International Journal of Recent Development in Engineering and Technology
Website: www.ijrdet.com (ISSN 2347-6435(Online) Volume 12, Issue 07, July 2023)

# Optimal Power Management with Back-up of Virtual Power Plants Considering Demand Response and Capacity

Shubham Agnihotri[1], Dr. Shweta Chourasia[2]

[1]*Research Scholar,* [2]*Associate Professor & HOD, Department of Electrical and Electronics Engineering, Bhopal Institute of Technology and Science, Bhopal, India*

***Abstract*-- The expanded enthusiasm of renewable energy sources builds the extent of generation closer to the shopper. This situation will roll out impressive improvements in power industry. In not so distant future, a noteworthy part of the power will be overseen through virtual power plant system. The idea of virtual power plant (VPP) can empower the market cooperation of little creating units. VPP has a primary energy the board as well. So they can be in contact with distribution system administrator and every nearby energy the board systems of every dg through primary energy the executives system, so the VPP can settle on choices when and which and how much every dg supply. The VPP can likewise give subordinate administrations like recurrence support, reactive power support. In this paper clarifies the VPP idea and the structure of VPP likewise incorporate generation from conventional energy source hydro, coal and renewable energy sources (RES) like sunlight based, wind, biomass and biogas and furthermore from cogeneration units.**

***Index Terms*– Microgrid, Distributed generation. Electrical Energy Management, Virtual Power Plant, Renewable Energy Sources.**

## I. INTRODUCTION

The high entrance of renewable resources in the current matrix, builds the complexities of the network. These days, the coordination of renewable resources turned into a major issue. These resources can't take an interest in power markets in light of their littler size. Compelled by low limit and unpredictability, the fast development of distributed energy resources are clearly stoppage bringing about utilization trouble and venture snag. As a powerful joining and the board innovation, in microgrid with distributed energy stockpiling, the line reactance of each distributed energy resource (DER) isn't same because of their diverse separation a long way from the heaps. This will prompt the maturing rate of each battery to be not predictable. A portion of the batteries initially seem maturing, the remainder of the battery likewise rapidly ages if these maturing batteries are not supplanted in time. This will in the end make the entire microgrid can't work appropriately.

In the course of recent years, various articles have concentrated on VPP and different perspectives identified with this thought, including on the interactions among them and the energy networks.

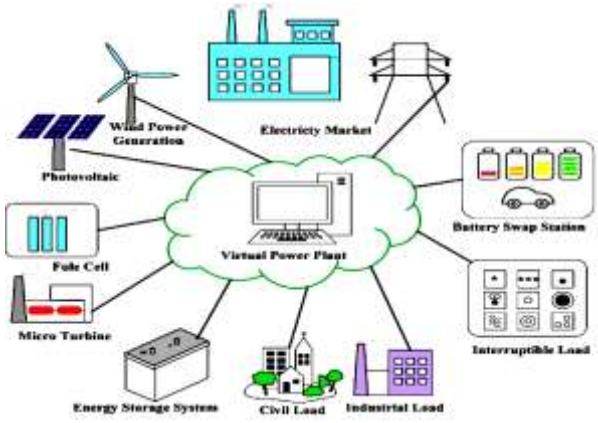


**Figure1: VPP Distribution system**

A virtual power plant (VPP) is a cloud-based distributed power plant that totals the limits of heterogeneous distributed energy resources (DER) for the reasons for upgrading power generation, just as exchanging or selling power on the power market.

They have likewise considered issues, for example, power expenses, DGRs, and how the VPP assesses the vulnerability of renewable generation; examined the impediment and loss limitations; explored the impacts identified with DRPs and interruptible loads; and measurements associated with the unwavering quality of the network. Different investigations have presented a probabilistic value mean on unit commitment program for a VPP to show the likelihood of the market cost and generation resources, just as to improve introduction in the EM. All the above plans have concentrated on the VPP planning troubles, while none of them has demonstrated an answer, the issues expanding variance in the EM as a result of expanding incorporation of the DGRs to the supply loads at the distribution level. Also, none of the contemplated writing has thought about the conduct of burdens and the co-operations of prosumers in booking issues and in the EM.

