Providing an optimal method based on SARIMA In the short-term electricity market considering DER resources

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Abstract

Determining the production arrangement of power plants Is to provide a coherent planning for the operation of power plants in order to determine the entry and exit of power plant units, to determine the production arrangement of power plants and the amount of production of each during the day so that we bear the lowest cost, the investigations show. Optimum exploitation of pumped storage power plants is dependent on accurate prediction of next day energy market behavior and offer of buying and selling energy based on possible market prices. Considering this issue, Increasing the accuracy of forecasting the next day's market prices reduces the unit allocation risk and increases the power plant's profit to the same extent. Therefore, the way to put these joint producers in the circuit with power plants is the basis of an optimization problem for production units, where the goal is to minimize the production cost of power plants by considering various technical and physical limitations and satisfying the load supply condition. In this research paper, a new model for the allocation of storage pump power plant units In the day-ahead market is presented. Considering that the day-ahead market prices are highly volatile and have high uncertainty, seasonal ARIMA or SARIMA time series is used to predict the day-ahead market price. Investigations and simulation results show that SARIMA can predict the next day's daily market prices with acceptable accuracy. It has also been shown that the use of the presented model using the robust optimization method increases the accuracy of the optimal planning of the storage pump power plant and Improves the reliability of the network. The proposed method for planning the participation of units improves the reliability of the network by using the robust optimization method.

Keywords: Uncertainty of production units, system security - operational reservation

Introduction:

In recent years, Investment in pumped storage power plants has increased. On the other hand, to evaluate the economic justification of investing In pumped storage power plants, very accurate methods are needed that are able to cover the uncertainties related to the electric energy market . providing a coherent plan for the operation of power plants and power plants in order to determine the amount of makeup each day . so that the lowest cost to be incurred.(2) note that in the circuit of the plant means that the unit is turned on,it quickly raised. It was a synchronous system and (3).restructured system creates a competitive environment and open market.in this altered state power,resources(power plant)to compete with each other.in addition consumers are allowed to have electric energy supplier,to choose their choice.given these fundamental changes,traditional methods for control and operation of power plants should be amended(4).Modeling studies program in response time in the circuit of the power plant TOU model is implemented as a linear model to determine TOU rate as a stochastic model is used.TOU rates are set a ccording to the indicators of reliability,so that in this way a promotional rate for any of the macro and micro hours a day recommended intake, and by taking the ENS index for reliability problem in the power circuit by indicating the security system has been studied(5).Here methods stochastic uncertainty inapplication response times have been used to improve the reliability of sight ISO.LOLP to the level of risk is less defined,ensure(6).Given the uncertainties once and production for renewable sources.including wind generators and enter DR programs presented in the unit(7).Using neural networks as a tool for simulating the uncertainty of the market price and stronge system,used in input and actually using probabilistic neural network being used spinning reserve by measures such as restrictions on the transfer ,networking events and production unit and the uncertainty of the market price determined as an input for manufacturing units of UC was used(8).In addition to the greenhouse gas emissions as a constraint on the operation of thermal power plants has been studied(8).In other bodies of dynamic programming algorithm(9).Invasive weeds (IWO)(10).and particle swarm algorithm(PSO)(11).In combination with the release of logrange method to obtain initial results have been used in space exploration scenarios.in this article we intend to achieve a robust optimization technique for orbit insertion of wind power and wind energy penetration in getting the modification of operational uncertainty.this optimization based on mathematical models and consider the worst-case scenario takes place.it also uses pumped water storage with wind turbine can reduce the total cost of creating that examine this model.in this article,in cluding the following questions will be answered and tried the simulation results in this paper:

- How uncertaintyout of the wind and deal with the worst-case scenario.
- Choose the best circuit in the power optimization algorithm with the addition of wind power to the power system water storage

- The algorithm used in the ultimate goal is the same cost.
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The following article structure:the first part introduces variables analyzed and presented in the second part of the formulation in partnership units.in the third section describes the methodology and the proposed algorithm introduced and finally in the fourth section is taken results will be analyzed and the trial is one of the previous methods.

