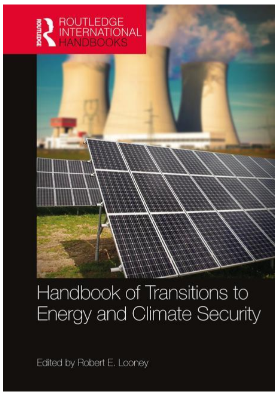

Handbook of Transitions to Energy and Climate Security

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Energy transitions in carbon-producing countries

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10

Energy transitions in carbon-producing countries

Russia

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Introduction

In the context of the study of energy transitions in carbon-producing countries, Russia presents a case that is both highly significant and highly interesting, due to its specificity. Russia's significance as a carbon-producing country derives from its status as a world-leading energy producer: in 2014, Russia ranked second for oil and gas production, sixth for coal production, third for nuclear power production, fourth for hydroelectricity generation, and fourth for electricity generation overall.[1] Not only does Russia produce fuel for its own consumption, it facilitates the fuel consumption (and, therefore, CO_2 emissions) of other countries through its hydrocarbon exports.

As well as being the world's third largest energy consumer, Russia is also the fourth largest emitter of CO_2 in the world, after China, the United States, and India. Indeed, in 2012, Russia's CO_2 emissions were equal to those of the entire Middle Eastern region, and approximately one and a half times those of the non-OECD Americas and one and a half times those of the whole of Africa.[2] Clearly, trends in Russia's energy consumption and CO_2 emissions are highly significant factors in the global challenge of reducing CO_2 emissions.

This chapter examines how Russia's energy consumption patterns, and by extension, CO_2 emissions, have changed over the past decade. In doing so, it identifies trends that are likely to continue into the medium term (to 2020) and the causes of those trends. In addressing these questions, it is possible to draw conclusions as to whether Russia, as one of the world's most significant carbon producers, is undergoing an "energy transition," or whether Russia's energy consumption and CO_2 emissions will continue along the lines of "business as usual" for the medium term, and why this is the case.

In order to answer these questions, this chapter begins by establishing trends in Russia's levels of energy consumption and related CO_2 emissions (total and per capita), placing them into the international context. The second part of this chapter then seeks to explain these trends by examining a range of factors, including population growth, economic growth, levels of energy efficiency (measured in terms of energy consumption per unit of GDP produced). The third part of this chapter analyses trends in Russia's energy consumption by fuel and by sector, and in doing so, identifies areas in which Russia could make an "energy transition." Finally, this chapter examines the participation of the Russian government in international climate change politics, to draw inferences about the orientation of the Russian government, and the level of its commitment to managing Russia's fuel consumption and related CO_2 emissions.

Russia's energy consumption 2004–2014: identifying trends

Russia's total energy consumption has risen steadily over the past decade. In 2004, Russia's energy consumption was 649.5 million tonnes of oil equivalent (mtoe). By 2014, that figure had risen by 5% to 681.9 mtoe.[3] To put the gradual increase in Russia's energy consumption into context, Table 10.1 clearly illustrates that energy consumption in the most developed economies (United States, Japan, and EU-28) fell between 2004 and 2014. By contrast, the world's largest countries by population, China and India, exhibited dramatic increases in energy consumption. Mexico and Brazil demonstrated substantial increases in energy consumption, in line with their regional neighbours. In terms of current trends in total national energy consumption, Russia's closest comparative countries are Canada, South Africa, and Australia.

However, a slightly different picture emerges when trends in energy consumption per capita, measured in kilograms of oil equivalent, are considered. Per capita energy consumption declined, or at least stabilized, in the most advanced economies (United States, Japan, EU-28, Canada, Australia) and increased to the greatest extent in the world's largest countries by population, China and India, albeit from a low base. In terms of trends in energy consumption per capita between 2004 and 2012, Russia's closest comparative countries are South Korea, Brazil, Venezuela, and Belarus. However, while levels of energy consumption per capita in 2012 in Russia and South Korea are rather similar, per capita energy consumption levels in Brazil, Venezuela, and Belarus are considerably lower.

Russia's CO_2 emissions 2005–2014

According to data from the United Nations (UN), Russia's CO_2 emissions were 2,510 million tonnes in the baseline year of 1990. Thereafter, Russia's emissions declined every year to reach a trough of 1,441 million tonnes in 1998, before rising every year (except 2009) to reach 1,659 million tonnes in 2012.[4] This means that by 2012, Russia's CO_2 emissions had declined by 34% against the baseline of 1990, but had been also on an upward trend for more than a decade.

Data from the World Bank is not available for the base year of 1990, but states Russian CO_2 emissions of 2,082 million tonnes in 1992, falling to 1,498 million tonnes in 1998, and rising to 1,603 million tonnes in 2004 and 1,808 million tonnes in 2011. Therefore, according to the World Bank, Russia's CO_2 emissions grew by 12.8% between 2004 and 2011. Although the data from the UN is more complete, data from the World Bank has been used in Figure 10.1 below, due to the availability of comparable data from the same source, on per capita CO_2 emissions.