The nonattendance of VPP assessments, especially on MVPPs containing different generation types in a stochastic situation, is recognizable in the papers checked on.

International Journal of Recent Development in Engineering and Technology
Website: www.ijrdet.com (ISSN 2347-6435(Online) Volume 12, Issue 07, July 2023)

Along these lines, this article centers around improving the MVPP in a power system with the goal that it can oversee totaled generations spread in a DS. The MVPPs can deal with a few MGs containing the fitting burdens and generations and affect the EM.

## II. PROPOSED METHODOLOGY

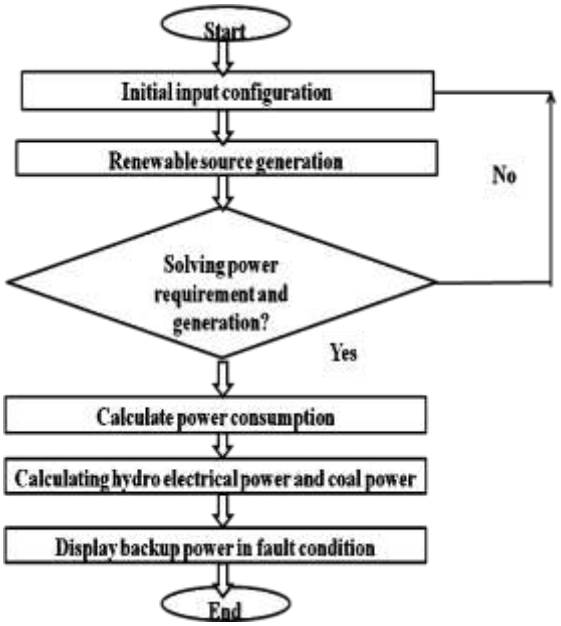


**Figure 2: Flow Chart**

A Virtual Power Plant is a network of decentralized, medium-scale power generating units such as Combined Heat and Power (CHP) units, wind farms and solar parks as well as flexible power consumers and batteries.

- A Virtual Power Plant consists of a central IT control system and distributed energy resources (often renewable energy resources like solar, wind, hydropower, and biomass units) as well as flexible power consumers.
- By networking all participating units through a remote control unit, it establishes a data transfer between the central control system and the participating units.
- The central control system is then able to monitor, forecast, and dispatch the networked units.

*Steps-1:* Firstly take the data set from ministry of new and renewable energy. This dataset is based on survey and available energy sources of "Miyapur District Hyderabad".

*Step-2:* Now make GUI using MATLAB software and initialize renewable energy source generation.

*Step-3:* Now solving power requirement and generation through simulation. If simulation optimizes desired result then calculate power consumption and requirement. If simulation does not optimize desired result then again check all input parameter and configuration.

*Step-4:* There are two conditions normal and fault. In case of normal condition calculate power generation from hydro electric and coal power and in case of fault, manage and calculate power from different resources like photovoltaic, wind and solar in all season (Rainy, normal and summer).

*Step-5:* Therefore successfully achieved power generation, backup plan and requirements.

## III. SIMULATION RESULT

*Case –I Normal*

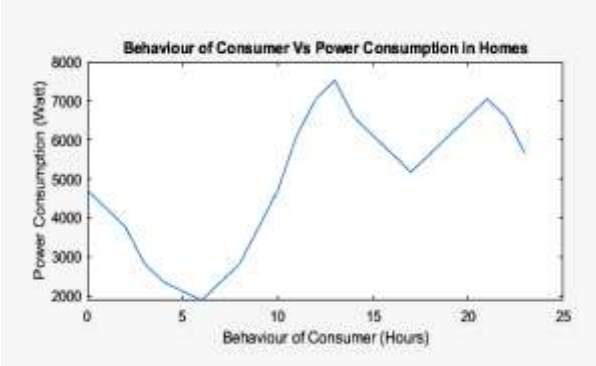


**Figure 3: Power consumption in homes vs Behavior of consumer**

In figure 3, appearing of purchaser versus power utilization in homes of 24 hours. It very well may be seen that power prerequisite demand for every one of the 24 hours.