1.formulation of the problem

This is part of two- stage optimization resistant formulation will be able to cope with the uncertainties of wind fluctuations.assume that the power out put of the wind farm on the interval [($\widehat{Q^v_{bt}}$, $\widehat{Q^u_{bt}}$)] and the average is Q^n_{bt} . that this priod of uncertainty using old data can also be achieved.thus,if the actual amount of power a wind turbine on bass b and period t is my q_{bt}, we can say that $q_{bt} = \widehat{Q^v_{bt}}$ or $q_{bt} = \widehat{Q^u_{bt}}$ the worst possible.considering that small fluctuations can be the main generator(fuel)gave balance, in this thesis on the large fluctuations in power (due to wind changes)will focus.to adjust the conservative variable Γ_b (between O and T)we use so that Γ_b number of courses shows that the expected quantity Q^n_{bt} away.after determining the optimization problem described above.if z-bt^+ determines the power turbine to the top and z-bt^- characteristic of the power turbine to the lower limit(if $z^+_{bt} = 1$ $\widehat{Q^u_{bt}}$;q-bt=(Q-bt^u)if $z^+_{bt} = z^-_{bt} = 0$ > q_{bt}=$\widehat{Q^u_{bt}}$and if z-bt^- =1=> q_{bt}=($\widehat{Q^v_{bt}}$)),then set the uncertainty is expressed as follows:

$$D = \left\{ q \in R^{|B|\times T} : \sum_{t=1}^{T} (z^+_{bt} + z^-_{bt}) \le \Gamma_b \ , \qquad q_{bt} = Q^n_{bt} + z^+_{bt}\widehat{Q^u_{bt}} + z^-_{bt}\widehat{Q^v_{bt}} \quad \forall\, t, \forall\, b \in B \right\}$$

For a priod of time T of studies to optimize assume horizon B variable E is the total transmission in the power system.for each of the buses is assumed that the number of generators in each bus,and to determine the cost of each generator is turning generators b I bus and so the cost of shutting down the generator,the minimum time and minimum system turned on when it is necessary to remain silent generator.the minimum and maximum power is prodused by each generator.the rate of increase and decrease output power unit.and for each line between nodes I,j bass line capacity between the two networks.the proposedpower system for a two-stage optimization method,firstly for participatory planning unit has an initial response,is determined for each generator.

1-if the generator at bus i at time t b in circuit 1 will be equal to zero otherwise.

2-if the generator at bus i at time t b is 1 will be switched on,otherwise it is zero.
3-if the generator is turned off at time t b i bus 1 will be equal zero otherwise.

$$\min_{y,u,v,x} \sum_{t=1}^{T}\sum_{b=1}^{B}\sum_{i\in N_b}\left(S_i^b u_{i,t}^b + W_i^b v_{i,t}^b\right) + \max_{q\in D}\ \min_{x\in \aleph(q)} \sum_{t=1}^{T}\sum_{b=1}^{B}\sum_{i\in N_b} f_{i,t}^b\left(x_{i,t}^b\right)$$

Secondly,assuming that the demand in each bus per hour is the amount of power generated by the objective function can be expressed as follows.

$$s.t$$

$$-y_{i,t-1}^b + y_{i,t}^b - y_{i,k}^b \le 0 \quad k \in \{t, t+1, \ldots, G_i^b + t - 1\}$$

$$y_{i,t-1}^b - y_{i,t}^b + y_{i,k}^b \le 1 \quad k \in \{t, t+1, \ldots, G_i^b + t - 1\}$$

$$-y_{i,t-1}^b + y_{i,t}^b - u_{i,t}^b \le 0$$

$$y_{i,t-1}^b - y_{i,t}^b - v_{i,t}^b \le 0$$

$$y_{i,t}^b, u_{i,t}^b, v_{i,t}^b \in \{0,1\}$$

Note that this is a problem “hard and the uncertainty” according to the relevant provisions is or was entitled below,direct solution with software such as CPLEX is not done.in the next section in to a series of simplifications(relaxations)will go and we will express the algorithm.

$$X(q):$$

$$L_i^b y_{i,t}^b \le x_{i,t}^b \le U_i^b y_{i,t}^b$$

$$x_{i,t}^b - x_{i,t-1}^b \le \left(2 - y_{i,t-1}^b - y_{i,t}^b\right) L_i^b + \left(1 + y_{i,t-1}^b - y_{i,t}^b\right) R_i^b$$

$$x_{i,t-1}^b - x_{i,t}^b \le \left(2 - y_{i,t-1}^b - y_{i,t}^b\right) L_i^b + \left(1 - y_{i,t-1}^b + y_{i,t}^b\right) P_i^b$$

$$\sum_{b=1}^{B}\left(\sum_{i\in N_B} x_{i,t}^b + q_{bt} + q_{bt}^{Hout} - q_{bt}^{Hin}\right) = \sum_{b=1}^{B} D_{bt}$$

$$\sum x_{i,t}^b + q_{bt} + q_{bt}^{Hout} - q_{bt}^{Hin} + D_{bt} + \sum_{i,j\in E} r_{ij,t}^l = 0$$

