# Critical Role for Environmental Cooperation in Northeast Asia

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This paper examines reasons for cooperation among Northeast Asian economies in reducing energy-related airborne pollution, and whether cooperation could be a catalyst for cooperation on broader economic development issues. Energy-related pollution from various fossil energy and technology options is reviewed. The central focus of the paper is the environmental and economic benefits resulting from regional cooperation to facilitate the development of a regional natural gas pipeline in Northeast Asia.

## INTRODUCTION

Discussions on environmental issues have played a significant but minor part in most of the previous Northeast Asia Economic Forums. The reason appears to be that cooperation to encourage economic growth has priority over cooperation to effectively address regional environmental issues. The conventional view is that actions to reduce environmental pollution add to project costs, therefore reducing project economic viability, and impact negatively on investment levels.

The thesis of this paper is that strategic cooperation to address energy-related environmental problems in Northeast Asia can promote greater long-term economic development, and greater regional stability. The priority case for cooperation is in facilitating the development of a regional natural gas pipeline.

## ASIA'S ENERGY MIX IS DIFFERENT

Discussions on energy-related pollution should begin with an assessment of the energy mix. It is important to note that the Asian region's energy mix is different from the rest of the world, as shown in Figure 1. In Figure 1, the vertical axis shows the primary energy mix in the world, excluding the Asia-Pacific, and the horizontal axis shows the primary energy mix in the Asia-Pacific in 1998. The diagonal line represents points where the percentage of a primary energy is the same in both Asia and the rest of the world. As shown for oil, nuclear, and hydroelectric power, their energy shares are similar for Asia and the rest of the world. However, as shown in Figure 1, coal is more than twice as important in Asia in percentage terms as in the rest of the world. In contrast, natural gas is almost three times more important in percentage terms in the rest of the world as in Asia. As will be discussed later, the low use of clean natural gas, and high consumption of dirty coal, are key factors behind the high energy-related pollution levels in Asia, including Northeast Asia.

The largest factor in the high share of coal in Asia's energy mix is China's dependence on coal for more than 70 percent of its primary energy needs. The different primary energy mix in Asia is partially explained by the endowment of energy resources. This is also true of Northeast Asia, where China, Mongolia, and to a lesser extent, North Korea, have substantial coal reserves, but limited natural gas.

However, the overall energy mix of Asia is different from Northeast Asia[1] due to the heavy influence of the large, oil-consuming Japanese economy. The primary energy mix of Northeast Asia is as follows: 47 percent oil, 32 percent coal, 10 percent nuclear, 8 percent natural gas, and 3 percent hydroelectric power.[2]

## LOCAL AND REGIONAL ENVIRONMENTAL PROBLEMS

The most important local and regional energy-related pollutants in Northeast Asia include $SO_2$, $NO_x$, and particulates. These pollutants have major detrimental health impacts, particularly in heavily polluted industrial areas in China. In China, the World Bank estimates the economic costs of pollution (primarily energy-related pollution) at more than 50 billion U.S. dollars each year.

Coal is the largest contributor to airborne energy-related emissions of $SO_2$ and particulates in Northeast Asia. Figure 2 gives a broad indication of the concentration of $SO_2$ across Northeast Asia in 2000. It is important to note that wide variations in $SO_2$ occur over short distances; therefore the $SO_2$ concentrations shown in Figure 2 may not reflect concentrations in specific local areas. As shown in Figure 2, relatively high concentrations of $SO_2$ already exist over large areas of Northeast Asia. Figure 3 shows the estimated distribution of $SO_2$ in 2020 assuming a continuation of present energy trends, the use of low-to-medium-efficiency domestic pollution control technologies, and limited substitution of cleaner fuels in the Northeast region. If present energy trends continue, much more serious $SO_2$ concentration levels will occur across much of Northeast Asia by 2020.

