

The Economic and Environmental Benefits of Integrating International Coal and Natural Gas Markets

By Frank Wolak

Unconventional natural gas and the technologies developed to extract it in the U.S. point to a possible lower carbon energy future for China that can be facilitated through international cooperation between them, improving China's reliance on domestically produced coal, and creating economic and environmental benefits for both countries as well as the rest of the world.

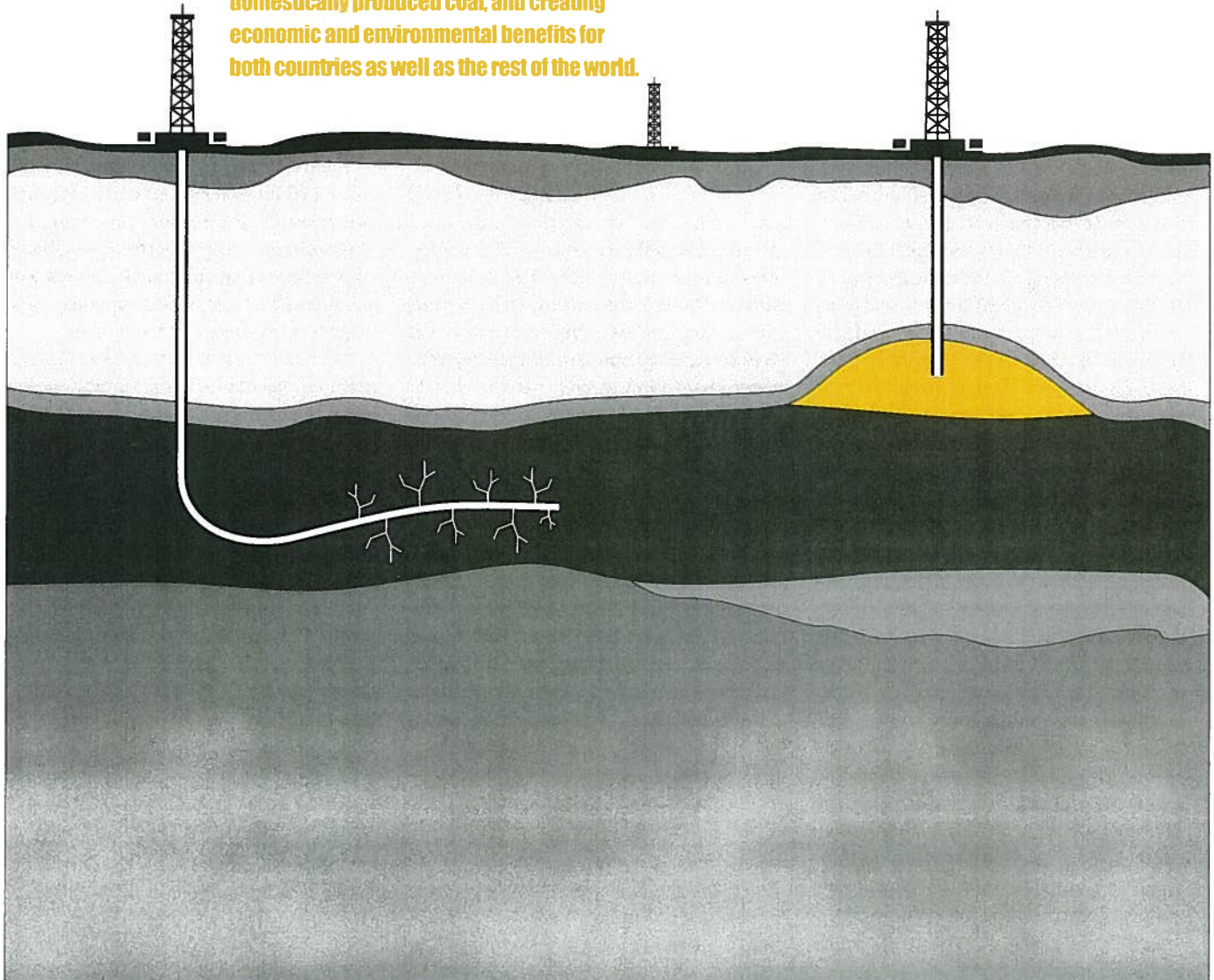


Figure 1: Chinese and Global Coal Consumption in Millions of Tons of Oil Equivalent

