



**ENERGY POLITICS IN EUROPE:  
KILOCALORIES, KILOWATTS AND THE EUROPEAN UNION**

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## **SUMMARY**

**T**he European Union is large, diverse, and like the rest of the world, needs energy to be competitive and maintain, and hopefully to improve, its citizens' standard of living. Unfortunately, since the European Union is a net importer of oil, natural gas, coal and uranium, it is vulnerable to energy shortfalls and higher prices than can have enormously negative impacts on its member countries' economies.

Energy shortfalls may arise from natural disasters, from a variety of accidents, from terrorist activities in many countries, from political disputes and brinkmanship, from "resource nationalism" by the exporting countries, and from depletion of oil and gas basins.

Moreover, the economies of several countries with poor but large and increasing populations, including those of China, India, Indonesia and Pakistan, will require vast additional amounts of food, water, steel, petrochemicals, and certainly energy, in the near future. These countries will increasingly compete with the European Union members for supplies of fuels. Although many large energy projects are planned, and many are underway, current bottlenecks can not be eliminated within the immediate future.

Given the international geopolitical situation and the current energy infrastructure weaknesses, suddenly arising long-duration disruptions should be expected, together with extremely large increases in fuel and electricity costs. In order to handle this situation effectively, it would be advantageous for the European Union countries to cooperate to a significantly greater extent than now being exhibited. As stated succinctly by Benjamin Franklin prior to signing the United States Declaration of Independence: "*We must all hang together in this effort or we shall surely hang separately.*"<sup>1</sup>

The fundamentals of the supply and demand situation must be incorporated into relationships between nations to produce a win-win situation. The alternate is a catastrophic lose-lose dénouement of a worldwide depression and quite possibly military battles over control of energy resources.

This presentation discusses the current international and European Union's energy situations with a focus on the relatively near term problems and opportunities.

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<sup>1</sup> Second Continental Congress, 04-July-1776

## I OVERVIEW

### FUEL USAGE

The world relies on a handful of primary<sup>2</sup> fuels for transportation, lighting, heating and cooling, production and manufacturing, and other purposes that bring health, comfort and quality to lives. These primary fuels fall into three broad categories: fossil fuels (coal, petroleum and natural gas,) nuclear, and “renewable” (hydropower, biomass, wind, solar and geothermal.)

Usage of these within the European Union<sup>3</sup> is illustrated on Figure 1 which shows that oil is dominant, followed by natural gas. Each country, of course, has its unique use profile. Importantly, many European Union countries, as shown on Figure 2, generate substantial percentages of their electricity from nuclear power plants, lowering the potential impact of disruptions to (or higher prices of) hydrocarbon fuels. Conversely, this leads to an increased reliance on a handful of nuclear fuel processing countries.

Within the European Union, the largest use (after conversion losses) of primary energy is, as shown on Figure 3, for transportation, followed by industrial uses, then for residential and commercial buildings. The production of many materials on which modern economies depend is highly energy-intensive. These include chemical products and intermediates such as ethylene, ammonia, methanol, chlorine and paper. Production of major construction materials including iron and steel, aluminum and cement is also energy-intensive. A relatively small amount (6 percent) is used as a feedstock for producing chemicals and construction materials.

While the European Union and the United States consume disproportionately large amounts of fuel on a per capita basis, other countries' economies are growing rapidly. The international oil trade and shipping profile is undergoing dramatic changes, with China, whose economy grew at 9 percent in 2005, becoming a major oil and coal importer. In fact, imports by China have accounted for 40 percent of the increase in oil exports since 2000. India, Indonesia and Pakistan are also countries with growing economies (6.9, 5.5 and 8.4 percent per year increases in gross domestic product, respectively), large populations and currently low per capita energy usage that will undoubtedly increase.

An examination of the overall economic situation in many countries shows that their populations are large and growing, their populations are poor (as measured by per capita gross domestic products) and they lack modern society's amenities (as measured by per capita electricity generation.) See Table 1 and Figure 4.

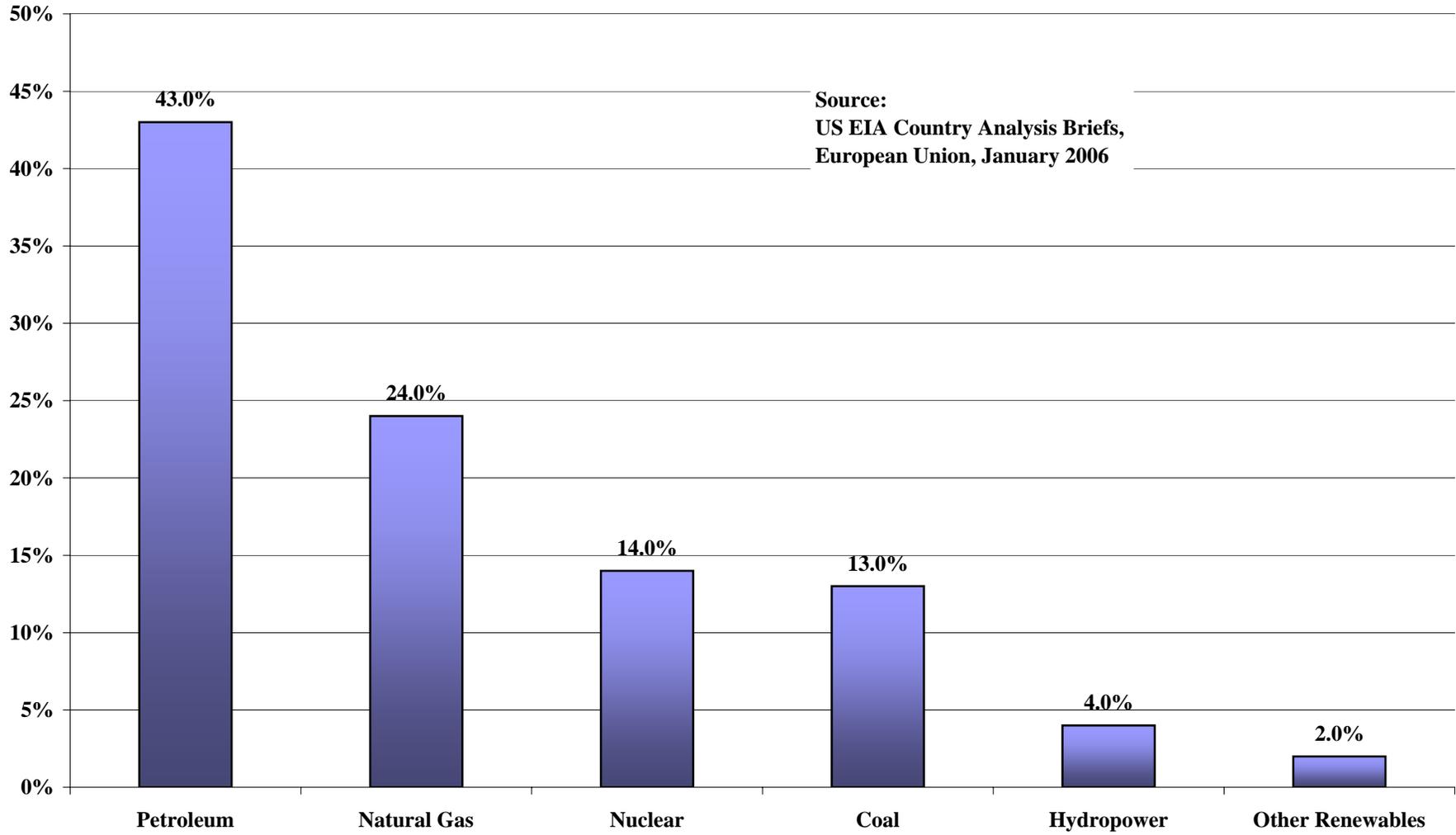
It is certain that world energy use will increase as populations increase. Those of China, India, Indonesia and Pakistan, for example, are increasing at 0.6, 1.7, 1.6 and 2.4 percent

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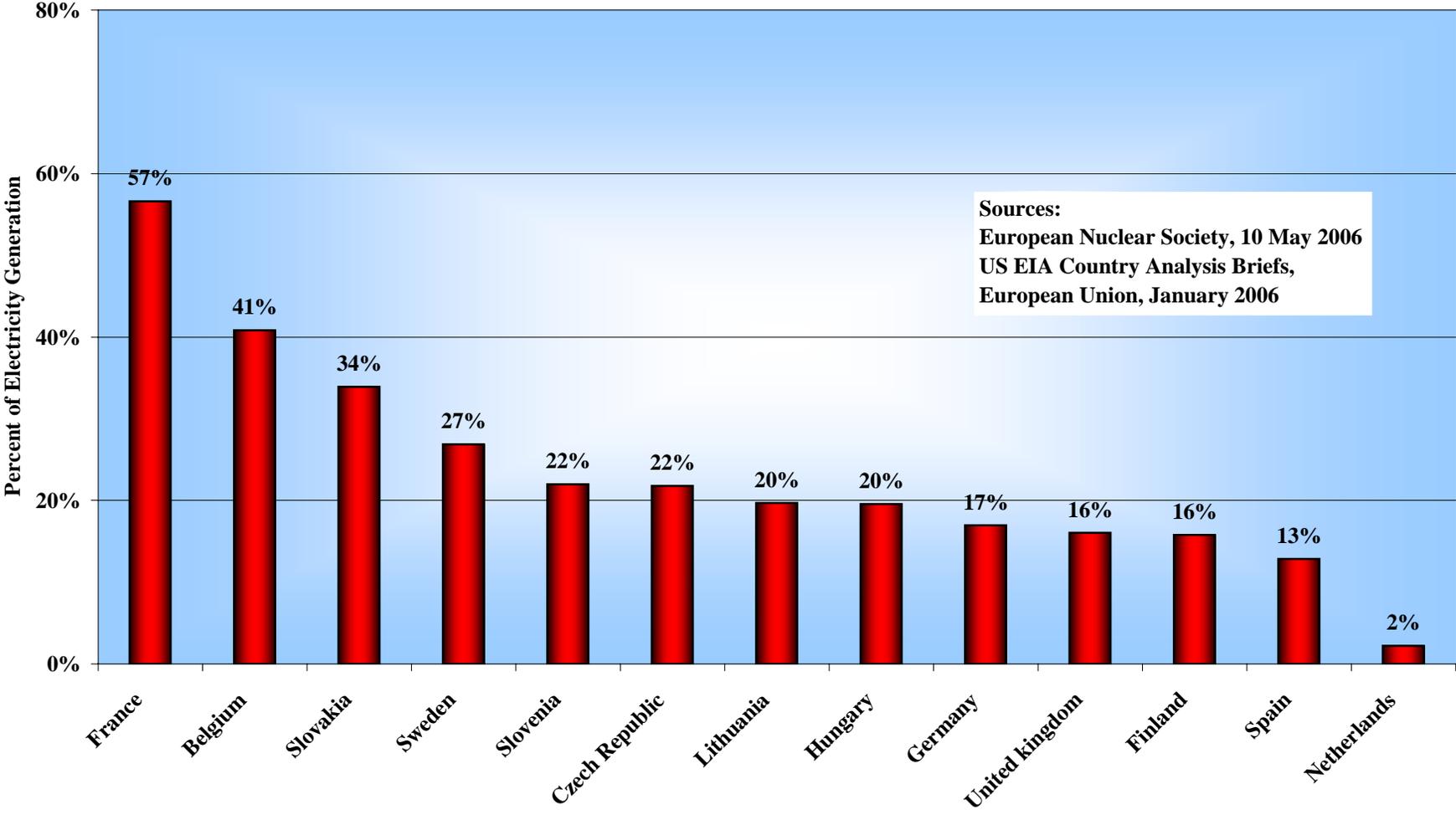
<sup>2</sup> Primary Fuels are those used directly or converted to other types of energy such as Diesel oil, gasoline or electricity.

<sup>3</sup> [U.S.] Energy Information Administration, Monthly Energy Review, Table 1.3, December, 2005

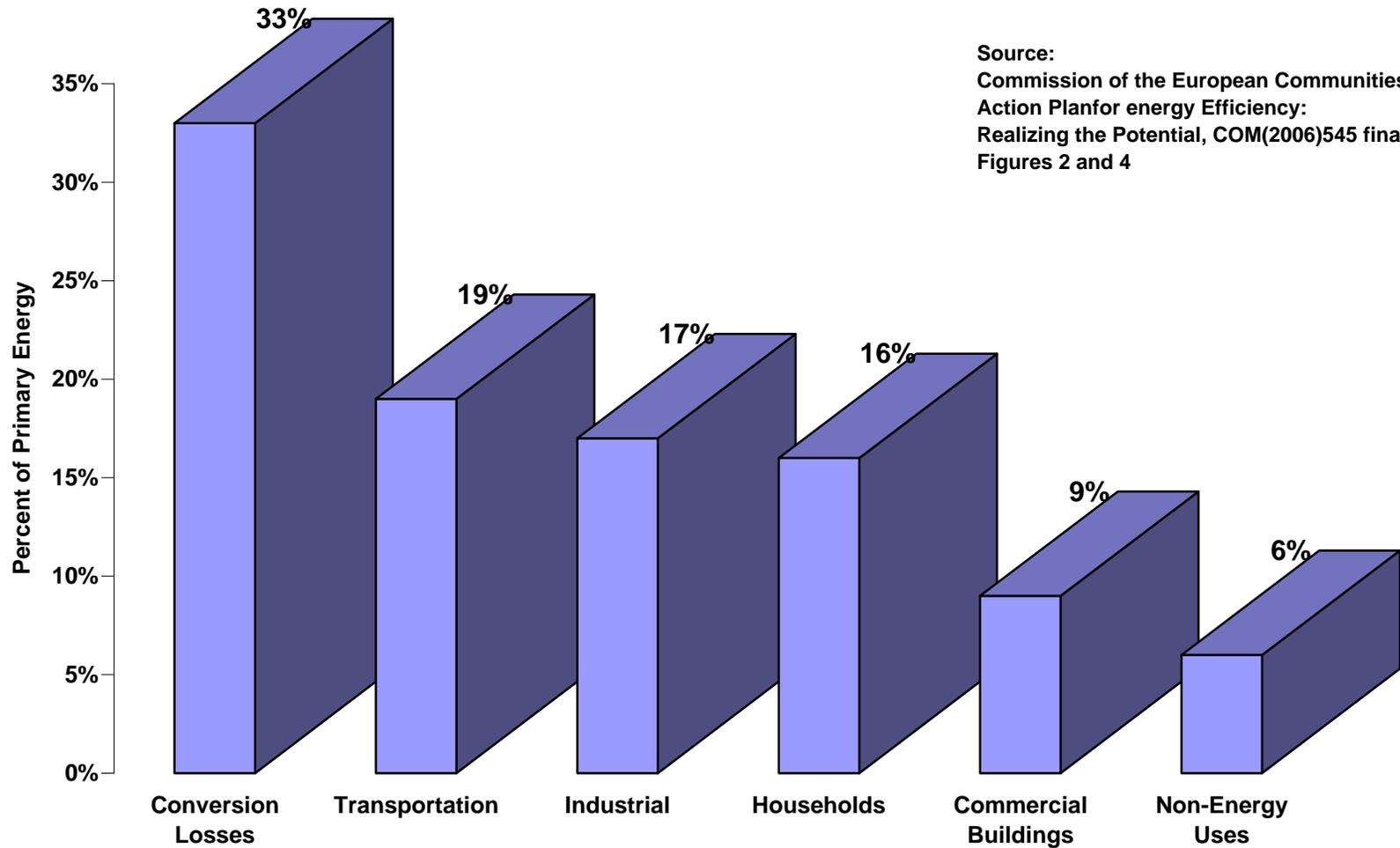
**Figure 1**  
**European Union Primary Energy Usage by Type**



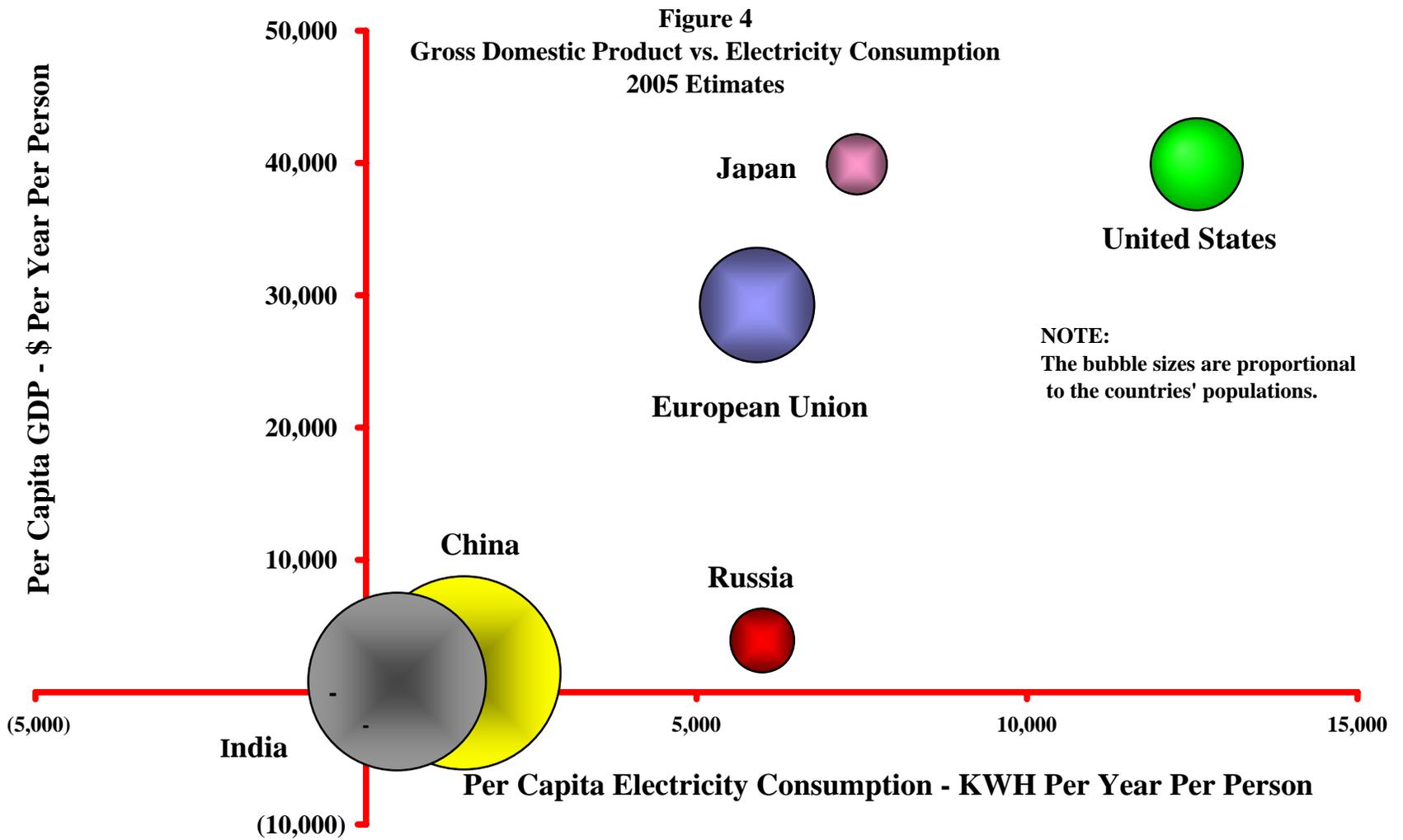
**Figure 2**  
**Nuclear Power Plant Share of Total Generation Capacity**  
**European Union - 2006**



**Figure 3**  
**EU's Uses of Primary Energy**  
**- 2005 -**



Source:  
Commission of the European Communities  
Action Plan for energy efficiency:  
Realizing the Potential, COM(2006)545 final,  
Figures 2 and 4



annually,<sup>4</sup> leading to an additional 34,300,000 people each year in these countries alone who will need energy. Further, the per capita energy use in developing countries must increase to provide a higher standard of living. These factors will certainly lead simultaneously to increased international competition for fossil and nuclear fuels, while many exporting countries will have to use more energy internally, leading to less available for export.

**Table 1**  
**Economic Development**

Country	Population	Annual Per Capita Electric Generation KWH/Yr/Person	Annual Per Capita Gross Domestic Product \$/Yr/Person
China	1,300,000,000	1,390	1,454
India	1,100,000,000	506	735
Indonesia	242,000,000	453	3,419
Pakistan	162,400,000	473	2,138
Russia	142,400,000	6,426	3,933
Nigeria	137,300,000	145	418
Japan	127,400,000	7,986	36,887
Mexico	106,200,000	1,970	7,156
Canada	32,500,000	16,889	29,508
Venezuela	25,400,000	3,444	5,722
<b>United States</b>	<b>295,700,000</b>	<b>13,367</b>	<b>39,901</b>

China, for example, has a rapidly growing economy with a manufacturing sector that requires large increases in fuel supplies. It has therefore recently concluded fuel supply agreements with countries as near as Russia (a major supplier to the European Union) and as far away as Canada and Venezuela. It has also purchased a share of a Canadian oil sands developer and reached an agreement with Enbridge (Canada's second largest pipeline company) to participate in developing a \$2 billion pipeline that will transport oil from Northern Alberta to the West Coast for export to China. In late December 2006, one of China's largest conglomerates, The CITIC Group, purchased the Kazakhstan oil assets of a Canadian company. Additionally, the China National Petroleum Corp. owns 40 percent of Sudan's Greater Nile Petroleum Operating Company that produces 350,000 barrels per day of crude oil. (In fact, 10 percent of China's oil comes from Sudan.)

<sup>4</sup> Population Reference Bureau, Washington, D.C. [www.prb.org]

Looking to insure its future, the Chinese oil and gas company (Sinopec) and the National Iranian Oil Co. (NIOC) have agreed to explore for oil and gas in central Iran, and the China National offshore Oil Corp (CNOOC) is in talks with NIOC to develop the offshore North Pars field which is estimated to have 1.4 trillion cubic meters<sup>5</sup> of gas reserves. These aggressive steps to insure its own fuel supply are certainly understandable, but do result in less oil and gas being available for other countries such as the members of the European Union.

The member countries of the European Union, unlike most other countries are experiencing a strong decline in birthrates. Not a single one, possibly excepting Ireland, is at the 2.1 births per woman that it takes to sustain a population level other than by immigration. Several members are now at rates of 1.2 to 1.3.<sup>6</sup> Even with these low population growth rates, the European Union's primary energy demand is forecasted to increase by:<sup>7</sup>

- Oil – 2.0 percent per year
- Gas – 2.7 percent per year
- Coal – 1.7 percent per year

### **FUEL SOURCES ARE INTERNATIONAL**

Every country has reserves, varying from miniscule to enormous, of some of the fossil fuels, and many have uranium-bearing ores. Relatively few countries, however, have them in sufficient quantity, quality, concentration and accessibility to make it economically practical to produce and export them. The reserves of fossil fuels within the European Union are shown on Table 2

**Table 2  
European Union's Primary Fuel Reserves<sup>8</sup>**

Type	Proven Reserves
Coal - Billion Short Tons	38.979
Natural Gas - Trillion Standard Cubic Feet	113.69
Petroleum - Million Barrels	7,527

Estimates of reserves provided by various countries and companies are, however, somewhat questionable for several reasons.

Exports of primary fuels are certainly important revenue sources. For example, the twelve members of the Organization of the Petroleum Exporting Countries (OPEC)<sup>9</sup>

<sup>5</sup> Multiply normal cubic meters by 37.33 to obtain standard cubic feet (includes different temperature bases)

<sup>6</sup> Eurostat, quoted in The New York Times, September 4, 2006

<sup>7</sup> IEA Forecast

<sup>8</sup> [U.S.] Energy Information Administration, Annual Energy Review, Table 1, 2003

<sup>9</sup> Algeria, Indonesia, Iran, Iraq, Kuwait, Libya, Nigeria, Qatar, Saudi Arabia, United Arab Emirates, Venezuela. Angola became a member on 01-Jan-07.

derive virtually all their incomes from oil sales. Although not scrupulously adhered to, production quotas are nevertheless important, and these are assigned by OPEC based in large part on estimated reserves. Relatively few countries, however, exhibit any degree of transparency or offer data that would allow independent estimates of reserves.

In the private-industry sector, reserves shown as assets on balance sheets impact the valuation of companies, occasionally leading them to publish highly exaggerated estimates. The Royal Dutch/Shell Group had, as a notable example, overstated its reserves by 5.63 billion barrels in 2005 and had to ultimately reduce its estimate by 41 percent to 13.72 billion barrels. The United States Department of Justice is now conducting a criminal investigation of the situation.

In addition to deliberate mischaracterizations, there are in fact many technical uncertainties in estimations. These relate to the physical properties of the basin or mine, the extraction techniques and rates contemplated.

These factors, and a need for more accurate and timely data, have led to an agreement by seven organizations<sup>10</sup> and 90 countries to attempt to foster transparency by creating the Joint Oil Data Initiative (JODI) in April 2003. It assesses and consolidates the data of other groups and publishes a comprehensive database on a monthly basis showing production, demand and closing stock levels of crude oil, diesel oil, fuel oil, gasoline, kerosene, LPG and total oil.

Production of any nonrenewable material such as crude oil or natural gas comes initially from the sources that are easiest and most economical to develop and then, as these are depleted, from increasingly more difficult and more expensive sources and/or by use of more complex technologies. As development challenges are overcome, new sources will very significantly increase the availability of oil and gas, but only after perhaps five to ten years from today. In time technological and economic barriers to developing underutilized sources of fuels such as coal bed methane and sub-sea hydrates will also be overcome. This will, however, not occur within the immediate future that is the focus of this presentation. The world will not “run out” of oil or gas in the foreseeable future; prices will simply increase, perhaps dramatically, to compensate for higher extraction, transportation and refining costs. They are also likely to rise because various groups such as OPEC or individual countries such as Russia and Algeria can use their near monopoly powers to increase prices or withhold supplies from the market.

**Coal:** Although coal is widely scattered throughout the world, 81 percent of the currently economically recoverable reserves are found in six countries; the United States (27 percent), Russia (17 percent), China (13 percent) and India (10 percent), Australia (9 percent) and South Africa (5 percent). The European Union countries have only 4 percent of the world’s coal reserves. Lead by Germany, Poland, Greece and the Czech

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<sup>10</sup> Asia Pacific Research Centre (APEC), Statistical Office of European Communities (Eurostat), International Energy Agency (IEA), International Energy Forum Secretariat (IEFS), Latin American Energy Organization (OLADE), Organization of Petroleum Exporting Countries (OPEC) and the United Nations’ Statistical Division (UNSD)

Republic the European Union does produce approximately 77 percent of its total coal consumption of 837,000,000 tons. Coals, also like crude oils, differ with respect to composition to greater or lesser extents. They are broadly classified as anthracite, bituminous, and sub-bituminous, with several finer gradations. On a world-wide basis approximately 84 percent is “steam coal,” used in utility company boilers for electrical production, and approximately 12 percent is “coking coal”, used directly for steel production.<sup>11</sup>

**Uranium:** Because of its military uses, there is significantly less transparency about uranium import sources, quantities and costs than there is for hydrocarbons and coals. The major producers of newly mined and processed uranium are shown on Figure 5. Secondary sources are also significant, such as from nuclear weapons, reprocessed uranium and re-enrichment of the low concentration “tails” from enrichment plants.

### **Renewable Energy**

The European Union has set a goal<sup>12</sup> of doubling the share of energy that is provided by renewable energy from 6 percent in 1995 to 12 percent in 2010 in order to reduce the amount of hydrocarbon-based fuels consumed. One specific target<sup>13</sup> is to increase the share of green electricity from 14 percent in 1997 to 22 percent in 2010. Member countries are now experimenting with ways to accomplish this, such as use of feed-in tariffs paid by utility companies to domestic producers of Green Energy, or issuing Green Certificates that must be purchased by users, or bidding systems.

Another specific target<sup>14</sup> is to raise the share of biofuels in transport fuel market to 5.75 percent (based on energy content) of all transport petrol and diesel by December 2010. This was facilitated in part by the Common Agricultural Policy reform of 2003 that now allows direct payments for non-food crops produced on any land without loss of financial support. In June 2006, the Members of the European Parliament further established strong support for renewable energy (and efficiency improvements) by voting to devote two thirds of the non-nuclear energy research budget to these matters through 2013. Biofuel production was then further encouraged on 1 January 2007 when the European Union Parliament enacted further legislation that provides farmers with a premium of €45 per hectare of land used for producing biofuels.

Several countries, in fact, are strongly encouraging use of renewable fuels. Although producing energy from biomass is generally more expensive than from fossil fuels, even with crude oil at \$70 per barrel, utility companies in Germany, for example, are legally required to purchase electricity generated from renewable fuels, including biomass, at stated above-market prices for a 20-year period.<sup>15</sup>

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<sup>11</sup> The World Coal Institute, Coal Facts, 2005 Edition

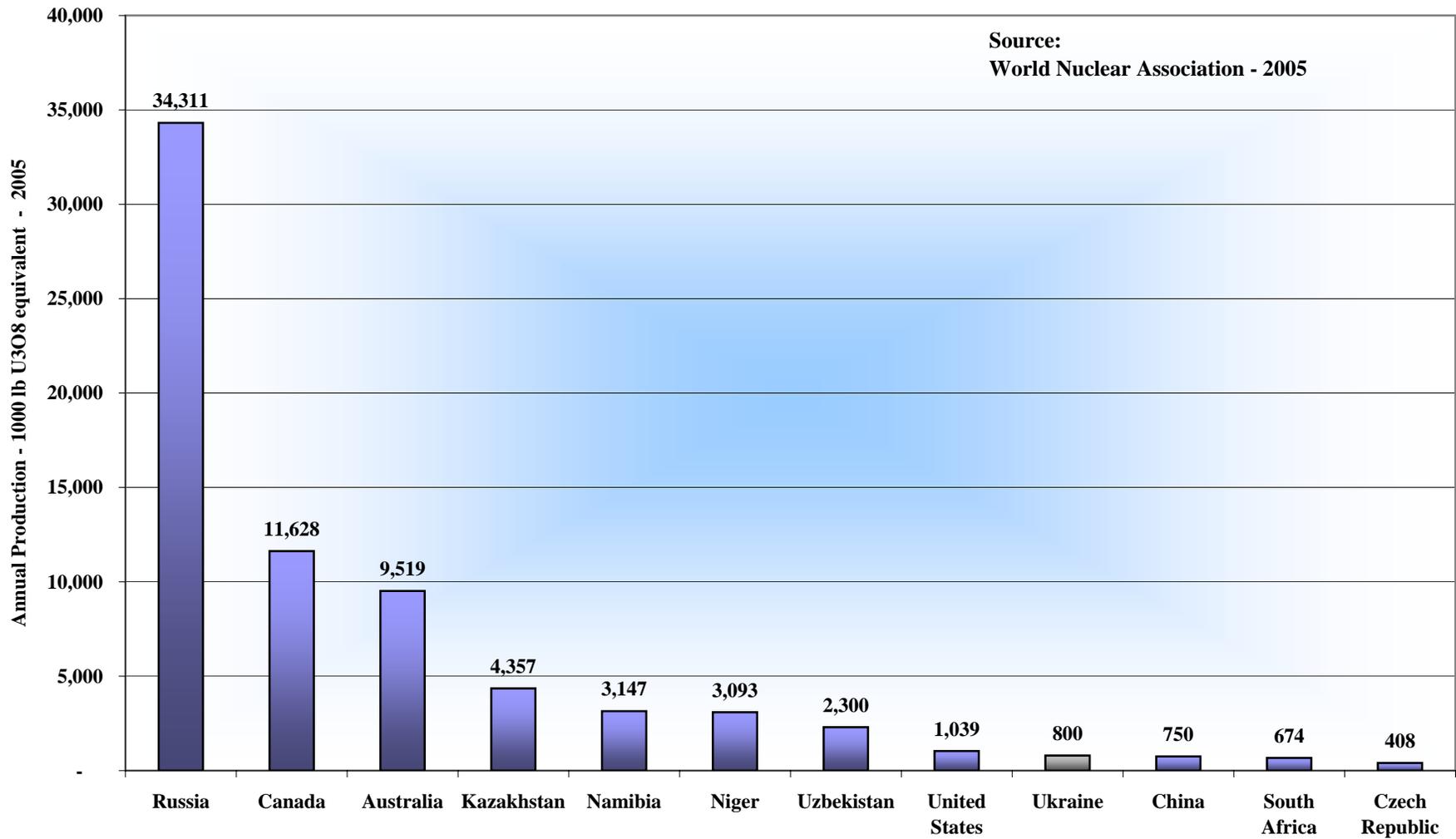
<sup>12</sup> Directive 2003/30/EC

<sup>13</sup> Directive 2001/77/EC

<sup>14</sup> Directive 2003/30/EC

<sup>15</sup> Erneuerbare Energien Gesetz, March 31, 2000, Bundesgesetzblatt I/13, p. 305

**Figure 5**  
**Uranium Producing Countries**



Within the European Union, biomass (wood waste, straw, animal and vegetable wastes) displaced 61 million tons of fuel oil, which represents 4 percent of the primary energy used during 2006.<sup>16</sup>

**Hydropower:** Hydropower is a major source of electricity throughout the world. It, however, leads to many difficult environmental and social problems and therefore, with the exception of China, will not have an important role in new electrical generation for many years.

**Solar and Wind:** These energy sources, unlike other renewables, are unquestionably environmentally benign. Economic hurdles are being overcome and, in technically suitable sites, these are being increasingly used. Currently 80 percent of all global wind power is produced in the European Union; 90 percent of this from Germany, Spain and Denmark. Much progress is being made in decreasing the high capital costs required to obtain and install these technologies. Faced with their high costs and intermittent operation, these technologies, however, also will not have an important role in new electrical generation for many years.

### **European Union Energy Imports**

**Crude Oil:** The European Union produces only about 2,160,000 barrels of oil per day<sup>17</sup> and is a net importer of crude oil. As a group, the OPEC countries have the world's largest hydrocarbon reserves and are the largest exporters, accounting for approximately 45 percent of the European Union's crude oil imports. As critical as OPEC is however, the European Union obtains crude oil and hydrocarbon products from many other countries, particularly including Norway and Russia, which are not members of OPEC. During 2005 the European Union used 14,738,000 barrels per day, of which 2,911,000 were internally produced and 11,827,000 were imported.

**Natural Gas:** The European Union (mainly The Netherlands and the UK) produced approximately 6,250 billion cubic feet of natural gas in 2006.<sup>17 above</sup> It, however, is also a net importer of natural gas which comes primarily from Russia (40 percent), Algeria (30 percent) and Norway (25 percent.) During 2005 the European Union used 17,041 billion cubic feet of natural gas, of which 6,447 were internally produced and 10,594 were imported.<sup>18</sup>

**Liquefied natural gas:** Liquefied natural gas (LNG) is the fastest growing segment of the energy sector throughout the world, averaging 10 percent per year. The world's major LNG producing countries are Qatar, Indonesia, Malaysia, Algeria and Australia. The total European Union imports of LNG, as shown on Table 3, were 40.9 billion cubic meters in 2005, which represents approximately 23 percent of the world's total.

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<sup>16</sup> Euractiv, Biomass Action Plan, [www.euroactiv.com/en/energy/bio-action-plan/article-155362](http://www.euroactiv.com/en/energy/bio-action-plan/article-155362), updated 4 January 2007

<sup>17</sup> Oil & Gas Journal, Page 62, January 8, 2007

<sup>18</sup> Eurogas, Statistics 2005, pages 25 and 28

Unlike natural gas delivered by pipelines, LNG delivered by ships can be readily diverted to another destination for operational or financial reasons; this is not an extremely unusual occurrence.

**Table 3**  
**European Union Imports OF LNG<sup>19</sup>**

<b>Importing Country</b>	<b>Billion Cubic Meters</b>	<b>Percent of World's Total LNG Imports</b>
<b>Spain</b>	<b>21.4</b>	<b>12.1</b>
<b>France</b>	<b>12.2</b>	<b>6.9</b>
<b>Belgium</b>	<b>2.5</b>	<b>1.4</b>
<b>Italy</b>	<b>2.3</b>	<b>1.3</b>
<b>Portugal</b>	<b>1.6</b>	<b>0.9</b>
<b>United Kingdom</b>	<b>0.5</b>	<b>0.3</b>
<b>Greece</b>	<b>0.4</b>	<b>0.2</b>
<b>Total:</b>	<b>40.9</b>	<b>23.1</b>

**Uranium:** Because of its military uses, there is significantly less transparency about uranium import sources, quantities and costs than there is for hydrocarbons and coals. Nevertheless it is clear that although the Czech Republic, Germany and France produce small amounts, the European Union imports virtually all of the natural uranium it consumes.

**Coal:** The use of coal has declined very substantially in Western Europe because of the increased availability and use of natural gas, and in the Eastern European countries because of their deteriorating economies. The European Union, as a whole, is a net importer of steam coal for producing electricity and of coking coal for the steel industry's blast furnaces. During the twelve-month period ending June 30, 2006, imports were approximately 143,994,000 and 38,017,000 metric tons, respectively.<sup>20</sup> The largest coal imports into the European Union came from South Africa, The United States, Australia and South America.

## **II - THE ENERGY-RELATED ISSUES**

### **ENVIRONMENTAL**

Although the production and use of fuels leads to environmental challenges with respect to solid and liquid discharges, the major long-term issue is that there is overwhelming evidence that global warming is occurring at an alarmingly dangerous rate, that carbon dioxide is a major contributor, and that emissions of it must be reduced. These have lead

<sup>19</sup> Table 2, LNG Observer, 3(3), July-September 2006

<sup>20</sup> Directorate General for Energy and Transport, European Commission, B-1049, Brussels (available at <http://EC.Europa.European Union>)

to the Kyoto Protocol, which the European Union has ratified as a binding obligation, that calls for a reduction of greenhouse gas<sup>21</sup> emissions to 92 percent of those experienced during 1990.

The European Commission has set a goal of meeting the requirements of the Kyoto Protocol partly by increasing the efficiency of generation and usage and partly by increasing the amount of renewable energy used. Taking a coordinated approach to climate change and meeting the terms of the Kyoto Protocols, a European Union-wide CO<sub>2</sub> cap-and-trade system (with quotas for six key industries<sup>22</sup>) and a European Union-wide renewable energy approach, including a Biomass Action Plan<sup>23</sup> have been enacted. It appears, however, that actual emission reductions will fall short of requirements, and additional investments of €1.6 billion per year will be required to meet the 12 percent target by 2010. Germany's decision to exempt its coal mines from Kyoto requirements will only exacerbate the situation.

Among the elements of various energy-related plans that will be announced during 2007 are offering rewards through tax credits for increases in efficiencies of using energy. Member countries, however, have always been categorically opposed to any effort to interfere with their sovereign rights to set their own tax policies and rates. It will be very difficult, if not impossible, to obtain agreement on this approach. It will, likewise, be difficult to arrive at a harmonized approach to implementing penalties for polluters.

### **FUEL PROCESSING PRESENTS BOTTLENECKS**

**Crude Oil:** All crude oils differ to greater or lesser extents with respect to composition. As cumulative production from a given basin increases, the next incremental quantities tend to be heavier, requiring more intensive processing, limiting refinery production rates, and yielding less of the desirable materials. Newly produced crude oils now being marketed also tend, in many cases, to contain high percentages of sulfur and therefore can not be processed in many refineries. Desulphurization capacities in refineries are definitely constraints. Other problems with many newly produced crude oils include high amounts of water and salts which can overwhelm crude oil desalters, and high acid contents, leading to unacceptable corrosion rates. These and other problems that limit the usefulness of many crude oils, together with a lack of spare refining capacity throughout the world, are causing bottlenecks in the crude oil supply chain.

**Natural Gas:** Natural gases, like crude oils, differ with respect to composition to greater or lesser extents. Processing, however, is simpler, most often limited to removing hydrogen sulfide and carbon dioxide by well established solvent absorption processes, adjusting the volumetric heating value by adding compounds, drying and adding odorizers. Many gas plants are integral parts of oil refineries; excess gas plant capacity is not known.

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<sup>21</sup> Carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>), nitrous oxide (N<sub>2</sub>O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF<sub>6</sub>)

<sup>22</sup> Production of brick, cement, energy, glass, paper/cardboard, steel

<sup>23</sup> COM(2005) 628 7.12.2005

**Liquefied Natural Gas (LNG):** LNG is an internationally used commodity that is produced in the exporting countries by using large-scale liquefaction plants that operate at very low temperatures. The LNG is then delivered by specially designed ocean-going tankers, then regasified by heating it at the receiving terminals and finally introduced into the gas distribution pipeline system. LNG as usually produced, however, has a relatively high concentration of ethane and heavier hydrocarbons, leading to volumetric heating values that do not fall within the limits required for various markets. Regasification plants therefore also contain processes for adjusting the heating value of their product. Although it is possible to deliver LNG to an end-user for local on-site use, in fact however, virtually all imported LNG is regasified at the import terminal.

Liquefaction facilities are very capital intensive and are experiencing rapidly increasing costs. They, moreover, have experienced various startup and operating problems. Currently the world has a liquefaction capacity in mid-2006 of 184 million tons per year. Receiving terminals, however, are operating at approximately 90 percent of production capacity.<sup>24</sup> Today's bottleneck is thus inadequate liquefaction capacity.

**Uranium:** Nuclear fuel results from converting naturally occurring uranium ore to the more concentrated product,  $U_3O_8$ , commonly known as yellowcake. This is then further processed by chemically converting it to uranium hexafluoride and enriching its U-235 concentration in a gaseous diffusion or a gas centrifuge plant to a level of 3 percent to 5 percent for commercial power reactors, and simultaneously producing a "waste stream" (tail) of 0.35 percent U-235. An alternate approach is to downblend (dilute) highly enriched uranium from military surpluses from the former Soviet Union and United States to produce the required lower concentration. Ex-military material now, in fact, provides 45 percent of the utility market's needs.<sup>25</sup> Downblending obviously has a major political component.

The enriched uranium is then converted into uranium dioxide,  $UO_2$ , fabricated into small pellets, and then into larger fuel assemblies for use in reactors.

The work required to enrich uranium is commonly expressed as Separative Work Units (SWU);<sup>26</sup> the capacity of a uranium enrichment plant is commonly expressed as SWU per year, analogous to a refinery's capacity being expressed as barrels per day. Because of its military significance, the world-wide SWU capacity can not be precisely established from the open published literature. The International Atomic Agency, however, lists the capacity of eight countries (plus "others"), totaling 51,750,000 SWU as of 2006.<sup>27</sup> These are shown on Figure 6, on which it can be seen that four of them, although with relatively

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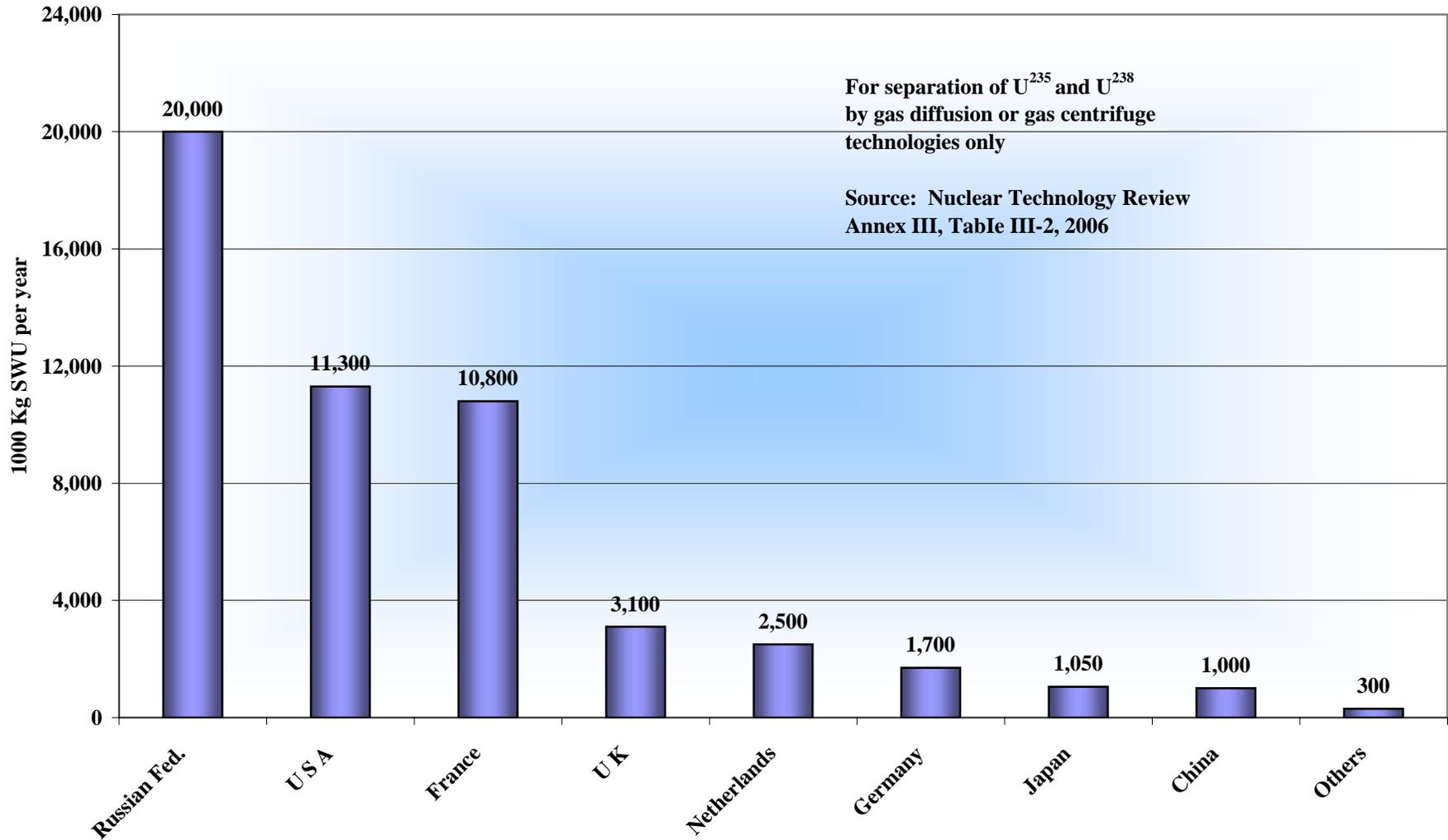
<sup>24</sup> Flower, A., Will 2007 dispel disappointment sown by 2006?, LNG Observer, January –March 2007

<sup>25</sup> World Nuclear Association, Uranium Markets, October 2004

<sup>26</sup> SWU (more precisely, Kg-SWU or Lb-SWU) is a mathematical function relating work requirement to the quantities of feed, product and waste materials, and their concentrations. Typically, it takes 4.3 SWU to produce 1 kilogram of 3.5 percent U-235. A 1,000 MW reactor requires approximately 100,000 to 120,000 SWU per year.

<sup>27</sup> International Atomic Energy Agency, Vienna, Austria, Nuclear Technology Review, Table III-2, p. 79, 2006

**Figure 6**  
**Separative Work Units**  
**(By Country)**



small capacities, are members of the European Union. Assuming no significant changes in the cost of producing and shipping uranium hexafluoride, the concentrations of products leaving the enrichment plants, and, importantly, that downblending activities continue, then the current enrichment demand can be comfortably met for several more years. Capacities for conversion of yellowcake to UF<sub>6</sub> and for fuel fabrication are also being met.<sup>28</sup>

Conversely, various European Union member countries do possess capacities for handling the enrichment of uranium and fabrication to fuel pellets and assemblies.

World-wide uranium mining capacity is now only providing 55 percent of today's demands by 441 civilian nuclear power plants for uranium oxide. The balance is supplied from utility company stockpiles or recycled military material. This, however, will become increasingly difficult to maintain since utility stockpiles have been drawn down, China has announced it will build 29 additional nuclear power plants by 2020 and India announced it will build 8 additional nuclear power plants by 2017; permits and financing have been secured for these. Russia, moreover, has decided to limit its uranium exports to conserve nuclear resources for the 25 nuclear power plants it plans to build by 2020.

Two countries, Iran and North Korea, have announced that they will proceed with vertically integrated nuclear facilities, including the enrichment activities. These, of course, have major political dimensions that are beyond the scope of this paper.

A new European nuclear power plant is now being constructed in Finland, and Romania has started work on a plant that was abandoned on 1990. Approvals for new nuclear power plants have been given by France and Bulgaria, and the Czech Republic is planning two more within the next few years. Additionally, the UK and Germany are reconsidering their decisions to not construct and operate new nuclear power plants. Regardless of the outcome of the enrichment dispute, the additional nuclear power plants that are coming online or have secured the necessary approvals will require additional enriched uranium.

Increasing demand has resulted in the price of Uranium increasing from \$18 in the 1990s to \$62 in mid-2005 to \$112 per kilogram of uranium in May 2006.<sup>29</sup> It is therefore not at all clear what the price of nuclear fuel will be in the future, or for how long the supply of nuclear fuel assemblies will be adequate. It is noted that the Environmental Permitting process for virtually all parts of the nuclear fuel cycle is lengthy.

**Coal:** The coal mining industry is experiencing two serious problems. The major long-term issue, as noted above, the European Union's commitment meeting the requirements of the Kyoto Protocol. Combustion of coal unfortunately produces 80 percent more carbon dioxide (a greenhouse gas) per unit of energy than from natural gas and 20

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<sup>28</sup> Euratom Supply Agency, Analysis of the Nuclear Fuel Availability at European Union Level from a Security of Supply Perspective – Final Report of the task Force, June 2005

<sup>29</sup> Ux Consulting Company (www.uxc.com)

percent more than from residual fuel oil. Much theoretical and research effort is underway to develop practical processes to capture and sequester the carbon dioxide from power plants. To date, however, no large-scale processes have been shown to be technically or economically practical.

A second issue is that key mining components such as specialty steels and the very large tires used on mine trucks have become scarce throughout the world, and in some cases unavailable at any cost; this could become a major bottleneck. The extent to which coal production could be increased if necessary is not clear. Coal preparation plant capacity and the coal transportation system may limit producers' ability to deliver substantial amounts of additional coal.

### **FUEL PIPELINE TRANSPORTATION PRESENTS A BOTTLENECK**

Although promising discoveries of new oil and gas fields occur throughout the world, often in remote and harsh locations, they will be useless unless their raw products can be moved to refineries. Crude oil and liquid products are transported from the oil wells to refineries by combinations of pipelines and ocean-going tankers, and to a smaller extent by trucks, railroads and barges. Each mode has a critical role.

Although the international shipping industry has a history of boom and bust cycles, it appears that trans ocean shipping will not be a weak link in the energy supply chain.

**Pipelines:** Pipeline transportation is important, and usually the only economically feasible possibility, for moving large amounts of crude oil or gas from interior wells to ports. Examples that are particularly important to the European Union include the 840,000 barrel per day *Baltic Pipeline System* connecting Western Siberia to the Gulf of Finland, and the *Caspian Pipeline Consortium* that transports approximately 400,000 barrels per day from Kazakhstan's northern Caspian Sea basin across Russia to Novorossiysk on the Black Sea. The crude oil, from both of these pipelines then moved by ocean-going tankers to the international market. Kazakhstan has now started flow through a new pipeline that carries oil to Western China, allowing export that does not cross Russia. The *Baku-Tbilisi-Cehan Pipeline* is also now in service and will soon carry 1,000,000 barrels per day 1,100 miles from Azerbaijan through Georgia to the Ceyan Terminal on the Mediterranean coast of Turkey, avoiding the tanker congestion delays in the Turkish Straits. Approximately 1,200,000 barrels of crude oil per day are also delivered to Eastern Europe by Russia through the *Druzhba (Friendship) Pipeline*.

Fuel gas is transported internationally and within most countries through a series of pipelines. Currently, the world's largest gas exporter, Russia, sells 565 billion cubic feet per year to European customers, delivered through Turkey via the 750-mile long *Blue Stream Pipeline*, 246 miles of which is located beneath the Black Sea at a depth of 7,000 feet. Gazprom and its minority partners, BASF and E.ON, have started construction of the *Nord Stream Pipeline* (formerly the North European Gas Pipeline) that will connect an existing Russian gas pipeline network to the port of Vyborg on the Gulf of Finland, and then under the Gulf and the Black Sea to Greifswald in Northeastern Germany, with

an initial capacity of 970 billion cubic feet per year. An important strategic consideration is that this route bypasses Belarus, Estonia, Poland, Latvia, Lithuania and Ukraine. Polish Prime Minister Kaczynski has expressed his objection that it will make the current pipeline irrelevant, eliminating transit fees that his country receives. Gerhard Schröder, formerly Chancellor of Germany, has been appointed Chairman of the pipeline company.

Continental Europe also receives large amounts of natural gas via pipeline from two other sources. *The Enrico Mattei Pipeline*, (formerly named the Trans-Mediterranean (Transmed) Pipeline) carries 900 billion cubic feet of gas per year from Algeria via Tunisia, 96 miles of which pass under the Mediterranean Sea at a depth of 2,000 feet, to Sicily and mainland Italy. *The Pedro Duran Farell (PDF) Pipeline*, (formerly named the Maghreb-Europe Gas (MEG) Pipeline) carries 300 billion cubic feet of gas per year from Algeria via Morocco, 28 miles of which pass under the Strait of Gibraltar at a depth of 1,312 feet, to Cordoba, Spain. Additionally, the *Trans-Pyrenean Pipeline* carries 120 billion cubic feet per year of gas from Norway through France to Calahorra Spain.

Baku-Tbilissi-Ceyhan (BTC) Pipeline opened on 25-May-2005. It connects Azerbaijan capital on Caspian Sea with Ceyhan, Turkey on East Mediterranean coast. Importantly from an energy security viewpoint, it bypasses Russia. Possible accession of Turkey into European Union and bilateral trade with Azerbaijan, Georgia, Kazakhstan and Turkey form the political context of BTC.

Within Europe, Norway will soon supply up to 2.5 billion standard cubic feet per day of natural gas to the United Kingdom, which is 20 percent of the UK's consumption. This will flow through the new Langedale Pipeline, completed in May, 2006, which originates in Nyhamna, Norway and terminates at Easington, UK. The 44-inch diameter, 745 mile long pipeline is the longest offshore unit ever constructed. As another recent European inter-country development, the gas grids of Spain and France can now send or receive 17.7 billion standard cubic feet per day of natural gas from each other through the new Euskadour Interconnection.

The Nabucco gas pipeline is possible new project with strong geopolitical and economic components. It would bring 30 billion cubic meters per year of gas from Azerbaijan through Romania, Bulgaria and Turkey to Austria, all of which have agreed to support its successful completion. This 3,300 kilometer pipeline is capital intensive, requiring an estimated 4.8 billion Euro investment. By mid-June 2006 the European Investment Bank indicated that it would finance one-third of the cost, and expectations are that the remainder will come from the European Bank for Reconstruction and Development and private investors. It remains to be seen how they assess the political stability of the Caspian region, and of Azerbaijan itself that is in the midst of a separatist movement by its Armenian minority in Nagorno-Karabakh. Gazprom naturally opposes the project and is actively seeking investors for an extension of its Blue Stream Pipeline to transport gas through the Balkans to Hungary.

## **SUPPLY CHAIN VULNERABILITIES**

The European Union countries have substantial inter-country electricity ties. France, for example exports, as an annual average, approximately 8,100 megawatts while Italy imports approximately 5,000 megawatts. Almost all countries experience electricity disruptions either routinely or rarely. These, nevertheless, are almost always intra-country events, and, while occasionally serious, will not be discussed further herein.

### **Natural disasters**

The world's primary energy supply and delivery system may be disrupted by numerous unfortunate and unplanned factors such as hurricanes, earthquakes and abnormally low and long duration freezing temperatures. These may occur anywhere in the world and, if sufficiently severe, will impact the energy situation in all countries.

While not at all minimizing the tragedies that arose from the 2004 tsunami in Southeast Asia, the entire world would have suffered greatly from an extreme fuel shortage if it occurred further east at the Strait of Malacca, through which 25 percent of the seaborne crude oil flows by tanker. The Strait is also quite important for coal shipments as well as other dry materials such as grains.

Less awesome and destructive, floods and severe thunderstorms routinely interfere with railroad shipments. Hurricanes and cyclones fall between storms and tsunamis with respect to the misery and damage they can cause. Hurricanes Ivan, Katrina and Rita struck the major gas and oil producing and processing regions of the United States, leading to massive losses and shut-ins. Similarly, during 2006 there were precautionary suspensions of oil and gas production in Australia due to cyclones Claire and Hubert.

While weather effects on oil and gas facilities are dramatic, other sectors may also be affected. Unusually high rainfalls in the first half of June 2006 led to flooding of Australia's Ranger uranium mine, reducing production by 30 percent. Similarly, all uranium production operations in Australia's Northern Territory were stopped as a precaution before the arrival of cyclone Monica.

Unusually cold weather can lead to fuel supply disruptions on an international basis. For example, as shown dramatically in mid-January 2005, when temperatures in Russia and Eastern Europe fell to -20 to -30 degrees F, the coldest since 1927, demand for gas naturally rose. Attempting to cope with its own internal needs and weather-related production difficulties, Russia had to reduce its exports to various European countries by 5 to 20 percent.

### **Strikes, anti-governmental actions and international disputes**

Refineries and pipelines have been shut down by strikes and protests due to economic disparities in many countries including Bolivia, Mexico and Venezuela.

They have also been subject to anti-government protests, violent civil wars and separatist movements, inter-ethnic tensions in Algeria, Chechnya, Georgia, Indonesia, Iran, Iraq, Nigeria, Pakistan and Sudan.

Several unresolved boundary disputes are potentially serious problems. In the Far East, these include those between China and Japan concerning natural gas rights to the Chunxiao gas field in the East China Sea. Japan and Russia each claim sovereignty over several islands, called the “Northern Territories” by Japan and the “Southern Kurils” by Russia. One-third of the common border between Georgia and Russia has not been defined.

In the Mideast, Iran and the United Arab Emirates each claim ownership of three islands in the Strait of Hormuz, and Iran, Saudi Arabia and Kuwait each claim partial ownership of a huge offshore gas field, called “Arash” by Iran and “Dorra” by the other two countries. Algeria and Libya have a dormant dispute about 32,000 square km in Southeastern Algeria. Algeria also rejects Moroccan administration of the Western Sahara where 102,000 refugees live in camps in Tindorf, Algeria; each accuses the other of supporting militias and arms smuggling.

Iran is certainly a major supplier of crude oil, exporting approximately 2,700,000 barrels per day. It, however, is involved in a serious dispute with the United Nations concerning its nuclear enrichment activities. The confrontation escalated when Iran removed United Nation’s seals from, and is not allowing inspection of, its Natanz enrichment plant. Obviously, Iran’s strongest bargaining tool is its ability to withdraw a substantial amount of crude oil from the international marketplace. This would lead to a worldwide inability to satisfy current demands, even if all other producers maximized their production, a politically difficult decision to expect. In 2006 Iran unilaterally repudiated a price clause in an Iranian-Indian LNG project, leading to a lack of confidence in its reliability.

### **Terrorist attacks**

A relatively new concern is that a terrorist group will deliberately interfere with production and/or international transportation of fuel. Given its importance to the world’s economy and indeed civilization itself, it is a tempting target for many groups.

Many international terrorist groups have indicated that they consider all Westerners and their properties to be legitimate targets, and in fact have proclaimed it a duty to attack them. One well known terrorist stated:<sup>30</sup>

*“Take jihad to stop (the Americans) from getting hold of the oil. Concentrate your operations on the oil, particularly in Iraq and the Gulf.”*

Another group indicated:<sup>31</sup>

*“We are capable and determined to destroy the ability of Nigeria to export oil.”*

Components of the energy infrastructure have, in fact, been sabotaged by terrorist attacks in many countries notably including Kuwait, Nigeria, Pakistan, Saudi Kingdom and Yemen.

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<sup>30</sup> Bin Laden, Osama, Videotape to Saudi Arabia, December 16, 2004

<sup>31</sup> Movement for the Emancipation of the Niger/Delta (MEND), email on January 12, 2005

Damage to the sub-sea pipelines such as those that bring gas from Algeria and Russia to Europe could be difficult and time-consuming to repair. Construction of the deep sub-Black Sea portion of the Blue Stream pipeline, for example, took approximately eight months without fear of attacks. Extensive repairs while being concerned about terrorists could easily take six months. There was, in fact, an explosion in the TransMed Pipeline in 1997 that has been labeled as a terrorist act. Very little detailed information has been made public, but it is estimated that the gas flow to Italy through this pipeline was interrupted for 45 days.