Figure 4 shows, schematically, one of the proposed natural gas pipeline infrastructure networks for Northeast Asia. It is important to note that neither the actual pattern of pipeline infrastructure or the timing of natural gas pipeline

1. Defined as Heilongjiang, Jilin, and Liaoning Provinces and Inner Mongolia of China, Japan, Mongolia, North and South Korea, East Siberia, and the Russian Far East.
2. Toichi Tsutomu, 1999, “Energy Problems in North-East Asia and Potential for Regional Cooperation,” Institute of Energy Economics, Japan (in Japanese).

developments is known. However, I have no doubt that a regional pipeline system will eventually be developed in Northeast Asia. Figure 5 overlays the possible natural gas pipeline infrastructure with the $SO_2$ concentration map for 2020. As most natural gas produces extremely low $SO_2$ and particulate emissions, the introduction of a major natural gas system in Northeast Asia would contribute markedly to reduce health-damaging emissions in areas that have high concentrations of $SO_2$ and particulates. The potential environmental benefits of enforced, sound environmental legislation and reduced $SO_2$ and particulate concentrations in Northeast Asia are speculative, but is likely to be several billion U.S. dollars per year.

## GLOBAL GREENHOUSE GAS EMISSIONS

In international forums, the leading environmental issue of the 1990s has been how to address global warming problems. There remains considerable debate about the magnitude of human activities on rates of global warming. However, most independent scientists believe that human activities are accelerating the rates of increase of greenhouse gases (GHG) in the atmosphere, and that this is contributing to global warming. The leading contributor to global warming is believed to be carbon dioxide ($CO_2$) primarily produced from the burning of fossil fuels. The focus of global climate change meetings has been on reaching international agreements on how best to reduce the growth in greenhouse gases, and how the burden should be shared among countries.

Figure 6 compares the estimated percentage contribution of $CO_2$ from fossil fuels in Asia and the rest of the world in 1998.[3] As shown, coal dominates with about 55 percent of $CO_2$ emissions, a result of the combination of its 44 percent share of fossil energy mix and its higher carbon content. In contrast, in the rest of the world, oil is the leading source of $CO_2$ emissions, accounting for 46 percent of emissions, with coal trailing at 28 percent of emissions. The dominance of coal as a contributor of the $CO_2$ in Asia is attracting attention in international climate change meetings as a target for $CO_2$ emission reductions.

## $CO_2$ EMISSIONS FROM COAL, OIL, AND NATURAL GAS

Among all energy options, coal is the largest emitter of $CO_2$. Figure 7 shows the relative carbon emissions of natural gas, oil, and coal per unit of contained energy. As shown in Figure 7, oil and coal produce, respectively, about 30 percent and 70 percent more carbon (and $CO_2$) per unit of contained energy than

3. Emissions estimates vary significantly between sources.

natural gas.[4] Therefore, the substitution of natural gas for coal can reduce carbon emissions by about 40 percent, assuming the same fuel conversion efficiencies. However, this option is not available over most of Asia, including Northeast Asia, owing to the lack of natural gas pipeline infrastructure.

The significance of substituting natural gas for coal to reduce $CO_2$ emissions is much more important than indicated in Figure 7. The actual reduction in carbon emissions is both a function of the "carbon content" of fuels, and the "efficiency" of the fuel conversion technologies. Figure 8 illustrates this point for a range of power plant types. Figure 8 shows the potential reduction in carbon emissions per kilowatt-hour for a range of power plant technologies and the three alternative fossil-fuels. The technologies shown are a new coal-fired PC (37% efficiency), a coal-fired supercritical plant (44% efficiency), an integrated gasification combined-cycle (IGCC) plant (46.5% efficiency), an oil-fired plant (37% efficiency), a natural gas turbine (37% efficiency), and a natural gas combined-cycle plant (50% efficiency).[5] Figure 8 shows both the reductions in carbon emissions due to "efficiency gains" and due to the different carbon contents of the three fuels. When compared to the 33 percent average efficiency of Chinese power plants, the total carbon reductions per kilowatt hour for various technology and fuel options are: (1) new coal-fired PC (~11 percent), (2) coal-fired supercritical PC (~25 percent), (3) IGCC plant (~29 percent), (4) oil-fired plant (~31 percent), (5) gas-fired turbine (~47 percent), and (6) a natural gas combined-cycle (~61 percent). It is clear from Figure 8, that substantial reductions in carbon emissions are possible with existing technologies and fuel switching. Natural gas combined-cycle plants have a substantial lead over all other fuel-technology combinations in carbon reductions. In addition, over most of Northeast Asia, natural gas combined-cycle plants are expected to be competitive with alternative fossil fuels on a cost/kWh basis when natural gas is available by pipeline.

