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Energy Optimization and Power Stack Shed Reduction of Oil Depots by using Renewable Energy Resources

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Abstract: Most of the industries including the oil sector are looking forward towards the renewable energy resources with proper energy management system (EMS) as it is the need of time. For this purpose, solar and wind energy are the renewable energy resources, which are obtained from natural resources and produce clean and environment - friendly electrical energy and can be used for oil depots. The proper utilization of solar and wind energy from natural resource may result in economical and cost-effective EMS. In the proposed research work, an effective energy management demonstration is delivered to ensure the ceaseless flexibility of power. Furthermore, reduction of production per unit cost to the oil sector industry by utilizing multiple objectives streamlining. In the proposed oil depot, connected loads are divided into Shiftable and Non-Shiftable loads and then apply Branch and Bound Algorithm (BnB) with binary integer linear programming (BILP). By using the BnB technique, selected shiftable loads are shifted to the low cost energy resource automatically and resultantly, we get the low price unit cost and continuous power supply. Simulation results for the above-mentioned research work are performed on MATLAB. The proposed technique helps to reduce the power stack shedding issue as well.

Keywords*: Energy management, Multiple objective optimization, Branch & Bound algorithm, Binary integer linear programming*

I- INTRODUCTION

Electrical Energy plays a major role in economy of any country. For this purpose, oil industries sectors are required continuous electricity to store and to dispatching the products across the country. Oil depots has different types of loads in which, Product Pumps load, Fire Water pumps house load, Area lighting load, Admin building load, Control room and Gantry load as well. These types of loads are including non-shift-able and shift able loads is including Fire Water Pump pumps loads. Presently the Power generation in Pakistan is by four methods. Power generation by Thermal Energy is 62%, Hydel Energy is 25.8%, Nuclear Energy is 8.2%, and renewable energy 3.9% Cumulative energy production of Pakistan is 22,700 MW [1]. The shortage is approximately 3,000 MW.

Currently, demanding percentage is 12% rising every year. Per unit cost of Supply rate is increasing 7% to 10 %. Different types of power losses are also the effect on supply to receiver end accordingly and its losses percentage is 18%. Main consumer of power consumption is residential areas and its used electricity is approximately 48% of total power generation, industrial load is approximately 27%, Rural areas including agriculture load is approximately 9%, other government & commercial sector load is approximately 8% [1]. There are many types of loads but We differentiate in to two parts. First is Shiftable load and second is Non Shiftable load. Shiftable loads will be shifted from peak hours to off peak hours and low price per unit cost electricity source shall be charged. Non shiftable loads could not be shifted from peak hours to off peak hours. This system will help to optimize with respect to the per unit cost. Various improvement techniques are used like Target network and related tools to solve the energy problems of selected system [2]. Main target of this research is "receiving side OEM and minimize the per unit cost. [3]. PID controller (Proportional. Integral, Derivative) is to be used to determine the multi objective issues [4]. In this paper, different types of tools are discussed in which MATLAB, Simulation to solve the multipurpose solutions [5]. Multiple purpose functions based on the operation, planning and designing are formulated. As mentioned in the below chart the multiple optimization techniques are used to solve the problems. Linear optimization technique is used to minimize the energy cost in form formula which is known by linear technique shown in Fig. 1. This technique is used in many articles to solve the multiple issues [6].

