http://www.epa.gov/waterscience/316b/phase2/econbenefits/final/a3.pdf - Microsoft Internet E...

File Edit Go To Favorites Help

Back Search Favorites

Address http://www.epa.gov/waterscience/316b/phase2/econbenefits/final/a3.pdf Go

Save a Copy Search Select 47% Sign

Pages Attachments Comments

Chapter A3: Profile of the Electric Power Industry

A3-1 Industry Overview

1 of 24

Done Unknown Zone

United States Environmental Protection Agency | Office of Water (4303) | EPA-821-R-04-005 February 2004

EPA

Economic and Benefits Analysis for the Final Section 316(b) Phase II Existing Facilities Rule

Economic and Benefits Analysis for the Final Section 316(b) Phase II Existing Facilities Rule

U.S. Environmental Protection Agency
Office of Science and Technology
Engineering and Analysis Division

Washington, DC 20460
February 2004

ACKNOWLEDGMENTS AND DISCLAIMER

This document was prepared by the Office of Water staff. The following contractors provided assistance and support in performing the underlying analysis supporting the conclusions detailed in this document.

Abt Associates Inc.
Science Applications International Corporation
Stratus Consulting Inc.
Tetra Tech

Table of Contents

PART A: BACKGROUND INFORMATION

Chapter A1: Introduction and Overview

Chapter A2: Need for the Regulation

Chapter A3: Profile of the Electric Power Industry

PART B: COSTS AND ECONOMIC IMPACTS

Chapter B1: Summary of Compliance Costs

Chapter B2: Cost Impact Analysis

Chapter B3: Electricity Market Model Analysis

Chapter B4: Regulatory Flexibility Analysis

Chapter B5: UMRA Analysis

Chapter B6: Other Administrative Requirements

PART C: NATIONAL BENEFITS

Chapter C1: Regional Approach

Chapter C2: Summary of Current Losses Due to I&E

Chapter C3: Monetized Benefits

PART D: NATIONAL BENEFIT-COST ANALYSIS

Chapter D1: Comparison of Costs and Benefits

Chapter A3: Profile of the Electric Power Industry

INTRODUCTION

This profile compiles and analyzes economic and operational data for the electric power generating industry. It provides information on the structure and overall performance of the industry and explains important trends that may influence the nature and magnitude of economic impacts from the Final Section 316(b) Phase II Existing Facilities Rule.

The electric power industry is one of the most extensively studied industries. The Energy Information Administration (EIA), among others, publishes a multitude of reports, documents, and studies on an annual basis. This profile is not intended to duplicate those efforts. Rather, this profile compiles, summarizes, and presents those industry data that are important in the context of the final Phase II rule. For more information on general concepts, trends, and developments in the electric power industry, the last section of this profile, "References," presents a select list of other publications on the industry.

CHAPTER CONTENTS

The remainder of this profile is organized as follows:

- Section A3-1 provides a brief overview of the industry, including descriptions of major industry sectors, types of generating facilities, and the entities that own generating facilities.
- Section A3-2 provides data on industry production, capacity, and geographic distribution.
- Section A3-3 focuses on the Phase II section 316(b) facilities. This section provides information on the physical, geographic, and ownership characteristics of the Phase II facilities.
- Section A3-4 provides a brief discussion of factors affecting the future of the electric power industry, including the status of restructuring, and summarizes forecasts of market conditions through the year 2025.

A3-1 INDUSTRY OVERVIEW

This section provides a brief overview of the industry, including descriptions of major industry sectors, types of generating facilities, and the entities that own generating facilities.

A3-1.1 Industry Sectors

The electricity business is made up of three major functional service components or sectors: *generation*, *transmission*, and *distribution*. These terms are defined as follows (Beamon, 1998; Joskow, 1997; U.S. DOE, 2000a):[1]

- The ***generation*** sector includes the power plants that produce, or "generate," electricity.[2] Electric power is usually produced by a mechanically driven rotary generator called a turbine. Generator drivers, also called prime movers, include gas or diesel internal combustion machines, as well as streams of moving fluid such as wind, water from a hydroelectric dam, or steam from a boiler. Most boilers are heated by direct combustion of fossil or biomass-derived fuels or waste heat from the exhaust of a gas turbine or diesel engine, but heat from nuclear, solar, and geothermal sources is also used. Electric power may also be produced without a generator by using electrochemical, thermoelectric, or photovoltaic (solar) technologies.