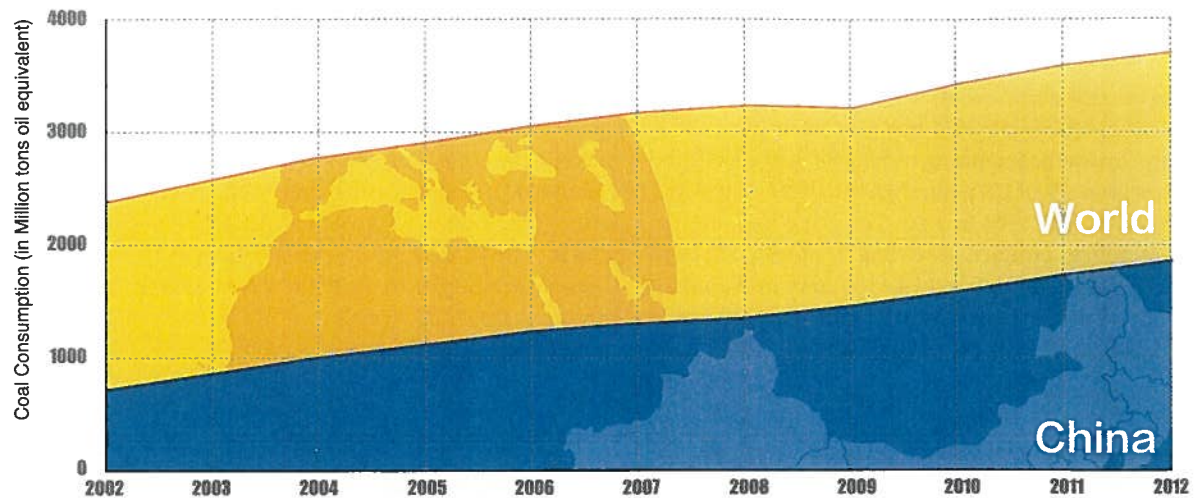
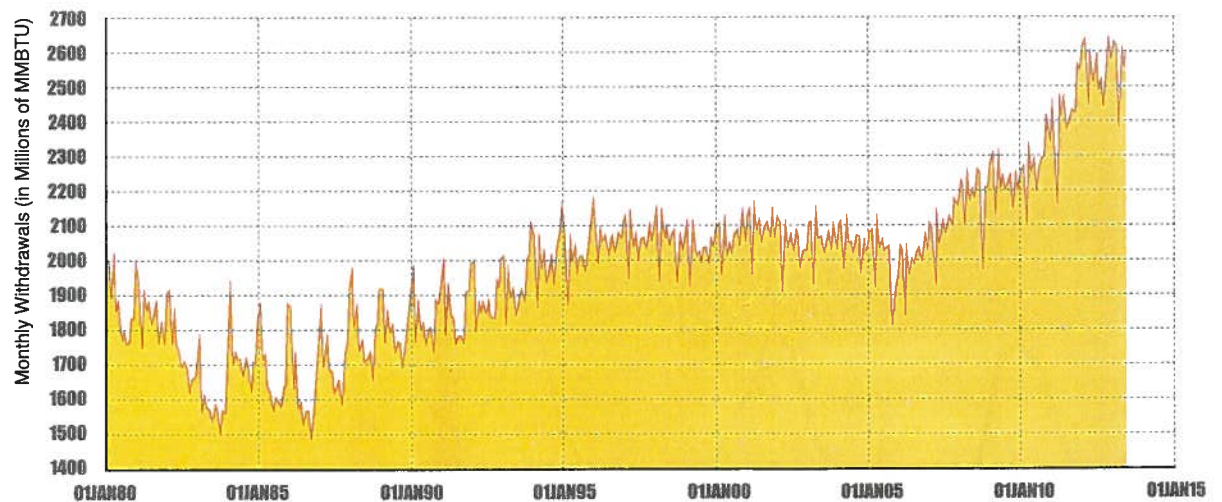


Figure 2: Monthly US Natural Gas Production



China's share of global coal consumption increased from approximately 30 percent in 2002 to slightly over 50% in 2012. Figure 1 shows that over this period, global coal consumption increased by more than 55%, far more than any other fossil fuel. These two facts explain how China has surpassed the United States as the world's largest emitter of greenhouse gas (GHG) emissions.

