RUSSIA AND THE GLOBAL ENERGY TRANSITION
(June 4th 2021)

In this year of the pandemic, there has been a rapid intensification of the drive to reduce the anthropogenic impact on the global climate system. The overarching goal is to reduce emissions of greenhouse gases to keep the rise in global average temperature to well below 2 °C (3.6 °F) above pre-industrial levels; and to pursue efforts to limit the increase to 1.5 °C (2.7 °F), recognizing that this would substantially reduce the risks and impacts of global warming - as agreed in the 2016 Paris Agreement.

Here in California, after a blazing hot August and epic wildfires across the western US, Governor Newsom declared that, by 2035, all new cars and passenger trucks sold in California be zero-emission vehicles. Transportation currently accounts for more than 50 percent of California's greenhouse gas emissions.

The European Union has enacted an historic set of policy initiatives known as A European Green Deal which has the goal of making Europe climate neutral by 2050, with an interim emissions reduction target of 40% by 2030.

On March 21st, the world's seven largest advanced economies (G7) agreed to stop international financing of coal projects that emit carbon by the end of this year, and phase out such support for all fossil fuels, to meet globally agreed climate change targets.

On April 22nd, the US federal government added to the momentum when the Biden administration announced a new target for the United States to achieve a 50-52% reduction from 2005 levels in economy-wide net greenhouse gas pollution in 2030.

Attention will be further focused in November when the 2021 United Nations Climate Change Conference, more popularly known as COP26, is scheduled to be held in Glasgow, Scotland. The conference is set to incorporate the 26th Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC), the 16th meeting of the parties to the Kyoto Protocol (CMP16), and the third meeting of the parties to the Paris Agreement (CMA3).

These aggressive initiatives in Europe - and increasingly elsewhere around the world - will have a direct impact on Russia, one of the world's largest producers – and exporters - of fossil fuels and processed natural resource commodities. Europe remains Russia's primary export market for fossil fuels and metals - despite sustained efforts to reorient exports to new markets in the Asia Pacific (China, Korea, Japan, etc).

China's climate and environmental goals may be structurally more pragmatic than Europe's goals. Nevertheless, China's energy transformation goals are vast and fundamental in scale, driven by national security concerns – in addition to domestic pollution and global environmental concerns.

Russia faces the prospect of losing substantial national income and investment turbulence should European and other markets phase out fossil fuels and limit greenhouse gas emissions outside the EU. That said, economic change has always been inevitable albeit experienced incrementally. Despite common misperceptions, Russia is a developed economy where over 2/3 of the workforce are employed in services. The speed – and details - of the global energy transition is what will determine the level of stress experienced in Russia.

RUSSIA CONSIDERS GLOBAL WARMING & THE ENVIRONMENT

Russia has long been seen as an outsider in global climate action - despite having signed the Kyoto Protocol in 2004 and joined the Paris Agreement in 2016.

This perception was supported by the once-predominant view in Russia that warming of the climate was a good thing for Russia. Winter cold – even killing cold - is a central, penetrating theme of traditional Russian cultural identity. Even today, preparing for winter and provision of municipal heating services are seen as central responsibilities of government. In these contexts, 'warmer is better'.

However, warming in Russia is also destabilizing. Most of Russia's oil and gas is produced in Siberia, and much of that infrastructure is anchored in permafrost, which acts as bedrock. Approximately 65% of Russian territory is underlaid with permafrost. Similarly, many northern cities and towns are built on permafrost. Retrofitting structures that are or could be destabilized by melting permafrost would be massively expensive, if not completely impractical. Such retrofitting costs would reduce the economic viability of a considerable portion of Russia's oil and gas resources. The risks & costs of destabilization are coming to be accepted by much of Russia's political & economic elite.

According to Russian environmental minister Alexander Kozlov, about 23% of technical failures and 29% of loss in fossil fuel extraction are caused by permafrost degradation. "There are problems with building new railway lines and roads. [We estimate] that more than 40% of buildings and infrastructure facilities in permafrost-covered areas have already been damaged," the minister said.

Most models also show a warming Russia will be a drier Russia – particularly Siberia. The boreal forests of Siberia have already experienced a striking increase in summer wildfires. These fires have been big news in Russia and have penetrated popular consciousness.

In the summer of 2019, in response to media coverage of several huge fires in Siberia, the public demanded the government take action to fight the fires. Over 1.2 million people signed a petition circulated online by an ecologist from Siberia demanding the crisis be dealt with. President Vladimir Putin ordered the army to help firefighters battle the fires. Russia's Investigative Committee (the main federal investigating authority in Russia) also said it had opened a criminal case over the fires and was investigating officials in the Siberian city of Krasnoyarsk for suspected negligence at having not taken action to stop them.

Following the ratification of the Kyoto Protocol in 2004, the problem of global warming received considerable attention for the first time in Russia. Development of Russian climate policy can be subdivided into three main stages that are linked to the Kyoto Protocol (2004), the Presidential Decree on greenhouse gas emissions reduction (2013), and the Paris Agreement (September 2019). (*A library of Russian climate legislation and decrees can be found here*).

Some in the Kremlin see a positive side to the efforts to reduce emissions. In 2016, the Russian Minister of Natural Resources and the Environment Sergey Donskoy said that implementation of the Paris Agreement would give a positive impetus to modernization of the economy.

Such modernization of industry would reduce pollution – which is seen by the Russian public as the greatest global threat in the 21st century (global warming is #4).