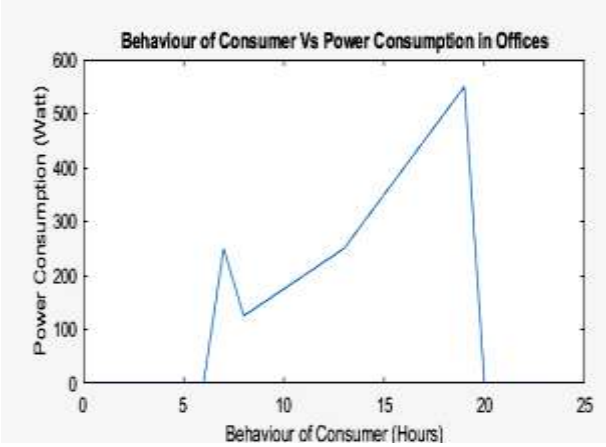


**Figure 4: Power consumption in offices vs Behavior of consumer**

International Journal of Recent Development in Engineering and Technology
Website: www.ijrdet.com (ISSN 2347-6435(Online) Volume 12, Issue 07, July 2023)

In figure 4, appearing of purchaser versus power utilization in workplaces of 24 hours. It very well may be seen that power prerequisite demand during chosen hours.

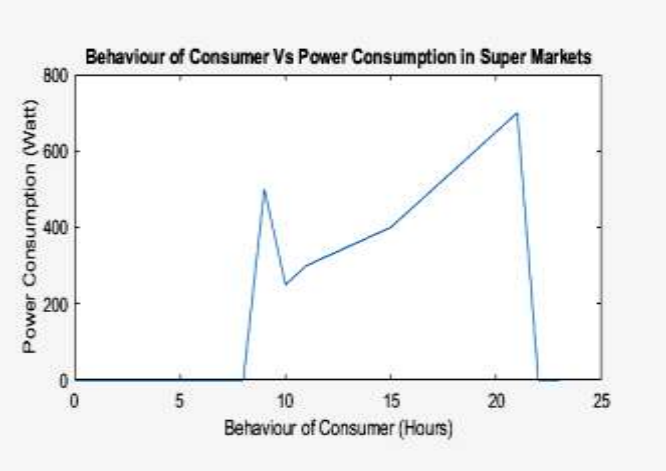


**Figure 5: Power consumption in super market vs Behavior of consumer**

In figure 5, appearing of buyer versus power utilization in general stores of 24 hours. It tends to be seen that power necessity demand during chosen hours.

*Case-II Fault*

In fault condition back up is prepared to diminish dark out. In this cases renewable energy source sun oriented, wind and biogas are watched. In ordinary season sun oriented reinforcement is high at that point wind and biogas.

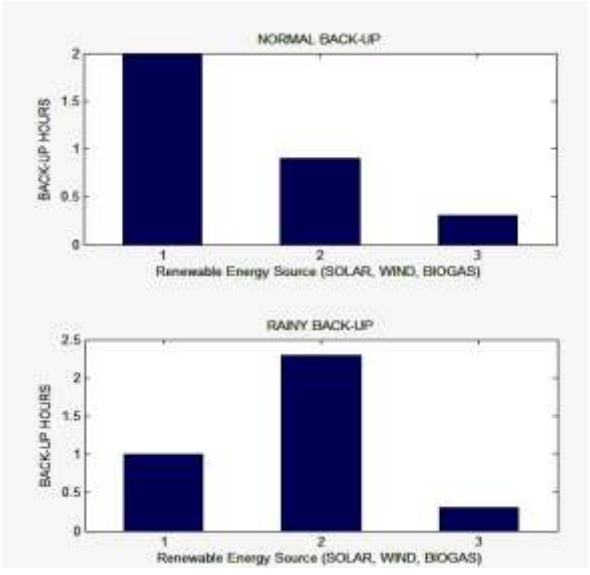


**Figure 6: RES vs Backup in normal and rainy season**

In rainy season solar backup is low and wind is high.

