IJEAST

INTERNATIONAL JOURNAL
OF ENGINEERING APPLIED SCIENCE
AND TECHNOLOGY

VOLUME : 3 ISSUE : 11 Print / Issue Publication Date: 29-May-2019

ISSN : 2455-2143

DOI : 10.33564/IJEAST.2019.v03i11.014

Indexed In

Google SCHOLAR OPEN ACCESS doi Crossref

WWW.IJEAST.COM

editor@ijeast.com

International Journal of Engineering Applied Sciences and Technology, 2019
Vol. 3, Issue 11, ISSN No. 2455-2143, Pages 71-77
Published Online March 2019 in IJEAST (http://www.ijeast.com)

ECONOMIC LOAD DISPATCH PROBLEMS IN SMART GRID: A REVIEW

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ABSTRACT – **Economic dispatch problem is one of the fundamental problems in power system as proved by many researchers. Since working on smart grid at lowest cost with high efficiency is a big challenge. Solving this problem will be active research topic for future. In the current paper, we are going to show detailed description of progress on economic dispatch, centralized and decentralized algorithm, and demand side management, classical and modern techniques by looking for the way and key factors in their progress. Plenty of work is available on demand side management, using different alternatives as it is related to optimization of generation, and system load cost models. With this scope of review work, the perspective of the economic dispatch problem in the smart grid has been investigated. This paper revises different author's work related to the economic dispatch problem and gives an insight to future work.**

Keywords: **Centralized algorithm, Distributed algorithm, Demand response, Demand side management, Economic dispatch, Unit commitment, Smart grid**

I. INTRODUCTION

The main aim of today's electrical utility is to provide electrical power in a reliable way and in a possible low cost. Electrical energy cannot be stored, but it can be generated from available sources be it conventional resources or renewable energy sources. In Q. Xu. et al (2013)Matlab is used to implement real time generation dispatch and communication architecture of smart grid with renewable energy. In Yang, Z .et al (2014) non-convex nonlinear dispatch problem was solved by self-leaning teaching learning based optimization. Sailaja. et al (2017)have presented artificial neural network and fuzzy systems in smart grid using distributed energy storage systems for solving unit commitment problem.

In L. I. Dulau.et al (2017) economic dispatch approach in smart grid without considering network equality security constrained by testing three generator and one battery storage to minimize total power generation cost. In N. Nikmehr. et al (2015) determined optimal economic generation of each micro grid (MGs) by using stochastic and probabilistic modeling for both small scale energy resources and load demand at each micro grids since particle swarm optimization techniques was used to optimize cost function, In K. Gnanambal. et al (2016)have proposed quasi-oppositional particle swarm optimization by considering network loss and security constrained to control system losses, fuel consumption and control movement of generator output. H.Sita. et al (2016)summarized recent trends in economic dispatch problem.

In N. Ghorbani. et al (2016) use a method of solving multi-objective optimization problems by using per unit coding for converting multi-objective functions to a single objective model. Kaima. et al (2017) had been proposed economic dispatch strategy with the consideration of demand response to keep the electricity real time balance. In M. Nassourou.et al (2017) economic model predictive control was applied in smart micogrid system connected to an electric power grid and compares several subsystems.

In V. Bhattachajee. et al (2017) introduce a convex nonlinear cost saving model for optimal economic dispatch problem in smart micro grid and combined storage degradation cost and intermittent renewable energy generation without considering the effect of variation of temperature on the charging and discharging a battery efficiency. In S. Surender Reddy (2017) combined environmental and economic dispatch problem has solved by using multi objective based adaptive immune algorithm. In M .Uassouvoll, etal (2017) applied robust optimization on economic dispatch problem of smart grid to minimize cost and guarantee service of reliability. F. Fioretto .et al (2017) introduce an effective multi objective algorithm and distributed constrained optimization approach was done with demand responses to maximize th benefits of customers and

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Vol. 3, Issue 11, ISSN No. 2455-2143, Pages 71-77
Published Online March 2019 in IJEAST (http://www.ijeast.com)

minimizes generation cost. In Shahid, H.et al (2018) Genetic algorithm (GA) was implemented to model ELD problem for solar power plants synchronized with thermal power plants.

II. MOTIVATION OF THE REVIEW

The issue of continually increasing demand and price of electricity at the consumer end inspire the review presented. For a better knowledge how we have to reduce the price by searching and knowing of economic dispatch problems for smart technologies.

III. OBJECTIVE OF THE REVIEW

The objective of the review is to discuss in detail about the various smart grid components, their continuous development, technical challenges faced during their development, outcomes achieved and ways to reduce the price of electricity with related to smart grid.

IV. OVERVIEW OF ECONOMIC DISPATCH PROBLEM ON SMART GRID

Economic dispatch is a short term determination of optimal output of number of electricity generation facilities, to meet the system load at the lowest possible cost subject to transmission and operational constrained [6]. But it's one of the fundamental problems in power system. Its objective is to minimize the total power generation cost. And it can be done by considering transmission loss or without considering transmission loss [24].