Russia has become an important crude oil supplier to Asia and Europe, with major terminals at Primorsk (880,000 barrels per day) on the Baltic Sea, Novorossiysk (900,000 barrels per day) and South Ozerereyevka (600,000 barrels per day), both on the Black Sea, Pivdenny (180,000 barrels per day) near Odessa, Poland, and several smaller facilities. Loss of any one of these would have serious adverse impacts on the European Union's, as well as the Asian and Russian, economies.

Various international agencies have identified many locations as critical to the world-wide flow of oil, coal and many other items; Table 4 presents six of them. These have narrow inlets/outlets that could be blocked by accidents or terrorist attacks. If they were closed the economic result would be staggering. Costs of shipping, security and insurance would undoubtedly greatly increase, driving up costs substantially.

**Table 4**  
**Crude Oil Shipping Chokepoints<sup>32</sup>**

<b>Chokepoint</b>	<b>Location</b>	<b>From / To</b>	<b>To / From</b>	<b>MM<sup>33</sup> Barrels Per Day</b>
Strait of Hormuz	Oman / Iran	Persian Gulf	Gulf of Oman (Arabian Sea)	16.5 – 17.0
Strait of Malacca	Malaysia / Singapore	Indian Ocean	South China Sea (Pacific Ocean)	11.7
Bab el-Mandab	Djibouti / Eritrea/Yemen	Red Sea	Gulf of Aden (Arabian Sea)	3.0
Bosporus/Turkish Straits	Turkey	Black Sea	Mediterranean Sea	3.1
Suez Canal	Egypt	Red Sea	Mediterranean Sea	1.7
Panama Canal	Panama	Pacific Ocean	Caribbean Sea (Atlantic Ocean)	0.5

<sup>32</sup> World Oil Transit Checkpoints, Country Analysis Briefs, [U.S.] Energy Analysis Briefs, November 2005

<sup>33</sup> MM: million (1,000,000)

While the focus of this paper is on energy, many other materials pass through these points such as grains, metals, ores, industrial equipment and consumer products. An interruption would, curtail delivery of these and, moreover, impact shipping traffic in each direction. It would, moreover, lead to a demand for more tankers to compensate for the use of non-optimum routes, thus increasing delivery times and shipping costs. Premiums for shipping insurance, if available, would also dramatically increase. The duration of a blockage would obviously depend on its nature.

As bad as an attack on any of these chokepoints would be, it must be remembered that terrorist groups frequently attack several points simultaneously. Recent examples include the September 11<sup>th</sup> 2001 attack by four teams (three successful) on the United States, the May 16<sup>th</sup>, 2003 simultaneous attacks on five sites in Casablanca, Morocco, the November 15<sup>th</sup>, 2003 bombing of two synagogues in Istanbul, Turkey and the March 11<sup>th</sup> 2004 attacks on three train stations in Madrid, Spain.

Loss of any of the first three of these chokepoint routes could not be accommodated by simply diverting tankers to the Bosphorus, Suez or Panama Canals; the largest tankers they can handle are the Suezmax<sup>34</sup> class or the Panamax<sup>35</sup> class vessels. Transit time and cost would, of course, increase if smaller tankers and non-optimum routes had to be used. Although the loss any of these routes may be somewhat mitigated by using trucks, smaller tankers, barges and increasing flows through pipelines, the adverse impact would, nevertheless, be substantial.

### **Antiterrorist Measures**

Although the oil producing countries and companies spend tens of million dollars on security, piracy and terrorist attacks continue. International initiatives have not led to impressive results. Among the many efforts are the United Nations “*Convention of the Law of the Sea*” which defines the conditions under which hot pursuit of a foreign ship, arrest of persons, seizure and disposal of property, and imposing penalties is permissible. Additionally, the United Nation’s International Maritime Organization has adopted ‘*Measures to Prevent the Registration of “Phantom” ships.*’<sup>36</sup> This, however, “*invites governments to...*” and “*urges governments to...*” It is a very weak document.

Law enforcement within territorial waters is, of course, the responsibility of each nation. Several South Asian countries, however, do not have the naval and military resources to perform satisfactorily; informal cooperation has helped on an ad hoc basis. In 2004, however, Indonesia, Malaysia and Singapore began coordinated patrols of the Malacca Strait, with Japan participating in drills. A more intense structured “*Regional Maritime Security Initiative*” (RMSI) has been discussed within which the United States would provide military assistance upon request. Although it has been resisted by various countries as an intrusion into their national sovereignty, discussions continue.

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<sup>34</sup> Suezmax Class Crude Carriers: Capacities of 126,000 to 199,999 tons (~790,000 to 1,250,000 barrels)

<sup>35</sup> Panamax Class Crude Carriers: Capacities of 50,000 to 79,999 tons (~314,000 to 503,000 barrels)

<sup>36</sup> Resolution 923(22), 22<sup>nd</sup> Assembly, November 2001

After numerous discussions, four countries (Indonesia, Malaysia, Singapore, and Thailand) agreed that they would jointly implement an “*Eye in the Sky*” program to enhance the security of the Malacca Strait. The countries provide sufficient resources so that one or two aircraft now patrol the Straits every day, providing timely information to naval vessels.<sup>37</sup>

Japan hosted a Ministerial Conference on International Transportation Security in Tokyo in January 2006. With fourteen countries and four international organizations participating, its concluding joint communiqué states that:

*“We recognize that acts of terrorism pose a serious threat to international transport and that acts of piracy and armed robbery against ships recur with alarming consequences ... We therefore believe that it is essential to reduce the vulnerability of international maritime transport to such unlawful acts.”*

The Ministers present agreed to adopt various Conventions and Protocols that, if truly implemented, should enhance maritime security.

Several groups collect information about successful and attempted piracy incidents and disseminate details to the maritime community. These include weekly reports from the United States Office of Naval Intelligence, monthly reports from the International Maritime Organization (Division of the United Nations) and daily status bulletins and weekly reports from the Piracy Reporting Centre (a group within the International Maritime Bureau, which in turn is part of the International Chamber of Commerce.)

### III - PLANNING

#### **Increasing Intra-European Union Competition**

The European Commission has set a goal of reducing prices paid by consumers of fuels and electricity and is thus taking steps to increase internal competition. Within the European Union, however, many of its members and their utility companies do not yet appear to have accepted the concept of sacrificing possible short-term advantages to obtain long-term benefits through participation in European Union-wide activities. The utility sectors are dominated by a few large companies that clearly wish to maintain their near monopoly positions. One set of barriers to be overcome before new suppliers can enter the market is that they must have access to the gas and electric grids, fuel storage and the like without being discriminated against, and must receive technical, operational and economic information. These and other monopoly-related issues are well summarized in reference 38. Attempts to overcoming these and to establish common electric and gas grids have however been thwarted by the entrenched companies.

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<sup>37</sup> The Jakarta Statement on Enhancement of Safety, Security and Environmental Protection in the Straits of Malacca and Singapore, Meeting on September 7, 2002

<sup>38</sup> Commission of the European Communities, Communication from the Commission, Inquiry pursuant to Article 17 of Regulation (EC) No 1/2003 into the European gas and electricity sectors (Final Report) COM(2006) 851 Final, 10.1.2007

The European Commission is certainly encountering resistance as it tries to eliminate energy monopolies and certainly to also stop their growth. As one of several examples, Spain opposes any foreign investment into its energy sector and has created the Comisión Nacional de Energía (CNE) to oversee such activities. When Germany's E.ON Group attempted to acquire Spain's large utility company, Endesa, CNE approved the transaction, but imposed various "Poison Pill" conditions such as requirements to use only coal from Spain and that Endesa must sell some of its coal and nuclear power plants. The European Union Commission then claimed that CNE was established specifically to stop this takeover; its regulators overturned the conditions and threatened legal action if they were not removed by 19-January-2007.

In another actions, the European Commission raided the offices of Gaz de France and several German utility companies in May and December 2006 seeking proof that they conspired to violate antitrust rules. No outcome of this has yet been announced. Then in December the European Commission sent "*reasoned opinions*" to sixteen countries as a prelude to starting legal actions against them for not properly implementing various 2003 electricity and gas directives.

Expressing his frustration, European Commission President José Barroso stated<sup>39</sup> "*In energy terms I can tell you that I am more convinced than ever that we need new legislation concerning regulation. We have not yet achieved a completely coherent approach between national regulators. If you want an internal market to work in Europe in energy, then you need some more muscle in terms of regulator's effectiveness.*" The next day Germany's secretary of Energy, Joachim Wuermeling, strongly dissented: "*It is not the task of the European Commission to shape the structure of European Industry.*"

Assuming that the European Commission is able to impose its will on fractious companies and countries, there are many cross-border technical/commercial differences that must be resolved; progress toward a unified energy sector will continue to be slow.

### **Increasing Supplies**

On the supply side, the European Union has entered into numerous international dialogs and protocols. Among many others, these include:

European Union-OPEC bilateral dialogs: The 1<sup>st</sup> European Union-OPEC Energy Dialogue at Ministerial level was held in June, 2005 to seek greater transparency on stocks and investment needs. This was followed by the 1<sup>st</sup> European Union-OPEC Roundtable on oil market developments in Vienna, November 2005 that addressed more accurate global oil demand forecasts, constraints in the refining sector, and a better understanding of impact of trading in future markets

Baltic Sea Regional Energy Cooperation (BASREC) & Eurogas. This effort is intended to address ways in which the Baltic countries situation of being a gas energy island linked only to Russia and supplied only by Gazprom may be addressed.

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<sup>39</sup> Statement to Financial times, 12-September-06

Euro-Mashrek (Egypt, Lebanon, Jordan, Syria, Turkey) - A Declaration of Intent was signed in December 2003 for cooperation in field of natural gas.

Baku Initiative - In November 2004, the affected countries met to facilitate integration of the energy markets of the Caspian Sea region into the European Union. Participants included Azerbaijan, Armenia, Bulgaria, Georgia, Iran (observer), Kazakhstan, Kyrgyz Republic, Moldova, Russian Federation (observer), Romania, Tajikistan, Turkey, Ukraine and Uzbekistan.

The European Union and Kazakhstan signed a Cooperation Agreement in October 2006 on peaceful uses of nuclear energy. This provides a stable framework for developing nuclear trade and improves security of supply of uranium. Kazakhstan has the third largest uranium reserves after Australia and Canada.

European Union and Ukraine have entered into agreements in December 2005 concerning nuclear power plant safety, the integration of electricity & gas markets, and environmental standards in the coal sector.

### **Emergencies**

**Supranational Planning:** The essential elements of planning for energy disruptions are:

- providing an acceptable mechanism for coordinating the use of stocks, and redirecting supplies
- having adequate reserve stocks in place

These are meant to alleviate the effect of interruptions; they are not intended for short-term management of high energy prices.

Each government will, of course, respond to a fuel emergency in its own way. Coal and nuclear fuel reserves appear to be adequate for at least a year of operation at 100 percent capacity; oil and gas reserves are the problem. Member countries<sup>40</sup> of the International Energy Agency have agreed to and indeed appear to maintain emergency oil stocks of at least 90 days of import. These stocks may be any combination of public and private reserves. While cooperative sharing under emergency conditions is envisioned, this has not yet been extensively tested; they have actually been used only twice:

- In 1991 on the eve of the Gulf war
- In 2005 after Hurricane Katrina

Additionally, the system had been put on alert before January 1, 2000 because of concerns about computer problems affecting energy supplies, in 2002 in response to the shutdown of production in Venezuela, and in 2003 prior to the invasion of Iraq.

**Responding to emergencies:** The major international system for responding to an energy emergency is embodied in the International Energy Agency's International

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<sup>40</sup> Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, Republic of Korea, Luxembourg, The Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, United Kingdom, United States

Energy Program (IEP) and Coordinated Emergency Response Measures (CERM.)<sup>41</sup> These present numerous requirements related to emergency energy self-sufficiency through national oil storage, demand restraint, and oil allocation to each country. The measures would be triggered when an international disruption produces a 7 percent loss of supply. Although much of the IEP is clearly defined and self-executing, many of the credible threats to the international oil supply such as strikes or major accidents are specifically excluded from the activation triggers. Importantly, much of the CERM requires unanimous agreement of member nations, each of which has different political, fuel demand and supply situations. These programs have not yet been tested.<sup>42</sup>

The European Union has developed a parallel emergency response system<sup>43</sup> that provides guidance when stocks exceed IEA minima. No central coordinating authority, however, yet exists within the European Union, although new initiatives continue to be considered. European Union requires<sup>44</sup> that its member countries maintain oil stocks of 90 days of consumption, which is more than 90 days of import required by the IEA.

