Chapter 27
Quantum-Inspired Computational Intelligence for Economic Emission Dispatch Problem

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ABSTRACT

Economic emission dispatch (EED) problems are one of the most crucial problems in power systems. Growing energy demand, limited reserves of fossil fuel and global warming make this topic into the center of discussion and research. In this chapter, we will discuss the use and scope of different quantum inspired computational intelligence (QCI) methods for solving EED problems. We will evaluate each previously used QCI methods for EED problem and discuss their superiority and credibility against other methods. We will also discuss the potentiality of using other quantum inspired CI methods like quantum bat algorithm (QBA), quantum cuckoo search (QCS), and quantum teaching and learning based optimization (QTLBO) technique for further development in this area.

DOI: 10.4018/978-1-7998-2448-0.ch027

INTRODUCTION

Electrical power system of almost all countries in the world mainly consists of thermal plants which use fossil fuel such as coal, oil and gas to produce electricity. The use of fossil fuels increases tremendously due to the rapid economic growth in the developing countries especially in China and India. At the same time, the capacity to deliver fossil fuels as per their growing demand are limited due to limited production capacity and lack of infrastructure such as pipelines, refineries and terminal capacities. In order to build such infrastructure to support such increasing demand of fossil fuels could cost trillions of dollars (Birol, 2004). Moreover fossil fuels are always not easily accessible to all as fossil fuel reserves are concentrated in a small number of countries. Almost 85% of the world's total coal reserves are located in just eight countries (Dudely, 2015). Again, more than 65% world's total gas stock has been found in only four countries (Agency, 2015) and eight countries (six of them are OPEC members) have almost 80% of the world's total proved oil reserves (Dudely, 2015). Some of these countries may exercise their power to restrict supply or influence the supply of fossil fuels. On the other hand, with the increase of economic growth fossil fuels reserves are declining. According to a research conducted by S. Shafiee and E. Topal, coal will be the only fossil fuel remains after 2042 (Shafiee & Topal, 2009). Several other studies indicate that projected crude oil reserves will run out between 2050 and 2075 (Ivanhoe, 1995; Walsh, 2000). From these studies, it is very clear that fossil fuels will become distinct and too expensive in the near future, which will lead the electricity production to be much more expensive.

In addition, thermal plant is one of the main sources that releases polluted particulates and gases into the air such as sulfur dioxide (SO_2), carbon dioxide (CO_2), nitrogen dioxide (NO_2), ozone (O_3) etc. Burning coal can even cause to emit radioactive materials (McBride, Moore, Witherspoon, & Blanco, 1978) and toxic heavy materials like arsenic, mercury etc. Sulfur and nitrogen dioxide contribute to smog and acid rain, whereas large emission of carbon dioxide is contributing to the greenhouse effect which ultimately leads us to global warming. Global warming has far-reaching, long-lasting and, in many cases, devastating consequences on environment. As the temperature is rising due to global warming, lower areas of the world will soon be flooded by sea water.

Therefore, it is important to employ a model that optimizes both the generation/fuel cost as well as the cost associated with the control of emissions from thermal unit operation and other constraints. Both the objectives cannot be optimized simultaneously and hence there exist a conflict between them. This conflicting behavior gives rise to a type of optimization called multi-objective optimization. The economic emission dispatching (EED) option is an attractive option (Kumar, Bavisetti, & Kiran, 2012), where the objective is to minimize fuel cost and polluted emission while satisfying all constraints including transmission loss, load balance, upper and lower generation of thermal unit, ramp rate limit, prohibited zone of thermal unit etc. Multiobjective optimization with two or more objective functions that are usually noncommensurable and conflicting in nature often gives rise to a set of optimal solutions rather than a single optimal solution. It is because that none of the solution can be considered to be better than any other solutions with respect to the objective functions. All these optimal solutions are known as Pareto-optimal solutions. Fuzzy set theory (Vasant, 2006) often utilized to get the best compromised solution from obtained Pareto-optimal set of nondominated solutions (Abido, 2003).