LEVADA POLL ON RUSSIANS' VIEWS OF GLOBAL THREATS

January 23, 2020

IN YOUR OPINION, WHICH OF THE FOLLOWING GLOBAL THREATS THAT HUMANITY COULD FACE IN THE XXI CENTURY ARE THE MOST DANGEROUS? (Respondents were offered a card with a list of answers, and they could choose more than one and / or name their own; answers are ranked in descending order)

	Dec 2019
Environmental pollution	48
International terrorism	42
Armed conflicts, wars	37
Climate change, global warming	34
Technogenic disasters and accidents	31
Nuclear proliferation and the threat of their use	25
Global economic crisis	25
World epidemics, new unknown diseases	24
Hacker attacks, cybercrime, data leaks	18
Lack of food and fresh water	16
Overpopulation and mass migrations	15
Reduction of energy resources	12

Widening gap between developed and developing countries	9
Other *(" meteorite " , " the problem of alcoholism and drug addiction ", " low wages , unemployment ," and so on . D .)*	1
I am at a loss to answer	3

DO YOU THINK WHAT KIND OF ENVIRONMENTAL ISSUES LISTED ON THIS CARD IS NOW THE MOST SERIOUS FOR RUSSIA ON THE WHOLE?

	Dec 2010	Dec 2019
Air pollution	29	26
Disposal of household waste	8	17
Nuclear waste	8	1
Depletion of our natural resources	7	9
Genetically modified foods	9	9
Water pollution	15	9
Changing of the climate	8	7
Chemicals and pesticides	7	7
Lack of water	4	2
None of the above	1	2
I am at a loss to answer	4	3

Of course, emissions goals and policies involve a heavy dose of politics. Geopolitics, too. Choices will result in winners – and losers. For much of the world the costs of emissions reduction – and the costs of global warming and related adaptations – will be measured against the costs of impaired economic and human development. There is notable resentment in societies that seek to modernize - toward those that have achieved modernization - and who now are concerned about the buildup of the greenhouse gases they emitted to achieve their modern lifestyle.

Looking forward, there will be hard negotiations over cost-sharing and burden-sharing when it comes to reducing emissions. At his annual speech to the federal Duma on April 21, 2021, Russian President Vladimir Putin stated: "Over the next 30 years, accumulated net greenhouse gas emissions in Russia must be lower than in the European Union." The mention of the word "accumulated" inserts Russia into the geopolitics of global cost-sharing and burden-sharing of emissions reduction.

RUSSIAN EMISSIONS

Russia is the 5th largest emitter of greenhouse gases on the planet - contributing around 4.6% of all global emissions. Most of Russia's greenhouse gases are emitted by the energy industry (78.9%). Nearly half of these emissions come from the production of electricity and heat for the general population, while the rest largely come from the production of solid fuels, petroleum refining and fuels used in transportation. Russia's industrial production accounts for a further 10.8% of total greenhouse gas emissions — with metals production accounting for most. Agriculture makes up another 5.9% of total emissions and waste 4.4%.

Russia's greenhouse gas emissions are around half of the total of the 27 EU countries, which combined have more than three times the population. Russia's carbon dioxide emissions held steady – perhaps surprisingly – from 2006 to 2019 at a little over 1.5 billion tons per year. This, after CO2 emissions peaked in 1990 at about 2.25 billion tons.

The sharp decline in emissions in the 1990s was caused by the post-Soviet economic collapse that devastated Russia. As the Russian economy retooled, refurbished, and recovered, it has made more efficient use of energy thereby holding emissions in check. Methane leaks in Gazprom's pipeline network were sharply reduced – though more can be done, especially when it comes to flaring of natural gas in oil fields.

OIL

Russia is the world's 3rd largest producer of oil, producing 11.5 million barrels per day (mbd) in pre-pandemic 2019, about 11% of global production. In terms of the global liquid hydrocarbons trade, Russia is the 2nd largest exporter of crude oil – estimated at 5.225 million barrels per day (mbpd) in 2018. Russia is also the 2nd largest exporter of refined oil products - more than 2.4 mbpd of petroleum products in 2016, mostly destined for Europe. Russian oil refiners have invested vast sums to upgrade their capabilities to meet the most demanding environmental standards for fuel required by the European Union.

Russian refined product output continues to grow, and export markets now include the US – where Russia has emerged as the 2nd largest source of US imports…second only to Canada. These imports consist mostly of fuel oil and diesel and supply consumers in the northeast US.

Some say oil is the “backbone” of the Russian economy. Indeed, oil accounts for 20 percent of Russia’s gross domestic product, 40 percent of its budget and 60 percent of its exports (and steadily falling). However, in my experience, natural gas is the true backbone of the country. Approximately 54% of Russia’s total domestic energy demand is supplied by natural gas. Oil supplies about 22% of domestic demand - overwhelmingly for transportation fuels. Coal supplies only 13% - while nuclear, hydro, and other sources supply the rest. While Russia produces about 11% of the world’s oil, it consumes only about 4% - the rest being exported as crude oil or refined fuels.

The proposed rapid introduction of battery-powered electric vehicles may reverse demand for oil-based fuels including gasoline and diesel. Phasing-out kerosene-based jet fuels for aircraft in favor perhaps of biofuels will take much longer.

Russia's revised oil strategy will focus on maximizing monetization from crude exports before hitting peak production in 2027-2029 and seeing world demand drop, according to a draft document on the development of the sector up to 2035 being reviewed by the State Duma. "The main thesis in this strategy is the monetization of current reserves and resources -- that is, the maximum monetization of exports," Pavel Zavalny, head of the energy committee at the Duma, said at the presentation of the document April 14. "Everything that can be produced should be produced while there is still demand to sell it," he added.

In the scenario labeled most probable by the Energy Ministry, Russia’s oil output will grow over the rest of the decade — but fall short of the record output of 2019, with production hitting a post-coronavirus peak of 11.1 million barrels a day in 2029 before decreasing to 9.4 million barrels a day by 2035.

"In all scenarios, we forecast a decline in oil production without gas condensate after peaking in 2027-2029," the draft document reads. (In all scenarios, Russia sees gas condensate output rising steadily from 730,000 bpd in 2020 to 1.15 mbpd in 2035, supported by the increasing role of natural gas and LNG in the Russian energy mix. Condensate is excluded from most traditional oil production statistics). At the same time, Russian crude production *capacity* is forecast to hit 13.9 mbpd, in 2029, which "can be produced in favorable economic conditions or if the homeland orders it," the ministry's oil refining department head Anton Rubtsov said.

