Chapter 3
Energy Management System Concepts

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ABSTRACT

World energy is rapidly approaching a point of transition where the traditional types of generation will be replaced with distributed generation. This will put an enormous strain on existing power grids and, if not properly managed, may lead to brownouts, blackouts, and enormous expenditures to upgrade the grids. Energy management technologies provide a means of smoothing the transition to these new technologies by manipulating generation and storage technologies and managing demands. Energy management coupled with energy storage is particularly important because it can deliver improved efficiency and reduce power spiking, reducing the strain on the grid. Improving the operation of the grid will be key to future developments in developed nations; however, the lessons learned could help to advance the structure of developing nation's power grids to accelerate the introduction of clean energy worldwide.

INTRODUCTION

This chapter is intended to give an overview of energy management and its application to existing and future energy generation. It will also introduce energy storage concepts and demonstrate how they may be used to influence generation, demand and power grid efficiencies.

The next section will provide some background about the structure of national grids including regulations, methods of generation and transmission, explanation of power quality and some of the basic issues surrounding the introduction of distributed generation.

The importance of energy management section gives the major arguments for energy management and recent figures for world energy demands.

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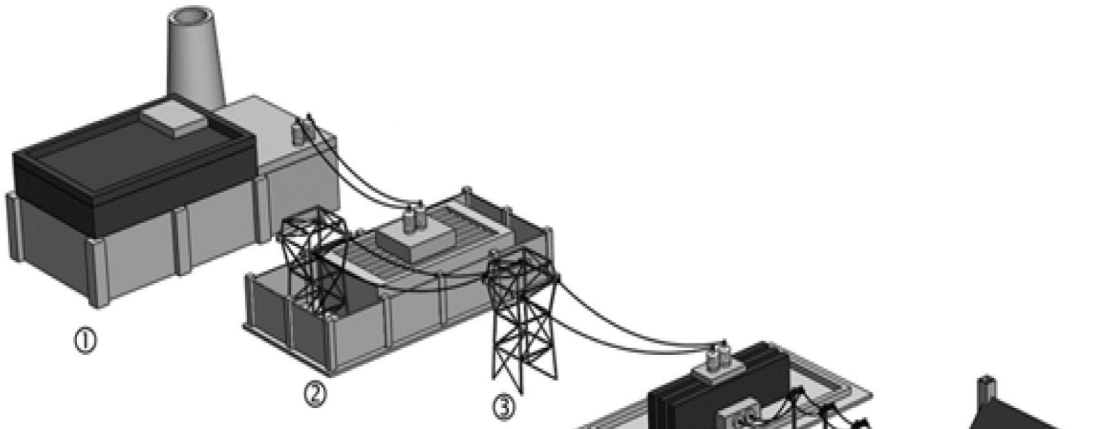
Figure 1. Example grid



1. Central Generation (Coal, Oil, Nuclear)
2. Transmission Substation
3. Transmission Tower/Pylon
4. Distribution Substation
5. Consumer/Demand

The managed systems section gives more details about individual energy systems including centralized and distributed generation, descriptions and explanations of all major existing energy storage concepts/technologies, the key potential benefits of energy storage in the future grid, outlines for different types of energy demand and introductory material on smart metering and intelligent systems.

Key Factors outlines the drivers for energy management.

This chapter concludes with the international dimension, discussing the need for and potential benefits of energy management in the developed and developing world.

BACKGROUND: DISTRIBUTED ENERGY AND THE NEED FOR ENERGY MANAGEMENT SYSTEM

The National Grid

National grids, such as are established throughout much of the world, have been designed and constructed with the use of centralised generation in mind. Large power plants, for example coal and nuclear, feed power in the transmission network, gradually filtering down through lower power networks until it reaches the consumers (see Figure 1).

With the advent of distributed generation however, we are now attempting to feed power back into that same network through various points in the grid. Distributed generation sites are connected at all levels of the grid. Some will feed into the main grid directly, whilst others will feed into it by transmitting power back through substations from lower voltage areas of the grid (see Figure 2).

There are numerous factors which affect the efficiency of the grid as a whole, related to loading, power factor and power quality.

1. Regulation: There are a number of conditions required in order to be able to feed power into the national grid. These are strictly regulated to make sure that the supplied power is suitable for the devices that will be attached to the grid. The two primary conditions are