Entering Russia's Power Sector

Challenges in Creating a Credible Carbon Trading System

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Executive Summary

As the countries of the world continue to debate the elements of an acceptable global framework to reduce greenhouse gases, support grows for the use of "flexibility mechanisms" to help signatories meet their goals and to spread out reduction costs more evenly across economic sectors and countries. Russia, with its large energy consuming sector and its recent reductions in carbon emissions linked to the condition of its economy, is seen by many as playing a pivotal role in such an international regime. More specifically, the Russian electricity sector, with its inefficient plants and its centralized management is a promising candidate for a significant volume of cost-effective emission reductions.

However, the Russian power sector suffers from numerous structural, regulatory and financial problems that will not be easily surmounted. Poor market conditions and a heavily politicized regulatory regime are two among a multitude of problems plaguing this industry. If the electricity sector is to attract private investors for carbon reduction projects, these deficiencies must be corrected. This will take time and resources.

Potential for CO_2 reductions

Measurable carbon dioxide reductions in the electricity sector could be obtained in at least four areas.

- *Modernizing Electricity Generating Technology*

Much of Russia's electricity generating equipment is out of date and inefficient. The amount of fossil fuels used by Russia's thermal power plants to generate electricity (measured on a per unit of output basis) is, on average, much greater than consumed by plants operating in Europe, Japan, and the United States. Replacing this outdated technology with modern equipment, such as combined-cycle generators, would mean significant efficiency improvements, thus reducing carbon dioxide (CO_2) emissions per unit of electricity produced. Such upgrades would create substantial sources of CO_2 emissions credits that might be sold in international or domestic markets.

- *Use more natural gas*

The share of natural gas as well as that of hydroelectric power generation in Russia's generating capacity could be increased. Certainly Russia has sufficient natural gas resources. Fuel switch or altering the mix of fuels would mean fewer CO_2 emissions per unit of electricity and would result in further decreases in the "carbon intensity" of the power generation sector.

- *More efficient dispatching*

At present, the rules governing Russia's electricity markets preclude the optimal use of available generation technologies. Opening up the markets to competition would allow greater use of cheaper hydro plants and relatively modern thermal generating technology at the expense of older and less efficient capacity. This could result in significant fuel savings, emissions reduction and, consequently, carbon credit creation.

- *Other opportunities*

Other opportunities for energy savings and CO_2 emissions reductions could include investments to upgrade the antiquated transmission grid, modernizing the heating systems operated by many Russian power plants, and the introduction of cost effective renewable technology (using energy sources such as wind or biomass).

In addition, interest recently shown by Unified Energy Systems — Russia's gigantic electricity monopolist — for JI and emissions trading can in itself be considered an important opportunity. The company's direct and indirect control over the majority of the assets belonging to the electricity sector and its ability to deliver the necessary data and local cooperation for CO_2 abatement projects make its active cooperation indispensable to the successful realization of any large scale trading program.

Many Obstacles to Success Exist

Numerous obstacles, largely stemming from the economic, political, and institutional uncertainties of the Russian economic transition, will need to be removed if the Russian electricity sector is to realize these opportunities. There are three main categories of obstacles: lack of profitability, limited potential for assured sustainability, and an absence of predictability/manageability.

Profitability

If CO_2 reduction projects in the Russian power sector are ever to flourish, they will need to be attractive to foreign investors. Most investments in upgrading Russia's generating facilities in the early years will not be directed solely at carbon credit accumulation, since it will take time to remove all of the uncertainties surrounding the timing, economics, and management of establishing a carbon trading program. This reality means most projects will have to be profitable on the basis of the returns earned solely from selling electricity and heat. However, the potential returns offered to investors by the electricity sector at the moment are far from adequate to justify investment in new technology to replace Russia's aging electricity infrastructure. Low electricity tariffs and poor bill collection, as well as markets operated on the basis of administrative and political fiat rather than economic rationality, make the Russian power sector, and projects involving CO_2 abatement in that sector, less than attractive to private investors.

Sustainability

Effective CO_2 reduction projects in the power sector (and anywhere else) require a reliable monitoring and compliance system: once emissions reduction commitments are made, there must be a way to make sure that they are sustained. Those who will invest in the resulting CO_2 credits will have to be sure that those credits actually exist. At present, Russia's environmental regulatory system is not up to the task of effectively monitoring and enforcing of CO_2 reductions. Both federal and regional environmental agencies are underfunded and understaffed, their prerogatives vis-à-vis each other and their clients are unclear, and their work is largely ignored by a government with more pressing priorities. Meanwhile, the electric power sector is largely self-regulated when it comes to pollution abatement.

