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Energy Saving by Chopping off Peak Demand Using Day Light

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Abstrak

Teknik kecerdasan buatan diimplementasikan dalam penelitian ini menggunakan data waktu-nyata untuk menghitung energi yang dapat dikurangi saat beban puncak. Hasil yang didapatkan berbasis data waktu-nyata yang didapat dari pusat pembagian daya. Data ini merefleksikan kondisi terkini terkait daya dan solusi untuk kondisi kritis pada saat periode beban puncak. Hal ini dilakukan sedemikian rupa sehingga membantu dalam penjadwalan beban yang adil. Penjadwalan beban berdasarkan waktu telah dilakukan sebagai kriteria dasar dalam memecahkan krisis daya selama periode puncak di pagi dan sore. Ketersediaan sinar matahari dan persentase beban yang akan menggunakan teknik day light saving (DLS) telah dimasukkan dalam perhitungan. Hasilnya menunjukkan bahwa sekitar 0.5% hingga 1% beban dapat dihindarkan pada saat periode beban puncak sehingga mengurangi permintaan daya pada waktu tersebut. Hal ini juga berarti bahwa sejumlah energi dan biaya nasional telah diselamatkan. Hasil ini dapat ditentukan secara bulanan dan bahkan harian. Dengan demikian teknik DLS dapat memberikan keuntungan dalam penghematan energi.

***Kata kunci**: Penghematan Energi, Cahaya Siang, Jam Siang Hari, Beban Puncak*

Abstract

An artificial intelligent technique has been implemented in this research using real time data's to calculate how much energy can be chopped from peak load demand. The results are based on real time data that are taken from power delivering centers. These data's do reflect the present condition of power and a solution to those critical conditions during the peak period. These are done in such a way such that helps in judicious scheduling of load. The time based load scheduling has been done so as to understand the basic criteria for solving power crisis during morning peak and early evening peak. The sunray availability and percentage of load that will use day light saving (DLS) technique has been taken into account in this work. The results shows that about 0.5% to 1% of load can be shedded off from the peak load period which otherwise is reduction of power. Thus it otherwise also means that an equivalent amount of energy is saved which amounts to a large saving of national money. This result is obtained on monthly and even daily basis. Thus this paper justifies DLS gives a new renewable technique to save energy.

***Keywords**: Energy Saving, Day Light Saving, Day Light Hour, Peak Demand*

1. Introduction

The main objective of any power distribution system is to ascertain that minimum loss has incurred while distributing power to the end users. For countries like India it is an important requirement for ascertaining good quality power. It is also true that existing systems never meet up such requirement. Therefore to keep in pace with the rapid industrialization in India, it is necessary to develop a system which can take care of such need, without interrupting power.

Our earlier research work had concluded that chopping of peak demand can reduce load at peak hours, thereby reducing the necessity to shed off load indiscriminately and also not to setup new power plants. This process could be achieved by judicious scheduling of loads during day time, by shifting these identified loads from peak hours to off peak hours. One of the reasons for using this technique is that our country is vast, stretching from west to east [1].

Sun's rise time and set time do differ by an hour or more from far East to far west. This time period is of utmost importance for us. This is the time span when we can hire power from western side to eastern side or vice versa and also remove few loads during peak hours in

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eastern side or western side, thus reducing the overall peak demand at peak hours. This method is said to be as day light saving (DLS) technique [2].

The removed loads can be fedback after the peak load period by saving energy and at the same time reducing the indiscriminant power cut to some extent. The entire system has already been proposed and designed as per the requirement by the current power delivering centers. In this paper, real time data has been used to actually find out how much energy could be saved or chopped off so as to ascertain uninterrupted power supply. Ultimately the peak hour load demand could be reduced, just by implementing the process of judicious scheduling of loads in such a way that it dose not hamper the existing setups or neither proposing any costly methodology [3].

This paper show how developed software can reduce peak demand using real time data. The mathematical approach is based on fuzzy basiean technique which takes cares of all the parameters and hence develops a robust yet flexible energy management system where the user just inputs the present power scenario and what outcomes is a saving of energy by either reducing loads or hiring energy from a far off state there by shifting the peak demand by a considerable amount. In our earlier paper, this technique has already established, but in this paper we have used real data's to find out its acceptability. We found that the results are promising as a new renewable energy saving technique.