## Reducing Greenhouse Gas Emissions in Northeast Asia

As a result of the 1992 Framework Convention on Climate Change and the 1997 Kyoto Protocol, thirty-eight industrialized economies have agreed to reduce their GHG emissions by 2008-2012 by an average of 5.2 percent below 1990 levels.

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4. It should be noted that natural gas (methane) emissions during production and transportation could be an important contributor to greenhouse gas emissions. For the purposes of this analysis it is assumed that methane emissions from future natural gas developments will be highly restricted.
5. The assumed efficiencies are based on high heating value (HHV) and include industry assumptions about operational efficiencies that can be achieved over the next decade.

Developing economies have made no such commitments, although many developing economies have policies to improve their energy efficiencies, and change their energy mix to reduce GHG emissions. There are various options being considered (primarily the clean development mechanism) that would allow the thirty-eight signatories to the Climate Change Convention to obtain credits toward their GHG reduction commitments by investing in GHG reducing technologies in developing countries.[6] The direct implication is that GHG reductions can be considered a commodity with a substantial market value.

The development of a natural gas pipeline system in Northeast Asia would cost tens of billions of dollars. Given pipeline economics and risks, no multilateral bank or private company is willing to commit to such a large investment at this time. However, the economics of substituting natural gas for other fossil fuels in much of Northeast Asia is believed to be favorable, if the environmental costs of pollution are internalized (the polluter pays the cost of pollution).

The benefits of regional cooperation to develop a natural gas system in Northeast Asia would include the reduction in environmental damages of several billion dollars per year, and would make an important contribution to reducing GHG emissions. As GHG reductions potentially have substantial market value, if investors could obtain GHG credits for the pipeline, this would substantially improve the overall attractiveness of investments in the Northeast Asian pipeline.

It will probably take a concerted, cooperative effort of the Northeast Asian governments to obtain agreements that would allow GHG credits resulting from a natural gas pipeline system in Northeast Asia. In the climate change debate, there is substantial resistance to allowing GHG credits for natural gas pipelines, and only with the unified and sustained efforts of Northeast Asian governments can there be a reasonable likelihood of success.

It is my view that the combination of the economic benefits from the regional reduction in health-damaging $SO_2$ and particulates, as well as credits for the reduction in $CO_2$, will substantially outweigh the added costs of the natural gas pipeline system. The combined economic and environmental benefits of the Northeast Asian natural gas pipeline and enforced, sound environmental regulations will have far-reaching positive impacts on investment climates and economic growth in Northeast Asia.

6. "The clean development mechanism (CDM) defined by the Kyoto Protocol (Article 12) is a new cooperative mechanism involving developing countries. Through the CDM, certified emission reductions accruing from sustainable development projects in developing countries can be used by developed countries to meet part of their reduction commitments as specified in Annex B of the Protocol" (UNDP, 1998, *Issues and Options: The Clean Development Mechanism*).

## CONCLUSIONS

Energy-related pollutants in Northeast Asia have large direct costs, probably exceeding 10 billion U.S. dollars per year, as well as substantial global costs resulting from GHG emissions. There are numerous options for reducing harmful energy-related emissions in Asia. The largest option using proven, conventional technology appears to be the introduction of a large natural gas system in Northeast Asia. Only through strong regional cooperation is such a natural gas system likely to be developed over the next two decades.

