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Multi-Objective Congestion Management in a Deregulated Power System - A Review

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ABSTRACT

Congestion management is one of the technical challenges in power system Deregulation. There are two types of congestion Management Methodologies such as non-cost free methods and cost free methods to relieve congestion in transmission lines. In this research work congestion is relieved using cost free methods considering various FACTS Devices such as TCSC, UPFC, SVC, TCPAR etc. Both single objective and multi objective optimization approaches are used for optimal choice locations and size of FACTS devices in deregulated power system to improve branch loading(minimize congestion), Maximize total system social Welfare, Voltage stability and reduce line losses. FACTS devices offer many advantages but their installation cost is very high. So that Independent system operator(ISO) has to locate FACTS Devices optimally to satisfy a desired objective functions. In congestion management objective function is non linear for solving that various soft computing techniques will be applied. The above methods will be tested on Various IEEE test bus system and the results will be validated.

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INTRODUCTION

In a regulated power system Generation, transmission and Distribution are controlled in a single company, but in a deregulated power system has entities like Generation Companies (GENCO), Transmission Companies (TRANSCO), Distribution Companies (DISCO), Retailer (RESCO), Independent system operator (ISO). The ISO has the responsibility of ensuring the security and reliability of entire power system. The power transaction between the companies will create congestion in a transmission lines which may get overloaded.

There are two techniques used to relieve congestion management.

A. Cost - free methods

(I) Out-aging of the congested lines from the active system.

(II) Transformer taps changer/phase shifters used.

(III) Series FACTS devices used.

B. Non-cost-free methods:

(I) Re-dispatch of power generation.

(II) Load shedding.

Cost free method have the advantage as compared with non cost free method, Cost free methods is not going to affect economic matters, so to relieve the congestion Generation Companies and Distribution Companies will not come into picture.

2 Literature review:

Congestion management is one of the most challenging operational problems in deregulated power systems. Congestion may occur in transmission line due to lack of coordination between generation and transmission utilities. Due to that generation outages, sudden increase of load demand, or failure of equipments may happen, which will be rectified using FACTS devices. To relieve that congestion so that the system is maintained in secure state. In deregulation power system generation, transmission and distribution are independent activities. The benefits from the deregulation environment are cheaper electricity, efficient capacity expansion planning, cost minimization, more choice and better service. Different entities in the Deregulated power system are Genco, Transco, Disco, Resco, ISO, Customers.

Flexible alternating current transmission systems (FACTS) technology is a collection of Power electronics controllers which can be applied individually or in coordination with other devices. It control one or more interrelated system parameters, such as current, voltage, shunt impedance, series impedance etc., that govern the operation of transmission systems. FACTS to improve the

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controllability, stability and power transfer capability of ac transmission system

Basic types of FACTS Controllers:

Series controllers eg: SSSC,TCSC,TSSC, shunt controllers eg: STATCOM, SVC,TCR,TSR, Combined series-series controller eg: IPFC, Combined series-shunt controller eg: UPFC

Applications of FACTS Controllers:

- Power flow control
- Voltage control
- Reactive power compensation
- Stability improvement
- Interconnection of renewable and distributed generation storages
- Power conducting
- Power quality improvement
- Increase of transmission capability

In this research paper (Mojtaba Khanabadi, 2013) contributed in the area Transmission congestion management using Transmission Switching (TS) and voltage security criteria. Methodology used here is Mixed-integer nonlinear programming (MINLP) problem which is solved using Benders decomposition. It is tested on IEEE 57-bus and IEEE 300-bus test systems. In this paper transmission switching with AC constraints includes voltage and security criteria formulated and used to reduce extra generation costs imposed due to transmission congestion. Benders decomposition is employed to solve the resulted Mixed-integer nonlinear programming problem. A method is introduced providing the system operator with a priority list for performing switching actions.

In this research paper (Bharadwaj R. Sathyanarayana, 2013) contributed in Locational marginal prices (LMPs), Real time pricing, Sensitivity analysis, Jacobian-based sensitivity analysis. Methodology is Pareto optimality criterion. It is tested on Roy Billinton Test System. In this paper develops a model for extending time-of-day pricing to distribution circuits, using an ac sensitivity- based approach. A multi-objective optimization algorithm has also been developed that minimize the use of distributed energy storage in power distribution systems.

In this research paper (Kanwardeep Singh, 2011) objective functions are Maximize social welfare, Minimize real and reactive power generation cost, congestion management and controlling the LMP spikes in pool-based day-ahead electricity markets. Price responsive demand shifting (PRDS) bidding mechanism has been used. It is tested on five-bus, IEEE 30-bus, realistic UP 75-bus Indian, and IEEE 118-bus systems. In this paper PRDS bidding, being a multi-period bidding mechanism, is able to minimize the LMPs at system buses and shadow prices of congested lines in day-ahead markets.. PRDS bidding proves to be a promising demand side management tool for congestion management.