If Russia fails to adapt financial or tax incentives over time or its economy stagnates, Russian crude output risks not ever returning to its 2019 record output of 11.5 mbpd. Russia's Arctic reserves will play a key role closer to 2035, especially in the Taimyr region, but for now they are profitable only at Brent prices over $80/b. The ministry forecast the price of Brent crude at $68 in 2025 and $73 in 2035.

NATURAL GAS

Russia is the 2nd largest producer of natural gas in the world - in 2019 producing 679 billion cubic meters, about 17% of global output. Russia holds the world’s largest reserves of natural gas – about 48 trillion cubic meters. The scale of the resource is almost beyond imagination. Furthermore, about 26.5 trillion cubic meters of gas, or almost 70% of all gas reserves in Russia, are concentrated on the Yamal Peninsula, which reaches into the Arctic Ocean in Russia’s far north. There are addition major reserves in the nearby Gydan Peninsula, and the adjacent Arctic shelf.

Russia has over many years invested vast sums in the development of the natural gas reserves of the Yamal Peninsula, and companies Gazprom and Novatek now operate some of the country’s biggest

industrial projects in the region. Gazprom's Bovanenkovo field alone produces up to 115 billion cubic meters annually, most of which is pipelined westwards to European consumers. Nord Stream 1 (and soon Nord Stream 2) draw gas from the Yuzhno-Russkoye field and gas fields in the Yamal.

Meanwhile, Novatek's Yamal LNG in 2020 delivered more than 16 million tons of liquified natural gas to the markets around the world. More is to come. Several new projects are under development, including Novatek's Arctic LNG 2, Gazprom's Kharasaveyskoye and Gazprom Neft's Kamennomysskoye. Additional LNG projects drawing on Yamal gas and gas from fields in adjacent Western Siberia are planned over the next decade.

LNG and petrochemical developments on and near the Yamal will facilitate the development of the Northern Sea Route across the Arctic Ocean to the Asia Pacific region.

However, the planned shift in international energy markets away from fossil fuels could ultimately lead to catastrophe for the export-oriented Russian oil and gas sector. Unless radical adjustments are made. Russia's new Energy Doctrine that was adopted in May 2019 made clear that Russia's position as an energy superpower is challenged by international efforts to combat climate change.

In December 2020, the country's First Deputy Prime Minister Andrey Belousov set up a working group that is to propose ways forward for the Yamal.

Powerful companies such as Gazprom, Novatek, Gazprom Neft, Rosatom, Sovcomflot, Russian Railways and the Russian Direct Investment Fund are all represented in the group, newspaper RBC reports. Several leading government officials also serve on the working group including Deputy PM and former energy minister Aleksandr Novak.

The primary direction for monetizing Yamal's gas resources is the production of liquefied natural gas (LNG). Long term plans are for production of 120-140 million tons of LNG annually by 2035 and to increase Russia's share in the world market to 15-20%. Currently, there are only two LNG production facilities in Russia: Sakhalin-2, now controlled by Gazprom, and Novatek's Yamal LNG, located on the Yamal Peninsula. Russia's current share in the world LNG market is about 8%. However, Novatek has already begun construction of a second LNG complex in the Yamalo-Nenets Autonomous Okrug named "Arctic LNG-2". The company's strategy until 2030 envisages the production of at least 57-70 million tons of LNG annually.

Also on the agenda is the possible development of a petrochemical industry in the region, including the production of plastics. Russia's share of global petrochemical production is only 2.5%, despite the fact that Russia is one of the world leaders in the production and exportation of oil and gas.

Deputy Prime Minister Aleksandr Novak (who also headed the Ministry of Industry and Energy from 2012 – November 2020) said: "The large-scale resource base of the Yamal Peninsula makes it possible to extract [from gas] ethane and liquefied petroleum gases (LPG) as feedstock for the gas chemical complex." A debate is under way to determine whether to build plastics/petrochemical facilities at Yamal – or ship the ethane and LPG to factories closer to final markets – including Sibur's vast petrochemical plants under construction in Amur and at Tobolsk.

However, there are diverging opinions over how to develop the resources and where to do the processing. Petrochemical company Sibur argues that it will be far cheaper and convenient to process

the natural gas closer to consuming markets such as China (see Sibur's China-oriented Amur plant in Eastern Siberia - near Gazprom's Amur gas processing plant), instead of building new processing plants on the harsh tundra lands of Yamal. Both the Sibur and Gazprom facilities target Asian markets, with a hub planned for the Russian port city of Vladivostok.

But the natural gas companies might see the issue otherwise. Gazprom made clear in 2019 that they are planning the construction of a gigantic petrochemical plant in Bovenenkovo, the company hub in the Yamal Peninsula, that would be able to produce about 3 million tons of plastics products polyethylene and polypropylene per year.

BLUE HYDROGEN

For the purposes of the global energy transition – particularly for the EU - the vast natural gas resources in the Yamal could be directed in part toward the production of hydrogen - blue hydrogen. Large-scale trunk pipelines direct from the gas fields to consuming markets exist today.

Some argue against the blue hydrogen approach. An article posted on the Global Witness website details these arguments. A crucial argument is that "fossil hydrogen also keeps alive the same fossil fuel companies that are working hard to block the progress of clean energy sources that threaten to take away their business." (The same energy companies many activists demand redirect their capital and competency toward zero-emission goals…).

Left unsaid in these arguments is that consumers in Europe and elsewhere are technologically and practically unprepared to use hydrogen. Massive retooling/re-equipping of homes, businesses, and manufacturing/processing is required. The quick route to using hydrogen at scale is to burn it in power plants to make electricity. Fuel cells can also use hydrogen to produce electricity. However, remember that the time scales being mandated are short – 2030 and 2050. Remember: we are talking about repowering modern societies, our entire global civilization – perhaps even including the 800 million people without access to electricity.

