International Journal of Emerging Technology in Computer Science & Electronics (IJETCSE)
ISSN: 0976-1353 Volume 24 Issue 9 – JUNE 2017.

A NEW APPROACH TO DEPENDENT REQUEST REACTION CONTROL IN THE SMART GRID

M.SUMITHRA [#1] and B. BUVANESWARI [*2]

[#] *Department of IT, Panimalar Engineering College, Chennai, Tamil Nadu, India.*

[*] *Department of IT, Panimalar Engineering College, Chennai, Tamil Nadu, India.*

***Abstract*— Day to day world, technology has developed a lot. At the same time the need for systems with automation and highest security are tendered. To cross these new challenges, such as generation diversification, greenhouse gas emissions power conservation, request response and a novel liberalized market system. It is clear that these firmly determined cannot with the present infrastructure. Worldwide energy generation and delivery structure are transitioning to a new computerized "smart grid". One of the concept elements of the smart grid is an advanced metering infrastructure (AMI). AMI replaces the analogy meters with automatic systems that report consumption over digital communication interfaces, e.g., service provider lines. However, with this infrastructure comes novel risk of probability. Smart grid is the mix of cutting edge insights, affiliation and networking advances in conventional electric lattice to make it more astute and quicker in making conclusion. The novel proposed electric grid is helpful for providing consecutive power supply to the freightage with automated request management. The request management was proposed with request response management by shifting the loads to the weak bus once if the bus is loaded with its highest capacity. To improve the execution of the power system, smart grid technology is implemented with automated metering interface that provides two way communications between the utility and supply.**

***Index Terms*—About four key words or phrases in alphabetical order, separated by commas.**

I. Introduction

The challenges with the traditional power grid are the aging infrastructure, and the increasing greenhouse gas emission with increase in population and demand. Further issues have been corroborated with the recent blackouts[1], grid into a more responsive, efficient, and reliable system. The smart grid [2], offers upgrade efficiency, reliability, and domain friendliness in power production, communication, distribution, utilization, and management, by integration of advanced statistics and communication technologies which is widely believed to be the future power grid. Demand response management (DRM) is the response system where the end users will see changes in electricity cost across time or to other forms of inducement. DRM plays a important role in improving multi aspects of both supply and demand sides, in the smart grid. For instance, DRM can result in higher utility efficiency and lower bills for end users. The price of power generation and also the improvement in the revenues to retailers or utility companies (UCs) can be done with DRM. In DSM, the costing mechanisms and straight be in charge of strategies are employed by the energy dealers that it affects consumers consumption behaviours and reshape the total load [3]–[5]. DRM sets different prices during the day to motivate consumers to shift their request to off-peak hours [7]–[9] to reduce the time-of-use pricing strategy. Similar to the time-of-use pricing, the critical extreme cost applies a pre specified highest cost during the delegate critical peak periods [10], [11]. Along with the DSM techniques, the integration of dispersed energy resources (DERs) into the grid can also usually increase the grid's size and reduce the discharge of CO2 [12]. Equipped with the dispersed energy production, the residential consumers can also participate in the electricity market as an energy provider. In this system we make use of two algorithms the DRM algorithm along with v/f controls.

II. RELATED WORK

Several studies on DSM and DRM have purposeful on either only one usefulness or a number of utilities treated as one entity [5]–[10]. Mohsenian-Rad *et al.* [3] have formulated an energy utilization scheduling problem as a non cooperative game among the customers for increasing and strictly convex price functions. Fan [7] has considered a distributed system where cost is modelled by its dependence on the overall system usage capacity. Based on the cost information, the users adapt their demands to increase their own utility. In [9], a robust optimization problem has been constructed to increase the utility of a customer, taking into account cost reservations at each hour. Wang and Groot [8] have demoralized the awareness of the users and proposed a method to summative and manage customers' preferences to increase energy efficiency and customer fulfilment. In [9], a dynamic costing scheme has been proposed to provide incentives for customers to attain an aggregate load profile suitable for UCs, and the request response problem has been investigated for different levels of information sharing among the customers. In [10], a multi resolution two-layer game is studied using mean-field game reach to incorporate inner communications between users in the region and outer communications between regions for dynamic dispersed request response in the smart grid. References [11] and [12] have also included electric vehicles into the DRM framework. To this end, compared to relating existing survey we propose a system which can change the source when there is an enlarge in the threshold load, where here the dimension of load is obtained using the 1. DRM(demand response management system) and the shifting is done by using the 2.v/f controller.

