長期計画策定会議
第六分科会(第 7 回)
資料第 6 号

地球温暖化問題と欧米諸国の対応

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1. 地球温暖化問題と欧米諸国の考え方

・科学的知見－IPCC の第 2 次報告書（1995 年）

人間活動に起因する GHGs 濃度の上昇－CO2 は 280ppm から 360ppm

過去 100 年間で世界の平均気温 0.3-0.6 度 C、海面 10-25cm 上昇

実証過程にあるが、気温上昇に対する人間活動の影響は認められる

21 世紀末までに平均気温 1-3.5 度 C(2 度)、海面 15-95cm(50cm) 上昇

不確実性－GHG s やｴｱﾛｿﾞﾙの排出量と吸収量、雲・海洋との相互作用等

・地球温暖化対策に対する考え方

EU－温暖化防止のため、早急に先進国が率先して対策を講ずるべき

米国－科学的不確実性を考慮すると、経済成長を損なわない取り組みを

途上国の意味ある参加がなければ、実効性のある対策は困難

2. 京都議定書と欧米諸国の対応

・ＥＵ－各国で大きく異なる削減目標（ＥＵバブル）

各国とも公式の長期エネルギー計画は未発表

燃料転換、省エネ、再生可能エネの導入－自主協定、規制、課税の組合せ

大きな削減効果が期待できる燃料転換－石炭から天然ガスへ

ＥＵの議定書コストは 200 億 ECU－発電・産業部門に排出権取引を導入

将来の中・東欧諸国の EU 加盟により拡がる CO2 削減のポテンシャル

・米国

計量モデルを用いた京都議定書の経済コスト分析（添付資料参照）

大きな削減ポテンシャルを持つ石炭から天然ガスへの転換

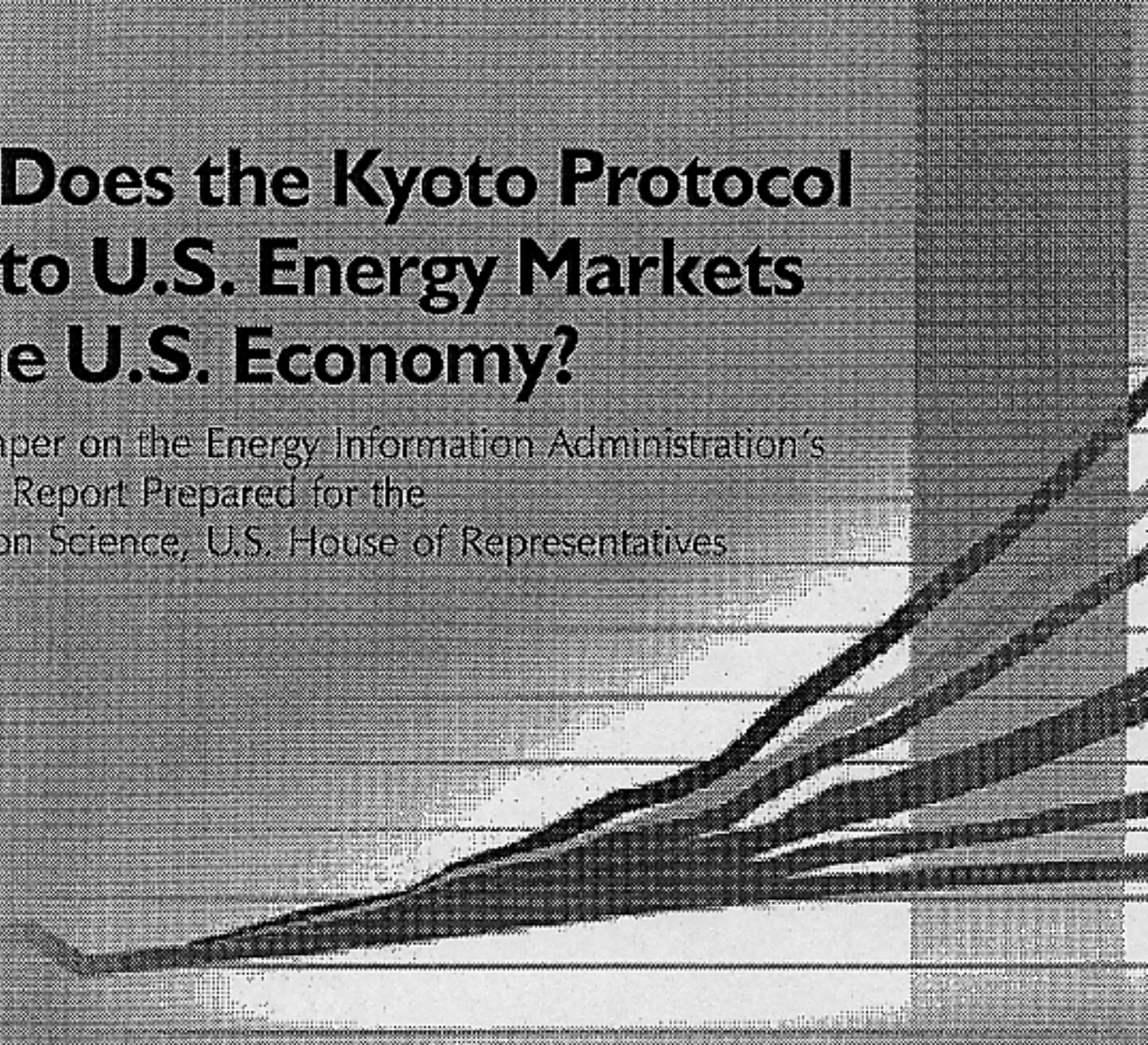
規制や課税政策ではなく、京都ﾒｶﾆｽﾞﾑ（排出量取引、JI、CDM）の活用

植林等の吸収源による大幅な CO2 削減の可能性

SR/OIAF/98-03 (S)

What Does the Kyoto Protocol Mean to U.S. Energy Markets and the U.S. Economy?

A Briefing Paper on the Energy Information Administration's Analysis and Report Prepared for the Committee on Science, U.S. House of Representatives



