Predictive economic dispatch on *Microgrid* with high penetration of renewable energy sources

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I. Abstract

In this work, a framework for incorporating renewable energy sources into the economic dispatch problem of microgrid system is presented. It shows the possible advantages of adopting a predictive economic dispatch approach. In particular, simulation of the economic dispatch solution for a microgrid system -with both solar and wind technologies and also a battery storage system- illustrates the conditions under which the operation of power systems, with conventional economic dispatch algorithms do not provide a suitable solution. In addition, the purposed predictive strategy shows that it can leads to technical as well as economical improvements depending on the composition of the generation portfolio.

II. Introduction

Planning and operation of power systems are going through important transformation due to: i) the advances in electronics and information technologies that make it possible to infer customer behavior from real time data turning them into potential active agents of the system ; ii) the fast growth in energy demand that must be satisfied without incurring in investment costs that are infeasible for utility companies [1], [2]. iii) The high environmental awareness, which leads to the integration of new clean sources for power generation [3], [4]. The motivation of this paper is to understand the possibilities and challenges that emerge in the context of the item iii. for designing optimal solutions that bring the possibility to integrate high levels of renewable energy sources (RES) efficiently.

Due to the considerable cost reductions and the rapid deployment of many renewable energy technologies, the incorporation of RES (like wind and solar) into the power grid has become an important topic of discussion for public and environmental regulators around the world. Many countries in Europe and North America have declared ambitious goals in terms of renewable energy integration. For example, in 2011 the state of California signed a commitment saying that 33% of its electricity must come from renewable sources by 2020 [5], [6].

As the use of intermittent generation increases, there exist undesired consequences that have not been well established so far and affect both the operation cost and safety of power systems. For instance, meeting the power balance between supply and demand is a complex task, given the natural variability of RES. Additionally, RES production has a direct impact on the short-term frequency regulation (safety) and long-term conventional generation scheduling (generation cost), a non-optimal economic dispatch solution will derive in both, technical and economical operation problems.

Until recently, most of the work related with the economic dispatch problem was focused on heuristic techniques such as genetic algorithms, particle swarm optimization, and neural networks [7]–[11]. But the intermittent nature of the RES, changes the characteristics of the dispatch problem and requires new models that characterize and manage the variability on the dispatch of solar and wind technologies.

In recent years, different works have posed this challenge [12], [13]. In [12], the authors propose to treat intermittent energy sources as a controllable generators using electronic inverters which decides the power level in order to control the dispatch of renewable generators based on the dynamics given by the prediction of the resources availability (wind or solar). The resulting solution is to dispatch the least amount of power from the RES in order to reduce the consumption of expensive units. The limitation of the work is that the RES data is probabilisticaly generated and do not correspond to real data patterns.

The main objective of this paper is to show the behavioral and technical difficulties that emerge in a low scale power system (microgrid) that incorporates a high percentage of RES into its generation portfolio. By comparing a conventional static dispatch with a proposed two stages dispatch control (including a model predictive control strategy (MPC)). It is possible to illustrate the reasons and benefits of adopting a dynamical predictive approach to solve the economic dispatch problem in microgrid system.

Simulation results demonstrate that if the microgrid includes slow responsive generators the conventional economic dispatch sometimes produce unfeasible solution which leads to risk operation, while the MPC solution handles efficiently the integration of intermittent resources guaranteeing a safe operation in all the scenarios. In addition, the predictive dispach ensures an economical solution against the static economic dispatch. On the other hand, both conventional and MPC dispatch have a similar performance when all the generators of the microgrid are fast responsive units.

The remainder of the paper is organized as follows: section 3 shows the system description of the microgrid proposed. Section 4 state the problem formulation of the economic dispatch in the presence of high RES penetration. Section 5 describes the conventional and predictive dispatch for the economic dispatch solution. In section 6 the simulation results are discussed. Finally, section 7 shows the conclusion and furtherwork.