Yes, commercial carbon capture and sequestration is untried, in part because the economics where carbon is unpriced do not support the investment. Capturing CO2 is most cost-effective at point sources. Methane reforming facilities would present an ideal scenario. In the Yamal and Western Siberia, the geology required for CO2 internment exists. The natural gas exists in large fields capable of large production rates sustainable for decades. Methane reforming technology is well-understood, with a fraction of the energy losses that would be incurred by electrolysis using green renewable electricity. Large-scale pipelines are in place today, that would require modest investment to upgrade the lines to handle pure hydrogen - including polymer coating of the inside of the pipes to avoid hydrogen damage to pipeline metal. Further, the capability of rapidly scaling up blue hydrogen allows for the sustainable buildup of green hydrogen capacity. The infrastructure and markets for green hydrogen would be ready and waiting.

Blue hydrogen would also be the feedstock for blue ammonia. Ammonia is rapidly drawing attention from shipping companies as the zero-carbon emission fuel of the future for commercial shipping vessels.

It is worth noting that Gazprom Neft has experience in closed-cycle CO2 collection, processing, and re-injection. Its Serbian subsidiary NIS (a joint venture between Gazprom Neft and the Republic of Serbia) has been involved in a project collecting and purifying high CO2-content natural gas from various fields

since 2015. The CO2 extracted is then injected into developed reservoirs, at a depth of more than 2,500 meters.

Other oil and gas companies around the world have similar experience in collecting and purifying high CO2-content natural gas and reinjecting the CO2 back deep underground. So, to say carbon capture & sequestration is untried is, well, inaccurate.

COAL

Russia is the 3rd largest producer of coal in the world. Over the last 10 years, Russia has increased its annual coal production by more than 30% to a total of 440 million tons, and the country is now the world's third-largest producer, Energy Minister Alexander Novak said. Over the same period, investments in the industry have surged 150%. Nearly half of Russia's current 58 coal mines in operation have opened in the last 20 years, as older mines were closed or re-equipped. Asian Pacific markets are the destination for Russia's growing coal production, as European markets fade in importance. Domestic Russian demand for coal is essentially flat.

According to the same Moscow Times report, a government draft development program stated annual coal production might reach as much as 670 million tons over the course of the next 15 years. My sense, though, is this figure is unlikely as unfavorable market conditions abroad may present serious headwinds to Russian coal exports.

There are 2 general types of coal. One, is thermal coal – used for generating electricity and heat. The other is higher-priced metallurgical coal, used primarily to make coke for smelting steel in blast furnaces. Russia is a major producer of both. Several big producers, Raspadskaya (a subsidiary of steelmaker EVRAZ), Yuzhkuzbassugol, Yuzhny Kuzbass, Kuzbassugol, Vorkutaugol, Yakutugol and Sibuglemet, share the Russian coking coal market.

Siberian Coal Energy Company (SUEK) operates 27 open-pit and underground mines, which produce about 24% of the thermal coal mined in Russia. SUEK also operates 27 power plants in Siberia and in the Russian Far East which generate 6% of Russia's electricity. It is the world's fourth largest coal supplier by international sales (after Glencore, BHP Biliton, and Anglo American) and the fifth largest company by coal reserves. Its coal, power generation and logistics enterprises in 12 Russian regions employ over 70,000 people.

Russia's coal miners could boost exports to China, the world's number one energy consumer, after Beijing slapped tariffs on Australian imports amid a growing trade rift. Subsequently, Chinese authorities completely halted supplies of coal from Australia in late 2020. In December 2020, Elgaugol, the company behind the Elga coal project in the Russian Far East, agreed to launch a joint venture with China's Fujian Guohang Ocean Shipping Group that will export metallurgical coal to China. The Elga project aims to ship 30 million tons of coal to China in 2023, almost doubling Russia's total coal exports to China, which stood at around 33 million tons in 2019.

DOMESTIC ENERGY ECOSYSTEM
ELECTRICITY

"Communism is Soviet power plus electrification of the whole country" was iconic revolutionary Vladimir Ilyich Lenin's famous formula. In the 1990s Anatoly Chubais, former CEO of the Russian joint

stock company Unified Energy System (UES), formerly the world's largest utility, once made the striking statement that electricity is a high technology product. His comment was made in the context of prospects for future exports of Russian-generated electricity. (It remains a perspective worth developing. Electrification really is the future – decarbonization or not).

Russia is the 4th largest producer of electricity in the world. In Russia, electricity generation is based primarily on natural gas (46%), followed by nuclear, coal, and hydro power – each generating roughly 18% of Russia's total output. 60% of thermal generation (gas and coal) is from combined heat and electric power plants. Most heating and hot water in Russian cities and towns is distributed through centralized municipal systems. In Russia, less than 1% of electricity is generated from non-hydro renewable energy sources – wind, solar, geothermal - combined.

On average, a Russian family spends 16.6% of its monthly income for public utility services, while families in Europe, America, and Canada, on average, spend only 13.5%, 12.9% and 11.8%. Therefore, lower-cost energy sources and investments in energy efficiency are attractive to Russian household, business, and government consumers.

The dissolution of the USSR at the end of 1991 provided Russia the legacy of a vast dilapidated electricity system. In 1992 the Soviet-era Ministry of Electric Power was dissolved, and a state-controlled holding company called the Unified Energy System (RAO-UES) was formed. The epic post-Soviet collapse of Russian industry left UES with vast excess capacity and poor cash flow, as the Russian government mandated subsidized electricity to support the impoverished Russian household sector.

From 1999-2003 plans were considered to break up the UES along two lines of business: electricity transmissions and the 70% of national generation and sales UES controlled. (Rosatom was another monopoly utility responsible for nuclear power generation). Chubais argued that, if unreformed, the Russian power sector would not support future economic development, and that if the still-massive UES were reformed, it would need to be designed to attract private investment. It would be one of the most ambitious electricity sector reforms ever undertaken anywhere.