Energy Prices

Values of Carbon Emissions Credits

Changes in Energy Mix

Impacts on Motor Fuel and Electricity

Market Penetration by New Technologies

Improvements in Efficiency

Changes in Potential vs Actual Growth of the Economy

A Range of Cases, Based on Means of Compliance

Prepared for the Committee on Science U.S. House of Representatives

October 1998

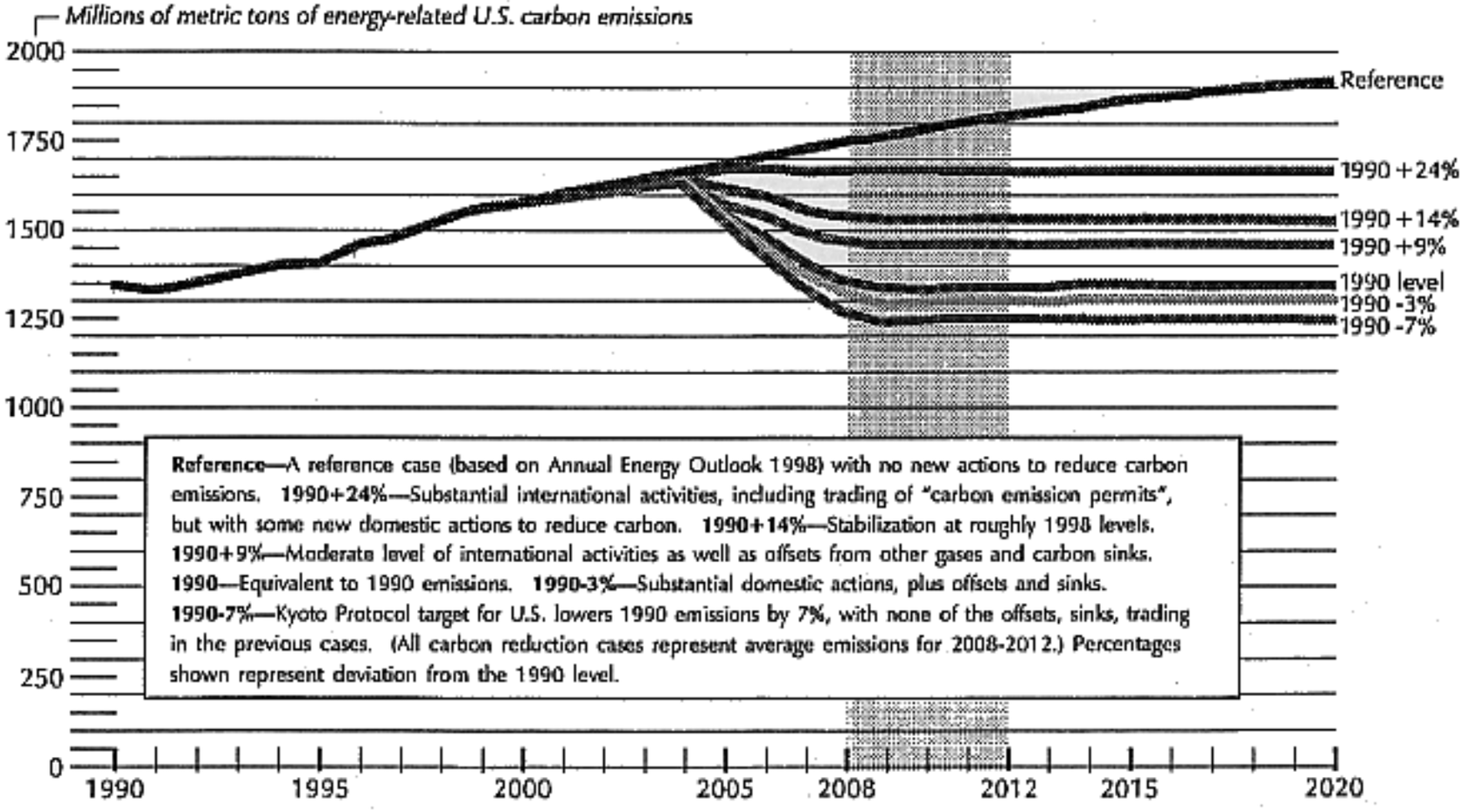
Economic Effects of a Complex Agreement

The Kyoto Protocol, negotiated by more than 160 nations in December 1997, aims to reduce net emissions of certain greenhouse gases (primarily carbon dioxide (CO_2)). Each of the participating developed countries must decide how to meet its respective reduction goal during a five-year period (2008-2012); but specific ground rules remain to be worked out at future negotiating sessions. The next meeting is in Buenos Aires (November 1998).

In a study entitled *Impacts of the Kyoto Protocol on U.S. Energy Markets and Economic Activity*, the Energy Information Administration (EIA), an independent statistical and analytical agency in the U.S. Department of Energy, has projected that meeting the U.S. targets under the Protocol will call for significant market adjustments:

- Reductions in CO_2 emissions will result in between 18 and 77 percent less coal use than projected in the EIA Reference Case in 2010, particularly affecting electricity generation, and between 2 and 13 percent less petroleum use, mainly affecting transportation.
- Energy consumers will need to use between 2 and 12 percent more natural gas in 2010 and between 2 and 16 percent more renewable energy, and extend the operating life of existing nuclear units.
- To achieve these ends via market-based means, average delivered energy costs (in inflation-adjusted 1996 dollars) must be between 17 and 83 percent higher than projected in 2010.

EIA Analyzed 6 Cases for Reducing Energy's Carbon Emissions To Comply with the Kyoto Protocol



For more detail, see the Executive Summary and Chapter 1 of the main report

Depend on Many Assumptions

- The amount prices must rise is uncertain. Accounting procedures and international trading rules for greenhouse gases are not finalized. Forecasting technological change and public response to it under various pricing scenarios is an inexact science. The more stringent the need for domestic emission reductions, however, the more costly the adjustment process will be.

