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UPFC Location and Optimum Power Flow in Wind Power Generation Using Evolutionary Program Techniques

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ABSTRACT

Wind energy conversion systems convert the kinetic energy of the wind intoelectricity or other forms of energy. As one of the most viable sources ofrenewable energy, wind power is undergoing rapid expansion. In this paperpresents solution of optimal power flow problem of large wind power systemsvia a simple evolutionary program algorithm. The objective is to minimize thegenerating cost and keep the power outputs of generators, bus voltages, in theirsecure limits. CPU times can be reduced by decomposing the optimizationconstraints to active constraints and passive constraints manipulated directly bythe evolutionary program algorithm. The IEEE 14-bus system has been studiedto show the effectiveness of the algorithm. Over the last two decades, Evolutionary Computation (EC) has shown tremendous success for solvingcomplex real-world problems. Although the great success for EC was firstrecognized in the 1980s, the researchers in other domain are still confusedabout the acceptability of Evolutionary Algorithms (EAs) as optimization tool. The focal point for this confusion is the lack of convincing mathematicalfoundation which is the strong basis of all conventional optimizationtechniques.

Keywords: *UPFC; EP; OPFl; 14 BUS SYSTEMS.*

1.0 Introduction

Wind power generation has experienced a tremendousgrowth in the past decade, and has been recognized as anenvironmentally friendly and economically competitivemeans of electric power generation. In addition to businessopportunities as a result of deregulation in the electricitymarket, wind power generation has great potential to createemployment in wind system development, manufacturing, maintenance and operation. The lack of stability in oilprices has triggered additional pressure to improve theefficiency of energy generation from alternative sources. Inthis paper presents a optimum power flow using Evolutionary Programming technique with facts device andwithout facts device. Flexible AC transmission systems (FACTS) are an option to mitigate the problem ofoverloaded lines due to increased electric powertransmission by controlling power flows and voltages. Theoptimal power flow of OPF has had a long history in itsdevelopment. It was first discussed by Carpentier in 1962 and took a long time to become a successful algorithm thatcould be applied in everyday use. Current interest in the OPF centers around its ability to solve for the optimalsolution that takes account of the security of the system. Werealize that what it is actually saying is that the generationmust obey the same conditions as expressed in a powerflow-with the condition that the entire power flow isreduced to one simple equality constraint. There is goodreason, as we shall see shortly, to state the economicdispatch calculation in terms of the generation costs, and theentire set of equations needed for the power flow itself asconstraints. This formulation is called an optimal powerflow. We can solve the OPF for the minimum generationcost and require that the optimization calculation also balance the entire power flow-at the same time. Note alsothat the objective function can take different forms otherthan minimizing the generation cost. It is common toexpress the OPF as a minimization of the electrical losses inthe transmission system, or to express it as the minimumshift of generation and other controls from an optimumoperating point. We could even allow the adjustment ofloads in order to determine the minimum load sheddingschedule under emergency conditions. Regardless of theobjective function, however, an OPF must solve so that theentire set of power constraints is present and satisfied at the

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solution. The OPF is a natural choice for addressing theseconcerns because it is basically an optimal control problem. The OPF utilizes all control variables to help minimize thecosts of the power system operation. It also yields valuableeconomic information and insight into the power system. Inthese ways, the OPF very adeptly addresses both the controland economic problems. In this way, the results of theeconomic and control operations of the OPF can easily beutilized by the user of the program. Before beginning thecreation of an OPF, it is useful to consider the goals that the OPF will need to accomplish. The costs associated with thepower system may depend on the situation, but in generalthey can be attributed to the cost of generating power (megawatts) at each generator. From the viewpoint of an OPF, the maintenance of system security requires keepingeach device in the power system within its desired operationrange at steady-state. This will include maximum andminimum outputs for generators, maximum MVA flows ontransmission lines and transformers, as well as keepingsystem bus voltages within specified ranges. It should benoted that the OPF only addresses steady state operation ofthe power system. Topics such as transient stability, dynamic stability, and steady-state contingency analysis arenot addressed. To achieve these goals, the OPF will perform all the steady-state control functions of the power system. These functions may include generator control andtransmission system control. For generators, the OPF willcontrol generator MW outputs as well as generator voltage. For the transmission system, the OPF may control the tapratio or phase shift angle for variable transformers, switchedshunt control, and all other flexible ac transmission system (FACTS) devices. A secondary goal of an OPF is thedetermination of system marginal cost data. This marginalcost data can aid in the pricing of MW transactions as wellas the pricing ancillary services such as voltage supportthrough MVAR support. The optimal power flow is a verylarge and very difficult mathematical programmingproblem. Almost every mathematical programmingapproach that can be applied to this problem has beenattempted and it has taken developers many decades todevelop computer codes that will solve the OPF problemreliably.