$$s_t^b = s_{t-1}^b + \Lambda_1 x_{i,t}^b - \frac{x_{i,t}^b}{\Lambda_2}$$

$$L_{bt}^{Hin} \le q_{bt}^{Hin} \le U_{bt}^{Hin}$$

$$L_{bt}^{Hout} \le q_{bt}^{Hout} \le H_{bt}^{Hout}$$

$$-C_{ij} \le r_{ij,t}^l \le C_{ij}$$

$$x_{i,t}^b \le x_{i,t}^b \le x_{i,t}^b$$

$$s_{b0} = S_b^{beggin}$$

$$s_{bT} = S_b^{last}$$

$$q_{bt}^{Hin} \le M\left(1 - z_{b,t}^H\right)$$

$$q_{bt}^{Hout} \le M\, z_{b,t}^H$$

Constraints related to,respectively,about the production of generators,increasing and decreasing power plants,the power balance in the power grid, the storage ,the balance of water supply,upper and lower limits in the absorption of energy by a single pumpand constraints binary optimal are.in order to clarify this issue by indicating last two pump units at a specified time or energy that absorbs or emits
(both at the same time is impossible)

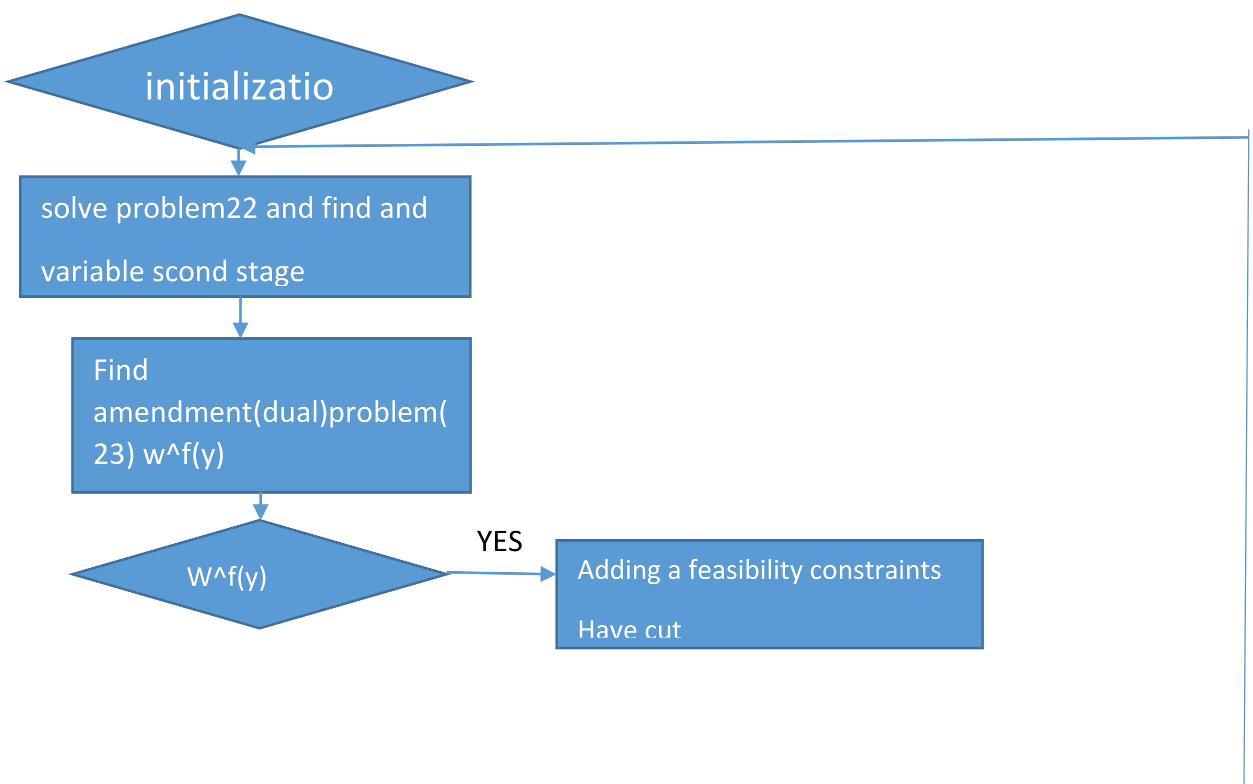
2) optimization problem solvent

In this episode to solve the problem (2) some simplification (relaxations) done and we will express problem .solving algorithm.
Where in addition to the provisions contained in ,or impossible to remove non-optimal solutions ,each cut possibility for indicating (4)and the optimal cut of a form indicating (5) is added:

$$\sum_{t=1}^{T}\sum_{b=1}^{B}\sum_{i\in\Lambda_b}\sigma_{it}^{br}y_{it}^{b} \leq \xi_r$$

$$\theta-\sum_{t=1}^{T}\sum_{b=1}^{B}\sum_{i\in\Lambda_b}\hat{\sigma}_{it}^{bn}y_{it}^{b} \geq \widehat{\xi_n}$$