Predictability and Manageability

To bring the Russian power sector into a global emissions trading regime will require some idea of the path of its baseline emissions. Given the state of the economy and the sector itself, however, this will prove difficult. Russia's economic growth in the near future is still uncertain, as is the effect of growth in electricity demand (and thus on CO_2 emissions). This uncertainty adds to the difficulty of estimating CO_2 reduction costs in an economy with unclear future fuel and electricity pricing, and an unstable currency and interest rates. In addition, the long-term supply of natural gas available to the sector is also under threat, as Gazprom — the country's giant gas monopoly — lobbies the government to allow it to export greater percentages of its gas, which would reduce the supply for Russia's domestic electricity generators. If there is less gas, there will inevitably be more coal in Russia's electricity mix and thus more CO_2 emissions.

Conclusions and Recommendations

The creation of a credible carbon trading regime in Russia will be no easy task. Many of the fundamental problems that currently stand in the way of such a system are beyond the control of outsiders. Ultimately, it is up to Russia's government and the industry to complete the economic, institutional and political reforms (including those aimed at electricity restructuring) and to establish a more reliable and trustworthy regime for monitoring the country's environmental performance.

While the Russian government must address many issues, if its electricity sector is to be able to effectively participate in an effective carbon trading regime, we would make three specific recommendations:

a) <u>Pace the reforms, do not overreach:</u> Given the scope and magnitude of the international barriers and challenges that will have to be overcome, Russia is unlikely to be able to manage a full-blown carbon trading regime within the next five years, at least in a way that would be credible to the European countries and the United States. Developing the appropriate

institutions, the human capital and the appropriate legal structure are critical steps and none can or will happen quickly. Attempts to accelerate the pace of change are likely to stimulate opposition within Russia, which may in fact slow down the process. Efforts to sequence reforms, with each reform building a foundation for the next has a much greater probability of gaining the confidence of investors and the Russia public.

b) Improve the effectiveness of the regulatory system: Reforming the Russian system of electric regulation is an essential step, not only to gaining investor confidence, but also to any effort to restructure the electricity sector. Such reforms should have two key ingredients: 1) the transfer of more authority and responsibility to the Federal Energy Commission and away from the Regional Energy Commission, and 2) the introduction of greater transparency into the regulatory process.

c) Implement an effective system of verification and monitoring: Without strong and transparent verification and monitoring capabilities, an emission trading or reduction program will lack international credibility. Russian officials must work with international officials to develop these capabilities and to commit the resources, both financial and human, to implement them.

The Putin Administration has announced its intention to restructure Russia's electricity sector. If the promise of its proposals are fulfilled, the reform could significantly improve the capacity of this sector to participate in an international carbon trading regime.

While most of the essential reforms can only be made by Russia, there are two actions that the United States and other OECD countries might consider.

1) Training: Russian regulators and their staffs at both the federal and regional level do not have a solid understanding of the fundamental concepts of emission trading, environmental reforms, or carbon rights, nor are they well-versed in the science of global climate change. These issues have not been on their proverbial radar screen. Hence, Western assistance to educate and train regulators, both economic and environmental, as well as federal and regional public officials, could be extremely valuable.

2) Pilot Projects: Emission trading programs, especially those involving carbon dioxide and greenhouse gases, represent a significant departure from the existing Russian environmental policies. Officials are not familiar with these programs and lack of familiarity often breeds distrust. The best way to overcome this barrier is to demonstrate their operation on a small-scale, where successes can be transferred to other communities and regions. Hence, we urge international organizations to design, develop, and fund pilot carbon abatement and trading

programs, preferably in concert with UES officials so that participants have an opportunity to “learn by doing."

Introduction

Any international proposal for reducing carbon emissions will require active Russian participation. Russia is the fourth largest emitter of carbon in the world. Its resource base of natural gas is unmatched by any other country, and its energy sector and industry are significant consumers of fossil fuels, and thus major emitters of carbon. For most of this decade, Russian emissions are likely to remain below their 1990 levels, due to the havoc created by the economic crisis within the Russian industrial sector. While the administration of Russian President Vladimir Putin is making strides to revitalize the economy, it will take time to restructure and rebuild. This may provide Russia with a unique opportunity to benefit from emissions trading.

