Electricity Restructuring: Consequences and Opportunities for the Environment

Dallas Burtraw, Karen Palmer,
and Martin Heintzelman

September 2000 • Discussion Paper 00–39

RESOURCES
FOR THE FUTURE

Resources for the Future
1616 P Street, NW
Washington, D.C. 20036
Telephone: 202–328–5000
Fax: 202–939–3460
Internet: http://www.rff.org

Electricity Restructuring: Consequences and Opportunities for the Environment

Dallas Burtraw, Karen Palmer, and Martin Heintzelman

Abstract

The universal theme of deregulation of the electricity industry is the dismantling of the exclusive franchise, opening up some segments of the industry to competition. Technological changes in generation have helped eliminate the perception that generation is a natural monopoly, but this change has not occurred in transmission and distribution services. Marketing functions have also been opened up to competition in many places. This paper includes a brief overview of the different approaches to restructuring that have been adopted in selected countries around the world. It also surveys the existing literature that explores various aspects of how electricity restructuring is likely to affect the environment.

The effect of restructuring on the environment consists of four constituent influences: (1) changes in electricity demand and how it substitutes for (and complements) the consumption of other products, (2) the substitution among fuels and other inputs in electricity production, (3) efficiency improvements that stem from the introduction of competition, and (4) the interaction of firm behavior and market structure with existing and new incentive-based approaches to environmental regulation. Notwithstanding the possibility that electricity consumption displaces the use of other fuels in end uses, most studies find some negative environmental effect from increased consumption, especially with respect to carbon emissions. However, the efficiency gains that can be expected in delivering electricity services create the opportunity for additional environmental controls. Regulatory reform has arrived in the electricity sector, and it is expected to offer welfare gains that can be shared between economic and environmental objectives.

Key Words: electricity restructuring, air quality, incentive-based regulation, technological change

JEL Classification Numbers: Q28, L51 and L94

Contents

Electricity Restructuring: Consequences and Opportunities for the Environment

Dallas Burtraw, Karen Palmer, and Martin Heintzelman*

1. Introduction

The universal theme of deregulation of the electricity industry is the dismantling of the exclusive franchise. In the United States, the ongoing march of economic deregulation began in the 1970s with natural gas, followed by trucking, railroads, financial markets, and telecommunications. This march is now reaching full stride in the electric power industry, where most of the industry is privately owned and publicly regulated. The first regulatory development foreshadowing deregulation was the Public Utility Regulatory Policies Act (PURPA) in 1978, which created the opportunity for some small independent producers using renewable energy or combined heat and power to sell power to regulated utilities serving retail customers. Access to wholesale electricity markets was expanded under the Electricity Policy Act (EPAct) of 1992 and subsequent regulatory decisions issued by the Federal Energy Regulatory Commission (FERC).

More dramatic and sweeping steps toward deregulation first occurred in the United Kingdom, where the Electricity Act of 1983 ended the exclusive franchise of government-held enterprise, and encouraged the entry of new competitors in electricity generation. The subsequent Electricity Act of 1989 began the process of allowing for full retail competition in British electricity markets. At an increasing pace, electric power deregulation is spreading globally, though in a variety of forms, each designed to address specific preexisting market structure and political conditions. In countries and regions around the world, markets for electricity generation, and sometimes for retail sales, are opening up to competition. At the same time, electricity transmission and distribution remain regulated, although increasingly these functions are privatized. Hence, the deregulation of the electricity industry is more properly termed the “restructuring” or “liberalization” of electricity regulation and markets, because in virtually all cases the industry remains regulated in important ways.

* The authors received very helpful comments from Gert Brunekreeft, Carol Dahl, Peter Zapfel, and the editors of this volume.

Electricity restructuring has several important implications for the environment. First, the electric power sector is a major consumer of natural resources and fossil fuels, and changes in the sector have a direct effect on resource use and prices. Second, electricity generation is a major contributor to air pollution, in some settings the major source of conventional air pollutants, including sulfur dioxide (SO_2), nitrogen oxides (NO_X) and secondary particulates derived from these gasses, and an important source of greenhouse gases and toxic air pollutants, including mercury. It is also an important source of pollutants to land and water, and of radioactive waste. Changes in the regulation of the industry affect incentives for the use of various facilities and fuels in electricity generation, and the resulting discharges to the environment. Third, changes in regulation are intended to have a direct effect on the price of electricity, which in turn affects the quantity of consumption of electricity and of its complements and substitutes. Fourth, changes in the economic regulation of the industry directly affect the incentive to comply with environmental regulation.

Conjectures and concerns about restructuring are plentiful. However, despite a number of book-length manuscripts and studies with background on restructuring, the literature is thin with respect to economic and environmental modeling and analysis.[1] In this survey we provide a sketch of how restructuring has taken shape globally.[2] Then, we focus on the potential environmental impacts and the contribution of the literature to the ongoing debate. The environmental impacts are not necessarily expected to be positive or negative. They vary significantly across settings and according to assumptions about how restructuring is likely to affect electric power markets. We also examine how restructuring is likely to affect the performance of new and existing environmental regulation applied to the electric power industry.

2. Electricity Regulation and The Introduction of Competition

Until the past decade or so, the electric power industry was widely viewed as a “natural monopoly”, meaning the cost of generating, transmitting, and distributing electricity would be lower if only one firm undertook each activity. Generation is the process used to create electricity, usually at a central power plant. Transmission is the process of transporting electricity at high voltages, often long distances from where it is generated, to groups of electricity

[1] Brennan et al. 1996; Fox-Penner 1997.

[2] A majority of electricity customers in the EU and United States are now committed to reforms that will allow them the opportunity to choose electricity suppliers in the near future.

consumers. Distribution is the process of transforming electricity to lower voltages and transporting it shorter distances to individual consumers. The existence of a natural monopoly in any of these components provides some justification for granting an exclusive franchise, for example, limiting operation in that component to a single firm.

Nonetheless, public policy tends to view exclusive franchise and other forms of monopoly with disdain for two general reasons. One concern relates to the inequity implicit in the ability of a monopoly to raise prices arbitrarily above production costs, enabling a transfer of wealth away from consumers and to the monopolist. To accomplish this feat the monopolist must reduce output below the level that would be supplied in a competitive market. This strategy raises a second concern that has to do with the loss of efficiency that accompanies the reduction in output.

Hence, it has been widely acknowledged that if natural monopoly provides a cost-based justification for exclusive franchise, the broad set of desired social objectives—such as low prices and universal service—would not be achieved unless a market or regulatory institution exists to enforce these objectives. The resolution to the dilemma took a variety of forms around the world through the 20th century. One prominent model was public ownership, which is common at either the national, regional, or municipal levels in many countries. Another form was public regulation of privately owned firms. Typically, this arrangement involves oversight of investment and operation, and approval of tariffs.

Granting of exclusive franchise affected both horizontal and vertical organization of the electric power industry. In the horizontal dimension, the exclusive franchise typically extended to each of the three primary components of electricity supply: generation, transmission, and distribution. Traditionally all three components of the electricity industry were considered natural monopolies. Today, however, electricity generation is no longer viewed as a natural monopoly. Views about generation started to change in the 1970s with the observation that many large power plants exceeded the size consistent with minimum average cost. The introduction in the 1980s of new technologies, such as combined-cycle gas turbine plants, which achieve minimum average cost at a scale that is substantially smaller than a traditional steam-powered generating unit, further contributed to this change in views. Also, aerospace technology has contributed to the development of new gas turbines with capacities that are several times smaller still. These changes have undermined the perceived need to maintain monopoly in generation, with the promise that competition could better minimize the costs of production and promote incentives for innovation than can various forms of regulation or public ownership.

The exclusive franchise has also affected the vertical structure of the industry. In most of the world, electricity suppliers have been integrated vertically and the exclusive franchise was extended beyond any single component to joint ownership and control of generating power stations, the transmission grid, and the distribution system. One argument for maintaining the status quo is the possibility that essential features of the quality of service, including voltage regulation and reliability of supply, are better served through a vertically integrated monopoly. The notion is still widely held that transmission and probably distribution remain natural monopolies. But the perception of the need to operate the industry as a vertically integrated monopoly is fading. In its place are several alternative models that would enforce separation in the operation, if not in the ownership, of generating and transmission assets. The separation is intended to ensure equal and competitive access to the electricity grid for all electricity generators, while, it is hoped, to also maintain efficient and reliable integration with the transmission and distribution system.

Many other issues in addition to efficiency are elements of the restructuring debate. Traditional forms of regulation or public ownership have attempted to serve a variety of other goals such as maintenance of electricity service to poor households, independent of their ability to pay, which is also known as universal service. Another goal is establishing a method for sharing the fixed costs of electricity supply among various classes of electricity customers, as some are more able to pay than others. Economic theory suggests that an efficient approach to allocating fixed costs among different customers is to do so in inverse proportion to each class of customers' elasticity of demand, so-called Ramsey Pricing (Ramsey 1927, Robinson 1933, Boiteux 1956). Equity concerns, however, may lead policy makers to choose another approach. In some cases, electricity has been a source of public revenue, and in other cases it has received significant subsidies. Further, regulation of electricity has been an important forum with respect to debates about energy security and investments in various technologies.

Finally, electricity has become an integral feature in debates about the environment. An important aspect of this debate is the appropriate role for renewable energy sources and technologies, which are usually viewed as more environmentally benign than conventional generation technologies. Another aspect is the role for investments to improve energy efficiency.

3. International Examples of Industry Restructuring

Discussion of electricity restructuring began in the United Kingdom, where change was dramatic and the first to be achieved. Prior to privatization and restructuring, the British electricity industry consisted almost entirely of a single vertically integrated, nationalized monopoly. Reform began with the Electricity Act of 1983, which granted independent power producers (IPPs) open access to the transmission grid and required that the national electricity agency, the Central Electricity Generation Board (CEGB), purchase electricity produced by IPPs. The next big step towards comprehensive restructuring came with the Electricity Act of 1989, which provided a step-wise process toward the final goal of a completely privatized, competitive retail electricity market by 1998.

The changes in the United Kingdom set the stage for policies that were subsequently adopted for the European Union, where historically the industry structure has varied greatly. Some national electricity systems in Europe have sustained as many as 1,000 utilities, while others have only one or two. Recently privatized generation companies in the United Kingdom compare with healthy state- owned enterprises in France and Italy, while Germany retains the decentralized, privately owned systems established before World War II. Sweden and Denmark exhibit a mixed ownership system and yardstick competition, at least indirectly, between private and state owned enterprises.

Traditionally, regulation has rested at a variety of levels as well. Most often a national ministry oversees rate setting, though a different ministry may oversee investments and planning. Sometimes rates have been set by industry and approved by the government, sometimes the converse holds. This variety of models has led to tremendous disparity in the setting of prices and access to markets. In response to the oil price shocks in the early 1970s and for a decade thereafter, governments in Europe played an increasingly important role in the decision-making process of electric power sector participants.[3] Energy policy was pursued as a tool for macroeconomic policy and for supporting specific sectors such as coal in France, Spain, England, and Germany; gas in the Netherlands; and nuclear in France.

In the late 1980s, the promotion of national policies and subsidies became widely recognized as an obstacle to European integration.[4] This hindrance led to a number of directives aimed at promoting transparency in electricity pricing and opening of markets and transmission

---

[3] Bouttes and Lederer 1990, Helm and McGowan 1989.

[4] The elimination of subsidies is central to the larger goal of integration of European markets. Subsidies have played a particularly important role in European energy markets. For instance, according to Commissioner António Cardoso e Cunha, aid to the coal industry from 1965 to the late 1980s may have cost European taxpayers more than 70 billion Euro. (Commission of the European Communities, 1991a; Royal Institute of International Affairs/Science Policy Research Unit 1989.)

lines to competition in generation. In 1987 the Single European Act (SEA) addressed energy in the context of a free movement of services and the elimination of subsidies within member states and, incidentally, placed environmental protection on an equal footing with economic growth.[5] The EU Directive specifying common rules for a single electricity market entered into force in February 1997.[6] This directive provides a template for all EU countries to follow as they deregulate or liberalize their electricity markets, with the final goal of creating a single Pan-European market for electricity.[7]

The regulatory framework for the U.S. electricity industry has supported almost as much variety and sovereignty among the states as has been observed in Europe. Regulation began at the state level in Wisconsin and New York in 1907 and spread nationally, but remained largely in the purview of state government. The dominant model for most of the century was the vertically integrated company with exclusive franchise within a service territory. With exclusive franchise came an obligation to serve all customers in that territory at a regulated price that guaranteed a fair rate of return on invested capital. In 1935, The U.S. Congress passed the Public Utility Holding Company Act (PUHCA) to legitimize interstate restraints on geographic and financial operation of utilities. The same year Congress passed the Federal Power Act providing federal regulation of interstate electricity transmission.

A long period characterized by increasingly centralized power generation, declining average costs, and stable prices was upset by energy supply disruptions and high capital costs of the 1970s. These developments prompted price increases and sparked consumer advocacy that was coincident with a growing environmental awareness.

One result was PURPA in 1978 (part of the National Energy Act), which required electric utilities to purchase power from so-called qualifying facilities, including renewables and

---

[5] Amended Articles 2 and 3, respectively, of the Treaty of Rome (1957). The Treaty on Political Union signed in 1991 strengthens consideration of the environment, and the European Community has stepped up its role in environmental regulation within the European Union. Folmer and Howe (1991) point out that the main role of the European Community in environmental regulation is in dealing with transboundary issues and minimum product standards. A goal of the “polluter pays” principle is to discourage member states of the European Community from granting subsidies to polluters (Coudert Brothers 1992, p. 8.).

[6] Legislated by EU Directive 96/92/EC, and adopted by the Council of Ministers in December 1996.

[7] Information on the directive and on member states’ efforts to comply with the directive come from European Commission (2000a) and European Commission (2000b). For a shorter summary of the Directive see Burchett (2000).

combined heat and power units. Utilities were required to compensate these facilities at the utilities' avoided cost, and to interconnect with and provide back-up power to these facilities. This requirement ushered in a boon to the renewable energy supply industry, but PURPA's most important historic role was to crack the exclusive generation franchise of the vertically integrated utility. Brennan et al. (1996) reports that "in 1986, nonutility generators were contributing 20% of new generation capacity; by 1994, their share had grown to over 60%." In 1994, nonutilities owned 7% of total generating capacity, and four-fifths of this capacity was delivered under provisions of PURPA.

If the possibilities for restructuring were illustrated by PURPA, the EPAct of 1992 signaled the beginning of widespread restructuring in the United States.[8] The act required utilities to deliver power from generators to other utilities and wholesalers at nondiscriminatory, cost-based transmission rates.[9] Also, the act established "exempt wholesale generators", which allowed a parent utility to construct independently operated generation stations in the service territories of other utilities. Finally, FERC Order 2000 (in 1999) went further by providing specific guidelines and incentives for the establishment of independent system operators to manage use of the transmission grid. Since 1992, most of the action in the United States has been at the state level. Between 1992 and the end of 1998, about half of the states in the country passed legislation and/or made regulatory decisions to allow retail competition.[10]

These developments in Europe and the United States set the context for policies established at the national or state level, there and in other developed nations. In the next few sections we distinguish these policies by their strategy with respect to key features of the electricity supply industry. Table 1 provides a summary these features.[11] Subsequently we discuss trends in developing nations.

[8] The intellectual viewpoint began to filter out of academic circles in the late seventies that questioned the natural monopoly status of generation. This perspective, coupled with the view that transmission and distribution remained natural monopolies was developed in an influential manuscript by Joskow and Schmalensee (1983) that proposed deregulation of the vertical monopoly while preserving the regulated status of transmission and distribution.

[9] This was finally implemented in Federal Energy Regulatory Commission Order 888 in 1996.

[10] Ando and Palmer (1998), White (1996) and Hunt and Sepetys (1997) analyze the factors that influence state decisions about the direction and pace of restructuring. The states that made the earliest moves toward allowing full retail competition tended to be the states where retail prices under regulation were substantially higher than the national average such as California, New Hampshire and New York.

[11] An appendix with a more detailed description of international restructuring efforts is available from the authors. For more information on domestic restructuring see http://www.eia.doe.gov/cneaf/electricity/page/restructure.html.

Generation and the Addition of New Capacity

The most common feature of restructuring efforts has been promotion of competition in the generation portion of the electricity market. This effort often has involved privatization of government-owned generation assets to remove any fiscal shelter provided by a government bureaucracy, and to force generation companies to act in a way that is profitable. Privatization in the United Kingdom created two generation companies in 1990 followed by further sell-off of roughly 15% of the combined generating capacity to reduce each company's market power. The United Kingdom now has seven major generation companies.[12] Argentina went even further in breaking up its generation assets, and created some 30 independent generation companies.

Countries also differ in the way they organize their generation markets. Some countries, including New Zealand and Argentina (and at one time the United Kingdom), have created an official centralized power pool or power exchange that generators are either required to sell through or given the option of selling through. In these centralized markets, generators submit a price and associated quantity they are willing to sell at a given time. The pool then matches demand with supply and determines the marginal plant in that period. The price submitted by the marginal plant then becomes the price for all electricity in that time block. Electricity is also traded through bilateral contracts between generators and customers. Contract markets may be used in conjunction with the power pool (for example, New Zealand) or as the sole means of trading electricity (for example, Germany). Many of the states in the United States that have retail competition, including California and Pennsylvania, have also created or are affiliated with a centralized power exchange, but they also allow electricity trades through bilateral contracts.