Thus,according to figure 1 in the following two steps will solve the optimization problem.first, a lower limit of the answer to fix u,v,y earned and then adding constraints(3)and(4) in each solution impossible and non-optimal removed and the final answer to the cost minimization is,will achieve.
Note that amendment (dual) problem (3) can be w^f(y) defined and when:
1)w^f(y)=0 this means that a possible answer to the problem (2) is.
2)w^f(y)>0 this means that an impossible answer to question (2) arriving to a cut in the feasibility constraints have to add.
3) $\omega^P(y) > \hat{\theta}$ this means that a non optimal answer is for problem(2) and the optimal cut to have a problem constraints add.


initializatio
solve problem22 and find and
variable scond stage
Find
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23) w^f(y)
W^f(y)
YES
Adding a feasibility constraints
Have cut

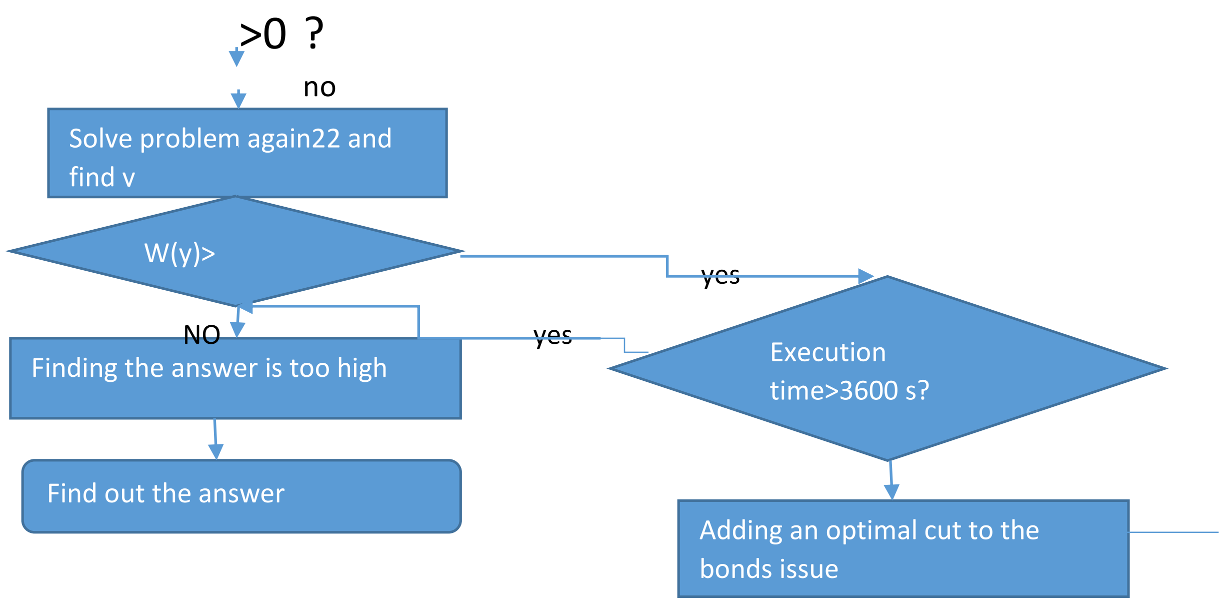

Figure 1: planning partnership units solved by the algorithm port (bneder algorithm)

3-simulating and analysis

In this method the first on the gird to sixth-bus ieee apply a-6-bus network As in figure 2 can be seen,6-bus network ieee includes four generators and transmission lines is 7.boss 3 a pump unit and a wind farm is located in boss 4. In figure 3 the predicted wind power with “the worst possible”(wind power in the upper and lower) can be seen. NREL have provided data from the source. In this thesis, we assum ,meaning that in the coming days,6 hours of wind power can be predicted much away.