EIA undertook this study in response to a request by the Chairman and Ranking Minority Member of the House Committee on Science that it analyze impacts of the Protocol (which the President has not yet submitted to the U.S. Senate for ratification) on U.S. energy use, prices, and the general economy in the 2008-2012 time frame. That is when this country is supposed to reach an average level of net greenhouse gas emissions 7 percent lower than they were in 1990—having shown demonstrable progress toward that goal by 2005. At the Committee's request, EIA assumed that actions begin in 2005.

EIA was asked to do the study for several reasons. More than 80 percent of the human-originated greenhouse gas emissions are energy-related. EIA's National Energy Modeling System (NEMS) is perhaps the most complete, integrated, regional computer model available to simulate all elements of U.S. energy supply and demand in the context of the full U.S. macroeconomy. NEMS presents year-by-year projections over a 20-year horizon, accounting for capital stock turnover and the availability and penetration of specific energy-consuming technologies. Its annual "Reference Case" assumes no change from existing laws and regulations, and so it provides a base from which to evaluate policy options or alternative assumptions.

EIA analyzed six cases to investigate the uncertain range of impacts which could result from the Kyoto Protocol. Differences among the cases analyzed arise from three facts: 1) The Protocol gives credit for "CO_2- equivalent" reductions in five gases other than CO_2—methane, nitrous oxide, and three synthetic gases—as well as for certain actions that take carbon out of the atmosphere (such as preserving or extending forests); 2) participating developed countries are allowed to sell excess "permits" (e.g., because of economic problems since 1990 in the participating countries of the former Soviet Union, they may have about 165 million metric tons of carbon permits easily available); and 3) support for effective programs in other countries can earn permits. Details of this last process (called "Joint Implementation" among developed countries and the "Clean Development Mechanism," or CDM, for developing countries) are unsettled.