In 2008, UES's holdings were unbundled: generation, transmission, and distribution are today structurally divided and managed by private companies with diversified ownership. Generation is produced by 14 territorial power and heating companies (indicated by the Russian abbreviation TGK) and seven wholesale power-generating companies (OGK). An antimonopoly service prohibits a single private owner from controlling more than 20% of generating capacity in one of eight defined regional zones. The state retains 100% ownership of nuclear—through the State Atomic Energy Corp. (Rosatom)—as well as most hydropower and major transmission facilities.

The national transmission grid in Russia is operated by Federal Grid Co of Unified Energy System PJSC is the country's largest transmission grid company. Rosseti FGC UES is a Russian energy company that provides electricity transmission services through the Unified National Electric Grid (UNEG). It is a state-owned natural monopoly.

There is a two-level (wholesale and retail) electricity and capacity market in Russia. More than 80% of electric power is traded at nonregulated market prices. The average price of electricity for Russian households is $0.06 kWh (business pays $0.09). In the US it is $0.15 (business pays an average of $0.12), and in Germany it exceeds a shocking $0.37 kWh (German business pays $0.24).

Boris Kovalchuk, CEO of Inter RAO energy holding, stated last August that "for export-driven major industrial operators who generate most of their revenue in foreign currency, prices in Russia were 25% lower compared to the EU."

Russia currently exports only about 1.4% of its total electricity production to neighboring countries - to the Commonwealth of Independent States (CIS) countries, as well as Latvia, Lithuania, China, Poland, Turkey and Finland. Growth opportunities for exports seem substantial – particularly to China.

NUCLEAR POWER:

State-owned Rosatom operates 31 nuclear power reactors in 10 locations, with an installed capacity of 21,000 MW, generating about 20% of Russia's electricity, free from carbon emissions. According to the World Nuclear Association, Russia is one of the few countries without an energy policy favoring wind and solar generation; the priority is unashamedly nuclear.

Rosatom is Russia's largest generator of electricity (over 20% of total generation) and ranks first in the world in terms of the order book for the construction of nuclear power plants: 35 power units in 12 countries are at different stages of implementation. Rosatom is the only company in the world that has competencies in the entire technological chain of the nuclear fuel cycle, from the extraction of natural uranium to the final stage of the life cycle of nuclear facilities.

Rosatom's small modular reactors (SMR) have emerged as a solution to repowering or upgrading remote or isolated communities and/or projects in Russia. Russia has pioneered the development and application of floating small modular reactors. "Akademik Lomonosov" is a stationary power barge that operates as the first Russian floating nuclear power station. Akademik Lomonosov is docked at the port of Pevek, in the Chukotka region of Russia's Far East. It connected to the grid on December 19, 2019.

On December 23, 2020, Rosatom and the government of the Republic of Sakha (Yakutia) signed an agreement on electric power tariff formation for a small modular reactor (SMR) power plant construction project in Ust-Kuyga, Ust-Yansky District, Russia. Under the agreement the Republic of Sakha (Yakutia) confirms delivery of 40-50 MW of electricity and its readiness to assist in siting the power plant.

The construction of the SMR power plant will cut the price of electricity by nearly half in Ust-Yansky District as compared to that currently produced by the local coal & diesel-fired power plant. Much of the expanded low-cost electricity will go to power the planned Kyuchus multi-metal gold-antimony mine and ore processing facility - 200km from Ust-Kuyga. The SMR construction in Yakutia will be completed by 2028.

The SMR project in Yakutia is based on RITM-200 reactors. These reactors utilize Rosatom's 50+ year experience in operation of small reactors in the Russian nuclear icebreaker fleet. On October 21, 2020, the new generation Arktika icebreaker with RITM series SMRs officially joined the Russian nuclear fleet. Four more RITM-200 reactors have already been installed at the 22220 project icebreakers that are currently under construction.

Rosatom claims RITM-200 reactors are an improvement on the KLT-40 reactor type, which power the Akademik Lomonosov, and has also long been used for nautical purposes. The RITM-200s, the company

says, feature compact design, modularity, a short construction period, and high safety standards, with a service life of more than 60 years.

SMR's can produce low-carbon hydrogen to be further used in various industries. They can serve as a reliable and clean source of heat and electricity both for mining facilities and for residents in remote areas located in isolated grids. The new SMR will replace coal-fired and diesel facilities in Ust-Yansky District and contribute to the reduction of up to 10,000 tons of CO2 per year.

Rosatom plans to build another small modular nuclear plant to power the operations of the Suroyamskoe iron ore mine in the Chelyabinsk region of central Russia. In May 2021, Russian president Vladimir Putin approved a proposal by Rosatom to build floating nuclear power plants to power the world-class $8b Baimskaya gold and copper mine located deep inside Chukotka (Russia's easternmost province), according to a report by the RBC news agency. The $2.3bn proposal was put forward by Rosneft in competition with another by gas company Novatek based on floating power plants fueled by LNG.

The potential exists for much wider application of nuclear power in the Russian economy. Rosatom has announced that implementation of Russian President Vladimir Putin's decision to increase the share of nuclear power in the country's energy mix to 25% by 2045 will require…the construction of 24 new reactor units, including in new regions.

Nearly 74 percent of Russian citizens want their government to maintain and develop the country's nuclear industry, a sector they consider to be safe and clean despite Moscow's troubled history with the technology and the government's lack of transparency about its use, according to a recent poll by the independent Levada Center. Russians are also likely to see nuclear energy as environmentally friendly. When asked by the Levada Center whether they thought nuclear energy was a "green and clean" energy solution, 50.4 percent said yes.

HYDROPOWER

Hydropower is the most used form of renewable energy in Russia, generating 18-20% of Russia's electricity. Production has increased by about 15% since 2010. There is large potential in Russia for more production of hydropower – despite the obvious environmental consequences of damming rivers. According to the International Hydropower Association Russia is the seventh largest producer of hydroelectricity in 2020. It is also second in the world for hydro potential, yet only 20% of this potential is developed. Russia is home to 9% of the world's hydro resources, mostly in Siberia and the country's far east.