2. Factors to be Considered for Application of DLS Technique

The majors factor that should be kept in consideration before applying DLS Technique [2] are availability of sunray, month of a particular year, type loads, percentage of the load that could be applied with DLS technique, and whether a region can participate in this kind of application which can be determined as per results obtained from the execution of algorithm.

Table 1 shows the availability of sunray in India for a period of one year. It is shows that DLS technique is ideal in such regions or countries where total solar day light hour is available for 6 to 8 hours. Availability of sunray depends on these following factors [4], thera are surface azimuth angle (γ), solar declination angle (δ), solar time (E), angle of incidence (θ), and slope (the angle between the plane surface in question and the horizontal). Thereby all these parameters are related by the following equation.

$$\delta = 23.45 \text{ Sin } [\underline{360}(284+n)]; \quad (1)$$
$$365$$

where n = day under consideration.

$$E = \text{standard time} + 4(L_{st} + L_{loc}) + E \quad (2)$$

Therefore number of daylight hours is calculated by

$$N = \frac{2}{15} \cos^{-1}(-\tan \Phi \tan \delta); \quad (3)$$

Thus applying these formulas we can calculate the total available solar daylight hour. Thereafter depending upon the result and the considered day in a given year we have indeed set the factor by which the loads that could be brought under DLS technique. We have found that 6 to 8 solar daylight hours are required for such DLS technique implementation for energy saving or peak load calculation.

Table 1. Day light in India

Month	Average Sunlight (Hours/Day)	Month	Average Sunlight (Hours/Day)
January	7.6	July	5.6
February	8.6	August	6.2
March	7.8	September	7.5
April	9.2	October	9.4
May	8.1	November	9.5
June	6.4	December	8.0

2.1 Types of load

Loads which are considered for application of DLS technique are generally agricultural, commercial, domestic, and public lighting loads. Application of DLS technique is percentage of these loads are removed from the peak demand by judicious scheduling and prioritizing the loads and only a percentage of these loads are considered for the purpose [3]. These loads contribute a major portion in peak demand but less priority compared to industrial or traction loads. These loads can be taken off during morning or evening peak hours and restored back after the peak period. In this way the problem of shutting down all major loads without proper scheduling will be avoided. And last but not the least, only a percentage of the loads are affected.

2.2 Percentage of load to be considered for DLS

The percentage of load is decided by the factor of availability of total solar day light hour and factors under consideration as given on the Table 1. Depending upon availability of solar day light hour, percentage of load sharing is considered for DLS. The percentage varies from 0.1% to 0.5% depends on type of load, region on the globe, season, priority, availability of sun ray, and other factors like festive season or examination time. Load distribution as shown in Table 2 is best fit for India per the condition or requirement detailed above. System takes care of load, season and region under consideration. The load percentage shared is utilized and a calculation on real time data for the year 2009-2010.

2.3 Data of two states: Punjab and West Bengal

Power data of the region with geographical positioning at Latitude 30°4`N and Longitude 75°5`E of the State of Punjab in far west is listed in Table 3. Data of the region with geographical positioning at Latitude 23°00`N and Longitude 87°00`E, as listed in Table 4, is the state of West Bengal at far east of India [5], [6].

Table 2. Load distribution on DLS technique

Month	Available Solar day (hour)	Agriculture Load (%)	Commercial Load (%)	Public Light (%)	Industrial Load (%)	Domestic Load (%)
January	7.6	4	4	2	3	3
February	8.6	4	3	3	3	3
March	7.8	3	2	4	3	2
April	9.2	2	2	4	2	2
May	8.1	2	2	5	2	2
June	6.4	2	2	4	2	2
July	5.6	3	3	3	3	3
August	6.2	4	4	4	3	4
September	7.5	4	4	3	3	4
October	9.4	3	2	3	4	3
November	9.5	4	3	2	3	4
December	8.0	4	3	2	4	4