For comparison, World Bank data shows that between 2004 and 2011, US CO_2 emissions fell from 5,510 million tonnes to 5,306 million tonnes, EU CO_2 emissions fell from 4,052 to 3,574 million tonnes, China's CO_2 emissions rose from 5,288 million tonnes to 9,020 million tonnes, and India's CO_2 emissions rose from 1,349 million tonnes to 2,074 million tonnes. The current trend for CO_2 emissions to decline in developed countries and rise in developing and middle-income countries is borne out by the fact that between 2004 and 2011, OECD CO_2 emissions declined by 5.8% from 13,133 million tonnes to 12,377 million tonnes, while non-OECD CO_2 emissions rose dramatically by 44.5% from 15,411 million tonnes to 22,273 million tonnes.[5]

Table 10.1 Total Primary Energy Consumption (TPES) (million tonnes of oil equivalent – mtoe) and Energy Consumption per Capita (kilograms of oil equivalent)

Country	*TPES (2004–2014) and energy consumption per capita (2004–2012)*					
	TPES (mtoe)			*Energy consumption per capita (kg oil equivalent)*		
	2004	*2014*	*Change*	*2004*	*2012*	*Change*
Russia	*649.5*	*681.9*	*+5.0%*	*4,494*	*5,283*	*+17.6%*
Australia	115.3	122.9	+6.6%	5,598	5,644	+0.8%
Belarus	24.9	28.6	+14.9%	2,753	3,223	+17.1%
Brazil	201.3	296.0	+47.0%	1,129	1,392	+23.3%
Canada	315.6	332.7	+5.4%	8,365	7,226	−13.6%
China	1,573.1	2,972.1	+88.9%	1,265	2,143	+69.4%
Estonia	–	–	–	3,983	4,174	+7.2%
EU-28*	1,818.2	1,666.3	−8.4%	3,606	3,254	−9.8%
India	345.1	637.8	+84.8%	460	624	+35.7%
Iran	166.3	252.0	+51.5%	2,244	2,883	+28.5%
Japan	525.1	456.1	−13.1%	4,090	3,546	−13.3%
Kazakhstan	43.0	54.3	+26.3%	3,383	4,458	+31.8%
Latvia	–	–	–	1,961	2,171	+10.7%
Lithuania	9.1	5.4	−40.7%	2,779	2,469	−11.2%
Mexico	158.9	191.4	+20.5%	1,486	1,543	+3.8%
Norway	39.9	46.7	+17.0%	5,756	5,817	+1.1%
Saudi Arabia	174.4	239.5	+37.3%	4,980	6,789	+36.3%
South Africa	117.0	126.7	+8.3%	2,757	2,675	−3.0%
South Korea	213.8	273.2	+27.8%	4,337	5,268	+21.5%
Turkmenistan	18.6	31.3	+68.3%	3,919	4,943	+26.1%
Ukraine	137.7	100.1	−27.3%	3,031	2,690	−11.3%
United States	2,349.1	2,298.7	−2.2%	7,882	6,815	−13.5%
Venezuela	67.5	84.3	+24.9%	2,148	2,558	+19.1%

Sources: BP, *Statistical Review of World Energy*, 40; Eurostat, "Simplified Energy Balances: Annual Data," Eurostat, last modified February 2, 2016, http://ec.europa.eu/eurostat/product?code=nrg_100a&mode=view; World Bank, "World Data Bank: Energy Use (kg of Oil Equivalent per Capita)," World Bank, 2015, http://data.worldbank.org/indicator/EG.USE.PCAP.KG.OE/countries/1W-RU-ZA-AU-CA?display=default.

* Statistics for EU-28 for TPES are given for 2013, not 2014.

In terms of per capita emissions, the world average in 2011 was 4.9 metric tonnes per capita. Only 26 geographical entities, from a list of 218 given by the World Bank, had per capita CO_2 emissions above 10 metric tonnes. Of these 26, eight were geographic entities with very small populations (Aruba, Brunei, Cayman Islands, Faroe Islands, Greenland, Luxembourg, New Caledonia, and Palau) and six were small states with significant oil and/or gas exports (UAE, Bahrain, Kuwait, Oman, Qatar, Trinidad and Tobago). This leaves a group of 12 states with significant populations and high levels of CO_2 emissions per capita: Australia, Canada, Czech Republic, Estonia, Finland, Kazakhstan, South Korea, Netherlands, Russia, Saudi Arabia, Turkmenistan, and the United States. Of this group, only six (Russia, Kazakhstan,

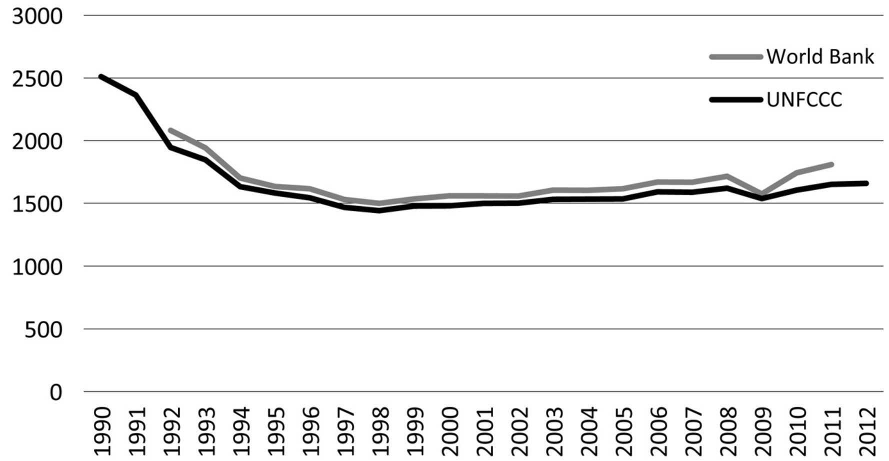

Figure 10.1 Russia's CO_2 emissions, 1990–2012
Source: UNFCCC, "Greenhouse Gas Inventory Data"; World Bank, "CO_2 Emissions (kt)," World Bank, 2015, http://data.worldbank.org/indicator/EN.ATM.CO2E.KT/countries.

