# Comparison of Russian and Japanese patterns for energy use: implications for business and policy

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## Summary

This article's objective is to provide a brief overview of the Russian energy supply industries for those interesting in investment opportunities and international energy security improvements. The overview is built upon a technological foundation, comparing Russian and Japanese natural circumstances, energy consumers, and energy supply industries. There are similarities and differences. The data for energy demand was derived from the IEA energy balances, while information to compare energy intensity comes from publicly available national statistics.

The general issues, such as climate, energy security, and energy pricing policy are presented in the Introduction and are followed by a discussion of energy consumption structure and energy intensities in industry, transportation, and residential and commercial sectors. The driving forces for enormous investments in transformation sectors are discussed, and the scale of primary energy industry extraction provides a vision of importance to the domestic and international energy markets and energy security. Finally, two different layers of investments to the Russian energy supply chain up to year 2030 are presented: one following the energy transformation path and one as a breakdown by energy.

As a conclusion, some implications for business and politicians are provided for each matter discussed above.

Additional information on status quo and recent developments for Russian energy-related industry, energy – related regulation and policy – can be found at the APERC website under the annual overview section.

## 1. Introduction

Over the last twenty years, the institutional structure of the Russian energy industry had changed considerably, and understanding its current status and development trends, as well as challenges, is important to international businessmen and politicians. Huge business opportunities are now opening up in Russia at the federal, regional, and local levels, while growing Russian energy consumption and production have great economic and policy implications.

There are two dimensions of understanding Russian energy industries – domestic and international. Both are important for international business, while the Russian impact on international energy markets is related primary to geopolitical issues and thus are under tight monitoring by political institutions.

In this article, the first section is devoted to a general description of domestic energy consumption, followed by a brief observation of the energy industry's development. The information basis for comparison comes from energy balance tables for 2008 published by IEA in 2010, and national statistics, where appropriate. The article is structured to follow energy demand flow – from final consumption to primary energy extraction/production – and provides comparisons of Russian and Japanese energy supply patterns, as the primary audience is supposed to be energy-related Japanese businesses looking for opportunities in Russia.

While comparing Russia and Japan, two major characteristics should be kept in mind: climate and vast natural resources.

It is important to mention that winter in populated areas of Russia lasts from three months (south regions, densely populated) to six months (Central region, Ural industrial region, south of the Far East region); and it lasts up to nine or ten months in Siberia (along TransSiberian railroad)

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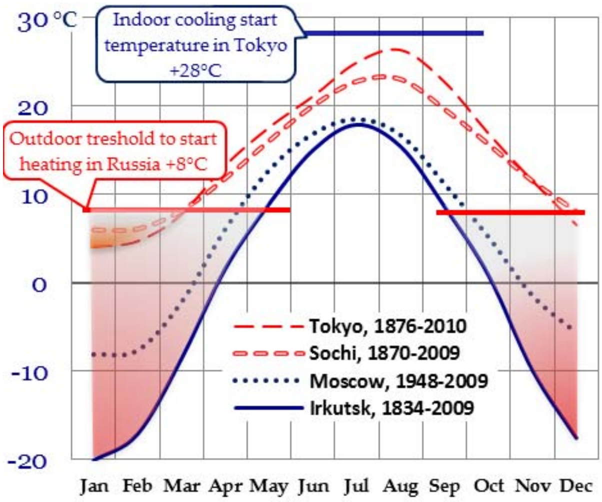
and Far North industrial centres,. In Fig. 1-1, the average daily temperatures for some metropolitan areas in Russia and Japan are provided. These cities represent significant shares of the populations in Russia and Japan.

**Fig. 1-1 Average daily ambient temperature for some Russian cities and Tokyo**




The climate is pivotal to residential/commercial and (partly) industrial energy demand. For example, the recommended indoor temperature to start air cooling in Tokyo last summer was set at + 28°C. The average daily temperature at +8°C is officially recognised in Russia as a threshold to start heating service, i.e., it is the temperature critical to human survival. That simple fact has a lot of implications; the most important among them is that **security of energy supply at the local level is even more important in Russia than in Japan**. The other less obvious, but no less significant point is that **to conduct any activity**, either economic or non-economic, **in Russia requires more energy than in Japan**, simply due to compulsory heating of working/living space and handling materials under ambient temperatures below freezing. This means that more energy is spent for warming materials before processing, and for keeping affordable operation conditions within industrial sites and office buildings.

The next important factor for mid- and long-term energy development in Russia is that **domestic energy pricing mechanisms eventually will be market-based, including socially sensitive energy pricing for residential consumption**. This general approach took a great step forward in 2011, after industrial electricity prices became completely determined by competitive market mechanisms. The natural gas market pricing for industry will follow in 2014, and the residential consumption market-pricing mechanisms are supposed to come into force in 2015. Coal and petroleum prices have not been controlled by the state since the middle of the 1990s. The reason for eventually eliminating energy subsidies is that private capital and the market approach for economic development have been fortifying their positions in Russia since 1991, including energy-related industries. The overwhelming share of the energy-related business in the country's GDP is characteristic for the importance of the mechanisms to translate export energy prices to domestic ones.

