International Journal on
"Technical and Physical Problems of Engineering"
(IJTPE)
Published by International Organization of IOTPE

ISSN 2077-3528
IJTPE Journal
www.iotpe.com
ijtpe@iotpe.com

December 2022 Issue 53 Volume 14 Number 4 Pages 385-391

MULTI-STRATEGY OPTIMAL CONTROL FOR COMPENSATING DEVICES IN POWER SYSTEM WITH WIDE RANGE LOAD CONDITIONS

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Abstract- Lack of development in the manufacturing sector to meet the growing demand for electrical energy highlighted the need for economical use of the ultimate capacity of current systems in different operating conditions. This paper presents a multi-strategy optimization process organized using modern compensation devices including shunt and series FACTS devices, and demand management program. With the aim of achieve the practical optimal solutions, it is necessary to consider the real system conditions in the optimization process. One of the important conditions affecting the behavior of the power system is the nature of the uncertainty of electrical loads. The multi-strategy optimization process allows the study of load uncertainties on the capacity of the compensating devices and demand response programs as well as the associated costs for a wide range of operating conditions. Also, designing and adopting different strategies for selecting suitable multi-objective functions in the proposed optimization process, ensures the simultaneous improvement of technical and economic indicators of the power system in a competitive market. Another important feature of this article is the analysis of data obtained from optimization processes in making the optimal decision foe perfect management of the power grid. Furthermore, in order to strengthen optimization processes evolutionary algorithm is applied to them. Simulation programs are performed in MATLAB and PSAT environments on the standard IEEE 30-bus test network.

Keywords: Demand Management Program, Shunt and Series FACTS Devices, Economic Optimization, Technical Optimization, Multi-Objective Function, Power Loss, System Loadability, Voltage Static Stability.

1. INTRODUCTION

Uncertainty of electrical loads as an inevitable factor in power grids shows decisive effects on the results of optimization processes. Achieving important economic goals in competitive electricity markets is often impossible without considering the uncertainties conditions of electric loads in optimization processes.

In this regard, organizing the presented multi-strategy optimization process provides the possibility of auditing the effects of load uncertainty over a broad range of operating situations. Thus, the implementation of the multi-strategy optimization process in the presence of a variety of shunt and series FACTS compensators, and demand management program individually and in combination. In addition, assessing the impact of errors and uncertainties in each of these situations, create a strong control system for optimal operation of the power system. Another important aspect of the multi-strategy optimization process is the use of a variety of multi-objective technical and economic functions tailored to the operating conditions of the system. In addition, increased response times of the multi-strategy optimization process to achieve optimal solutions in an acceptable amount of time employs an evolutionary algorithm. The implementation of the evaluation and selection method of the Pareto front is guaranteed.

In reference [1] based on the concept of flexible pricing of demand; the customer benefits from an economic model of price/incentive responsive loads as presented. A combination of flexible alternating current transmission system (FACTS) devices and demand response (DR) were added on transmission lines to manage the power in a restructured market environment [2]. In reference [3] using optimal location and rating of single TCSC in the system, a new optimization method is presented based on an objective to minimizing the device investment cost and maximizing the social welfare. Reference [4] proposes an electricity market strategy under conditions of uncertainty, including distributed generators, renewable power generators, and load support units. The predominant methods for power system operations are to manage the uncertainties caused by large-scale integration of renewable energy and active load demand are discussed [5]. In reference [6], the optimal location and capacity of the demand response program has been determined using multi-objective function. In reference [7], to achieve minimum power losses and maximum voltage static stability, the optimal capacity and location of a TCSC have been targeted.

In reference [8] synthesizing thyristor-controlled phase shifter and flexible AC transmission systems (FACTS) devices, namely, thyristor-controlled series capacitor was applied for solving the optimal power flow (OPF) in the electric power system. In reference [9] the optimal capacity and location of shunt FACTS devices have been determined by the use of genetic algorithm.

In reference [10] the outcomes of uncertainty in prognosticating the wind farm's power output in on location of marginal price in the market have been analyzed. The presented procedure maximizes the social welfare. Simultaneous application of shunt and series FACTS compensators, and demand management program (DR) for purpose of improvement multi-purpose function using evolutionary algorithm is investigated [11].