III. SYSTEM MODEL

Fig. 1 depicts our hierarchical system model, which consists of three levels: 1) power generation units at the top level; 2) distribution algorithms and 3) residential and industrial consumers at lowest bottom with AMI(Automated Metering Interface). The framework is motivated by the hierarchy of the real power grid system. The power production units or power plants give power, the UCs determine the unit cost and optimal amount of power to supply, and the bottom level denotes the request response to the cost signal from the residential consumers. The power generation units, UCs and the customers have bidirectional communications support to switch over cost and request information. The information communication is carried out through the communication channel using wireless technologies.

IV. DEMAND SIDE ANALYSIS

Let y be the cost per unit power. For given y, user n $(n \in NR)$ calculates its most favourable request response by solving the user optimization problem to improve its welfare WR,n as follows:

$$\max_{x_{R,n}} \quad W_{R,n} := U_{R,n}(x_{R,n}) - y x_{R,n} \qquad (1)$$

$$\text{s.t.} \quad x_{R,n} \geq x_{R,n,\min} \qquad (2)$$

where xR,n,min is the minimum power prerequisite of customer n. The above, that is, (1) and (2) characterizes a strictlyconvex optimization problem for given y. Hence, the inactive solution is distinctive and most favourable.

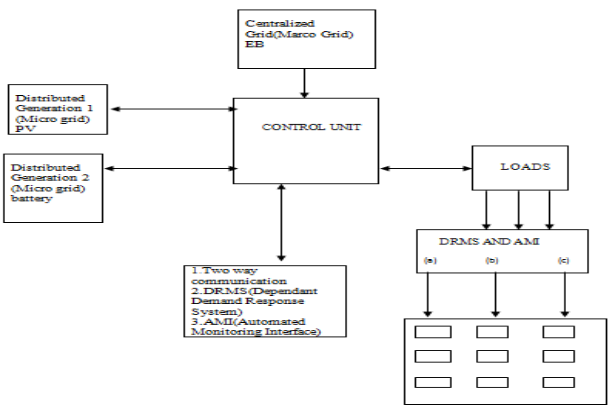


FIG.1 System model of smart grid system

The first-order optimality form for the optimizing suburban customers leads to $(\partial WR,n/\partial xR,n,k) = 0$, $\forall n \in NR$, that is

$$U'_{R,n} = y, \Rightarrow x_{R,n} = \left(U'_{R,n}\right)^{-1}(y). \qquad (3)$$

The form required for constraint (2) to be fulfilled can be recognized by substituting (3) into (2), which requires $y \leq [U\_R,n]xR,n=xR,n,\min$, $\forall n \in NR$. This can be ensured if

$$y \leq y_{\max} := \left[U'_{R,n}\right]_{\substack{\min \\ n \in \mathcal{N}_R}} x_{R,n} = x_{R,n,\min}. \qquad (4)$$

For the reason of illustration and to supply function specific insights, we employ two broadly adopted achieve functions for residential consumers: 1) piecewise quadratic function [12]; and 2) logarithmic function [10]. We describe the piecewise quadratic gain function of suburban customers n, $(n \in NR)$, as

$$U_{R,n}(x_{R,n}) = \begin{cases} v_{R,n} x_{R,n} - \dfrac{z_{R,n} x_{R,n}^2}{2}, & \text{if } x_{R,n} \leq \dfrac{v_{R,n}}{z_{R,n}} \\ \dfrac{z_{R,n}}{2 v_{R,n}} & \text{if } x_{R,n} > \dfrac{v_{R,n}}{z_{R,n}} \end{cases} \qquad (5)$$

where vR,n and zR,n are customer-specific parameters $\forall n \in NR$. In this case, (3) and (4), respectively, take the form

$$x_{R,n} = \frac{(v_{R,n} - y)}{z_{R,n}} \qquad (6)$$

And

$$y \leq y_{\max} := \min_{n \in \mathcal{N}_R} \left(v_{R,n} - z_{R,n} x_{R,n,\min}\right). \qquad (7)$$