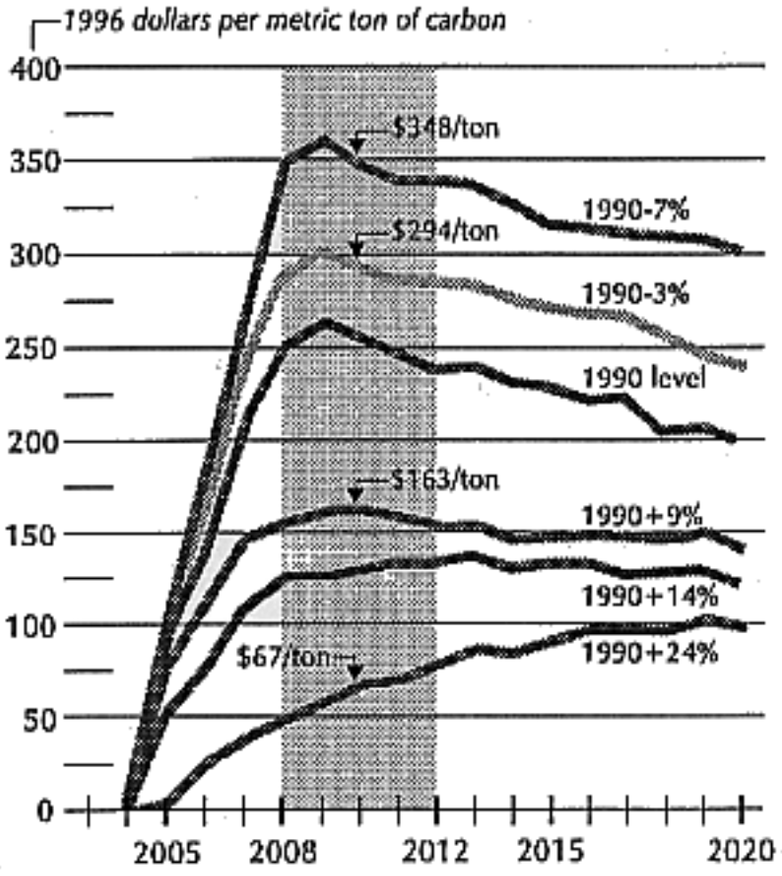
EIA's six cases cover a range of reductions in energy-linked carbon emissions from an annual average of 122 million metric tons below the expected baseline emissions (1990+24% Case) to 542 million metric tons (1990-7% Case) in 2008-2012. In the 1990+24% Case, domestic actions may furnish about one-fifth of all reductions, with the rest coming from international activities (including trading), offsets of other gases, and carbon sinks in the U.S., while the 1990+9% Case assumes that nearly 60 percent of the reductions result from such domestic initiatives as fuel-switching, improved technology, and cutbacks in energy use. EIA did not separately calculate the contributions of international activities, offsets or sinks for any case. The 1990-3% Case assumes all reductions are from domestic actions, with a 4 percentage point contribution from sinks and offsets from other gases. In the 1990-7% case, all reductions must come from domestic energy-related reductions.

The Kyoto Protocol does not specify targets for greenhouse gases after the period 2008-2012. At the Committee's request, EIA held the target for energy-related carbon emissions in the commitment period constant to 2020, the end of the forecast horizon. Targets following the 2008-2012 period will be a topic at future negotiating sessions.

To reduce carbon emissions, EIA assumes that a "carbon price" is added to the price of delivered energy fuels based on their carbon content. For example, coal prices rise more than petroleum and natural gas prices; and

For more detail, see the Executive Summary and Chapter 1 of the main report

"Carbon Price" For a Range of Deviations From 1990 Carbon Emission Levels



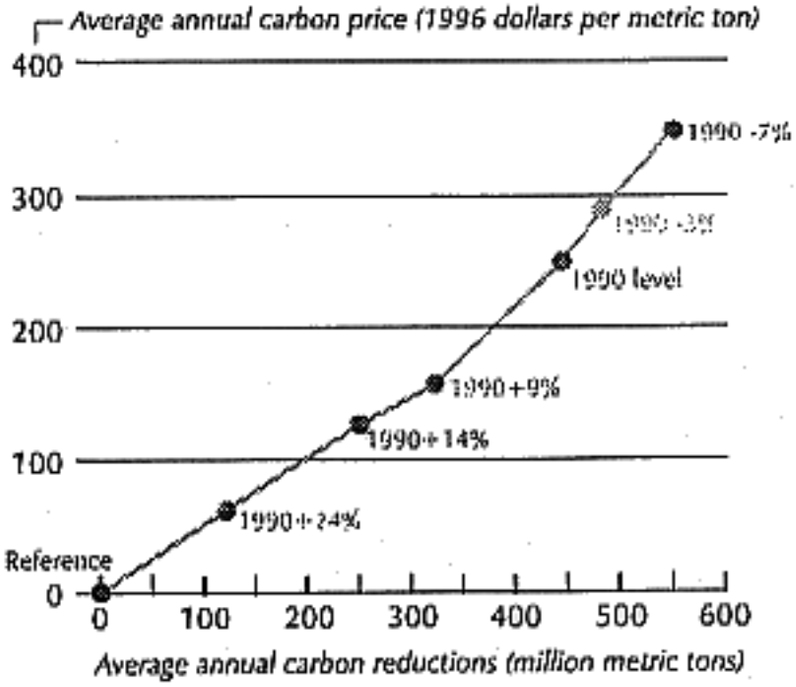
the cost of generating electricity from non-carbon-emitting nuclear and renewable fuels is not increased due to the carbon price. Although electricity does not have the carbon price directly added to it, its price is increased due to the higher cost of fossil fuels used for generation.