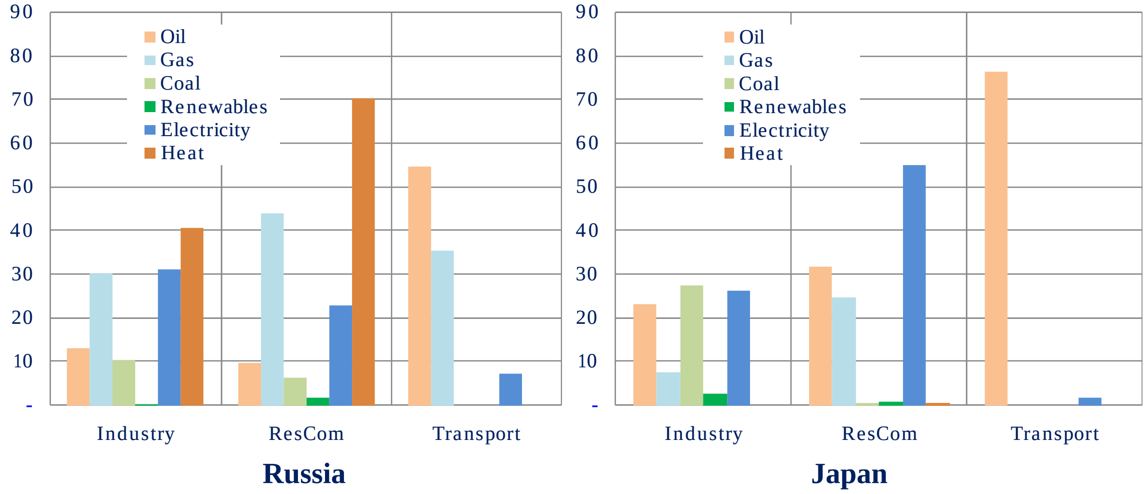
## 2. Industry

In terms of population, Russia and Japan are quite close: 142 million and 125 million respectively, or a 12% difference. However, final energy demand diverges significantly. In 2008, it reached 387 Mtoe in Russia, compared with that of 283 Mtoe in Japan (a 27% difference):

- industry – 125 Mtoe in Russia, and 87 Mtoe in Japan;
- transport – 59 Mtoe in Russia (excluding 38 Mtoe for pipeline), and 78 Mtoe in Japan;
- residential – 114 Mtoe in Russia, and 48 Mtoe in Japan;
- commercial – 51 Mtoe in Russia, and 70 Mtoe in Japan.

The structure of the final energy consumption for Russia and Japan in 2008 is presented in Fig. 2-1. Russian energy consumption shows a distinct difference from that of Japan due to much higher heat consumption in industry and residential/commercial sectors, and natural gas consumption for pipeline transportation.

**Fig. 2-1 Final energy consumption for Russia and Japan in 2008, Mtoe**




Source: IEA 2010, Mtoe

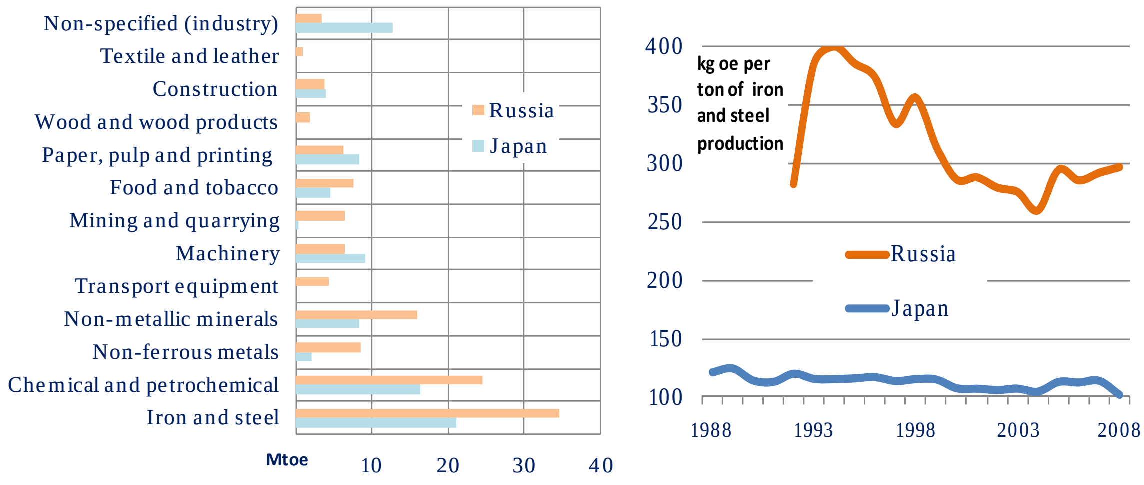
Russia has a large share of energy intensive (and labour non-intensive) bulk industry for metal and basic chemicals, and non-metal and construction materials production using raw materials, while the share of labour-intensive and hi-tech production (other than military, nuclear, and space manufacturing) is very low compared with the other industrialised economies. The rationales for such specifics of industrial structure are:

a) *enormous mineral and energy resources,*
b) *established heavy industries – iron and steel, basic chemistry, pulp and paper, construction materials, etc., and*
c) *international demand for energy-intensive raw materials.*

