УДК 338.46:621.31

RESEARCH ENERGY EFFICIENCY AND ECONOMIC EFFICIENCY INCREASE OPPORTUNITIES FOR OIL AND GAS INDUSTRY. BARRIERS TO ENERGY EFFICIENCY

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Russia is important to world energy markets because it holds the world's largest natural gas reserves, the second largest coal reserves, and the eighth largest oil reserves. Russia is also the world's largest exporter of natural gas, the second largest oil exporter, and the third largest energy consumer. In 2007, Russia ½s real gross domestic product (GDP) grew by approximately 7.1 percent, surpassing average growth rates in all other G8 countries, and marking the countryï¿½s sixth consecutive year of economic expansion. Russia ½s economic growth over the past five years has been fueled primarily by energy exports, given the increase in Russian oil production and relatively high world oil prices during the period.

Russia ½s economy is heavily dependent on oil and natural gas exports, making it vulnerable to fluctuations in world oil prices. Typically, a $1 per barrel change in oil prices will result in a $1.4 billion change in Russian revenues in the same direction ½a fact that underlines the influence of oil on Russia's fiscal position and its vulnerability to oil market volatility. The government's stabilization fund, a rainy-day storage facility for windfall oil receipts that came into effect on January 1, 2007, is designed to help offset oil market volatility. Even before oil prices reached near-record levels, the fund was expected to be worth almost $52 billion by the end of 2008, or about 7 percent of the country ½s GDP. Raw materials, such as oil, natural gas, and metals, dominate exports and account for over two-thirds of all Russian export revenues.At nearly twice the size of the United States, and encompassing 11 time zones, Russia is by far the world's largest country. Russia also contains some of the world's most abundant natural resources. In addition to huge deposits of fossil fuels, Russia's *other* natural resources include boreal forests that comprise over 20% of the world's forest cover; a vast Arctic tundra; seemingly endless steppe lands (the 'taiga'); and Lake Baikal, the world's largest inland lake, which alone accounts for 20% of the world's freshwater. The Arctic, the Siberian forests, and Russia's Far East regions - home to geothermal resources, indigenous peoples and endangered wildlife - make up ecosystems that are important parts of the world's biological balance.

Oil and Natural Gas Issues.

The oil and gas extraction industries not only contribute to the air pollution problem in Russia, but are also significant sources of pollution in their own right. Environmental standards are weak, enforcement is poor, and small-scale accidents, pipeline leakage, and tanker spills have contaminated many areas of Russia. Oil pipelines in areas like the Tyumen region and Khanty-Mansiysk autonomous district leak significant volumes of oil. Serious health problems from oil pollution have been reported in the more contaminated areas. Heightened concerns about the environmental impacts of oil and gas development in Russia could hinder growth in these sectors. However, the importance of the hydrocarbon sector to Russia's economy could mean that new projects in eastern Siberia will go ahead regardless of the environmental consequences. Planned oil and natural gas pipelines from eastern Siberia to Asian markets are being challenged by environmental groups who claim that Russian officials are ignoring the protected status of the Siberian Plateau (Ukok Plateau), which covers parts of Mongolia, China, Russia and Kazakhstan. Road and pipeline projects will not only incur enormous costs in both construction and maintenance, but they will also have a severe impact on the environment, since they would be routed through highland marshes, tundra, permafrost areas, mountain passes and elevations of up to 1.6 miles. Due to Russia's poor record of protecting the environment, as well as the country's lenient standards and lax enforcement of existing regulations, environmental groups feel that the road and pipeline projects could endanger the Siberian Plateau. However, a proposed oil pipeline from Angarsk in eastern Siberia to Daqing, China, was put on hold in 2003 after the Natural Resources Ministry ruled that the proposed route would violate Russia's environmental regulations (although a different oil pipeline from Angarsk to the Russian Pacific coast at Nakhodka has been proposed and may be built instead of the pipeline to China). In addition, the Natural Resources Ministry, which was created in 2000 through the combination of the functions of the former State Committee for Environmental Protection and the State Committee on Forestry, has been taking a more stringent approach in punishing oil companies for violating environmental terms of their field license agreements.