Turkmenistan, Estonia, South Korea, and Saudi Arabia) recorded an increase in their per capita emissions between 2004 and 2011 (the latest year for which per capita data is available from the World Bank). By contrast, the advanced economies showed declines of between 3% (Australia) and 20% (Finland).[6] The growth rate of Russia's CO_2 emissions per capita during this period (13.7%) was broadly similar to those of Estonia (11.2%) and South Korea (17.9%), but far below the growth rates of Kazakhstan (37.9%) and Turkmenistan (32.3%). A further three states with emissions of between 5 and 10 metric tonnes per capita in 2011 exhibited growth rates of 11–12%, similar to those of Russia: Belarus, Bulgaria, and Venezuela.[7]

The trends in total and per capita energy consumption and CO_2 emissions discussed above suggest that Russia is following a different trend to the advanced economies of North America, Western Europe, and Japan, where levels of per capita energy consumption and CO_2 emissions are falling, and a different trend to the rapidly developing countries of China and India, whose emissions grew 50–60% during the 2005–2012 period, on the basis of a combination of economic and population growth. Clearly, Russia does not fit into either the group of advanced economies or the group of rapidly developing economies with large populations. To explain why Russia is following its own trends in energy consumption and CO_2 emissions, it is now necessary to examine possible causes of these trends, in order to draw conclusions about the likelihood of their continuation.

Causes of trends in Russia's energy consumption and related CO_2 emissions

Explaining trends in Russian energy consumption: population, economic growth (GNI per capita), and energy consumption per unit of GDP

In its report on world energy resources, the World Energy Council (WEC), noted, "Population growth has always been and will remain one of the key drivers of energy demand, along with economic and social development."[8] In the case of Russia, demographic data suggests that the latter factors are far more influential than the former.

Table 10.2 Trends in CO_2 emissions, total and per capita, 2004–2014

Country	*CO_2 emissions, total and per capita, 2004–2012*					
	CO_2 emissions (total-million tonnes)			*CO_2 emissions (tonnes per capita)*		
	2004	*2011*	*Change*	*2004*	*2011*	*Change*
Russia	*1,603*	*1,808*	*+12.8%*	*11.1*	*12.6*	*+13.7%*
Australia	343	369	+7.7%	17.0	16.5	-3.0%
Belarus	58	63	+9.1%	6.0	6.7	+12.0%
Brazil	338	439	+30.1%	1.8	2.2	+20.7%
Canada	552	485	−12.1%	17.3	14.1	−18.1%
China	5,288	9,020	+70.6%	4.1	6.7	+64.5%
Estonia	17	19	+8.3%	12.6	14.0	+11.2%
EU-28	4,052	3,574	−11.8%	8.2	7.1	−15.4%
India	1,349	2,074	+53.8%	1.2	1.7	+38.9%
Iran	447	587	+31.1%	6.5	7.8	+20.9%
Japan	1,259	1,188	−5.7%	9.9	9.3	−5.7%
Kazakhstan	172	262	+52.0%	11.5	15.8	+37.9%
Latvia	7	8	+9.4%	3.2	3.8	+20.2%
Lithuania	13	14	+3.1%	3.9	4.5	+15.0%
Mexico	412	467	+13.3%	3.8	3.9	+1.9%
Norway	43	46	+6.8%	9.3	9.1	−1.0%
Saudi Arabia	396	520	+31.4%	16.5	18.1	+9.8%
South Africa	425	477	+12.4%	9.1	9.3	+1.8%
South Korea	482	589	+22.2%	10.0	11.8	+17.9%
Turkmenistan	43	62	+43.9%	9.2	12.2	+32.3%
Ukraine	343	286	−16.6%	7.2	6.3	−13.4%
United States	5,763	5,306	−7.9%	19.7	17.0	−13.5%
Venezuela	152	189	+24.4%	5.8	6.4	+11.3%

Sources: World Bank, "CO_2 Emissions (kt)," World Bank, 2015. http://data.worldbank.org/indicator/EN.ATM.CO2E.KT/countries; World Bank, "CO_2 Emissions: Metric Tonnes Per Capita." 2015, http://data.worldbank.org/indicator/EN.ATM.CO2E.PC/countries.

Russia's population peaked in 1992 at 148.7m, and fell every year thereafter to 142.7m in 2008. Since then it has recovered to 143.8m in 2014. However, Russia's annual population growth rate remains low, at 0.0–0.2% per year, against a global average of 1.2% per year.[9] If Russia's population continues to grow at its 2009–2014 rate of 1m every five years, Russia will not surpass its 1995 population level until 2040. Therefore, any significant changes in Russia's total energy consumption and CO_2 emissions will occur on the basis of changes in consumption and emission per capita under relatively stable population conditions, rather than under conditions of rapid population growth. This puts Russia in stark contrast with the other major CO_2 emitters (United States, China, and India), but in a similar situation to Japan and its post-Soviet neighbors (Ukraine, Belarus, Estonia, Latvia, Lithuania), with the latter experiencing population stagnation or decline over the past decade.

With economic and social development highlighted by the World Energy Council as key drivers in energy demand, it is worth examining the relationship between socio-economic

Table 10.3 Population and GNI per capita (adjusted for purchasing power parity – PPP), 2004–2014