Another aspect of the generation side of the market is how new companies can enter and compete in the market. The European Union directly confronted this issue and allowed its member nations two options, which define fairly well the options of any country restructuring its market. The "authorization" option seems the more competitive and decentralized. This plan allows any entity to apply to build a generating facility and, provided that the entity meets other requirements not directly related to the electricity market system, the application should be approved and guaranteed access to the transmission and distribution network. The alternative "tendering" system option follows a central planner's forecasts for new capacity demand and

[12] United Kingdom Office of Gas and Electricity Markets, *The Government's Review of Energy Sources for Power Generation*, April 2000.

then takes bids to fulfill this demand. Most jurisdictions both in and out of Europe have opted for a form of the authorization system. In the United States, states that have restructured their electricity sectors generally allow for free entry into the generation market, subject to receiving the necessary environmental approvals. The extent of competition in generation markets depends on open access to the transmission and distribution systems.

Transmission, Distribution, and Marketing

Almost all jurisdictions continue to view the transmission and distribution segments of the electricity market as natural monopolies. For this reason, competition has not been mandated for these segments. The exception is New Zealand, where these segments are privately owned and have been deregulated. Customers have recourse to pursue anticompetitive behavior through general mechanisms that apply in other industries. In other countries though, the transmission and distribution segments are most often tightly regulated with respect to prices and also are mandated to allow open, nondiscriminatory access to their networks. In some cases (for example, Ireland and Spain) generators who are denied access to the network are given the right to build lines connecting them with their customers.

Countries in the European Union are obligated to designate an independent entity to govern the dispatch of electricity over the high-voltage transmission network, and most other countries have also followed suit. The existence of a transmission system operator (TSO) also allows countries to enact feed-in laws, which make special exceptions to transmission access rules for either environmentally friendly technologies or technologies that are important to the economy (for example, domestic coal in the United Kingdom and East German lignite in Germany).

In the United States, several regions of the country, including California, Texas, New England, New York, and the mid-Atlantic region, have created independent system operators (ISOs) with varying degrees of power. Some ISOs, including those in New England, New York, and the mid-Atlantic, also operate the centralized power exchange, while others such as those in California and Texas do not. All of these ISOs have independent boards and operate or coordinate the operation of transmission facilities that are owned by utilities. FERC Order 2000 also allows for the possibility of placing ownership and control of transmission assets with an independent privately owned and regulated transmission company; however, none are yet operational in the United States.

Distribution companies have many of the same open-access requirements and similar pricing policies as transmission companies. In addition, they typically have public service obligations (PSOs) that require the distribution companies to provide access to all customers within a geographically specified region or, despite competition, to continue to serve their historic customers at a regulated price if these customers should opt out of competition (for example, Sweden). PSOs can also serve as a way to provide incentives for preferred fuels and technologies.

Unlike transmission and distribution, retail marketing is widely considered a competitive venture. Marketing refers to the act of selling electricity to customers and can also include metering and billing services when they are not assigned to the distribution company. Marketing may be performed by historic distribution companies, independent power marketers, or generation companies. If distribution companies also are marketing electricity, they may have an incentive to restrict access by competitive retail marketers to the distribution grid. Thus, some jurisdictions, such as the State of Texas, limit power marketing by distribution companies within their own service territories. Environmentally friendly generation companies have been especially aggressive in marketing to consumers.

Ownership and Vertical Integration

In most countries and states, electricity was historically provided by either a municipal or federal utility or by a regulated, vertically integrated monopoly. Hence, determination of the rules for private ownership of these assets in a competitive market is very important. One aspect of the issue that is relevant in many settings is whether to privatize assets. The other aspect of the issue has been whether to divest generators from T&D operators. Many jurisdictions have taken a gradual approach to one or both of these issues by first separating the books on the different activities, and for public companies, by removing the books from the government budget. These moves intend to achieve managerial independence between generation and T&D without requiring companies to immediately divest themselves of assets. Companies that remain vertically integrated generally are required to charge themselves the same prices for T&D services as they charge their generation competitors. However, in the United Kingdom and Argentina, the electricity companies were privatized and the generation assets were separated from the transmission and distribution assets at the very beginning of the market restructuring.

Table 1. Summary of International Electricity Market Restructuring

	Generation	Transmission	Distribution	Marketing	Ownership	Timing	Special
UK	Fully competitive with seven major competitors.	Regulated monopoly; price cap with productivity adjustment.	Regional regulated monopolies.	Fully competitive.	Formerly publicly owned companies have been privatized.	Gradual phase in now complete.	Temporary moratorium on new gas plants to protect domestic coal concerns.
EU	Member-state specific, most with authorization procedure for new capacity.	Regulated monopoly with open access rules; either negotiated or regulated third-party access (TPA).	Most with regional distributors acting as regulated monopolies.	Mostly competitive; some distributors acting as single regional buyer.	Network assets do not need to be divested, but accounts must be unbundled.	Gradual; by 2003, one-third of all customers with right of choice.	Reciprocity rules so that early movers are not punished.
Germany	Fully competitive.	Negotiated TPA to grid; very little regulatory structure.	Regional regulated monopolies.	Very many small fully competitive companies.	Accounts must be unbundled, and prices must be nondiscriminatory.	Immediate; all customers already with choice.	Protections for East German lignite until 2003.
Norway	Fully competitive with plans for pan-Scandinavian market.	Regulated monopoly with open access for all generators.	Regulated monopolies.	Fully competitive.	Municipal and federal utilities have not been privatized.	Gradual with fees for choice reduced and then eliminated.	Ninety-nine percent of Norwegian generation is from hydroelectric sources.
Alberta, Canada	Competitive but dominated by	Owned and operated by independent	Same as transmission.	Mostly competitive.	Generation companies divested of	Gradual, with full customer	Creative policy requires utilities to sell power

	Generation	Transmission	Distribution	Marketing	Ownership	Timing	Special
	three firms.	entity; all transactions must go through the power pool.			control over transmission assets.	choice by 2001.	through independent marketers who in turn sell power in the pool; decreases market power.
Argentina	Fully competitive with 30 generation companies.	Six private transmission companies, tightly regulated; price cap with productivity adjustment.	Mostly municipal utilities.	Competitive through the power pool using merit-order dispatch and bilateral contracts.	Recently privatized companies given long-term concessions for the operation of government-owned entities.	Rapid change as companies were privatized in early 1990s.	Most of the newly privatized companies are controlled by foreign interests.
Central America	Semicompetitive; country-specific.	Regulated prices with guaranteed open access.	Same as transmission.	Presently the market in each country acts as a single-buyer from the larger regional market.	Country-specific; some still publicly held.	Partial regional integration by 2001, full integration by 2004.	Many of the details have yet to be worked out.
New Zealand	Fully competitive with 75% of sales going through the central market.	Unregulated.	Unregulated; all distributors must maintain connections at least to the same extent as in 1993.	Fully competitive.	The three largest generation companies are still government owned; complete separation of ownership of vertically integrated	Immediate.	60% of generation is from hydroelectric sources.

	Generation	Transmission	Distribution	Marketing	Ownership	Timing	Special
					companies by 2004.		
California	Competitive with free entry; central market run by power exchange.	Regulated monopoly; Price cap regulation; operated by ISO.	Regulated monopoly.	Competitive.	Substantial divestiture of generation by T&D utilities.	No phasein; electricity price capped and fixed until stranded costs recovered.	Surcharge funded subsidy to support renewables.
Penn-sylvania	Competitive with free entry; central market run by the ISO.	Regulated monopoly; grid operated by regional ISO.	Regulated monopoly.	Competitive; roughly 7% of electricity consumers have switched providers as of July 2000.	Vertical integration allowed, but open access required.	Competition phased in over two-year period starting January 1, 1999. Stranded cost recovery extends for up to nine years.	
Texas	Competitive with free entry; no official centralized market.	Regulated monopoly with an ISO that administers transmission access.	Regulated monopoly.	Competitive; limits on price reductions that distributed utility can offer customers in its service territory.	Separate affiliates for different functions.	Competition phases in over six months, starting June 2001.	Requires stricter environmental controls on older plants; requires 50% of new capacity to be fired by natural gas.

Timing

The timing of electricity restructuring varies from a gradual approach (for example, United Kingdom, the EU directive) to rapid and immediate (for example, Germany, New Zealand). Most jurisdictions have set up a timeline of thresholds giving choice of providers first to the largest consumers and gradually to smaller customers. This approach provides time for the development of market institutions and provides companies and customers time to prepare for dealing in a competitive environment. In the United States, several states, including Pennsylvania and Texas, have selected a middle-ground approach that phases in competition over a more compressed two-year period. However, provisions in U.S. states that allow for recovery of stranded cost—the difference between undepreciated book values of assets and their value in a competitive market—over a several-year transition period create an additional delay until prices faced by consumers actually reflect market prices.

4. Determinants of the Environmental Effects of Restructuring

The effect of restructuring on the environment consists of four constituent influences. Three of these influences are economic. One is the influence of changes in output, or output substitution, including the change in the consumption of electricity in the economy and how it substitutes for (and complements) the consumption of other products. A second is the influence of input substitution, which refers to the substitution among fuels and other inputs in electricity production. The third is efficiency improvements that stem from the influence of competition on productive efficiency and endogenous technological change. Finally, a fourth influence is the interaction of firm behavior and market structure with existing and new incentive-based approaches to environmental regulation.

Output Substitution: Falling prices and growing consumption

A primary motivation for allowing competition in electricity markets is the expectation that, in general, prices to electricity consumers will fall. The effect of price declines would be to encourage substitution toward increased electricity consumption. This change in itself raises concerns and the objection that restricting growth in demand should be the top environmental priority (Ferguson 1999). However, Brennan (1999) describes the possibility that the need for environmental policy could fall, not rise, with a reduction in the cost of electricity. This finding holds in a competitive market if demand or supply is sufficiently inelastic to keep market output from changing much. In this case, the welfare loss from inefficient overproduction of the dirty good will fall as its production costs fall. The same result holds in a regulated market, or under the process of restructuring, if production of the dirty good exceeds efficient levels and output does not change much as costs fall. However, if production was below the efficient quantity, perhaps due to the influence of market power, the addition of environmental controls could lower welfare (Oates and Strassmann 1984, Brennan 1999). Furthermore, though the majority of the literature in the context of electricity restructuring has presumed potentially significant increases in output, from a broader perspective the substitution of electricity consumption for consumption of other fuels in end use—in other words "output substitution"—is likely to have environmental benefits (Mills et al. 1992, Schurr 1984, Devine, 1982).

The size of price declines resulting from restructuring depends on a number of factors.[13] On the one hand, if prior to restructuring the industry was relatively inefficient and the new market is very competitive and provides options for all classes of customers, then restructuring could produce substantially lower electricity prices. On the other hand, if the incumbent utility is a low-cost supplier within a region, then prices in the local area could actually rise under competition, particularly if new entrants cannot beat the incumbent's price. This price rise could occur either because of decreased production and increased profit-taking in a newly unregulated market, as may characterize monopoly, or because of increased generation aimed at export markets that raise the marginal costs of generation, or both. If the low-cost supplier is a hydroelectric utility then any change in generation associated with a price change would have little impact on emissions. If it is a largely fossil-fueled power company, however, reduction in generation could have an emissions-reducing effect or, conversely, generation increases to capture an export market could cause an increase in emissions.

One important influence on size of the price decline associated with restructuring is the treatment of previous investments in the transition to restructured markets. In the transition from public ownership to private ownership, revenue from the sale of infrastructure is usually used to retire debt incurred by the public sector, as occurred in Argentina and elsewhere. In the United States, although ownership does not necessarily change the value of existing utility plant and equipment is likely to change and the evidence suggests that it has. When the undepreciated book value of infrastructure is greater than its value in a restructured industry, the difference has been

---

[13] See Palmer (1997) for assorted predictions of what could happen to the price of electricity in the United States as a result of restructuring.

termed “stranded cost” and a variety of approaches such as energy surcharges have been used to recover these costs with an important effect on electricity price (Energy Modeling Forum 1998). The larger the amount of stranded costs that must be recovered through an electricity surcharge, the smaller the price reductions arising from competition in the short-run. Over time, the impact of stranded costs on retail electricity prices will diminish as the contribution of stranded cost recovery to electricity prices becomes smaller and ultimately disappears. In several cases stranded costs have turned out to be much less than anticipated, and even negative (the value of assets in a restructured market are more than their book value in the regulated market). This surprise was revealed by the high winning bids in auctions of divested generation assets.

In the near term in the United States, retail price declines resulting from restructuring may be determined more by policy than by market forces. Many of the states that have already formally embraced retail competition have also enacted a guaranteed rate reduction or rate freeze that persists throughout a transition period of 3–13 years and that allows for recovery of a large portion of anticipated stranded costs.[14] Generally, these rate caps, which tend to be targeted at residential and small commercial customers, are 3%–10% lower than current retail prices, but can be as much as 20% lower than current prices. Under standard assumptions about demand elasticities, these price changes suggest that demand could rise .3%–5%. The environmental effect of this increase in demand will likely diminish over time as new generators enter and displace existing and higher-emitting generators. If aggregate emissions of a particular pollutant are capped, then increases in demand will not increase total emissions of that pollutant. In the United States, such caps are relevant for SO_2 emissions from all large generators throughout the United States and for NOx emissions from all generators in the northeastern states during the summer months.

Competition could also bring about the development of a thriving market in energy services. Energy service companies use electricity in combination with other fuels and capital equipment to produce services such as lighting and space conditioning, which they market directly to residential and business consumers. These companies will have strong incentives to minimize the costs of providing energy services and to increase energy efficiency. Their entrance

[14] In these states, legislators or regulators or both have guaranteed rate reductions either by imposing a retail rate cap or by establishing a “standard offer” rate below the existing regulated price. This standard offer rate is what will be charged to those customers who choose not to participate in the competitive retail market and it effectively caps the competitive market rates to the eligible classes of customers.

into the market is expected to reduce the derived demand for electricity among their customers as they seek to deliver services using a more cost-effective mix of energy and equipment inputs.

Input Substitution: Fuel choice and the rate of capital turnover

For any given level of electricity demand and fixed set of environmental policies, the environmental effect of restructuring will depend on what happens to the mix of fuels and technologies used to generate electricity. One pessimistic scenario foretells that restructuring will reduce the penetration of zero-emitting (at least of conventional air pollutants) technologies such as nuclear and renewables. This scenario suggests an increase in generation at older coal-fired generators without NO_X controls, where facilities are currently under-utilized, as in the Midwest of the United States, to sell into new markets in other regions. This condition would lead to dirtier air under competition. Another more optimistic scenario envisions new entry of merchant generators using highly efficient and low-emitting gas-combined cycle units and combustion turbines. This approach would be complemented by anticipated strong market demand for "green power"—power from nonfossil or relatively environmentally friendly technologies—leading to a cleaner fleet of generators and lower emissions in a competitive world. Other mixed scenarios have also been suggested with more uncertain net impacts on air emissions.

Prospects for Nuclear Generation

Nuclear power is a significant source of generation for much of the world. Although the disposal of nuclear waste is associated with substantial environmental problems, nuclear power plants do not emit conventional air pollutants or carbon dioxide. Thus, from an air pollution perspective at least, nuclear power is clean.

The prospects for nuclear power have faded with concerns about their financial performance. Nuclear power is also a very significant source of potentially stranded costs as countries begin to deregulate. As part of restructuring in the United Kingdom, the government planned to sell its nuclear assets in 1989 but found that the combination of decommissioning costs, spent-fuel reprocessing costs, and liability made nuclear assets hard to sell. The government then instituted the Fossil-Fuel Levy as a way to subsidize nuclear power until all the generators were sold as British Energy in 1996. The eight most advanced plants were sold for $2.2 billion, which accounted for the costs of all but one of the plants. The government absorbed the remaining cost. Likewise, the government also took on the cost of the older plants that could not be sold.[15]

Sweden is another country with significant nuclear assets. However, Sweden has committed itself to phasing out all nuclear power production by 2010. Whether this phaseout will be achieved remains subject to question, but the first plant was closed in 2000. It is possible that due to this phaseout of nuclear power, deregulation will have little or no effect on the nuclear issue. The government is stranding the costs of nuclear power by 2010 regardless of other policies, so any stranding that is done by competition would not affect the nuclear complex.[16] The German government has also reached an agreement with its utilities to phase out nuclear generation by 2030. They plan to achieve this phaseout through the use of an aggregate cap on total nuclear generation during the intervening years where the right to generate power will be tradable among generating facilities.

In the United States, absent a change in public policy and in public attitudes, no new nuclear power plants are likely to be constructed in the near future, so the percentage of generation from nuclear plants will diminish as electricity demand grows and as operating licenses of existing plants expire. Competition may result in early retirement of some portion of the existing nuclear capacity. In a regulated environment most nuclear power plants would be expected to remain on-line at least until the expiration of their current operating licenses. At market prices, a few nuclear plants will be unable to cover the costs of fuel, operation, and maintenance, and meeting safety requirements. Estimates of the annual amount of nuclear generation potentially subject to early retirement range from 40 billion kWh hours per year to over 110 billion kWh per year, or 6.3%– 17.5% of current levels of nuclear generation (Rothwell 1998).

