# Efficient Demand Centric Power Generation and Distribution Model for Improved Market Gain in Power Distribution Grids

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**Abstract:** The market gain of power grids is well studied and there exist various models to maximize the market gain of power distribution systems. However, the methods suffer to achieve higher performance in maximizing the market gain of power grids. Towards this, an efficient Demand Centric Power Generation Model (DCPGM) is presented in this article. The method maintains the traces of various power grids which have the capacity of grid in producing required voltage. The model focused on reducing the voltage loss and increasing the market gain of the power grids. To perform this, the method monitors the power demand at each cycle and maintains the cost of various power grids. According to the requirement and the cost of purchase, the method identifies set of grids and computes Market Gain Factor (MGF). Based on the MGF value, the method identifies set of grids and triggers them for power production. The rest of the grid units are triggered to silent mode. The proposed model improves the performance of power generation with higher market gain.

Index Terms: Power marketing, Power Grids, DCPGM, MGF, Grid Selection.

## 1.Introduction:

The electric energy has been marketed to various organizations and power sectors. The power distribution sector generates enormous unit of electricity which has been consumed by various power sectors to be supplied to their consumers. But the cost of electricity is different between the consumer and the producer. When the power generation units produces the electricity continuously, the most energy has been lost due to the non-requirement and voltage loss happened at the carriers and conduction. This affect the gain of the power sectors which is the huge challenge for them. To handle this issue, it is necessary to look on the market gain achieved by the power generation units. Instead of producing the electricity independently, it is necessary to control the units depend on the requirement of electricity.

There will be number of power generation units exist in various geographic regions of the country. By handling the properly, the market gain of the plants can be

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improved. The cost of production varies between the power units due to many factors like the source, scarcity of source and availability of the source. Also, some of the units would produce k unit of electricity with limited cost where some other are not. On the other side, some of the units are capable of producing huge unit of electricity in limited span according to their capacity. So, it is necessary to look into both the factors like capacity and the cost. The existing models are looking in to the cost alone which does not meet the requirement of the consumer.

On the other side, the performance of the grid units and the gain of the units is greatly depending on the selection of grid for the requirement. It is necessary to optimize the selection of power grid and power unit according to various factors which should maximize the performance and gain of power generation units.

With the consideration of producing electricity with nominal cost with meeting the requirement, an efficient Demand centric power generation model (DCPGM) is presented in this article. The model is focused on producing electricity according to the requirement with the cost afford. To perform this, the method considers various factors and analyzes the capacity of various grid units in producing electricity. . The method maintains the traces of various power grids which have the capacity of grid in producing required voltage. The model focused on reducing the voltage loss and increasing the market gain of the power grids. To perform this, the method monitors the power demand at each cycle and maintains the cost of various power grids. According to the requirement and the cost of purchase, the method identifies set of grids and computes Market Gain Factor (MGF). Based on the MGF value, the method identifies set of grids and triggers them for power production. The rest of the grid units are triggered to silent mode.

## 2.Related Works:

There are various schemes has been recommended in literature to handle the problem and this section details some of the methods in detail.

An integrated transmission distribution flexibility market is presented in [1], which uses alternating direction method of multipliers (ADMM) scheme towards distributed marketing. The model monitors the market requirement and integrate various features to identify the flexibility conditions to perform voltage distribution.

To support marketing wind power, an quantification model with building stock towards electrical market is presented in [2]. The quantification model monitors the stock value of different distributors and consumers. Based on that the method quantify the price of unit to perform effective distribution and to maximize the gain.

A detailed analysis is presented in [3], which consider the barriers in region, trading potential and different gaps present in different regulation frameworks. The article analyzes the different factors which affect the gain of various models and how the gain is measured. Such analysis has been used to infer various conditions to be considered on market gain analysis.

Integrating wind energy with small side utilities is presented in [4], and a theoretical framework is presented in [4]. The model considers various small side units and their market gain to analyze the gain achievement of wind energy distribution networks.

The jamming attack in energy market model is analyzed and a multitack dynamic game model is presented in [5]. The presence of jamming attack in the energy market has been briefed in detail and the way to mitigate the attack has been briefed well. To perform this, a multitrack dynamic game theory is prescribed to support effective voltage distribution.