Country	*Population and GNI per capita (PPP), 2004–2014*					
	Population (million)			*GNI per Capita (USD, PPP)*		
	2004	*2014*	*Change*	*2004*	*2014*	*Change*
Russia	144.1	143.8	−0.2%	10,010	24,710	+146.9%
Australia	20.1	23.5	+16.7%	30,420	42,880	+41.0%
Belarus	9.7	9.5	−2.7%	8,510	17,610	+106.9%
Brazil	186.1	206.1	+10.7%	9,950	15,590	+56.7%
Canada	32.0	35.5	+11.1%	32,860	43,400	+32.1%
China	1,296.1	1,364.3	+5.3%	4,410	13,130	+197.7%
Estonia	1.4	1.3	−3.6%	13,950	25,690	+84.2%
EU-28	494.3	508.3	+2.8%	26,489	36,275	+36.9%
India	1,126.4	1,295.3	+15.0%	2,560	5,640	+120.3%
Iran	69.3	78.1	+12.7%	11,850	16,140	+36.2%
Japan	127.8	127.1	−0.5%	29,920	37,920	+26.7%
Kazakhstan	15.0	17.3	+15.2%	11,570	21,580	+86.5%
Latvia	2.3	2.0	−12.1%	13,130	23,150	+76.3%
Lithuania	3.4	2.9	−13.3%	12,810	25,390	+98.2%
Mexico	108.3	125.4	+15.8%	11,050	16,500	+49.3%
Norway	4.6	5.1	+11.9%	43,280	65,970	+52.4%
Saudi Arabia	24.1	30.9	+28.4%	32,260	(2013) 51,320	+59.1%
South Africa	46.7	54.0	+15.6%	9,070	12,700	+40.0%
South Korea	48.0	50.4	+5.0%	22,920	34,620	+51.0%
Turkmenistan	4.7	5.3	+13.0%	4,940	14,520	+193.9%
Ukraine	47.5	45.4	-4.4%	5,980	8,560	+43.1%
United States	292.8	318.9	+8.9%	42,260	55,860	+32.2%
Venezuela	26.3	30.7	+16.6%	11,510	17,230	+49.7%

Source: World Bank, "World Data Bank: Population," World Bank, 2015, http://databank.worldbank.org/data//reports.aspx?source=2&country=RUS&series=&period=#selectedDimension_WDI_Ctry; World Bank, "World Data Bank: GNI per Capita, PPP (Current International $)," World Bank, 2015, http://data.worldbank.org/indicator/NY.GNP.PCAP.PP.CD/countries.

development (measured as gross national income [GNI] per capita, adjusted for purchasing power parity – PPP) and per capita energy consumption. Data from the World Bank highlights Russia's impressive economic growth between 2004 and 2014. Russia is the only country in the world to have had a GNI per capita of above $10,000 in 2004, and still experience a growth in GNI per capita of over 100% during the decade that followed. Russia aside, the only countries to have recorded such growth rates between 2004 and 2014 were those that began their economic growth from a much lower base, China and India. Conversely, all countries with a GNI per capita (PPP) of over $10,000 in 2004, and a population above 2 million, recorded growth rates between 5 and 95%, with the exception of Libya, which recorded negative growth.[10]

However, while economic growth and per capita energy consumption may be linked in Russia's case, this is not true of all countries. To find the link, one must be more specific. The advanced economies of the United States, Canada, Japan, and the EU-28 all recorded GNI per capita (PPP) growth of approximately 27–37% between 2004 and 2014, whilst simultaneously reducing their per capita energy consumption. Conversely, several states that recorded the largest increases in energy consumption per capita (Brazil, India, and China) also recorded large increases in GNI per capita (PPP) from a low base. Russia has yet to follow the developed economies in breaking the link between economic growth and energy consumption, yet it also has a significantly higher GNI per capita (PPP) than less-developed countries that rely more strongly on increased energy consumption for economic growth (Brazil, China, India, Iran, Kazakhstan, Turkmenistan, and Venezuela). This is also illustrated in the table below, which highlights the fact that while Russia's energy efficiency in GNI creation is improving, it remains at a low level.

It is notable that by 2012/2014, Russia's GNI per capita (PPP) was in the upper middle-income range: significantly below the advanced economies (EU-28, United States, Canada, Australia, Japan, South Korea, and Norway), significantly above the lower middle-income countries (Brazil, India, China, South Africa, Mexico, Iran, Venezuela, Ukraine and Belarus), and broadly similar to several of its post-Soviet neighbors (Estonia, Latvia, Lithuania,

Table 10.4 Units of gross domestic product (GDP) produced per unit of energy consumed, 2004–2012

Country	*GDP per unit of energy consumed*		
	2004	*2012*	*Change*
Russia	3.78	4.41	+16.8%
Australia	6.81	7.53	+10.6%
Belarus	3.58	5.25	+46.6%
Brazil	10.63	10.74	+1.0%
Canada	4.71	5.90	22.9%
China	4.05	5.14	+26.9%
Estonia	5.05	5.64	+17.4%
EU-28	8.97	10.56	+17.8%
India	6.50	7.79	+20.0%
Iran	6.23	5.59	−10.2%
Japan	8.19	9.87	+20.5%
Kazakhstan	4.25	4.82	+13.6%
Latvia	7.87	9.49	+20.6%
Lithuania	6.86 (2005)	9.60	+40.1%
Mexico	10.00	10.47	+4.7%
Norway	10.83	10.94	+0.9%
Saudi Arabia	7.47	7.19	−3.8%
South Africa	3.89	4.63	+19.0%
South Korea	5.68	6.06	+6.6%
Turkmenistan	1.48	2.52	+69.8%
Ukraine	2.32	3.09	+33.5%
United States	6.17	7.42	+20.3%
Venezuela	6.42	6.92	+7.8%

Source: World Bank, "World Data Bank: GDP (PPP) per Unit of Energy Use," World Bank, 2015, http://data.worldbank.org/indicator/EG.GDP.PUSE.KO.PP.KD.

Kazakhstan). Yet to achieve this level of economic development, Russia's energy consumption per unit of GDP was broadly similar to that of South Africa and Kazakhstan, and slightly lower than that of Turkmenistan, and Ukraine.

This leads us to consider how Russia was able to achieve exceptional economic growth, in terms of GNI per capita (PPP), between 2004 and 2014, with relatively modest increases in energy consumption. Looking forward into the medium-term future, it is also worth considering the slowing of Russia's economic growth between 2013 and 2015, and the potential for several years of economic stagnation between 2015 and 2020, and the potential impact of this on Russia's energy consumption and carbon emissions.