Countering this effect, however, competition will likely improve efficiency at nuclear power plants that continue to operate. Improvements that have already taken place in the late 1990s in anticipation of competition take the form of fewer unplanned outages or shorter downtimes associated with refueling and, therefore, increased generation at existing plants over the course of the year. As a result of these improvements, nuclear generation at the surviving plants has risen by an average of nearly 10% between 1993 and 1998. Future efficiency gains

[15] U.S. Energy Information Administration (1997a).

[16] See Nordhaus (1997) for a thorough discussion of the nuclear situation in Sweden.

could also result from reductions in operating and maintenance costs as nuclear operators actively seek to reduce their production costs and increase their operating returns. Higher returns will help to keep nuclear plants on-line longer.

The bottom line for nuclear generation in the United States is still highly uncertain. The official analysis of the Clinton administration's Comprehensive Electricity Competition Act of 1999 forecasts that increased generation resulting from future productivity improvements at existing nuclear plants will more than offset the generation lost due to premature nuclear retirements (U.S. Department of Energy 1999). Indeed, while over 5700 MW of nuclear generation retired in advance of license expirations between 1992 and 1998, no additional early retirements occurred in 1999 or in the first half of 2000. Moreover, announcements of sales of nuclear power plants to specialized nuclear generation companies, who presumably expect to operate them at a profit, are becoming increasingly common. Allowing competition in generation may actually prove to be the salvation of the existing nuclear power industry.

Prospects for Renewables

Renewable generating technologies, or simply renewables, include all forms of generation that use a nondepletable energy source. This category of generators includes hydro-power, solar thermal and photovoltaics, biomass, geothermal, and wind power. Like nuclear power, most renewables do not contribute to emissions of conventional air pollutants or of carbon dioxide.[17]

Renewables represent a small fraction of total electricity generation in the world. However, policies can be effective at accelerating the introduction of new technologies. Efforts to promote renewable technologies in Europe have led to a 200% increase in the installed base of nonhydro renewable-generating capacity between 1990 and 1998, from 4.8 GW to over 15 GW (Goldstein et al. 1999). Absent such policies, however, nonhydro renewables have been slow to

---

[17] However, renewable energy sources attract their own environmental criticisms (Bradley 1997). For wind power the concerns include unsightliness, noise, problems with television reception, and bird kills associated with wind turbines. Biomass combustion leads to emissions of CO_2 and conventional air pollutants. However, closed loop-biomass with dedicated energy crops has virtually zero CO_2 emissions associated with combustion but it does have emissions from fuel transport. Typically, renewables are land-intensive, which can have environmental implications. Lee et al. (1995) and European Commission (1995) provide comprehensive analyses of externalities for the entire fuel cycles of renewables and conventional technologies for environmental protection. Burtraw and Krupnick (1997) contrast and evaluate these estimates.

penetrate electricity markets because of their relatively high cost.[18] If, as expected, increased competition leads to lower electricity prices, renewables will have an even tougher time competing. will further work against renewables. Moreover, as the industry transitions to greater competition, some of the regulatory mandates and programs that have helped to support the use of renewables in the past are disappearing. All of these factors suggest that absent new environmental policies or a strong expression of preference for green power in a restructured marketplace, renewables will be less likely to penetrate the market.

The suggestion of policies for the adoption of renewable energy sources takes a prominent role in most discussions of electricity restructuring and its environmental effects. In the EU directive on electricity competition, special allowances are made for renewables. Specifically, countries are allowed to break from merit-order dispatch and give first priority to renewable sources; or countries can encourage new capacity to be renewable through the authorization system for new capacity.[19] Many countries, including Austria, Denmark, Italy, the Netherlands, and Germany, have taken advantage of this allowance.[20] Denmark, which has a strong history of supporting renewables, has taken advantage of restructuring to institute something akin to a renewable portfolio standard (RPS), which has been proposed in the United States. The RPS would require that a fixed percentage of total generation come from renewable sources at the aggregate level. Electricity distributors in Denmark are then required to meet this obligation either by developing their own renewable sources or by contracting out to other facilities. Proponents of such a policy have claimed that it could achieve up to 20% penetration of renewables in the United States, while allowing for continued declines in prices, though not as great a decline as would be achieved otherwise (Clemmer et al. 1999).

Germany also has a history of supporting renewable technology, dating back to the 1990 Electricity Feed Law, which requires German distribution companies to purchase renewable energy from producers at a regulated minimum price that was tied to the price of electricity. Market restructuring in Germany in 1998 led to a substantial fall in electricity prices, which lowered the payments to renewables. The new Renewable Energy Law of 2000 sets higher fixed

[18] Renewables costs have declined at a substantial rate over the past three decades and in fact have exceeded expectations for reductions in cost. However, they have had to compete in a market of declining prices for other fuels (McVeigh et al. 2000).

[19] European Commission (2000a).

[20] For a description of many of these policies see Moore and Ihle (1999).

rates based on renewables costs and divorced from electricity prices that are expected to boost development of wind and other renewables.[21] This law aims to increase the renewables' share of electricity generation, currently about 5%, to 10% by 2010. In addition to this law, the German government plans to promote combined heat and power (CHP) as well by allowing distribution companies to give preferential network access to CHP facilities. The EU Directive explicitly makes these sorts of indirect subsidies legal despite their anticompetitive nature. The United Kingdom also has taken steps to encourage renewable power through the nonfossil fuel obligation (NFFO), which is discussed elsewhere in this chapter. Also as a part of restructuring laws in the United States, states have adopted various forms of an RPS to ensure that a minimum percentage of generation comes from renewable sources. California has adopted an innovative approach using a reverse auction, in which new providers of renewable generation bid for a subsidy to be paid per kilowatt hour of generation delivered to the grid (Kirshner et al. 1997).

Competition also brings greater possibilities for differentiating service offerings that provide an opportunity for customers to express a preference for green power, potentially providing a boost to renewables. The idea that consumers will be willing to pay more for green power is often suggested. Some companies in Europe and the United States are beginning to market electricity that way. In particular, a Swedish environmental group has begun a green labeling program for bilateral supply contracts.[22] In the United Kingdom and the United States, renewable generators and power marketers are developing green power service packages. Under these packages customers contract for power that is, for example, 20%, 50%, or 100% renewable and generally pay a premium above the market price of conventional power. Some of these service packages are limited to nonhydro renewables, but many are not.[23]

Whether green power marketing ultimately increases renewables generation depends on whether the size of the green power market exceeds the contribution of existing renewable generators and on the selectivity of green power purchasers.[24] Some green power packages specifically indicate that a certain percentage of the power will come from new renewables,

[21] Speech by Andreas Wagner at Conference titled "Electricity Restructuring and the Environment: A United States German Dialogue", Washington, DC, May 23, 2000.

[22] Seventeen percent of total Swedish electricity supplies are sold on green contracts with a substantial price mark-up (Eikeland 1998).

[23] Wiser et al. (1999) provide a useful status report and assessment of existing programs.

[24] Rader, Nancy 1998; Glaser, 1999.

presuming that penetration above and beyond current levels is something that customers care about. However, penetration of new renewables also does not necessarily preclude early retirement of existing renewables that have difficulty profiting in a more competitive market place.

The size of the potential market for green power is difficult to estimate. In the United Kingdom, a consultant report by Ecotec found that 10% of respondents to a survey of U.K. businesses would be willing to pay a 7% premium for renewable power.[25] Similar findings have been found in marketing surveys in the United States. Surveys of residential customers indicate a majority of 52%–95% say they are willing to pay at least a modest amount more per month for electricity from renewable sources. Reality indicates a difference between stated preference and revealed preference, though, and a substantially smaller percentage of the customers eligible to do so have purchased green power to date.[26] Proponents of green power suggest that this low penetration rate is in part a function of the incentives to shop for power provided under restructuring. Concern for the environment may not often provide a sufficient incentive for customers to switch away from the incumbent provider, because doing so requires initiative, incurs a time cost, and may entail perceived risk. However, it may be that when placed in a position of having to choose, customers would choose green power and be willing to pay more for it.

Three models of restructuring have emerged in the United States that have successively strengthened the role of customer choice and improved the prospects for green power markets. The first was the California model where the 1996 restructuring law called for retail customer choice to be extended to all customers beginning in 1998. The law froze rates at 1996 levels for all customers and imposed an additional 10% rate reduction below 1996 rates for residential and small commercial customers, effective through the end of 2002.[27]

Though the California law allows customer choice, it provides no incentive for customers to consider switching away from their incumbent providers. The rate charged by distribution utilities is capped at the difference between an aggregate price cap for customers who remain

---

[25] Eikeland (1998).

[26] However, consumer education has proven an important variable that boosts participation (Farhar, 1999).

[27] Between 1998 and 2002, utilities will be allowed to recover stranded costs to the extent that their current costs fall below the capped rates with the potential for stranded cost recovery extending to 2008, although diminishing over time.

with the utility and its own cost of generation. If a customer picks an alternative supplier for its generation, the overall price of electricity faced by that customer may not go down at all because distribution utilities can raise their fees as long as the total price of electricity faced by the customer is under the cap. This situation means that electricity consumers in most of the states will see no substantive savings in their electricity bills from switching to a competitive electricity provider before the end of 2002.[28] Therefore, to attract retail and small commercial customers, competitive suppliers must differentiate their products along dimensions other than price. It is not surprising that most of the customers who have switched from their local regulated utility have done so to purchase green power. Of the 50,000 customers who have switched providers, about 50% are buying from green power suppliers.[29]

Pennsylvania passed a retail competition law in 1996 that phases in competition between 1999 and 2000 and provides a second model for promoting customer choice.[30] Like California, customers in Pennsylvania are given the option of choosing providers. Unlike California, customers in Pennsylvania are given an incentive to actively choose a provider. The incentive is a credit that provides a slight discount to customers who switch to a provider with a price below the established price for incumbent suppliers.[31] Consequently, a larger number of customers have switched (more than 425,000 in 1999, rising to 528,000 by July 2000) than in California.[32] Like in California, a large number (about 20%) of those Pennsylvania customers who switched providers chose a supplier that offered some element of support for renewables. Further, about 2% of nonresidential customers in Pennsylvania who switched have chosen green suppliers,

---

[28] San Diego Gas and Electric ended its rate freeze in the summer of 1999 after it completed recovery of all stranded costs.

[29] Hirsch and Serchuck (1999).

[30] Unlike California, much of Pennsylvania was already part of a competitive wholesale electricity spot market operated by the PJM Independent System Operator, so new institutions to facilitate the functioning of competitive wholesale markets were not needed.

[31] Specifically, most of the utilities in the state offer default generation service at a price that exceeds the price that is available in the open market, thereby providing a so-called shopping credit. According to Joskow (2000) this discount means that utility customers in Pennsylvania who switch providers are paying a lower share of stranded cost recovery than customers who remain with the incumbent provider. Consumers that switch suppliers may realize savings up to 15%, and this difference allows for the provision of relatively expensive green power at a price that can be lower than the rates of incumbent suppliers.

[32] Over 425,000 customers, or 10%, had switched as of January 1999, the first month of customer choice for just two-thirds of the state's customers. This compares with a .9% response rate in California after nine months (Wiser et al. 1999).

more significant than many expected (Wiser et al. 1999). This finding is important given the fact that nonresidential customers represent about two-thirds of total electricity consumption in the United States.

A third model, with respect to supporting renewables, is emerging in Texas. Customers have the opportunity to switch suppliers and, like Pennsylvania, they are given the incentive to do so. In addition, incumbent suppliers are prohibited from lowering their rates for residential and small commercial customers until 2005 or until 40% of their customers are served by competitors. The consequence is that existing utilities are allowed to offer discounts on energy sales everywhere except in their native, formerly exclusive territories, inducing a much larger percentage of customers to switch suppliers. Renewable advocates hope that a strong fraction of those who switch, like in those in California and Pennsylvania, choose a supplier that offers renewable energy as part of its portfolio.

New Markets for Old Coal

Many of the short-run economic benefits from more competitive generation markets will be realized through greater international electricity trade in Europe and Central America or through interregional electricity trade in Germany and the United States. Especially in the United States, allowing generators to compete to serve distant customers may create opportunities for generation from low-cost older coal-fired facilities to displace generation from oil or natural gas facilities. This increased electricity trade will result in higher emissions of CO_2 and other air pollutants. On the one hand, competition will also give exporting generators incentives to improve plant availability, which could further increase the amount of electricity generated for export and, therefore, the level of emissions. On the other hand, generators will have an incentive to economize on fuel use, perhaps by actually improving their heat rates, and this could contribute to offsetting reductions in the emission rate per kilowatt hour for carbon and other pollutants.[33]

The extent to which interregional power trade will increase under competition depends significantly on the amount of available interregional transmission capability. Large differences in electricity prices between regions suggest, at first glance, that there will be greater incentives

[33] Carlson et al. (2000) estimate the rate of exogenous technological change affecting coal-fired generation and find it to contribute significantly to changes in the marginal cost of pollution abatement over time. Ellerman (1998) provides observations with respect to technological change and life extensions at existing coal plants.

to expand transmission capacity under competition to exploit those price differences. In addition, the FERC open transmission access order requires transmission-owning utilities to expand transmission capacity if necessary to satisfy a demand for transmission service that cannot be met with existing capacity. But the incentives to expand transmission capacity will depend importantly on how transmission service is priced.

Also important in the United States context is the fact that increasing the output from older plants will also increase their maintenance costs. This situation will tend to make them uneconomic after a time, and major maintenance expenditures could subject the plant to the stricter emissions restrictions (known as new source performance standards) that apply to new sources or sources of emissions that have undergone major modifications. In late 1999, the U.S. Justice Department, on behalf of the U.S. EPA, sued seven Midwestern and Southern utilities for making major modifications to 32 of their collective plants without installing the required pollution-control equipment. If this lawsuit is successful, it will raise the costs to all utilities continuing to keep older, dirty plants on-line. New environmental regulations to limit emissions that contribute to the formation of fine particulates could also accelerate retirement of these plants.[34]

Market Penetration of New Gas

When England simultaneously privatized and introduced competition into its power sector, it also was phasing out price supports for the British coal industry. The result was a substantial penetration of new gas-fired generation, owned and operated largely by new independent power producers. This switch from coal to gas resulted in both a reduction in carbon emissions and a dramatic reduction in emissions of SO_2.

Many analysts suspect that a similar phenomenon will occur in other countries including the United States, given low natural gas prices and the advantages of gas-fired combined-cycle turbines (high-efficiency, low cost, modularity, and the short lead-time for bringing these units

[34] In early 2000, a federal appeals court upheld the United States EPA's authority to require at least 18 states and the District of Columbia to reduce nitrogen oxide (NOx) emissions that are transported from state to state and aggravating smog problems across the Northeast. The rules originally applied to 22 states, but the court said further review was needed to determine how the requirement applies to Georgia, Missouri and Wisconsin. However, eight Eastern and Midwestern states are appealing the ruling.

on-line). Energy market entrepreneurs will seize opportunities to make money by selling electricity generated with this technology.

Nonetheless, whether gas plants penetrate electricity markets faster than they would have in the absence of competition remains an open question. First, competitive markets are riskier for investors than regulated markets with more ensured returns, and the cost of capital in a competitive market therefore will be higher than it would be under regulation. Together these factors tend to depress investment, ceteris paribus. Second, the siting of new power plants will continue to be a regulatory hurdle, even in a deregulated environment. Concerns over the effect of power plants on environmental quality will have to be addressed before regulators will permit these plants to operate. In addition, new generating plants will need to locate in areas that have access to gas pipelines and high-voltage transmission lines. The number of sites ideally situated for new gas plant development may be largely in the hands of existing generators, potentially limiting the number of sites for new entry by independent producers (at least in the short run). Third, uncertainty about the future path of natural gas prices could reduce enthusiasm for gas-fired technologies. Lastly, the rate at which the industry can bring new gas-fired combined-cycle turbines on-line may be limited by the capacity of manufacturers to deliver the equipment. If demand exceeds their capacity to produce, equipment prices will rise, and this situation could have a dampening effect on the rate of new entry. Increases in the price of natural gas relative to competitive fuels such as coal could also slow the rate of entry of new gas combined cycle units.

Substituting Generation and Transmission.

Restructuring can also affect the extent to which transmission inputs are substituted for generation inputs. In some countries, such as New Zealand, and in some regions of the United States, such as the PJM power pool in the mid-Atlantic states, transmission congestion is explicitly priced at a very disaggregated level. Explicit pricing of transmission congestion means that when the grid is congested and it is infeasible to transmit additional power between two points, the prices of electricity at those points will diverge and the difference in the generation prices will be reflected in the price of transmission.

As noted in the context of new markets for old coal, the incentives to expand transmission capability will depend importantly on how transmission service is priced. If transmission is priced in a way that allows transmission owners to earn excess profits whenever lines are congested, then they will have incentives to delay expanding transmission capacity in order to restrict supply and drive up price. Alternatively, if transmission users have rights to congestion revenues, the incentive to delay investment in new capacity could be muted.