Energy consumption by industrial subsectors is presented in Fig. 2-2 a. It should be noted that industrial energy intensity, as a rule, is higher in Russia than in Japan. For example, Russia has produced 68.5 Mt of crude steel and 48.3 Mt of pig iron in 2008, while consuming 34.7 Mtoe of final energy. At the same year Japan has produced 118.7 Mt of crude steel and 86.2 Mt of pig iron consuming only 21 Mtoe of energy. That shows almost three times more efficient energy utilisation per unit of production in Japan compared to Russia (see Fig. 2-1 b).

**Fig. 2-2 a) Industrial energy consumption for Russia and Japan in 2008, Mtoe;**

**b) Energy intensity comparison of iron and steel industry in Russia and Japan**




a) b)

A similar tendency for higher industrial energy intensities in Russia in comparison to Japan is observed in other industries. Russia is producing 2.5 times less pulp and paper products than Japan, while consuming only 25% less energy (6.3 Mtoe vs. 8.4 Mtoe). In other words, the energy intensity in Japan's industry is 1.9 times lower. While the production structure and statistic methodology are different for the non-metallic minerals industry in Russia and Japan, however, general comparison of energy consumption and cement production in 2008 also reflect the scale of the energy efficiency issue for Russia: energy consumption at 16 Mtoe and production 53.4 Mt of cement. In Japan, to produce 67.6 Mt of cement requires 8.3 Mtoe.

While part of the difference in energy consumption could be explained by much lower ambient temperatures, the major part is coming from energy non-effective and obsolete technologies – the average amortisation of fixed capital stock in energy extraction industry is above 60% (and 25% of capital assets are completely amortised, but still in operation, i.e., it should be replaced immediately).

Another specific distinction in Russia is the structure of industrial energy consumption – heat holds the top position among other energy types, including electricity, gas, petroleum, and coal; there are no statistics for industrial heat consumption in Japan. The reason is that energy supply infrastructure in Russia historically was optimised for industrial clusters developed under state control, thus power and the industrial steam supply came from central cogeneration plants, along with power and hot water to heat industrial, commercial, and residential buildings during the winter season. In Japan, industrial boilers are an integral part of the business facilities, and thus industrial steam supply through cogeneration and boilers is not accounted separately within transformation and final energy consumption sections in the energy balance tables, but rather as fuel input (coal, gas, petroleum, or electricity) for final energy consumption.

## 3. Transportation

Russia uses more diversified modes of transportation, comparable to Japan, as pipelines and cargo trains are important for this vast country to deliver domestically and for export oil, gas, coal, and balk minerals, along with other living and industrial goods.

Russia has much lower road density than Japan, especially for intercity connections, and main freight transportation mode remains pipelines, railways, and inner waterways, while Japan primarily depends on road and marine transportation.

**Table 3-1 Comparison of energy consumption for transportation in Russia and Japan, 2008**

| Item | Units | Russia | Japan |
|---|---|---|---|
| **All transportation modes** | | | |

| Item | Units | Russia | Japan |
|---|---|---|---|
| Petroleum products | Mtoe | 54.7 | 74.6 |
| Natural gas | Mtoe | 35.4 | |
| Electricity | Mtoe | 7.1 | 1.6 |
| **Road** transportation, Petroleum products | Mtoe | 45.6 | 69.1 |
| **Aviation** (domestic and international) | | | |
| Petroleum products | Mtoe | 11.8 | 9.4 |
| Passenger traffic | bln passenger·km | 122.6 | 163.5[1] |
| Cargo traffic | bln t·km | 3.7 | 9.5[1] |
| **Rail** transportation | | | |
| Electricity | Mtoe | 3.8 | 1.6 |
| Petroleum products | Mtoe | 2.0 | 0.2 |
| Passenger traffic | bln passenger·km | 176 | 255[1] |
| Cargo traffic | bln t·km | 2,116 | 23[1] |
| **Pipeline** transportation | | | |
| Electricity | Mtoe | 2.3 | *negl.* |
| Natural gas and petroleum products | Mtoe | 35.5 | *negl.* |
| Cargo traffic | bln t·km | 2,464 | *negl.* |

Note: [1] – data for fiscal year 2007

The average distance for rail freight in Russia increased from 1,067 km in 1995 to 1,510 in 2009 (at an average growth rate of 2.5% per year), while for coal cargo deliveries, the growth is even more considerable – from 1,144 km in 1995 to 2,129 km in 2009, which corresponds to a 4.5% annual average growth rate. The growth is attributed to the economy's recovery and general industrial revitalisation after the 1998 default. Unfortunately, comparative statistics for Japan were not available to the author.