2.0 Facts Device

Limitations in transmission and generation systemexpansion, such as right-of-way and environmentalproblems, have made it inevitable to use the current networkcapacity as much as possible .The competition in arestructured power system leads to its optimization and newways for cost reduction.

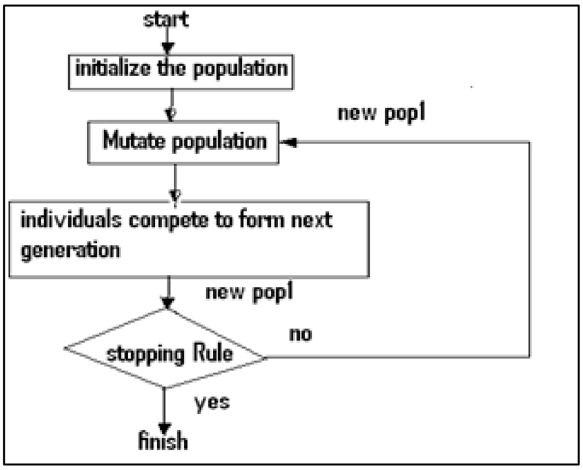
FACTS devices can be used for

1. Congestion management
2. Energy loss minimization
3. Power flow control
4. Security enhancement
5. Social welfare maximization
6. Network stability improvement
7. By employing UPFCs, electricity generation cost andactive power Losses can be reduced
8. Both real and reactive power spot prices maysubsequently change drastically.

3.0 Evolutionary Programming

In the economic dispatch we had a single constraintwhich held the total generation to equal the total load pluslosses. If we think about the single “generation equals loadplus losses” constraint: we realize that what it is actuallysaying is that the generation must obey the same conditionsas expressed in a power flow with the condition that theentire power flow is reduced to one simple equalityconstraint. There is good reason, as we shall see shortly, tostate the economic dispatch calculation in terms of thegeneration costs, and the entire set of equations needed forthe power flow itself as constraints. This formulation iscalled an optimal power flow. We can solve the OPF for theminimum generation cost and require that the optimizationcalculation also balance the entire power flow-at the sametime. Note also that the objective function can take differentforms other than minimizing the generation cost. It iscommon to express the OPF as a minimization of theelectrical losses in the transmission system, or to express itas the minimum shift of generation and other controls froman optimum operating point. Evolutionary Programmingseeks the optimal solution of an optimization problem byevolving a population of candidate solutions over a numberof generations or iterations. A new population is formedfrom an existing population through the use of a operator. This operator perturbs each component of every solution inthe population by a random amount to produce newsolutions. The degree of optimality of each of the newcandidate solutions or individuals is measured by its fitnesswhich can be defined as a function of the cost or objectivefunction of the problem. Through the use of a competitionscheme, the individuals in each population compete witheach other. The winning individuals will form a resultantpopulation which is regarded as the next generation. Foroptimization to occur, the competition scheme must be suchthat the more optimal solutions have a greater chance ofsurvival than the poorer solutions. Through this thepopulation evolves towards the global optimal point. TheEP technique is iterative and the process is terminated by astopping rule. The rule widely used is either (a) stop after aspecified number of iterations or (b) stop when there is noappreciable change in the best solution for a certain numberof generations. The main stages of the EP techniqueincluding initialization, mutation and competitions areshown in the flowchart of Fig. 1.