In this research paper (Hajforoosh1, S., 2012) contributed in the areas are Minimize the total generation cost, Voltage profile improvement, The GenCos cost functions, the UPFC cost function. Coordinated aggregated-based particle swarm optimization algorithm (CAPSO), Load duration curve (LDC) is used Placement and sizing of one unified power flow controller (UPFC) device for congestion management. In this paper the proposed method shows the benefits of UPFC in a deregulated power market and demonstrates how it may be utilized by ISO to improve the total system cost and prevent congestion. It is compared with other optimization techniques such as SQP and the proposed CAPSO algorithm attains the better solutions.

In this research paper (Tiwari, P.K., Y.R. Sood, 2012) contributed in the area to calculate Social Welfare by determining locational marginal pricing based on the marginal cost theory, system real power losses has also been investigated. Optimal allocation of UPFC used in a pool and bilateral power market. It is tested on 39-bus New England system. In this paper optimal location, number and parameter settings of multiple UPFCs in the deregulated power system. The system real power losses minimize with the installation of multiple UPFCs. This approach can be applied to any large and small system and it can also be extended for the optimal location of other FACTS devices.

In this research paper (Jagabondhu Hazra, 2007) Objective functions are Mitigation of overload, Minimization of cost of operation. Multiobjective particle swarm optimization (MOPSO) method is used. It is tested IEEE 30 &118-bus system, India (NREB) 390-bus system. In this paper Congestion management in transmission grids using cost-efficient generation is rescheduling and/or load shedding.

In this research paper (Sudipta Dutta and S. P.Singh, 2008) optimum selection of participating generators has been introduced using generator sensitivities to the power flow on congested lines. particle swarm optimization (PSO) algorithm is used. It is tested on IEEE 30-bus and 118-bus systems and the 39-bus New England system. In this paper generators from the system are selected for congestion management based on their sensitivities to the power flow of the congested line followed by corrective rescheduling. Proposed method is effective in managing congestion.

In this research paper (Singh, A.K., S.K. Parida, 2013) analyzes allocation of DGs using sensitivity factor, Impact analysis on Available transfer capability, Congestion cost, Reliability. N-1 contingency criterion, determine the optimal capacity by using GA. It is tested on 39-bus New England test system. Advantages are improvement in ATC, minimize the congestion cost, reliability of the system, voltage stability maintained. The proposed approach is computationally efficient and simple as it utilizes the sensitivity factors, which can be easily updated for future expansion of the system. This method will provide a solution to planning and operation of system economically.

In this research paper (Masoud Esmaili, 2013) the problem1 is to minimize total operating cost of power market, problem2 is to minimize branch overloads. Two-stage solution using a modified Benders decomposition technique is used. It is tested on 39 bus New-England power system. In this paper most efficient solution is obtained when two problems simultaneously optimized.

In this research paper (Kumar, A., 2013) optimal rescheduling of generators strategy for real time congestion management and impact of Sen Transformer (ST), comparison of ST with UPFC for congestion management are contributed, optimal location of FACTS devices using mixed integer nonlinear programming. In this paper the congestion cost with ST and UPFC are found lower than without FACTS devices and the results obtained with ST is comparable to UPFC for congestion management. ST being a low cost power flow control device. It is economically efficient and secure operation in a deregulated electricity markets.

In this research paper (Nima Amjady, Mahmood Hakimi, 2012) objective functions are Minimize congestion management cost & dynamic voltage stability. Two Dynamic voltage stability of power system is formulated based on bifurcation theory. It is tested on 39 bus New-England power system. In this paper that method can result in a more robust power system, especially in response to contingencies, with a lower congestion management cost. This method can be applied to power systems including static, dynamic and composite load models.

In this research paper (Yousefi, A., 2012) Congestion management in a restructured market environment using a combination of demand response (DR) and flexible alternating current transmission system (FACTS) devices. Mixed integer optimization Technique is used. It is tested on IEEE 30-bus system. Here conventional generators and FACTS devices are improved by demand responses. Various options of using FACTS devices and demand response are compared.

In this research paper (Nagalakshmi, S., N. Kamaraj, 2012) computational intelligence algorithms to determine the optimal location and control of FACTS devices to improve the loadability of pool and hybrid models in restructured power system. PSO, Differential Evolution (DE) and Composite Differential Evolution (CoDE) algorithms are used. TCSC, SVC and TCPST are considered. It is tested on IEEE 118 bus system. In this paper FACTS devices are used to enhance the loadability in transmission system. Performance of PSO, Differential Evolution DE and CoDE are compared for loadability enhancement of pool and hybrid model of deregulated power systems with FACTS devices.