**Fig. 3-1 Energy consumption by transportation mode in Russia and Japan**

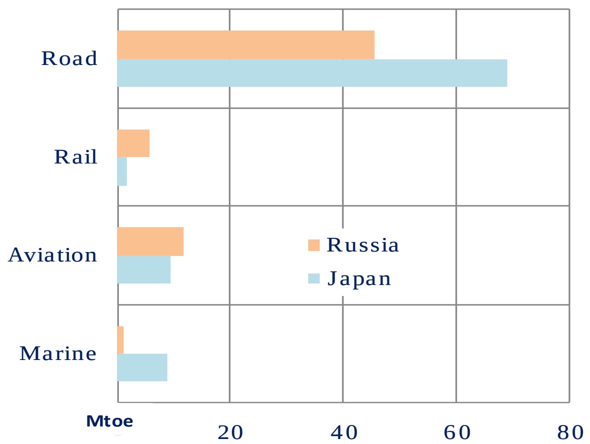
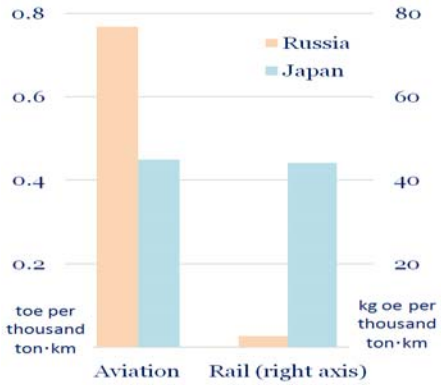


**Fig. 3-2 Energy intensity by transportation mode in Russia and Japan**




Japan's energy intensity is 42% less than Russia's energy intensity per unit of aviation traffic (combined passenger and cargo), while for railway it is vice versa – Russia has only 6% of Japan's energy intensity per unit of rail traffic (combined passenger and freight). The reasoning for such inverse patterns are in the combination of more advanced jets, a larger share of long-distance international air routes, and very intensive urban passenger rail transportation traffic for Japan; while in Russia, some 50% of airplane stock is still energy inefficient Soviet-era types flying on relatively short domestic routes (one to two thousand km). The rail transportation keeps the major share of intercity cargo traffic within the country, which is spread for more than 10 thousand km from west to east, and some 4 thousand km from north to south. Discussions for introducing high-speed intercity passenger trains are taking place in Russia.

However, there is a lot of room for energy efficiency improvements within transport systems, even for seemingly energy-efficient railways. Along with economic recovery, air transportation should recover to its pre-crisis level (or the level prior to 1990), while using a renewed stock of new domestically made aircrafts. Similarly, energy-efficiency improvements for road transportation should be provided through renewal of rolling stock (trucks, buses, cars). More stringent requirements for fuel quality and convenience for road cargo transportation will increase needs for advanced trucks. Growing wealth will drive demand for new cars, and the price of high petroleum products will increase the preference for more advanced and energy-effective cars.

**Table 3-2 Comparison of land transportation systems indicators for Russia and Japan, 2008**

| Indicator | Units | Russia | Japan |
|---|---|---|---|
| Railway length | km | 87,157 | 23,506 |
| Freight intensity | mln t·km per km | 24.3 | 0.98 |
| Passenger intensity | mln pass·km per km | 2.0 | 10.9 |
| | | | |
| Road length | mln km | 0.75 | 1.26 |
| incl. intercity roads | | 0.58 | 0.25 |
| Trucks | mln | 4.862 | 6.884 |
| Buses | thousands | 64 | 231 |
| Cars | thousands | 31,856 | 41,469 |
| *Cars ownership* | cars per 1000 population | **224** | **447** |

## 4. Residential and Commercial sectors

For several reasons the largest reserves for efficiency improvements in Russia are in the heat supply systems:

- the share of heat energy supply accounted for 28% in the total final energy consumption in Russia in 2008,
- the share of residential and commercial consumers amounts to ¾ of the total heat supply,
- almost all consumption of natural gas, petroleum products, and coal by the residential and commercial sectors (60 Mtoe in 2008) is allocated to heat supply, and additional heat is supplied by cogenerators and large boilers (70.3 Mtoe in 2008),
- in general some 45% of all primary energy supply and over 50% of fossil fuel is devoted to heat supply, and
- the losses at heat distribution systems are high, the large share of the stock of small-sized heat generating facilities is outdated, and, as a consequence, most local centralised heat systems needs urgent rehabilitation.