An adaptive CGM approximation (ACA) model is presented in [6], which uses direct current power flow theory. According to the current flow theory the method estimates the gain in the network and approximate the possible chance of getting more gain in the network.

An electricity transmission investment assessment methodology is presented in [7], which evaluate the economic impact on different stakeholders. By analyzing the impact of different economic events in the stock market, the model would identify the most reliable source for the purchase of electricity which in turn would support the growth of power distribution.

An agent based system operator is presented in [8], towards energy trading which works according to network constraints. A two stage scheduling model is presented in [9], which uses a zero sum gains-data envelopment analysis (ZSG-DEA) model based multi-criteria allocation scheme.

An P2P energy trading framework is presented in [10], towards energy trading which uses blockchain for data security. An consumer centric market framework is presented in [11]. A effective game-theoretic model is presented in [12], which allows the trading between consumer and seller and uses game theoretic scheme to find the price of electricity. A bi level optimization model is presented in [13], to ensure the guarantee between the grids and DSO.

All the methods discussed above suffer with poor performance in electric marketing.

Demand Centric Power Generation Model (DCPGM):

The Demand Centric Power Generation Model (DCPGM) maintains the traces of various power grids which have the capacity of grid in producing required voltage. The model focused on reducing the voltage loss and increasing the market gain of the power grids. To perform this, the method monitors the power demand at each cycle and maintains the cost of various power grids. According to the requirement and the cost of purchase, the method identifies set of grids and computes Market Gain Factor (MGF). Based on the MGF value, the method identifies set of grids and triggers them for power production. The rest of the grid units are triggered to silent mode.

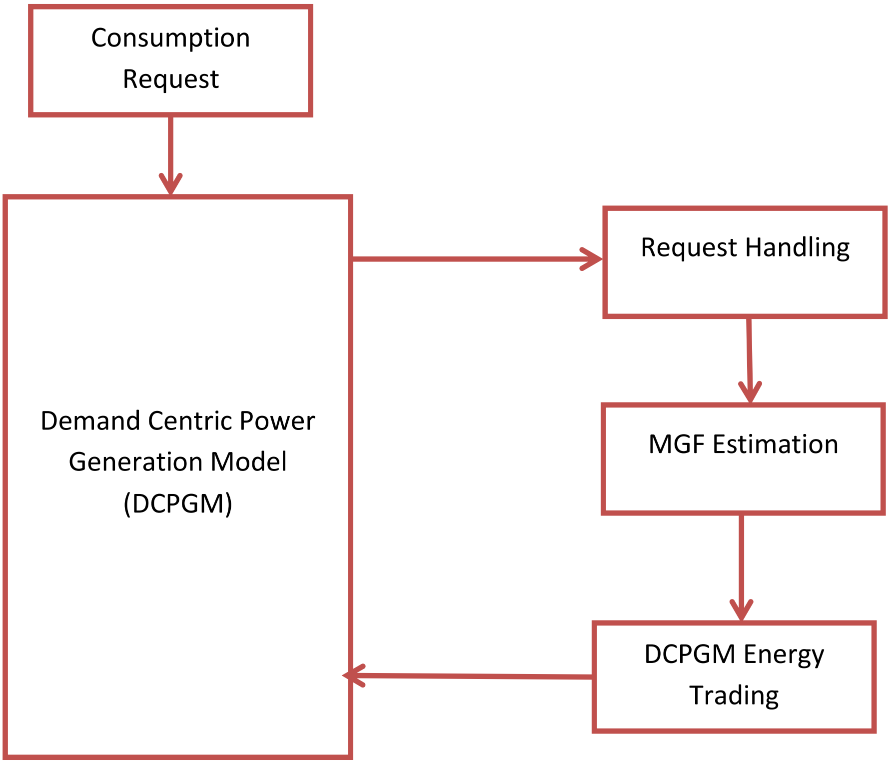


Figure 1: Architecture of DCPGM Energy Trading

The working of proposed DCPGM energy trading has been presented in Figure 1, and the components of the model are described in detail in the next chapter.