As noted above, the U.S has proposed an international nuclear fuel reserve, partly as a way to assure Iran, North Korea and other countries that their nuclear power plants will be able to obtain fuel without developing an indigenous uranium-enrichment or plutonium reprocessing capability. Many basic issues will need to be resolved before this reserve becomes a reality. For example: Who would own the fuel? How and by whom would the reserve be administered? How would the receiving country's spent fuel be handled? Who is responsible for transportation? Until these and other matters are resolved, this internationally oriented reserve will not be established. Based on the history of other international efforts, it appears unlikely that it will be realized within the next five years.

Decisions about international cooperation, of course, always have major political components. The largest crude oil and natural gas suppliers to the Asian market are, as noted above, Saudi Arabia and Russia, both of which have been subjected to terrorist attacks by fundamentalist and separatist groups. They are the only two countries with any noticeable spare production capacity, but they have large Muslim populations they might fear offending by openly cooperating with the Western countries when important. Moreover, they might decide that while the West now provides the largest market for their crude oil and gas exports, their future might be better served by favoring the rapidly growing Asian economies when allocating their suddenly limited production.

While reactions to disruptive events can not be precisely predicted, there are clues to be assessed. Russia, for example, has recently announced that a major new, although environmentally controversial, 2,500-mile trans-Siberian pipeline (the *Eastern Pipeline*) will originate from Taishet near Lake Baikal and go eastward in two phases. During the

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<sup>41</sup> OECD/IEA, 2003

<sup>42</sup> See Willenborg, R., C. Tonjes and W. Perlot, Europe's Oil Defences, Clingendael International Energy Programme, CIEP 01/2004, The Hague

<sup>43</sup> Council Directives 68/414/EEC, 73/238/EEC, 77/706/EEC, 98/93/EC

<sup>44</sup> European Union Directive 98/93/EC of 14 December 1998

first phase 600,000 barrels per day will travel 1,800 miles to a point near the Chinese border, and 400,000 barrels per day will then be diverted to a direct pipeline to China, The remaining 200,000 barrels per day will be sent by railroad to the Pacific Ocean for delivery to Japan. In the second phase, the capacity will be increased to 1.6 million barrels per day, and a line extended 1,200 miles to the Pacific coast from which the Japanese market can be readily served. This approach appears to demonstrate Russia's confidence in the Asian future and mitigates the risks of having only one country as a customer for its oil. Russia's response to an energy emergency is simply not predictable.

#### IV - INTERNATIONAL POLITICAL DIMENSIONS

Although maintaining good relations with all countries in today's globalized energy network is important, those with Russia, Algeria and Norway, are particularly critical for the immediate future of the European Union countries. These will be discussed in turn.

**Russia:** Russia is clearly a major gas supplier to many European countries, as seen on Figure 7, and therefore its activities are exceedingly important. Having had a difficult history in various wars and revolutions, it sees itself as being exposed to many military threats. For example, Georgia, Moldova and Ukraine have, however unrealistically, expressed an interest in joining NATO, which Russia sees as a challenge. In the recent past, it has seen disturbing color revolutions, including the Rose,<sup>45</sup> the Orange,<sup>46</sup> and the Tulip<sup>47</sup> events. Russia, moreover, now sees a danger from various Islamic fundamentalist groups in its Southern neighboring countries. In reaction to various decisions, statements and slights, both perceived and real, made by Western leaders, Russian policies have fundamentally changed. *“Until recently, Russia saw itself as Pluto in the Western solar system, very far from the center but still fundamentally part of it. Now it has left that orbit entirely: Russia's leaders have given up on becoming part of the West and have started creating their own Moscow-centered system.”*<sup>48</sup>

The general Russian energy position may be summarized by two points.

- If we do not control energy resources and distribution, others will.
- Why should we subsidize other countries with below market-price gas or oil?

Russia has refused to ratify the Energy Charter Treaty (ECT) that aims to create a level playing field. The Treaty addresses fundamental matters such as assuring access to pipelines, assuring transit across third countries, nondiscrimination against foreign investors, investment in new markets, and arbitration of energy disputes. Russia is clearly favoring its own facilities. It has, in fact, stated publicly that *“When allocating the country's exports, precedence will be given to sea ports in which Russia has a stake over foreign ones.”* – e.g., Primorsk over other Baltic ports.

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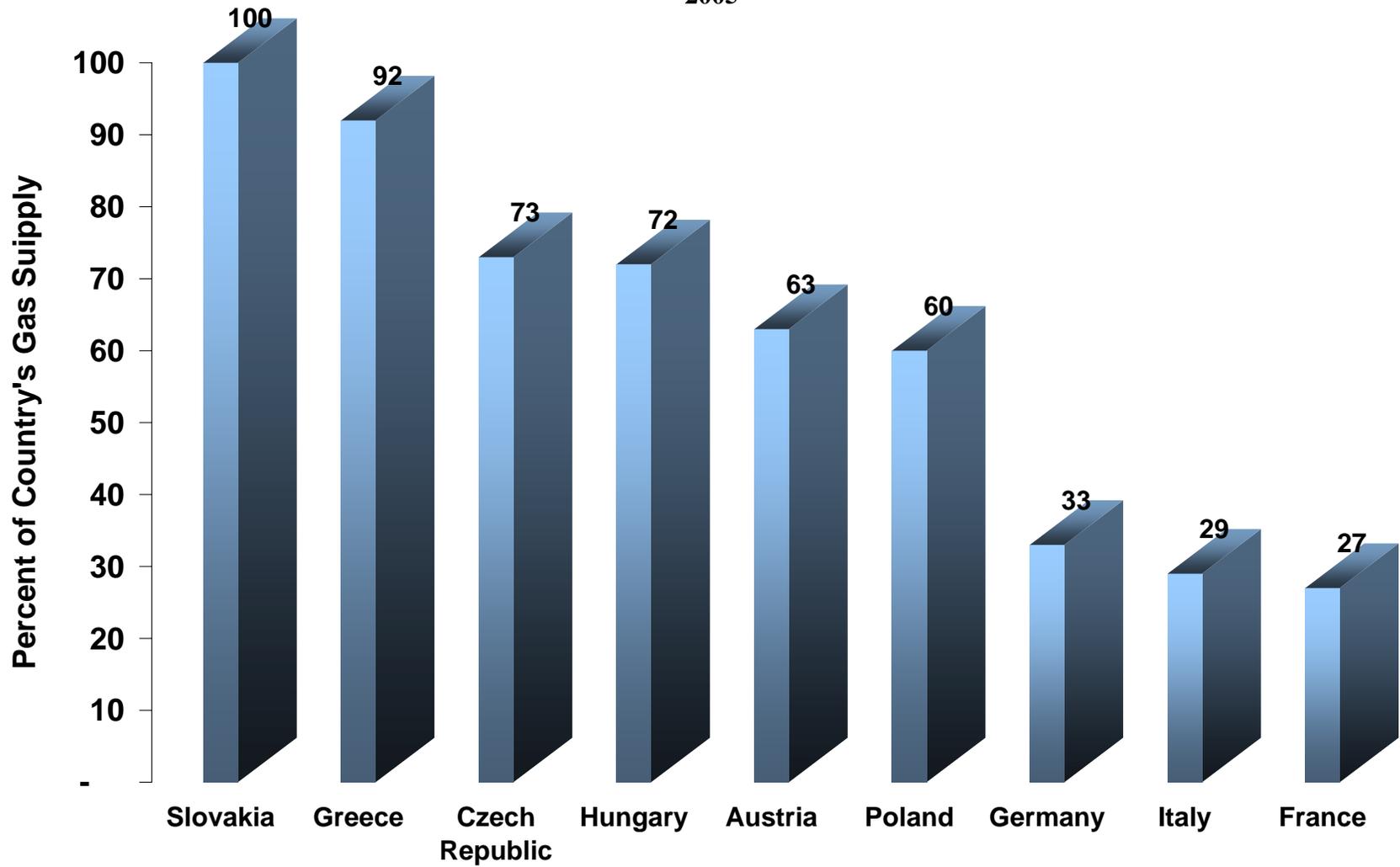
<sup>45</sup> Mikhail Saakashvili replaced Eduard Shevardnadze in Georgia in 2003

<sup>46</sup> Viktor Yushchenko replaced Viktor Yanukovich in Ukraine in 2004

<sup>47</sup> Revolution in Kyrgyzstan in 2005, followed by a more violent disputed parliamentary election

<sup>48</sup> Trenin, Dmitri, Russia Leaves the West, Foreign Affairs , July/August 2006

**Figure 7**  
**EU Countries Dependence on Russian Gas**  
**- 2005 -**



One new set of issues is centered on the prices that Russia is charging other countries for its gas, and the ways in which they have been increased. Russia, for example, doubled the gas cost to Moldova unilaterally, and decided in January 2006 to reduce gas supplies to obtain quick agreement to the 100 percent price increase. Similarly, in October 2006 Russia announced a doubling of gas prices to Georgia. As part of its negotiating strategy, Russia imposed bans on importing agricultural products, mineral water and wine from Georgia and additionally suspended air and railroad traffic. Georgia had no choice and agreed to the new prices in December 2006.

The Ukrainian episode has been widely cited as an example of a country using its position as a major gas and oil supplier as a political weapon. Russia caused much alarm when it attempted to quadruple the gas prices it charged Ukraine, through which 20 percent of Europe's gas flows. While Ukraine disputed the claim, Russia continued to deliver it gas for further transport to Western countries, but reduced the total by the amount that Ukraine claimed it was due. Ukraine, however, continued to take its full share from the pipeline, leading to a shortfall in Europe's gas supply. After several days, a complex somewhat opaque compromise was reached within which Ukraine agreed to pay almost twice its previous rate for the Russian gas, but also will receive a 47 percent higher transit fee from Russia for gas transportation. Shortly thereafter Ukraine's Parliament fired the President's cabinet, causing much political turmoil. One important consequence is that support for a common European Union energy policy is becoming increasingly unpopular, with support dropping from 47 percent before this situation to 42 percent after the dispute arose.<sup>49</sup>

These, of course, may be viewed as cases where Russia was simply exercising its rights in rather straightforward commercial matters.

Setting aside questions about corruption and personal gain, Russia is now exhibiting even more troubling behavior by actions that are clearly directed to placing all aspects of oil and gas production and their transportation under governmental control for use in attaining international geopolitical goals.<sup>50</sup> During the European Union-Russian Summit in October 2006, Vladimir Putin stated *"I'll remind you that some European countries, members of the European Union, cover 90 percent of their gas needs with Russian hydrocarbons. Ninety percent! And no one's complained so far."*

A disconcerting situation, for example, arose in Lithuania. Lithuania attempted to sell its Mazeikiu Nafta Refinery which was 53.7 percent owned by the private Russian company, Yukos, and 30.6 percent owned by Lithuanian government. The sale was handled by Lehman Brothers of New York, with bids submitted by Lukoil (Russia), TNK-BP (Russia-UK), one from Kazakhstan and one from PKN Orlen (Poland.) PKN Orlen was the high bidder at \$2.34 billion. Yukos had been forced into bankruptcy (in what appears to be partly a political move against Mikhail Khodorkovsky who opposed

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<sup>49</sup> Eurobarometer, Attitudes towards Energy, Fieldwork October-November 2006, Published January 2006

<sup>50</sup> Note that Russia is also negotiating to consolidate global control of two important metals:  
Renova Group – South African Manganese, Evraz – South African vanadium

President Putin) in March 2006, with Rosneft as a creditor. Rosneft then sued unsuccessfully in US and Netherlands to block the sale.

Subsequently to losing the bid, Transneft (Russia) shut the pipeline that supplies oil to the town of Mazeikiai and the refinery claiming the pipeline was unsafe, using metals from 40 years ago that are now not allowed (but it continued using the pipeline to supply Belarusian refineries.) Oil via tankers however began arriving at the refinery. Its output was then unfortunately reduced by 50 percent by a non-suspicious fire on October 12<sup>th</sup>, which caused \$75 million in damages and lost profits.