In this research paper (Nabavia, S.M.H., 2012) maximize the total system social welfare and perform congestion management in a double-sided auction market. Fuzzy-genetic algorithm is used, Placement and sizing of TCSC and SSSC devices considered. It is tested on IEEE 14-bus and IEEE 30-bus test systems. In this paper TCSC and SSSC have the ability to restructure the power flow, influence load and generation levels at different buses, and significantly increase social benefits. Result is compared to other optimization techniques, such as SQP and Genetic Algorithm; the proposed Fuzzy-GA achieves better solutions without/with TCSC/SSSC.

In this research paper (Masoud Esmaili, 2011) objective functions are minimize cost of congestion management, Maximize voltage stability margin, Maximize corrected transient energy margin. Fuzzy proposed modified augmented e-constraint method is used. It is tested on New-England test system. Multi-objective optimization method is best method for non-linear problems. The proposed method as well as the ordinary and augmented e-constraint techniques and also the weighting Multi-objective MMP method and single objective optimization are tested in this paper.

In this research paper (Seyed Abbas Taher, 2011) objective functions are optimal power flow (OPF) and congestion management. Immune algorithm (IA) is used, Find optimal location of UPFC. It is tested on IEEE 14-bus and IEEE 30-bus test systems. In this paper Optimal location of UPFCs to minimize total active and reactive power production cost of generators, and congestion management. The UPFC can provide control of the voltage magnitude, voltage phase angle and impedance. UPFC can be increase power transfer capability of the existing power transmission lines, and reduce operational and investment costs.

In this research paper (Ch Venkaiah, 2011) generators are selected based on their sensitivity to the congested line, optimal rescheduling of the active powers of the participating generators. Fuzzy adaptive bacterial foraging (FABF) used, results are compared with the simple Bacterial Foraging (SBF) and Particle swarm optimization (PSO). It is tested on IEEE 30-bus system and Practical Indian 75-bus system. In this paper Generators are selected based on the generator sensitivities to the congested line for relieving congestion in the congested line, thereby reducing the generator costs, the results show that FABF algorithm is giving the best optimal solution in comparison with SBF and conventional PSO algorithms with respect to cost and runtime for relieving congestion in the congested line.

In this research paper (Panigrahi, B.K., V. Ravikumar Pandi, 2009) objective functions are Minimize total congestion cost, OPF problem formulation. In this paper an effective implementation of adaptive bacterial foraging – Nelder Mead algorithm used for congestion management. Adaptive bacterial foraging algorithm is used to removal of congestion in a better manner.

In this research paper (Masoud Esmaili, 2009) objective function includes congestion management cost, voltage stability, and Transient stability. Fuzzy decision maker methodology used. It is tested on New-England test system. In this paper multi-objective framework for congestion management and optimizes competing objective functions of congestion management cost, voltage security, and transient security.

In this research paper (Visalakshi, S., S. Baskar, 2011) contributed in the area maximization of social welfare, Minimization of Voltage and reactive power effects. Fuzzy Modified Non-dominated Sorting Genetic Algorithm II (MNSGA-II) is used. It is tested on IEEE 30-bus test system. This method used to solve congestion management problem.

In this research paper (Vijayakumar, K., R. Jegatheesan, 2012) cost of installation of DG and congestion index, Minimize congestion cost and transmission line loss are considered. Methodologies used are Real coded Genetic Algorithm & NSGA II. It is tested on IEEE 14 bus system. In this method gives a set of pareto optimal solution, so operator has a flexibility in choosing the solution based on the need.

In this research paper (Mohsen Gitizadeh, Mohsen Kalantar, 2009) mitigates congestion in the transmission lines and increasing static security margin and voltage profile are contributed. TCSC and Static Var Compensator are used to achieve the determined objectives SQP, Genetic Algorithm (GA)-based fuzzy multi-objective optimization approach is used. It is tested on IEEE 14-bus test system is selected. In this paper congestion management problem solved using FACTS Devices.

In this research paper (Vijayakumar, K., 2012) objective functions are Minimize total congestion cost, Minimize the transmission congestion, Minimize the voltage deviation index. Multi-objective fuzzy evolutionary programming (FEP) and non-dominated sorting genetic algorithm II methods are used to solve congestion management in transmission line. It is tested on IEEE 30 bus system. In this paper congestion cost is less in FEP than PSO. FEP method gives best solution considering both the objectives simultaneously, NSGA II algorithm is used to find a set of non dominated Pareto-optimal solutions.