Congestion pricing of transmission services and the cost of increasing transmission capability, and especially the difficulty in citing new power lines, provides incentives for locating generation near load. This situation, in turn, will affect environmental quality in a variety of ways. First, transmission losses will be reduced, meaning that less generation will be necessary to meet a given quantity of demand, which will tend to decrease emissions. Second, locating generation closer to load centers (which typically coincide with population centers) could lead to increased exposure to the emissions from power plants. This scenario would result in greater health effects associated with those emissions. However, the choice of technology also may be affected. Generation sources closer to load are more likely to be gas-fired than coal-fired, with associated advantages in reduced emissions.

The cost of transmission may lead to increased penetration of even smaller-scale generation, often termed “distributed generation”. In some cases, distributed generation may be located on the grid to provide ancillary services such as voltage regulation and reliability. In other cases it may be located off the grid to serve remote areas. Natural gas-fired micro-turbines and renewable wind, solar, and fuel cell technologies are often cited as those that would benefit from an increase in distributed generation. In general, these technologies are considered relatively benign compared with coal-fired or nuclear central power stations. However, distributed generation would be accompanied by distributed emissions, noise, or other environmental problems that can be significant, especially if it is located within large population centers.

Distributed generation is more likely with net metering. Net metering is the practice of allowing customers with small renewable generating facilities that are interconnected with the local distribution company to sell all generation in excess of their own demand back to the grid at retail rates, effectively allowing the meter to run backwards. This provision creates an incentive for electricity consumers to install small-scale on-site renewable generation, thereby reducing the need for generation from conventional sources. Whether net metering is in the financial interest of the transmission operator depends on how transmission is regulated, and net metering is one of many issues that has emerged as part of the debate about restructuring.

Efficiency Improvements: Stronger Incentives for Efficiency and Technological Improvement

Greater competition is expected to hasten the improvement in performance of existing facilities and the introduction of new technologies.[35] In fact, the portion of the time that existing facilities are available for generation when needed for generation, known as the "availability factor", has been increasing over time and many analysts associate improvements in the past decade with the prospect or reality of competition. Under competition, increasing availability creates an opportunity to earn greater revenues per unit of invested capital, thereby increasing profits. Whereas under regulation, revenues are tied to costs and such incentives are muted. For example, the U.S. Energy Information Administration (U.S. EIA 1997b) explicitly associates improvements in heat rates (the amount of energy needed to generate a kilowatt hour of electricity) with the introduction of competition.

The prospect for longer-term R&D is less clear under competition. At the governmental level, funding for long-term research and development is down in every country, possibly except Japan, as nations increasingly turn to the private sector to manage their energy futures.[36] At the same time, major research institutions like the Electric Power Research Institute have suffered a loss of funding from individual member companies faced with stiffening competition and a need to cut costs. It is possible that firms could face even greater rewards from innovation in a competitive environment than under regulation. However, it remains to be seen whether private incentives are sufficient to encourage R&D, especially with respect to new technologies that may have a longer gestation before they are practical. Some observers fear that competition will slow the pace of technological improvement and lengthen the wait until new environmentally friendly technologies become practical.

In addition to technological improvement, institutional improvements can also provide a potential boost to efficiency. Critics of exclusive franchises in energy markets complain that

---

[35] For example, Kumbhakar and Hjalmarsson (1998) investigate the productive efficiency in Swedish retail electricity distribution and compare privately owned, municipal utilities, municipal companies and companies with mixed ownerships. They find privately owned companies are relatively more efficient, but they find little variation in the rate of technical change among ownership structures. The measure of productive efficiency in distribution services differs from generation services. While production in generation is largely determined by technology, management mainly determines productivity in retail distribution.

[36] Dooley and Runci 2000.

enterprises lack adequate incentive to differentiate products to meet customer desires.[37] Marketing green power described above is one type of change resulting from restructuring that could affect the environment in a beneficial way. A second change is the greater use of marginal cost pricing coupled with time-of-day pricing of electricity at the retail level. This method of setting prices yields higher prices during periods of peak electricity demand and lower prices during off-peak periods.

As consumers see prices rise during peak periods, they may choose to shift some of their electricity-consuming activities to off-peak periods when prices are lower. The effect of this peak-shifting activity on emissions depends on the composition of the generating capital stock. In those regions where base-load capacity is mostly coal and peaking units are fired by natural gas, emissions would increase as a result of peak shifting. This scenario probably characterizes a majority of settings that have initiated restructuring to date, with the notable exceptions of Norway, New Zealand, and parts of the United States. The effect with respect to conventional pollutants is not entirely bad. If emissions are higher mostly at night, the effects on air quality, particularly on ozone concentrations, may be less damaging than emissions during the day. However, the increase in greenhouse gases is strictly harmful for the environment.

Widespread use of time-of-day pricing is unlikely in the near term, especially in a climate of declining prices. However, its ultimate arrival likely will be accompanied by other technological innovations that make electricity consumption “more intelligent”. These innovations include the introduction of so-called smart appliances and smart houses, which would do a better job of regulating energy consumption in the house. Comparable innovations would be expected in the industrial and commercial sectors. Together, these innovations may reduce the overall level of energy use per capita.

Aligning the Interests of Environmental and Economic Regulators

In addition to affecting emissions directly, the transition from regulation to competition has implications for the performance of environmental regulations already facing the industry. Deregulation will influence the extent to which environmental regulation reduces pollution and the cost of doing so.

---

[37] Bohi and Palmer 1996.

An expected virtue of restructuring is that competitive firms may be more responsive to private interests than a firm with an exclusive franchise, because of the profit motive. However, one might suspect restructuring could inaugurate a lower level of responsiveness to social concerns. At least with respect to environmental performance, the evidence about this result is mixed.[38] State-owned enterprise may be exempt from formal regulatory control, and state ownership is not a guarantee of positive responsiveness to social priorities; however, some publicly owned utilities have been among the leaders in energy conservation and renewable technology.[39] Meanwhile, regulated privately owned firms in the United States face requirements outside of environmental laws through mandated investments in less-polluting technologies and mandated programs for conservation. When firms have failed to meet the goals of these mandates they have been penalized through denial of cost recovery.

Because competitive electricity generators face greater pressures to reduce costs than do regulated or publicly owned generators, which are ensured recovery of costs, they are likely to respond differently to environmental regulatory requirements. Some advocates of restructuring have pointed out the incentives of unregulated power producers and marketers to appeal to environmental concerns. However, if protection of the portfolio of "benefit programs" such as demand-side management, investments in renewable technologies, and so on, is a goal, this approach inevitably will require regulatory oversight and incentives, or an unprecedented level of product disclosure to promote customer choice.

Competitive firms have stronger incentives to respond to regulations that allow flexibility in achieving pollution-reduction goals than do firms with exclusive franchises. Perhaps the most visible example of an incentive-based approach to environmental policy to date has been the sulfur dioxide (SO_2) emission allowance trading program in the United States electricity industry, which is the source of roughly two-thirds of SO_2 emissions in the United States.[40] A leading argument for the use of incentive-based regulation is that it can allow society to afford greater levels of environmental quality at less cost than other regulatory approaches. This

---

[38] Wilson and Rachel 1977.

[39] For instance, the 1970s the quasi-public United States Tennessee Valley Authority (TVA) was widely viewed as a pollution offender. Prior to the advent of federal clean air requirements that empowered the states to enforce federal standards, the state authorities had no power to impose sanctions on the federally owned utility. (Roberts and Bluhm 1981, 333–335, 380.) See Smeloff and Asmus (1997) for examples of innovative programs at publicly owned utilities.

[40] Carlson et al. (2000), Ellerman et al. (2000), Stavins (1998), Schmalensee et al. (1998).

assertion depends on the ability of decentralized decisionmakers to pursue investments that minimize the cost of compliance, and the congruence of their own least-cost strategy and the least-cost strategy from the social perspective.

In traditionally regulated electricity markets, however, significant obstacles exist to the pursuit of least-cost compliance with emission trading.[41] The objective of environmental regulators to minimize the cost of compliance with stated environmental goals is not necessarily shared by economic regulators, who may have other constitutional objectives such as promoting economic development and preserving jobs in their state.[42] Bohi (1994) and Lile and Burtraw (1998) document state-level actions taken in the early years of the SO_2 program that provided disincentives to participate in the market and that promoted use of in-state fuels to protect in-state jobs. Even when objectives of different regulators are aligned, to achieve this common objective will require significant departures from traditional regulatory treatment of alternative compliance options. For example, regulated utilities in the United States normally are not allowed to earn a capital gain on capital investments. In a system of tradable permits, however, the income from the sale of permits will normally include a capital gain. In addition, the cost of purchased permits is likely to be treated as an expense and recovered annually, while capital costs are amortized and recovered over time at a set rate of return. Hence, the relative marginal opportunity costs of compliance options as perceived by the utility will differ from their relative market prices whenever the utility's allowed rate of return on capital costs differs from society's true opportunity cost of capital.[43]

These obstacles already appear to have been diminished by the realization or expectation of competition.[44] Where generators are free to earn as much as they can, the incentive to take advantage of all possible compliance options to lower costs will become stronger. Therefore, we expect that in a competitive electricity market the advantages of emission allowance trading programs relative to command-and-control methods of regulation would be greater than in a regulated market.[45]

---

[41] Bohi and Burtraw (1992), Fullerton et al. (1997), Rose (1997), Winebrake et al. (1995).

[42] Burtraw et al. (1995), van Egteren (1992), Baron (1985).

[43] Bohi and Burtraw (1992).

[44] Burtraw (2000). Baumol and Oates (1988) and Fischer et al. (1998) distinguish the performance of incentive-based approaches with respect to incentives for innovation.

[45] Carlson et al. (2000).

Other concerns also have been expressed about allowance trading, including the concern that it is immoral to buy and sell the right to pollute.[46] However, perhaps it is worse to give the right away for free, as occurs under conventional approaches to regulation.[47] The possibility that the spatial or temporal pattern of emissions that result from trading may degrade the environment has also attracted much attention. Burtraw and Mansur (1999) use an integrated assessment model of electricity generation, atmospheric transport, public health, and economics to examine the effects of trading and banking under the SO_2 program.[48] They find trading has actually led to environmental and public health benefits compared with an approach that would have achieved the same emission reductions without trading.[49] Other trading programs have adopted specific designs to deal with possible environmental effects of trading and banking.[50] Nonetheless, concern about environmental impacts of trading in an international context has contributed to the reluctance to trade sulfur emission reductions in Europe, even though such trades would be allowed under international agreements to reduce the long-range transport of sulfur.[51]

Restructuring may have at least one other important effect in the United States by changing the management of hydroelectric facilities. Management of a hydropower facility affects other water uses, including flood control, water quality, recreation, fish and wildlife habitat, and the availability of water for domestic, irrigation, and industrial use. At issue in restructuring of the electricity industry is how operators of privately owned hydroelectric facilities will recover costs for environmental protection. For example, in California the Pacific Gas and Electric Company plans to divest in 2001 its 174 dams and 99 reservoirs, which may be acquired by dozens of individual operators. Traditionally, the utility regulator would enforce environmental constraints and allow the regulated utility to recover costs for a variety of mandated mechanisms such as environmental constraints on minimum stream flow and change

---

[46] Michael J. Sandel, It's Immoral to Buy the Right to Pollute. *New York Times* December 15, 1997.

[47] Dallas Burtraw, Call It "Pollution Rights," But It Works. *Washington Post* March 31, 1996.

[48] "Banking" refers to the practice of a firm saving an emission allowance issued in one year to cover emissions in a future year.

[49] See also Swift 2000.

[50] The RECLAIM program in Southern California uses a zonal approach to trading, and precludes trades between zones that may degrade the environment (Lents 2000). The Ozone Transport Commission program in the Northeast United States uses a mechanism called "progressive flow control" to prevent degradation that may occur because of excessive emissions at one point in time. Tietenberg (1985) and Klaassen (1996) provide introductions to the design of flexible policy instruments when the spatial and temporal pattern of emissions are important.

[51] Burtraw et al. (1998), Klaassen (1994), Forsund and Naevdal (1994).

in flow, protection and mitigation of wetlands and spawning areas, and public access improvements. However, as a result of restructuring, there may be less incentive for firms or less oversight by regulators to see that these investments and management practices are realized.[52]

5. Political Reality and Compromise: Sharing an Expanding Pie Between Economic and Environmental Objectives

If electricity restructuring enhances productive efficiency and intensifies competition as expected, economic welfare will improve. If the gains from competition are as large as expected, perhaps in excess of $20 billion per year in the United States (U.S. DOE 1999), then society could chose to spend some of those gains to purchase environmental improvements. These new environmental programs could substitute for prior environmental programs lost with the transition to competition or they could be wholly new initiatives. Examples of ways in which these gains are being or could be used are below.

Under regulation in the United States or public ownership elsewhere, renewable energy and conservation have received at least fledgling support. Some would argue that environmental advocacy groups have had some success injecting proenvironment initiatives into the traditional process of electric-utility regulation. Thus, some environmental groups might oppose regulatory reform because it would “place great pressure on the taxation-by-regulation game that they have learned to play so well” (Joskow 1996, p. 258; see also Heydlauff 1999).[53] A more generous perspective would be to note the strong regulatory prohibition against “environmental backsliding” in the United States and abroad, and the “paramount significance” of electricity to regional environmental concerns (Cavanagh 1999).

---

[52] Though economic regulation occurs at the state level, privately operated dams are licensed for operation at the federal level by FERC. Most existing licenses were granted four or five decades ago. Over the next dozen years nearly 250 privately operated hydroelectric projects, totaling over 20,000 megawatts of capacity, will come up for relicensing. These projects represent more than one quarter of the nation’s hydroelectric capacity and almost 3% of all electric generating capacity. Under provisions of the Electric Consumers Protection Act (ECPA) of 1986, FERC is required to give power and non-power benefits equal consideration in evaluating applications for the licensing or relicensing of hydropower facilities. However, the slow pace of relicensing by FERC has led to extensions of previous licenses for many facilities, leaving state regulators with even more responsibility for environmental management. Also, although ECPA requires a public relicensing process, restructuring of the industry and the advent of competition have made information a strategic resource and made firms less willing to engage in public dialogue.

[53] The phrase “taxation-by-regulation” refers to the additional costs that utilities incur to comply with the many environmental regulations and other regulatory requirements such as demand-side management programs and renewables set-asides that they have faced in the past.

In many places policy makers have explicitly incorporated renewables and energy conservation into restructuring policies. As noted, restructuring laws in several nations and in the United States (along with proposed federal restructuring legislation) include an RPS or its equivalent requiring that a minimum percentage of generation or power sales come from renewables, generally nonhydro renewables. In the United States, the levels for the proposed RPS range between 4% and 20% of total electricity sales or generation. If renewables did achieve a 20% share of all generation, sizable reductions in emissions of air pollutants from the electricity sector would result. (Clemmer et al. 1999) However, more modest levels are likely to be adopted ultimately and these will have smaller emission-reducing effects.

Competition is already threatening the demise of many utility-sponsored energy conservation or “demand-side management” programs. These programs have been credited with helping to reduce demand for power; thereby delaying construction of new power plants. If these programs are truly effective in reducing electricity demand, then eliminating them will lead to more electricity being generated and higher levels of emissions of noncapped pollutants.[54] Many state policy makers in the United States have already decided to implement competition and have made provisions for continued funding of energy-conservation during a three- to six-year transition period using funds raised through a competitive transition charge added on to the regulated electricity distribution rate.

In addition, several state laws and federal legislative proposals in the United States contain provisions to help reduce air pollution from the electricity sector. Whereas some of these provisions intend to prevent increases in emissions that might result from introducing competition, others use the occasion of introducing competition to place tighter limits on emissions from the electricity sector. Proponents of this latter type of provision see tighter emission limits as a way of leveling the burden of environmental controls between new sources that must comply with restrictive new source performance standards and existing sources that face less stringent emission limits.[55]

[54] For an estimate of the emissions impacts of reduced utility spending on demand-side management programs in the United States, see Lee and Darani (1996).

[55] For example, the Texas restructuring law, SB7, requires by 2003 a 25% reduction in SO_2 and a 50% reduction in NOx emissions from older generating plants that are exempt from new source performance standards. The cost of these retrofits may be recovered as stranded costs. Also, 50% of new generation must be fueled by natural gas.

The environmental protection title of the Comprehensive Electricity Competition Act proposed in 1999 falls into the former category. This title explicitly clarifies EPA's authority to impose a regional (inter-state) cap and trade program for NOx emissions to combat ozone pollution. Explicitly granting this authority reduces the probability of court challenges to an EPA-initiated regional NOx cap and trade program. This provision also increases the probability that the currently proposed cap and trade program for NOx emissions in the eastern United States might come into force in time to eliminate any potential NOx emissions increases resulting from more competitive electricity markets.

Other legislative proposals go much farther in terms of imposing new environmental restrictions on a more competitive electricity sector. Several bills include tight caps on total annual emissions of NOx, particulates, and CO_2 and propose to cut the current annual SO_2 emissions cap by 50%. These stricter caps generally are designed to bring the average emission rate across all sources closer in line with the maximum emission rate allowed for new sources.

Palmer et al. (1998) evaluate the economic welfare and health benefits and costs of potential retail competition together with proposed new regulations to reduce NO_X emissions. They find that NO_X emission reductions are less costly in terms of foregone customer and producer surplus when initiated in a restructured electricity industry than under cost-of-service regulation. Further, retail restructuring improves the affordability of NO_X emission reductions. Finally, they find that allowing NO_X trading, as opposed to requiring uniform performance standards, can lead to a $200 million increase in consumer and producer surplus in electricity markets with virtually no change in aggregate health related benefits.