Oil prices and exports: the link between energy and economic growth in Russia

For the past decade, Russia has been the world's second-largest exporter of crude oil and refined petroleum products and the world's largest natural gas exporter.[11] According to the Russian Ministry of Finance (MinFin), tax on oil and gas production accounted for 19.0% of federal budget revenues in 2012, while export duties (on all products, not just minerals such as oil and gas) accounted for 38.6%. MinFin also states that in 2012 the federal budget was equal to 20.7% of Russia's GDP.[12] The Russian state statistical service, RosStat, states that between 2005 and 2012, the share of "mineral products" in the total value of Russia's exports grew from 65% to 72%, up from 54% in the year 2000.[13] Therefore, if oil and gas accounted for 72% of Russia's export duties, the combined share of tax on oil and gas production and export duties levied on oil and gas exports would be 46.8% of federal budget revenues and 9.7% of Russia's GDP. However, the International Energy Agency (IEA) estimates the share of oil and gas in Russia's GDP at approximately 20%, and suggests that it could even be higher.[14]

It is interesting to note that, although such tax revenues are included in calculations of Russia's GNI and, therefore, in Russia's GNI per capita,[15] the definition of "Energy Use" by the World Bank does not class exports as consumption.[16] Statistics from the Energy Information Administration (EIA) show that between January 2004 and July 2008, the spot price of Brent crude oil rose dramatically, from $30 per barrel to $144 per barrel. Despite the slump in 2008–09, the price of Brent crude remained above $100 a barrel from February 2011 to August 2014.[17] Despite the fact that Russia's oil and gas exports increased by just 5 and 9% respectively between 2004 and 2014, Russia benefitted from a dramatic increase in oil and gas sector tax revenues (due to rising prices), which contributed to GNI growth.

The fact that Russia's oil and gas exports contributed significantly to Russia's GNI growth between 2004 and 2014, and yet were not classed as energy consumption, helps explain how Russia was able to achieve rapid economic growth without a dramatic increase in domestic energy consumption. The link between energy exports and nominal economic growth in Russia has been proven by research on the close correlation between international oil prices and Russia's annual GNI growth figures.[18] Given that a significant proportion of Russia's GNI growth between 2004 and 2014 was based on improved terms of trade for fuel exports, the dramatic increase in GNI, which rose faster than total energy consumption, may have created the illusion of an improvement in energy efficiency, as measured in GDP per unit of energy consumed. Conversely, a dramatic decline in export revenues (caused by declining prices), may create the illusion of a decline in energy efficiency, as measured in GDP per unit of energy consumed. Furthermore, the fluctuations of international oil and gas prices may exaggerate Russia's nominal GNI rates of growth/decline

Therefore, a continuation of the current depression of international oil prices (and, by extension, a depression in the value of Russia's oil exports and the rate of Russia's nominal economic growth) will not necessarily result in a decline in energy consumption and related carbon emissions in Russia. Given that population growth, economic growth, and the nominal energy efficiency of Russia's economy are insufficient explanatory factors for explaining trends in Russia's energy consumption and CO_2 emissions, it is necessary to analyse Russia's domestic energy consumption by fuel and sector.

Trends in Russia's energy consumption

Total Primary Energy Supply (TPES)

Russia's energy consumption is overwhelmingly dominated by hydrocarbons (see Tables 10.5, 10.6, 10.7 and 10.8). Together, oil, natural gas, and solid fuels accounted for 88.2% of TPES in 2012, a slight decline from 88.8% in 2004. As can be seen from the tables below, the most significant trends during this period were the increases in oil consumption and nuclear power generation, and an absolute decline (in addition to a relative decline) in the consumption of solid fuels. To understand why these shifts took place, it is necessary to consider how energy is consumed in Russia, by examining trends in Russia's final energy consumption.

Final energy consumption – heat and electricity generation and consumption

According to the latest data available from the IEA, the most significant use of energy in 2012 was for the generation of heat and electricity, accounting for 52.5% of total primary energy consumption. This includes 54.7% of total coal consumption, 62.3% of natural gas consumption, 100% of nuclear and renewable energy consumption, and just 6.1% of refined oil products consumption.[19]

The production of heat and electricity takes place at electricity plants, heat plants, and combined heat and power (CHP) plants. Nuclear and hydroelectric power stations already account for 94.6% of fuel inputs for electricity-only power generation stations, but just 0.2% of fuel inputs at CHP plants and are not used at all in heat-only plants.[20] Therefore, Russia's electricity-only power plants are already essentially carbon-free.

CHP plants account for 67.1% of Russia's electricity generation and 46.7% of Russia's heat production. Given that natural gas accounts for 71.0% of fuel used in Russia's CHP plants,[21] it

Table 10.5 Changes in Russian fuel consumption 2004–2014

Fuel	*Consumption of fuel (million tonnes of oil equivalent – mtoe)*					
	2004	*2008*	*2012*	*2014*	*Change 2004–14*	
Oil	126.2	133.9	145.7	148.1	+21.9 mtoe	+17.4%
Natural gas	350.4	374.4	374.6	368.3	+17.9 mtoe	+5.1%
Solid fuel	99.9	100.7	98.4	85.2	−14.6 mtoe	−14.7%
Nuclear	32.7	36.9	40.2	40.9	+8.2 mtoe	+25.1%
Hydro	40.2	37.7	37.3	39.3	−0.9 mtoe	−2.2%
Other renewables	0.1	0.1	0.1	0.1	0.0 mtoe	0.0%
Total	649.5	683.7	696.3	681.9	+32.4	+5.0%

Source: BP, *Statistical Review of World Energy*, 10, 22, 32, 35, 36, 40.