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III. System description

The microgrid model is by definition the placing of small scale energy generators grouped close to the consumption points in an energy distribution system. This grouping can work connected to the main energy grid (grid connected) as well as isolated from it (island). In both scenarios, the main purpose of a microgrid is to guarantee a safe, reliable, and efficient operation while ensuring certain technical and economic criteria [14], [15].

The remain of this work is focused on grid connected microgrids and how they could integrate efficiently high penetration of RES in the generation side. Also, the microgrid system is defined to operate as a single controlled unit, and no participation in the power market is desired. Thus, the main grid is not considered as a dispatchable generation unit but as a extremely large storage system so that no transmission limits are taken into account. This formulation let us propose that the main grid and the battery storage system are the correction units that guarantee the safety operation by absorbing the dispatch errors even when the forecast errors are high.

IV. Problem Description

Economic dispatch treats the problem of dynamic resource (energy) allocation, where a set of generation units must satisfy the energy demand in a given time at the most economical solution. The introduction of technologies based in RES involve big challenges to the safety and economical operation of the existing energy systems, in particular, due to the difficulty of predicting the availability of these resources. The lack of prediction causes big fluctuations in the power delivered by the generators in short-time intervals (in the order of minutes). This situation may lead to operational problems in terms of dispatch provoking outages and unsafe operation.

Now, given that the behavior of photovoltaic and wind turbine technologies vary constantly in time it would be more desirable to perform dynamically the optimization routine for the economic dispatch in order to adapt the dispatch of conventional generators to the predicted fluctuations of the RES. For that reason, a MPC based strategy is used for dynamic scheduling the generation output of both conventional and RES. The MPC uses the information of the predicted future behavior of the system not only to calculate an optimal solution but also to adjust the dispatch allocation in order to handling disturbances (renewable sources variability).

The following variables and parameters are used in the formulation of the problem:

Notation	Description	Units
n	Number of conventional generators.	
m	Number of renewable generators.	
T	Prediction horizon for the MPC.	
$P_i^c(k)$	Generated power by the conventional generator i at the instant k, $i = 1, 2, \ldots, N$.	(MW)
$\overline{P_i^c}$	Maximum generated power by the conventional generator i at the instant k, $i = 1, 2, \ldots, N$.	(MW)
ΔU_i^c	Conventional generation input of the i conventional generator, at the instant	(MW)
ΔU_j^r	RES input of the j RES generator, at the instant k, $j = 1, 2, \ldots, M$.	(MW)
$P_j^r(k)$	Generated power by the renewable generator j at the instant k, $j = 1, 2, \ldots, M$.	(MW)
$\overline{\hat{P}_j^r}(k)$	Maximum predicted power from the renewable generator j for the instant k.	(MW)
$\bar{P}_j^r(k)$	Scheduled power for the renewable generator j for the instant k.	(MW)
$\hat{P}_j^r(k)$	Power prediction of renewable generator j for instant k.	(MW)
$C_i(P_i^c(k))$	Production cost for conventional generator i supplying $P_i^c(k)$ power at the instant k,$i = 1, 2, \ldots, N$.	($)
R_i	Ramp rate limit for a generator i in an interval of time $\Delta\tau$. $i = 1, 2, \ldots, N$	$(MW/\Delta\tau)$
$L(k)$	Demand of power ($L(k) = L^{nc}(k) + L^c(k)$) for instant k.	(MW)
$L^c(k)$	Controllable load node	(MW)
$L^{nc}(k)$	Non-controllable load node	(MW)
$\hat{L}(k)$	Forecasted demand of power of the load nodes at instant k.	(MW)
$\Delta\tau$	Time constant corresponding to the sampling frequency e.g. 5 minutes	$minuts$
$PB^{error}(k)$	Power balance error produced by the forecast error	(MW)
PB^{limit}	Second controller condition to jump from model predictive controller to charging control.	(MW)
$P^{mg}(k)$	Power exchange with the main grid at the instant k.	(MW)
$\overline{P^{bss}}$	Power rated capacity of the storage	$(MW/5min)$
$P^{ch}(k)$	Charging power of the battery storage system at the instant k.	(MW)
$P^{dch}(k)$	Dis-charging power of the battery storage system at the instant k.	(MW)
$P^{ch}(k)$	Charging power of the battery storage system at the instant k.	(MW)
$P^{dch}(k)$	Dis-charging power of the battery storage system at the instant k.	(MW)
$SOC(k)$	State of charge of the battery storage system at the instant k	%
P^{tr}	Trade power between the main grid and the battery storage system for charging purposes.	(MW)
γ	Charge and Discharge efficiency	%