- The ***transmission*** sector can be thought of as the interstate highway system of the business – the large, high-voltage power lines that deliver electricity from power plants to local areas. Electricity transmission involves the "transportation" of electricity from power plants to distribution centers using a complex system. Transmission requires: interconnecting and integrating a number of generating facilities into a stable, synchronized, alternating current (AC) network; scheduling and dispatching all connected plants to balance the demand and supply of electricity in real time; and managing the system for equipment failures, network constraints, and interaction with other transmission networks.

- The ***distribution*** sector can be thought of as the local delivery system – the relatively low-voltage power lines that bring power to homes and businesses. Electricity distribution relies on a system of wires and transformers along streets and underground to provide electricity to residential, commercial, and industrial consumers. The distribution system involves both the provision of the hardware (e.g., lines, poles, transformers) and a set of retailing functions, such as metering, billing, and various demand management services.

Of the three industry sectors, only electricity generation uses cooling water and is subject to section 316(b). The remainder of this profile will focus on the generation sector of the industry.

A3-1.2 Prime Movers

Electric power plants use a variety of ***prime movers*** to generate electricity. The type of prime mover used at a given plant is determined based on the type of load the plant is designed to serve, the availability of fuels, and energy requirements. Most prime movers use fossil fuels (coal, oil, and natural gas) as an energy source and employ some type of turbine to produce electricity. According to the Department of Energy, the most common prime movers are (U.S. DOE, 2000a):

- *Steam Turbine:* "Most of the electricity in the United States is produced in steam turbines. In a fossil-fueled steam turbine, the fuel is burned in a boiler to produce steam. The resulting steam then turns the turbine blades that turn the shaft of the generator to produce electricity. In a nuclear-powered steam turbine, the boiler is replaced by a reactor containing a core of nuclear fuel (primarily enriched uranium). Heat produced in the reactor by fission of the uranium is used to make steam. The steam is then passed through the turbine generator to produce electricity, as in the fossil-fueled steam turbine. Steam-turbine generating units are used primarily to serve the ***base load*** of electric utilities. Fossil-fueled steam-turbine generating units range in size (***nameplate capacity***) from 1 ***megawatt*** to more than 1,000 megawatts. The size of nuclear-powered steam-turbine generating units in operation today ranges from 75 megawatts to more than 1,400 megawatts."

- *Gas Turbine:* "In a gas turbine (combustion-turbine) unit, hot gases produced from the combustion of natural gas and distillate oil in a high-pressure combustion chamber are passed directly through the turbine, which spins the generator to produce electricity. Gas turbines are commonly used to serve the peak loads of the electric utility. Gas-turbine units can be installed at a variety of site locations, because their size is generally less than 100 megawatts. Gas-turbine units also have a quick startup time, compared with steam-turbine units. As a result,

[1] Terms highlighted in bold and italic font are defined in the glossary at the end of this chapter.

[2] The terms "plant" and "facility" are used interchangeably throughout this profile.

gas-turbine units are suitable for ***peakload***, emergency, and reserve-power requirements. The gas turbine, as is typical with peaking units, has a lower efficiency than the steam turbine used for baseload power."

- ***Combined-Cycle Turbine:*** "The efficiency of the gas turbine is increased when coupled with a steam turbine in a combined-cycle operation. In this operation, hot gases (which have already been used to spin one turbine generator) are moved to a waste-heat recovery steam boiler where the water is heated to produce steam that, in turn, produces electricity by running a second steam-turbine generator. In this way, two generators produce electricity from one initial fuel input. All or part of the heat required to produce steam may come from the exhaust of the gas turbine. Thus, the steam-turbine generator may be supplementarily fired in addition to the waste heat. Combined-cycle generating units generally serve ***intermediate loads***."

- ***Internal Combustion Engine:*** "These prime movers have one or more cylinders in which the combustion of fuel takes place. The engine, which is connected to the shaft of the generator, provides the mechanical energy to drive the generator to produce electricity. Internal-combustion (or diesel) generators can be easily transported, can be installed upon short notice, and can begin producing electricity nearly at the moment they start. Thus, like gas turbines, they are usually operated during periods of high demand for electricity. They are generally about 5 megawatts in size."