The United States, Russia, Japan, Canada, and Australia have advocated the establishment of "flexibility mechanisms" within any international agreement to reduce carbon emissions. These mechanisms include those that allow entities with high abatement costs to purchase carbon emissions reduction credits from entities with low abatement costs. Credits could be generated, for example, if a high-cost country (or a firm within a high-cost country) invests in a project that will reduce emissions in a low-cost country. The flexibility mechanisms, like joint implementation and emissions trading, could create substantial new markets and investment opportunities.

As one of the world's largest greenhouse gas (GHG) emitters, Russia offers numerous opportunities for cost-effective reductions and straightforward emissions trading. This is because the costs of carbon emissions reductions in Russia — a country with an antiquated and energy-inefficient industrial base — are likely to be significantly lower than in economies already using more efficient fossil fuel–burning technology, such as Japan or the United States. The financial benefits of carbon trading for Russia's cash-strapped economy could be, according to one estimate, as high as $25 billion in the period 2008–2012.[1]

Establishing an internationally sanctioned carbon trading regime within Russia will be a daunting challenge. The economic and institutional chaos that has enveloped the country since the devolution of Soviet authority has made it difficult to construct a broad Russian response to climate change and, more specifically, to establish a reliable and well-functioning greenhouse gas emissions reduction regime. The problem is not that the Russians are not interested in carbon reductions or credit trading; rather it is that the cost of the first trade — that is, the cost of establishing the institutional foundation, the rules, regulations, and human capital,— is very high.

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[1] Environment and Natural Resources Program (ENRP), October 2000: "Emissions Trading in Russia: Opportunities and Challenges. Rapporteur's Report," John F. Kennedy School of Government, Harvard University, p. 3.

This reality has led many observers to focus on certain large and reasonably well-organized sectors, rather than on Russia's economy as whole. One of the most obvious candidates has been the energy sector, which accounts for the lion's share of Russia's carbon emissions and is the country's principal economic dynamo. Among Russia's energy producers, the electric power sector arguably offers the greatest potential for emissions reductions. According to various estimates, it presently emits approximately 515–550 million tons of CO_2, or 30–35 percent of Russia's annual CO_2 emissions.[2]

As the country's largest single emitter of carbon and one of its most influential industries, the electric power sector will be integral to any domestic or international emissions abatement system. Detailed understanding of Russia's electricity industry — its physical structure, its markets, its investment climate, and the regulatory regime that oversees it — is therefore crucial to any serious plan aiming to draw Russia into global carbon emissions markets.

The first section of this paper reviews the physical, corporate, and regulatory structures of the electricity sector, describes the evolution of this sector during the first decade of Russia's stormy economic transition, and identifies the factors that will affect both its future growth and its carbon emissions. Part II discusses the opportunities for carbon emissions reductions. Part III identifies the obstacles that stand in the way of involving the Russian power sector in carbon trading. Part IV is a case study examining the Russian Far East, one of Russia's seven "electricity zones," to illustrate the problems and opportunities that apply, to a greater or lesser degree, throughout Russia.