V. Economic dispatch in microgrid

A. Conventional Economic dispatch

The economic dispatch problem for the conventional power system is posed as a static optimization problem (See e.q (1) to e.q. (7)). E.q. (1) corresponds to the function that must be minimize. The operation cost of the microgrid is the cost of only the conventional generators because the RES are supposed to have zero operational cost given that the capital cost is not taken into account, then the operational cost is performed by the function shown in the e.q. (8). The quadratic cost function relates the conventional generation fixed cost, the linearly dependence of the power produced and the fuel cost.

The economic dispatch must be solved at every instant satisfying the following constraints: e.q. (2) refers to the power balance of the system and e.q (3) and e.q. (6) to e.q. (7) are the technical constraints of the conventional generation units. When the RES are introduced into the existing power system the dispatch policy adopted by the utilities in order to minimize costs is to define them as negative loads which deliver all its total (variable) capacity at any instant of time (See e.q. (2)). Then, the conventional generation must be able to compensate the variability of both load consumption and renewable resources.

In this case, a prediction for the power availability of the renewable sources is required (See e.q. 5) in order to compute the value of the RES amount of energy available for the next economic dispatch operation point. Because of the main objective of the project is not associated with the forecast study, a set of auto-regressive moving average models are used to predict the next step load consumption and RES generation (See e.q.(4) and e.q.(5)).

$$\min_{U_i^c(k)} \sum_{i=1}^{n} C_i(P_i^c(k)) \tag{1}$$

s.t.

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$$\sum_{i=1}^{N} P_i^c(k) = \hat{L}(k) - \sum_{j=1}^{M} \hat{P}_j^r(k) \tag{2}$$

$$P_i^c(k+1) = P_i^c(k) + \Delta U_i^c \tag{3}$$

$$\hat{L}(k+1) = f(L(k), L(k-1), \ldots, L(k-nb)) \tag{4}$$

$$\hat{P}_j^r(k+1) = h(P_j^r(k), P_j^r(k-1), \ldots, P_j^r(k-nb)) \tag{5}$$

$$0 \leq P^c(k) \leq \overline{P_i^c} \tag{6}$$

$$|P_i^c(k) - P_i^c(k-1)| \leq R_i * \Delta\tau \tag{7}$$

$$C_i(P_i^c(k)) = a0 P_i^c(k)^2 + a1 P_i^c(k) + a2 \tag{8}$$

B. Proposed predictive dispatch

Given the high uncertainty of the RES the forecast errors led to undesired operating conditions in which the power balance is not zero. Then, as long as the RES grows the power balance error becomes higher and the microgrid system is at risk of failures. To overcome that difficulty a cascade control strategy is proposed and test by simulation.

As shown in the Fig. 1 the economic dispatch optimization is divided into two subproblems: i) first, the generation side of the microgrid must balance the energy demanded from the load side solving the economic dispatch. ii) Second, due to the forecast error a remaining quantity of power is still needed to be allocated, for that task a second controller is performed.