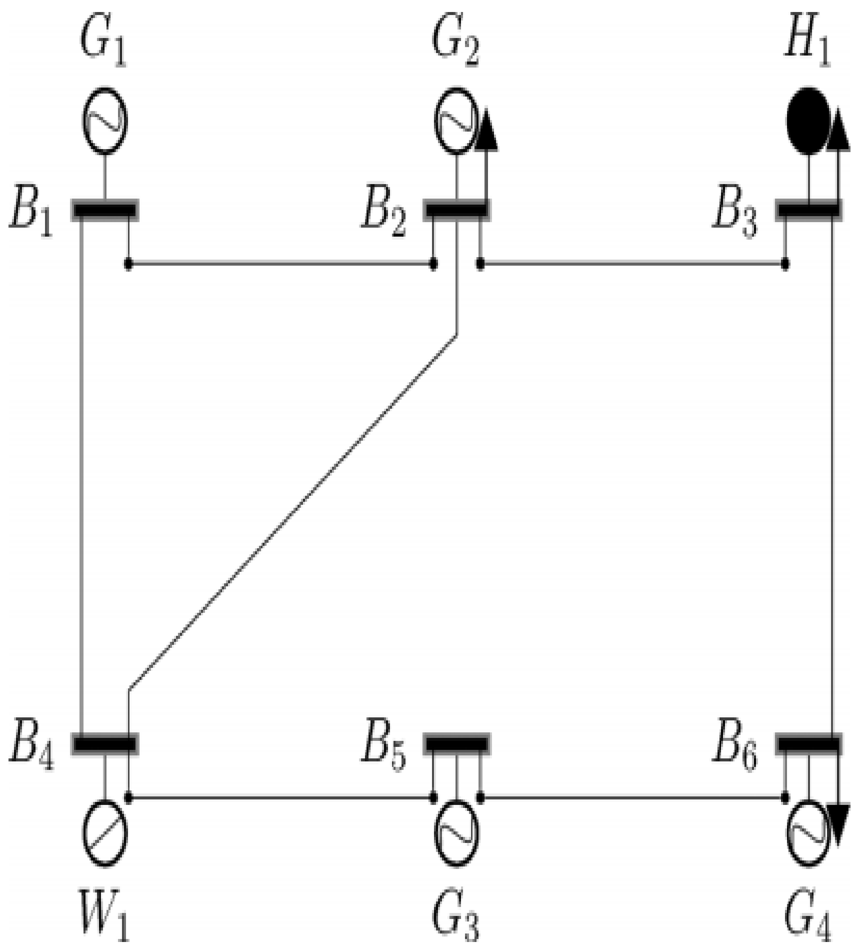

Figure 2: 6 bus network ieee

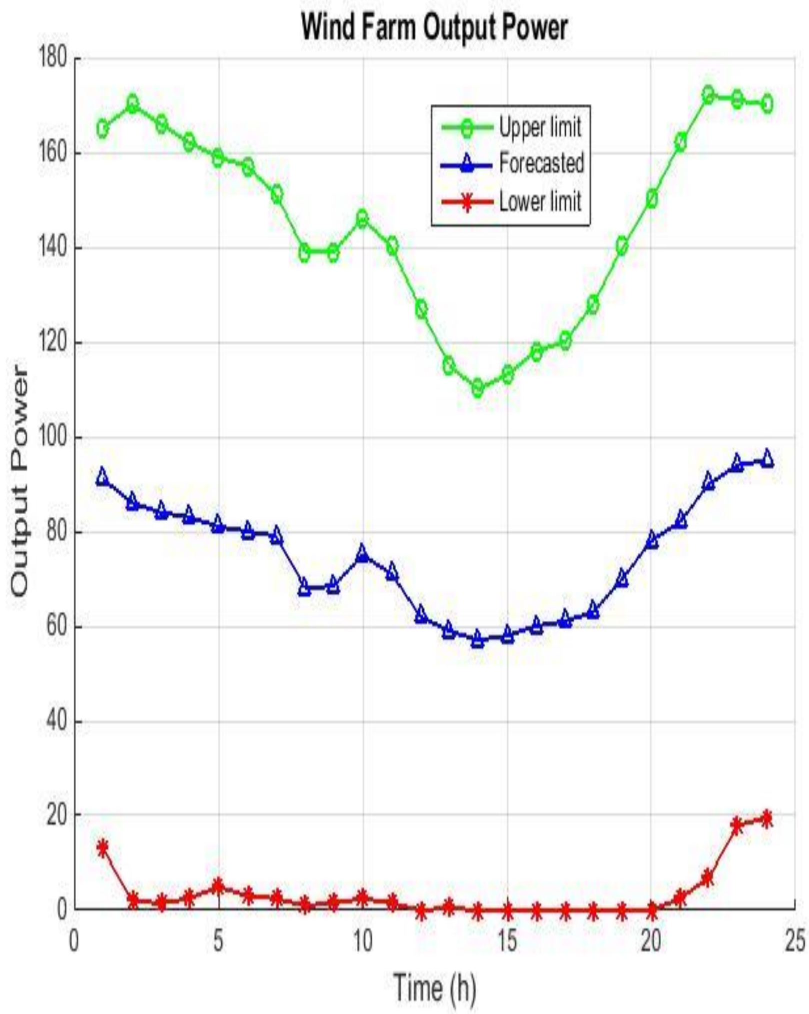

Figure 3. wind farm power output

Also in figure 4 can be stored in water level ,once determined, net charge (which is defined as the difference between the load and power output of the wind farm is onticipated),and expected the worst possible time to be seen. As can be seen from figure(3) and (4) found that ,when we net charge to predict the difference between certain load(blue lines figure 4)and can be predicted wind turbine(blue lines form (2)) use and if the expected worst-case scenario in order to obtain the upper limit of expenditure is concerned,the difference between certain times and at the top or bottom wind turbine(red and green lines figure 3)are use according to