The energy statistics for 2008 show that fossil-fuel consumption in Russia by the residential and commercial sectors was almost two times higher than in Japan – 0.92 ton versus 0.47 ton of oil equivalent per capita, respectively. However, electricity consumption is different – 5,100 kWh per capita in Japan versus 1,870 kWh per capita in Russia. The different patterns are explained by decentralised systems for water heating and conditioning of living/commercial space in Japan, while in Russia, much of this service is centralised and thus energy consumption accounted for the energy transformation sector, rather than for residential and commercial.

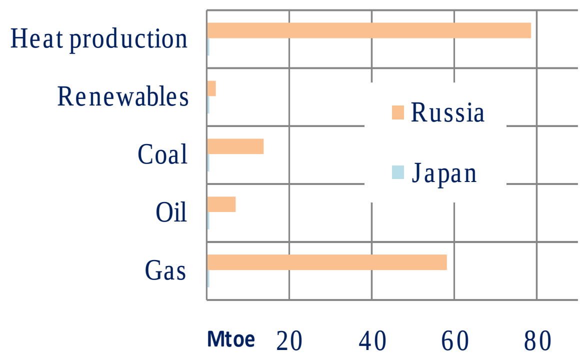
Heat supply is the largest single product market in Russia, and this market is split into 50,000+ local markets. Total sales in the heat supply market amounts to more than 30 billion dollars. Efficiency improvement and rehabilitation potential of the market are enormous, as there is a shortage of metering and remote control equipment at residential apartments, and the majority of heat supply infrastructure require urgent transformation into advanced technical systems.

Residential and commercial heat supplies have important social implications and are an imminent concern for local governments in Russia. Historically, the heat supply industry was subsidised by local budgets and thus has accumulated a lot of room for efficiency improvements. The law *On Heat Supply* was introduced in July 2010 to create investment opportunities, decrease energy losses, eliminate subsidies, and provide business incentives. A transparent market for heat supply will provide additional incentives to develop small CHP facilities at district and building levels as a primary option for heat generators powered by natural gas. Special attention in the law is provided to registration (data collection) equipment, which should be compulsory for new buildings. The heat supply industry restructuring in Russia will be a cornerstone for energy conservation activities and provide enormous business opportunities for both domestic and international businesses.

## 5. Transformation sectors – refining, power and heat generation

The most important point for power generation, heat and gas production, transportation, and distribution facilities in Russia is that their average depreciation is 46%, while 15% of them are completely amortised (became obsolete), but still in operation; for refineries, corresponding indicators are 39% and 12%, respectively. This means that at least 12% of refineries in Russia should be immediately replaced by new facilities. The Federal Government confirms its position to introduce high fuel standards no later than 2015. That is very important, as environment is degrading in Russian cities primarily due to the road traffic and the car fleet is rapidly restructuring towards advanced models.

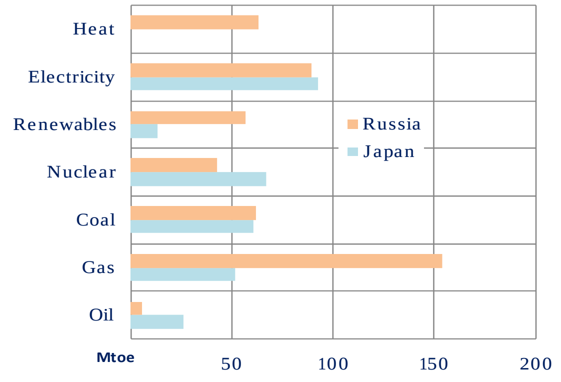
**Fig. 5-1Heat production and energy mix for heat plants in Russia and Japan (for 2008)**




The heat producers (without cogeneration) in Japan at 0.5 Mtoe are dwarfed by Russia's 78.5 Mtoe, while fuel-to-heat energy conversion efficiency for both economies equally stands at 97% (Fig. 5-1). It is important to mention the high share of natural gas in energy input for heat plants in Russia, as it is an indicator of social and energy security, which is literally a survival issue for this country, with its harsh natural environment. In the summer of 2010, a major step to crucial institutional changes was initialised by adoption of the *On Heat Supply* law. This will eventually lead to privatisation of the heat supply industry for residential/commercial sectors, while international businesses already invest in heat supply at the local level.

Japanese thermal power plants in 2008 produced 738 TWh with an average efficiency of 44.4%, while in Russia, corresponding indicators were 714 TWh and 38.6%. Much lower power generation efficiency for Russian thermal power plants should be attributed to the obsolete technology for natural gas steam turbines still in use after switching coal power plants to natural gas in the Soviet era some 30 years ago, low natural gas prices, and a lack of advanced coal technologies (Fig. 5-2).