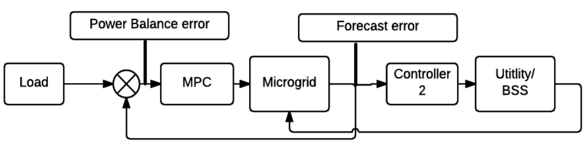

Fig. 1: Proposed predictive dispatch block diagram

1) Economic dispatch using MPC: Model predictive control is a widely used control technique for multi variable constrained problems and its effectiveness has been well demonstrated particularly in the field of process control. The control task is to find the optimal values of the generators set points (both conventional and renewable sources) which minimize the operation cost over a prediction horizon, while ensuring that the total load consumption must be equal to the resulting power generation and works as follow: first, the system to be controlled has to be modeled so that a prediction of the future outputs can be calculated. In most cases, the modeling is done through a linear state space representation of the form $x(k+1) = Ax(k) + Bu(k)$, where $x(k) \in R^n$ are the states and $u(k) \in R^m$ denote the inputs. Secondly there is an optimization block that calculates the input to the plant, ensuring a secure and desirable behavior (minimizing an objective or control task) of the system.

At any specific time the MPC process the information from the past states and outputs in order to compute the solution of the optimal control problem for the whole control horizon (T). When the MPC solution is ready, only the first step is applied to the plant, then new measurement outputs are introduced to the controller and the finite-horizon optimization cycle starts again as shown in Figure 2.

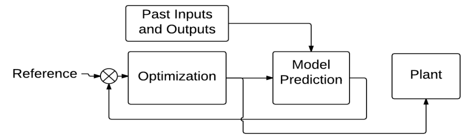

Fig. 2: MPC block diagram

By adopting the MPC strategy the economic dispatch problem is reformulated as shown in e.q. (9) to e.q. (17).

$$\min_{U(k)} \sum_{k=1}^{T} \sum_{i=1}^{n} C_i(P_i^c(k)) \tag{9}$$

s.t.

$$\sum_{i=1}^{n} P_i^c(k) + \sum_{j=1}^{m} P_j^r(k) = \hat{L}(k) \tag{10}$$

$$P_i^c(k+1) = P_i^c(k) + \Delta U_i^c \tag{11}$$

$$P_j^r(k+1) = P_j^r(k) + \Delta U_j^r \tag{12}$$

$$\hat{L}(k+1) = f(L(k), L(k-1), \ldots, L(k-nb)) \tag{13}$$

$$\hat{P}_j^r(k+1) = h(P_j^r(k), P_j^r(k-1), \ldots, P_j^r(k-nb)) \tag{14}$$

$$0 \leq P_j^r(k) \leq \overline{\hat{P}_j^r}(k) \tag{15}$$

$$0 \leq P^c \leq \overline{P_i^c}(k) \tag{16}$$

$$|P_i^c(k+1) - P_i^c(k)| \leq R_i \Delta\tau \tag{17}$$

The main differences with the previous formulation are that the MPC algorithm is a dynamic optimization problem carried out over a prediction horizon T (see e.q. (9)) and the renewable energy resources are included into the decision variables. The dynamic optimization problem is compoused by the conventional and renewable energy sources dynamics (See e.q. (11) and e.q.(12)) as well as the prediction of the RES and load (See e.q.(13) and e.q.(14) Due to the power generation output of RES is part of the decision variables, they can vary from the variable maximum predicted capacity at any instant k (see e.q. (15)). Finally, the optimization problem is completed with the power balance equation (See e.q.10) and the technical constraints of the conventional generation (See e.q.(16) and e.q.(17)).

2) Power balance error dispatch: Fig. 3 shows the control developed to accomplish the task of allocating the forecast error after the MPC economic dispatch stage. On one hand, a static dispatch of the main grid and the battery in charge of compensating the power balance error. On the other hand, the charge control strategy charges the battery with power from the main grid.

Depending on the conditional shown in Fig. 3, the power balance error dispatch control will switch between the static dispatch and the charge control. The power balance limit (PB^{limit}) is defined in terms of the safety operation of the microgrid, thereby for $PB_{error} \geq PB^{limit}$ values the microgrid generators could not respond properly and the operation is risky. Therefore, the static dispatch control will be active. Contrary, for $PB_{error} \leq PB^{limit}$ values the microgrid could handle the power balance error by the frequency control of the generators and the charge control will be active.