Table 3. Power data of Punjab

Peak Demand (MW)	Peak Generation (MW)
6162	5256
6506	4957
7762	5598
8457	5815
8292	4998
7688	5536
7335	4802
5179	4654
5042	4352
5388	4549
5179	4359
6097	4572

Table 4. Power data of West Bengal

Peak Demand (MW)	Peak Generation (MW)
5270	5197
5162	4995
5051	5036
4979	4892
5339	5264
5330	5318
5386	5368
5095	5095
4694	4656
4656	4632
5056	5056
6094	5963

3. Research Method

An algorithm has been developed based on Fuzzy basiean synthetic method to predict, calculate, and determine the exact amount of peak power demand which can be chopped or saved. Data used for share of power or to reduce peak demand are for the regions of West Bengal or Punjab which are two region lying in far east and west of the country. Two states or regions are apart by about one hour, time sun rises locally. The power demand and generation pattern are almost same or nearly same [7] – [10]. Both regions also have similar power pattern during peak hours. Hence the algorithm takes care of all aspect and then determines how to chopp the peak demand and reduce the power stress in these peak periods. Certain aspects like geographical distance, available solar day light hour, peak period power pattern, tarrif, human habits of energy usage, working hours and system configuration has been taken into consideration. This method chopps off peak power demand 1% to 5% of peak demand by a great amount of energy is saved. The algorithm of research method is written below.

```
/*45 mins before minimum sun rise time of all the states, predicted demand of all
states are found out using fuzzy synthetic evaluation*/[5]

Start
For j=1 to n
Enter parameters of the state Sj
dpj = Average of values of all parameters
Enter evening peak of last day
Stop

/* If a state wants to borrow power from other states, it creates a matrix with
other states and itself as alternatives and ratio of power offered by power
required, geographical proximity and tariff as columns*/

Start
For i =1 to n
45 minutes before sun rise time of state Si
For j=1 to n
Enter demand and generation in dj, gj
/* Set the first column as follows*/
If j==i then
prj = decrease of load by applying DLS/power reqd.
else If dj< gj
prj =(gj- dj)/power required
else
prj= 0
end if
/*Entry of fuzzy values for geographical proximity
and tariff*/
Enter value in vgj and vtj
smj= prj+vgj+vtj
j=j+1
Stop
max=0
ind=0

Start
For j=1 to n where j!=i
if max < smj
max= smj
ind=j
end if
j=j+1
Stop

/*max gives the best option to take power and ind indicates the state number. If
one state is unable to provide all the power required then the process of
selecting sum can be repeated every time omitting the provider states one by one
and decreasing the value of power required each time by the power provided in

a step*/
i=i+1
Stop
End
```

Therefore it is very important that DLS technique be implemented between these two states and therefore amount of energy saving or reduction in peak demand can be calculated which happens to be our ultimate goal. Using the above data we have found out conclusive result which shows that using DLS technique peak power demand has been reduced considerably between two regions of India.

4. Results and Analysis

Figure 1 shows the reduction in peak demand of the region on far west of India (Punjab). This region has been applied with DLS technique on loads like agricultural, public lighting, commecial etc. This figure shows a shift in peak demand by about 50 to 80 MW. This amount is achieved by applying the proposed method DLS Techinique on the data which were collected from the load despatch centers in India on 2009-2010.

Figure 2 shows the condition of the state which lies in the eastern part of India (West Bengal). The red dashed line is the actual demand, which is more than the generation available shown by the blue dashed line. After applying the said method DLS Technique, the peak demand has reduced considerably.