In reference [12] the importance of demand response program to deal with the out-of-tolerance conditions and control of costs are investigated. The generation capacity expansion in a multi-stage embedded strategic generation companies has been studied using a new framework [13]. In reference [14] a bi-level model including binary variables in both lower and upper levels has been proposed and solved by applying a personalized decomposition and reformulation algorithm. Some ideas for future research have been proposed based on reviewing different research works on DR optimization problems [15].

In [16] new methods for optimal allocation of DR, series and parallel FACTS devices considering both the technical and economic criteria are presented. The impact of the set of lateral conditions on the flexible optimization process is solved in a complex manner considering technical and economic indices for various multi-objective functions. This is according to the current needs of the system [17]. The major purpose of this study is to evaluate the efficiency of shunt and series FACTS compensators, and demand management program to optimizing multi-objective function and comparing them to enhance technical and economic indices for reaching the use of the ultimate capacity of current systems.

In reference [18] the efficiency of shunt and series FACTS devices, and demand management program in optimizing multi-objective function and improvement of technical and economic indices to meet the use of the ultimate capacity of current systems have been evaluated and compared. This paper is arranged as follows. In the next section, optimization approaches are classified according various operating scenarios of the power system. The third section deals with designing of multi-strategy optimization process. In the fourth section, data analysis and recommendations are made. Fifth section presents our conclusions.

2. CLASSIFICATION OF OPTIMIZATION APPROACHES

The approach to solving optimization problems in power systems is highly dependent on the operating conditions and current needs of the system. This includes low load and peak load conditions, normal and fault conditions as well as load uncertainty.

In this way, depending on the mentioned conditions, the targets of the objective function such as reduction of loss, system loadability enhancement, voltage stability improvement and reduction of compensation costs can be selected. In this research, optimization approaches are classified as shown in Table 1. As can be seen from the table, in the case of low load, the approach of loss reduction, voltage stability improvement and costs reduction are targeted.

While in peak load conditions, in order to prevent blackouts, regardless of losses and compensation costs, the approach of system loadability enhancement and voltage stability improvement is a priority. It is worth noting that the choice of compensation equipment or the use of load response program and their individual or group implementation provides the multi-strategy property of the optimization process. Also, all classified approaches and strategies are implemented for normal / fault conditions, as well as fix loads / load uncertainty conditions. In the next section designing and applying of categorized approaches and strategies are described. The most important advantage of these classifications is to help the system operator to make the best decision in order to achieve the maximum potential and benefits of technical and economic opportunities.

Table 1. Approaches Classification

All approach repeated for Normal / fault & fix load / load uncertainty							
	Approaches Classification						
Operation Conditions	Loss reduction	Loadability Enhancement	Series FACTS	Parallel FACTS	Demand Response	Technical Optimization	Technical & Economic Optimization
Low Loads	*	-	*	-	-	-	*
Low Loads	*	-	-	*	-	-	*
Low Loads	*	-	-	-	*	-	*
Low Loads	*	-	*	*	*	-	*
peak Loads	-	*	*	-	-	*	-
peak Loads	-	*	-	*	-	*	-
peak Loads	-	*	-	-	*	*	-
peak Loads	-	*	*	*	*	*	-

3. MULTI-STRATEGY OPTIMIZATION DESIGN

With the aim of achieve the practical optimal solutions, it is necessary to consider the real system conditions in the optimization process. develop the optimization process and to achieve optimal solutions in accordance with the needs of the real power system in all operating conditions, the multi-strategy optimization process is developed. This process provides the possibility of examination and evaluation of the influence of load uncertainty on electric power system effectiveness in various operating scenarios.

Figure 1 shows the block diagram of multi-strategy optimization process. To compare the effect of uncertainty loads on optimal answers; initially the possibility of choosing one of two fixed or uncertain modes for loads is considered. Here the scenario method is used to enter uncertainty conditions in the process.

