Chapter 21
An Optimal Asset Allocation in Electricity Generation Market for the Policy Makers and Stakeholders

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ABSTRACT

Electricity has a crucial role for not only human daily life but also industry, commerce, and development of countries. It is a unique product that should be generated and consumed simultaneously. In many countries today, to increase effective and efficient use of electricity, deregulation of electricity markets continue. Power suppliers as a market player which is operating in this volatile deregulated market environments need to optimize their generation capacities and bidding strategies. The methods presented in the chapter provide strategic decisions for key stakeholders with different risk aversion levels and various instruments to minimize related market risks while maximizing benefits. The optimal asset allocation applications such as financial optimization models have a significant capability to provide viable solutions to improve efficient decision- making systems for key policy makers and other stakeholders. Being a brand new asset allocation approach for electricity market, it is believed that this study provides a significant contribution to literature in this field.

INTRODUCTION

Electricity has a crucial role for not only daily life but also industry, commerce, and development of countries. There is a strong relationship between development level of countries and electricity consumption per capita. In addition, depending upon its generation type, electricity generation has a great effect on the environment. Primary energy sources, which are converted to electricity, can take many forms.

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Most common forms of primary energy sources are coal, natural gas, oil, nuclear energy, the wind, solar, hydropower. World primary energy consumption is projected to grow by 36% from 2011 to 2030 (BP Energy Outlook 2030, 2013). These limited primary energy sources are converted to electricity, as a secondary energy source (Energy, 2015). After adding up all of these, it can easily be seen that there are so many stakeholders such as policy makers, governmental bodies, regulation authorities, profit and non-profit organizations, electricity generators, dispatchers and transmission companies, consumers, industry, and the world itself etc. Taking into account all above mentioned indisputable facts, it is understood that electricity is strategic, and effective and efficient use of electricity provide with many benefits.

In many countries today, to increase effective and efficient use of electricity, deregulation of electricity markets continue and there is a remarkable tendency for the restructuring of vertically integrated and regulated electricity industry. Mostly state-owned companies in electricity industry are being transformed into vertically separated power generator, distributor and retail companies to support deregulation process (Gökgöz, & Atmaca, 2013, pp. 348-353). This new environment is quite volatile than any other security and commodity market (Vehviläinen, & Keppo, 2003, pp. 136-147). Power suppliers as market players which are operating in volatile deregulated market environments need to optimize their generation capacities and bidding strategies. They can sell electricity in the spot market or *via* bilateral contracts and they have to deal with continuously changing electricity prices, generation constraints, and marketing issues in the competitive electricity market environment. Electricity has become a unique product due to its non-economically storage and instantaneous consumption potential. Besides there are fuel price, water regime, network, operation, the sun, and wind risks and uncertainties depending on the type of generation. In the scene described above, prudent decision-making methods are of critical importance to manage risks while maximizing benefits.

Portfolio optimization approach which is widely used in finance is one of the effective decision tools based on risk management and it provides decision makers so many precious opportunities to take decisions based on risk-profit trade off. According to classical portfolio theory, the risk of portfolio converges to market risk with the diversification of assets in the portfolio. Results of the theory can be seen from related stock market studies and proven with mathematical calculations (Gökgöz, & Atmaca, 2012, pp. 357-368; Statman, 1987, pp. 353-363; Jones, 1999; Copeland, et al., 2005). Nonetheless, according to Markowitz, who was awarded the Nobel Prize for developing the theory of portfolio choice, this is not a systematic way of managing risk in the portfolio because, in classical theory, co-movements of assets are not taken into account, it only focuses on number of assets in the portfolio (Markowitz, 1952; Nobelprize.org, 2015). The presence of high correlation between assets can prevent us from reaching low risky portfolios (Gökgöz, & Atmaca, 2013, pp. 348-3531; Liu, & Wu, 2006, pp. 1512-1519). Portfolio optimization is one of the risk control technique and refers to the optimal allocation of risky assets with the aim of minimizing portfolio risks while maximizing related benefits (Gökgöz, & Atmaca, 2012, pp. 357-368; Liu, et al., 2006).

In the 1950s, fundamentals of Modern Portfolio Theory were introduced to finance literature by an article *"Portfolio Selection"* introduced by aforementioned Nobel Prized academician H.M. Markowitz (Markowitz, 1952; Sharpe, et.al, 1999). It is concerned with the choice of a portfolio (Markowitz, 1952). After Markowitz's milestone study, the theory was improved and amplified by Sharpe (1964) and Linther (1965) separately (Sharpe, et.al, 1999; Sharpe, 1964; Linther, 1965a, 1965b). Markowitz's portfolio theory is based on mean-variance and it searches efficient portfolios that provide a minimum risk for a given return. Downside risk is another technique and it is one of the special cases of Lower Partial Moments *(LPM, first order)* and it is based on left-hand side of the returns. Where the LPM is described as the

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