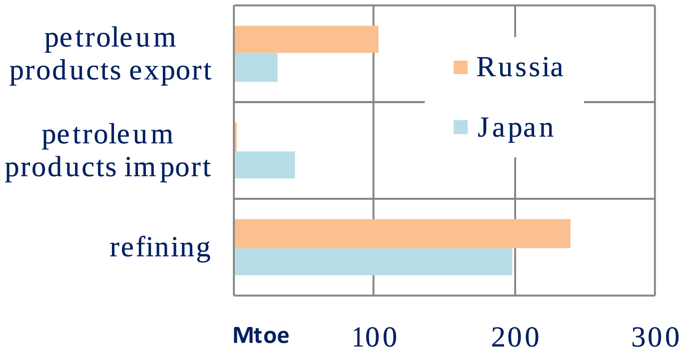
**Fig. 5-2 Electricity and heat production and energy mix for power plants in Russia and Japan (for 2008)**




The gas dominance in the energy mix for thermal power plants in Russia is partially attributed to the price disadvantage of coal to natural gas. The price for imported natural gas is averaged at

2.3 times higher than coal in Japan since 1983 (ranging from 1.4 to 3.6), since the same energy content is considered. In Russia, while gas prices historically are under tight regulation, the ratio was reversed before summer 2005. Only after that did "gas energy" become more expensive than "coal energy." In 2010 that ratio was 1.3 (i.e., the amount of energy contained in natural gas is 30% more expensive than the amount of energy contained in coal for producing the same amount of heat). If the current trend under the domestic energy policy to liberalise energy markets continues, new gas and coal technologies will have even more economic advantages in Russia. The institutional structure in the power industry has changed over the last five years. Thermal power generators, including heat producers, and distribution grids are private now in Russia, while the state continues to hold business in nuclear, hydro generation, and transmission lines. The market for system services in power supply, such as reliability and power quality control within the grid, has been operational since 2011. The regulatory framework was established in 2010 to help renewable energy developers (including hydro power plants with less than 25 MW capacities) enter the power market by providing fiscal incentives.

**Fig. 5-3 Crude oil refining and petroleum products export/import in Russia and Japan (for 2008)**




Since the 2006 restructuring of the nuclear industry and military/civil energy facilities separation in Russia, regulation has allowed private investors to participate in the nuclear industry developments for uranium mining, power, and heat generation and nuclear fuel production.

While the amounts of crude oil refining are similar in Russia and Japan, petroleum product exports in Russia are deemed to be an additional source of value added in energy export, while in Japan, it is more than compensated by import of LPG and naphtha (as chemical raw material) (Fig. 5-3). The quality of petroleum products in Russia is still low, and the introduction of more stringent standards was postponed several times.

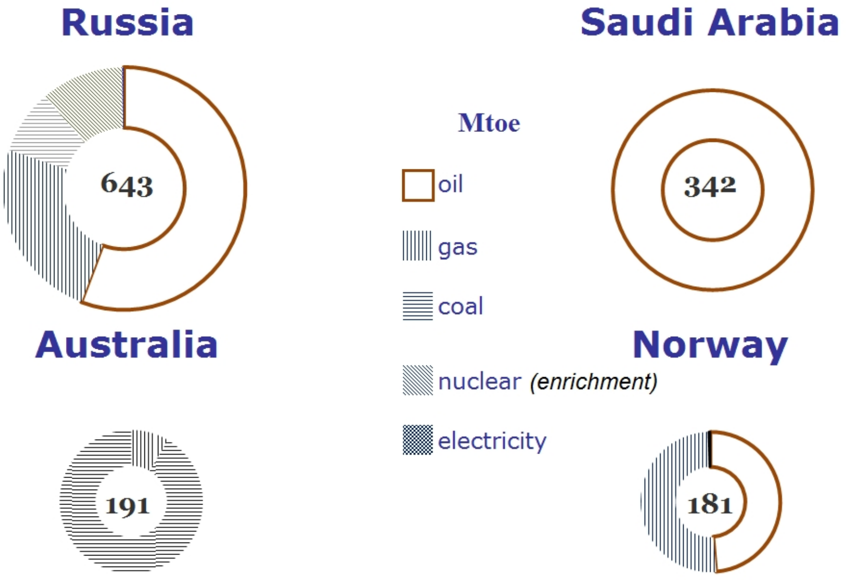
## 6. Primary energy supply – extraction, export policy

Russia is the second largest primary energy producer (behind the United States), the third largest energy consumer (behind the United States and China), the world's largest exporter of energy (some 45% of total energy produced is exported), the largest exporter of natural gas, and the second largest oil exporter. The energy sector's output accounts for a large share of Russia's GDP, and is very important not only to economic development but also to the very survival of the population during harsh winters.

The importance of Russian energy export is illustrated, firstly, by a more than 25% share of energy-related industries in national GDP (the directly measured value added in 2008 is 14%, and the total related activity in other sectors is assessed at a similar level); and secondly, by volume and structure of net energy export among the top four energy exporters in the world (Fig. 6-1).