Currently, in Russia, there are 102 hydropower plants with a capacity of more than 100 MW. Most of the large hydro-industrial complexes in Siberia were built in the 1960s and 1970s. RusHydro is the largest hydroelectric company in Russia and the second largest hydroelectric producer in the world.

Hydro-power generation is an important element in ensuring the reliability of Russia's Unified Energy System. It provides more than 90% of regulating power reserve. Of all existing power plants, hydropower plants are the most flexible and can, if necessary, in a matter of minutes significantly increase the volume of generation to cover peak loads.

On August 17, 2009, there was a severe accident at the giant Sayano-Shushenskaya hydroelectric power plant, which killed 75 plant workers and injured 13. The Federal Service for Ecological, Technological, and Nuclear Supervision's investigation concluded that poor management and technical flaws were responsible. The disaster was caused by a 29-year-old turbine that experienced an uncontrolled and excessive vibration – and shattered in an explosive manner, flooding the generating hall. Since then, officials from RusHydro, the operator of the plant, have called for better oversight and safety at hydroelectric plants.

WIND POWER

In Russia, less than 1% of electricity is generated from non-hydro renewable energy sources – combined. Yet, Russia ranks among the top countries with vast wind energy resources - including among the top CO2 producers as well. At the same time, the utilization of wind energy is extremely low compared to other CO2 emitting states. An excellent analysis of the prospects for wind energy in Russia is presented in a recent paper by Artem Kudelin and Vladimir Kutcherov.

The optimistic scenario suggests that, depending on global economic growth by 2030, the volume of wind generation capacity could reach up to 10 GW by 2030. The pessimistic scenarios limit the growth by 3.6 and 6.4 GW - depending on the rate of change in gross domestic product.

However, several factors may significantly reduce generating and grid companies' interest in solar, wind, and small-scale hydropower. First, there is a surplus of installed capacity (the load-to-installed capacity rate is 0.69). Installing more capacity would only aggravate the situation further, despite the plans for dismantling inefficient, outdated coal-fired heat and power plants.

Second, the predominant traditional management views are to have 100% back-up facilities for renewable-based power plants: conventional power plants' flexibility must be stepped up (such as nuclear power plants and older gas-burning thermal power plants). At the same time, Russia's national grid faces the problem of unloading power plants at night and in summer – as well as the low-capacity utilization of heat power plants (less than 49% of the time). Third, the insufficient density of electric grids significantly limits the scope for a free flow of electricity.

Given this context, the future development of wind energy generation in the Russian Federation depends significantly on the level of economic growth, which, in turn, is sensitive to world fossil fuel prices and Russian fossil fuel exports.

Lack of social demand to build a "green" energy future makes the process extremely vulnerable to the unstable economic situation. The goal set by the Russian Federation's present Energy Strategy to reach 38% of renewable energy generation by 2030 was based on an optimistic prognosis for growing energy consumption with constant GDP increase. Lower GDP directly strikes the power consumption and new capacities installations as a result. Lower GDP also has an indirect effect of government revenue shortfalls that could slow or halt government support of renewable energy development.

The reorientation of hydrocarbon producers from foreign to the domestic market make the competition even more difficult. There are early signs of this process in Russia, including regional gasification programs, which are supported by the Russian Federation government. Further, there are subsidies to individuals and small businesses to switch cars from gasoline to natural gas. Moreover, the oil and gas

lobby are powerful in Russia. They show little interest in losing their high margin business in favor of reorienting the energy sector from hydrocarbons to renewable energy sources.

Meanwhile - Fortum, headquartered in Finland, is an active participant in renewable energy development in Russia. Fortum's wind portfolio accounts for 50% of the total volume of wind power plants commissioning in Russia under the acting renewable energy sources (RES) development program, based on capacity supply agreement mechanisms.

The Fortum-Rusnano wind investment fund has made one of the most ambitious renewable energy commitments in Russia. Following the results of competitive selections of RES investment projects in 2017 and 2018, the Fund won the right to build 1,823 MW of wind capacity (this corresponds to 55% of total wind energy generation capacity in Russia by 2024). Wind farms are expected to be commissioned before 2024.

In January 2018, Fortum added 35 megawatts (MW) of wind power to the Russian power market when their Ulyanovsk wind farm was listed in the registry of capacity. This power plant is Russia's first wholesale market wind generation facility.

In December 2020, Fortum and the Russian Direct Investment Fund (RDIF) set up a joint venture to invest in the renewable energy sector in Russia. They have announced investments in the acquisition of fully completed and commissioned wind power plants in the Ulyanovsk and Rostov regions with a total capacity of over 350 MW. Fortum and RDIF will continue to work on other joint projects in wind (and solar energy) with the aim of creating one of the leading renewable energy players in Russia.

As of June 2021, Fortum's and their partners completed projects include eight wind farms with a total installed capacity of 670 MW. One of these wind power farms, in Ulyanovsk, started operation in 2019. Four wind power farms in the Rostov region and two in Kalmykia started operation in 2020. The four wind power farms in the Rostov region form a wind power cluster that is so far the largest in Russia. The projects with a total capacity of 495 MW are currently in the construction stage in Astrakhan, Volgograd, and Rostov regions. The projects with a total capacity of 728 MW are currently in the development stage.

The investment decisions related to the renewable capacities won by the Fortum-Rusnano wind investment fund are made on a case-by-case basis, within Fortum's maximum equity commitment of RUB 15 billion (about $200 million) for the development of wind and solar renewables in Russia.

GEOTHERMAL ENERGY

Geothermal energy is the second most used type of renewable energy in Russia after hydropower. Yet, it represents less than 1% of the total national energy production in the country. Geothermal resources are of local importance in Kamchatka and the Kurile Islands. However, until hot dry rock (HDR) geothermal becomes economically competitive with other sources of electricity and/or heat, it will remain a tiny factor in Russia's overall electric energy profile.