One aspect of the SO_2 emission-trading program in the United States is that emission allowances are "grandfathered"; that is, allocated for free based on historic emissions. The authorizing legislation was passed in 1990, a time preceding the initiation of restructuring, when the vast majority of affected facilities were regulated under cost of service. For the purpose of cost recovery, regulators could be expected to treat allowances at original cost, which was zero, in setting the regulated price for electricity. However, the transition to competitive markets meant that the market, rather than the regulator, would price electricity and this price is expected to approximate marginal cost. Emission allowances take on a value equal to their opportunity cost (permit price) in the calculation of marginal cost. So, suddenly the asset that was acquired at zero cost would take on a value much greater than zero. The net present value of these allowances, in excess of compliance cost borne by the industry, is on the order of $10 billion (1997 dollars) (Burtraw 1999).

This wealth transfer from consumers to industry can have potentially important efficiency implications as well. Goulder et al. (1997) have investigated the magnitude of the tax-interaction effect in the context of the SO_2 program using both analytical and numerical general equilibrium models. They find that this effect will cost the economy about $1.06 billion per year (1995 dollars), adding an additional 70% to their estimated compliance costs for the program. Other studies have found similar estimates of the cost of grandfathering permits for NO_X and CO_2. They have found that this additional social cost can be dramatically reduced if permits are auctioned rather than grandfathered, which provides revenue that the government can use to reduce preexisting taxes (Goulder et al. (1999), Burtraw and Cannon (2000), Parry and Williams (1999)). The difficulty with this proposal is a political one, because it would impose additional costs on industry in addition to compliance costs.

Various proposals and experiments have surfaced for sharing the cost savings from incentive-based approaches between industry and consumers. For example, some U.S. federal proposals capping emissions of NO_X also have suggested allocating NO_X emission allowances to all generators, including those that emit none of the pollutant of concern, and doing so based on recent generation levels, so-called output-based allocation. Because emission allowance allocations are updated over time, this method of allocation provides incentives for low-emitting or zero-emitting generators to increase their generation over time to receive a larger allocation of emission allowances. The approach is similar to that used in Sweden for taxing NO_X emissions from major sources. Revenues collected are refunded to the industry on the basis of kilowatt-hour production over the course of the year.[56]

The effect of this approach is similar to the effect of an output subsidy; however, entry through additional investment will tend to dissipate that subsidy, as the allocation per unit of output falls in equilibrium. Fischer (1999a), Goulder et al. (1999), and Burtraw and Cannon (2000) show that this strategy can have very different efficiency and general equilibrium effects from allocation based on historic emissions. Entry and other effects under output-based allocations can be complicated if generators have large local market shares (Fischer (1999b) or if other regulatory practices vary. Burtraw et al. (1999) illustrate that allocating allowances within a geographic zone, with transmission capability connecting the zone with outside generators, can lead to effects on the geographic location of generation and emissions. These effects are absent

[56] Hoglund (2000), Sterner and Hoglund (2000).

in a system based on historic allocation because historic allocation is divorced from present or future behavior. In sum, output-based allocation may have political advantages and may provide transitory incentives regarding technology choice not provided with historic allocation, but it falls far short of a revenue-raising scheme on efficiency grounds.

Bovenberg and Goulder (1999) have proposed a different political compromise for achieving carbon reductions. They suggest that by grandfathering a small portion (in the neighborhood of 20%) of carbon permits and auctioning the remainder, the wealth transfer to the carbon-dependent industries in the United States, including electricity, would offset the impact on future profits. The auctioned permits could be used to obtain the lion's share of efficiency gains achievable by lowering other taxes.

Although these proposals seem a bit removed from restructuring, they hinge in an important way on competitive or marginal cost pricing of electricity. For instance, if carbon-emitting facilities are never at the margin of the dispatch order for generation and never determine market price, then the price would not adjust to reflect the opportunity cost of carbon emission permits. Conversely, if they are always at the margin, the price will always adjust, yielding additional revenue for all generators whether they emit carbon. Hence, these approaches to environmental policy are tied to the structure of the industry, in one way or another, and many proponents have suggested an explicit linkage between environmental reforms such as these and industry restructuring.

Another environmental feature of some electricity restructuring laws is the requirement that all electricity retailers and wholesalers disclose the fuel mix and the emissions associated with their generation in a standard format established by a government regulation. The purpose of requiring disclosure is to make it easier for customers to compare competing suppliers on the basis of these features as well as price. The expectation is that this information will give customers a better idea of what they are buying in terms of emission reductions when they choose to purchase green power (or alternatively what types of emission reductions they are forgoing when they purchase from a traditional electricity supplier). The actual environmental improvements associated with this requirement are likely to be small, however, because most electricity consumers will have an incentive to free-ride on the green power purchase decisions of others.

Finally, we note that the political context of environmental issues can even have an important effect on the structure of the industry. A recent merger case in the Northeast United States between PECO and Unicom was decided in part on the provision of numerous measures, such as support for renewable energy and a commitment to net metering and the improvement of connections between renewables and the grid, which are designed to benefit the environment.[57]

6. Developing Nations

Different patterns of current energy use and the relative unavailability of electricity distribution infrastructure in many parts of the developing world will likely lead to very different environmental effects of electricity restructuring than are likely in the developed world. In rural areas in developing nations, nearly 2 billion people do not have electricity or access to modern fuels, and extending electrification is likely to have large environmental and economic benefits. The consequence is that communities that are not served by electricity are much more likely to rely on biomass fuel supplies for cooking and heating. One-third of all energy consumed in the developing world comes from biomass, including wood fuels and dung. These fuel sources are relatively inefficient and they are often combusted in poorly ventilated space, presenting health hazards from indoor air pollution. Some authors place more importance on this factor than on outside air pollution from all sources, including electricity generation, with respect to effects on human health.[58] The expanded use of biomass fuels that accompanies population growth has contributed to deforestation and depletion of many fuel-wood sources and substitution to even less efficient fuels.

Restructuring may contribute to rural electrification by making possible a broader diversity of services and prices. Many developing nations provide subsidies to energy use and require universal uniform pricing, meaning the same price must be offered to all customers. Barnes et al. (1997) argue that, as a consequence, rural electric service is not financially feasible because of its high cost relative to average cost. Requirements of uniform prices effectively prohibit local “off-grid” power companies and cooperatives from providing electric service to households. Furthermore, the requirement of a consistent quality of service to all service areas imposes high costs for grid connection to remote areas.

In developing countries, the removal of subsidies and diversification in levels of service and pricing to reflect local costs could lead to higher prices in many cases, but this effect may be

[57] Citizens for Pennsylvania’s Future (2000). PECO-Unicom Merger May Benefit the Environment, Consumers and the Competitive Market After All. Vol. 2, No. 7 (April 7), Harrisburg PA.

[58] Murray and Lopez 1996.

key to rural electrification. Subsidies to grid-connected power consumption have discouraged the development of decentralized, off-grid companies. Prices that reflect costs would do a better job of encouraging off-grid companies to expand service and provide consumers with more choices. Kozloff (1998) labels this reform “commercialization” of government-owned utilities by requiring full recovery of costs. Commercialization may advance renewables use, particularly in off-grid applications in remote areas. This result is possible because, though the capital cost per kilowatt of capacity for these systems is relatively high, compared with grid connected technologies the total costs, including transmission and distribution, may be considerably less in remote areas. In remote areas, alternatives to biomass consumption can be promoted by reducing design standards and encouraging “micro-grids” supplied by diesel and micro-hydropower generators and distributed generation by renewable technologies such as wind and photo-voltaic systems.

7. Evidence

The evidence on the environmental effects of restructuring is thin at this juncture, and it depends very much on the circumstance. Some of the most dramatic changes have occurred in the United Kingdom, with the substitution of gas for coal. Elsewhere there is sparse empirical evidence but some evidence from simulations or conceptual models, leading some brave souls to offer predictions based on analysis.

United Kingdom

The short-run environmental effects of restructuring in the United Kingdom have been positive. Since 1990, coal has declined from 65% of the fuel mix to 50% in 1994 and further to 33% in 1998. Correspondingly the share of natural gas has increased from 32.5% in 1998 from 1% in 1990 with the introduction of combined cycle gas turbine (CCGT) technology.[59] As a result of this change, emissions of all major pollutants have declined.

The change has also had social consequences. In March 1984 British Coal had 246,000 employees, in March 1991 they had 74,000, and the number continued to decline at less drastic rates through the 1990s. This changeover has virtually eliminated small- and medium-sized coal-

---

[59] Department of Trade and Industry, *UK Energy Report 1999*.

fired plants. The drastic "dash for gas" is forecast to continue, with gas projected to represent 49% of fuel use by 2020.[60]

This transition to gas prompted the government to review its policies for authorizing the construction of new gas plants and their implications for future fuel diversity. To protect generation "diversity" through the protection of coal plants, the government issued a policy in 1998 to temporarily make it more difficult for new gas generators to be built. Despite these controls, a number of new gas generators had previously been permitted, and new gas generators continue to be commissioned, most often in the form of CHP.[61]

Nuclear generation also has increased since competition began. This increase by the nuclear sector is partially caused by the Fossil-Fuel Levy (FFL) and the Non-Fossil-Fuel Obligation (NFFO). The FFL is a surcharge on all electric bills that has been used to subsidize the continued life of British nuclear plants (subsidies to nuclear plants ended in 1998), and also to support renewable power generation. The NFFO is somewhat akin to the proposed RPS in the United States; it mandates that electricity suppliers contract a specified amount of their generation from renewable plants. In addition, support by the NFFO of renewable technology has created private interest in the development of renewable technologies, as evidenced by a declining target price of wind power.[62]

Between 1990 and 1993, SO_2 and NO_X emissions from the electricity sector fell by about 25%. Likewise CO_2 emissions also fell significantly in conjunction with the switch to gas, and the increased use of renewable sources through the NFFO.[63]

Norway

The environmental effects of restructuring in Norway are a little more ambiguous due to the major role of hydroelectric power. Unlike traditional fossil fuel-powered generation of the United Kingdom, the primary environmental concern of hydroelectric power is not emissions, but nature conservation. From a purely domestic standpoint, opening the market has been environmentally beneficial, as development of new hydro projects has declined markedly. Prior

[60] U.S. EIA, *International Energy Outlook 2000*.

[61] Department of Trade and Industry, *UK Energy Report 1999*.

[62] Brower et al. (1997).

[63] Brower et al. (1997).

to restructuring, local generators would meet increases in demand by expanding capacity and passing these costs onto their captive consumers. Restructuring has made it more difficult to pass these costs along, and as a consequence companies are more likely to trade with other generators instead of building new dams.

In conjunction with domestic restructuring, the Norwegian market has also been opened up to trade with Sweden, and is in the process of being opened to other Northern European countries. The environmental results of these reforms hinge on whether Norway will be a net importer or exporter of electricity. If Norway is a net importer, then it likely will be causing an increase in emissions from foreign fossil fuel plants. However, if they export more than they import than these emissions would likely be reduced. A likely outcome is that Norway will use hydroelectric resources to export during times of peak demand, and import fossil-based generation at other times.[64]

Amudsen et al. (1999) looks at the welfare gains from allowing international trade in electricity when Nordic firms are expected to comply with a CO_2 cap (either national or international). The paper shows that there are welfare gains associated with allowing international trade in electricity and even greater gains from allowing international trade in both CO_2 emissions and electricity. The paper also shows that, in the absence of any CO_2 policy, opening up the Nordic market leads to reduction in CO_2 emissions from electricity generators in the region as Norwegian hydro plants are used more intensively to generate power for export.

Vennemo and Halseth (2000) investigate environmental regulation of Norwegian power projects that reduce emissions elsewhere in the Nordic region as a result of increased Norwegian power exports. The paper uses a conceptual model calibrated with empirical information about expected damages from pollution, placed in the context of restructuring and increased international trade in electricity. The “optimal” regulation when the nation has altruistic preferences, offered as the general case, differs substantially from purely domestic regulation. Given that market prices of electricity do not fully reflect damages from emissions in other countries, they find that energy conservation should be subsidized at a level equal to the current market price of electricity.

[64] Eikeland (1998).

United States

The policy debate in the United States over the potential environmental effects of restructuring emerged in 1995 when the Federal Energy Regulatory Commission (FERC) proposed an industry-wide rule to allow open access to the transmission grid (FERC 1996a). A primary purpose of the proposed rule, ultimately issued as FERC Order 888, was to require transmission-owning utilities to allow competing generators and wholesale customers to gain access to their grids under the same rates and terms the utility charges itself for transmission services. This rule facilitates expanded trading of electric power at the wholesale level. Several analyses have attempted to quantify the potential impacts of increased inter-regional power trading on emissions (Lee and Darani 1995; Center for Clean Air Policy 1996a, 1996b, and 1996c; Rosen et al. 1995; U.S. EIA 1996). One study looked at the potential impact of restructuring on emissions of NO_X and CO_2 and on subsequent changes in atmospheric concentrations of NO_X and nitrates at the regional level, and the ultimate effect on human health (Palmer and Burtraw 1997).

When wholesale open access was initially proposed, environmentalists were concerned that greater inter-utility trading of power could lead to increased emissions of NO_X and CO_2 from low-cost, older, and previously underutilized coal-fired generators in the Midwest that are exempt from certain environmental regulations. The expectation was that open transmission access would provide these plants with access to distant higher priced markets into which they could sell their excess generation. The resulting increases in NOx emissions were predicted to have adverse effects on air quality, particularly on concentrations of ozone, in areas downwind of these power plants. This issue was analyzed in the FERC's Environmental Impact Statement (EIS) of Order 888. The FERC EIS concluded that the effect of Order 888 on NOx emissions from the utility sector and on ozone concentrations in the East was likely to be very small (FERC 1996b). In 1999, FERC also did a smaller scale environmental assessment of the emissions effects of its rule on the creations of regional transmission organizations, Order 2000 (FERC 1999). This assessment looked at the effects of additional power trading at the wholesale level from regional consolidation of transmission control and of efficiency improvements resulting from that additional competition. The study found small increases in emissions of NOx and CO_2 associated with the new rules and a change in SO_2 emissions banking, where the bank is drawn down much faster in a world with more power trading than in the base case.

The two FERC analyses provide an incomplete picture of the potential environmental impacts of restructuring for at least two reasons. First, both studies were limited to the environmental impacts of wholesale competition only. Allowing retail competition expands the potential for inter-regional electricity trading by vastly expanding access to competitive power markets and provides greater economic pressure to enhance the efficiency of generator performance. Improvements in generator heat rates will reduce emissions per unit of electricity generated, but the impact on overall emissions is uncertain because changes in heat rates lower unit fuel costs, which could lead plants to run more. On the other hand, reductions in variable operation and maintenance costs could be expected to lead to greater utilization and associated increases in emissions.

Second, in both studies FERC failed to include any demand response to the lower electricity prices expected to result from wholesale competition. As a result, the studies probably under-predict the effect of wholesale competition on the quantity of electricity being generated to meet customer demand. Moving from wholesale to retail competition further increases the magnitude of the expected declines in retail prices and is expected to lead to greater access to time-of-day pricing of electricity (Bohi and Palmer 1996). These changes in price levels and price structure are likely to have impacts on the mix of generation technologies and the quantity of electricity generation, which could have associated impacts on emissions.

Considering these and other effects of moving from wholesale to retail competition, Burtraw et al. (1999) find restructuring is likely to reduce the overall average price of electricity by between 6% and 11% by the year 2003 with an associated 2% to 3% increase in demand. These changes lead to an annual increase in national NOx emissions of up to 4%. However, the impacts of restructuring on NO_X emissions are roughly 80% smaller under more stringent NO_X policies focused on the eastern states. In addition, they find that in the short run restructuring will lead to a modest increase in CO_2 emissions from the electricity sector of 1.3% to 2.9%. The results further suggest that NO_X policies will provide little in the way of CO_2 emissions reductions; however, the results are not considered representative of the long-run impacts of restructuring on CO_2 emissions.