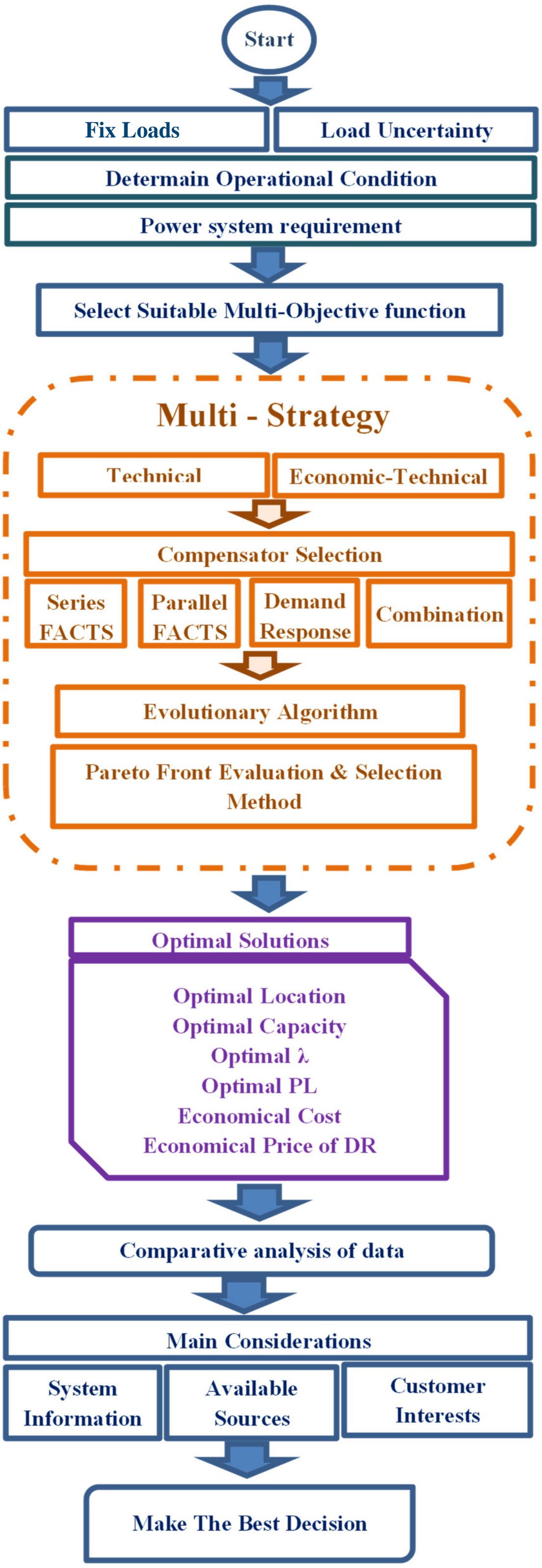

Figure 1. Multi-strategy optimization process flowchart

The mathematical model of the scenario method is performed as Equations (1) and (2).

$$PL_m = \frac{\sum_{i=1}^{n} PL_{OPT}(Loads \times KS_i)}{n} \tag{1}$$

$$\lambda_m = \frac{\sum_{i=1}^{n} \lambda_{OPT}(Loads \times KS_i)}{n} \tag{2}$$

In the second step for normal or fault operating conditions of system are determined. The choice of fault conditions changes in the network topology. By determining the initial conditions in the third stage; the essential needs of the power system can be defined. In the next step the multi-objective functions are determined based on the operator's interests and power system priorities. Using the multi-objective function ensures the simultaneous improvement of several power system parameters. Also, by defining the objective function and requirements of the power system, the design of the multi-strategy optimization process is initiated. The application of this process outlines various paths to achieve the desired outcome. This provides the possibility of having the most appropriate optimal answers in accordance with the needs of the system. The next stages are based on the initial analysis and the problem-solving approach can be selected between the technical approach and the technical-economic approach.