Request Handling:

The request handling function receives the power request from various consumers. Upon receiving the request, the method extracts the voltage requirement value and cost. Using both of them, the method performs DCPGM energy trading. The energy trading algorithm computes the MGF value for various grid units and selects set of grids to perform voltage regulation.

```
Algorithm:
Given: Power Request Preq, Power Trace Ptr
Obtain: Null
Start
        While true
                Read Preq and Ptr.
                Extract voltage requirement value Vrv = VoltageRequired ∈ Preq
                Extract cost per unit Cpu = Cost ∈ Preq
                Perform DCPGM power trading (vrv, cpu)
                Wait for next request
        End
Stop
```

The request handling function always look for the power request from various consumers. From the power request, the method extracts the value of Vrv and Cpu to perform power trading.

MGF Estimation:

The market gain factor (MGF) is the measure which represent the suitability of any power grid in regulating power towards any request being received. It has been measured according to the power required, power can be produced, and the cost afford with the residual voltage. To measure the value of MGF, the method reads the voltage requirement value and cost per unit given and the voltage production value. Estimated value of MGF has been used to perform energy trading.

Algorithm:
Given: Voltage required value Vrv, Cost per unit cpu, grid g, Grid Trace Gt
Obtain: MGF.
Start
    Read Vrv, cpu, g, gt.
    Identify grid trace Grt = $\sum_{i=1}^{size(Gt)} Gt(i).grid == g$
    Compute MGF = $\dfrac{\sum_{i=1}^{size(Grt)} Sum(Grt(i).voltproduced) \Big/ Size(grt)}{Vru} \times cpu$
Stop

The MGF estimation algorithm computes the value of MGF for any power grid given and has been used to perform power trading.

DCPGM Energy Trading:

The energy trading algorithm receives the feature obtained from the power request. According to the features, the method identifies the set of power grids available. For each of them, the method computes the value of MGF and based on that a single or multiple grids are selected to perform voltage regulation.

Algorithm:
Given: Grid Trace GT, Feature Vector Fv
Obtain: Null
Start
    Read Gt and Fv.
    Find grid sets available Gsa = $(\sum_{i=1}^{size(GT)} GT(i).g \ni Gsa) \cup Gsa$
    For each grid g
        If g.state==idle then
            MGF = MGF_Estimation (Fv.Vrv,Fv.cpu,g,GT)
        End
    End
    Grid g = Choose the grid with maximum MGF.
    Perform voltage regulation.
Stop

The energy trading algorithm computes MGF value for various grid units and based on that the method trigger the power generation unit to generate the power and distribute to the consumer.

## 3.Result and Discussion:

The demand centric power generation model (DCPGM) has been implemented and evaluated for its performance under various circumstances. The performance of the model has been recorded and compared with the result of other models.

| Factor | Value |
|---|---|
| Tool Used | Simulink |
| Grids | 200 |
| Time | 15 minutes |

Table 1: Experimental setup

The experimental setup considered for the performance evaluation is presented in Table 1.