- ***Hydroelectric Generating Units***: "Hydroelectric power is the result of a process in which flowing water is used to spin a turbine connected to a generator. The two basic types of hydroelectric systems are those based on falling water and natural river current. In the first system, water accumulates in reservoirs created by the use of dams. This water then falls through conduits (penstocks) and applies pressure against the turbine blades to drive the generator to produce electricity. In the second system, called a run-of-the-river system, the force of the river current (rather than falling water) applies pressure to the turbine blades to produce electricity. Since run-of-the-river systems do not usually have reservoirs and cannot store substantial quantities of water, power production from this type of system depends on seasonal changes and stream flow. These conventional hydroelectric generating units range in size from less than 1 megawatt to 700 megawatts. Because of their ability to start quickly and make rapid changes in power output, hydroelectric generating units are suitable for serving peak loads and providing spinning reserve power, as well as serving baseload requirements. Another kind of hydroelectric power generation is the pumped storage hydroelectric system. Pumped storage hydroelectric plants use the same principle for generation of power as the conventional hydroelectric operations based on falling water and river current. However, in a pumped storage operation, low-cost off-peak energy is used to pump water to an upper reservoir where it is stored as potential energy. The water is then released to flow back down through the turbine generator to produce electricity during periods of high demand for electricity."

In addition, there are a number of other prime movers:

- ***Other Prime Movers:*** "Other methods of electric power generation, which presently contribute only small amounts to total power production, have potential for expansion. These include geothermal, solar, wind, and biomass (wood, municipal solid waste, agricultural waste, etc.). Geothermal power comes from heat energy buried beneath the surface of the earth. Although most of this heat is at depths beyond current drilling methods, in some areas of the country, magma--the molten matter under the earth's crust from which igneous rock is formed by cooling--flows close enough to the surface of the earth to produce steam. That steam can then be harnessed for use in conventional steam-turbine plants. Solar power is derived from the energy (both light and heat) of the sun. Photovoltaic conversion generates electric power directly from the light of the sun; whereas, solar-thermal electric generators use the heat from the sun to produce steam to drive turbines. Wind power is derived from the conversion of the energy contained in wind into electricity. A wind turbine is similar to a typical wind mill. However, because of the intermittent nature of sunlight and wind, high capacity utilization factors cannot be achieved for these plants. Several electric utilities have incorporated wood and waste (for example, municipal waste, corn cobs, and oats) as energy sources for producing electricity at their power plants. These sources replace fossil fuels in the boiler. The combustion of wood and waste creates steam that is typically used in conventional steam-electric plants."

The section 316(b) regulation is only relevant for electric generators that use cooling water. However, not all prime movers require cooling water. Only prime movers with a steam electric generating cycle use large enough amounts of cooling water to fall under the scope of the final rule. This profile will, therefore, differentiate between steam electric and other prime

A3-3 PLANTS SUBJECT TO PHASE II REGULATION

Section 316(b) of the Clean Water Act applies to point source facilities which use or propose to use a cooling water intake structure that withdraws cooling water directly from a surface waterbody of the United States. Among power plants, only those facilities employing a steam electric generating technology require cooling water and are therefore of interest to this analysis.

The following sections describe power plants that are subject to the Final Section 316(b) Phase II Existing Facilities Rule. The final Phase II rule applies to existing steam electric power generating facilities that meet all of the following conditions:

- They use a cooling water intake structure or structures, or obtain cooling water by any sort of contract or arrangement with an independent supplier who has a cooling water intake structure; or their cooling water intake structure(s) withdraw(s) cooling water from waters of the U.S., and at least twenty-five (25) percent of the water withdrawn is used for contact or non-contact cooling purposes;
- they have an National Pollutant Discharge Elimination System (NPDES) permit or are required to obtain one; and
- they have a design intake flow of 50 million gallons per day (MGD) or greater.

The final Phase II rule also covers substantial additions or modifications to operations undertaken at such facilities. While all facilities that meet these criteria are subject to the regulation, this Economic and Benefit Analysis (EBA) focuses on 543 steam electric power generating facilities identified in EPA's 2000 Section 316(b) Industry Survey as being "in-scope" of this final rule. These 543 facilities represent 554 facilities nation-wide.[5] The remainder of this chapter will refer to these facilities as "Phase II facilities" or "Phase II plants."

The following sections present a variety of physical, geographic, and ownership information about the Phase II facilities. Topics discussed include:

- ***Ownership type:*** Section A3-3.1 discusses Phase II facilities with respect to the entity that owns them.
- ***Ownership size:*** Section A3-3.2 presents information on the entity size of the owners of Phase II facilities.
- ***Plant size:*** Section A3-3.3 discusses the size distribution of Phase II facilities by generation capacity.
- ***Geographic distribution:*** Section A3-3.4 discusses the distribution of Phase II facilities by NERC region.
- ***Water body and cooling system type:*** Section A3-3.5 presents information on the type of waterbody from which Phase II facilities draw their cooling water and the type of cooling system they operate.