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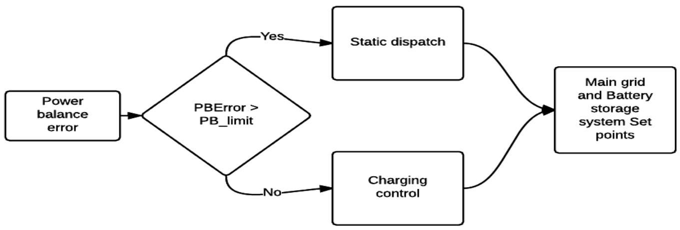


Fig. 3: Two stages control

The static dispatch is modeled as an economic dispatch problem similarly to the conventional economic dispatch. The optimization procedure is presented in the following equations: e.q. (18) to e.q. (25). In this case the cost function e.q. (18) represent a weighted cost function in order to balance the use of the main grid and the battery. The power balance equation correspond to the equality constraint e.q. (19). Main grid dynamical system is carried out by the difference equation e.q.(20). On the other hand the battery system dynamic is modeled by the state of charge (SOC) which gives the measurement of the battery capacity in percentage as e.q.(21) shows.

$$\min_{\Delta P^{mg}, P^{ch}, P^{dch}} \alpha(P^{mg}(k)^2) + \beta(P^{ch}(k)^2 + P^{dch}(k)^2) \tag{18}$$

s.t.

$$P^{mg}(k) + P^{ch}(k) - P^{dch}(k) = PB^{error}(k) \tag{19}$$

$$P^{mg}(k) = P^{mg}(k-1) + \Delta P^{mg} \tag{20}$$

$$SOC(k) = SOC(k-1) + \gamma(P^{ch}/\overline{P^{bss}} - P^{dch}/\overline{P^{bss}}) \tag{21}$$

$$P^{ch} \leq \overline{P^{bss}} \tag{22}$$

$$P^{dch} \leq \overline{P^{bss}} \tag{23}$$

$$P^{ch} \geq 0 \tag{24}$$

$$P^{dch} \geq 0 \tag{25}$$

VI. Results

In the following section the simulation results of the whole economic dispatch purposed are presented. Each simulation correspond to one day operation of 24 hours solving the economic dispatch every 5 minutes. The economic dispatch is solved with Matlab R2013a software. In addition, Yalmip toolbox using gurobi solver is in charge of the optimization calculations.

The microgrid set up is defined by one common coupling point with the main grid, three conventional generators, two RES (one photovoltaic field, and one group of wind turbine), a battery storage system and one load aggregation node. The data corresponding for the RES is taken from one location at California from the national renewable energy sources laboratory simulated data. The microgrid has a RES installed capacity corresponding to 100% of penetration level. For the load consumption data, the set of information from the New York independent system operator at New York City location is used.

Table I shows the result of the different scenarios were the microgrid generation portfolio is composed by two slow and cheapest unit (e.g. coal) and one expensive fast responsive unit (e.g. gas). It can be notice that if the economic dispatch is solved with the conventional optimization technique it is always more costly than the predictive dispatch.

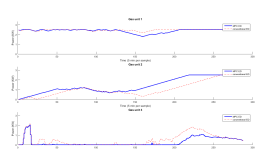
In addition, it is important to remark that when the economical benefit of the predictive strategy is 99% against the conventional strategy it means that the conventional optimization solution is infeasible, so no generation combination could handle the variability of the RES. This fact allows to said that the predictive strategy guarantees a safer operation given that always it could produce a feasible solution for the entire simulation day.