It is believed that pipeline natural gas would be competitive over much of Northeast Asia if strict environmental legislation is enforced that prevents the burning of dirty fuels without proper pollution control equipment. The local and regional health savings alone may justify the added cost of the natural gas pipeline. However, when the possible credits from reducing GHG emissions are included, a stronger case can be made for regional cooperation to facilitate establishment of a major natural gas pipeline.

The pipeline scheme will eventually be developed, with or without regional cooperation. However, with strong regional cooperation, the development of the pipeline might be advanced forward by one or two decades. The economic benefits to Northeast Asia of adding a clean, reliable and competitive energy fuel to the energy mix may far exceed simple estimates of environmental benefits. International investors are attracted to regions with competitive labor, reliable, clean energy supplies, and proximity to major markets. Northeast Asia has the potential to achieve all of these investor attributes, given the commitment of the region's governments to the common goal of a sound environmental legislation, and a clean mix that includes a regional natural gas pipeline.

## ACKNOWLEDGEMENT

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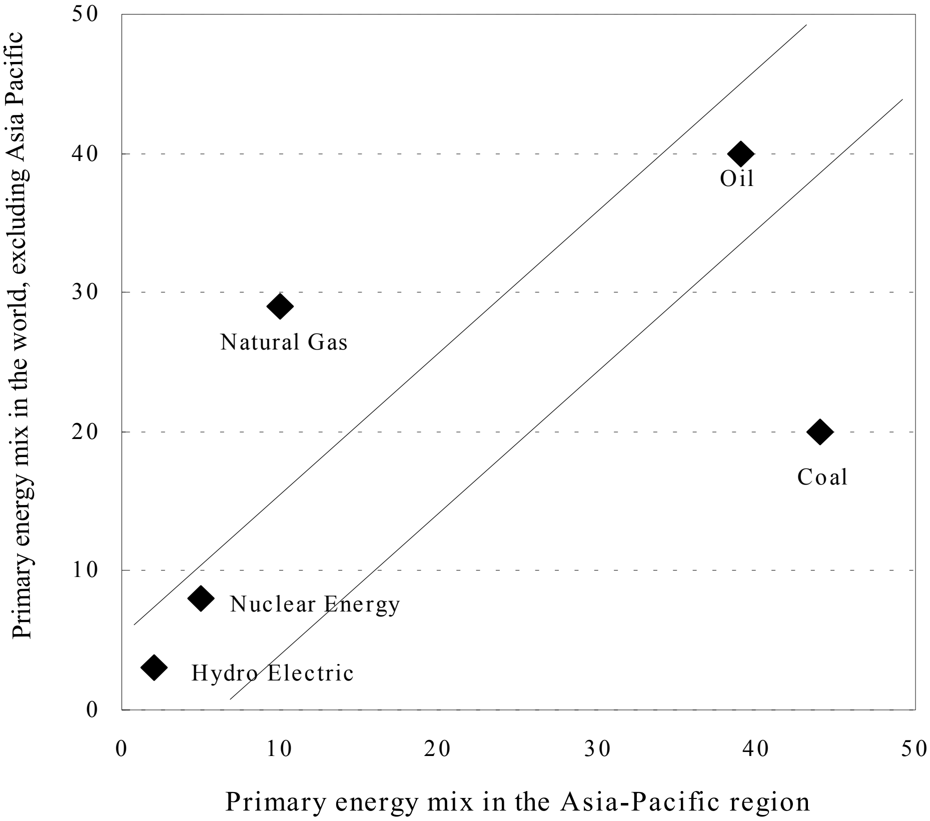


Figure 1. Comparison of primary energy mix of the Asia-Pacific region and of the world excluding the Asia-Pacific region, 1998

*Source: BP Amoco Statistical Review of World Energy*, 1999.