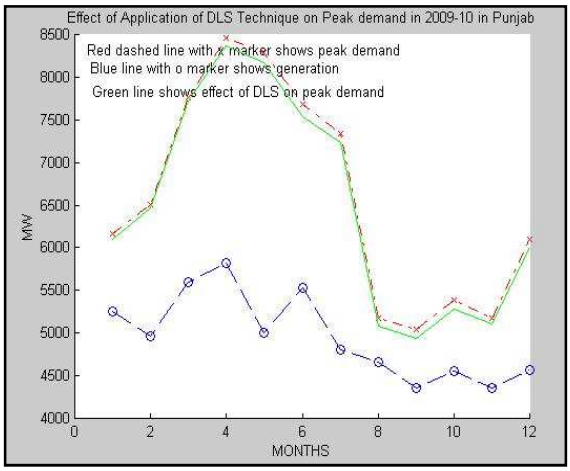

Figure 1. Reduction in peak demand after applying DLS technique in Punjab

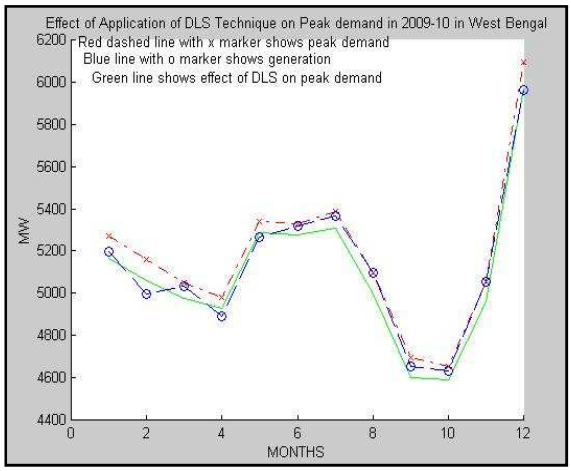

Figure 2. Reduction of demand by application of DLS technique in West Bengal

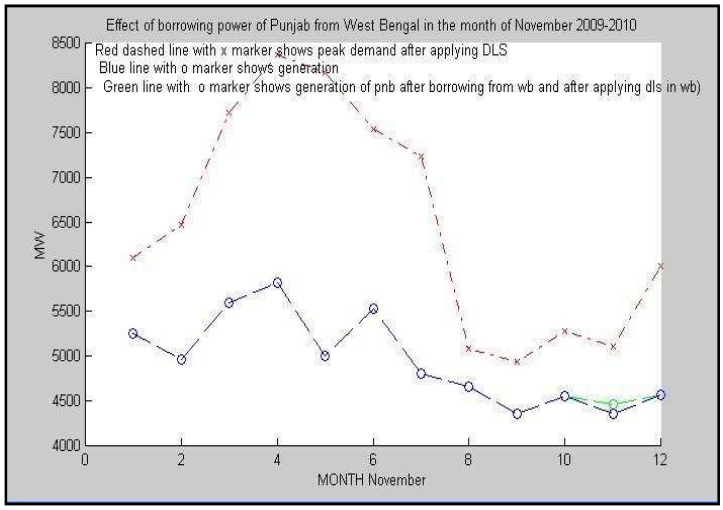

Figure 3. Reduction in demand in West Bengal with excess generation was shared to Punjab

The peak demand and generation data of both the states has been considered and used by fuzzy basiean technique for the proposed method for chopping peak power demand reduction. It is eveident that there is a reduction of peak power demand by about 100 MW on an average. Now as the generation is more than demand, hence it is easy to share power with the state which is in need of power lying in the far west.

Figure 3 shows the effect of DLS on the overall situation of the region in the far west. It shows that power is shared between the two states or regions under consideration. Since the Figure 2 showed excess generation of power for the state in east, therefore the excess power can be transmitted to the state lying in western side which have high peak demand and needs to be reduced. Initially the demand is reduced by applying DLS technique on different loads, locally thereafter the excess power is borrowed from the state in the east. By this the generation level increases. The amount is about 50 to 100 MW approximately on daily basis.

5. Conclusion

The results shows that application of DLS for real time data of power generation and demand the peak demand of the two states for DLS has been found to reduce and effective to share power between the two regions or states under consideration. It gives a concrete result based on data for the year 2009-2010 and power have been shared effectively on November. The amount of power that was saved varies between 50 to 100 MW which is equivalent to 2.2% of the generation in the November. Thus we conclude that DLS technique is an effective measure in chopping peak demand and saving energy about 1 to 2% of 50 to 150 MW. If this amount is calculated for a year, the amount of revenue genarated is great importance to any region in short of power. These results are for a year and effective on any one month. This technique has already further implemented on mothly basis.

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