The logarithmic gain function can be defined for suburban customers n, $(n \in NR)$, as

$$U_{R,n}(x_{R,n}) = \alpha_{R,n} \ln\left(\beta_{R,n} + x_{R,n}\right), \quad \forall k \in \mathcal{K} \qquad (8)$$

where $\alpha R,n$ and $\beta R,n$ are user-specific parameters. In this case, for known y, (3) and (4), respectively, take the form

$$x_{R,n} = \frac{\alpha_{R,n}}{y} - \beta_{R,n} \qquad (9)$$

And

$$y \leq y_{\max} := \min_{n \in \mathcal{N}_R} \frac{\alpha_{R,n}}{\beta_{R,n} + x_{R,n,\min}}. \qquad (10)$$

V. SUPPLY SIDE ANALYSIS

If the sum of power supplied by UC k is Pk, the revenue of supplier k is defined as

$$R_{\text{UC},k} = y P_k - C(P_k). \qquad (11)$$

Then, the optimization problem for each UC is as follows:

$$\max_{0 \leq y \leq y_{\max}, P_k \in \mathbb{R}_+} \quad R_{\text{UC},k}$$
$$\text{s.t.} \quad P_I + \sum_{n \in \mathcal{N}_R} x_{R,n} \leq \sum_{k \in \mathcal{K}} P_k$$
$$P_k \leq P_{k,\max}; \forall k \in \mathcal{K} \qquad (12)$$

where Pk, max is the highest power UC k can supply. When Pk, max is adequately large, PI , $Pk << Pk$,max. Then the second constraint can be undisturbed. For a given y, (12) is a convex optimization problem. Given y, the first-order optimality state for the UCs, *(∂RUC,k/∂Pk)* = 0, gives the optimal amount of power to be supplied by UC *k* as

$$P_k = (C_k')^{-1}(y);\ \ \forall k \in \mathscr{K}. \tag{13}$$

Normally, if the power provide of different UCs are given, the unit cost would be summated based on the supplied power. However, we are taking into consideration here a planning level problem where both unit cost and optimal power to be supplied, are the variables. Thus, the finest power of each UC is summated by backward induction, based on the optimal unit cost, a limitation obtained as a result of the highest earnings optimization of the UCs. With the optimal request response of residential consumers (3) and UCs' power supply (13) in response to the cost *y*, the purpose of the UCs is to set the optimal cost *y*. For supply request equilibrium, it is required that

$$\sum_{k\in\mathscr{K}} P_k = P_I + \sum_{n\in\mathscr{N}_R} x_{R,n}. \tag{14}$$

Substituting (3) and (13) into (14) we attain

$$\sum_{k\in\mathscr{K}} (C_k')^{-1}(y) = P_I + \sum_{n\in\mathscr{N}_R} (U_{R,n}')^{-1}(y). \tag{15}$$

where *G1(y) = _k∈K (C_k) −1(y) − _n∈NR (U_R,n)−1(y)*. We employ a quadratic price function for power

generation [12], [13]. Let *ak* > 0 and *bk, ck* ≥ 0 be the coefficients of the price function *Ck(Pk)*. Then, if the total

power supplied by UC *k* is *Pk*, then the price incurred to the UC is

$$y = (G_1)^{-1}(P_I) \tag{16}$$

When the gain functions of the residential consumers are piecewise quadratic as given by (5), (16) takes the form

$$C_k(P_k) = a_k P_k^2 + b_k P_k + c_k. \tag{17}$$

Proposition 1: When the gain functions of the residential consumers are piecewise quadratic as given by (5), (18) is the distinctive feasible solution to the profit maximization problem (12) only if

$$y = \frac{P_I + \sum_{k\in\mathscr{K}} \frac{b_k}{2a_k} + \sum_{n\in\mathscr{N}_R} \frac{v_{R,n}}{z_{R,n}}}{\sum_{k\in\mathscr{K}} \frac{1}{2a_k} + \sum_{n\in\mathscr{N}_R} \frac{1}{z_{R,n}}}. \tag{18}$$