In this research paper (Vijayakumar, K., 2011) contributed in the area Social welfare maximization, Solve line overloading problem (OPF). optimal location of TCSC and UPFC to relieve congestion using genetic algorithm (GA) technique. It is tested on IEEE 57 bus system. In this paper to relieve congestion multiple types of FACTS devices are located optimally by considering thermal limits of the lines. In future other FACTS devices and objective functions can be used for relieving congestion.

3. Objective function:

Congestion management is the challenging operational problems in deregulated power systems. Congestion may occur in transmission line due to lack of coordination between generation and transmission companies. Due to congestion generation outages, sudden increase of load demand, or failure of equipments may happen, which will be rectified using FACTS devices. To relieve the congestion so that the system is maintained in secure state. The Objective functions are

3.1 Minimize total congestion cost:

First as the main objective function is minimizing the cost of congestion management, It is the Difference between Generation cost function and demand cost function. Maximize the social welfare is to minimize the congestion cost.

$$\min \left(\sum_{i=1}^{N_G} C_{G_i}(P_{G_i}) - \sum_{i=1}^{N_D} B_{D_i}(P_{D_i})\right) \tag{1}$$

In this objective function CGi(PGi) is generating cost function, real power PGi at bus-i, and CDi(PDi) is the demand cost function.

3.2 N-1 contingency analysis:

Congestion may occur in power system due to transmission line outages, generator outages, changes in energy demand and uncoordinated transactions. In this objective, N-1 contingency analysis is carried out to identify the most severe lines and those lines are considered for analysis.

3.3 Maximize the voltage stability margin:

To securely operate the power system, it is necessary to maintain an adequate level of voltage stability. Voltage stability margin in the load domain, which measures the distance from the current operating point to the voltage collapse point in terms of the load increment, is an efficient and widely used voltage stability index.

Voltage stability Margin(VSM)= VSMo + ΔVSM (2)

where VSMo is the VSM value before applying congestion management

ΔVSM - VSM change due to rescheduling in demand and generation powers

3.4 Maximize corrected transient energy margin:

It is an important task to prevent increasing the generation of critical generators to keep the transient stability of the power system after congestion management. The result of congestion management would be more secure from transient stability viewpoint if the effect of generator outputs on transient stability margin is considered. Especially, for faults with a high probability of occurrence, the power system should be able to tolerate the faults without losing synchronism.

Transient energy margin (CTEM) = CTEMo + ΔCTEM (3)

where CTEMo is the CTEM value before applying congestion management

ΔCTEM - CTEM change due to rescheduling in demand and generation powers

4.Conclusion:

Based on the Literature survey the following objective functions will be considered for Congestion Management. Minimize total congestion cost, Social Welfare Maximization, N-1 contingency analysis, Maximize the voltage stability margin, Maximize corrected transient energy margin, Determine Locational Marginal Price.

To compare with soft computing methods like Particle swarm optimization, Harmony search algorithm, Honey Bee algorithm, Shuffled Frog Leaping Algorithm, Cuckoo Search Optimization Algorithm, Ant Colony Optimization Algorithm, Spiking Neural Network, Installation cost of FACTS controllers are very high. Hence ISO has to locate them at optimal locations. The below methods will be tested on IEEE test bus system.

REFERENCES

Bharadwaj R. Sathyanarayana, StudentMember, IEEE, and Gerald Thomas Heydt, Life Fellow, 2013. IEEE " Sensitivity-Based Pricing and Optimal Storage Utilization in Distribution Systems" IEEE TRANSACTIONS ON POWER DELIVERY, 28(2).

Ch Venkaiah, D.M. Vinod Kumar, 2011. "Fuzzy adaptive bacterial foraging congestion management using sensitivity based optimal active power re-scheduling of generators" ELSEVIER, Applied Soft Computing, 11: 4921-4930.

Hajforoosh1, S., S.M.H. Nabavi2 M.A.S. Masoum3, 2012. "Coordinated aggregated-based particle swarm optimisation algorithm for congestion management in restructured power market by placement and sizing of unified power flow controller" IET Sci. Meas. Technol., 6(4): 267-278.

Jagabondhu Hazra, Student Member, IEEE, Avinash K. Sinha, Member, IEEE 2007. "Congestion Management Using Multiobjective Particle Swarm Optimization" IEEE TRANSACTIONS ON POWER SYSTEMS, 22(4).