Energy Consumption.

Between 1992 and 2001, Russia's energy consumption declined 19%, falling from 34.9 quadrillion Btu (quads) to 28.2 quads. The country's economic contraction in the early and mid-1990s, along with the transition from a centrally-planned system to a market-based one, resulted in lower levels of energy consumption. Still, Russia's energy consumption in 2001 accounted for 7% of the world total, making the country the world's third largest energy consumer behind the United States (97.1 quads) and China (39.7 quads). Russia's large industrial sector accounts for over 60% of the country's energy consumption, with the transportation and residential sectors each making up around one-fifth of the total, and the nascent commercial sector accounting for only a small percentage of overall consumption. Russia has the world's largest natural gas reserves, so it is not surprising that natural gas made up more than half (51.5%) of total energy consumption in 2001, followed by oil (19.1%) and coal (18.2%). Natural gas is the principal source of fuel for Russian power plants and domestic Russian natural gas prices are capped by the government below market rates, providing a disincentive to reduce consumption. Russia's long, cold winters require significant natural gas supplies for heating purposes as well, boosting natural gas and overall energy consumption. Per capita energy consumption in Russia was 195.3 million Btu per person in 2001, the highest in Eastern Europe and the Commonwealth of Independent States (CIS). Among large energy-consuming countries, Russia's per capita energy consumption in 2001 was higher than Japan's (172.2) and Germany's (174.3), but lower than in the United States (341.8 million Btu/person).

Energy and Carbon Intensity.

Russia's energy intensity (energy consumption per dollar of GDP) in Russia has decreased only slightly since the collapse of the Soviet Union. The strongest export sectors in the Russian economy tend to be energy-intensive, resource-intensive, and pollution-intensive industries, such as oil, natural gas, timber and metals. Russia also continues to use its abundance of energy resources inefficiently. A somewhat more rational use of energy (leading to lower levels of consumption), as well as strong economic growth since 1999, means that Russia's energy intensity in 2001 stood at 76,852 Btu per $1995 (purchasing power parity, PPP), down from a post-Soviet high of 85,681 Btu per $1995 (PPP) in 1996 and lower than the 1992 level of 78,959 Btu per $1995 (PPP). Although continued economic growth likely will bolster energy consumption, improved environmental awareness, energy efficiency improvements, and marked-based price reforms consequently should lead to a lower energy intensity in Russia in the long-term. Russia's carbon intensity (carbon emissions per dollar of GDP) stood at 1.2 metric tons of carbon per thousand $1995 (PPP) in 2001. Although nuclear energy (which emits no carbon) plays a major role in the Russian energy balance, the country's carbon intensity remains high (relative to other industrialized nations) due to a continued reliance on coal and other fossil fuels. Nevertheless, Russia has become less carbon intensive since 1992, when its carbon intensity was 1.3 metric tons of carbon per thousand $1995 (PPP). Russia's rapidly rising in GDP has more than offset the country's growth in carbon dioxide emissions since 1999, resulting in the decreased level of carbon intensity. However, the country's continued dependence on oil, natural gas, and coal production likely will mean that the country's carbon intensity level will remain relatively high.

Renewable Energy. With the exception of hydropower, Russia's utilization of renewable energy sources remains low relative to its consumption of fossil fuels. Of the country's 205.6 gigawatts (GW) in installed power-generating capacity, hydropower accounts for 21.7% of the total, with 44.7 GW of installed capacity. Russian hydropower plants generated 173.5 billion kilowatt-hours (Bkwh) of electricity in 2001, accounting for 20.5% of Russia's total power output (846.5 Bkwh) for the year. Almost 75% of Russia's hydroelectric capacity is located at 11 power stations with more than 1,000 megawatts (MW) of capacity each, including the 6,400-MW Sayano-Shushenskaya facility in the Krasnoyarsk province, the country's largest power plant. Russia's Unified Energy Systems (UES) is building a number of mega-hydropower projects in the Far East as well, including the 3,000-MW Boguchansk in Krasnoyarsk and the 2,000-MW Bureya hydropower plant. Russia's use of other renewable energy resources is quite small. The Kamchatka Peninsula in the Far East has rich geothermal resources, and an estimated 380 MW to 550 MW of potential geothermal capacity potentially could be exploited there. The first phase of the 200-MW Mutnovskaya geothermal power plant on the Kamchatka Peninsula was put into service in 2002, with the European Bank for Reconstruction and Development (EBRD) providing approximately $100 million in financing for the project.

Barriers to Energy Efficiency

Formidable barriers stand in the way of the implementation of energy-efficient changes. First, energy prices are artificially low because they do not account for environmental or energy-security externalities, such as air and water pollution, greenhouse gas emissions, and other environmental effects, and the costs of ensuring a stable supply of energy imports. A high price for energy, such as the prices in July 2008 for gasoline, natural gas, and coal, would justify the implementation of more efficiency measures. In addition, high prices tend to focus attention on efficiency and conservation, an important factor in potential savings. Unfortunately, wildly fluctuating prices in 2008 wound up undermining the ability of producers and consumers to predict future prices and thus tended to also undermine arguments for investments in efficiency.

Second, current tax policies encourage expenditures on energy rather than on greater efficiency. Energy expenses are considered a current cost while expenditures for efficiency must be depreciated over time.

Third, in most states, utilities' profits go up when they sell more electricity or natural gas, and, logically, they go down by encouraging efficiency. Some states, such as California, have changed the compensation rules to motivate utilities to invest in efficiency rather than increasing energy use. A related issue has been that each utility has exclusive rights to sell its product in its service area, which has impeded the development of combined heat and power, microgrids, and other energy-efficient technologies.

Fourth, the decision about whether to invest in energy efficiency is often made by someone other than the person paying the energy bill. For example, a landlord may select appliances, but the tenant pays for electricity. Similarly, architects and builders, who are motivated to keep the price of a building down, may choose windows, insulation, and other materials with a focus on minimizing first costs rather than minimizing lifetime costs.

Fifth, architects, builders, workers, and customers all need more and better information. If they do not understand the benefits of alternatives, they cannot make informed choices.

Sixth, because energy expenditures are often a small part of the cost of occupying a residence or running a business, they often get little attention.

Seventh, energy-efficient appliances must be mass produced to be competitive with less efficient appli-ances. This cannot happen, however, until a substantial number of customers express a desire for these products. This chicken-and-egg problem can keep products with important advances from entering the market.

Finally, energy-efficient alternatives often have a higher initial price tag than less efficient products. If customers cannot afford the higher price or if they have to pay credit card interest rates, they are not likely to choose the energy-efficient alternative. Examples of improvements in energy efficiency are plentiful. Burning coal to produce electricity to generate light is perhaps 0.8 percent efficient. A modern compact fluorescent lamp (CFL) is roughly four times as efficient as an incandescent lamp. The *New York Times* reports that manufacturers are displaying light-emitting diodes (LEDs) that are 10 times as efficient as an incandescent lamp (Taub, 2009). Another example, is the annual energy use of a refrigerator. Compared to a 1974 model, a new refrigerator, which is both larger and cheaper, would use only 31 percent as much electricity.

Conclusion

Existing technology, or technologies that will be developed in the normal course of business, could save 30 percent of the energy that would have been used by 2030 under current policies and assumptions. About half of that efficiency increase could be achieved by 2020. The energy savings represent a savings in dollars as well as in energy. However, formidable obstacles must be overcome to realize these savings, which will require major public and private support, including product labeling, efficiency regulation, changes in tax policy, and educating and informing designers, builders, operations personnel, and customers about the benefits of energy efficiency.

Finally, special attention must be paid to the design and purchase of long-lived assets, from buildings and automobiles to refrigerators and air conditioners. Because of their long lifetimes, when an energy-inefficient product is purchased, the inefficiency cannot be eliminated until the product is replaced, which may take decades. Therefore, the energy efficiency of long-lived products should be improved, and purchasers should not only have the information they need to appreciate their energy efficiency, but should also have incentives to choose them over less efficient, often lower priced, competitors.