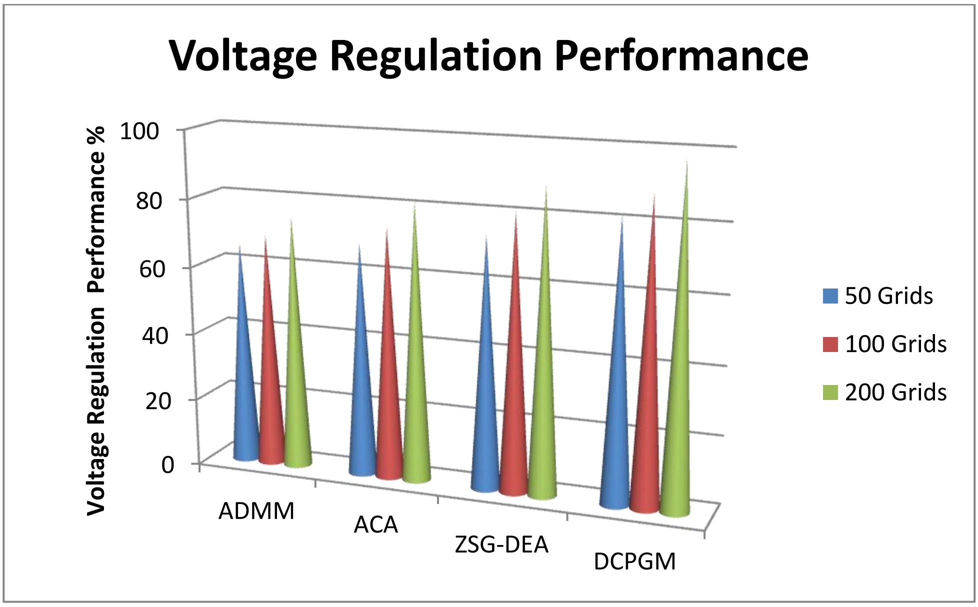


Figure 2: Voltage Regulation Performance

The performance of methods in voltage regulation has been measured and compared in Figure 2, where the DCPGM model has produced higher voltage regulation performance than others. The performance of voltage regulation is measured at varying number of grids in the network. In each test case, the proposed DCPGM model has achieved higher performance than others.

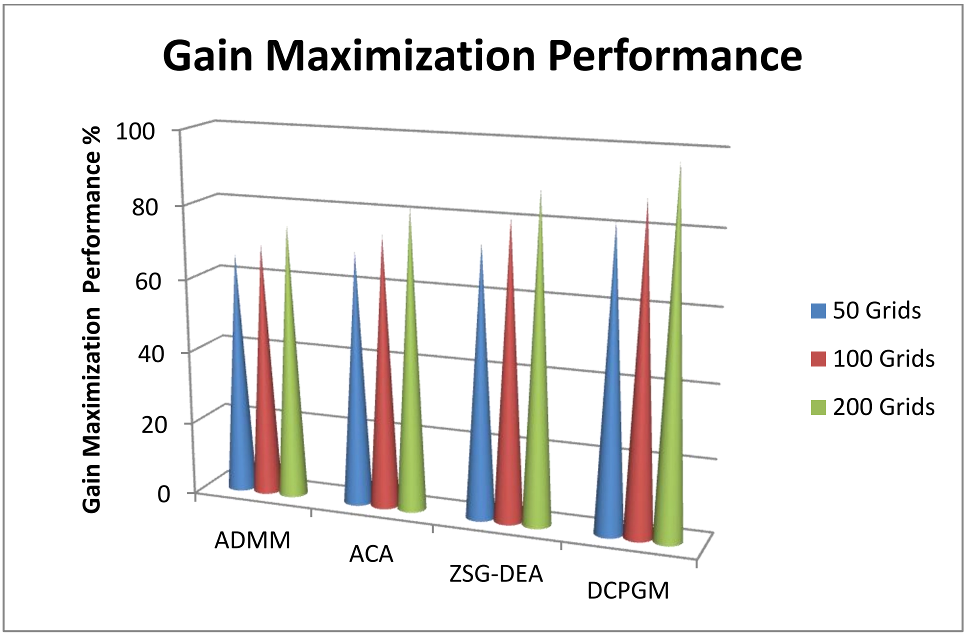


Figure 3: Gain Maximization Performance

The performance of methods in in Gain maximization has been measured and presented in Figure 3. The proposed DCPGM model has produced higher gain maximization than others. The gain achieved by various models is measured at the presence of different number of grids in the environment. In each case, the proposed DCPGM has achieved higher performance than others.

## 4.Conclusion:

This paper presented a novel Demand Centric Power generation model (DCPGM) towards maximizing the gain of power grids. The Demand Centric Power Generation Model (DCPGM) maintains the traces of various power grids which have the capacity of grid in producing required voltage. The model focused on reducing the voltage loss and increasing the market gain of the power grids. To perform this, the method monitors the power demand at each cycle and maintains the cost of various power grids. According to the requirement and the cost of purchase, the method identifies set of grids and computes Market Gain Factor (MGF). Based on the MGF value, the method identifies set of grids and triggers them for power production. The rest of the grid units are triggered to silent mode. The proposed model improves the voltage regulation and gain maximization performance than others.