In the technical optimization approach, regardless of the compensation costs, achieving the maximum improvement of the objectives set by the system operator is desired. As shown in Equation (3), the multi-objective function ensures the simultaneous improvement of important power system parameters.

$$F(\lambda, PL) = (\lambda_{NEW} - \lambda_0)_{\max} \,\&\, (PL)_{\min} \tag{3}$$

In technical-economic optimization, the required improvement of the system index is determined by the operator based on the needs of the network. In this case, reaching the specified set point with the minimum compensatory capacity is carried out. The general form of the multi-objective economic-technical function is represented using Equations (4) and (5).

$$F(PL,\, C_{Compensator}) = (|PL_{NEW} - PL_{Set}|)_{\min} \,\& \\ \&\, (C_{Compensator})_{\min} \tag{4}$$

$$F(\lambda,\, C_{Compensator}) = (|\lambda_{NEW} - \lambda_{Set}|)_{\min} \,\& \\ \&\, (C_{Compensator})_{\min} \tag{5}$$

The multi-strategy optimization process allows the desired results to be achieved utilizing different shunt and series FACTS devices, and demand management program, individually or any desired combination of them. Following stage's locations allow the installation of compensating equipment or demand response program. In addition, the range of capacity change for each the mentioned options are determined. The general figure for determining the range of location changes and the capacity of series compensating devices is shown in Equations (6) and (7), respectively.

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$$L_{Series} = \{L_S \mid 1 \le L_S \le L_{\max} \text{ , } L_S \notin \{UPL\}\} \tag{6}$$

$$-K_S \times X_{Line} \le X_{Series} \le K_2 \times X_{Line} \tag{7}$$

where, L_{Series} is collection of candidate locations for installation of series compensating devices, L_S is line number of installation place of series compensating devices, $L_{S\max}$ is the largest line number in the network, X_{Series} is range of reactance changes of series compensating devices, X_{Line} is reactance of the desired transmission line, K_1 is fixed coefficient to determine the maximum series compensator reactance in inductance mode, K_2 is constant coefficient to determine the maximum series compensator reactance in capacitive mode and *UPL* is a set of lines in which it is not possible to install series compensating devices

Equations (8) and (9) show the general shape of the range of location and capacity of the parallel compensating devices, respectively.

$$B_{Paralel} = \{B_P \mid 1 \le B_P \le B_{\max} \text{ , } B_P \notin \{UPB\}\} \tag{8}$$

$$-Q_{\min}^{pu} \le Q_P \le Q_{\max}^{pu} \tag{9}$$

where, $B_{Parallel}$ is a set of candidate buses for the installation of parallel compensating devices, B_P is bus number for installation of parallel compensating devices $B_{\max}$ is the largest bus number in the network, Q_P is range of changes in the capacity of parallel compensating devices, $Q_{\min}$ is maximum parallel compensator capacity in induction mode, $Q_{\max}$ is maximum parallel compensator capacity in capacitive mode and *UPB* is a set of buses in which it is not possible to install parallel compensating devices.

The general figure for determining the range of capacity and location changes of the demand management program is shown in Equations (10) and (11), respectively.

$$\begin{aligned} B_{Demand\,Response} = \{&B_{DR} \mid 1 \le B_{DR} \le B_{\max} \\ &B_{DR} \in \{PQ\} \text{ , } B_{DR} \notin \{UPDR\}\} \end{aligned} \tag{10}$$

$$0 \le S_{DR} \le K_3 \times S_{BUS} \tag{11}$$

where, $B_{Demand\,Response}$ is a set of candidate buses for implementation of Demand Response program, B_{DR} is bus number for implementation of Demand Response program, $B_{\max}$ is the largest bus number in the network, S_{DR} is range of changes in the capacity of Demand Response program, S_{BUS} is apparent power of the desired bus, K_3 is constant coefficient to determine the maximum capacity of the demand response program and *UPDR* is a set of buses in which it is not possible to implement a demand response program

In the next step a genetic evolutionary algorithm is used to achieve optimal answers in an acceptable time. The loop of multi-objective function optimization the process at each iteration requiring evaluation and arranging multifaceted answers. This is achieved by implementation of the Pareto front assessment and selecting method. Utilizing this method; the output of the multi-strategy optimization process, instead of an optimal solution, a set of optimal solutions are obtained in the form of the Pareto front. Finally, on the basis of the outcomes of comparative analysis, the operator of system makes the best decision taking into account the needs of the power system and predetermined goals.