(4) and the final output optimization problem in(5),can be realize when the expected rises (for example,approximately 10)by adding a generator or raise the exiting generators will try to keep the balance between the supply and distribution.for example ,around 10 generator 3 in bass 5 is turned on and its power increases .the first power generator in your bass adds. But when the wating time is less(eg.about 9 pm),some of the exiting power generators and even sometimes cut off.for example about 21:00 generators and other generators 4 in bass 6 off the power applied.

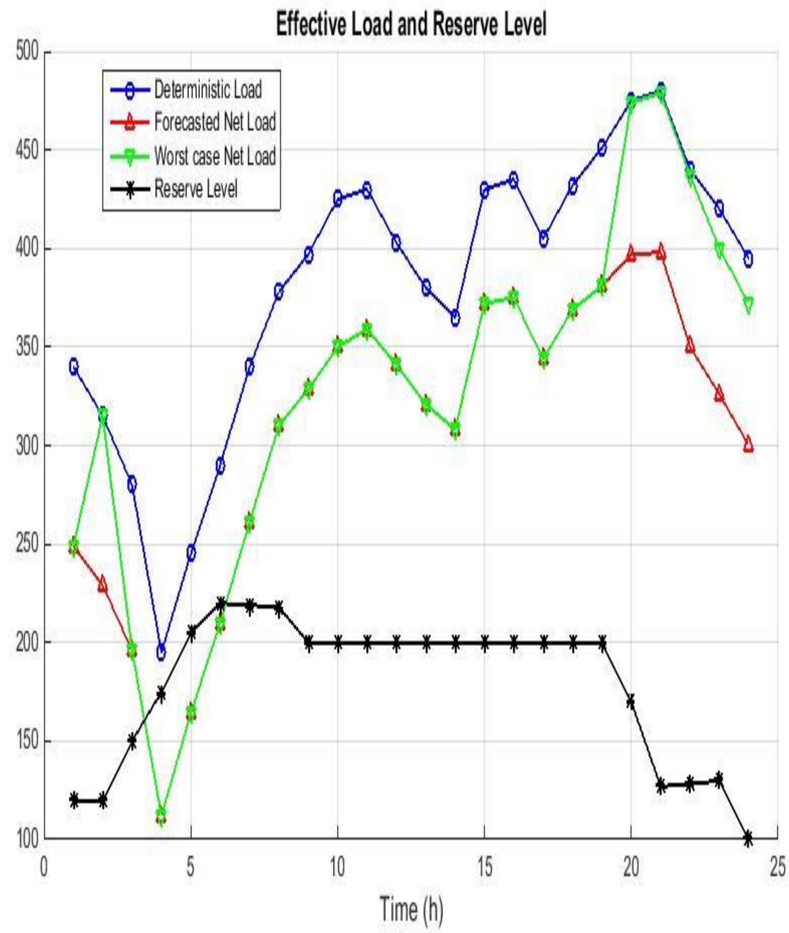

Figure 4:once determined,net charge,the expected worst-case scenario,the level of water stored