Sim	Forecast	MPC cost (USD)	Conv cost (USD)	MPC cost benefit (%)
1	no	2.99E5	3.034E5	1.3
	yes	2.992E5	3.019E5	0.9
3	no	3.041E5	4.2E6	99
	yes	3.061E5	4.2E6	99
5	no	2.985E5	3.068E5	3
	yes	3.003E5	3.070E5	2.2
7	no	2.970E5	6.7E6	99
	yes	2.997E5	5.7E6	99
9	no	3.987E5	3.055E5	2.3
	yes	3.004E5	3.034E5	1

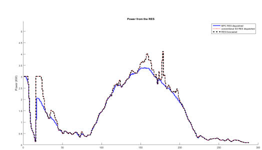
TABLE I: Result for slow ramp rate simulations

Fig. 4 illustrates the behavior of the economic dispatch from the simulation number 5. From Fig.4a it can be seen that the predictive strategy anticipates and corrects the scheduling of the cheapest units (See unit 1 and unit 2 at 150 time samples) in order to lower the use of the expensive unit. In addition in Fig.4b it is shown how the predictive dispatch reduces the power generation from the RES, so that optimal scheduling of the conventional generators can be done (e.g. from time sample 150 to 180 in Fig.4a).

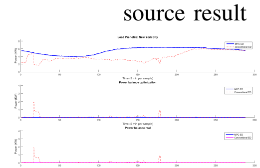
Given that there is no forecast error (RES are assumed to be perfectly known) the second controller do not has to compensate any imbalance of energy, then the main grid and the battery remains in active.



(a) Gas generators result



(b) Renewable energy source result



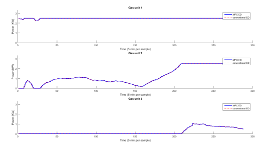
(c) Load profile and power balance error

Fig. 4: Simulation 5 (without forecast)

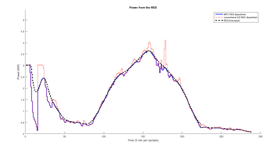
Table II shows the results of different scenarios were the conventional generators correspond to three fast responsive units (e.g. gas). It is important to notice that the performance of the conventional dispatch as well as the predictive dispatch is the same for all the simulations. The fast response capacity of the gas units allows them to follow even the high variations of the RES, Therefore, the conventional dispatch solution can meet the optimal solution.

Sim	Forecast	MPC cost (USD)	Conv cost (USD)	MPC cost benefit (%)
2	no	2.97E5	2.97E5	≈ 0
	yes	2.977E5	2.977E5	≈ 0
4	no	2.993E5	2.993E5	≈ 0
	yes	2.992E5	2.992E5	≈ 0
6	no	2.947E5	2.947E5	≈ 0
	yes	2.949E5	2.949E5	≈ 0
8	no	2.935E5	2.935E5	≈ 0
	yes	2.935E5	2.935E5	≈ 0
10	no	2.962E5	2.962E5	≈ 0
	yes	2.963E5	2.963E5	≈ 0

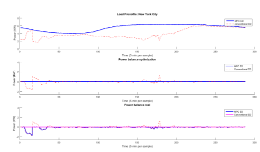
TABLE II: Result for fast ramp rate simulations



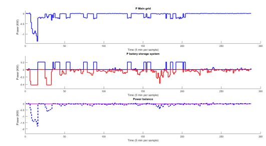
(a) Gas generators result



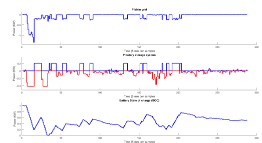
(b) Renewable energy source result



(c) Load profile and power balance error



(d) Main grid, battery storage system and power balance error



(e) Main grid, battery storage system and battery SOC

Fig. 5: Simulation 6 (with forecast)

In addition, Fig.5a shows that the conventional economic dispatch solution is mostly the same as the optimal solution found with the predictive strategy in the previous scenario (See Fig.4a).

In this scenario, the forecast estimation is taken into account, thus the forecast error appear and the second controller is active as Fig.5d and Fig.5e shows. It can be appreciated that in this simulation the RES experience little variability, hence the forecast error appear significantly only at the beginning of the simulation (See Fig.4a bottom plot). As a result of the forecast error the battery and the main grid absorb that energy. Fig.5e (bottom plot) shows the SOC dynamic of the storage system and it illustrates how it charges and discharges following the static dispatch and charge control modes.