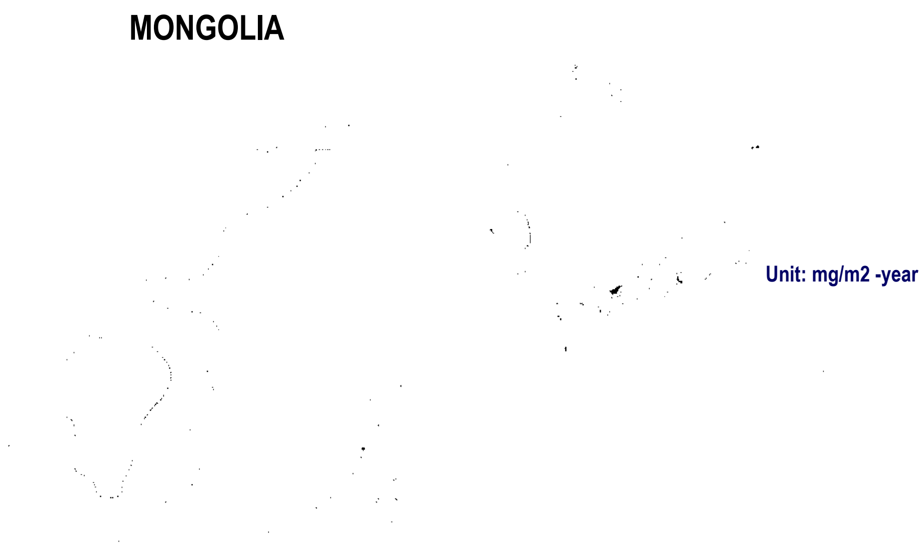


Figure 2. $SO_2$ depositions in Northeast Asia in 2000

*Source:* World Bank, Asian Development Bank, and IIASA, 1999.

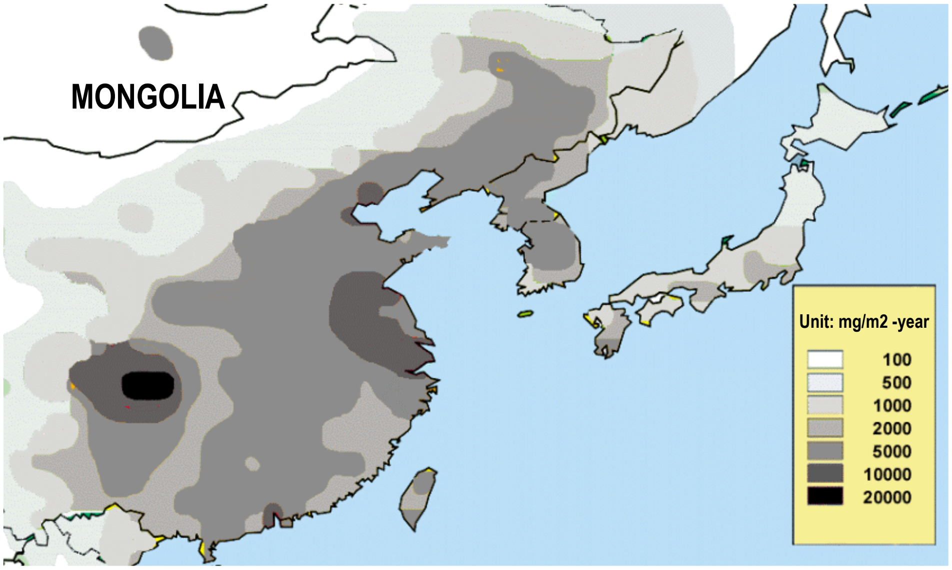


Figure 3. $SO_2$ depositions in Northeast Asia in 2020

*Source:* World Bank, Asian Development Bank, and IIASA, 1999.