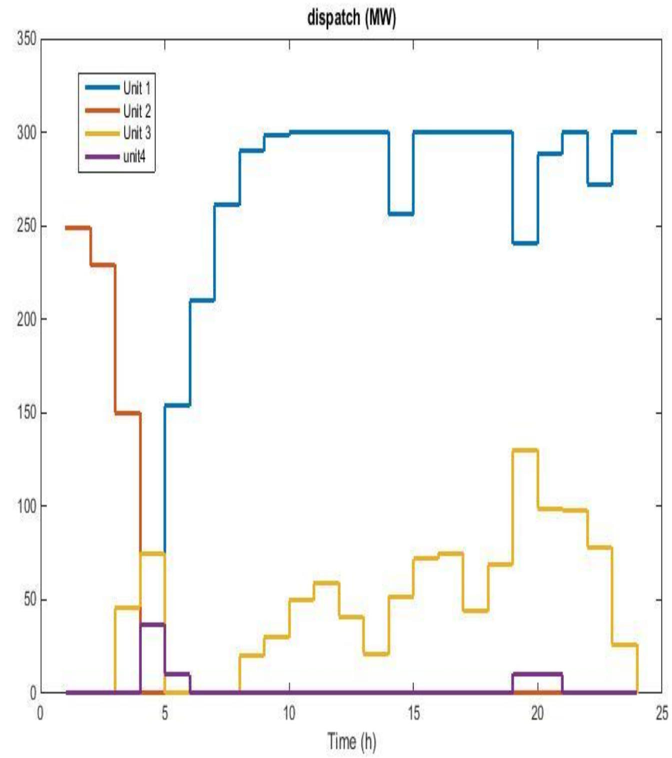

Figure 5: 6-bus load distribution between the four generators on the network.

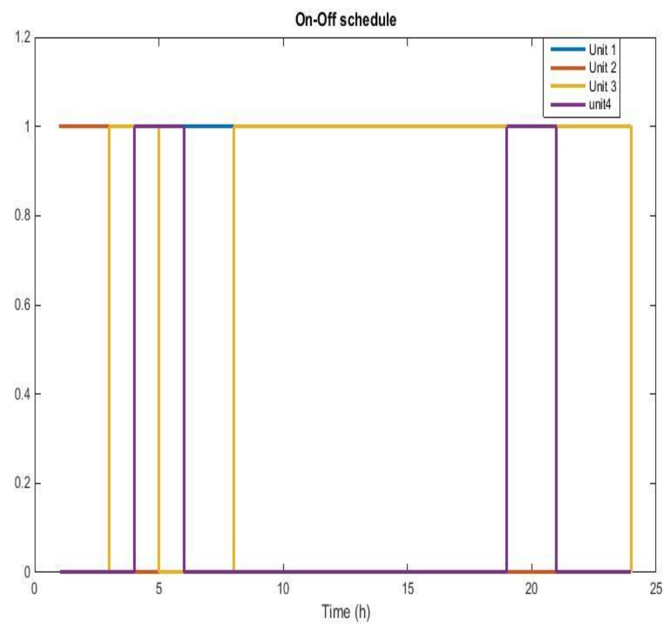

Figure 6. the timing of various units in the 6-bus network

in figure(6) the program on and off the generator can be observed in the coming 24 hours. In fact,in the optimization of a binary variable used to display the power on or off that can be put in orbit with respect to cost and cost of production per unit and other exiting constraints.due to the circuit or circuit units to find out.(for various reasons,including cost and indicating the maximum power transfer to the nearly bus) figure (7) shows charge/dis charge unit shows. Here we see that consumption is high,storage unit as a generator (low power), and low power consumption during such a time and it saves energy generator.finally,figure 8, comparison of the simulation out put in a showcase three different modes.as is expected the presence lowers the total cost storage unit. It should be noted that at the end of a storage unit negligible installation costs and assumption that effect the final price do not know.