The price increases encourage a reduction in the use of energy services (heating, lighting, and travel, for example), the adoption of more energy-efficient equipment, and a shift to less carbon-intensive fuels. The carbon price reflects the amount fossil fuel prices in the U.S., adjusted for the carbon content of the fuel, must rise to achieve the removal of the last ton of carbon emissions that meets the carbon reduction target in each case.

In most of the cases, the carbon price peaks early in the 2008-2012 period, reaching between $67 and $348 per metric ton in 2010, and then declines as energy markets adjust and more efficient, new technologies become available and gradually penetrate the market. In the least stringent reduction cases, the increase is more gradual throughout the period because less severe reductions need to be made. Looking at average carbon prices over the commitment period 2008 to 2012 shows how the cost of compliance increases with increasingly stringent targets.

Differences in the cost of energy will affect the outlook for U.S. jobs, consumer prices, investment, technical change, and economic growth. Whenever use of a factor of production such as energy is restricted, economic performance falls for some period of time, the price of energy and other goods and services rises, and consumption and employment decline. Hence the various cases affect the national economy to varying degrees.

"Carbon Price" Rises with Higher Emissions Reductions, 2008-2012



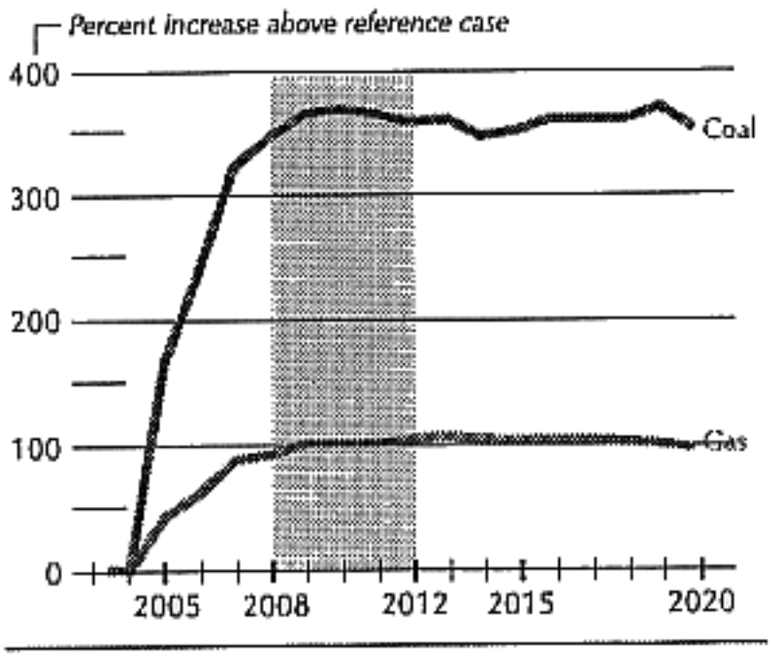
For more detail, see Executive Summary and Chapter I of the main report

Electricity and Coal Industries Face Major Adjustments

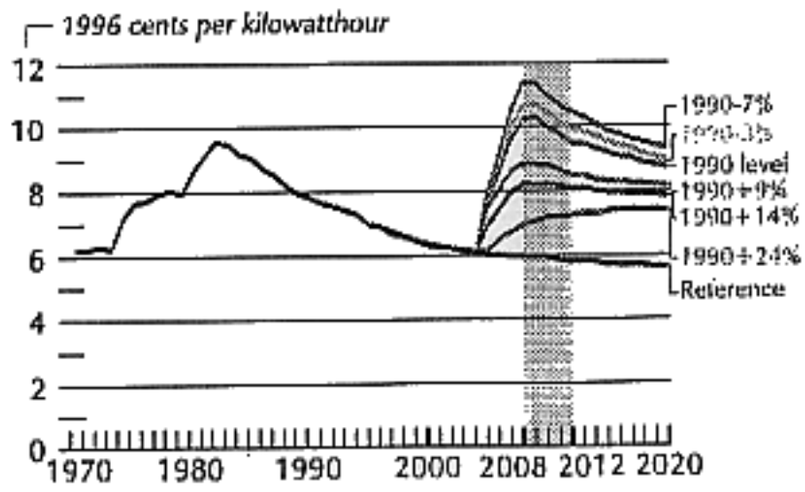
Well over one-third of all primary energy consumed by the United States today goes into producing and delivering electricity. At the point of use, electricity can be highly efficient; and there are certain end uses where fuel substitution is not feasible. More than one-half of all U.S. electricity generated in 1997 was produced from coal—a fuel that emits more carbon dioxide during combustion than any other fossil fuel. Thus, electricity production and consumption is likely to be a major focus in meeting Kyoto targets, accounting for between two-thirds and three-fourths of the domestic carbon reductions in 2010 in the various cases examined. Historically, this industry has responded when relative fuel prices have changed.