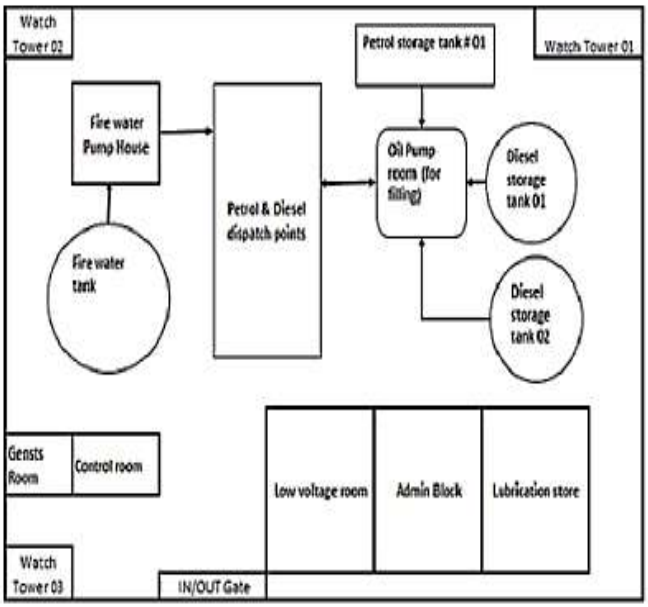


FIGURE 1. Design model of Oil Depot

Main purpose is to use this technique for minimization of the electricity bills and to achieve the maximum system stability of the installed system and the other purpose is to minimize the load shedding factor with the usage of renewable energy and maximum load shifted in to the renewable energy sources [7]. To expand the constancy and limit the vitality acquiring cost [8]. Reduced operational price and environmental factor are main purpose [9]. The minimize the power production price by using this technique [10].

Nonlinear optimizing technique is used to resolve the optimization issue of balance and unbalance system that's why it is called non-linear optimization technique. Main purpose of using this technique is to minimize the installed system cost and minimize the greenhouse gasses as well [11]. To find the ideal operation plans, minimization of price and emission by micro grid generation strategy [12]. In this session of NLO, limitation of generation plants, security and Bi-direction transmission of power [13]. This model helps to reduce all mentioned factors and balance the system [14]. Mix integer linear technique is used for liner objective function. Planning of selected system that contain clashing targets, efficiently and very costly [15]. This technique is used to minimizing of price and greenhouse production effect. Multiple purpose to use this technique is to resolve the, sending generation [16]. Multi objective structure with the combination of wind and solar network to distribute the power. Distribution system upgradation of generation system planning is suggested to minimized the operational and estimated project cost [17]. Mix integer nonlinear technique is used to factor to solve the problems. First one is continuous, second is linear and third is non-linear function. These techniques are helpful to manage the DG sets voltages issue [18]. Dispersed storage system (DSSs) is very important to control and operational activity of distributed network [19]. This system can be applied to a house which is consisting of wind energy & solar panels, AC batteries are used to minimize the operational cost of load [20-22]. This optimization model has a realistic approach taking into account the following factors concurrently:

i- Cost minimization
ii- Minimizing the cost of greenhouse gases emission
iii- Power Stack Shed Reduction

II- OBJECTIVE AND APPROACH

we have following main objectives which are to be achieved,

i- Solution for continuous supply and cost effective electricity has been formulated by the help of Binary Integer Linear Programming (BILP).
ii- Cost optimization problem to be solved by applying algorithm of Branch and Bound (BnB).
iii- Human association factor, release of flue gases and the framework of Oil Depot are to be observed as well.

The proposed system model considers the utility source, DG sets, Wind Energy and Solar Energy. BILP is used to resolve per unit cost factor and continuous power supply problem. The main purpose is cost optimization of system therefore BnB algorithm has been selected to get the less complex efficient system. In B&B, the lowest unit cost source will be connected with the load and utility source and DG sets and standby sources which can be used in the absence of both renewable sources.

III- PROBLEM STATMENT

Different types of sources are not being used to utilize the renewable energy in Pakistan. However, in this research work, we considered only solar energy and wind energy for energy optimization of oil depot. The proposed multiple optimization techniques (i.e. BILP and BnB) technique are used as shown in Fig. 2. Oil depots are constructed outside of population area therefore, Wapda connection and relevant development cost is very high. In this case, continuous tripping of Wapda fidders causes problem due to which operation work could not be proceeded. In the absence of sustainable energy, Wapda supply shall be ON and diesel generators are to be used as a backup supply source. By using optimization techniques, per unit cost would be minimized and continues power supply would be available. Cost Optimization and continuous power supply problems are solved by the utilization of Sustainable energy and OEM techniques. The energy management helps to reduce power losses just as limit the expense of vitality of our network. BnB system model and BILP are used to enhance the planning of load as for the time, limited power cost with utilizing various kinds of tariff.