Additionally, there was pressure on PKN Orlen to claim that the market-value has dropped materially, and the bidding should be reopened; its lenders decided against this. In response, Lithuania indicated it might shut down the only Russian railroad supplying Kaliningrad for repairs to “*guarantee the safety of trains and passengers.*”

After much tense maneuvering, the sale to PKN Orlen was finally consummated in December 2006, becoming the largest investment ever made by a Polish company.

Sakhalin-2 presents another recent example of a very troubling Russian approach to increasing its control of gas and oil supplies by forcing renegotiation of an existing agreement. This is the world’s largest LNG liquefaction plant, with a capacity of 7 percent of world’s LNG supply. Located on Sakhalin Island in the Sea of Okhotsk north of Japan, near Eastern Siberia, it is estimated to have 4.5 billion barrels of oil equivalent. The ownership is: Royal Dutch Shell – 55 percent, Mitsui – 25 percent, and Mitsubishi – 20 percent. In exchange for an investment that has now exceeded \$12 billion and will require an additional \$8 billion for completion, Russia was to receive \$300 million per year until costs are recovered, then \$2 billion per year, for a total of \$85 billion in taxes & royalties by 2050 under Production Sharing Agreements that were executed when oil was selling for \$15 per barrel.

Gazprom had been negotiating for 25 percent ownership of the consortium plus a blocking vote on its Board of Directors. As part of its negotiating strategy, Russia had claimed environmental problems, withdrew an environmental permit, threatened to stop work and even publicly threatened criminal charges. Diplomatic responses, including that from the European Union, were verbal, but contained no substance:

- Japan – “*I am concerned that major delays might have a negative influence on overall Japan-Russian relations.*”<sup>51</sup>
- UK – “*We have expressed our concerns to the Russian government at a number of levels. We are deeply concerned.*”<sup>52</sup>
- European Union – “*I take this announcement very seriously indeed. In order to ensure that companies are willing to invest in multi-billion Euro projects, a secure and predictable investment climate is necessary in Russia as in the European Union or indeed any country. Without this, investment in new*

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<sup>51</sup> Shinzo Abe, Chief Cabinet Secretary

<sup>52</sup> Andy McGuffie, Foreign Office spokesman

*energy projects will be highly problematic, providing uncertainties for the world's future energy supply.”<sup>53</sup>*

After many tense months, Russia succeeded in obtaining the share and control it sought, in exchange for \$7.45 billion (\$4.00 per barrel of reserves). A more reasonable market price would have been \$4.90 per barrel of reserves, or a total of \$9.13 billion. Following this, the European Bank for Reconstruction and Development decided to withdraw consideration of the \$300 million syndicated loan to the project. As of mid-January 2006, decisions by other lenders have not been announced.

As another example, consider Russia's plan to develop the Shtokmanovskoye field. This is a huge gas field deep under the Barents Sea above the Arctic Circle, 555 km east of Murmansk. It is estimated to contain approximately 3.7 trillion cubic meters of gas and 31 million tons of condensate in its four main reservoirs that are 1900 to 2300 meters,<sup>54</sup> under 350 meters of water. Development costs are estimated to be \$10-20 billion plus another \$4 billion for the off-shore requirements. Western oil companies had been led to believe they were being seriously considered to participate as minority (49 percent) partners up to the last minute, when the results of their bids were announced. Bidders included large experienced groups from:

- France - Total
- Norway - Norsk Hydro and Statoil
- United States - Chevron and ConocoPhillips

All bids were rejected, with a statement from Gazprom that “[*the companies*] were unable to provide assets comparable to the volume and quality of reserves in the Shtokman deposit.” “Comparable” is, of course, in the eyes of the beholder; the bidders all offered to swap assets as part of their offerings. The original development plan included production of LNG to serve the eastern United States. This has now been changed to a new plan to deliver gas through 340 miles of new sub-sea pipeline to the Northeastern coast of Russia and then onward to Germany via a new pipeline under the Baltic Sea. It is certainly possible that this is an attempt to divide the United States and the European Union, and to also attack its common energy policy. In any case, these business decisions have substantially degraded the already poor relations between Russia, the western countries, and the major international oil and gas companies. They have also probably extended the initial delivery schedule by several years, and, if and when development succeeds will further increase the European Union's dependence on Russia for its gas supply.

In a somewhat surprising move, given a previously close relationship, Russia suddenly demanded that Belarus pay \$105 per cubic meter of gas instead of the then-current \$46.68. This demand for a 125 percent increase led to a series of increasingly hostile verbal exchanges between Belarus and Gazprom, partly because of the price aspect and perhaps more importantly because Gazprom indicated that if Belarus could not pay with

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<sup>53</sup> Commissioner Piebalgs, IP/06/1211, Brussels, 19 September 2006

<sup>54</sup> Multiply meters by 3.2808 to obtain feet

cash, it was willing to take a 50 percent share of the Belarusian gas pipeline company. This is clearly of major strategic importance to Russia since approximately 20 percent of gas sold to Europe flows through Belarus. It appears that, unlike the Ukrainian situation, Belarus will probably not be able to resist and will ultimately agree to a settlement that is close to Gazprom's terms. This, like other Russian moves, will even further increase the European Union's dependence on Russia for its gas supply. Then in January 2007, Russia imposed a new tax on oil it exports to Belarus, and Belarus retaliated by imposing transit fee on Russian oil that flows through its country to Central Europe. Russia, in turn, responded by cutting off its oil exports through Belarus to The Czech Republic, Germany, Hungary, Poland and Slovakia for three days.

While Russia's activities to increase its control of the oil and gas part of the energy sector are widely recognized, it is also taking less visible steps to expand its role in the nuclear fuel cycle. It is not self-sufficient with respect to uranium reserves, for example, and has consolidated three uranium production companies into a new entity, The Uranium Mining Company which is expected to quickly enter into joint ventures to obtain additional uranium ores from Kazakhstan and Uzbekistan. These and other countries often compete with Russia to be oil and gas suppliers. Russia is also playing an increasing role in the fuel preparation processes of the nuclear fuel cycle by accepting the low-level, but still radioactive, enrichment tails from several European Union countries. It then uses its excess separation capacity to re-enrich the tails' low uranium contents to levels similar to those in natural uranium, returns this product to the original owners. This trade arrangement is important to Russia, since it is able to use its excess enrichment capacity, keep the new tail product, and thus substantially increase its reserves of uranium. Additionally, it provides Russia with a way to avoid various trade restrictions. It is important to Western enrichment companies since it provides a way to avoid major costs of disposing of nuclear tails. Economic and other aspects of this rather opaque practice are well discussed in reference<sup>55</sup>.

Russia, however, is not without its own problems. In spite of its increasing wealth, much of its infrastructure such as transportation and machinery is outmoded and in poor condition, its political relations with many countries are deteriorating, and its health situation is poor, as shown on Table 5.

Moreover, Russia's economy will be somewhat dependent on the European Union for several years. Currently approximately two-thirds of its oil and gas is purchased by European Union members and although it is taking steps to broaden its oil and gas pipeline transportation situation, it does not yet have any capacity to divert gas to North America or Asia.

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<sup>55</sup> Diehl, P., Re-enrichment of West European Depleted Uranium Tails in Russia, WISE Uranium Project, 2004

**Table 5**  
**Health Indicators**

	Russia <sup>56</sup>	The European Union <sup>57</sup>
<b>Life Expectancy (males) - years</b>	<b>60.45</b>	<b>75.1</b>
<b>Infant Mortality (males) – Deaths per thousand live births</b>	<b>17.43</b>	<b>5.6</b>

As Russia’s grip on oil and gas reserves and on the European and Asian pipeline systems tighten, European Union’s Members’ opinions are evolving with respect to dealing with Russia.

- Austria’s position, stated by Chancellor Wolfgang Schüssel is that *“Given Europe’s energy demand, Russia will remain a very large provider. We should cooperate well with Russia.”*
- Germany is the biggest potential beneficiary of Russian energy activities, with two of its utility companies (Wintershall and EON Ruhrgas) being partners in the Russian Baltic Sea Pipeline project, and being a receiving terminus for gas pipelines. It has been negotiating bilateral deals, and Chancellor Angela Merkel has even stated that Russia’s role in talks with Iran have been *“extraordinarily positive.”* Subsequent to Russia’s curtailment of oil flowing through Belarus because of a commercial dispute, however, it appears that she is adopting a somewhat different position, stating that *“Even during the cold war, Russia was a stable energy supplier. [The message] to our Russian partners, and to Belarus as well, is that consultations are the least thing to do. It is not acceptable if there is no consultation on such issues. That destroys confidence, and this is no basis for smoothly building up a constructive relationship.”*
- France’s strategic position is complex. It believes in a non-confrontational approach, but would like to see a cohesive group approach to securing energy supplies, with Prime Minister de Villepin arguing<sup>58</sup> that *“Our weight in negotiations with producers will increase in proportion to our ability to speak with a single voice....It is up to us to explain [to our citizens] that the only long-term answer is to create a great European energy market.”*
- Poland is perhaps the country that is most aggressively seeking alternates to Russian gas and oil supplies. Its goal is to obtain one-third of its gas from Norway, on-third by domestic production and only one-third from Russia. Prime Minister Jaroslaw Kaczynski thus rejected an economically viable suggestion by Angela Merkel to construct a connection of the Blue Stream Pipeline from Greifswald, Germany to

<sup>56</sup> [U.S.] CIA – The World Factbook, Russia, Updated 02-November-2006

<sup>57</sup> [U.S.] Energy Information Administration, European Union, Country Analysis Brief, Updated January 2006

<sup>58</sup> At the Bertelsmann Forum, Berlin, September 2006

northern Poland. His position is that this is not a solution, stating “*We would become more dependent on Gazprom than before.*”

**Algeria:** To date, Algeria has acted in a cooperative and responsible manner, honoring agreements and issuing no threats. This is important since, as noted above, it provides the European Union with 30 percent of its gas. Moreover, the Southern Mediterranean Partner Countries (Algeria, Morocco, and Tunisia) executed a *Protocol of Agreement, Euromed*, on December 2003 for progressive integration into European Union internal electrical market.

Algeria has developed formal commercial ties to the European Union through an *Association Agreement* ratified in 2002, within which tariffs, duties and quotas on goods flowing in either direction will be reduced or eliminated over the next ten years. It has also entered into a cooperation pact with the European Free Trade Association (EFTA<sup>59</sup>) and is making progress to joining the World Trade Association.

A concern, however, arises from Vladimir Putin’s visit to Algeria in March 2006 at the invitation of President Bouteflika to strengthen the “Strategic Partnership” signed in Moscow in 2001. Subsequently Gazprom (Russia) and Sonatrach (the Algerian gas company) signed a *Memorandum of Understanding* in August 2006 to cooperate on:

- Exploration for new gas supplies in the Sahara
- Sharing markets for gas in North America and Europe
- Sharing LNG technology
- Jointly bidding for foreign assets

This is potentially a serious problem for the European Union and particularly for Italy which imports 80 percent of its gas, of which 32 percent comes from Russia and 37 percent from Algeria.

Algeria, however, faces many internal problems such as high unemployment, a lack of jobs and a lack of housing. Although its economy is rapidly improving at 6.4 percent per year, it is still a relatively poor country with a per capita GDP of \$2679 and 25 percent of its population living below the poverty line. Its economy, moreover, depends almost entirely on oil & gas exports which represent over 95 percent of its total exports and 30 percent of its GDP. Algeria clearly needs the European Union which takes 62.7 percent of Algeria’s exports and provides 58 percent of its imports.

It would be unfortunate for the European Union if Algeria sought short term advantages by following the Russian model of using its position as an indispensable energy supplier to impose its will on other countries and companies.

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<sup>59</sup> Iceland, Liechtenstein, Norway and Switzerland

**Norway:** To date, Norway, through Statoil ASA and Norsk Hydro ASA, has certainly proven to be a dependable supplier of gas and oil, with a long history of respecting contractual matters. These two companies have recently announced their intent to merge, creating the world's largest offshore operator, with a production rate of 1.3 million barrels of oil (equivalent) per day and proven reserves of 6.3 billion barrels. Although no country should be taken for granted (as Belarus has learned about Russia), given Norway's history and social makeup it is exceedingly difficult to imagine that it would act irrationally or selfishly. No changes in its behavior are expected.

## THE AUTHOR

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