Because coal is the most carbon-intensive of the fossil fuels, delivered prices for coal are affected by carbon prices more than other fuel prices. They are between 153 and 800 percent higher in 2010. The various cases studied for show prices for electricity between 20 and 86 percent higher in all end-use sectors, reflecting both the increased fuel costs and the incremental capital investments for non-coal generating capacity—either by traditional utilities or by non-utility generators in an increasingly restructured industry. The price rise for electricity is moderated somewhat by the fact that fuel is only part of the cost of generating electricity and that the cost of generation from renewables and nuclear power are unaffected by carbon prices. Neither of these fuels, however, can replace significant amounts of coal in the 2008-2012 timeframe. By 2020, non-hydro renewables (chiefly wind turbines, biomass in advanced technological applications, and to a lesser extent, geothermal facilities) penetrate the market in a significant way—providing as much as one-fifth of generation at the highest carbon prices. While hydroelectric dams have accounted for four-fifths of the renewable energy used for U.S. electricity production to date, the expansion of hydroelectric capacity is capital-intensive and is likely to meet with environmental objections; thus little additional

Cost of Fuels Used to Generate Electricity in the 1990 +9% Case

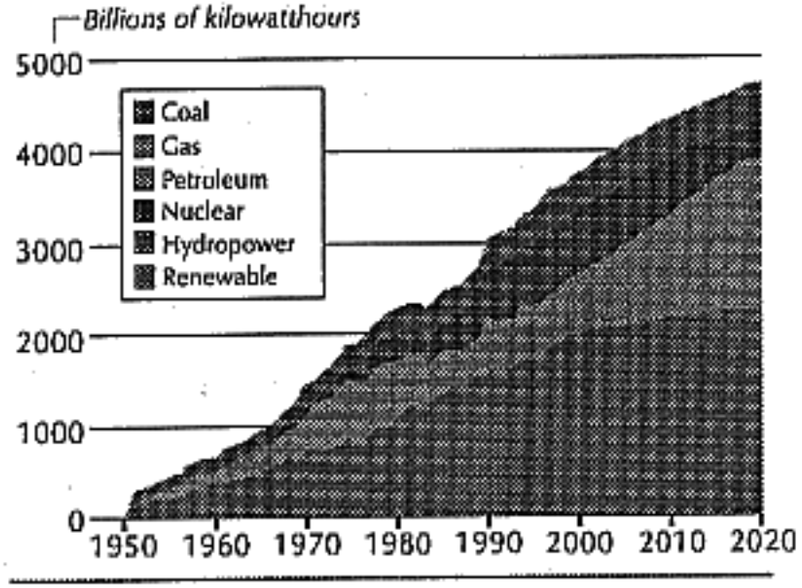


Average Price of Electricity to End-Users



For more detail, see Chapter 4 of the main report.

Electricity Generation by Fuel (Reference)

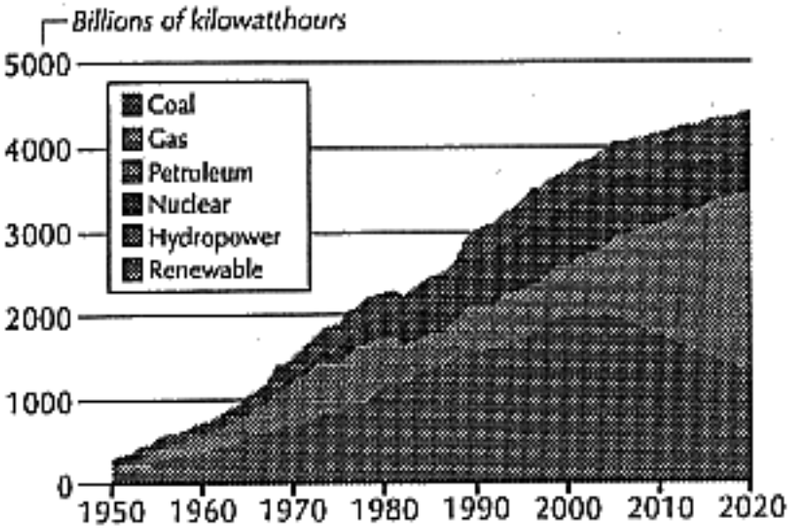


hydroelectric capacity is expected. The bulk of the substitution for coal generation would be natural gas, because of its lower carbon content and the high efficiency of gas-fired combined cycle plants.