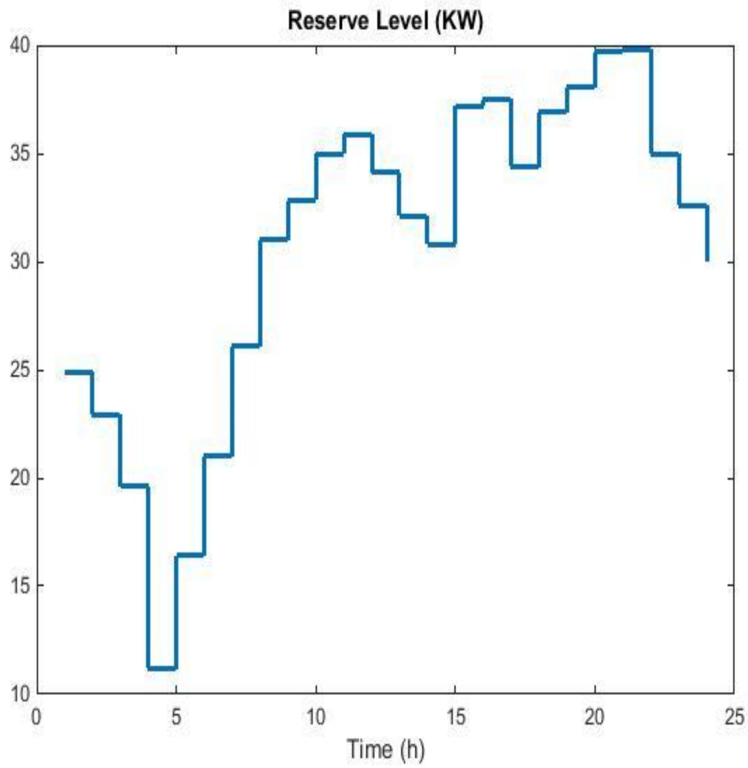

Figure 7: 6-bus status storage unit on the network in the next 24 hours

Another interesting point in the form of (8) increasing the cost when adding constraints on the capacity of the power lines.it is also quite logical , because like any other optimization problem ,move details will be further increased costs .

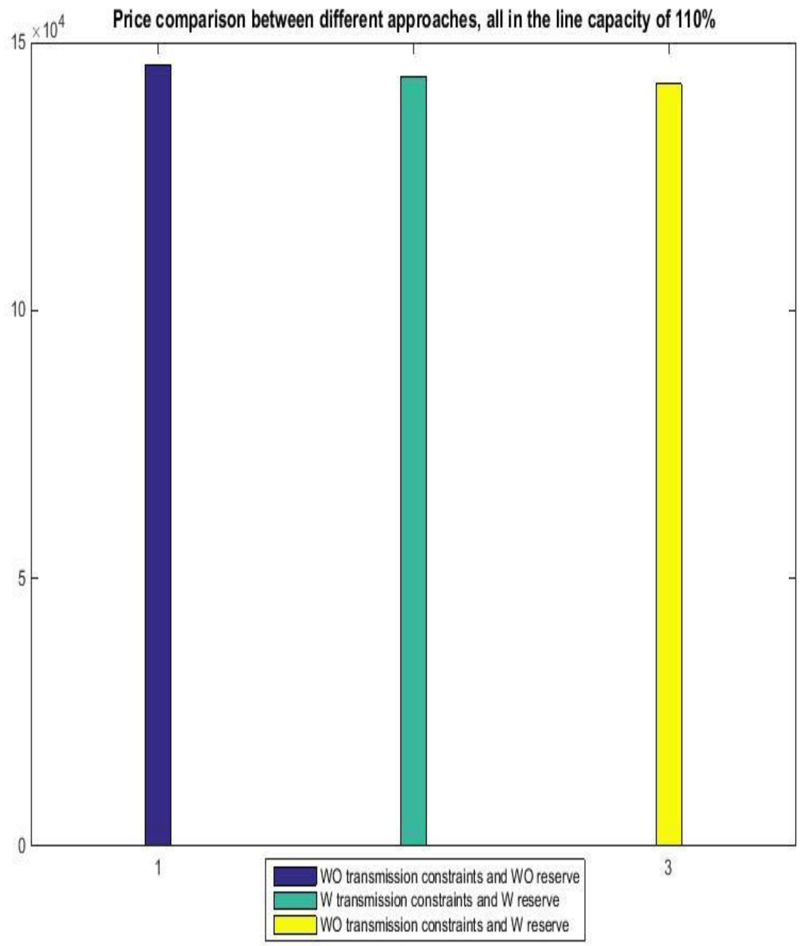

Figure 8:the final cost put in orbit 6-bus network units:storage units and the impact of the effect of limiting the power flowing through the transmission lines.

4-conclusion:

In this thesis ,the expression of the partnership and optimization of its units and relevant provisions formulated and explained.then to express the careful formulation for participation units and in the presence of wind power and pumped storage power plant there.what formulas and theories at the beginning of chapter 4 we found the net six-bus simulation .theoretical results and the results of simulation with MATLAB show that the optimization procedure proof that this thesis was ,could the uncertainty caused by the presence of wind turbines largely resolved,and the pump storage power plant at lower cost is effective . there for,given that currently used wind power plants in iran are limited ,using the method described.the intensity of the performance of these plants is effective and actually helps to exploit.considering what was the use of pumped water storage should be prioritized

5-future research:according to what was said following topics for futher research on the planning partnership units units in the presence of wind turbines and pumped storage power plant is proposed.

- ✓ All the better model for the behavier of wind turbines
- ✓ The new control methods such as neural networks and fuzzy control combined with the proposed model
- ✓ Demand respone proposed program participation and greater use of new energies
- ✓ More real and reactive power constraints
- ✓ Problem,including a discussion of relevant

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