Table 10.6 Changes in Russian total primary energy supply balance, 2004–2014

Fuel	*Share in Russia's total primary energy supply (% of total)*				
	2004	*2008*	*2012*	*2014*	*Change 2004–14*
Oil	19.4	19.6	20.9	21.7	+2.3%
Natural gas	54.0	54.8	53.8	54.0	0.0%
Solid fuel	15.4	14.7	14.1	12.5	−2.9%
Nuclear	5.0	5.4	5.8	6.0	+1.0%
Hydro	6.2	5.5	5.4	5.8	−0.4%
Other renewables	0.0	0.0	0.0	0.0	0.0%
Total	100.0	100.0	100.0	100.0	

Source: BP, *Statistical Review of World Energy*, 10, 22, 32, 35, 36, 40.

Table 10.7 Electricity generation by fuel source in Russia, 2004–2012

Fuel	*Share in electricity generation (% of total)*			
	2004	*2008*	*2012*	*Change 2004–12*
Natural gas	45.3	47.6	49.1	+2.3%
Solid fuel	17.3	18.9	15.8	−1.5%
Oil	2.6	1.5	2.6	0.0%
Hydro	19.1	16.0	15.6	−4.1%
Nuclear	15.5	15.7	16.6	+1.1%
Waste and biofuels	0.2	0.2	0.2	0.0%
Non-hydro renewables	0.0	0.1	0.1	+0.1%
Total	100.0	100.0	100.0	

Source: IEA, "Russian Federation: Energy Indicators."

Table 10.8 Heat generation by fuel source in Russia, 2004–2012

Fuel	*Share in heat generation (% of total)*			
	2004	*2008*	*2012*	*Change 2004–12*
Natural gas	66.5	65.8	67.6	+1.1%
Solid fuel	24.4	20.9	19.8	−4.6%
Oil	7.0	5.6	5.4	−1.6%
Hydro	0.0	0.0	0.0	0.0%
Nuclear	0.2	0.2	0.2	0.0%
Waste and biofuels	1.9	1.9	1.8	−0.1%
Non-hydro renewables	0.0	0.0	0.0	0.0%
Other (not specified)	0.0	5.6	5.2	+5.2%
Total	100.0	100.0	100.0	

Source: IEA, "Russian Federation: Energy Indicators."

is not a viable option for Russia to further reduce its coal consumption by switching from coal to natural gas in its CHP plants. In Russia's heat-only plants, natural gas already provides 74.1% of the source fuel, while biomass provides 2.7%. Coal provides 15.3%, and oil products the remaining 7.9%.[22] As with Russia's CHP plants, the existing dominance of natural gas in the fuel supply mix for Russia's heat plants makes the "quick win" substitution of gas for coal unlikely.

If Russia is going to continue using CHP plants, the only non-coal alternatives to natural gas are either a significant increase in the use of biomass/waste in CHP plants, or the introduction of nuclear power to Russia's district heating system along the lines of the proposed (later abandoned) Loviisa-3 project in Helsinki.[23] The latter approach is an area with significant potential. For example, the Leningrad II nuclear power plant in St Petersburg is currently under construction, with plans to supply district heating as well as electricity.[24] However, given Russia's large fuel demand for its CHP plants (238 mtoe in 2012) and the small size of Russia's biomass/waste production (7.4 mtoe in 2012) relative to Russia's coal consumption in CHP plants (58.8 mtoe in 2012),[25] the large-scale replacement of coal with biomass in the medium term is highly unlikely.

SRegarding Russia's final electricity consumption by sector, industry accounted for 45.7% in 2012, followed by commercial/public services (20.9%), residential (17.9%), and transportation (12.4%). In terms of heat consumption by sector, residential accounted for 46.3%, followed by industry (38.4%), commercial/public services (11.2%), and agriculture/forestry/fisheries (4.2%).[26] Given these statistics, it is clear that patterns of energy consumption, particularly heat and electricity, in the industrial and residential sectors have the greatest potential to affect Russia's overall energy consumption and related CO_2 emissions.

Final energy consumption – the industrial and residential sectors

Of Russia's 461 mtoe of final energy consumption in 2012, 31.2% was consumed by the industrial sector, 23.8% by the residential sector, 20.3% by the transportation sector, 14.5% as "non energy use" (predominantly the petrochemicals sector), 7.8% by the commercial/public services sector, and 2.4% by the agriculture/forestry/fishing sector.[27] Given that they account for more than half of Russia's energy consumption, an examination of the industrial and residential sectors is key to understanding whether Russia is undergoing an "energy transition."

Russia's industrial sector is not only a major consumer of heat and electricity, it is also a significant final consumer of coal and natural gas, accounting for 83.3% of final coal consumption and 26.6% of final natural gas consumption. When the use of coal for the generation of heat and power is discounted, 79.5% of Russia's coal supply is used for the creation of coke, with the use of bituminous coal and lignite consumption in the industrial, residential and commercial/public service sectors accounting for the remainder.[28] The use of coking coal in blast furnaces for steel production is highly significant for Russia. The IEA notes that Russia was the fifth-largest steel producer in the world in 2012, while "The steel industry is the main consumer of coking coal by far."[29]

According to the Intergovernmental Panel on Climate Change,[30] the production of steel, cement, ammonia, aluminum, and paper are the world's most energy-intensive industries. In addition to its role as a major steel producer, Russia was the world's seventh-largest cement producer in 2014.[31] The IEA reports Russia's cement industry as being largely gas-fuelled, with just five of Russia's 50 cement plants running on coal.[32] The IPCC also states that in 2012, Russia was the world's third-largest producer of ammonia (for which natural gas is an essential feedstock),[33] and the second-largest producer of aluminum (a process requiring large amounts of electricity). Finally, Russia was the fourteenth-largest paper producer in the world in 2013.[34]

While Russia's annual nominal GNI growth or decline may be "exaggerated" by the impact of international oil prices, "real" economic growth/decline will continue to influence the activities of these energy-intensive industries and, therefore, levels of energy consumption in Russia's industrial sector. Given that these industries will continue to form an important part of Russia's economy, they will also continue to contribute to Russia's energy consumption, particularly with regard to coal, natural gas, and electricity, for at least the medium term future.

