Chapter 2
Integration of Intermittent Resource in a Real Time Scheduling

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2.1 Introduction

Deregulation of the electric power industry is bringing unprecedented changes to previously predictable business. FERC’s Notice of Public Rulemaking for Standard Market Design (SMD) forwards a standard framework for the nation’s electricity markets and is intended to remedy undue discrimination through open access transmission service. The electricity market itself consists of the (1) forward and (2) spot or real-time markets. The forward market may include bilateral contracts, future, options, day-ahead and hour-ahead market for energy and ancillary service markets. In the real-time market, only the energy is traded.

Among alternatives that are investigated for the generation of electricity are a number of unconventional sources including solar and wind energy. In many parts of the US, photovoltaic (PV) and wind turbines are considered as a viable alternative for generating electricity. In recent decades, PV has found its first commercial use in space; as hardware costs decline, terrestrial applications of PV would become more economical and perhaps more viable for applications for bulk power generation. Wind power is also growing as an alternative resource in several states in the US. The number of wind plants operating in the state has increased significantly over the past few years. Wind-powered projects also comprise a dominant portion of the proposed new generation projects in several states in the US. The growth of renewable energy would require grid operators to evaluate their impact on peak load shaving, expansion planning, and backup generating capacity to ensure a reliable supply of electricity.

However, the electricity available from renewable resources such as wind and solar energy is intermittent due to their dependency on the weather. The location of these resources also presents a new challenge for grid and market operations. Many of the proposed wind plants are seeking to interconnect in concentrated clusters located away from the load centers. These regions are supported by an existing transmission network that will not be capable of delivering all the potential wind output to the load centers. Technology that provides the ability to store intermittently generated power can expand the use of such resources by
smoothing out the variations in its hour-by-hour, minute-by-minute and second-by-second availability. This can be particularly important for those renewable generation technologies such as wind that peak at night when demand is low or clouds moving over PV systems.

As the storage technology matures and becomes available for the electric utility’s load leveling, there may be ways to make batteries, pump storage, flywheel more viable by integrating them with intermittent resources. With the availability of advanced batteries, it will be possible to store large amounts of energy during off-peak periods for use during peak hours. However, because of the intermittent nature of the renewable generation, a dedicated battery may be considered in the design of integrated systems.

To effectively integrate intermittent resources into short-term scheduling, one must have detailed knowledge of the appropriate computational methods. The determination of prices and resolution of auctions hinges on the assumption one use to mathematically model the physical electric power system. The overall purpose of this Chapter is to help one understand a method for the short-term scheduling of an integrated intermittent resources and thermal system considering the effect of battery storage. To obtain a fast and efficient solution, we utilize both the successive DP approximation method. The successive DP is used to find the minimum cost trajectory for battery, and the augmented Lagrangian is used to solve unit commitment. Maximum intermittent resource penetration, battery constraints as well as the availability of natural resources is considered in the scheduling formulation.

2.2 Intermittent Resource Integration in Short Term Generation Scheduling

The most critical problem in operating a renewable resource plant arises from the fact that renewable sources cannot be dispatched in the same manner as conventional plants. The fluctuations in solar irradiance or wind speed may occur in a minute-to-minute time frame. Short-term generation changes in an integrated intermittent resource, such as those caused by clouds moving over PV systems, the resulting utility load following, and spinning reserve requirements were addressed in [5, 7].

It is conceivable that the energy storage is one of the alternatives to the random availability of intermittent resources. The results presented in [9, 6, 4] show that intermittent resources in conjunction with energy storage play a unique role in demand-side management (peak load shaving), and will likely impact the restructuring of electric power systems. The impact of intermittent resources will depend on prevailing constraints including the capacity of intermittent resources-energy storage vs. that of thermal utility system. The energy storage constraints include rate of discharge limit, charge/discharge current limit, and capacity limit at a particular hour.