VII. Conclusions

This paper compares two strategies in order to solve the economic dispatch problem of a microgrid that incorporates high penetration of RES. Contrary to the idea that define the intermittent resources as non-dispatchable units, the purposed predictive economic dispatch shows that it is desirable to control them and operate as dispatchable units when the generation portfolio includes cheap and slow units. By doing this, the MPC solution is economical against the coneventional dispatch. Also, predictive strategy can not only handle the high variations on the renewable sources output without using large amount of power from expensive generators but also guarantee a safe operation.

As further work, it is proposed to include control capabilities in the consumption side which means demand response. In this sense, including electric vehicles as dynamically responsive load, could be another alternative to deal with the RES forcast error.

References

[1] M. D. Ilic, "From Hierarchical to Open Access Electric Power Systems," *Proceedings of the IEEE*, vol. 95, no. 5, pp. 1060–1084, May 2007.

[2] G. Pepermans, J. Driesen, D. Haeseldonckx, R. Belmans, and W. D'haeseleer, "Distributed generation: definition, benefits and issues," *Energy Policy*, vol. 33, no. 6, pp. 787–798, 2005.

[3] U S Energy Information Administration, "Emissions of Greenhouse Gases in the United States 2009," no. March, 2011.

[4] H. Farhangi, "The path of the smart grid," *Power and Energy Magazine, IEEE*, vol. Volume:8, no. february, pp. 18–28, 2010.

[5] D. Hochschild, "California Renewable Energy Overview and Programs," 2014. [Online]. Available: http://www.energy.ca.gov/renewables/

[6] U. D. of Energy, "Wind Vision:A New Era for Wind Power in the United States," Tech. Rep., 2008.

[7] D. Llu, "Economic and optimal dispatching of power microgrid with renewable energy," no. Ciced, pp. 23–26, 2014.

[8] N. Singh and Y. Kumar, "Economic Load Dispatch Using MRPSO with Generator Ramp Rate Limits Constraint," *2012 Fourth International Conference on Computational Intelligence and Communication Networks*, pp. 632–637, 2012.

[9] S. Özyön and D. Aydin, "Incremental artificial bee colony with local search to economic dispatch problem with ramp rate limits and prohibited operating zones," *Energy Conversion and Management*, vol. 65, pp. 397–407, 2013.

[10] G. C. Liao, "The optimal economic dispatch of smart Microgrid including Distributed Generation," *ISNE 2013 - IEEE International Symposium on Next-Generation Electronics 2013*, pp. 473–477, 2013.

[11] J. Chen, X. Yang, L. Zhu, and M. Zhang, "Microgrid economic operation and research on dispatch strategy," *Proceedings - Power Engineering and Automation Conference, PEAM 2012*, no. 50977055, pp. 12–17, 2012.

[12] L. Xie and M. D. Ilic, "Model predictive dispatch in electric energy systems with intermittent resources," in *2008 IEEE International Conference on Systems, Man and Cybernetics*. Ieee, 2008, pp. 42–47.

[13] E. Mayhorn and K. Kalsi, "Optimal control of distributed energy resources using model predictive control," in *System Sciences (HICSS), 2013 46th Hawaii International Conference on*, 2013, pp. 1–8.

[14] S. Chowdhury, S. P. Chowdhury, and P. Crossley, "Microgrids and Active Distribution Networks," London, p. 297, 2009. [Online]. Available: http://www.farzadrazavi.com/files/Courses/microgrid/902/bookiee.pdf

[15] R. H. Lasseter, "MicroGrids," in *2002 IEEE Power Engineering Society Winter Meeting. Conference Proceedings (Cat. No.02CH37309)*, vol. 1. Ieee, 2002, pp. 305–308.

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