Proof: Since *ak* > 0, *bk, ck* ≥ 0, ∀*k* ∈ *K* , *vR,n, zR,n* > 0,\ ∀*n* ∈ *NR*, and *PI* ≥ 0, (18), implies that *y* > 0. For given *ak, bk, ck* ∀*k* ∈ *K* , and *vR,n, zR,n* ∀*n* ∈ *NR*, substitute (18) into (7), we obtain\

$$P_I \le P_{I,\max} := \left(\min_{n\in\mathscr{N}_R}\left(v_{R,n} - z_{R,n}x_{R,n,\min}\right)\right) \times \left(\sum_{k\in\mathscr{K}} \frac{1}{2a_k} + \sum_{n\in\mathscr{N}_R} \frac{1}{\alpha_{R,n}}\right) - \left(\sum_{k\in\mathscr{K}} \frac{b_k}{2a_k} + \sum_{n\in\mathscr{N}_R} \frac{v_{R,n}}{\alpha_{R,n}}\right). \tag{19}$$

$$\frac{P_I + \sum_{k\in\mathscr{K}} \frac{b_k}{2a_k} + \sum_{n\in\mathscr{N}_R} \frac{v_{R,n}}{z_{R,n}}}{\sum_{k\in\mathscr{K}} \frac{1}{2a_k} + \sum_{n\in\mathscr{N}_R} \frac{1}{z_{R,n}}} \le \min_{n\in\mathscr{N}_R}\left(v_{R,n} - z_{R,n}x_{R,n,\min}\right).$$

Further simplification of (20) yields (19). *Remark 1:* Note that, UCs may impose their individual limits on the unit cost, and usually there is a maximum limit the market impose, i.e., *yk*,min ≤ *y* ≤ *y*m,max ∀*k* ∈ *K* . Without loss of

generality, we consider *y*max ≤ *y*m,max and *y* ≥ *yk*,min ∀*k* ∈ *K* .

Proposition 2: When the gain functions of the residential consumers are logarithmic as given by (8), a distinctive feasible solution of (12) is

$$y = \frac{-T_1 + \sqrt{{T_1}^2 + 8AA_R}}{2A}, \text{ if} \tag{21}$$

$$P_I \le \min_{n\in\mathscr{N}_R} \frac{A\alpha_{R,n}}{2(\beta_{R,n} + x_{R,n,\min})} - \frac{B_A}{2} + B_R - \frac{A_R}{\min_{n\in\mathscr{N}_R} \frac{\alpha_{R,n}}{\beta_{R,n} + x_{R,n,\min}}} \tag{22}$$

where *T*1 = 2*BR* − BA − 2*PI* , *A* = *_k∈K 1/ak*, *AR* =*_n∈NR αR,n*, *BR* = *_n∈NR βR,n*, and BA = *_k∈K bk/ak*.

Proof: Substituting *Ck,UR,n* from (17) and (8) into (15) and further simplification yields

$$\sum_{k\in\mathscr{K}} \frac{y - b_k}{2a_k} = P_I + \sum_{n\in\mathscr{N}_R} \left(\frac{\alpha_{R,n}}{y} - \beta_{R,n}\right). \tag{23}$$

The solution of (23) is *y* = *(−T*1 } *_T*12 + 8*AAR/2A).*Since *A* > 0 and *_T*12 + 8*AAR* > *T*1, the root *y* =*(−T*1 + *_T*12 + 8*AAR/2A)* is the only actual, positive one, and hence, possible solution for *y*. Now, substituting (21) into (10) leads to

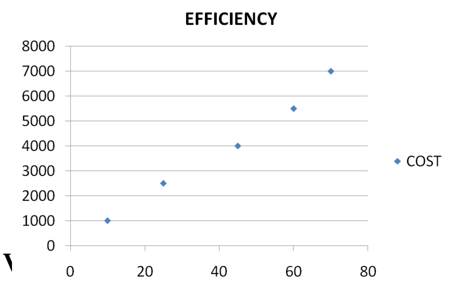
$$\frac{-T_1 + \sqrt{{T_1}^2 + 8AA_R}}{2A} \le \min_{n\in\mathscr{N}_R}\left(\frac{\alpha_{R,n}}{\beta_{R,n} + x_{R,n,\min}}\right). \tag{24}$$