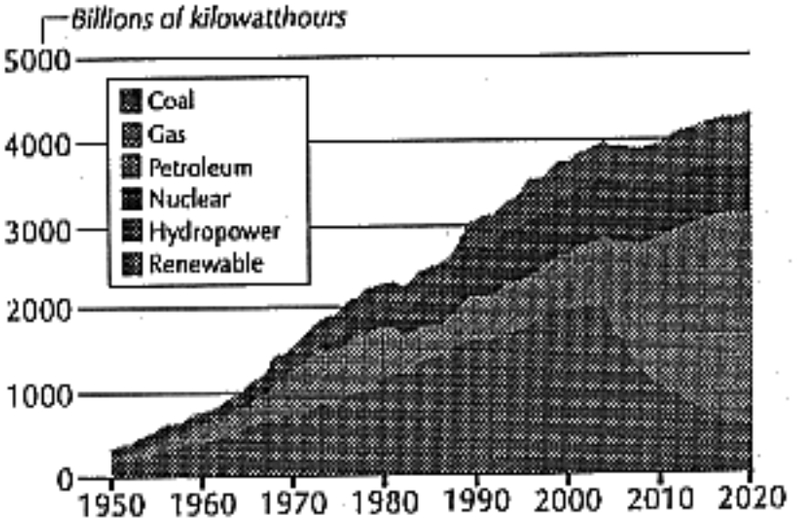
Furthermore, demand for industrial steam coal and metallurgical coal is also reduced because of a shift to natural gas in industrial boilers and a reduction in industrial output.

Because domestic coal consumption is between 18 and 77 percent lower in 2010 in the carbon reduction cases, there would be ripple effects on the industry. For example, even though total coal production drops, the average price per ton for coal at the minemouth in 2010 is between 3 and 28 percent higher than the Reference Case price. This is because a larger share of production would come from higher-cost Eastern coal mines, which tend to serve the remaining markets. Carbon prices raise the cost of rail transportation (involved now in delivering two-thirds of all coal) and make Western coal less competitive. The production of Western coal is discouraged further by the reduced size of the market and the reduced profitability of investing in new coal mines (which have been mostly in the West).

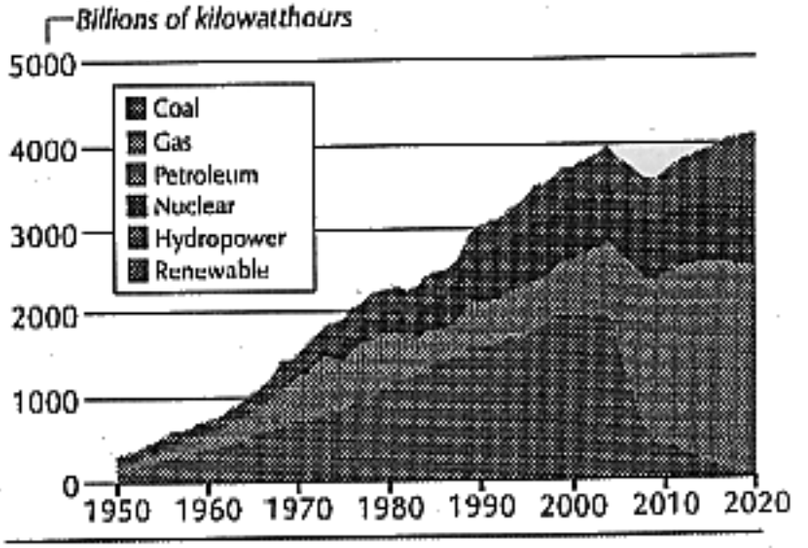
Electricity Generation by Fuel (1990+24% Case)



Electricity Generation by Fuel (1990+9% Case)

