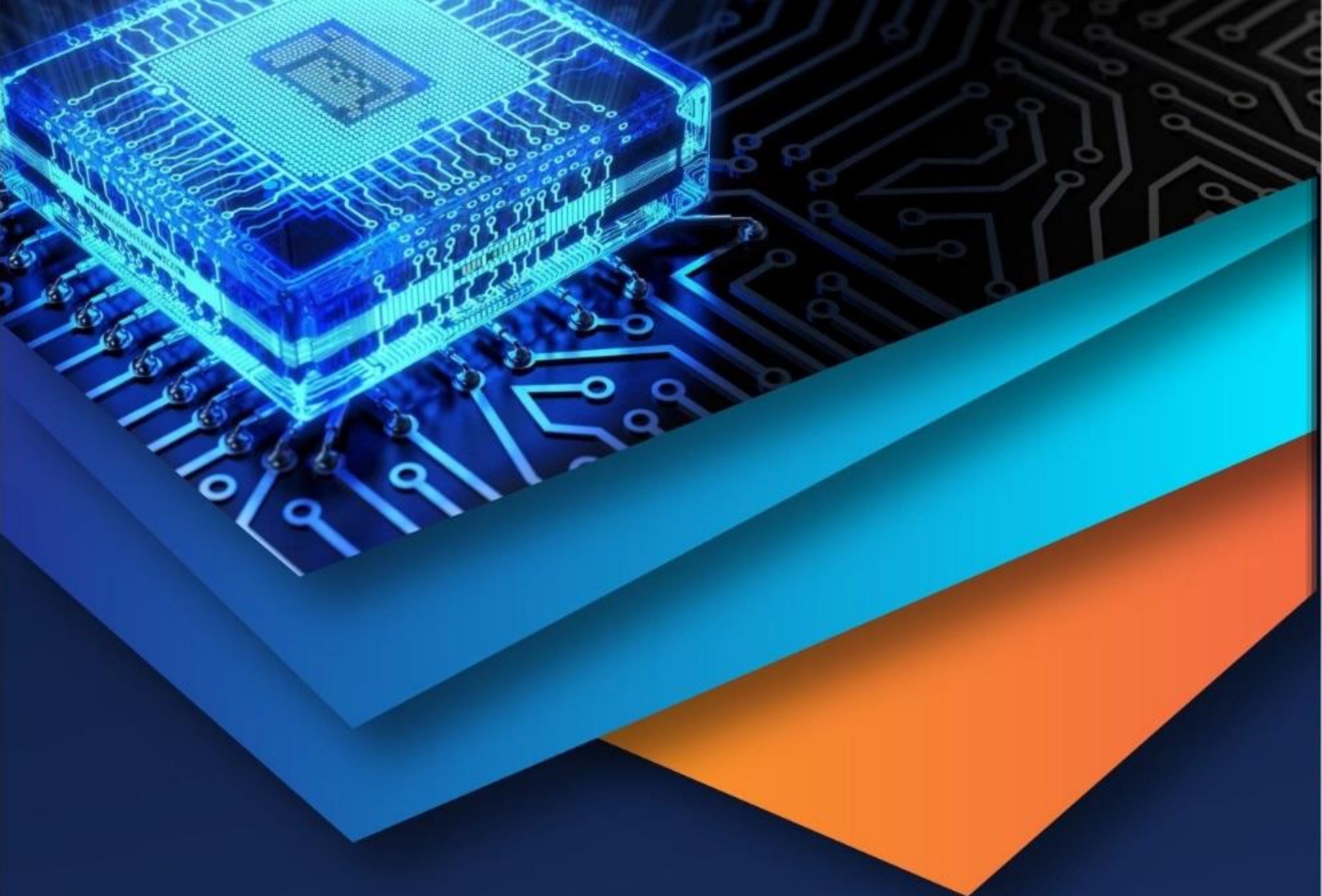
VI. CONCLUSION

Electrical energy is inseparable from economic development and social transformation particularly for a developing country like India. Electrical energy conservation or saving has been considered as electrical energy produced.

Therefore the conservation measures to be accepted and implemented require concerted efforts by many groups in the country. Government industries, associations, and individual consuming industries for their implementation require decisions and actions; electrical energy conservation is dispersed andrequires widespread adoption. The TUF for re sized transformers is more than double for most of the times and the equipment is utilised to maximum extent and core losses has been reduced to 40% and the system is operated more efficiently, the drawback in the technique is additional investment on automatic switch gear protection.

REFERENCES

[1] C .W.Gillings,the concept of DSM for Electric Utilization, Proc. IEEE. 73 (101,1468-1470,Oct1985).
[2] R.M.Delgado, Demand Side Management Alternative, Proc IEEE 73 (!0), 1471-1470, Oct 1985.
[3] K L Lo, Y.K. IEE Proc on Generation, Transmission and Distribution,Risk assessment to loaduncertainty in the competitive supply industry, 2002, pp. 573-582.
[4] P.Ravi Babu,S.F.Kodad , B.V.Shankar Ra, Application of Expert System for Demand side Management. Case Study , Proc INtern, Conf. on Computer application in Electrical EngineeringRecent Advancers, IIT Roorke, pp. 543-547.



doi crossref

10.22214/IJRASET

INDEX COPERNICUS

45.98

ISRA JIF

IMPACT FACTOR: 7.129

TOGETHER WE REACH THE GOAL

IMPACT FACTOR: 7.429

ISI

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY