Optimal Distribution of Power And Power Control The Trading Between Loads In Smart Grid-Powered Industry

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Abstract- *Deployment of smart grid technology into the conventional grid system provides us the different benefits regarding energy savings and solutions such as increased reliability, reduced functionality cost, empowerment to green energy, and improved overall efficiency of the grid system. The global infrastructure of electricity is perhaps the most complex network invented by men. And currently, we are using almost 50 years old technology when it comes to the electrical grid systems and distribution of electricity for an industrial plant. Considering the fact of increased global warming concern, it is very essential to replace this system with much-advanced technology such as a smart grid. An industrial plant with various operations consists of different kinds of loads. Those loads are different from each other in terms of their load profile. Power usage for each load may vary from other loads depending upon the hours of the day. At peak hours of the day when a situation of overloading occurs, the system is bound to control the overloading situation either by turning off the loads or by shifting the load to the other non-peak hours of the day. In this thesis, we come up with a solution of optimizing the cost of shutting down the required load without affecting the operation of the industrial plant. Categorizing the load according to their load profile and obtaining the optimal values of energy usage for the next hour depending upon the same values as last week, we make a feasible and profitable solution by using optimal power flow control techniques. The risk of peak load is considerably removed when we simulate and analyze the output. Our objective here does not only remain to supply energy to the consumer but also to allow users to make an effort to create clean energy from their part by maintaining proper communication between the supplier and receiver and keeping all the relevant parameters such as energy reliability, load balance, system efficiency and network complexities at their optimal level.*

Keywords- Smart Conventional Grid System, Power Distribution, Smart Grid, Load Balance, Reliability, Overloading

I. INTRODUCTION

Small business today is often powered by microgrids or smart grids. The main electricity supplier is usually the power company. Power plants substations transmission line transformers and smart meters are critical components of electricity. When properly interconnected they provide a means of generating electricity and the utility's main focus has always been to provide consumers with reliable high-quality low-rate electricity. Our main goal is to make our electrical systems more efficient and economical by applying the necessary controls and taking into account some special system parameters. We can make our computers efficient in two ways: the first by making them economically efficient and the second by making them engineeringly efficient. When we look at economic efficiency, we look at the cost-effectiveness of the process [1]. A vehicle is considered more affordable if it offers more benefits without exceeding the cost limit. To make it more energy efficient we try to get more output with the same amount of input. The electricity mix includes resources such as fossil fuels renewables and nuclear energy. Our main focus is to use renewable energy to generate electricity for use as a smart grid. There are several ways we can improve the efficiency of the energy industry. The purpose of this paper is to provide tools to improve the efficiency of the smart grid sector.

System efficiency can be improved by forecasting the energy consumption of regulated consumers and industries for a given period and reducing future energy demand through specific planning and an integrated system. We predict the future in terms of energy consumption. This thesis describes such a method to reduce energy costs and increase overall system efficiency[2]. We made some assumptions to get an estimate of the system. Many electric utilities are making advanced metering infrastructure (AMI) investments in smart meters to enable future smart grid energy management and customer engagement programs to support smart grid development and deployment. A critical issue facing utilities and regulators today is the need to ensure that the technologies or solutions that utilities choose and install today will be interoperable and compatible with future national standards. To protect their investmentutilities, want to ensure that the systems they choose allow the evolution and growth of smart grid standards.

The global demand for electricity is continuously increasing and adequate measures are always being taken to meet the demand for energy including building more power plants and more distribution and receiving centers for electricity transmission. But this process is very costly and labor-intensive to control and monitor operations and the process is also environmentally unacceptable as it does not support the rapidly increasing electricity demand. So, an alternative plan should be used. To meet the electricity and power requirements. We can transform the electricity distribution system by using smart grid technology to harness energy from renewable sources such as solar and wind and generate that energy wherever it is needed. A completely different small-scale power generation system can be built around the plant and with improved technology and appropriate energy management measures we can supply the plant with higher efficiency and lower capacity with the energy it needs at the moment. Cost This method is essentially the essence of smart grid technology[3].

A smart grid is defined as the integration of electrical networks of software communication systems to create more precise control and storage facilities for energy consumption and distribution of generation. Modern intelligent control is very sophisticated because it is self-healing and distributed control with two-way interaction. A smart grid is typically a modernized power distribution system. Smart grid systems are made up of many interrelated elements and this technology helps us monitor equipment and machinery for measurement and protection[4].

III. ELECTRIC UTILITY AND TYPES OF LOADS

Amendments There are wide ways of classifying loads such as residential industrial and commercial loads. Other load categories include lighting and electricity used on highways and street lights. Our main work in this article is industrial loads and if we look carefully, we can divide the loads into three main categories: the first category is critical construction sites the second category is residential and laboratory loads and the third category is supply road. Lighting loads can be divided into linear and non-linear loads. Since we are operational load management workload, we can divide it into two parts managed to load and time load[5]. Load management work is typically performed on residential and institutional laboratory loads and is not normally designed to work on construction site loads.

- Controllable load: Load management procedures can be implemented.
- Fixed Time load: Load management procedures can be applied at specific times.

Any load management program's goal is to get the system's load factor closer to 100%, which means a constant level of the load must be maintained almost always. In comparison to residential and private sector use of the electric utility, operation and control of electricity in industrial loads are complex due to the enormous operational loads. Therefore, it is crucial to apply load control to industrial loads as well.There are always some peak times when the demand for power is at its highest, therefore load shifting is crucial to lowering customer demand by moving the usage of less-essential machinery and appliances to times when the demand is not as high. By doing this, we are not turning off any equipment but rather rescheduling the operation for times when there is less demand; as a result, the plant's overall output is unaffected.

III. LITERATURE REVIEW

Before Buzzwords like energy conservation and emission reduction, green energy, sustainable development, safety factor, reduction of T&D losses, and optimal asset utilization have become the main topic of discussion as a result of cutting-edge technology. India is having trouble keeping up with its peak load and energy demands for electricity, thus smart grids can help manage the country's power shortage and improve the condition of its power grid. A "Smart Grid" is a perception of changing the national electric power grid's situation by the application of information and operational technology to the electrical grid, providing customers with sustainable options and improving security, dependability, and efficiency for utilities [1].

that algorithm includes the trust region method with unconstrained optimization, the trust region method with constrain optimization, merit function and decrease direction, and the Active set method in solving the QP sub-problem. In this paper IEEE 33- bus system with 2 DG units was taken as the prototype example. Ibrahim Abdulhadi. from Institute. for Energy & Environ., Univ. of Strathclyde, Glasgow, UK in his conference paper ‘Smart Grid control technologies: Achieving functional interoperability on a wider scale’ investigated the mean of avoiding functional conflicts such as maintaining voltage stability and frequency stability simultaneously during primary frequency response. Some alternative methodologies for investigating functional conflicts are formal behavioral modeling, and case study-based performance evaluation. It also explained the means of achieving functional interoperability. The inclusion of IEEE 10 generators39 bus systems have been done to increase the extent of simulation output to a practical limit. Klaus Trangbaek Mette Petersen Jan Bendtsen Jakob Stoustrup explained in their conference paper 'exact power constrained in smart grid control' the perks of model predictive control which helps in proper power management for balancing between supply and demand of power by distributing the power to the consumer in an optimal way. Consumers are termed as intelligent consumers in the paper.A. Monti, F. Ponci, A Benigni, and J. Liu described in their conference paper 'distributed intelligence for smart grid control' the challenges of electrical power distribution to consumers when it is drawn by distributed generators.

IV. LOAD FORECASTING

Load prediction curves for various industrial plants generally have non-linear characteristics and are highly dynamic in nature. The study of these curves becomes complicated if the performance demands of the system are too high. Therefore, the study of these graphs and curves is typically done over various periods ranging from 1 second to several hours. This study mainly focuses on hourly periods to observe the load prediction profile for a given load. Looking at the 24-hour load profile we can see several variations in the power demand curve.

Load forecasting is of great importance in the power industry from an economic point of view. Load forecasting has many applications including the purchase and sale of transmission power load shifting and the evaluation of power generation contracts. It is very important to perform planning and control forecasting of utility industry loads. This energy distribution is also important for the storage energy production and markets[9]. Load forecasts can be divided into three main categories based on the forecast time frame: short-term forecasts usually last from one hour to one week second medium-term forecasts last from one week to one year and third. Long-range forecasting which usually lasts from an hour to a week is done for more than a year.Distinct operations of an institute or a facility correspond to different forecasting time horizons. The nature of these forecasts varies as well. For instance, with an accuracy of 1-3%, it is possible to predict the estimated power needed for the following day for a certain load. However, because we lack precise information on long-term weather forecasts, we are unable to determine the estimated power consumption for the same load for the following year. For a long-term load prediction based on historical weather data, we can only provide the probability distribution function for the specific load; however, this does not ensure the prediction's correctness[10].These loads are referred to as weather-normalized loads and can be estimated by using average weather conditions over the course of a year, which are often the average of weather features during a specific period. The length of this term varies from firm to company. The average corporation lasts 20 to 25 years. The operational decisions made by industries rely heavily on load forecasting. However, with the deregulation of the energy sector of the economy, load forecasting is now crucial.

V. LOAD PROFILE CURVE

Due For load forecasting, we can use a variety of methods, including expert systems, statistical techniques, and artificial intelligence algorithms like regression, fuzzy logic, and neural networks. The literature review indicates that a wide range of mathematical models and concepts have been used in the past to produce more precise instruments to boost the effectiveness of the electric utility. Although it is outside the purview of our study, weather forecasting is nonetheless a crucial component of this research.Our goal is to predict the network's ideal 24-hour load profile and utilize that information to discover the best way to cut fuel and energy costs and achieve the ideal power flow distribution.

Table 1 Hourly consumption of energy by an industrial plant (Load 1)

HOURSOFT HEDAY	**LOAD(MW)**	**HOURSOFT HEDAY**	**LOAD(MW)**
1	12	**13**	300
2	12	**14**	360
3	12	**15**	324
4	12	**16**	300
5	24	**17**	240
6	180	**18**	62
7	180	**19**	42
8	420	**20**	20
9	420	**21**	18
10	456	**22**	12
11	360	**23**	12
12	180	**24**	12

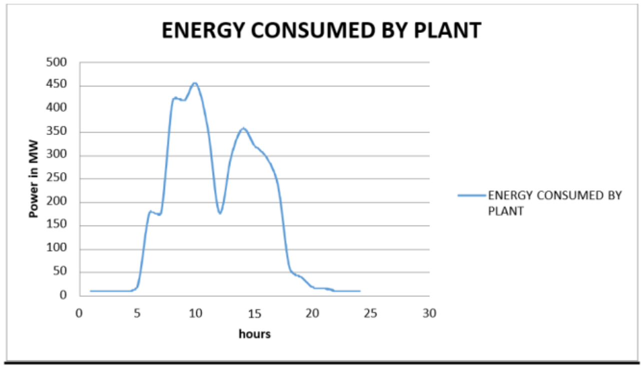

Figure .1 load curve of an industrial plant of a day (LOAD 1)

In the following figure, we have simply shown the graphical representation of the hourly consumption ofenergy by an industrial plant. This energy consumption serves the daily load energy of the plant. To make our research more practical we have taken 4 specificloads and the energy consumption graph for all four loads has been shown. Two of those loads may be put into the shed-able load category and the other two can be put in to nonshedable load category.

Table 2 Hourly consumption of energy by an industrial plant (Load 2)

HOURSOFT HEDAY	LOAD(MW)	HOURSOFT HEDAY	LOAD(MW)
1	20	**13**	254
2	24	**14**	200
3	28	**15**	185
4	80	**16**	300
5	195	**17**	357
6	280	**18**	368
7	290	**19**	280
8	390	**20**	200
9	415	**21**	189
10	435	**22**	60
11	389	**23**	18
12	320	**24**	15

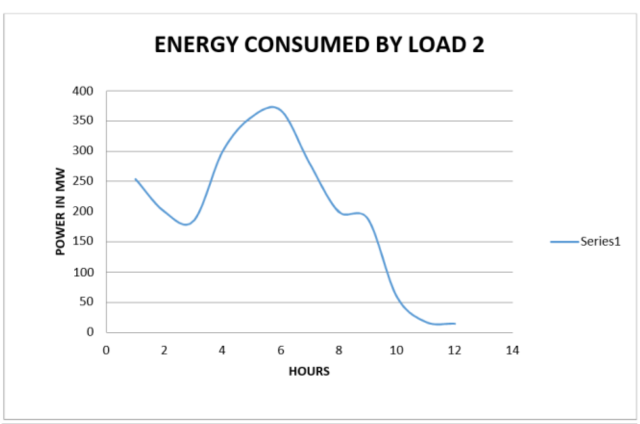

Figure.2 load curve of an industrial plant of a day (LOAD 2)

VI. PROPOSED METHODOLOGY

Technologies The proposed methodology involves the optimization of an objective function of various forms for example minimization of transmission loss of the electric utility or the minimization of the cost factor of power distribution. The constraints of the objective function can also vary, for example, constraints may include power flow equations, storage limits, voltage limits, and active power limits. We are optimizing the amount of power to be supplied to the shed able to load Wi(t). We can formulate an OPF problem as an optimized variable Wi(t) which is the amount of power supplied to the shed able load, constrained to the Bi(t). Where bi(t) is the power required for ith shed able load obtained from the previous week's load profile.

Constraint equations are as follows:

$$bi(t) - wi(t))/ \Sigma n\, i(bi(t) - Wi(t)) = Ii\ \% \quad (1)$$

$$bi(t) - wi(t) = Ii(\Sigma n\, i(bi(t) - Wi(t))\,) \quad (2)$$

Where i is 1, 2, 3, and 4 represent the number of loads we are optimizing power values for. And Ii is the percentage of a part of the energy consumed for all the loads.

The objective function can be defined as

$$F = \sum_{1}^{n} i(bi(t) - wi(t))^2 \qquad (3)$$

Where wi(t) is the optimization variable.

From constraint equations 1 and 2 we can realize the following set of equations since we are taking four loads into consideration, we are getting four sets of equations.

$$(-1 + I1)W1 + I1W2 + I1W3 + I1W4 = I1(b1 + b2 + b3 + b4) - b1\,(4)$$

$$I2W1 + (I2 - 1)W2 + I2W3 + I2W4 = I2(b1 + b2 + b3 + b4) - b2 \qquad (5)$$

$$I3W1 + I3W2 + (I3 - 1)W3 + I3W4 = I3(b1 + b2 + b3 + b4) - b3 \qquad (6)$$

$$I4W1 + I4W2 + I4W3 + (I4 - 1)W4 = I4(b1 + b2 + b3 + b4) - b4 \qquad (7)$$

The optimization tool that we have used here is fmincon. It finds a minimum of a constrained nonlinear multivariable function

Find Min f(x) subject to

$C(x) \le 0$
$Ceq(x) = 0$
$A.x \le b$
$Aeq.x = beq$
$lb \le x \le ub$

where x, b, beq, lb, and ub are vectors, A and Aeq are matrices, c(x) and ceq(x) are functions that return vectors, and f(x) is a function that returns a scalar. f(x), c(x), and ceq(x) can be nonlinear functions. In our optimization techniques, we have taken

$$A.x \le b$$

Matrices A and b can be obtained by the 4 constrained equations shown above. Where A and b are following matrices

$$A = \begin{bmatrix} (-1+I1) & I1 & I1 & I1 \\ I2 & (-1+I2) & I2 & I2 \\ I3 & I3 & (-1+I3) & I3 \\ I4 & I4 & I4 & (-1+I4) \end{bmatrix} \quad (8)$$

$$b = \begin{bmatrix} I1(b1+b2+b3+b4) - b1 \\ I2(b1+b2+b3+b4) - b2 \\ I3(b1+b2+b3+b4) - b3 \\ I4(b1+b2+b3+b4) - b4 \end{bmatrix} \quad (9)$$

Syntax of fmincon:

Description:

x = fmincon(fun,x0,A,b) (10)

fmincon finds a constrained minimum of a scalar function of several variables starting at an initial estimate. This is generally referred to as constrained nonlinear optimization or nonlinear programming. x = fmincon(fun,x0,A,b) starts at x0 and finds a minimum x to the function described in fun subject to the linear inequalities A*x <= b. x0 can be a scalar, vector, or matrix.Fmincon usesan active set algorithm for the given constraint equations and the objective function. In general, the structure of an active set algorithm can be described as follows:

It finds a starting point that is feasible enough, and it repeats the solution until it gets to a point that is optimal enough. Basically, it solves the equality problem that has been defined by the active sets then it does computations to calculate the LaGrange multiplier for the next iteration. Then it replaces one of the subsets of the constraints with the negative LaGrange multiplier. In the next step, it searches for infeasible constraints. It ends this and repeats the same steps until it comes to an optimal solution.

A. Optimal Power Flow Control

Values of the load profile obtained from the fmincon solution are optimal in nature. The basic problem of the smart grid-operated industry is that we can't store a bulk amount of energy for a long time. So, we have to dispatch the demanded energy instantly to the consumer. The generation of electricity is also not constant it also varies according to the supply to the demand. Since the demand of consumers is uncertain in nature and changes from time to time, the generation of electricity also changes from time to time. We can describe the optimal power flow system by a flow chart as shown below.

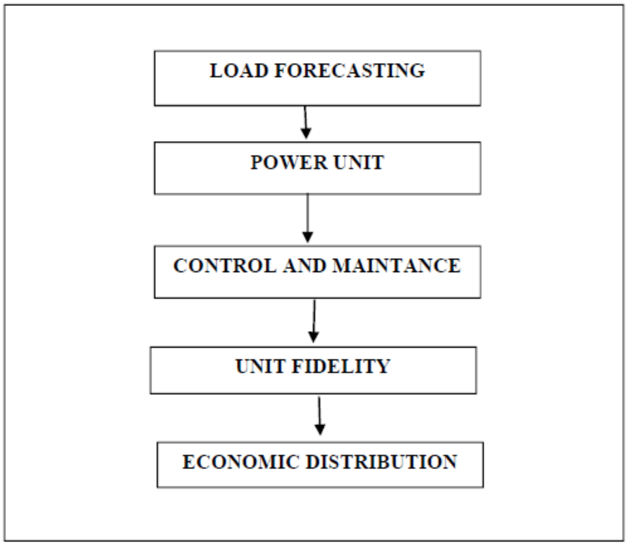

Figure.3. Power Flow Control

B.IEEE 10 Generators 39 Bus System

This IEEE 39 bus system is well known as a 10-machine New England Power System. Generator 1 represents the aggregation of a large number of generators. All parameters shown below come from the book titled 'Energy Function Analysis for Power System Stability'[1]. This book took them from the paper by T. Athay et al.

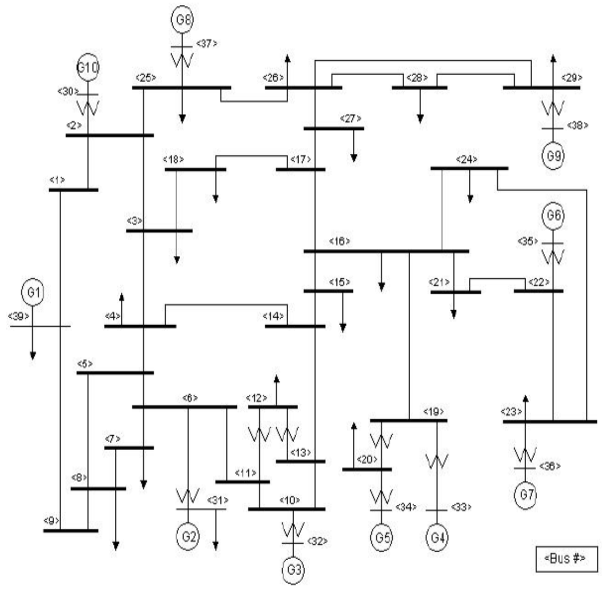

Figure.4. line diagram of IEEE 10 generators 39 Bus system

VII. RESULT ANALYSIS

The test system that we used IEEE 10 Generators 39 Bus system. We have simulated by taking different load curves and objectives that we are supposed to optimize. The minimum and maximum values of active and reactive power of generators are determined by Mat power and power world software. We have included our results such as values of lambda, power generated by all the 10 generating units, the total power generated, total demand by the consumer, and powerloss for every hour into a tabulated form. We have taken our results considering the fact that the load is attached to Bus 7 of the system. From chapter three we can show the variation in the power consumed by a plant for a day as follows.

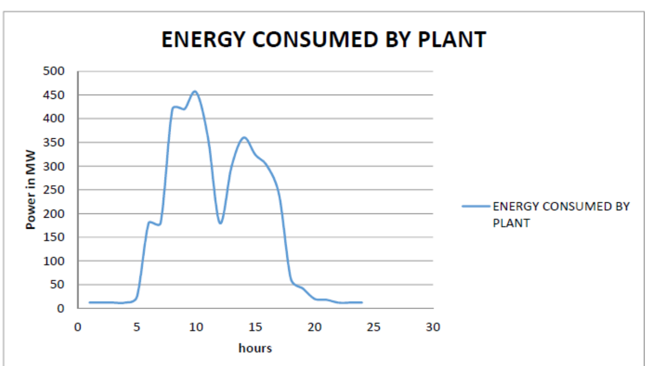

Figure.5. Load Profile

The optimized results for every hour can be represented in the following table:

Table 3Optimized Result for every hour

hours	Load value(MW)	Cost(Rs/hour)	Value of lambda(Rs/Mwh)	Xg1	Xg2	Xg3	Xg4
Mean value	274	2347.6 K	882	287.61	169.97	698.8	499.5
1	28.82	2138.4 K	831	277.86	160.22	670.22	455.51
2	28.82	2138.4 K	831	277.86	160.22	670.22	455.51
3	28.82	2138.4 K	831	277.86	160.22	670.22	455.51
4	31.40	2140.5 K	832	277.86	160.41	670.40	456.09
5	32.3	2139.7 K	832	287.87	40.48	690.37	445.89
6	58.1	2163.0 K	833	297.98	142.94	673.01	462.36
7	264.9	2339.8 K	876	298.69	161.84	712.51	490.25
8	598.4	2646.0 K	948	299.55	192.94	744.18	568.35
9	628.8	2684.2 K	960	299.69	198.9	750.23	603.57
10	621.7	2677.2 K	958	299.65	197.33	748.64	599.48
11	671.4	2720.1 K	978	299.86	206.92	758.38	624.46
12	341.2	2412.7 K	894	298.94	169.42	720.27	509.37
13	515.4	2568.0 K	930	299.37	185.19	736.33	568.97
14	566.1	2600.2 K	938	299.45	188.39	739.57	576.99
15	451.7	2485.1 K	944	299.49	190.09	741.3	561.24
16	478.1	2491.4 K	971	299.22	179.35	730.39	534.33
17	319.2	2389.8 K	810	299.28	181.72	732.8	540.28
18	390.1	2456.7 K	885	298.86	166.99	697.78	503.24
19	108.4	2240.8 K	848	298.16	147.48	697.72	453.9
20	43.1	2154.4 K	795	297.92	141.58	691.6	458.9
21	40.8	2152.1 K	789	297.91	141.28	691.29	438.14
22	38.8	2148.1 K	782	297.9	141.06	691.06	437.58
23	38.8	2148. 1K	782	297.9	141.06	691.06	437.58
24	38.8	2148.1 K	782	297.9	141.06	691.06	437.58

Table 3Optimized Result for every hour (Continue…)

hours	Xg5	Xg6	Xg7	Xg8	Xg9	Xg10	Xgt	Xdt	Xl
Mean value	510	631	670	630	940	1090	6126.88	6072.72	54.15
1	510	631	670	630	940	1090	6040.81	5989.4	51.41
2	510	631	670	630	940	1090	6040.81	5989.4	51.41
3	510	631	670	630	940	1090	6040.81	5989.4	51.41
4	510	631	670	630	940	1090	6035.76	5984.36	51.40
5	510	631	670	630	940	1090	5935.61	5883.73	51.88
6	510	631	670	630	940	1090	6047.29	5994.58	52.71
7	510	631	670	630	940	1090	6134.29	6081.56	52.73
8	510	631	670	630	940	1090	6276.02	6223.03	52.99
9	510	631	670	630	940	1090	6323.29	6272.17	51.12
10	510	631	670	630	940	1090	6316.1	6259.49	56.44
11	510	631	670	630	940	1090	6360.62	6304.01	56.61
12	510	631	670	630	940	1090	6169	6111.01	57.99
13	510	631	670	630	940	1090	6260.86	6206.67	54.19
14	510	631	670	630	940	1090	6275.4	6219.69	55.71
15	510	631	670	630	940	1090	6263.1	6206.57	56.53
16	510	631	670	630	940	1090	6214.29	6163.58	50.71
17	510	631	670	630	940	1090	6225.08	6173.96	51.12
18	510	631	670	630	940	1090	6137.87	6087.77	50.04
19	510	631	670	630	940	1090	6068.26	6017.35	50.91
20	510	631	670	630	940	1090	6061	6010.49	50.51
21	510	631	670	630	940	1090	6039.06	5988.84	50.22
22	510	631	670	630	940	1090	6038.6	5987.24	51.36
23	510	631	670	630	940	1090	5038.6	5987.24	51.36
24	510	631	670	630	940	1090	6038.6	5987.24	51.36

Given in the table values of generating power Xg1, Xg2,Xg3… are optimized values in MW. And the total power of all the generating units is equal to the sum of the total loss in transmission and total dispatched power. That is

$$Xgt = Xdt + Xl.$$

We have simulated approximately the same values of load after dividing it by a factor of 10. Using fmincon we can get the optimized values for the next hours for all four loads as follows.

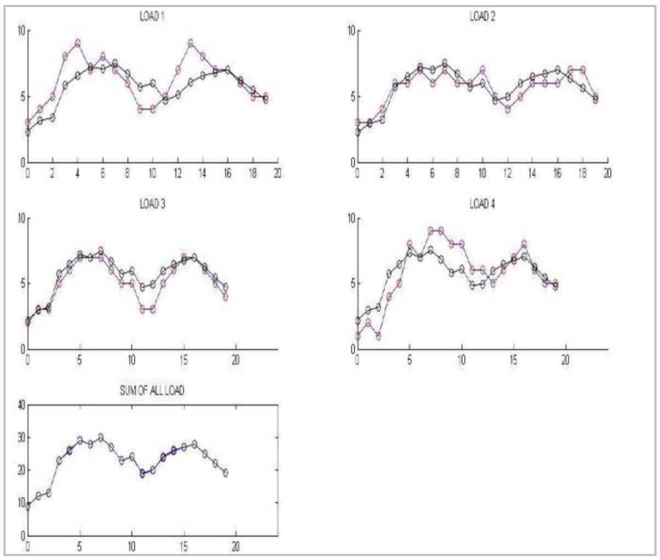

Figure 6. Optimized load profile X- axis hours, Y-axis Power in MW

The curve with blue lines is the data obtained by the hourly requirement of power of the same day of the previous week, while the black curve shows the optimized values of power predicted for the next hour.

When the required load is less than the power generated by the co-generating unit, we can sell the excess power to the main grid and benefits can be made, we can understand it from the following table:

Table 4.Optimized Result for every hour when power excess

Hours	**Loadvalue (MW)**	**Lambda Value (Rs/MWh)**	**Excess Power (MWh)**
1	28.82	882	71.18
2	28.82	831	71.18
3	28.82	831	71.18
4	31.40	831	68.6
5	32.3	832	67.7
6	58.1	832	41.9
7	264.9	833	-164.9
8	598.4	876	-498.4
9	628.8	948	-528.8
10	621.7	960	-521.7
11	671.4	958	-571.4
12	341.2	978	-241.2
13	515.4	894	-415.4
14	566.1	930	-466.1
15	451.7	938	-351.7
16	478.1	944	-378.1
17	319.2	971	-219.2
18	390.1	810	-290.1
19	108.4	885	-8.4
20	43.1	848	56.9
21	40.8	795	59.2
22	38.8	789	61.2
23	38.8	782	61.2
24	38.8	782	61.2

A positive sign in the excess power column shows that we are generating extra power at that particular hour of the day and we can extract profit by selling that power to the main grid. And the negative values in the last column of the table show that we have to purchase that much amount of electricity from the main grid at that particular hour of the day. And thus, we are able to analyze, minimize and optimize the required value of energy through the data that we have obtained.

VIII. CONCLUSIONS

This paper gives the optimization approach to get advantages out of the electrical energy distribution community in a clever grid-operated enterprise through the usage of the most effective strength drift methodology. The principal difficulty stays to maximize the records accumulated through the consumer to have higher management over choice-taking conditions to extend the effectivity of the electric-powered utility. We have used the time period lambda which represents the minimal or optimized value of the electrical energy era for the subsequent hour in MWh. The price of lambda is observed by way of simulating the top-quality strength glide programming in our check device IEEE10 Generators 39 Bus System on the device MatPower.

REFERENCES

[1] T. Kim, S. Lee, and S. Lee, "Optimization of Home Loads scheduling in Demand Response", Journal of the Korean institute of communication sciences, Vol.35, No.9,Oct. 2010.

[2] Korea Power Exchange, 2011 Survey on Electricity Consumption Characteristic of Home Appliances, 2011, [online] available
[3] Peeters E, Belhomme R, Batlle C, Bouffard F, Karkkainen S, Six D, et al. ADDRESS: scenarios and architecture for active demand development in the smart grid of thefuture. In: Proc of CIRED 20th international conference on electricity distribution;2009. p. 1–4.
[4] Amjady N, Keynia F, Zareipour H. Short-term load forecast of microgrids by a newbilevel prediction strategy. IEEE Trans Smart Grid 2010;1: 286–94.
[5] Shenai K, Shah K. Smart DC micro-grid for efficient utilization of distributedrenewable energy. In: Proc of IEEE Energytech; 2011. p. 1–6.
[6] R. E. Brown, “Impact of Smart Grid on Distribution System Design,” Proceedingsof IEEE Power and Energy Society General Meeting—Conversion and Delivery ofElectrical Energy in the 21st Century, Pittsburg, 20-24 July 2008, pp. 1-4.
[7] S. Ali and K. A. Smith, “On Learning Algorithm Selection for Classification,”Journal on Applied Soft Computing, Vol. 6, No. 2, 2006, pp. 119-138.
[8] Q. Yang, J. A. Barria and T. C. Green, “Communication Infrastructures forDistributed Control of Power Distribution Networks,” IEEE Transactions onIndustrial Informatics, Vol. 7, No. 2, 2011, pp. 316-327.
[9] X. Fang, S. Misra, G. Xue, and D. Yang, “Smart Grid—The New and ImprovedPower Grid: A Survey,” International Journal of IEEE Communications Surveys&Tutorials, Vol. 14, No. 4, 2011, pp. 944-980.
[10] A. Zahedi, “Developing a System Model for Future Smart Grid,” Proceedings in2011 IEEE PES Innovative Smart Grid Technologies Conference, ISGT Asia 2011,Perth, 13-16 November 2011, pp. 1-5.
[11] B. Panajotovic, M. Jankovic and B. Odadzic, “ICT and Smart Grid,” Proceedings forthe 10th International Conference on Telecommunication in Modern Satellite Cableand Broadcasting Services, Serbia, 5-8 October 2011, pp. 118-121.