Regarding opportunities for heat pump geothermal technology in Russia, with its current level of energy rates, heat pump systems turn out to be uncompetitive compared to gas-based heat supply systems – except when both heating and cooling services will be required during the year. This is particularly true in urban settings. However, in single family homes or dachas (second home), in combination with solar

power, heat pumps are competitive with gas over time, despite the significant upfront construction cost of heat pump systems. That all said, the heat pump market in Russia is still in its infancy.

SOLAR ENERGY

As is the case with wind power development in Russia, Fortum is the leading developer of commercial of solar power in Russia. In November 2017, Fortum signed an agreement to acquire three solar power plants from Hevel Group, Russia's largest integrated solar power company. The transaction was closed in December 2017. All three power plants are operational with a total capacity of 35 MW. The plants were commissioned in 2016 and 2017. Hevel Group will provide operation and maintenance services for all three power plants.

In February 2021, the Fortum-RDIF joint venture made the investment decision to build a 116 MW solar plant in Kalmykia. The first stage of the solar power plant with a capacity of 78 MW is to be commissioned in 4Q 2021 and the remaining 38 MW in the second half of 2022. When commissioned, it will become the largest solar power plant in Russia.

The solar power plant in Kalmykia will be constructed in accordance with the results of the Russian Capacity Supply Agreement (CSA) auctions held in 2018 and 2019.

THE RUSSIA RENEWABLE ENERGY DEVELOPMENT ASSOCIATION

The Russia Renewable Energy Development Association (RREDA) is a non-profit organization representing the RES sector participants in Russia and aims to stimulate investments and promote use of the renewable energy generation in the Russian Federation. It was formed to guide governmental policy formation of the renewable energy sector, to coordinate information for market participants and investors, and share best practices.

Their mission is to eliminate obstacles for RES development and ensure the competitive environment for increased adoption of the RES technologies into the energy system with a view to sustainable development.

Their aim is to consolidate a wide range of stakeholders, including energy generation companies, RES generation project developers, equipment manufacturers (OEMs) and suppliers, scientific research centers, and financial institutions in order to promote efficient institutional development of certain infrastructure for the development of RES sector.

On April 27, 2021 Russia oil major Gazprom Neft joined the Russia Renewable Energy Association (RREDA). Gazprom Neft will be represented on the RREDA by its Gazpromneft-Energoservice subsidiary.

EUROPE'S CARBON BORDER ADJUSTMENT MECHANISM

It is estimated that the net imports of goods and services in the EU represent more than 20% of the EU's domestic CO2 emissions. To support the competitiveness of European companies bearing emissions costs, and to prevent "carbon" leakage", the European Commission plans to introduce a Carbon Border Adjustment Mechanism (CBAM) regime compatible with World Trade Organization policies.

A CBAM would have the goal of leveling production costs between producers inside the EU's Emissions Trading System (ETS) - which establishes market prices of carbon emissions - and those outside the ETS. Europe's efforts to reach net-zero emissions by 2050 could be undermined by a "lack of ambition" by its international partners. This would mean a risk of carbon leakage – which occurs when companies transfer production to countries that are less strict about emissions, thereby impairing efforts to cut global emissions. This new mechanism would counteract this risk by putting a carbon price on imports of certain goods from outside the EU.

According to a report in S&P Global Platts dated March 17, 2021 "the European Parliament March 10 approved the principle of setting up a CBAM and the EC is expected to move ahead with a legislative proposal for its introduction in June, for possible implementation in 2023." WTO Deputy Director-General Alan Wolff said in February that cooperation between nations will be essential to avoid disputes around carbon border taxes. On March 5th, the WTO launched a Trade and Environmental Sustainability joint initiative group with 53 member countries, which is expected to be a forum for the discussion of carbon border taxes.

Russia faces both threats and opportunities from a European CBAM of a yet-to-be-determined scope given Russia's role as a supplier of energy-intensive metals and other primary or intermediate commodities. Russian companies stand to be among the biggest losers from the EU's proposed carbon tax on imports, prompting accusations of protectionism from Moscow. Estimates of the potential costs vary from $3bn a year, according to the Russian Ministry of Natural Resources and Environment, to a KPMG forecast of about $60bn between 2022 and 2030.

The European Commission is due to detail its proposals in July 2021. Negotiations with the European parliament and member states could then take months, if not years, to conclude. The tax would initially target a limited number of imports including iron, steel, cement, and fertilizers. "Russia is not ambitious enough," said Laurent Bardon, head of the trade and economic section at the EU delegation to Russia.

Moscow has also accused the EU of using emissions taxes as a way to raise funds for internal EU programs – a subtle, but important point when one considers that even in the US carbon taxes have been proposed as a way to raise revenue, while cutting other taxes. Taxing the Russian public to pay for EU social programs will be met with fury by the Russian public – let alone the Kremlin.

RUSSIAN METAL COMPANIES IN A CHANGING ENVIRONMENT

Russian companies have begun taking action to decarbonize their operations and adjust their corporate structures to reduce their carbon footprint and improve their marketability to consumers and investors. London-listed Rusal is the largest producer of aluminum outside of China and produces about 7% of global supply. It plans to demerge its high-carbon smelters and refineries into a new company so that it can focus on the fast-growing market for "green" aluminum. It plans to become the world's largest supplier of "green" aluminum. Smelting aluminum from alumina consumes large quantities of electricity. Many of Rusal's core facilities were originally constructed (recently modernized) as Soviet-era hydropower-metal complexes developed in Siberia. Rusal is also competing with a joint venture (named Elysis) between Rio, Alcoa and Apple to commercialize low-emission anode technology that releases oxygen rather than CO2.