A third study of the environmental effects of retail competition is U.S. Department of Energy Office of Policy’s analysis of the Clinton administration’s Comprehensive Electricity Competition Act (CECA) of 1999 (U.S. DOE, 1999). On net, restructuring as envisioned in the CECA is found to lead to 39 million metric tons (MMT) fewer carbon emissions in 2010 than would otherwise occur, a surprising result given the increase in demand that is expected under restructuring. The DOE result comes from adding together the positive effects on carbon emissions associated with: (1) increased demand for electricity, (2) incremental nuclear retirements and (3) increased availability of generating capacity and the negative effects on emissions associated with: (1) improvements in heat rates at existing fossil-fueled generators, (2) increased energy efficiency and (3) increased reliance on renewable energy.[65]

Palmer (1999) compares this breakdown with results from other studies that do not consider policies to promote conservation or renewables. She concludes that absent an explicit carbon policy such as a carbon tax, at least one of these two policy initiatives is necessary for restructuring to yield a net reduction in carbon emissions. Moreover, given the uncertainty surrounding the magnitude of the positive impacts of demand and other factors on carbon emissions, an RPS or energy efficiency policy by itself may not be sufficient to insure carbon emission reductions as a result of competition. Indeed, there is disagreement in the literature about the size of the likely or potential emission reductions associated with these two policies in a restructured environment. The DOE study also is more optimistic than most of the other studies about the overall effects of restructuring on carbon emissions in the absence of these two policy initiatives.[66] The differences in these results are attributable largely to different assumptions regarding demand elasticities, growth in transmission capability and extent of incremental nuclear retirements. Alternative findings in the literature with respect to key assumptions suggest that the DOE analysis could be understating the emissions impacts of restructuring in the absence of an RPS or DSM promoting policy by as much as 22 MMT of carbon in 2010. If this were the case, it would mean that both the RPS and the energy efficiency policy would be necessary for restructuring to reduce carbon emissions (Palmer, 1999). Also, the extent of emission reductions from a RPS will depend on the level of the standard and the same is true of a conservation policy.[67]

[65] The DOE analysis suggests that higher demand and incremental nuclear retirements contribute roughly 10 MMT and 11 MMT, respectively, of additional carbon in 2010 and greater availability of existing fossil plants leads to approximately 15 MMT of additional carbon emissions. On the other side of the equation are between 24 MMT and 25 MMT each of carbon emission reductions associated with heat rate improvements, energy efficiency and greater renewables penetration.

[66] The DOE analysis suggests that, absent renewables and DSM policy initiatives, restructuring would lead to roughly a 2 MMT increase in carbon emissions in 2010 and roughly a 4 MMT increase in carbon emissions in 2005 relative to the regulated reference case. This estimate is considerably below the findings of Burtraw et al. (1999), which suggests that by the year 2003 carbon emissions from national retail restructuring could increase by between 8.4 MMT and 16.2 MMT. Earlier studies found even greater increases.

[67] A recent comprehensive survey of state benefit programs under restructuring can be found at: "An Updated Status Report of Public Benefit Programs in an Evolving Electric Utility Industry," Martin Kushler, American Council for

8. Conclusion

To fully understand the environmental consequences of electricity restructuring, one would need to be able to predict what would have happened absent the move to more competitive electricity markets that is already well underway in many parts of the world. This task is exceedingly difficult, and becomes more so as time moves the world away from the counter-factual baseline.

The universal theme of restructuring of the electricity industry is the dismantling of the exclusive franchise. Technological changes in generation have helped eliminate the perception that generation is a natural monopoly, but other segments of the industry, including transmission and distribution services, remain natural monopolies. Marketing functions have also been opened up to competition.

Expectations vary with respect to what will happen under restructuring, but one expectation uniformly held is that prices are likely to fall for most customers. This expectation is likely to increase consumption, but the size of this effect depends on the size of price changes. In turn, this change depends on efficiency improvements, demand elasticities, and policies such as price caps and floors that have been put in place to protect customers and recovery of potentially stranded costs.

The environmental consequence of output changes will vary over time. In the short run, in many settings, expanded electricity consumption could lead to an expansion in the use of existing, relatively more polluting, coal facilities. But restructuring is also widely expected to strengthen incentives to improve production efficiency. In the longer run it could lead to investment in more efficient facilities, with an expansion in the use of relatively less-polluting natural gas facilities, but this investment will depend on the relative cost of fuels. In any event, electricity use is relatively clean and efficient compared with other forms of energy use and expanded electrification is likely to have many beneficial environmental and economic effects around the world.

For any given level of electricity demand and fixed set of environmental policies, the environmental effect of restructuring will depend on what happens to the mix of fuels and technologies used to generate electricity. Some countries (Sweden and Germany) are planning to

---

an Energy-Efficient Economy, http//www.aceee.org/briefs/mktabl.htm; updated December 17, 1999; accessed April 17, 2000.

phase out nuclear power. This action is not necessarily a function of restructuring, but it raises the need for substitute forms of energy. In the United States, some nuclear plants may retire early. But in the United States and the United Kingdom, most will continue to become more efficient in response to competitive pressures and utilization of existing nuclear plants continues to increase.

In the absence of specific policies to promote renewable technologies, the decline in price for electricity would be expected to undermine the opportunities for renewables because they remain relatively high-cost compared with fossil-based generation. In the minds of many, however, restructuring of the industry is contingent on policies to promote social goals such as the development of renewable technologies. One common proposal is a requirement that a minimum percentage of generation be achieved with renewables.

Perhaps the “knight in shining armor” for renewable technologies will be the diversification in energy services and marketing strategies. Some electricity marketers are expected to make a particular appeal to the preferences of consumers to choose environmentally friendly sources of electricity generation, potentially at a greater cost. The big unknown is the potency of consumer demand for green electricity, and especially their willingness to pay extra for renewable sources.

The diversification of services may affect the structure of demand in other ways. Ultimately, customers are expected to have the opportunity to obtain time-of-day pricing. As a consequence, demand may shift away from the peak period, which could be environmentally harmful because it is likely to lead to greater use of coal-fired baseload capacity. However, time-of-day pricing is likely to be coupled with other “intelligent” electronic monitors of electricity use that could decrease use in total.

One other important aspect of restructuring is how it will influence electricity-generating firm behavior with respect to existing and new environmental regulations, especially incentive-based approaches. A leading argument for the use of incentive-based regulation, of which the SO_2 emissions trading program in the United States is the prime example, is that it allows society to afford greater levels of environmental quality at less cost than other regulatory approaches. However, in traditionally regulated electricity markets or under public ownership, significant obstacles exist in the pursuit of least cost compliance. Competition is expected to enhance incentives for electricity generators to take advantage of emissions trading as a means of lowering costs.

While many issues are common to the literature, there is far from a consensus on most. As indicated, the one that yields the broadest consensus is the expectation that restructuring will yield decreases in price and increases in consumption. The environmental consequences of this change are uncertain, but notwithstanding the possibility that electricity consumption displaces the use of other fuels in end uses, most studies indicate some negative environmental effect from increased consumption, especially with respect to emissions of carbon. The effects of increased consumption and increased carbon emissions are probably linked inextricably. However, this tandem offers opportunity, because the efficiency gains that can be expected in delivering electricity services provide the means of affording additional environmental controls. Regulatory reform has arrived in the electricity sector, and it is expected to offer welfare gains that can be shared between economic and environmental objectives.

References

Amudsen, Eirik S.; Nesse, Arvid; Tjotta, Sigve. 1999. Deregulation of the Nordic Power Market and Environmental Policy. *Energy Economics* 21: 417–434.

Ando, Amy W.; Palmer, Karen L. 1998. Getting on the Map: The Political Economy of State-Level Electricity Restructuring. Resources for the Future Discussion Paper, May. 98–19.

Barnes, Douglas F.; Van Der Plas, Robert; Floor, Willem. 1997. Tackling the Rural Energy Problem in Developing Countries. *Finance & Development* June: 11–15.

Baron, David P. 1985. Noncooperative Regulation of a Nonlocalized Externality. *Rand Journal of Economics*. 16(4)(Winter): 553–68.

Baumol, William J.; Oates, Wallace E. 1988. *The Theory of Environmental Policy.* New York: Cambridge University Press, Second edition.

Bohi, Douglas R. 1994. Utilities and State Regulators Are Failing to Take Advantage of Emission Allowance Trading. *The Electricity Journal* 7(2): 20–27.

Bohi, Douglas R.; Burtraw, Dallas. 1992. Utility Investment Behavior and the Emission Trading Market. *Resources and Energy* 14: 129–153.

Bohi, Douglas; Palmer, Karen. 1996. The Efficiency of Wholesale Versus Retail Competition in Electricity. *The Electricity Journal* October: 12–20.

Boiteux, M. 1956. On the Management of Public Monopolies Subject to Budgetary Constraints. *Journal of Economic Theory* 3: 219–40.

Bouttes, J. P.; Lederer, P. 1990. *The Organization of Electricity Systems and the Behavior of Players in Europe and the U.S.* Electricité de France, General Economic Studies, (March 6). Draft document, presented at “Organizing and Regulating Electric Systems in the Nineties, A Euro-American Conference,” Paris, France, May 28–30, 1990.

Bovenberg, A. Lans; Goulder, Lawrence H. 2000. Neutralizing the Adverse Industry Impacts of CO_2 Abatement Policies: What Does it Cost? 2000. In *Behavioral and Distributional Effects of Environmental Policy*, edited by Carlo Carraro, Gilbert E. Metcalf. Chicago: University of Chicago Press, forthcoming.

Bradley, Robert L. Jr. 1997. Renewable Energy: Not Cheap, Not “Green”. Cato Institute Policy Analysis No. 280 (August 27).

Brennan, Timothy J. 1999. Do Lower Prices for Polluting Goods Make Environmental Externalities Worse? Resources for the Future Discussion Paper 99–40, (May).

Brennan, Timothy J.; et al. 1996. *A Shock to the System: Restructuring America's Electricity Industry*. Washington, DC: Resources for the Future.

Brower, Michael C.; Thomas, Stephen D.; Mitchell, Catherine M. 1997. Lessons from the British Restructuring Experience. *The Electricity Journal* 10(3).

Burchett, Shannon. 2000. A Continent United? Some Thoughts on Prospects for a Single Energy Market in Europe. *Public Utilities Fortnightly* 138:(2).

Burtraw, Dallas, 1999. Cost Savings, Market Performance and Economic Benefits of the U.S. Acid Rain Program. In *Pollution for Sale: Emissions Trading and Joint Implementation*, edited by Steve Sorrell, Jim Skea. Brookfield: Edward Elgar Publishing.

Burtraw, Dallas. 2000. Innovation Under the Tradable Sulphur Dioxide Emission Permits Program in the U.S. Electricity Sector. Washington DC: Resources for the Future Discussion Paper.

Burtraw, Dallas; Cannon, Matt. 2000. Heterogeneity in Costs and Second-Best Policies for Environmental Protection. Resources for the Future Discussion Paper 00–20, (March 15).

Burtraw, Dallas; Harrington, Winston; Freeman III, A. Myrick; Krupnick, Alan J. 1995. Optimal Adders for Environmental Damage by Public Utilities *Journal of Environmental Economics and Management* 29(2): S1–S19.

Burtraw, Dallas; Harrison, Kenneth W.; Turner, Paul. 1998. Improving Efficiency in Bilateral Emission Trading. *Environmental and Resource Economics* 11: 19–33.

Burtraw, Dallas; Krupnick, Alan J. 1997. The Social Costs of Electricity: Do the Numbers Add Up? *Resources and Energy* 18(4): 423–66.

Burtraw, Dallas; Mansur, Erin. 1999. The Environmental Effects of SO_2 Trading and Banking. *Environmental Science and Technology* 33(20): 3489–94.

Burtraw, Dallas; Palmer, Karen; Paul, Anthony. 1999. The Impact of Electricity Restructuring on NOx Emissions Affecting the Environment in Maryland. Final Report to the State of Maryland Department of Natural Resources Power Plant Research Program, (November 15). Washington DC: Resources for the Future.

Carlson, Curtis; Burtraw, Dallas; Maureen Cropper, Maureen; Palmer, Karen. 2000. SO_2 Control by Electric Utilities: What are the Gains from Trade? *Journal of Political Economy*, forthcoming.

Cavanagh, Ralph, 1999. Congress and Electric Industry Restructuring: Environmental Imperatives. *The Electricity Journal* 12(6): 11–20.

Center for Clean Air Policy. 1996a. Comments of the Center for Clean Air Policy on the Draft Environmental Impact Statement on Open Access for Transmission Service, February (Washington, DC, Center for Clean Air Policy).

Center for Clean Air Policy. 1996b. Emission Impacts of Increased Energy Exports from the American Electric Power (AEP) System, (Washington, DC, draft discussion paper) February 2.

Center for Clean Air Policy. 1996c. Emissions Impacts of Competition Further Analysis in Consideration of Putnam, Hayes and Bartlett, Inc.'s Critique, (Washington, DC, report), June 17.

Citizens for Pennsylvania's Future. 2000. PECO-Unicom Merger May Benefit the Environment. *Consumers and the Competitive Market After All.* Harrisburg PA. 2(7).

Clemmer, Steven L.; Nogee, Alan; Brower, Michael C. 1999. A Powerful Opportunity: Making Renewable Electricity the Standard. Cambridge, MA: Union of Concerned Scientists, (January).

Commission of the European Communities, 1991. Energy in Europe: Energy Policies and Trends in the European Community. Directorate General for Energy, Number 18, (December).

Coudert Brothers, 1992. The Environmental Policy of the European Community. Brussels (August).

Devine, Warren D., Jr. 1982. An Historical Perspective on the Value of Electricity in American Manufacturing. Oak Ridge Associated Universities, Institute for Energy Analysis, Research Memorandum ORAU/IEA-82–8(M), (September).

Dooley, James J.; Runci, P. J. 2000. Developing Nations, Energy R&D, and the Provision of a Planetary Public Good: A Long-Term Strategy for Addressing Climate Change. *The Journal of Environment and Development* 9(3): 216–40.

Eikeland, Per Ove. 1998. Electricity Market Liberalisation and Environmental Performance: Norway and the U.K. *Energy Policy* 26(12).

Ellerman, A. Denny. 1998. Note on the Seemingly Indefinite Extension of Power Plant Lives: A Panel Contribution. *The Energy Journal* 19: 129–32.

Ellerman, A. Denny; Joskow, P. L.; Schmalensee, R.; Montero, J. P.; E. M. Bailey. 2000. *Markets for Clear Air: The U.S. Acid Rain Program.*Cambridge, U.K.: Cambridge University Press.

Energy Modeling Forum. 1998. *A Competitive Electricity Industry* EMF Report 15, Volume 1 (April).

European Commission. 1995. *Externalities of Energy: ExternE Project. For the Directorate General XII.* Prepared by Metroeconomica, CEPN, IER, Eyre Energy-Environment, ETSU, Ecole des Mines.

European Commission. 2000a. Implementation of Electricity Directive 96/92 by the Member States. Available at: http://europa.eu.int/en/comm/dg17/elec/implgrid.htm (April 17).

European Commission. 2000b. Guide to the Electricity Directive 96/92. Available at: http://europa.eu.int/en/comm/dg17/elec/memor.htm (April 17).

Farhar, Barbara C. 1999. Willingness to Pay for Electricity from Renewable Resources: A Review of Utility Market Research, National Renewable Energy Laboratory, NREL/TP.550.26148 (July).

Ferguson, Rich. 1999. Electric Industry Restructuring and Environmental Stewardship, *The Electricity Journal* 12(6): 21–31.

Fischer, Carolyn. 1999a. Rebating Environmental Policy Revenues: Output-Based Allocations and Tradable Performance Standards. Resources for the Future Working Paper.

Fischer, Carolyn. 1999b. Output-Based Rebating: Imperfect Competition and Imperfect Participation, Resources for the Future Working Paper.

Fischer, Carolyn; Parry, Ian W. H.; Pizer, William A. 1998. Instrument Choice for Environmental Protection When Technological Innovation is Endogenous. Resources for the Future Discussion Paper 99–04, (October).

Folmer, Henk; Howe, Charles W. 1991. Environmental Problems and Policy in the Single European Market. *Environmental and Resource Economics* 1: 17–41.

Forsund, Finn R.; Naevdal, Eric. 1994. Trading Sulfur Emissions in Europe. In *Economic Instruments for Air Pollution Control*, edited by Ger Klaassen, Finn R. Forsund. Boston: Kluwer Academic Publishers.

Fox-Penner, Peter. 1997. *Electric Utility Restructuring: A Guide to the Competitive Era.* Vienna, VA: Public Utility Reports.

Fullerton, Don; McDermott, Shaun P.; Caulkins, Jonathan P. 1997. Sulfur Dioxide Compliance of a Regulated Utility. *Journal of Environmental Economics and Management* 34(September): 32–53.

Glaser, Peter S. 1999. Green Power Marketing Claims: A Free Rider on Conventional Power? *The Electricity Journal* 12(6): 32–40.

Goldstein, Larry; Mortensen, John; Trickett, David. 1999. Grid-Connected Renewable-Electric Policies in the European Union. National Renewable Energy Laboratory Topical Issues Brief, NREL/TP.620.26247 (May).

Goulder, Lawrence H.; Parry, Ian W.; Burtraw, Dallas. 1997. Revenue-Raising Versus Other Approaches to Environmental Protection: The Critical Significance of Preexisting Tax Distortions. *Rand Journal of Economics* 28: 708–31.

Goulder, Lawrence H.; Parry, Ian W.; Williams III, Roberton C.; Burtraw, Dallas. 1999. The Cost-Effectiveness of Alternative Instruments for Environmental Protection in a Second-Best Setting. *Journal of Public Economics* 72(3) (June): 329–60.

Helm, Dieter; McGowan, Francis. 1989. Electricity Supply in Europe: Lessons for the U.K. In *The Market for Energy*, edited by D. R. Helm et al. Oxford: Clarendon Press.

Heydlauff, Dale E. 1999. Electric Industry Competition and the Environment. *The Electricity Journal* 12: 6 41–49.

Hirsch, Richard F.; Serchuck, Adam H. 1999. Power Switch. *Environment* 41(7): 4–9; 32–39.

Hoglund, Lena. 2000. Essays on Environmental Regulation with Applications to Sweden, Ph.D. Dissertation, Goteborg.