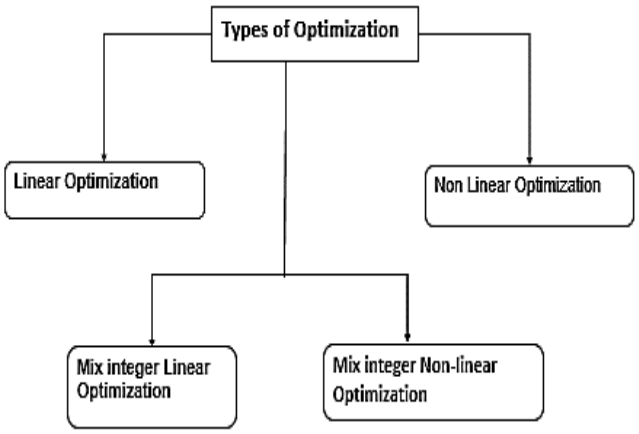


FIGURE 2. Types of Techniques

System objective is given by,

$$\min \sum_{t\in T} \sum_{1\in L} . \sum_{a\in A} w_1 X_{ta}^t Pl_a^t C_p^t + \min. \sum_{t\in T} \sum_{1\in L} . \sum_{a\in A} w_2 X_{ta}^t Pl_a^t C_p^t$$

$$W_1 + W_2 = 1$$

Where, X_{ta}^t is a variable for making decision and this variable has range [0,1], Pl_a^t is the cost of power, utilization during any time t, C_p^t is the cost of carbon emissions in time t, W_1 *and* W_2 are weights for cost of power utilization and cost of carbon emissions, Pl_a^t is the power utilization (where a is appliances, l is type of load).

C_1 : X_{ta}^t = [0,1] for all t, a. **(1.1)**

Here, C_1 gives information about decision variable that would be 0 or 1, If X_{ta}^t = 0, then appliances a would remain in off position. If X_{ta}^t = 1, then appliances a would be in on position.

While, C_2 *and* C_3 states about the slots of time,

C_2 : $\sum_{t=1}^{T} X_{ta}^t = t_a$ for all a, t **(1.2)**

C_3 : $\sum_{t=1} X_{t,a}^t = t_a$ for all a, t **(1.3)**

$C_4$is human involvement is allocated,

C_4 : $X_{t,a}^t = X_{t,a}^t Pl_a^t$ for all a, n, k **(1.4)**

C_5 states about working of each appliance,

C_5: $\sum_t^T \ (\sum_{t=1}^{T} X_{ta}^t + \sum_{t=1}^{T} X_{ta}^t) \leq 1$ for all t **(1.5)**

C_6 states about the maximum amount of used energy,

C_6: $\sum_{t=1}^{T} \sum_{1\in L} . \sum_{a\in A} w_1 X_{ta}^t Pl_a^t C_p^t \leq R_1$ **(3.8)**

The fundamental goal is to limit the expense and give the plenty for utilizing the levy as appeared in (1.1) by ideal vitality the executives the cost limited. The confinement C1 and C2 are related to endless opportunity to finish the work, start time and end time of the stack. The constraints C3 is for top area and C5 is for valley filling. We have particular essentialness charge like utility obligation and diesel imperativeness demand. bounty is furthermore charged for every obligation which is used by the load.

IV- APPLICATION DOMAIN

These applications identified with request side administration are quickly talked about, for example, smaller scale matrices, request side administration, disseminated lattices, keen vitality the board framework, joined warmth and power network, Energy and vitality network shown in Fig. 3.