Kanwardeep Singh, Narayana Prasad Padhy, Senior Member, IEEE, and Jaydev Sharma, 2011. "Influence of Price Responsive Demand Shifting Bidding on Congestion and LMP in Pool-Based Day-Ahead Electricity Markets" IEEE TRANSACTIONS ON POWER SYSTEMS, 26(2).

Kumar, A., Charan Sekhar, 2013. "Comparison of Sen Transformer and UPFC for congestion management in hybrid electricity markets" ELSEVIER ,Electrical Power and Energy Systems, 47: 295-304.

Masoud Esmaili, Fatemeh Ebadi, Heidar Ali Shayanfar B., Shahram Jadid, 2013. "Congestion management in hybrid power markets using modified Benders decomposition" ELSEVIER, Applied Energy, 102: 1004-1012.

Masoud Esmaili, Heidar Ali Shayanfar, Nima Amjady, 2009. "Multi-objective congestion management incorporating voltage and transient stabilities " ELSEVIER, Energy, 34: 1401-1412.

Masoud Esmaili, Nima Amjady, Heidar Ali Shayanfar, 2011. "Multi-objective congestion management by modified augmented e-constraint method " ELSEVIER, Applied Energy, 88: 755-766.

Mohsen Gitizadeh, Mohsen Kalantar, 2009. "Genetic algorithm-based fuzzy multi-objective approach to congestion management using FACTS devices " Springer Link,Electrical Engineering, 90(8): 539-549.

Mojtaba Khanabadi, Hassan Ghasemi, Senior Member, IEEE, and Meysam Doostizadeh, 2013. "Optimal Transmission Switching Considering Voltage Security and N-1 Contingency Analysis " IEEE TRANSACTIONS ON POWER SYSTEMS, 28(1).

Nabavia, S.M.H., A. Kazemia, M.A.S. Masoumb, 2012. "Social welfare maximization with fuzzy based genetic algorithm by TCSC and SSSC in double-sided auction market " ELSEVIER ,Scientia Iranica D., 19(3): 745-758.

Nagalakshmi, S., N. Kamaraj, 2012. "Comparison of computational intelligence algorithms for loadability enhancement of restructured power system with FACTS devices" ELSEVIER ,Swarm and Evolutionary Computation, 5: 17-27.

Nima Amjady, Mahmood Hakimi, 2012. "Dynamic voltage stability constrained congestion management framework for deregulated electricity markets " ELSEVIER ,Energy Conversion and Management, 58: 66-75.

Panigrahi, B.K., V. Ravikumar Pandi, 2009. "Congestion management using adaptive bacterial foraging algorithm " ELSEVIER ,Energy Conversion and Management, 50: 1202-1209.

Seyed Abbas Taher, Muhammad Karim Amooshahi, 2011. "Optimal placement of UPFC in power systems using immune algorithm " ELSEVIER ,Simulation Modelling Practice and Theory, 19: 1399-1412.

Singh, A.K., S.K. Parida, 2013. "Congestion management with distributed generation and its impact on electricity market " ELSEVIER, Electrical Power and Energy Systems, 48: 39-47.

Australian Journal of Basic and Applied Sciences, 9(16) Special 2015, Pages: 373-378

Sudipta Dutta and S. P.Singh, Senior Member, IEEE 2008. "Optimal Rescheduling of Generators for Congestion Management Based on Particle Swarm Optimization " IEEE TRANSACTIONS ON POWER SYSTEMS, 23(4).

Tiwari, P.K., Y.R. Sood, 2012. "Efficient and optimal approach for location and parameter setting of multiple unified power flow controllers for a deregulated power sector" IET Gener. Transm. Distrib., 6(10): 958-967.

Vijayakumar, K., 2011. "Optimal Location of FACTS Devices for Congestion Management in Deregulated Power Systems " International Journal of Computer Applications, 16(6): 0975-8887.

Vijayakumar, K., 2012. "Multiobjective OptimizationMethods for Congestion Management in Deregulated Power Systems " Journal of Electrical and Computer Engineering Volume 2012, Article ID 962402, 8 pages doi:10.1155/2012/962402.

Vijayakumar, K., R. Jegatheesan, 2012. "Optimal Location and Sizing of DG for Congestion Management in Deregulated Power Systems " Springer Link,Swarm, Evolutionary, and Memetic Computing Lecture Notes in Computer Science, 7677: 679-686.

Visalakshi, S., S. Baskar, 2011. "Decentralized Congestion Management Using Modified NSGA-II " Springer Link,Arabian Journal for Science and Engineering, 36(5): 827-840.

Yousefi, A., T.T. Nguyen, H. Zareipour, O.P. Malik, 2012. "Congestion management using demand response and FACTS devices" ELSEVIER ,,Electrical Power and Energy Systems, 37: 78-85.