Russia ranks 4th in crude steel output worldwide (though only 7% of China's massive output of 1.053 billion tons). Making crude steel is traditionally a carbon-intensive process. Currently, about 8% of global

CO2 emissions come from making steel. In aggregate, the Russian steel industry is towards the front of the pack when it comes to carbon intensity of crude steel production. Russian steel-maker EVRAZ is evaluating plans to de-merge its coal mining subsidiary Raspadskaya. The goals of a de-merger would include:

- establishing a clear and focused equity story for EVRAZ (as a leading global producer of steel, iron ore & vanadium) and Raspadskaya as a leading regional producer of high-quality metallurgical coal, and,
- increasing transparency over sustainability performance and goals (ESG): Allow each business to concentrate on its respective ESG priorities, enhancing accountability of ESG achievements and comparability of results against peer universe.

Some might consider such a de-merger to be greenwashing. Perhaps. That said, balance sheet clarity and transparency are crucial for intelligent investing.

Further, the reality remains that primary integrated steelmaking from iron ore to steel will be dependent on coking coal for another generation. While hydrogen-based direct reduced iron (DRI) is technically feasible, the current barriers to adoption are the cost and scalability of [renewable] hydrogen generation and the cost of storage of renewable electricity for reliably powering an electric arc furnace.

Meanwhile, Russia oil major Gazprom Neft has concluded an agreement with the Russian steel companies Severstal and EVRAZ on collaborating in developing hydrogen production, transportation, storage and utilization technologies, and on reducing CO2 emissions, in Russia and abroad.

CONCLUSIONS

The risks & costs of global warming and environmental destabilization have come to be appreciated by much of Russia's political & economic elite. Change is coming. However, solutions for Europe & the US are not going to be the solutions Russia takes onboard.

"Construction of green infrastructure by using oil and gas revenues could better prepare Russia for the energy transition. However, the green projects are still perceived in Russia with big skepticism," said Dmitry Marinchenko, a senior director at Fitch.

The year of peak oil demand seems to be approaching sooner than thought only a few years ago. Regardless of policies, however, it is performance that counts. It will be a challenging journey from aspiration to achievement. It remains to be seen how long the tail of fading oil demand will be. Same for coal. Same for natural gas. If there is responsible management of the global energy transition, Russia's natural gas will play a crucial role.

Overt discrimination in favor of intermittent and habitat-hungry solar and wind power and common opposition to nuclear technologies in the West call into question the degree to which net-zero 2050 is the real goal. Freeways have transition roads for a reason: physics does not allow for sharp turns at speed without crashing or rolling a vehicle. Similar transitional analogs apply to repowering our global civilization and its nearly 8 billion human passengers.

Yet there is also mounting concern that growing pressure to act on climate change fails to acknowledge the still robust demand for the goods that companies create — from petrol for cars to construction

materials. “We still need to provide the products on which society depends,” a steel executive said. Another at a European steel company said it wanted to engage with all stakeholders, including NGOs. “We have the same goal — to reduce CO2 emissions.”

One energy sector investor warned that targeting big, listed companies such as Shell would only shift business towards less transparent state groups and private companies that are often less scrupulous, rather than permanently reduce emissions for the sake of the planet. “It’s far from clear that the best venue to resolve these matters is a courtroom”, he said.

Joana Setzer, an expert on climate litigation and environmental governance at the Grantham Research Institute, said “lawsuits are a powerful way to raise awareness and advance many steps, by enforcing the Paris climate agreement and giving teeth to these non-binding government commitments.” While they could drive behavioral shifts across entire industries, she added, “on their own they won’t solve climate change”.

The Europeans will have to work out potential inconsistencies between goals that - on the one hand look to develop a power sector based largely on renewable resources, yet on the other secure an affordable EU energy supply. Such inconsistencies risk complicating, if not impeding, timely investment in energy resources and new manufacturing/resource process technologies and facilities – inside and outside Europe. The prices being paid for electricity by residential customers in Germany are a warning. The easy steps toward repowering with renewables have already been taken in much of Europe and California.

The current choice of plug-in technology for battery electric vehicles suggests the pace of electrification will plateau far short of stated goals. Having foregone swappable batteries, it will become prohibitively expensive to build-out charging infrastructure for those people who live in high-density urban locations – and in rural communities. Shared ownership and on-demand transportation services are unlikely to be a viable or timely replacement for vehicle ownership (or leasing) at scale. The scale, cost, and complexity of vehicle electrification is underappreciated by advocates, the public, and government. Therefore, slower than anticipated phaseout of fossil-fueled internal combustion engine vehicles will support consumer demand for oil products for some decades to come.

The politics and practicalities of making others bear the costs & consequences of aggressive decarbonization remain underappreciated in Europe and America. Economic strains caused by overly aggressive decarbonization would - in Russia - include large permanent layoffs – particularly in the Siberian coal industry. Alternate employment opportunities are essentially nonexistent under any scenario – meaning tens of thousands of well-paid workers and their families would become unemployed economic refugees – forced to move to Moscow or St Petersburg in European Russia.

For some activities there are currently no viable substitutes for oil, including aviation, maritime, and heavy commercial trucking, while natural gas is already playing a role as a lower-carbon transition fuel, replacing coal in the power generation sector – particularly if gas energy is less expensive than coal energy. Natural gas is indeed the crucial bridge fuel – particularly if hydrogen and ammonia are the no-carbon fuels of the future. If hydrogen and ammonia are Europe’s choice, then Russia can be the primary supplier of blue gas energy.

Such investments would be mutually dependent – ie, dependent on mutual trust…as neither party could walk away.

Regardless of the global energy future, Russia will retain a central role as producer and supplier – of products, technology, and leadership – discomforting as that may be for some. Russia has a key role to play in the global energy transition - decarbonization and repowering our global civilization.

Many of the challenges, opportunities, and perspectives regarding decarbonization experienced in Russia will be experienced elsewhere in the world. International and cross-cultural communication and mutual understanding will be crucial to avoiding nationalistic provincialism – or climate imperialism. Rescuing our environment while ending poverty are central to the legacy of our generation. No cherry picking. No magical thinking. Let's get it right.