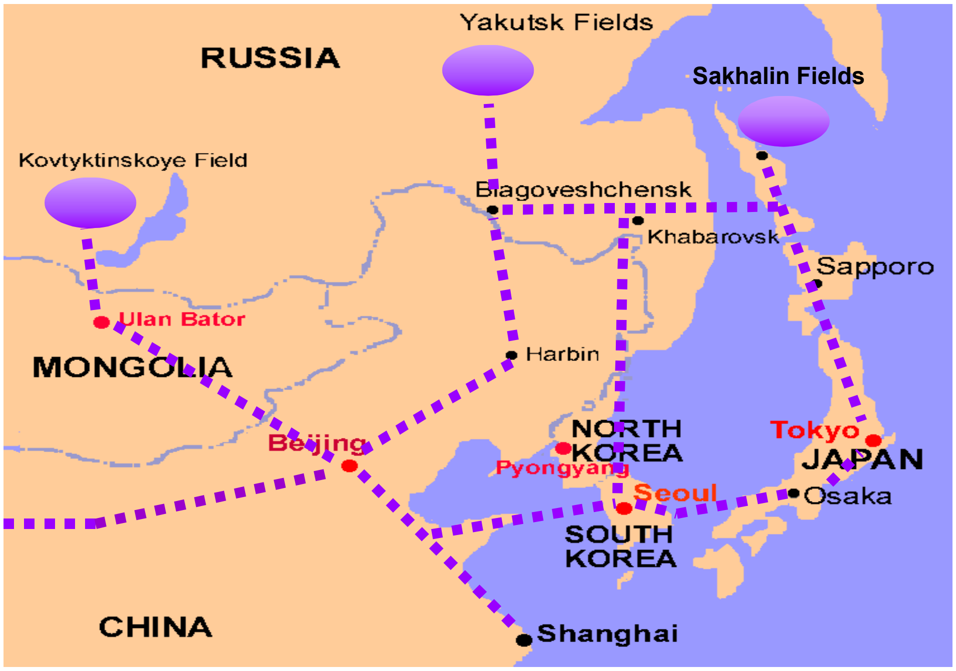


Figure 4. Schematic map showing possible natural gas pipeline infrastructure
*Source:* Charles Johnson and Saengroaj Srisawaskraisorn, 1999.

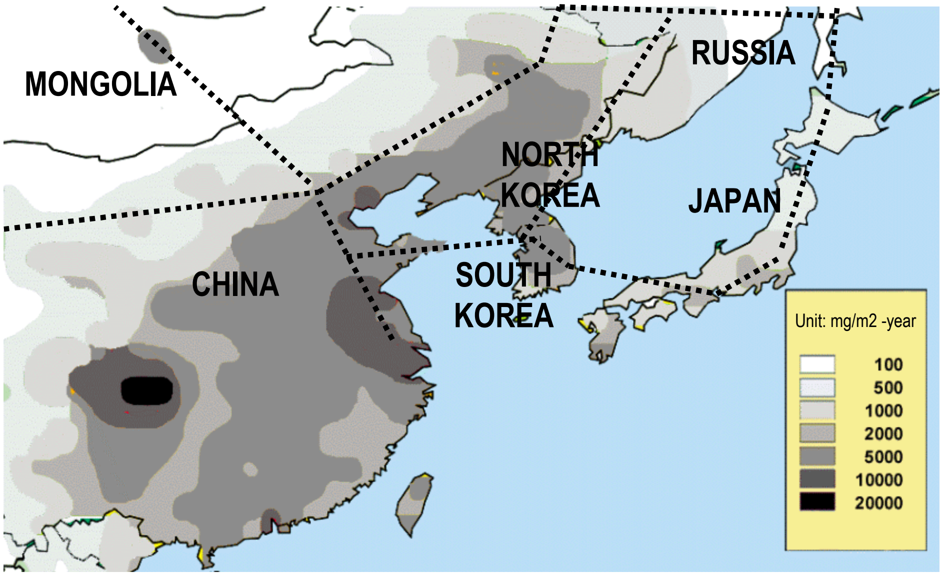


Figure 5. $SO_2$ depositions in 2020 and proposed natural gas pipeline network in Northeast Asia

*Source:* World Bank, Asian Development Bank, and IIASA, 1999.