China's rapid economic growth over the past decade has been primarily fueled by coal. China's large coal deposits, its proximity to major coal exporting countries, and the low per-unit-of-energy price of coal relative to other fossil fuels delivered to Asia makes coal the primary fossil fuel for meet-

ing its rapidly growing energy needs. Moreover, China's desire for a secure supply of energy is a major motivation for its significant reliance on domestically produced coal. For these reasons, without a positive price on GHG emissions, coal is likely to remain the input fossil fuel of choice for China.

Recent developments in the United States point to a possible lower carbon energy future for China that can be facilitated through international cooperation between them. Unconventional natural gas and the technologies developed to extract it in the U.S. have the potential to create economic and environmental benefits for both countries as well

as the rest of the world.

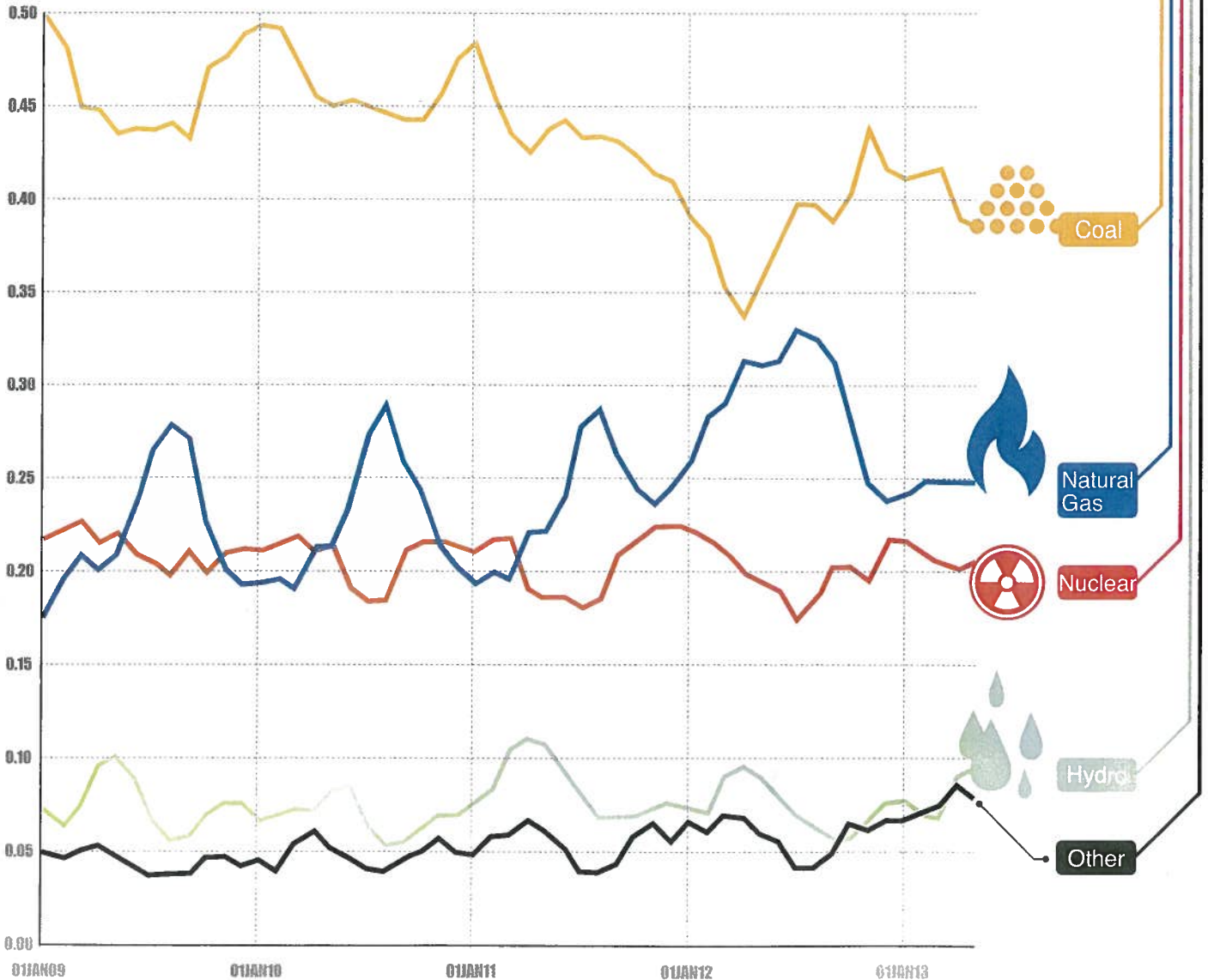
Shale gas extracted using horizontal drilling and hydraulic fracturing technology has gone from less than 2% of US natural gas production in 2000 to more than 28% in 2011. The surge in domestic natural gas production starting in late 2006 shown in Figure 2, has led to historical lows in the inflation-adjusted (real) price of natural gas in the US. These natural gas prices have caused natural gas-

fired electricity generation units to be cheaper to operate than coal-fired generation units in many parts of the U.S.. This had led to the share of US electricity production from coal-fired generation units going from over 50% in 2002 to as low as 34% in April of 2012, as shown in Figure 3.