Hunt, Sally; Sepetys, Kristina. 1997. Price, Now Less Than Ever. *Public Utilities Fortnightly* October, p. 62.

Jonassen, Torfinn. 1998. Opening the Power Market to End-Users in Norway 1991–1999. Unclassified Report to the Norwegian Water Resources and Energy Administration (December).

Joskow, Paul L. 1996. Comment on Power Struggles: Explaining Deregulatory Reforms in Electricity Markets. In *Brookings Papers on Economic Activity*: *Microeconomics*. pp. 251–64.

Joskow, Paul L. 2000. Why Do We Need Electricity Retailers? Or Can You Get It Cheaper Wholesale? MIT Center for Energy and Environmental Policy Research, Working Paper 2000–001.

Joskow, Paul L.; Schmalensee, Richard. 1983. *Markets for Power: An Analysis of Electric Utility Deregulation*. Cambridge, MA: The MIT Press.

Kirshner, Daniel; Barkovich, Barbara; Treleven, Kethy; Walther, Robin. 1997. A Cost Effective Renewables Policy Can Advance the Transition to Competition. *The Electricity Journal* (January/February): 54–61.

Klaassen, Ger. 1994. Trading Sulphur Emission Permits in Europe Using an Exchange Rate. In *International Environmental Economics: Theories, Models and Applications to Climate Change, International Trade and Acidification*, edited by Ekko C. van Ierland. Amsterdam: Elsevier.

Klaassen, Ger. 1996. *Acid Rain and Environmental Degradation,* Brookfield: Edward Elgar Publishing.

Kozloff, Keith, 1998. Electricity Sector Reform in Developing Countries: Implications for Renewable Energy, Renewable Energy Policy Project (REPP) Research Report, No. 2, (April).

Kumbhakar, Subal C.; Hjalmarsson, Lennart. 1998. Relative Performance of Public and Private Ownership Under Yardstick Competition: Electricity Retail Distribution. *European Economic Review* 42: 97–122.

Lee, Henry; Darani, Negeen. 1995. Electricity Restructuring and the Environment. CSIA Discussion Paper 95–13, Kennedy School of Government, Harvard University, (December).

Lee, Henry; Darani, Negeen. 1996. Electricity Restructuring and the Environment. *The Electricity Journal* December.

Lee, Russell; et al. 1995. *Estimating Externalities of Electric Fuel Cycles.* 7 vols. Prepared by Oak Ridge National Laboratory and Resources for the Future, Washington DC: McGraw-Hill/Utility Data Institute.

Lents, James M. 2000. The RECLAIM Program at Three Years. In *Emissions Trading*, edited by Richard F. Kosobud. New York: John Wiley & Sons, Inc.

Lile, Ron; Burtraw, Dallas. 1998. State-Level Policies and Regulatory Guidance for Compliance in the Early Years of the SO_2 Emission Allowance Trading Program. Resources for the Future Discussion Paper 98–35, (May).

McVeigh, Jim; Burtraw, Dallas; Darmstadter, Joel; Palmer, Karen. 2000. Winner, Loser, or Innocent Victim: Has Renewable Energy Performed As Expected? *Solar Energy* 68(3): 237–55.

Mills, McCarthy; et al. 1992. Sustainable Development and Cheap Electricity. Ministry of Commerce of New Zealand, 2000. Ministerial Inquiry into the Electricity Industry Issues Paper (February).

Moore, Curtis; Ihle, Jack. 1999. Renewable Energy Policy Outside the United States. Renewable Energy Policy Project (REPP) Issue Brief, No. 14, (October).

Murray, Christopher J. L.; Lopez, Alan D. 1996. *The Global Burden of Disease.* World Health Organization, Published by the Harvard School of Public Health, Distributed by Harvard University Press.

Nordhaus, William D. 1997. *The Swedish Nuclear Dilemma: Energy and the Environment*. Washington, DC: Resources for the Future.

Oates, Wallace E.; Strassmann, D. L. 1984. Effluent Fees and Market Structure. *Journal of Public Economics* 24(June): 29–46.

Palmer, Karen. 1997. Electricity Restructuring: Environmental Impacts. *Forum for Applied Research and Public Policy* 12(3): 28–33.

Palmer, Karen. 1999. Electricity Restructuring: Shortcut or Detour on the Road to Achieving Greenhouse Gas Reductions? Resources For the Future, Climate Issues Brief No. 18, (July).

Palmer, Karen; Burtraw, Dallas. 1997. Electricity Restructuring and Regional Air Pollution. *Resource and Energy Economics* 19: 139–74.

Palmer, Karen; Burtraw, Dallas; Paul, Anthony. 1998. The Welfare Impacts of Restructuring and Environmental Regulatory Reform in the Electric Power Sector, Resources for the Future (October).

Parry, Ian W. H.; Williams, Roberton C. 1999. A Second-Best Evaluation of Eight Policy Instruments to Reduce Carbon Emissions. *Resource and Energy Economics* 21: 347–73.

Rader, Nancy. 1998. *Green Buyers Beware: A Critical Review of "Green electricity" Products*. Washington DC: Public Citizen.

Ramsey, F. 1927. A Contribution to the Theory of Taxation. *Economic Journal* 37: 47–61.

Roberts, Marc J.; Bluhm, Jeremy S. 1981. *The Choices of Power.* Cambridge, MA: Harvard University Press.

Robinson, Joan 1933. *The Economics of Imperfect Competition*. London: Macmillan.

Rose, Kenneth. 1997. Implementing an Emissions Trading Program in an Economically Regulated Industry: Lessons from the SO_2 Trading Program. In *Market Based Approaches to Environmental Policy: Regulatory Innovations to the Fore*, edited by Richard F. Kosobud, Jennifer M. Zimmerman. New York: Van Nostrand Reinhold.

Rosen, Richard; et al. 1995. *Promoting Environmental Quality in a Restructured Electric Industry*. Prepared for the National Association of Regulatory Utility Commissioners (Boston Tellus Institute), December 15.

Rothwell, G. 1998. Air Pollution Fees and the Risk of Early Retirement at U.S. Nuclear Power Plants. Department of Economics, Stanford University, mimeo, (October).

Royal Institute of International Affairs/Science Policy Research Unit. 1989. *A Single European Market in Energy.* London: Energy and Environmental Programme.

Schmalensee, Richard; Joskow, Paul L.; Ellerman, A. Denny; Montero, Juan Pablo; Bailey, Elizabeth M. 1998. An Interim Evaluation of Sulfur Dioxide Emissions Trading. *Journal of Economic Perspectives* 12(3).

Schurr, Sam H. 1984. Energy Use, Technological Change, and Productive Efficiency, *Annual Review of Energy* Vol. 9.

Smeloff, Ed; Asmus, Peter. 1997. *Reinventing Electric Utilities.* Washington, DC: Island Press.

Stavins, Robert N. 1998. What Can We Learn from the Grand Policy Experiment? Lessons from SO_2 Allowance Trading. *Journal of Economic Perspectives* 12(3)

Sterner, Thomas; Hoglund, Lena. 2000. Output-Based Refunding of Emission Payments: Theory, Distribution of Costs, and International Experience. Washington, DC: Resources for the Future Discussion Paper 00–29.

Swift, Byron. 2000. Allowance Trading and SO_2 Hot Spots—Good News From the Acid Rain Program. *Environmental Reporter* 31(19): 954–59.

Tietenberg, Tom H. 1985. *Emissions Trading: An Exercise in Reforming Pollution Policy.* Washington DC: Resources for the Future.

United Kingdom Office of Gas and Electricity Markets (OFGEM). 2000. The Government's Review of Energy Sources for Power Generation: OFGEM's advice to the Government, (April).

U.S. Department of Energy. 1999. *Supporting Analysis for the Comprehensive Electricity Competition Act.* Office of Economic, Electricity and Natural Gas Analysis, Office of Policy and International Affairs, (May).

U.S. Energy Information Administration (EIA). 1996. An Analysis of FERC's Final Environmental Impact Statement for Electricity Open Access and Recovery of Stranded Cost. Prepared for Senator James Jeffords, Vice Chair, Subcommittee on Energy Production and Regulation, Senate Energy and Natural Resources Committee, U.S. Senate, (September).

U.S. Energy Information Administration. 1997a. Electricity Reform Abroad and U.S. Investment, (September).

U.S. Energy Information Administration. 1997b. *Electricity Prices in a Competitive Environment: Marginal Cost Pricing of Generation Services and Financial Status of Electric Utilities*. DOE/AIE –0614 (Washington, DC, August).

U.S. Energy Information Administration. 2000. International Energy Outlook—2000, (March).

U.S. Federal Energy Regulatory Commission (FERC). 1996a. Promoting Wholesale Competition Through Open Access Non-Discriminatory Transmission Services by Public Utilities (RM95-8-000) and Recovery of Stranded Costs by Public Utilities and Transmitting Utilities (RM94-7-001). FERC/EIS-0096 Washington, DC, (April).

U.S. Federal Energy Regulatory Commission (FERC). 1996b. Environmental Impact Statement, Promoting Wholesale Competition through Open Access Non-Discriminatory Transmission Services by Public Utilities and Recovery of Stranded Cost by Public Utilities and Transmitting Utilities, (April).

U.S. Federal Energy Regulatory Commission (FERC). 1999. *Regional Transmission Organizations, Order No. 2000.* Washington DC, (December).

van Egteren, Henry, 1992. State versus Federal Environmental Regulation in a Non-cooperative Monopoly Screening Model. *Journal of Environmental Economics and Management* 23(2): 161–78.

Vennemo, Haakon; Halseth, Arve. 2000. Environmental Regulation of a Power Investment in an International Narket. *Resource and Energy Economics* (forthcoming).

White, Matthew. 1996. Power Struggles: Explaining Deregulatory Reforms in Electricity Markets. In *Brookings Papers on Economic Activity: Microeconomics*. pp. 201–50.

Wilson, J.Q.; Rachel, P. 1977. Can the Government Regulate Itself? *The Public Interest* (Winter): 3–14.

Winebrake, James J.; Farrell, Alexander E.; Bernstein, Mark A. 1995. The Clean Air Act's Sulfur Dioxide Emissions Market: Estimating the Costs of Regulatory and Legislative Intervention. *Resource and Energy Economics* 17(3): 239–60.

Wiser, Ryan; Fang, Jeff; Porter, Kevin; Houston, Ashley. 1999. Green Power Marketing in Retail Competition: An Early Assessment. National Renewable Energy Laboratory NREL/TP.620.25939 (February).

Appendix – Electricity Restructuring Around the World

This appendix provides details about the path of restructuring in several countries and regions of the world outside the U.S. borders. For more information on how electricity restructuring is unfolding in the United States, see the U.S. Energy Information Administration Web site at www.eia.doe.gov/cneaf/electricity/page/restructure.html.

United Kingdom

Discussion of restructuring began in the United Kingdom, where change was dramatic and the first to be achieved. Prior to privatization and restructuring, the British electricity industry consisted almost entirely of a vertically integrated, nationalized monopoly. Reform began under the Electricity Act of 1983, which granted independent power producers (IPPs) open access to the transmission grid and required that the national electricity agency, the Central Electricity Generation Board (CEGB), purchase electricity produced by IPPs.

The next big step towards comprehensive restructuring came with the Electricity Act of 1989, which provided a step-wise process with the final goal of a completely privatized, competitive retail electricity market by 1998. The first step in this process was the 1990 breakup of CEGB into four entities: two generation companies (National Power and Powergen), a transmission company (later the National Grid Company), and the distribution system, which consisted of 12 regional boards (RECs).[68] The 12 RECs were each to consist of a distribution entity and a marketing entity to handle retail sales. In 1990, the government auctioned off each of the RECs, and the two generation companies were sold in 1991. Subsequently, in 1993, the generation companies were asked to sell off roughly 15% of their combined generating capacity

---

[68] To maintain reliability under the restructured system, all generators with capacity greater than 100 MW were originally required to sell their electricity through the power pool run by the National Grid Company (NGC). This requisite has since been changed, and the power pool has been eliminated in favor of a series of bilateral bidding markets operating over various periods of time. These markets operate like commodity futures markets, where the generators agree to sell a certain amount of electricity at a set price up to several years in advance to the RECs and other second-tier companies, which in turn sell the electricity to end-use consumers. To help balance demand and supply in the short term, a second bilateral market is set up to operate between 4 and 24 hours before real time, and a third balancing market operates between 4 hours ahead and real time where they contract with generators to balance supply and demand. See Green (1999) for the details of these changes.

to reduce the market power held by the two companies. More recently, this practice has continued, and now seven major generation companies exist in the United Kingdom.[69]

The transmission and distribution segments of the industry are constrained in what prices they can charge by a system called the RPI-X. This system, a price cap based on the retail price index (RPI), allows firms to improve profits by outstripping projected productivity gains (the X-factor in RPI-X). The system is reviewed every few years to revise the benchmark prices and the productivity factor.

Since 1990, the marketing segment has gradually opened up, beginning with only the largest industrial consumers, and, since April 1998, has expanded to include all residential consumers as well. This change means that all electricity consumers are now free to buy their electricity from any marketing company. The RECs and other licensed suppliers (called "second-tier" companies) set their own prices, and initial estimates indicate that real end-use electricity prices have declined modestly since the onset of competition.[70] However, there is considerable controversy regarding whether residential consumers have shared adequately in the cost savings that have been realized in the industry. The largest critique of the British system is that too much market power still remains in the hands of the two biggest generation companies despite the fact that the market is open to everyone. As of 1997, the pool price (the equilibrium price in the spot market run by NGC) had been set by one of the above mentioned generating companies about 85% of the time.[71] This result has been tempered recently by changes in the pool structure and has required sales of generating capacity by PowerGen and National Power.

The most interesting effect of restructuring in the United Kingdom has been on the choice of fuel used for generation, which has direct and immediate environmental implications, which we discuss below.

European Union

The changes in the United Kingdom set the stage for policies that were subsequently adopted for the European Union. Across Europe, the variety of industry structures is even greater

---

[69] United Kingdom Office of Gas and Electricity Markets, *The Government's Review of Energy Sources for Power Generation*, April 2000.

[70] United Kingdom Department of Trade and Industry, *U.K. Energy Report 1999*.

[71] Brower et al. (1997).

than one finds across the United States. Some national electricity systems in Europe have sustained as many as 1,000 utilities, whereas others have only one or two. Recently privatized generation companies in Great Britain compare with healthy state-owned enterprises in France and Italy, while Germany retains the same decentralized, privately owned systems established before World War II. Sweden and Denmark exhibit a mixed ownership system and yardstick competition, at least indirectly, between private and state-owned enterprises.

Traditionally, regulation has rested at a variety of levels as well. Most often a national ministry oversees rate setting, though a different ministry may oversee investments and planning. Sometimes rates are set by industry and approved by the government, sometimes the converse holds.

Historically, this variety of models has led to tremendous disparity in price setting and access to markets. Beginning in the early 1970s and for more than a decade, governments in Europe have played an increasingly important role in the decision-making process of electric power-sector participants.[72] This involvement occurred in response to the oil-price shocks; the use of energy as a tool for macroeconomic policy; and policies aimed at supporting specific sectors (such as coal in France, Spain, England, and Germany; gas in the Netherlands; and nuclear in France).

In the late 1980s, the promotion of national policies and subsidies to specific energy industries became widely recognized as an obstacle to European integration.[73] This view has led to a variety of directives aimed at promoting transparency in electricity pricing and opening markets and transmission lines to competition in generation. In 1987 the Single European Act (SEA) addressed energy in the context of a free movement of services and the elimination of subsidies within member states and, incidentally, placed environmental protection on an equal footing with economic growth.[74]

---

[72]Bouttes and Lederer 1990; Helm and McGowan 1989.

[73] The elimination of subsidies is central to the larger goal of unification of European markets. Subsidies have played a particularly important role in European energy markets. For instance, according to Commissioner António Cardoso e Cunha, aid to the coal industry from 1965 to the late 1980s may have cost European tax payers more than 70 billion Euro. (Commission of the European Communities 1991a; Royal Institute of International Affairs/Science Policy Research Unit 1989.)

[74] Amended Articles 2 and 3, respectively, of the Treaty of Rome (1957). The Treaty on Political Union signed in 1991 strengthens consideration of the environment. A goal of the "polluter pays" principle is to discourage member states of the EC from granting subsidies to polluters (Coudert Brothers 1992, p. 8.).

The EU Directive specifying common rules for a single energy market entered into force in February 1997.[75] This directive provides a template for all EU countries to follow as they deregulate or liberalize their energy markets with the final goal of creating a single Pan-European market for electricity. The directive does not force the complete breakup of vertically integrated utilities. However, it does call for the unbundling of accounts and nondiscriminatory pricing in the use of transmission and distribution assets, which is seen as necessary to the promotion of competition. Some countries (for example, Spain, Sweden, Finland) have gone further than this and have called for the complete separation of these companies into distinct legal entities, with further limitation on the holding of common stock.[76]

Member states are offered two models for planning to meet generation requirements: a centralized model and a decentralized model. Under the tendering procedure, a government-appointed planner provides an inventory of needed future capacity to meet demand projections and contracts with suppliers to build this capacity. Also, certain categories of generators (for example, IPPs) always are allowed to build new capacity, even if this capacity exceeds projected demand. Under the alternative model known as the authorization system, any party may apply to build new capacity and, provided that the applicant meets certain restrictions, her application should be accepted regardless of projected demand. Almost every member state has opted for an authorization system to build additional capacity. Many countries include in this procedure special preferences for renewable or otherwise environmentally friendly plants (for example, Austria, Belgium). Some countries (for example, Greece, France) will use an authorization procedure for most plants but have made allowances for a tendering procedure when the authorization procedure fails to meet stated goals on capacity growth.