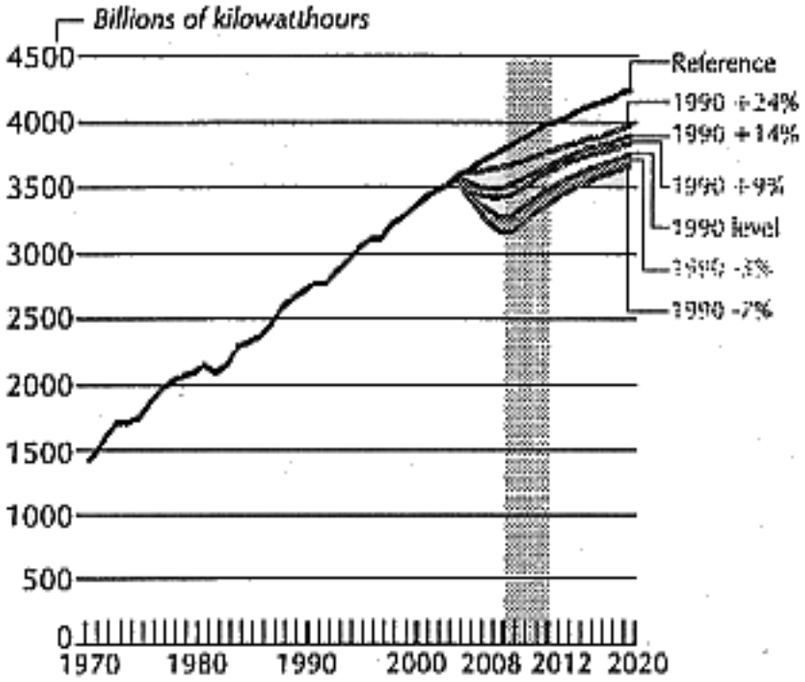


Electricity Generation by Fuel (1990-7% Case)

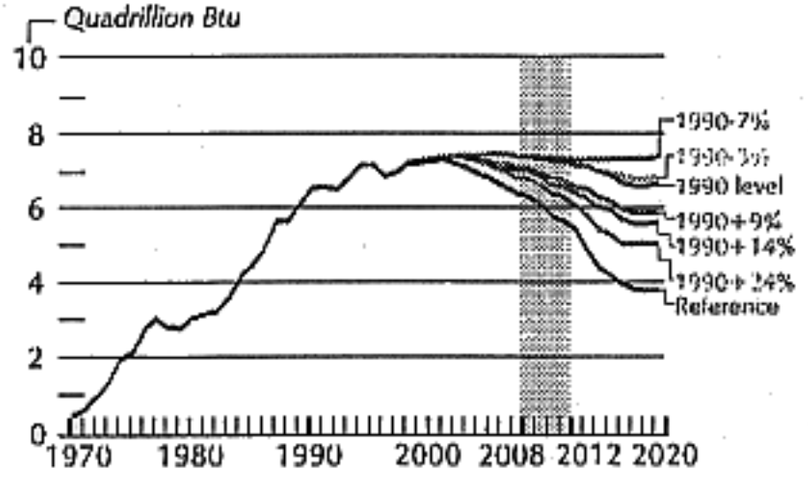


For more detail, see Chapters 4 and 5 of the main report

U.S. Sales of Electricity



Nuclear Inputs to Electricity Generation

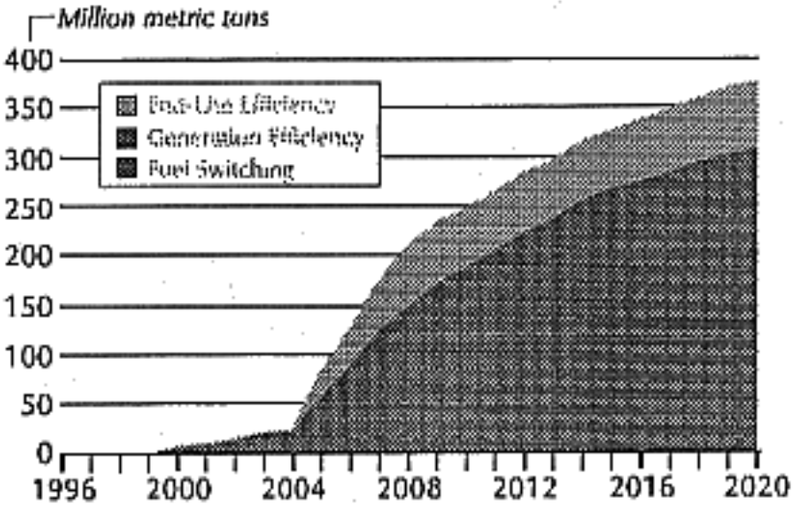


For the past two decades or so, the number of coal miners in this country has been declining by nearly 6 percent per year, primarily as a result of improved labor productivity (especially in large Western surface mines). Without taking the Kyoto Protocol in consideration, the Reference Case already projects a further employment drop of more than 15 percent—leaving only about 69,000 U.S. coal miners by 2010. In the carbon reduction cases, between 10,000 and 43,000 more jobs could be lost. Some of these job losses could be offset by growth in employment in the natural gas and renewable industries.

While no new nuclear power plants are considered in these cases, extending the licenses of existing plants is projected to become more economical with higher carbon prices. In more stringent carbon reduction cases, most existing nuclear plants are operated through 2020, in contrast to the Reference Case outlook that projected about half of the nuclear plants would be retired by that time.

Although reduced demand for electricity and improved efficiency in its generation can contribute to reducing carbon emissions from electricity generation, fuel-switching accounts for most of the reductions. In the short run, power suppliers would increase their use of less carbon-intensive plants, including steam plants that use oil and gas to heat their boilers. Much more efficient and cost-effective combined-cycle systems increase their share as new capacity is added.

How Carbon Cuts Would Be Achieved In Electricity Generation (1990+9% Case)



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