4. DATA ANALYZING AND MAKE SUGGESTIONS

This paper, provides a robust optimization process for solving electric power system problems in a broad range of loads conditions and system operation. Approaches appropriate to current needs are also identified. In this part, by comparative analysis resulting from optimal solutions for different strategies of improved control of compensators is shown. The following are examples of the calculated results obtained. are presented. Table 2 shows the comparative analysis of the optimal solutions obtained from the technical optimization approach. Simultaneous adaptation of series and parallel FACTS devices along with the demand response program in normal and fault conditions as well as for constant loads and uncertainty loads conditions for eight various approaches are part of the strategy.

As can be seen in Table 2, considering the load uncertainty conditions in all defined methods reveals the range of potentials of the system and causes more power loss reduction and improvement of system loadability and static voltage stability. Also, with adoption of the strategy of simultaneous implementation of three equipment, it is concluded the reduction of losses up to $PL = 0.0315$ and the increase of system load capacity up to $\lambda = 6.1389$. A comparative analysis of the loss reduction index for the simultaneous installation strategy of series and parallel FACTS devices along with load response program for the four most widely used approaches is shown in Figure 2. The blue dashed circle shows the system losses before compensation. As shown in the diagrams, in all adopted approaches, the multi-strategy optimization process ensures reduction of the loss index. The curves also show that the solutions resulting from the optimization of the multi-objective function in the form of Pareto front impose more power losses on the system at peak load conditions while focusing on increasing system loadability. The large range of changes in the loss reduction index proves the applicability of the presented multi-strategy optimization process.

Table 2. Sample strategy of simultaneous implementation of shunt and series FACTS devices along with demand management program

Solution Number	Approaches in accordance with different operating conditions of the system							
	N - Fix - PL	*N - Un - PL*	*N - Fix - λ*	*N - Un - λ*	*E - Fix - PL*	*E - Un - PL*	*E - Fix - λ*	*E - UN - λ*
1	0.0958	0.1007	3.3941	4.1355	0.0434	0.0419	3.0233	3.7529
2	0.202	0.4371	4.0816	5.57	0.0434	0.0349	3.0279	3.6441
3	0.0411	0.2855	2.9152	5.0777	0.2915	0.0452	3.9177	3.8441
4	0.4649	0.4296	4.7638	5.5511	0.2365	0.0422	3.8368	3.7835
5	0.0754	0.099	3.2454	4.1296	0.292	0.0487	3.9968	3.854
6	0.0791	0.3727	3.3069	5.3708	0.4326	0.0741	4.3456	4.1439
7	0.045	0.2769	3.0891	5.0475	0.4375	0.0516	4.3537	3.936
8	0.0802	0.0769	3.378	4.036	0.2241	0.3875	3.7352	5.4523
9	0.2867	0.1563	4.2868	4.4011	0.0961	0.3844	3.4066	5.4206
10	0.1227	0.3224	3.4979	5.1965	0.1534	0.3829	3.6611	5.4196
11	0.051	0.0315	3.2309	3.5847	0.4326	0.051	4.3494	3.9048
12	-	0.219	-	4.8604	0.167	0.2893	3.6842	5.3738
13	-	0.1935	-	4.7744	0.3374	0.3876	4.2638	5.4736
14	-	0.0315	-	3.5835	0.3325	0.2817	4.1123	5.3267
15	-	0.1372	-	4.3374	0.2541	0.0525	3.9072	3.991
16	-	0.107	-	4.2621	0.1074	0.1744	3.4781	4.94
17	-	0.1058	-	4.2563	0.2256	0.0326	3.8008	3.6285
18	-	0.1108	-	4.287	0.4397	0.0497	4.631	3.9024
19	-	-	-	-	0.2931	0.3877	4.0213	5.4744
20	-	-	-	-	-	0.2335	-	5.0259
21	-	-	-	-	-	0.5616	-	6.1389
22	-	-	-	-	-	0.1443	-	4.6347
23	-	-	-	-	-	0.128	-	4.5565
24	-	-	-	-	-	0.1034	-	4.4089
25	-	-	-	-	-	0.2738	-	5.2228
26	-	-	-	-	-	0.0435	-	3.8286
27	-	-	-	-	-	0.0574	-	4.1087
28	-	-	-	-	-	0.0574	-	4.028
29	-	-	-	-	-	0.3868	-	5.4398
30	-	-	-	-	-	0.4443	-	5.6155
31	-	-	-	-	-	0.1297	-	4.5697
32	-	-	-	-	-	0.5103	-	5.8092
33	-	-	-	-	-	0.0737	-	4.1417
34	-	-	-	-	-	0.13	-	4.5827
35	-	-	-	-	-	0.4408	-	5.6002
36	-	-	-	-	-	0.1518	-	4.6772
37	-	-	-	-	-	0.3847	-	5.4225
38	-	-	-	-	-	0.1639	-	4.7402
39	-	-	-	-	-	0.2372	-	5.035
40	-	-	-	-	-	0.0349	-	3.74
41	-	-	-	-	-	0.0743	-	4.2351
42	-	-	-	-	-	0.2723	-	5.1937