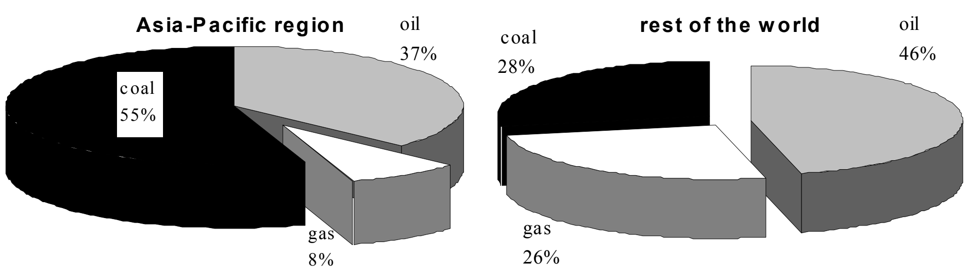


Figure 6. Comparison of the shares of $CO_2$ from each primary hydrocarbon source in the Asia-Pacific region and in the rest of the world in 1998

*Source:* Charles Johnson, 1999.

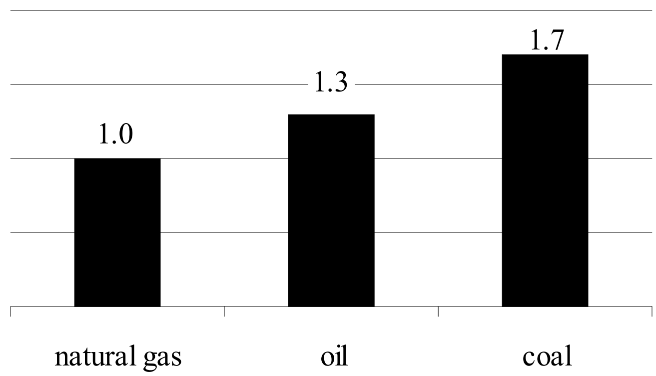


Figure 7. Relative carbon emissions per unit of contained energy for natural gas, oil, and coal (natural gas = 1.0)

*Source:* Charles Johnson and Saengroaj Srisawaskraisorn, 1999.

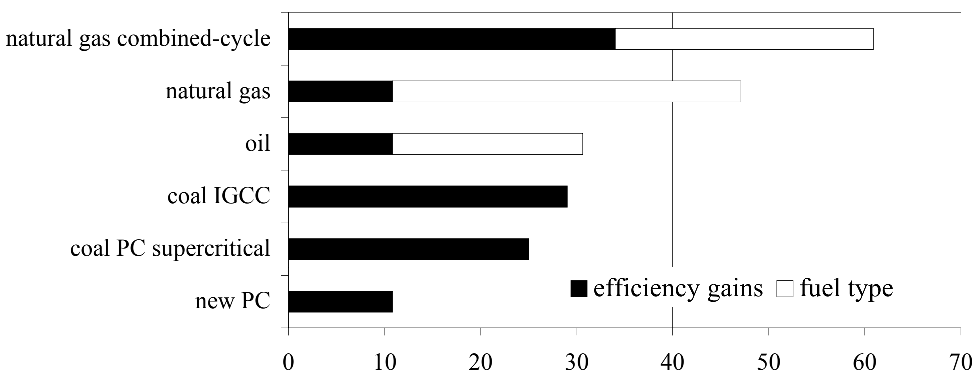


Figure 8. Reduction in carbon/kWh for fuel and technology options, compared with China's average 33% efficiency of coal PCs

*Source:* Charles Johnson and Saengroaj Srisawaskraisorn, 1999.