Squaring both sides of (25) and upon further oversimplification, (25) takes the form (22).

$$2A\left(\min_{n\in\mathscr{N}_R} \frac{\alpha_{R,n}}{\beta_{R,n} + x_{R,n,\min}}\right) + T_1 \ge \sqrt{{T_1}^2 + 8AA_R}. \tag{25}$$

Remark 2: If for any of the UCs, *(C_ k) −1(y)* > *Pk*,max, then instead of using (13), UC *k* supplies *Pk* = *Pk*,max. The power supply from UC *k* can, therefore, be expressed as *Pk* = min*((C_ k) −1(y), Pk*,max*)*

VI. PERFORMANCE MEASURES OF OUR PROPOSED SYSTEM



We have proposed a system which is included with forceful request side organization with the use of smart grid using the three major systems the demand response organization, v/f controller and the AMI(Automated Meter Interface) which plays a major role to send the data about power usage and storage details (i.e.,) the battery backup. With our system we can give uninterrupted supply to our customers even in the case of sudden surge in the load by shifting the phase automatically and again details regarding the usage is obtained via AMI. The output will be given in the form of simulation.

REFERENCES

[1] *U.S.—Canada Power System Outage Task Force*. [Online].Available: http://energy.gov/oe/downloads/us-canada-power-systemoutage-task-force-final-report-implementation-task-force, accessed May 15, 2015.

[2] H. Farhangi, "The path of the smart grid," *IEEE Power Energy Mag.*, vol. 8, no. 1, pp. 18–28, Jan./Feb. 2010.

[3] C. W. Gellings, "Power/energy: Demand-side load management: The rising price of peak-demand power means that utilities must encourage customers to manage power usage," *IEEE Spectrum*, vol. 18, no. 12, pp. 49–52, Dec. 1981.

[4] C. W. Gellings, "The concept of demand-side management for electric utilities," *Proc. IEEE*, vol. 73, no. 10, pp. 1468–1470, Oct. 1985.

[5] M. H. Albadi and E. F. El-Saadany, "A summary of demand response in electricity markets," *Elect. Power Syst. Res.*, vol. 78, no. 11, pp. 1989–1996, Nov. 2008.

[6] J. N. Sheen, C. S. Chen, and J. K. Yang, "Time-of-use pricing for load management programs in Taiwan Power Company," *IEEE Trans. Power Syst.*, vol. 9, no. 1, pp. 388–396, Feb. 1994.

[7] E. Celebi and J. D. Fuller, "Time-of-use pricing in electricity markets under different market structures," *IEEE Trans. Power Syst.*, vol. 27, no. 3, pp. 1170–1181, Aug. 2012.

[8] P. Yang, G. Tang, and A. Nehorai, "A game-theoretic approach for optimal time-of-use electricity pricing," *IEEE Trans. Power Syst.*, vol. 28, no. 2, pp. 884–892, May 2013.

[9] Q. Zhu and T. Ba¸sar, "A multi-resolution large population game framework for smart grid demand response management," in *Proc. 5th Int. Conf. Netw. Games Control Optim. (NetGCooP)*, Paris, France, Oct. 2011, pp. 1–8.

[10] S. Shao, M. Pipattanasomporn, and S. Rahman, "Grid integration of electric vehicles and demand response with customer choice," *IEEE Trans. Smart Grid*, vol. 3, no. 1, pp. 543–550, Mar. 2012.

[11] S. Rahman, "Green power: What is it and where can we find ?" *IEEE Power Energy Mag.*, vol. 1, no. 1, pp. 30–37, Jan./Feb. 2003.

[12] J. M. Carrasco *et al*., "Powerelectronic systems for the grid integration of renewable energy sources: A survey," *IEEE Trans. Ind. Electron.*, vol. 53, no. 4, pp. 1002–1016, Aug. 2006.