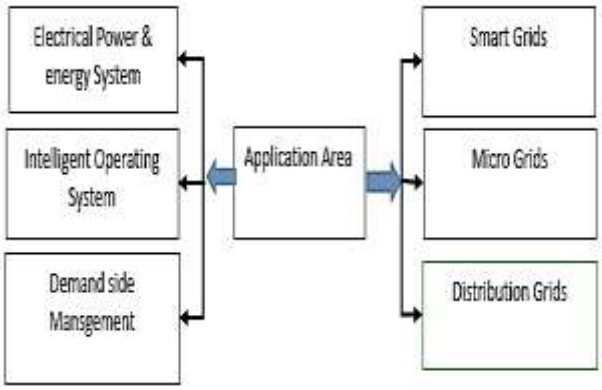


FIGURE 3: Domain of Application

V- ALGORITHM MODEL

Preference is given to solar based vitality asset since it has ease of power and no dirtying gas emanation cost. On inaccessibility of solar based vitality, move of load wind vitality asset will occur. Wind energy asset is considered as a sustainable power source asset. It has minimal effort of power and has no contaminating gas outflow cost. Consequently, inclination is given to both solar based and wind energy assets. Whenever referenced sustainable power source assets are not accessible, at that point inclination is given to utility energy source (Wapda). Utility energy cost is higher than solar energy and wind energy. Diesel generators have greatest expense of power and dirtying gas outflow because of the utilization of diesel fuel**.** It is proposed to use as a backup source of energy under unavoidable circumstances. The calculation begins by getting the solar, wind, utility, and diesel energy duty with their accessibility data. Shiftable load profile and human communication factors are likewise taken care of to the calculation. Apparatuses of various load types get energy tariff and ozone depleting substance outflow punishment of the accessible energy asset. Machines of interruptible load type and uninterruptable burden type work by utilizing most ideal accessible vitality asset immediately. The apparatuses of

shiftable load type can move their heap to the time allotments of most reduced power cost and least dirtying gas emanation punishment. In the proposed situation. The multi target issue is paired number direct programming type. A proportional released up issue is moved to holding up middle list and illuminate it. On the off chance that the arrangement is ideal, at that point continue it further in any case understand this hub. Ideal arrangement at that point checks the condition Yj= 0 is showed in Fig. 4.

Bintprog is utilized to take care of double whole number straight programming issue. To tackle the parallel whole number programming issues the direct programming B&B calculation is to be utilized. EMS model is working in matrix tied mode of oil depot. The recreation results are indicated graphically. On the off chance that all Yj are not equivalent to zero, at that point make two new hubs and add to the holding up list. On the off chance that the condition Yj= 0 is valid, at that point check the goal work (obj) with the lower limit (LB). In the event that condition obj > LB is valid, at that point continue it further in any case comprehend it.

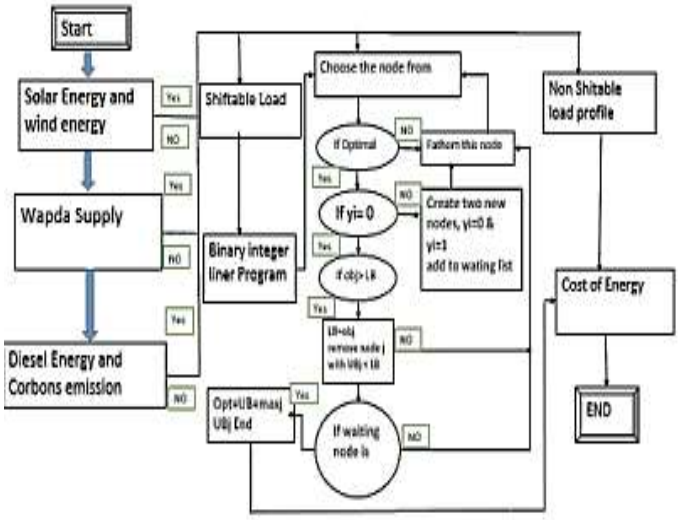


FIGURE 4: Design Model of Algorithm technique

The lower limit will be the target if condition obj > LB is valid and evacuate the hub j for its upper limit UBj if not as much as lower limit LB. This node if holding up node list is vacant in any case ideal arrangement is gotten for limiting his power utilization cost and gas emanation punishment.

VI- SIMULATION RESULTS

we shift the selected load from peak time to off time. The purpose of this technique is to utilize the power with low price (KW/h). We transfer maximum load to renewable portion and try to minimize the electrical cost. Fire water pump (motor driven) is considered as shiftable load as shown in Fig. 5 and Fig.6.