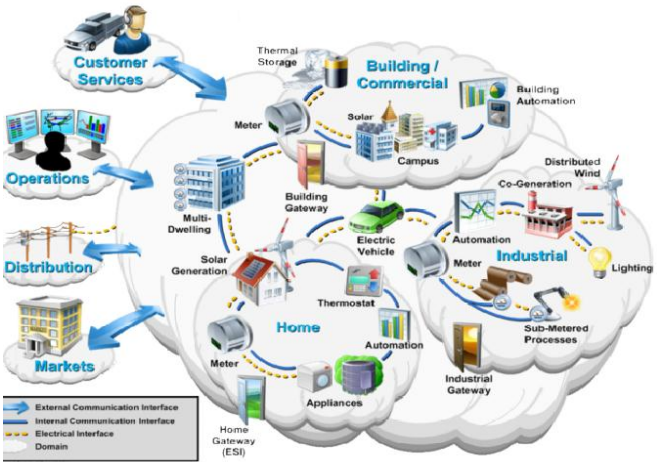

Fig 1: Overview smart grid [24]

V. COST REDUCTION METHODS IN SMART GRID

Reduction of different costs includes reduction of energy or production cost which are (fuel cost and operation and maintenance cost), timing of additional units which is (plant cost), and environmental costs which are (NOx, COx, SOx emissions). In addition to this, by using energy sources, direct algorithms and demand managements, we can reduce the cost of the systems [36].

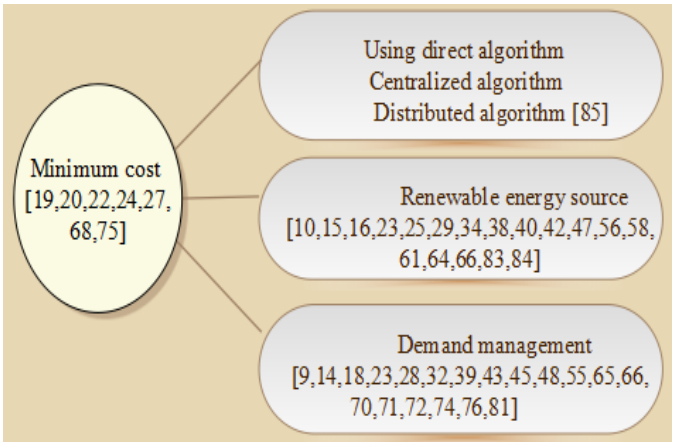

Fig 2: Different methods of cost reduction techniques

A. Energy source

Based on energy source some of author's doing their paper for minimization of cost either conventional energy, renewable energy, electric vehicle or fuel as a source. Distributed generation encompasses a wide range of technologies including solar power, wind turbines, fuel cells, micro turbines, reciprocating engines, load reduction technologies, and battery storage systems. Among all alternatives, solar and wind energy sources produce intermittent power and other technologies may need to be shut down for periodic maintenance [6].

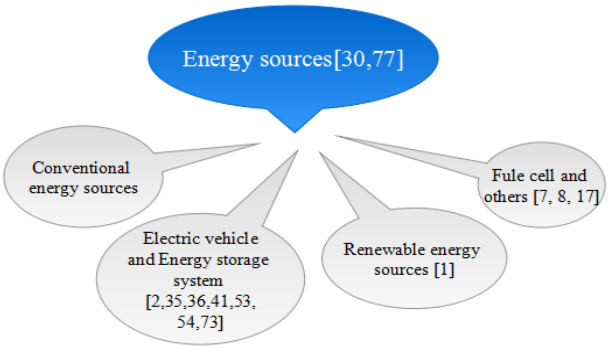

Fig 3: Energy source used in smart grid

B. Conventional and modern methods

Economic dispatch problem had been achieved by using centralized and decentralized approaches. Economic dispatch problem solved by many traditional methods or by using

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conventional methods that are used in the centralized algorithm has difficulty on local minima [11]. Centralized or conventional economic dispatch algorithm methods are Lagrangian, Lambda iteration, quadratic equation and so on. Those approaches are estimates or statistics of power generation and loads, acquired by a central controller are accurate [21]. The distributed one or modern methods are use artificial intelligent techniques like fussy logic, particle swarm optimization, and genetic algorithm.

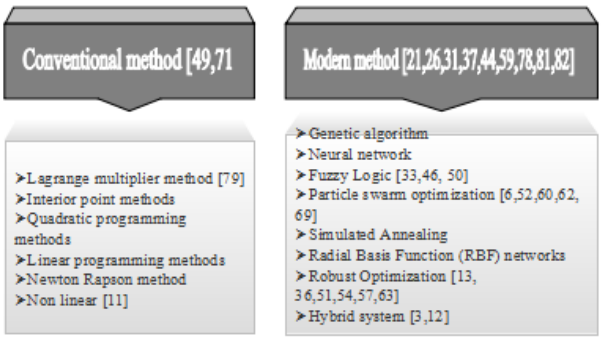

Fig 4: conventional and modern techiniques list.