The comparative analysis of the optimal solutions for the four main approaches of the power system to improve the loadability index and increase the voltage static stability is shown in Figure 3. Blue dashed circle displays the system loadability index before compensation. As can be seen in the diagram, the multi-strategy optimization process for all approaches strongly increases the loadability index, even during significantly reduction in loss index. Optimal responses in accordance with the change in increasing the system loadability at sharp points of the curves in all approaches are introduced as the best option to prevent global blackouts. Table 3 compares the results obtained for different strategies for the purpose of optimize the multi-purpose function in widely used approaches.

Table 3 shows the optimal capacity and location for the installation of each device and the relevant cost. In this table, the goals of λ = 2.6 and PL = 0.0450 are designated by the operator of system in accordance with the needs of the electric power system. As can be seen in Table 3, a specific strategy is not always the best strategy for all approaches. In this way, due to the large difference in costs, the advantage of using the proposed multi-strategy process is confirmed. Another advantage of using the multi-strategy optimization process is determining the optimal location and capacity of the demand response program and its price based on the strategy with lowest obtained cost.

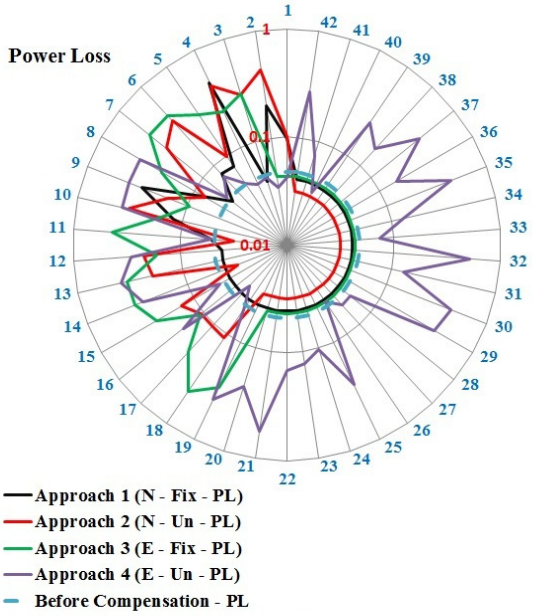


Figure 2. Comparison of loss reduction index in different approaches

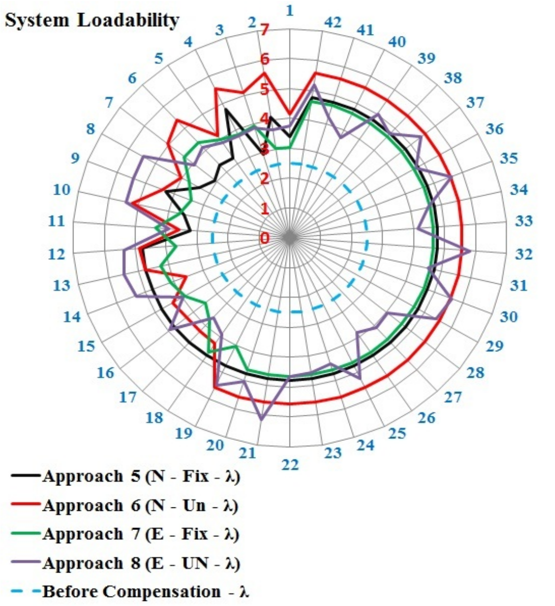


Figure 3. Comparison of system loadability index in different approaches

Table 3. Sample outputs of multi-strategy optimization process

Strategy		Strategy 1			Strategy 2			Strategy 3		
		Series FACTS			Parallel FACTS			Demand Response		
Parameters		Location	Capacity	Cost	Location	Capacity	Cost	Location	Capacity	Cost
Approaches in accordance with different operating conditions of the system	N-Fix-(*PL*=0.0450)	12	0.28 kvar	43.05	10	10 kvar	1273.8	5	7.18 MVA	43.05
	N-Un-(*PL*=0.0450)	10	0.5718 Mvar	87681	29	9.43 Mvar	1163400	5	1.04 MVA	87681
	E-Fix-(*PL*=0.0450)	12	140 kvar	21511	21	10 kvar	1273.8	21	1.72 MVA	1273.8
	E-Un-(*PL*=0.0450)	10	0.25 Mvar	38393	15	9.77 Mvar	1215700	5	8.52 MVA	38393
	N-Fix-(λ=2.6)	36	2.07 Mvar	315220	23	30 kvar	3821.1	21	2.01 MVA	3821.1
	N-Un-(λ=2.6)	29	4.3 kvar	661	22	110 kvar	14008	2	0.49 MVA	661
	E-Fix-(λ=2.6)	10	1.36 Mvar	207790	9	9.77 Mvar	1215700	21	0.97 MVA	207790
	E-Un-(λ=2.6)	29	4.3 kvar	661	9	10 Mvar	1243590	2	0.41 MVA	661

5. CONCLUSIONS