Member states are required to designate a transmission system operator (TSO), which would be responsible for dispatching generation within the country/region. Its dispatching rules must be nondiscriminatory and should apply economic merit order dispatch, which appears to be in practice. Many member states (for example, Austria, Denmark, Italy, Germany) have taken advantage of the allowance for the TSO to give priority access to environmentally friendly technologies and, to a limited extent, may also give priority to generators using indigenous fuels.

---

[75] Legislated by EU Directive 96/92/EC, and adopted by the Council of Ministers in December 1996.

[76] Information on the directive and on member states' efforts to comply with the directive come from European Commission (2000a) and European Commission (2000b). For a shorter summary of the directive see Burchett (2000).

With regard to distribution, the distributor need not be divested from the generation companies, but it must be nondiscriminatory in its practices. The member states may obligate distribution companies to supply electricity to local customers at a fixed rate via a public service obligation (PSO), which must be approved by the appropriate EU agency. Most member states seem to have in place a system of many local distribution companies, mostly run by municipalities. On the whole, the states have defined the rights of consumers to include the obligation of the local distributor to make electricity available to all consumers at a reasonable price. In some cases (for example, Sweden) they must continue to provide power to their formerly captive customers at a fixed price if that consumer opts out of using a third-party supplier.

Access by third parties to the transmission and distribution networks can be determined under either "negotiated" or "regulated" procedures, and the difference hinges on how tariffs are set. Under negotiated procedures, prices are negotiated subject to the rules of nondiscrimination on the part of the operator. The operator has a right to refuse access if capacity is full and the operator is not obligated to build capacity to meet demand out of the service territory. Under regulated procedures, prices are set to recover costs and access is obligatory. Most EU member states have opted for a system of regulated third-party access (TPA), with tariffs set or at least regulated by the government, maintaining the distribution of power as a regulated monopoly. In most cases, this monopoly can deny service to third parties only because of capacity limitation. However, in many places (for example, Ireland, Spain) third parties that were refused access may build, subject to regulation, direct lines to facilitate a trade with a consumer.

One of the most interesting issues in the transition to open markets is timing, because first movers may encounter important advantages or disadvantages. The European directive calls for a three-stage transition, defined by the share of all electricity customers that must be eligible to choose their supplier. By February of 2003, at least one-third of all electricity consumers in Europe will have the right to choose their supplier. To prevent suppliers in one country from being adversely affected by an early move to competition, arrangements have been made to ensure reciprocity. In this way, Country A may prevent a company from Country B from selling to a customer in A, who, under the law of B, would not be eligible to choose suppliers.

On the whole, the member states of the EU have met the deadlines set out by the EU in the electricity directive. Nations in Europe have adopted a variety of strategies to meet these obligations. The first mover in Europe, indeed the first mover anywhere, was the United Kingdom, whose initiatives predated the EU directive by nearly a decade. Other members have followed individual schedules for opening the market. Germany has proceeded most quickly, opening its market immediately to all customers as described below. Sweden and Finland have also proceeded very quickly and currently have completely open markets. Other countries have taken a more intermediate approach while still committing to full competition eventually (for example, Spain, Denmark, Netherlands). Other countries have set only intermediate time lines and appear to be dragging their feet (for example, Greece, Ireland, France, Luxembourg). Those countries that did not open their markets right away usually set a declining threshold of annual consumption, above which one was eligible for competition.

Germany

German law deserves special attention because it goes the furthest to date in establishing unregulated private markets. Further, though Germany was not the first country to restructure its electricity markets, it probably did it in the least amount of time.[77]

Before restructuring, the German electricity market was fractured under law that gave exclusive franchises to the local utilities and made most mergers of electric companies illegal. The nation had more than 950 local electric distribution utilities (many of which were owned and operated by municipal governments), roughly 50 regional electric systems that served the smaller local utilities, and 8 larger integrated companies. These eight integrated companies owned roughly 75% of the transmission grid. Before the liberalization law was enacted and brought into force in April of 1998, Germans were paying electricity rates roughly twice those in the United States. Since restructuring, some prices have dropped by as much as 39%. The new competition for electricity sales has also sparked a wave of mergers among German companies vying to cut costs in this era of falling prices.

The defining characteristic of German reform is its lack of a regulatory structure; most of the details were left up to private decisionmakers. No new federal regulatory bureaucracy or no single entity is responsible for running an electricity spot market or dispatching power plants. The elimination of local franchises gave any entity the right to sell electricity in any part of the country. Unlike many countries but similar to several U.S. states, this condition allowed all classes of customers simultaneously to choose their power supplier, instead of gradually phasing in competition by first allowing large industrial users the choice of provider and then gradually allowing commercial and finally residential consumers to choose. Local distributors have the

[77] See Terzic et al. (2000) and European Commission (2000a) for details on German restructuring.

option of applying for a single-buyer exception, which would allow them to act as the sole consumer in their region until 2005. This scenario prevents individual consumers from having their choice of suppliers, though only a handful of distributors have been granted this exception through 1999.

The German law does not require the divestiture of transmission assets by generation companies. However, the law does call for unbundling, which forces vertically integrated entities to manage their transmission, distribution, and generation assets as if they were separate. Vertically integrated companies also are required to charge to themselves the same prices they charge others for transmission.

In lieu of regulation, the German law has opted for the negotiated model for TPA to transmission and distribution under the EU guidelines. This model involves a bilateral negotiating process between local distributors and owners of transmission capacity. The law did call for an informal agreement that would allow for some standardization in transmission pricing.

The one exception to the wholesale privatization involves renewable resources. All distribution/retail companies (the operators of the distribution systems) are required to purchase renewable power at a guaranteed minimum price if such power is available. The law for East German Lignite also has some protections. The lignite producers are not guaranteed a place in the dispatch, but network operators may restrict transmission access to nonlignite suppliers until 2003.

Norway

Norway’s electric system is unique in that it is almost entirely supplied (99%) by hydroelectric power. Prior to restructuring, the industry was dominated by 200 municipally owned utilities with exclusive franchises, similar to Germany’s historic structure. These municipal companies filled roles as both distributors and generators, accounting for 55% of total generation. An additional 30% came from Statkraft, the nationally owned generation and transmission company. When restructuring began in 1991, Norway broke from the British model and did not privatize its utilities.[78]

[78] See Moen and Hamrin (1996), Jonassen (1998), and Hjalmarsson (1996) for information on the Norwegian system.

The first step in Norway's restructuring was the opening up of all transmission and distribution lines. The owners of these lines maintained monopoly on distribution but no longer maintained a monopoly in generation. End-use customers could choose their supplier and that supplier could send its electricity over the lines of any distributor. Transmission and distribution continue to be regulated as natural monopolies, with prices controlled by cost-of-service regulation with government-mandated revenue allowances.

Reform of the generation side of the electricity market was gradual. At first, end-users that desired to use a supplier other than the former monopoly supplier were charged a fee. Also, any supplier who sold electricity in a region other than its own was charged a significant fee. These conditions prevented large-scale market choice. These fees were reduced in 1994, and eliminated in 1997. Since then, approximately 5% of end-use consumers have switched from their previous supplier. Since 1996, Norwegians have also been able to choose suppliers from Sweden. Plans are in the works for this choice to soon include suppliers in other Northern European countries, including the United Kingdom.

The Norwegian government is confident that its system has been very successful in reducing the profit margins of suppliers (municipal, national, and privately owned) through price reductions. Because of the weather-dependent nature of hydroelectric power, price reductions in Norway are difficult to identify; but in comparing the prices faced by Norwegian consumers to those faced by their neighbors in Sweden, we can see that Norwegian prices are lower by as much as 40%.[79]

Alberta

The Canadian province of Alberta began restructuring its electricity sector in 1995 with the passage of the Electric Utilities Act, which deregulated the wholesale generation market and established the Power Pool of Alberta, in operation since January 1996. Under this initial act, control of utility-owned transmission lines was transferred to the transmission administrator, an independent entity responsible for ensuring open and nondiscriminatory access to the transmission grid. All energy transactions were required to go through the Power Pool.

[79] Jonassen (1998).

In 1998, the government of Alberta adopted the Electric Utilities Amendment Act, which reformed the operation of the generation sector and the Power Pool and promised full customer choice for electricity supply by January 1, 2001.[80] The 1995 act encouraged entry into the market by independent generators, but utility-owned generation still dominates the generation markets. Together, three utilities, consisting of two IOUs and one large municipal, supply 90% of the grid-connected generation in Alberta. Seventy-five percent of the utility-owned generating capacity is from coal-fired plants with the remaining split roughly 60 to 40 between gas and hydro. The 1998 act also allowed for bilateral contracts between independent power producers and electricity customers.

To help make generation markets more competitive, the 1998 act developed a creative alternative to divestiture for deconcentrating generation markets. The act required the existing generating utilities to enter into Power Purchase Arrangements with independent marketers who will in turn become the sellers of power into the Alberta Power Pool. Under the terms of the act, the existing utilities are required to auction off 20-year contracts for the right to sell the generation from each individual utility-owned generating units that existed prior to 1996 into the Alberta Power Pool. Each marketer faces a cap on the amount of capacity it can hold under contract, set in a way that will increase substantially the number of sellers participating in the Power Pool. Proceeds from these sales will be held by the Power Pool and windfall profits will be distributed to utility customers through electricity retailers, while provisions will be made for utilities to recover the costs of investments made under regulation not covered by the proceeds from these sales.

Argentina

The motivation for restructuring the Argentinean electricity industry was to introduce competition and also to privatize ownership. As in almost every country, the first step in restructuring was the separation of the functions of generation, transmission, and distribution. In the process of privatization, the government created more than 30 different generation companies. The remaining nonprivatized generation companies consist of three nuclear generators and two jointly held (with Paraguay and Uruguay) hydroelectric facilities. The government created six transmission companies, almost all of which were privatized.

---

[80] For more details, see Alberta Resource Development (2000).

Distribution continues to be handled mostly by municipal utilities, and three private companies serve the greater Buenos Aires area. The transmission and distribution companies are regulated tightly by the government in a manner similar to the RPI-X scheme used in the United Kingdom. In some cases, these companies are not privately owned, but instead the government sold long-term concessions.[81]

The government also created a wholesale market similar to that of the old U.K. power pool. The market sets two prices: a three-month seasonal price and a spot price set at marginal cost. Dispatch is also handled by the market and is done with merit-order dispatch. Although the wholesale spot market is growing, most electricity sales are conducted through bilateral contracts.

The restructured market has achieved many of the goals set at the outset. As of 1997, prices had declined by approximately 40% compared with their preprivatization levels.[82] Furthermore, productivity had notably increased along with reliability and sector investment. Almost all of the privatized companies are controlled by foreign companies. The few that were purchased within Argentina are mostly small units used for intra-corporate needs.

Central America

The situation in Central America is similar to that of the European Union. The governments of the six Central American countries have signed an agreement that calls for the complete integration of the six national markets into one regional market. Currently, some trading is already going on in Central America, mostly in two smaller regional markets. By 2001 these two smaller markets (consisting of two and four countries, respectively) will be connected. In 2004 a larger integrated network (SIEPAC) is expected to be fully established.[83]

Of the six countries, four already have competitive markets in place. The other two (Honduras and Costa Rica) are developing systems similar to those in the other four countries. In the short-run, these six open markets will operate in a way similar to the single-buyer systems in other countries, where the national network operators will be the agents of trade in the regional

[81] See U.S. Energy Information Administration (1997a) for details.

[82] U.S. Energy Information Administration (1997a).

[83] See Zapala (1999) for a complete description of the Central American market.

market. It is expected that eventually even these walls will be broken down and any market agent will be eligible to trade on the regional level.

Much like other countries around the world, the Central American market will be composed of a short-term spot-market in conjunction with longer-term contract markets. All generators will be guaranteed open access to transmission networks with transmission prices regulated by a regional board in conjunction with the national governments. Many of the details of the arrangement have not yet been finalized, however, it appears that all the building blocks of an effective regional market are falling into place.

New Zealand

New Zealand's electricity reform movement has been similar in many ways to Germany's. It was done relatively quickly with very little regulatory oversight. Electricity in New Zealand is generated mostly by hydro (60%) and supplemented with fossil fuels (36%) and other renewables (4%).[84]

Electricity reform began in New Zealand in 1987, with the passage of the Commerce Act that prohibited monopoly business practices. This act eliminated the monopoly franchises of the 60 Electricity Supply Authorities (ESAs), which were incorporated into tax-paying corporations and given the opportunity to compete. Despite this corporatization, the ESAs generally did not change ownership. The act also enshrined the transmission and distribution sectors of the industry as natural monopolies with regulated prices. The Electricity Act of 1992 requires all distribution companies to maintain their networks, at least to the extent they existed in 1993, and to service all customers who were on the grid in 1993 and still desiring service.

The Electricity Industry Reform Act of 1998 called for separation of ownership of vertically integrated power companies by 2004, with at least a corporate separation (separate books) by 1999. The government did not, however, divest its own generation assets. In fact, three of the largest generation companies (holding more than half of all generation capacity) are still government-owned. Generation and dispatch operate in a fully competitive framework. Seventy-five percent of all electricity sales go through the New Zealand Electricity Market, which is a privately owned and operated entity. The remaining 25% of sales are through bilateral contracts.

[84] For more details, see Culy et al. (1996) and Ministry of Commerce of New Zealand (2000).

References for Appendix

Alberta Resource Development. 2000. Power of Competition: A Guide to Alberta's New Competitive Electric Industry Structure. Available at: http://www.resdev.gov.ab.ca/electric/rgeneral/poc-toc.html#toc (April 17).

Bouttes, J. P.; Lederer, P. 1990. *The Organization of Electricity Systems and the Behavior of Players in Europe and the U.S.* Electricité de France, General Economic Studies, (March 6). Draft document, presented at "Organizing and Regulating Electric Systems in the Nineties, A Euro-American Conference," Paris, France, May 28–30, 1990.

Brower, Michael C.; Thomas, Stephen D.; Mitchell, Catherine M. 1997. Lessons from the British Restructuring Experience. *The Electricity Journal* 10(3).

Burchett, Shannon. 2000. A Continent United? Some Thoughts on Prospects for a Single Energy Market in Europe. *Public Utilities Fortnightly* 138(2).

Commission of the European Communities. 1991. *Energy in Europe: Energy Policies and Trends in the European Community.* Directorate General for Energy, Number 18, (December).

Coudert Brothers. 1992. *The Environmental Policy of the European Community.* Brussels (August).

Culy, J. G.; Read, E. G.; Wright, B. D. 1996. The Evolution of New Zealand's Electricity Supply Structure. In *International Comparisons of Electricity Regulation*, edited by Richard J. Gilbert, Edward P. Kahn. New York: Cambridge University Press.

European Commission. 2000a. Implementation of Electricity Directive 96/92 by the Member States. Available at: http://europa.eu.int/en/comm/dg17/elec/implgrid.htm (April 17)

European Commission. 2000b. Guide to the Electricity Directive 96/92. Available at: http://europa.eu.int/en/comm/dg17/elec/memor.htm (April 17)

Green, Richard. 1999. Draining the Pool: The Reform of Electricity Trading in England and Wales. *Energy Policy* 27: 515–25.

Helm, Dieter; McGowan, Francis. 1989. Electricity Supply in Europe: Lessons for the U.K. In *The Market for Energy*, edited by D. R. Helm et al. Oxford: Clarendon Press.

Hjalmarsson, Lennart. 1996. From Club-Regulation to Market Competition in the Scandinavian Electricity Supply Industry. In *International Comparisons of Electricity Regulation*, edited by Richard J. Gilbert, Edward P. Kahn. New York: Cambridge University Press.

Jonassen, Torfinn. 1998. Opening the Power Market to End Users in Norway 1991–1999. Unclassified Report to the Norwegian Water Resources and Energy Administration (December).

Ministry of Commerce of New Zealand. 2000. Ministerial Inquiry into the Electricity Industry. Issue Paper, (February).

Moen, Jan; Hamrin, Jan. 1996. Regulation and Competition Without Privatization: Norway's Experience. *The Electricity Journal* 9(2).

Royal Institute of International Affairs/Science Policy Research Unit. 1989. *A Single European Market in Energy.* London: Energy and Environmental Programme.

Terzic, Branko; Wurm, Berthold; Dietrich, Yorck. 2000. Germany: Taking the Lead in Electricity and Gas. *Public Utilities Fortnightly* 138(2).

United Kingdom Department of Trade and Industry. 1999. U.K. Energy Report 1999. (December).

United Kingdom Office of Gas and Electricity Markets (OFGEM). 2000. The Government's Review of Energy Sources for Power Generation: OFGEM's advice to the Government. (April).

U.S. Energy Information Administration. 1997a. Electricity Reform Abroad and U.S. Investment. (September).

Zapala, Ricardo Rios. 1999. Open Access for Electricity Transmission: Arrangements in Central America. Inter-American Development Bank Draft Report (September).