In 2008, exports of crude oil, petroleum products, and natural gas accounted for two-thirds of the total economy's exports and approximately 9% of GDP. Russia holds leading positions in each of the world's energy markets: 40% of uranium enrichment, 25% of natural gas trading, 16% of reactor construction, 15% of spent nuclear fuel conversion, 12% of crude oil and petroleum products trading, and 12% of coal trading. By destination, exports go overwhelmingly to Western and Eastern Europe (including the Commonwealth of Independent States), which accounts for more than 91% of Russia's total energy exports. In an attempt to secure its future energy export, Russia is currently diversifying export routes toward regional markets in the Asia–Pacific region, aiming to deliver oil, natural gas, and coal to China, Japan, and the Republic of Korea in East Asia, as well as economies in North America. Such exposure to international energy markets and the crucial social importance of secure domestic energy supply are very challenging for appropriate pricing of energy. Russia makes it a strategic choice to take the market approach for the domestic energy supply chain, including fair pricing mechanisms on the base of spot and exchange trading for matured energy markets, and long-term contracts for capital intensive industries and risky markets.

**Fig. 6-1 Top four world net energy exporters in 2010, Mtoe**




*Note (enrichment) – uranium enrichment service to produce nuclear fuel*

Sources: energy - British Petroleum, 2011. *BP Statistical Review of World Energy*; nuclear enrichment – author's estimations derived from IAEA, OECD NEA. 2010. *Uranium 2009: Resources, Production, and Demand,* and the RosAtom website.

One of the milestones in Russia's energy sector development was the adoption of the *Energy Strategy of Russia to 2020* in August 2003. The document identifies Russia's long-term energy policy and respective implementation mechanisms. A revised version of the strategy with an extended timeframe to 2030 was adopted by the government in November 2009. The document is seen as an umbrella under which more detailed industry-oriented medium-term and short-term programmes should be developed for future domestic energy supply and export to international energy markets.

The economic potential of hydropower in Russia is estimated to be 0.9 PWh per year, but only one-fifth of this has been developed. There is an enormous technical potential for renewable energy production, like large hydro energy and biomass in Siberia, windy Arctic and Pacific shores, geothermal energy at Kamchatka and Kuril Islands, and tidal energy in Okhotsk Sea. However, economic utilisation of this potential is constrained by a huge distance over which renewable electricity/energy should be delivered to domestic consumers, or exported. One of the attractive options for future global low-carbon energy supply is to convert this renewable electricity to hydrogen and then export it within the Asia-Pacific regional international market, as economies of scale and less environmental footprints are favourable for such new Russian energy export.

Institutional changes within the Russian energy-extraction industry over the last 20 years has led to decline from 100% state ownership to almost all private business in power, coal and oil industry, and more than 50% private interests in gas industry. The latter is due to the fact that a 15% share of gas production in Russia came from private businesses, while the state is controlling just over 50% in Gazprom. Unlike other major oil exporters such as OPEC economies, Mexico, and Norway, Russian oil business is driven by private investors. The state ownership is still (and will be for the foreseeable future) maintained in power transmission lines, oil and petroleum products pipelines, and natural gas transportation, strategic assets in gas and oil extraction business, and is critical to non-proliferation nuclear fuel cycle facilities. It seems that extraction industry privatisation is at the final phase in Russia and its transformation to the institutional structure of the state-business partnership is entering crucial stage. Officially, major efforts are devoted to levelling the playing field for private domestic and foreign investors in the energy supply chain, and related industries. The likely Russian accession to the WTO in 2012 will facilitate this process.

## 7. Outlook for energy investments

The amount and structure of expected energy investments are of primary importance for energy-related business, and is an attractive instrument for the financial system in both Russia and Japan. Furthermore, from the view point of international energy security and overall political cooperation, mutual investments should bring a lot of opportunities, providing the so-called window of "win-win" opportunities. The author will provide assessments for energy investments in Russia and Japan (Fig. 7-1 and 7-2) without more detailed analysis, leaving it for interested readers. The source for such assessments is completely based on the author's research results for *APEC 4th Energy Demand and Supply Outlook*, published by APERC in 2009.