In the residential sector, heat accounted for 52% of energy consumption in 2012, along with natural gas (29.3%), electricity (10.3%), refined oil products (5.7%), coal (1.5%), and biofuel/waste (1.1%).[35] Russia's district heating system is key to understanding energy consumption in the country's residential sector. According to the IEA, approximately 70% of Russia's population is connected to the district heating system.[36] However, supply chain losses (during the processes of heat generation, transmission, distribution, and end use) average 30–40%, and can be as high as 60%.[37] Clearly, there are significant opportunities to increase the efficiency of the production, transmission, and consumption of heat in Russia's residential sector, although a complete shift away from the district heating system towards boilers in individual apartments is unlikely.

The structure of Russia's energy consumption in the industrial and residential sectors highlights two areas in which Russia could reduce its per capita energy consumption and CO_2 emissions. Firstly, there is great potential for increases in the efficiency of Russia's heat and electricity generation. Secondly, although Russia's energy-intensive industries will remain significant consumers of heat and electricity for the foreseeable future, there is great potential for energy saving in the residential sector, by reducing losses in the district heating system and by lowering domestic energy consumption through better insulation of Russia's housing stock and the encouragement of more efficient use of electricity through a combination of metering, higher domestic prices, and higher energy efficiency standards for electrical consumer goods.

The importance of heat and electricity for Russia's energy consumption, particularly in the industrial and residential sectors, is matched by the huge potential for savings in energy consumption, in addition to the potential for a greater share of non-hydro renewables in Russia's electricity generation. Given that current trends suggest that the only significant increase in carbon-free electricity generation in Russia is due to come from increased nuclear power generation, energy efficiency, rather than a large-scale switch to renewables, is the key to Russia's potential energy transition.

Russia in international climate politics

Russia's engagement with international climate politics: the Kyoto Protocol (1997–2012)

The United Nations Framework Convention on Climate Change (UNFCCC) was signed at the Rio "Earth Summit" in 1992. In essence, the UNFCCC acknowledged that "change in the Earth's climate and its adverse effects are a common concern of humankind."[38] In doing so, it was declared, "The ultimate objective of this Convention [is] … stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system."[39] Parties to the convention divided into three, partially overlapping, groups. Annex I comprised "the industrialized countries that were members of the OECD (Organisation for Economic Co-operation and Development) in 1992, plus countries with economies in transition (the EIT Parties), including the Russian Federation, the Baltic States, and several Central and Eastern European States". Annex II comprises "the OECD members of Annex I, but not the EIT Parties". Non-Annex I comprised the developing countries.[40]

In 1997, parties to the UNFCCC adopted the first legally-binding commitments to stabilize, or reduce, greenhouse gas (GHG) emissions, in the form of the Kyoto Protocol. Article 25 of the Kyoto Protocol states that the protocol will enter into force when 55 parties, which includes Annex I parties comprising 55% of total (global) CO_2 emissions in 1990, have signed and ratified the Kyoto Protocol.[41] Iceland was the 55th state to ratify the Kyoto Protocol, on May 23, 2002. By April 2004, 25 of the current EU-28, along with Norway, Switzerland, Canada, Japan, South Korea, and Ukraine had ratified the Kyoto Protocol. However, several major emitters – Australia, Russia and the United States – had still not ratified the Protocol. For it to come into effect, either Russia or the United States had to ratify the Protocol. In the event, it was Russia that brought the Kyoto Protocol into effect. With the Russian Government having signed the Kyoto Protocol on March 11, 1999, it was then ratified by the Russian Parliament on November 18, 2004. Thus, the Kyoto Protocol entered into force on February 16, 2005.[42]

The Kyoto Protocol lists the following greenhouse gases as being targeted for reduction under the scheme: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride (SF_6). During the first commitment period of the Kyoto Protocol (2008–2012), the target for the Russian Government was to limit the collective emission of CO_2, CH_4, and N_2O (as measured in CO_2 equivalent) to 100% of the 1990 baseline level, and to limit the emission of HFCs, PFCs, and SF_6 to 100% of the 1995 baseline level.[43] Therefore, the ongoing target was to limit total greenhouse gas emissions to 3,368 million tonnes of CO_2 equivalent.[44]

For the Russian Government, this was not a strenuous target. Between 1990 and 1998, the economic decline that had accompanied the collapse of the Soviet Union had contributed to a dramatic fall in Russia's greenhouse gas emissions, from 3,368 million tonnes of CO_2 equivalent to just 2,005 million tonnes – a decline of 40.5%. Between 1998 and 2012, Russia's greenhouse gas emissions increased every year except 2009, to reach 2,297 million tonnes of CO_2 equivalent.[45] This was still 31.8% below the baseline target.

Under conditions of easily-attainable targets, ratification of the Kyoto Protocol was a no-cost policy that brought Russia the chance to promote its role in international cooperation. This stance was made evident in a statement issued by the Russian Government, to mark the ratification of the Protocol by the Russian Parliament:

> The Russian Federation proceeds from the assumption that the commitments of the Russian Federation under the Protocol will have serious consequences for its social and economic development. Therefore, the decision on ratification was taken following a thorough analysis of all factors, inter alia, the importance of the Protocol for the promotion of international cooperation, and taking into account that the Protocol can enter into force only if the Russian Federation ratifies it.[46]

Russia's ratification of the Kyoto Protocol brought further benefit: EU support for Russia's WTO accession, agreed at the EU-Russia Summit in May 2004, was at least partially dependent on Russia's ratification of the Kyoto Protocol.[47]

Why Russia did not participate in the Kyoto Protocol second commitment period (2013–2020)