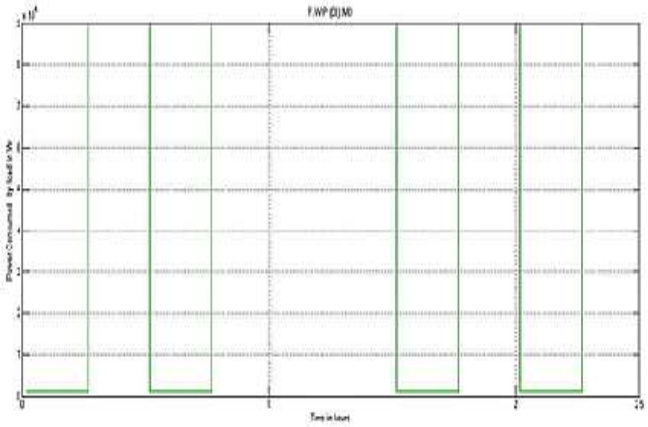


FIGURE 5: Energy Utilization of FIRE WATER PUMP (M.D)

These loads first move on the low cost energy source, in the absence of first lowest source complete load solar energy and after availability of solar energy these all loads shifted into the solar energy till the sun set time. As per "Department of Explosive of Pakistan" under rule #128, rules 2010 "Fire water pumps immediately on in case of any fire incident and its supply 5 Bar to 6 Bar pressure till thirteen minutes (upto 30 mints)" [1].

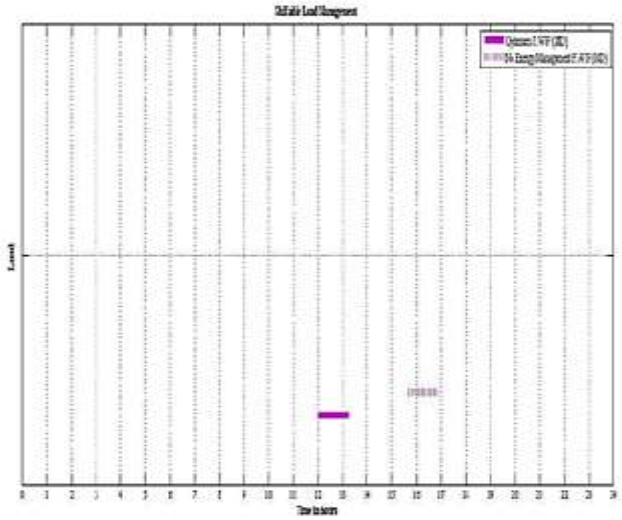


FIGURE 6: Energy Optimization of Fire Water Pump (M.D)

Solar Energy per unit charges are Rs. 9.25/unit, Wind Energy charges are Rs. 12/unit, Utility supply charges are Rs. 18/unit and diesel generator supply charges are Rs. 35.28/unit. The electricity tariff cost is shown through the graph in which Rs/kWh shown (see Fig. 7) with respect to the supply source. Figure 5 shows the energy charges with respect to the supply sources. Figure 6 shows the tariff of energy production by solar energy production is very cheap with respect to the others. The tariff of diesel source is very high with respect to the all other considered sources (see Fig. 8).

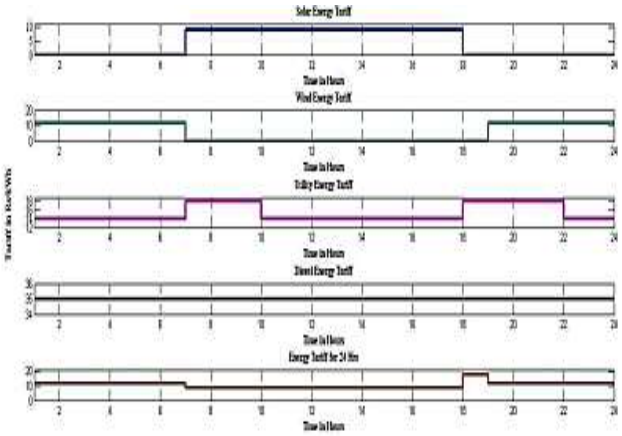


FIGURE 7: Sources Wise and Accumulative energy tariff result.