Fig 1: Flow Chart of Evolutionary Programming



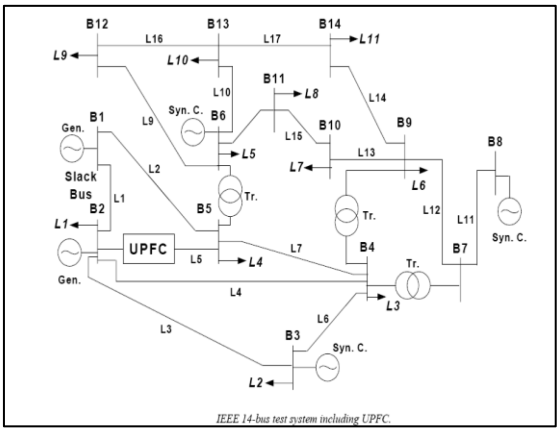
4.0 Control Variables

In the OPF, there are many more adjustable or

"control" variables that be specified. A partial list of suchvariables would include:

1 Generator voltage.
2 LTC transformer tap position.
3 Phase shift transformer tap position.
4 Switched capacitor settings.
5 Reactive injection for a static VAR compensator.
6 Load shedding.
7 DC line flow.

Fig 2: One Line Diagram of 14 Bus System



IEEE 14-bus test system including UPFC.

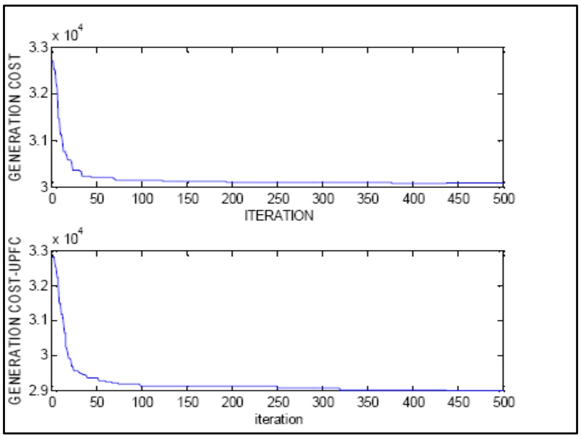
5.0 Results Analysis

Validation tests are performed on the 14bus test systemshown in Figure 2. The system consists of four generatingunits at buses and four loads. The bid prices of generatingunits are selected based on 14 bus system. The OPF resultsof the test system are summarized Table. The OPF cost inthis electricity market, f, 3.0086e+004$/hr (without UPFC) and 2.9023e+004$/hr (with UPFC). The population of thissystem is 200.

Table: 1.

Generator Bus	P(Mw)	Generation Cost W/O UPFC	Generation Cost With UPFC
1	50.3637	3.0086e+004	2.9023e+004
2	51.5958		
3	50.0069		
4	149.4555		
5	111.1233		

Output



6.0 Conclusions

In this paper, we discuss the Evolutionary programtechniques over the conventional mathematicalprogramming techniques. The optimal generation and costof the generating units have been evaluated usingevolutionary programming (EP) without violatingtransmission constraints. Validation tests are performed onthe 14 bus test system without installed UPFC device andwith installed UPFC device . The system consists of fourgenerating units at buses and four loads. The bid prices ofgenerating units are selected based on 6 bus system. TheOPF results of the test system are summarized in the tables.
The OPF cost in this electricity market has been calculatedfrom different population and different iterations

References

[1] X_P Zhang, E_ J Handschin, Advancedimplementation of UPFC in a nonlinear interior_pointOPF, IEE Proceedings: Generation, transmission andDistribution, 148, 2001, 489-496

[2] K. S Verma, S. N. Singh, H. O. Gupta, Location ofUPFC for congestion management, Electrical powerSystems research, 58(2), 2001, 89-96

[3] K.S Verma, S.N Singh, H.O Gupta, Impact on real andreactive power pricing in open power Marketing usingUPFC, IEEE Transaction on power systems, 21(1), 2006, 365-371

[4] R. Palma behnki, L.S vargas, J. R. Peraz, J. D. Nunez, R. A. Torres, OPF with SVC and UPFC modeling forlongitudinal systems, IEEE Transaction on powersystems, 19(4), 1742-1753