WATER USE BY STEAM ELECTRIC POWER PLANTS

Steam electric generating plants are the single largest industrial users of water in the United States. In 1995:

- steam electric plants withdrew an estimated 190 billion gallons per day, accounting for 39 percent of freshwater use and 47 percent of combined fresh and saline water withdrawals for offstream uses (uses that temporarily or permanently remove water from its source);
- fossil-fuel steam plants accounted for 71 percent of the total water use by the power industry;
- nuclear steam plants and geothermal plants accounted for 29 percent and less than 1 percent, respectively;
- surface water was the source for more than 99 percent of total power industry withdrawals;
- approximately 69 percent of water intake by the power industry was from freshwater sources, 31 percent was from saline sources.

USGS, 1995

A3-3.1 Ownership Type

Utilities can be divided into seven major ownership categories: investor-owned utilities, nonutilities, Federally-owned utilities, State-owned utilities, municipalities, political subdivisions, and rural electric cooperatives. This classification is important because EPA has separately considered impacts on governments in its regulatory development (see *Chapter B5: UMRA Analysis* for the analysis of government impacts of the final Phase II rule).

[5] EPA applied sample weights to the 543 facilities to account for non-sampled facilities and facilities that did not respond to the survey. For more information on EPA's 2000 Section 316(b) Industry Survey, please refer to the Information Collection Request (U.S. EPA, 2000).

Table A3-4 shows the number of parent entities, plants, and capacity by ownership type. Numbers are presented for the industry as a whole and the portion of the industry subject to section 316(b) Phase II regulation. Overall, four percent of all parent entities, 11 percent of all plants, and 53 percent of all capacity is subject to Phase II regulation. The table further shows that the majority of Phase II plants, or 274 plants, are owned by investor-owned utilities. An additional 179 Phase II plants are owned by nonutilities. A higher percentage of the plants owned by investor-owned utilities (24 percent) and rural electric cooperatives (15 percent) are Phase II facilities, compared to the percentage of facilities in other ownership categories. 66.5 percent of capacity owned by investor-owned utilities is subject to the final Phase II rule.

Table A3-4: Existing Parent Entities, Plants, and Capacity by Ownership Type, 2001[a]

Ownership Type	Parent Entities			Plants			Capacity (MW)		
	Total[b]	With Phase II Plants	% Phase II Plants	Total[b]	Phase II[c]	% Phase II	Total[b]	Phase II[c]	% Phase II
Investor-Owned	359	41	11.4%	1,147	274	23.9%	404,130	268,643	66.5%
Nonutility[d]	n/a	26	n/a	2,538	179	7.0%	329,550	154,844	47.0%
Federal	9	1	11.1%	193	14	7.3%	69,362	27,798	40.1%
State	27	4	14.8%	83	7	8.4%	19,046	5,409	28.4%
Municipal	1,868	36	1.9%	783	48	6.1%	45,120	17,763	39.4%
Political Subdivision	120	3	2.5%	42	7	6.7%	10,472	4,123	39.4%
Cooperative	889	15	1.7%	166	25	15.1%	29,010	8,821	30.4%
Unknown	0	0	0.0%	68	0	0.0%	7,666	0	0.0%
Total	3,272	126	3.9%	5,020	554	11.0%	914,356	487,401	53.3%

[a] Numbers may not add up to totals due to independent rounding.
[b] Information on the total number of parent entities is based on data from Form EIA-861 (U.S. DOE, 2001b). Information on plants and capacity is based on data from Form EIA-860 (U.S. DOE, 2001a). These two data sources report information for non-corresponding sets of power producers. Therefore, the total number of parent entities is not directly comparable to the information on total plants or total capacity.
[c] The number of Phase II plants and capacity was sample weighted to account for survey non-respondents.
[d] Form EIA-861 does not provide information for nonutilities.

Source: U.S. EPA, 2000; U.S. DOE, 2001a; U.S. DOE, 2001b.

A3-3.2 Ownership Size

EPA estimates that 25 of the 126 entities owning Phase II facilities (20 percent) are small.[6] The size distribution varies considerably by ownership type: only three percent of Phase II investor-owned utilities and four percent of Phase II nonutilities are small, compared to 44 percent of Phase II municipalities, 40 percent of Phase II cooperatives, and 33 percent of Phase II political subdivisions. In general, entities that own Phase II plants are larger than other entities in the industry. Out of 3,272 parent entities in the industry as a whole, 1,992 entities, or 62 percent, are small, compared to 20 percent of Phase II facilities.

For a detailed discussion of the identification and size determination of parent entities see *Chapter B4: Regulatory Flexibility Analysis*. That chapter also documents how EPA considered the economic impacts on small entities when developing this regulation.

[6] See Chapter B4 for information on EPA's small entity analysis.