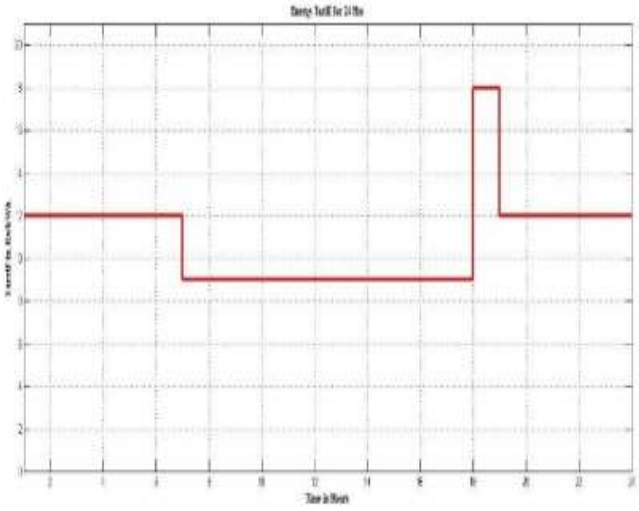
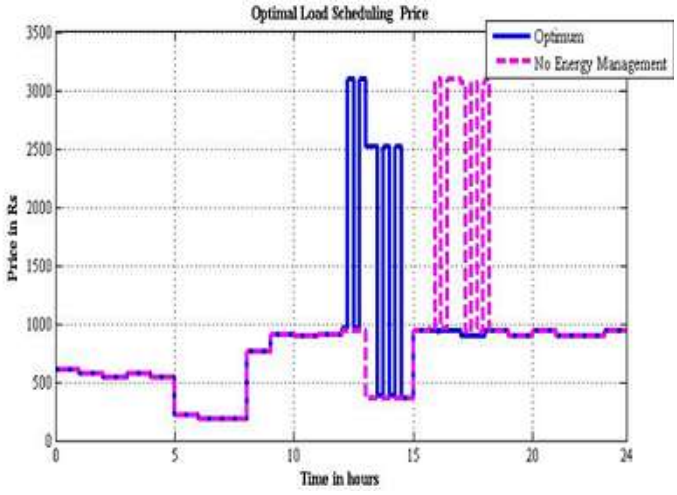


FIGURE 8: Tariff Using Time with connected Load Energy



OFIGURE 9: Optimal energy management (shifting of load with respect to cost).

Figure 9 shows the plot of OEM of Shiftable load scheduling with Rs rate. Dotted lines are shiftable load which is operating in peak hours. Figure 10 shows the final Optimal Shiftable load scheduling price graph show that the shiftable load at the time of peak charges time is shifted to the off peak time therefore, per unit cost will be reduce accordingly.

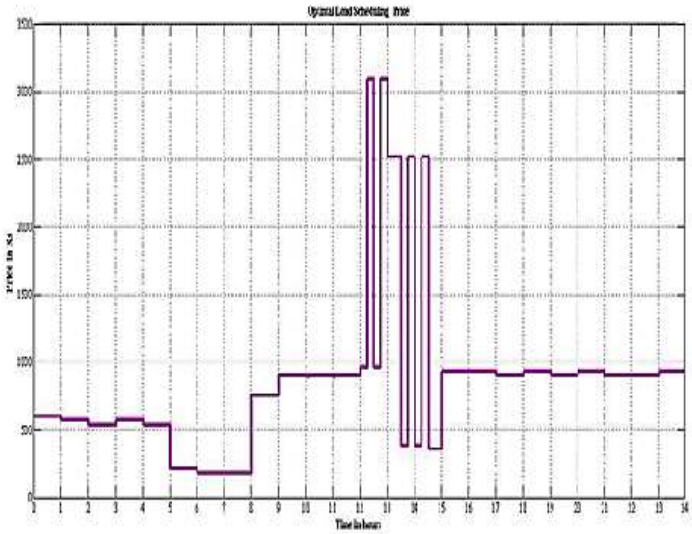


FIGURE 10: Energy Optimization of Shiftable load scheduling with Rs rate.

VII- CONCLUSIONS

Energy Management System (EMS) for oil depot has been designed by using BnB and BILP technique to get the less complex with higher efficiency system. Moreover, problems of cost effectiveness and continuous power sourcing are also solved by utilization of Sustainable energy and technique of OEM. The Energy Management helps to reduce power losses just as limit the expense of vitality of our network. In this research, there are different tariff of energy that are used. Cost of energy have been minimized using OEM.

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