## 5.References:

1. T. Jiang et al., "Solution to Coordination of Transmission and Distribution for Renewable Energy Integration into Power Grids: An Integrated Flexibility Market," in CSEE Journal of Power and Energy Systems, vol. 9, no. 2, pp. 444-458, March 2023, doi: 10.17775/CSEEJPES.2021.06390.
2. G. Papaefthymiou, B. Hasche and C. Nabe, "Potential of Heat Pumps for Demand Side Management and Wind Power Integration in the German Electricity Market," in IEEE

Transactions on Sustainable Energy, vol. 3, no. 4, pp. 636-642, Oct. 2012, doi: 10.1109/TSTE.2012.2202132.
3. A. Ul-Haq et al., "Cross-Border Power Trade and Grid Interconnection in SAARC Region: Technical Standardization and Power Pool Model," in IEEE Access, vol. 7, pp. 178977-179001, 2019, doi: 10.1109/ACCESS.2019.2958407.
4. Z. Ding, Y. Guo, D. Wu and Y. Fang, "A Market Based Scheme to Integrate Distributed Wind Energy," in IEEE Transactions on Smart Grid, vol. 4, no. 2, pp. 976-984, June 2013, doi: 10.1109/TSG.2012.2230278.
5. J. Ma, Y. Liu, L. Song and Z. Han, "Multiact Dynamic Game Strategy for Jamming Attack in Electricity Market," in IEEE Transactions on Smart Grid, vol. 6, no. 5, pp. 2273-2282, Sept. 2015, doi: 10.1109/TSG.2015.2400215.
6. P. C. See, O. B. Fosso, K. Y. Wong and M. Molinas, "An approach for establishing a common grid model for flow-based market mechanism simulations," in CSEE Journal of Power and Energy Systems, vol. 5, no. 3, pp. 374-381, Sept. 2019, doi: 10.17775/CSEEJPES.2018.01270.
7. Ha, J., Choi, Y., Choi, D., & Lee, H. (2014). Power Analysis Attacks on the Right-to-Left Square-Always Exponentiation Algorithm. Journal of Internet Services and Information Security, 4(4), 38-51.
8. Bharathi, C., & Rekha, D. (2023). Load Forecasting for Demand Side Management in Smart Grid using Non-Linear Machine Learning Technique. Journal of Wireless Mobile Networks, Ubiquitous Computing, and Dependable Applications, 14(1), 200-214.
9. Y. Wang, J. Qiu, Y. Tao and J. Zhao, "Carbon-Oriented Operational Planning in Coupled Electricity and Emission Trading Markets," in IEEE Transactions on Power Systems, vol. 35, no. 4, pp. 3145-3157, July 2020, doi: 10.1109/TPWRS.2020.2966663.
10. M. K. AlAshery et al., "A Blockchain-Enabled Multi-Settlement Quasi-Ideal Peer-to-Peer Trading Framework," in IEEE Transactions on Smart Grid, vol. 12, no. 1, pp. 885-896, Jan. 2021, doi: 10.1109/TSG.2020.3022601.
11. T. Baroche, P. Pinson, R. L. G. Latimier and H. B. Ahmed, "Exogenous Cost Allocation in Peer-to-Peer Electricity Markets," in IEEE Transactions on Power Systems, vol. 34, no. 4, pp. 2553-2564, July 2019, doi: 10.1109/TPWRS.2019.2896654.
12. W. Amin et al., "An Effective Pricing Mechanism for Electricity Trading Considering Customer Preference and Reserved Price in Direct P2P Electricity Market Under Uncertainty in Grid Supply," in IEEE Access, vol. 10, pp. 96197-96211, 2022, doi: 10.1109/ACCESS.2022.3205125.
13. Y. Du and F. Li, "A Hierarchical Real-Time Balancing Market Considering Multi-Microgrids With Distributed Sustainable Resources," in IEEE Transactions on Sustainable Energy, vol. 11, no. 1, pp. 72-83, Jan. 2020, doi: 10.1109/TSTE.2018.2884223.