Because a megawatt-hour (MWh) of electricity produced from the typical coal-fired generation unit produces roughly 1 ton of carbon dioxide (CO₂)



Figure 3: Share of Generation by Input Fuel Type





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and 1 MWh of electricity produced from a modern natural gas-fired generation unit produces 1/2 to 1/3 of a ton of CO₂, this coal-to-natural gas switching has led to a decline in US CO₂ emissions to close to 1990 levels. The absolute decline in CO₂ emissions in the US since 2007 is larger than the decline in CO₂ emissions in any other country over the same time period. Virtually all of this decline is due to the coal-to-natural-gas switching in the US electricity sector.

Transitioning China from coal to natural gas in the electricity sector could have an even greater impact on reducing global CO₂ emissions. Such a transition is also consistent with China's energy security goals, because according to the US Energy Information Administration, *China has the world's largest known reserves of shale gas. If China could develop these reserves, a shale gas revolution similar to what has occurred in the US could occur in China.*

Although China currently has virtually no natural gas-fired generation capacity, given its rapidly growing demand for electricity, the availability of low-priced shale gas is likely to cause more new generation capacity by burning natural gas as opposed to coal. A growing share of electricity produced from natural gas would significantly reduce the growth rate of CO₂ emissions from China. Low-priced natural gas could also replace coal in the provision of district heating, which would further reduce CO₂ emissions as well as significantly limit the production of harmful local pollutants such as sulfur oxides, nitrogen oxides, and particulates.

Thus far, China has had difficulty meeting its shale gas development goals. Limited access to capital to finance shale gas exploration and the fact that an estimated 80% of its shale gas reserves are owned by the large state-owned oil companies (with limited incentives to develop these resources) have been identified as key factors hindering the development of China's shale gas reserves. The geology of shale gas formations in China are also thought to be more complex than those developed in the US.

Working together, the US and Chinese governments can address these challenges. Entrepreneurial US firms, many of which did not exist 20 years ago, have adapted horizontal drilling and hydraulic fracturing technologies to extract natural gas from a number of geologically distinct shale deposits throughout the US. Under the appropri-

ate financial terms and with sufficient protections for the intellectual property employed, these firms should be able to successfully apply their expertise to extract shale gas from the geologic formations found in China.

If the Chinese government allows US firms to develop shale gas resources from the most attractive reserves and provides assurances that, if successful, US investors will earn returns commensurate with the risk they take on, funding to develop China's shale gas reserves should materialize. Creating a favorable climate for US investors is China's best hope for rapidly developing its shale gas reserves.

There are also significant local environmental benefits to China from pursuing this strategy. There are many potential adverse environmental consequences from shale gas extraction. Fugitive methane emissions, groundwater contamination, and micro earthquakes have all been identified as risks associated with shale gas extraction and have been used to slow or even prevent the extraction of shale gas in the US. As a rule, experienced firms have significantly better records at limiting these adverse consequences associated with shale gas extraction in the US. If China is able to take advantage of the accumulated experience of US firms in the exploitation of its reserves, the likelihood of these adverse environmental consequences should be reduced relative to the case that China develops these reserves without US assistance.

US Government should support the use of US technology to develop shale gas in China. A collaborative effort between the US and China that protects US intellectual property associated with shale gas extraction and ensures US investors are adequately rewarded for their successes in the development of China's shale gas will allow China to significantly ramp up its use natural gas. Depending on how successful these efforts are, China may even be able to reduce its use of coal.

International cooperation between the US and China has the potential to yield substantial economic benefits to both countries. Shifting China away from its ever-increasing use of coal has the potential to deliver enormous environmental benefits to the two countries as well as to the global economy. Hopefully, Washington and Beijing will both recognize and take advantage of this unique opportunity for each country to realize an economic and environmental win.