Benefits and Challenges of modern and conventional methods

Most the papers used the distributed algorithm techniques among the reference some author is compared the results of conventional techniques with modern one [36]. Conventional technique compared with modern one has its own limitations and advantages such as its old or traditional methods, less cost and uses more time for responses. It uses iterations, this lose more time and the modern (distributive methods) is high cost, used for smart grid and uses simple algorithm.

C. Energy managements

Energy managements is one of the method for reduction of cost in power systems. It includes generation planning and management, utility management, demand side management and smart metering.

- Utility management: - under utility management, we are looking their work as load research, load shape objective, program implementation strategy, implementation, monitoring and evaluation [21 - 23].
- Generation planning and management:-load forecasting, generation planning, generation costing, financial analysis, price allocation is included under this [23].
- Demand side management:- demand response program, smart metering, distributed generation under this small scale renewable generation, battery energy storage system, electric vehicles, Distribution generation DG sets, fuel cells are included [9, 14,18,23,28,32,39,43,45, 48, 55, 65,66,70,71,72,74,76,81]
- Smart metering: - smart metering and monitoring and security and privacy [27].

D. ***Benefit of economic load dispatch problems on smart grid***

Integration of electrical and information infrastructures and incorporation of automation and information technologies with our existing electrical network need comprehensive solutions such as:

- Improve distribution power system reliability, operational performance and overall productivity.
- Increases energy efficiency and decreases carbon emissions.
- By empowering the consumers manage their energy usage and save money without compromising their lifestyle.
- Optimize renewable energy integration and enabling broader penetration
- Delivers meaningful, measurable and sustainable benefits to the utility, the consumer, the economy and the environment [5, 17].

Advantages of smart grid over old grid [24]

Smart grid

- If the power outage is happening it restores automatically
- When demand is peak the utility suppresses
- Less cost
- It is working with higher wind and solar penetration
- It can manage distributed generation safely
- Reduce emissions, customer bill, and 2% power loss

Old grid

- When demand is peak utility pays
- Management high wind and solar penetration is difficult
- Cannot manage distributed generation safely
- Has 10% power loss in transmission & distribution systems

VI. OBSERVATIONS

- Genetic algorithm have no guaranteed to be optimum for optimal power flow solution, execution time and quality of the solution, deteriorate with the increase of the chromosome length. It's execution time could be a disadvantage of GA , if the number of generators increases [19].
- For lowest energy consumption, and successful control of energy dispatch in smart micro-grids EMPC (economic model predictive control) yields a better economic result and it is preferable [13][10].

- The better solution of cost minimization and efficiency improvement of the smart grid is installing of renewable energy sources [1].
- Negotiation problem between the generation company and multiple utility companies are bargaining problem [18].

VII. CONCLUSION AND RECOMMENDATION

A. Conclusion

Economic dispatch and unit commitment are essential problems to be solved in order to supply high-quality electric power to customers. Smart grid is used to improve economic dispatch and unit commitment problems. A smart grid is generally economic, reliable, secure, efficient and environmental friendly systems. Since, in smart grid interconnected elements from central and distributed generator up to end user is monitored, protected and automatically optimized. To reduce cost and getting efficient power many researcher proposed different methods by using high penetration of renewable energy sources, the large amount of energy that can be stored and different methods used in economic dispatch algorithm that are conventional and modern techniques, use energy management techniques like smart metering, demand side management, vehicle to grid connection and soon. This paper reviewed several papers related to economic dispatch problem, show used method, overview of smart grid, comparison between central and distributed algorithm and smart and old grid, observing the best method among them, and recommend some indication for future works.

B. Recommendation

- Distributed optimization algorithms are recommended for solving non-linear optimization problems with low latency and higher accuracy.
- Focus on studying effect of temperature variations on semi-empirical models of available capacity of the storage unit and designing faster distributed techniques for improving upon the convergence rates of the system.
- How to develop a distribute economic dispatch strategy based on stochastic programming method is an interesting topic worthy of consideration as a future work
- Scalability and on computing solutions using an iterative process to refine the level of discretization for the generators and load outputs.
- Genetic algorithm method is recommended because, it can use in both integer and discrete variables, it can globally optimum solution as it can avoid the trap of local optima and deal with the non-smooth, non-continuous, non-convex and non-differentiable functions which actually exist in practical optimization problems.
- Construction of a real intelligent communication network with high-speed two-way functions has been recommended.
- For solving of economic dispatch problem as well as optimal sizing of batteries banks Metaheuristic algorithm is recommended.

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