**Fig. 7-1 Outlook for energy investments in Russia up to 2030, billion 2009 US dollars**

**a) following the energy supply chain**

**b) by energy industry**

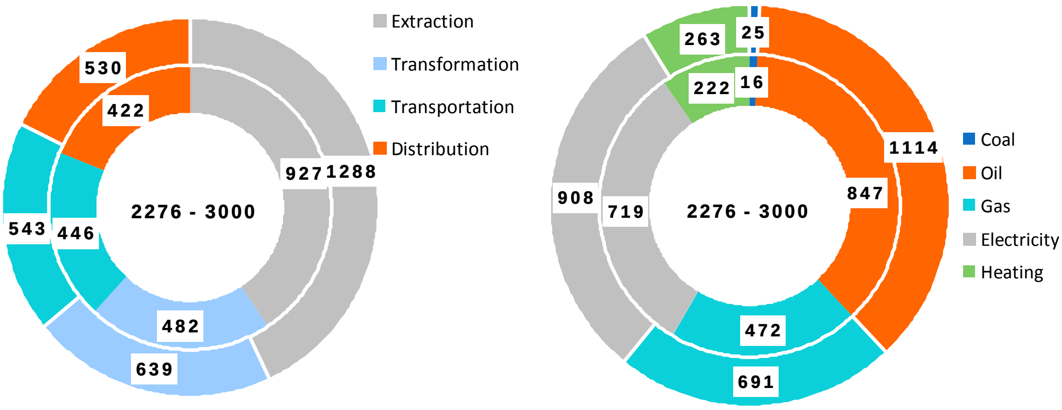
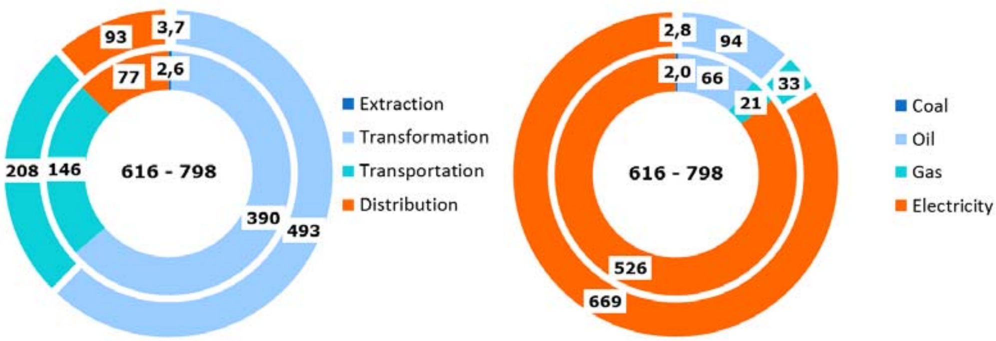



**Fig. 7-2 Outlook for energy investments in Japan up to 2030, billion 2009 US dollars**

**a) following the energy supply chain**

**b) by energy industry**




Sources: APEC 4th Energy Demand and Supply, 2009.

## 8. Business and policy implications

### Industrial energy consumption

Russia needs a large-scale retrofitting of energy-intensive industries, especially if the development of the energy-intensive industry becomes a major driver for its economy. It will be considerably more profitable to retrofit old and obsolete capital assets in Ural, Siberia, and Russian Far East regions, where most of the minerals, metallurgy, and chemical industries are placed. In turn, additional primary energy that's becoming available from thus reduced final energy consumption in heavy industry will be redirected to energy export, improving energy security by providing an additional supply to international energy markets. A lot of business applications for construction of new energy-efficient facilities, particularly in the refining and chemical industries, should be available in those regions in coming years, if basic the commodities market grows in line with the global economy.

Political implications for Japan's involvement into modernisation of the Russian energy–intensive industries will be a more secure and more environmentally friendly international energy supply to the Asia-Pacific region, as most of Russian domestic production of primary energy comes from the Asian part of the country.

### Transport systems development

Russia needs large-scale retrofitting and development of road, air, and inner waters transportation systems. Huge business opportunities exist for a combination of vehicles import and localised manufacturing, including export of the most critical advanced parts from Japan. Also, construction of the transport infrastructure provides additional business opportunities for export of Japanese construction equipment to Russia.

Political implications for Japan's involvement in the development of Russia's transport infrastructure could be considered under the "Joint Implementation" schemes designed for Kyoto Protocol back in 1997, thus highlighting both economies' commitments to the international cooperative efforts to secure energy supply and mitigate climate changes.

### Residential and commercial sectors

Residential and commercial sectors' energy supplies are the largest energy markets in Russia and ubiquitous in the economy at the local level. Business opportunities are enormous, as both centralised and decentralised heat supply require urgent rehabilitation for the whole chain from generation to distribution and final consumption, including metering and remote control equipment.

Being involved in the energy service business at the local level in Russia will reflect much better mutual understanding of the domestic business and political institutions for both Japanese and Russian business actors and population.

### Energy transformation/conversion and transportation

Russia needs a large-scale retrofitting of heating supply systems and crude oil refining, new construction for combining cycle gas turbines and advanced, clean coal technologies. The business opportunities are enormous, including cooperation in the nuclear industry. The most effective approach for "*greenhouse gas emissions*" mitigation in Russia concentrates on the energy conversion chain of energy supply, thus Japanese cooperation with Russia in the energy conversion sector would be extremely beneficial for international combat against climate change.

### Energy production

Russia needs investments and technologies to extract primary energy, as a resource base for conventional and unconventional coal, gas, oil, and renewable energy is enormous. However, the scale of the problems to monetise these resources are also challenging, due to geographical circumstances, international energy price volatility, and concerns over tightening global oil demand and supply balance. There are evident benefits for Japanese business in cooperation with Russia to explore all types of primary energy resources, including nuclear energy.

Major political implications for Japan in developing cooperation with Russia on energy extraction/production are energy security improvements and lessening environmental footprints for the energy supply chain, and commitments to liberalised global energy markets through fair pricing mechanisms.

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