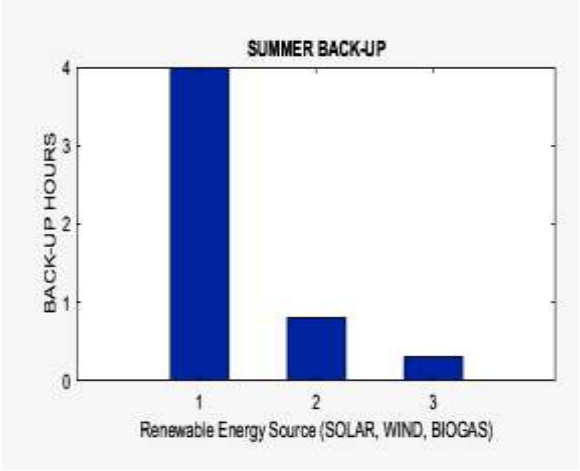


**Figure 7: RES vs Backup in summer season**

In summer season solar backup is high then wind and biogas.

Power generation per day in watt is 39120W. Solar, wind and biogas power generation is 28167W, 7953W and 3000W respectively. Total back up is 5 Hours.

**Table-1**
**Power back-up (hours) source in different season with maximum 5-hour backup**

| Sr No. | Season | Solar | Wind | Bio-Gas |
|---|---|---|---|---|
| 1 | Normal | 2 | 1 | 0.25 |
| 2 | Rainy | 1 | 2.3 | 0.25 |
| 3 | Summer | 4 | 0.8 | 0.25 |

International Journal of Recent Development in Engineering and Technology
Website: www.ijrdet.com (ISSN 2347-6435(Online) Volume 12, Issue 07, July 2023)

**Table 2:**
**Result Comparison**

| Sr. No. | Parameters | Previous work | Proposed Work |
|---|---|---|---|
| 1 | Total voltage | 20kV | 127kV |
| 2 | Total Power(W) | 12000 | 39120 |
| 3 | Power consumption(Home) | 800 W | 7500W |
| 4 | Power consumption(Office) | 1200 W | 550W |
| 5 | Power consumption(Market) | 400 W | 700W |
| 6 | Hydro Electricity Power | - | 76284W |
| 7 | Coal Power | - | 50856W |
| 8 | VPP generation time | 100s | 20s |
| 9 | Power generation from solar | 400 W | 28167W |
| 10 | Power generation from wind | 600 W | 7953W |
| 11 | Power generation from biogas | - | 3000W |

## IV. CONCLUSION

The WPP, PV, CGT, ESSs and DRPs are accumulated in VPP. This paper examine about the miyapur virtual power plant. The structure demonstrates that new energy-the executives control measures, for example, money related control systems achieved diagonally with the task of spot power markets, might be a urging course to help. The VPP model empowers a MVPP to go about as a value producer in a DA market, limiting in the meantime the foreseen lopsidedness costs forced by the adjusting market. The joining of DRP organizers into the optimization model backings the MVPP to deal with the DGRs inconstancy to its benefit. VPP is a decent answer for take an interest the distribution generators in the power market. The idea of VPP is acquainted all together with assistance the DG to partake in the markets. The offering procedures and booking is progressively significant in markets. In this work power figuring and generation with greatest reinforcement through renewable energy source in VPP is available. Recreation result demonstrates noteworthy execution improvement in determined parameters.

## REFERENCES

[1] M. Tabatabaei, M. S. Nazar, M. Shafie-Khah, G. J. Osório and J. P. S. Catalão, "Optimal Scheduling of Microgrid-Based Virtual Power Plants Considering Demand Response and Capacity Withholding Opportunities," 2021 IEEE Madrid PowerTech, Madrid, Spain, 2021, pp. 1-6, doi: 10.1109/PowerTech46648.2021.9494964.