Different approaches to increase the productivity of power systems were developed and presented based on different operating conditions and a broad range of load changes, utilizing different problem-solving technics in the form of a multi-strategy optimization process. In the technical optimization approach for peak load conditions; the use of the ultimate capacity of current systems regardless of the installation capacity of compensating devices and related costs, the concurrent improvement of the major indicators of the electric power system including loadability enhancement, improvement of voltage static stability and loss reduction was achieved. Also, the results obtained from the technical optimization approach in low load conditions ensured maximum loss reduction while maintaining the system loadability index. The outcomes, denote the advantages of the proposed different strategies in optimization of multi-objective function. In the economic-technical optimization approach, achieving the pre-determined set point by the operator with the least installation capacity of compensating devices and minimum costs are presented by implementing different strategies.

The sharp differences in costs incurred for the different adopted strategies proved the importance of the proposed multi-strategy optimization process. Finally, in this paper, the development of the optimization process and the classification of approaches and strategies provides a model for rising the power system efficiency by considering a broad range of real operational conditions and using other modern compensators.

REFERENCES

[1] M.P. Moghaddam, A. Abdollahi, M. Rashidinejad, "Flexible Demand Response Programs Modeling in Competitive Electricity Markets", Applied Energy, Elsevier, Issue 9, Vol. 88, pp. 3257-3269, 2011.

[2] A. Yousefi, T.T. Nguyen, H. Zareipour, O.P. Malik, "Congestion Management Using Demand Response and FACTS", International Journal of Electrical Power and Energy Systems, Elsevier, Issue 1, Vol. 37, pp. 78-85, 2012.

[3] P.K. Tiwari, "An Efficient Approach for Optimal Allocation and Parameters Determination of TCSC With Investment Cost Recovery under Competitive Power Market", IEEE Transactions on Power Systems, Issue 3, Vol. 28, pp. 2475-2484, 2013.

[4] S. Bose, "On the Design of Wholesale Electricity Markets under Uncertainty", The 53rd Annual Allerton Conference on Communication, Control, and Computing (Allerton), pp. 203-210, Monticello, IL, USA, 29 September -2 October, 2015.

[5] C. Peng, S. Lei, Y. Hou, Wu. Felix, "Uncertainty Management in Power System Operation", CSEE Journal of Power and Energy Systems, Issue 1, Vol. 1, pp. 28-35, 2015.

[6] M.R. Shadmesgaran, A.M. Hashimov, N.A. Yusifbeyli, "Optimal Location and Capacity of Demand Response Program for Simultaneously Power Loss Reduction and Static Voltage Stability Improvement Using Genetic Algorithm", The 11th International Conference on Technical and Physical Problems of Electrical Engineering (ICTPE-2015), pp. 75-79, Bucharest, Romania, 10-12 September 2015.