At the 16th Conference of Parties (COP16) of the UNFCCC, held in Cancun, Mexico, in December 2010, the Russian Special Envoy for Climate, Alexander Bedritsky, announced, "Russia will not participate in the second commitment period of the Kyoto Protocol."[48] The statement also confirmed that Russia would continue working towards a non-binding goal of emissions 15–25% below 1990 levels by 2020.[49] The declared reason was that Russia would not commit to more legally-binding targets, if other major emitters (and economic competitors) such as China, India, and South Africa, let alone the United States, were not prepared to do so. To quote from the Bedritsky statement:

> Russia has repeatedly stated, including at the highest political level, that the adoption of commitments for the Second Commitment Period under the Kyoto Protocol as it stands now would be neither scientifically, economically, nor politically effective … Russia consistently advocates the extension of the list of emissions-reduction-commitment countries and the inclusion of the fast-growing economies on it.[50]

Two years later, at COP18 in Doha, Bedritsky re-affirmed the position of the Russian Government:

> The Russian Federation, like a number of UNFCCC Annex-I countries, does not intend to make quantitative commitments for further GHG-emissions reduction in the second period … On the subject of a new agreement, a strategic determinant for the Russian Federation is the active participation of all countries of the world, primarily of major GHG-emitters, in the global climate solution. While the substance of the climate commitments and the actions of developed and developing countries may differ post 2020, everything should be reflected in a single document.[51]

The desire for a global agreement, with the participation of the major emitters that currently do not have legally-binding commitments (particularly the United States, China, and India), may not be the only reason for Russia's non-participation in the second commitment period. It is also possible that the Russian government is concerned that Russia might not meet its target of emissions 25% below the 1990 baseline by 2020, and therefore wishes to keep its target non-binding.

In the eight years from 2004 to 2012, Russia's GHG emissions rose by 6.6% (142 million tonnes of CO_2 equivalent), from 2,155 to 2,297 million tonnes of CO_2 equivalent.[52] This equates to an average annual emissions growth of 0.8%. If Russia's emissions were to grow at the same pace between 2012 and 2020, they would reach 2,449 million tonnes. For comparison, a 2020 target of 25% below the 1990 baseline would equate to 2,526 million tonnes. To exceed that target, Russia's emissions would need to grow by just 1.2% per year between 2012 and 2020. The fact that the Russian Government may well regard failure to meet its emissions reduction target as a distinct possibility, suggests that there is a strong degree of scepticism about the country's ability to change the structure of its energy consumption and related GHG/CO_2 emissions.

Conclusions

Trends in Russia's energy consumption and CO_2 emissions have shown gradual growth over the past decade, under conditions of broader economic growth and stable population levels.

Russia has yet to join the most advanced economies of the world in breaking the link between economic growth and rising energy consumption. The reason for this may be found in Russia's abundant hydrocarbon resources. These resources support energy-intensive heavy industry and ensure Russia's position as a world-leading hydrocarbon exporter – a position that encourages further energy consumption through the extraction, refining, and transportation of those resources. This is demonstrated by Russia's low scores on units of GDP production per unit of energy consumed. Russia's abundant hydrocarbon resources also reduce the urgency of improving energy efficiency in both energy (heat and electricity) generation and in energy consumption. The task of upgrading Russia's district-heating boiler houses, reducing heat losses during transmission in Russia's district heating system, and insulating Russia's vast housing stock to reduce demand levels is a monumental challenge that will require huge investment, which is simply not expected in the medium-term future.

Regarding attempts to reduce CO_2 emissions from heat and electricity generation, debates over the environmental merits of replacing coal with natural gas in thermal power plants, despite the economic cost, do not apply to Russia. In Russia, natural gas already provides the source fuel for half of Russia's electricity generation, with non-CO_2 emitting hydro and nuclear power providing a further third. The "quick win" of replacing coal with gas is not viable in Russia, simply because that option has already been utilized. One promising development, in terms of the reduction of CO_2 emissions, is the rising share of nuclear power in Russia's TPES and electricity generation, at the expense of coal. Building on the 25% increase in Russian nuclear power production between 2004 and 2014, the Russian Government is keen to promote a further expansion of nuclear power production in Russia, while the state-owned RosAtom is keen to market Russian technology abroad. This would suggest that Russia's nuclear industry will continue developing in the coming decade, making further growth in the role of nuclear power in Russia's energy mix all the more likely.

When hydropower is discounted, the development of renewable energy in Russia is virtually non-existent. Despite Russia's vast latent renewable energy potential, it will not be developed on a substantial scale until it is commercially profitable to do so. This would require feed-in tariffs and electricity prices that are simply not politically and economically viable at present. Furthermore, the lack of energy import dependence, due to Russia's abundant gas supplies and well-developed nuclear industry, means that using renewables as a means of improving the country's energy security is simply not an issue for Russia.

The stability of Russia's primary energy mix, lack of investment in renewables other than large-scale hydroelectricity, and sheer size of the challenge of improving Russia's energy efficiency, means that an energy "transition" in Russia is not expected in the medium-term future. The only significant development that may impact Russia's CO_2 emissions is the increasing use of nuclear power, at the expense of coal, for electricity generation. However, in the context of abundant hydrocarbon and nuclear power resources, Russia is unlikely to engage in a dramatic change in its primary energy mix, and is equally unlikely to limit its CO_2 emissions. This, in turn, influences government policies that prioritise investment in the oil, natural gas, and nuclear power sectors, and distance Russia from international, legally-binding commitments to reduce its CO_2 emissions as part of its engagement in global climate change action.

To conclude, under conditions of rising domestic energy demand, economic constraints, and abundant supplies of traditional hydrocarbon and nuclear fuels, if Russia does embark on an energy transition, it will be a transition to dramatically improved levels of energy efficiency rather than the widespread development of renewable energy supplies.

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