[2] A. K. Pandey, V. Kumar Jadoun and J. N. S., "Virtual Power Plants: A New Era of Energy Management in Modern Power Systems," 2021 8th International Conference on Signal Processing and Integrated Networks (SPIN), Noida, India, 2021, pp. 538-543, doi: 10.1109/SPIN52536.2021.9566063.

[3] Y. Han, H. Jia, D. Liu, X. Wang, Z. Liu and H. Zhang, "Practice of Virtual Power Plants Participating in Electricity Markets in China," 2021 IEEE 4th International Electrical and Energy Conference (CIEEC), Wuhan, China, 2021, pp. 1-5, doi: 10.1109/CIEEC50170.2021.9510325.

[4] J. Xu, H. Mahmood, H. Xiao, E. Anderlini and M. Abusara, "Electric Water Heaters Management via Reinforcement Learning With Time-Delay in Isolated Microgrids," in IEEE Access, vol. 9, pp. 132569-132579, 2021, doi: 10.1109/ACCESS.2021.3112817.

[5] A. Mnatsakanyan, C. Iraklis, A. A. Marzooqi and H. AlBeshr, "Virtual Power Plant Integration Into a Vertically Integrated Utility: A Case Study," 2021 IEEE 12th International Symposium on Power Electronics for Distributed Generation Systems (PEDG), Chicago, IL, USA, 2021, pp. 1-5, doi: 10.1109/PEDG51384.2021.9494165.

[6] J. Lee and D. Won, "Optimal Operation Strategy of Virtual Power Plant Considering Real-Time Dispatch Uncertainty of Distributed Energy Resource Aggregation," in IEEE Access, vol. 9, pp. 56965-56983, 2021, doi: 10.1109/ACCESS.2021.3072550.

[7] N. U. Padmawansa and L. N. Widanagama Arachchige, "Improving Transient Stability of an Islanded Microgrid Using PV Based Virtual Synchronous Machines," 2020 Moratuwa Engineering Research Conference (MERCon), Moratuwa, Sri Lanka, 2020, pp. 543-548, doi: 10.1109/MERCon50084.2020.9185333.

[8] C. Meng, P. Qin, Y. Wang, X. An, H. Jiang and Y. Liang, "A revenue-risk equilibrium model for distributed energy integrated virtual power plants considering uncertainties of wind and photovoltaic power," 2020 5th Asia Conference on Power and Electrical Engineering (ACPEE), Chengdu, China, 2020, pp. 2032-2038, doi: 10.1109/ACPEE48638.2020.9136400.

[9] C. P. Barala, P. Mathuria and R. Bhakar, "Coordinated Scheduling of Virtual Energy Storage System for Optimal Microgrid Operation," 2020 IEEE 9th Power India International Conference (PIICON), Sonepat, India, 2020, pp. 1-5, doi: 10.1109/PIICON49524.2020.9113017.

[10] G. Niu, J. Su, M. Wu, L. Kou, X. Qu and Y. Li, "Combination and Application of Virtual Power Plant, Microgrid and Demand Response Technology in Multi-court Distribution Network for Energy Use Optimization," 2019 IEEE 3rd Conference on Energy Internet and Energy System Integration (EI2), Changsha, China, 2019, pp. 2037-2042, doi: 10.1109/EI247390.2019.9061732.

[11] D. C. Urcan and D. BicĂ, "Simulation concept of a virtual power plant based on real-time data acquisition," 2019 54th International Universities Power Engineering Conference (UPEC), Bucharest, Romania, 2019, pp. 1-4, doi: 10.1109/UPEC.2019.8893565.

[12] X. Gao, T. Xu, Y. Li, P. Feng and X. Zhang, "Research on Feasibility of Distributed Energy Resource Based Virtual Power Plant," 2018 2nd IEEE Advanced Information Management,Communicates,Electronic and Automation Control Conference (IMCEC), Xi'an, China, 2018, pp. 49-53, doi: 10.1109/IMCEC.2018.8469679.