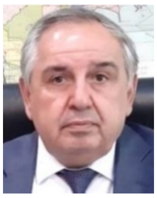
[7] M.R. Shadmesgaran, A.M. Hashimov, N.A. Yusifbeyli, "Optimal Location of TCSC Due to Power Loss Reduction and Static Voltage Stability Improvement Using Genetic Algorithm", Power Engineering Problems, No. 4, pp. 31-37, Baku, Azerbaijan, 2015.

[8] A. Mukherjee, V. Mukherjee, "Solution of Optimal Power Flow with FACTS Devices Using a Novel Oppositional Krill Herd Algorithm", International Journal of Electrical Power and Energy Systems, Elsevier, Vol. 78, pp. 700-714, 2016.

[9] M.R. Shadmesgaran, A.M. Hashimov, N.R. Rahmanov, "Optimal Location and Capacity of Parallel Facts Devices in Order to Improve Voltage Static Stability and Power Losses Reduction Using Genetic Algorithm", The 12th International Conference on Technical and Physical Problems of Electrical Engineering (ICTPE-2016), pp. 102-106, Bilbao, Spain, 7-9 September 2016.

[10] H. Dehghani, B. Vahidi, S.H. Hosseinian, "Wind Farms Participation in Electricity Markets Considering Uncertainties", Renewable Energy, Elsevier, Vol. 101, pp. 907-918, 2017.
[11] M.R. Shadmesgaran, A.M. Hashimov, N.R. Rahmanov, O. Z. Kerimov, I.I. Mustafayeva, "Technical Analysis of Demand Response Program and FACTS Devices Implementation Using Multi-Objective Optimization", International Journal on Technical and Physical Problems of Engineering (IJTPE), Issue 32 Vol. 9, No. 3, pp. 21-29, September 2017.
[12] R. Sharifi, S.H. Fathi, V. Vahidinasab, "A Review on Demand-Side Tools in Electricity Market", Renewable and Sustainable Energy Reviews, Elsevier, Vol. 72, pp. 565-572, 2017.
[13] J. Valinejad, M. Marzband, M. Funsho Akorede, T. Barforoshi, M. Jovanovic, "Generation Expansion Planning in Electricity Market Considering Uncertainty in Load Demand and Presence of Strategic Gencos", Electric Power Systems Research, Elsevier, Vol. 152, pp. 92-104, 2017.
[14] X. Zhang, D. Shi, Z. Wang, B. Zeng, X. Wang, K. Tomsovic, Y. Jin, "Optimal Allocation of Series FACTS Devices Under High Penetration of Wind Power Within a Market Environment", IEEE Transactions on Power Systems, Issue 6, Vol. 33, pp. 6206-6217, 2018.
[15] A. Rezaee Jordehi, "Optimization of Demand Response in Electric Power Systems, a Review", Renewable and Sustainable Energy Reviews, Elsevier, Vol. 103, pp. 308-319, 2019.
[16] M.R. Shadmesgaran, "Prevail Over Power Electric System Problems by Simultaneous Optimization of Both Technical and Economic Criteria Considering Load Uncertainty", International Journal on Technical and Physical Problems of Engineering (IJTPE), Issue 40, Vol. 11, No. 3, pp. 34-42, September 2019.
[17] M.R. Shadmesgaran, A.M. Hashimov, N.R. Rahmanov, "A Glance at the Effects of System Operating Conditions on both Technical and Economic Multi-Objective Optimization", International Journal on Technical and Physical Problems of Engineering (IJTPE), Issue 46, Vol. 13, pp. 1-10, March 2021.
[18] M.R. Shadmesgaran, A.M. Hashimov, N.R. Rahmanov, "Productivity Comparison of Different FACTS And DR To Enhance Technical Indicators and Economical Operation of Grid", The 2nd International Conference on Electrical, Communication and Computer Engineering (ICECCE), pp. 362-367, Istanbul, Turkey, 14-15 April, 2020.

BIOGRAPHIES



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