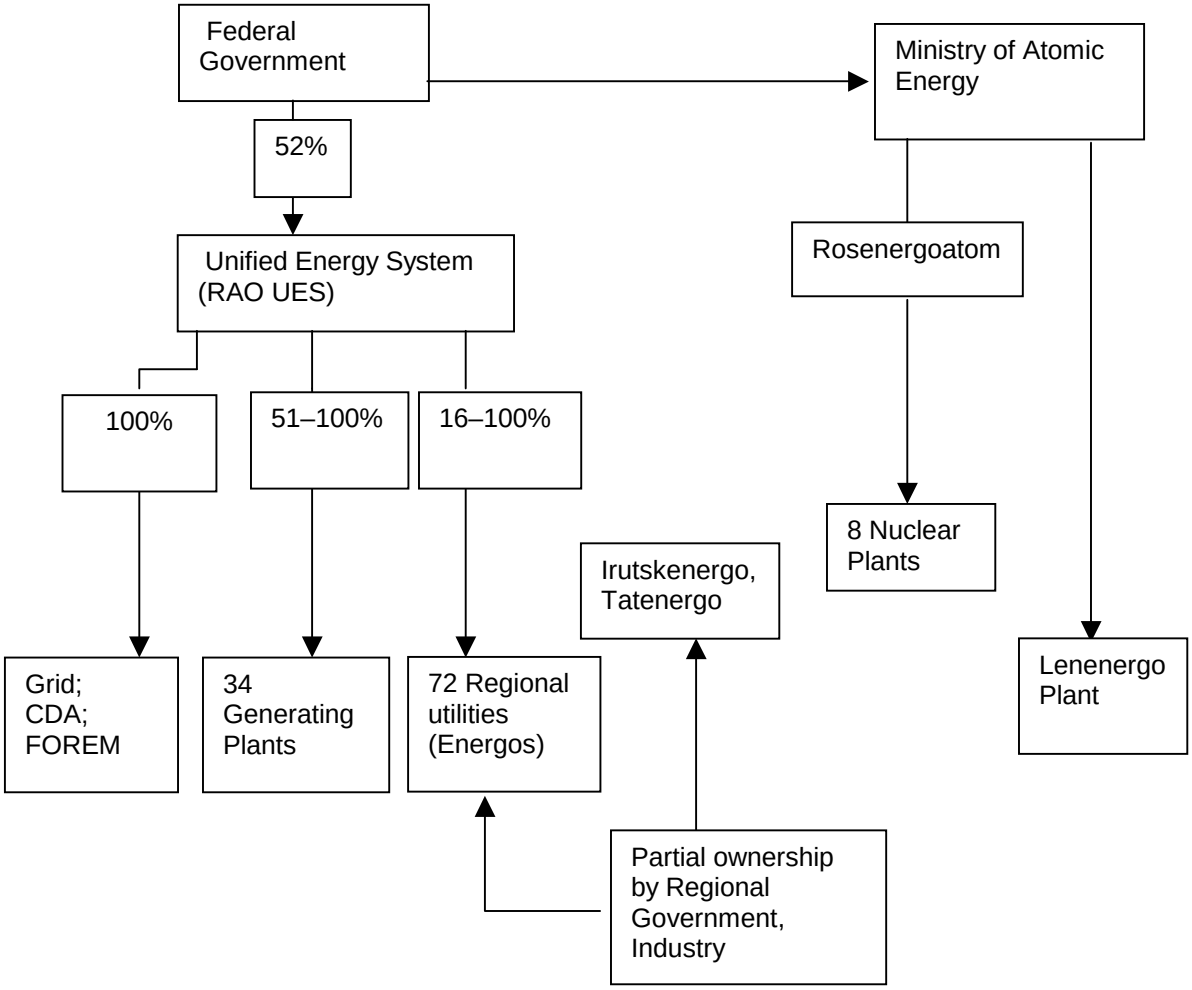
[2] Yeryomin, L.V., 1999: "The development of the Russian electricity sector and its environmental efficiency," p. 6, available at < http://www.emissions.de/climate-ru/documents/eremin-rus.doc> (Last Accessed: 04/24/01); New Energy and Industrial Technology Development Organization (NEDO), 1999 (d): "A study of CO2 reduction at coal-fired electric power plants in Russia," p. 102.

Part I: Russia's Electricity Sector: Structure, Operation and Development

Corporate Structure

Russia's electric power sector has four major components: the holding company called the Unified Energy Systems (UES) or "RAO[3] EES" in Russian, 74 regional utilities (AO[4] Energos), the national grid (along with central dispatch and the wholesale market), and the nuclear power industry (See Figure 1).

Figure 1: Ownership Structure of the Russian Electricity Sector



[3] RAO stands for *Rossiyskoye Aktsionernoye Obshestvo* or Russian Joint-Stock Company
[4] AO stands for *Aktsionernoye Obshestvo* or Joint-Stock Company

Unified Energy Systems

Unified Energy Systems is Russia's highly centralized power monopoly. Established in 1956 as the Soviet Union's single energy distributor, it was reborn as a state-controlled holding company in 1992, assuming the powers and responsibilities of the dissolved Ministry of Electric Power, including the ownership and control of all state-owned electricity facilities.[5] UES has controlling stakes (51-100 percent) in 34 power plants, which have a total thermal capacity of 39.5 GW and of 18 GW of hydroelectric capacity. Seven thermal power plants (12.1 GW) are on lease from the UES to local utilities.

In 1994 the company underwent partial privatization. The UES is presently owned by:

- State Property Committee (Russian Federal Government), 52.5 percent;
- Foreign entities, 34.3 percent;[6]
- Russian private entities;
- Individuals: 8.2 percent.[7]

AO Energos

Russia's 74 regional utilities, also known as AO Energos, own 135 GW (65 percent) of the country's generating capacity and are responsible for all local distribution of electric power and about 40 percent of the country's heating. UES owns stakes (16–100 percent) in 72 of the 74 Energos, while two — Irkutskenergo and Tatenergo — are independent.[8] Other shareholders include regional governments, local industry and private investors (both foreign and domestic). The AO Energos run mostly thermal power plants and have 107 GW of thermal capacity. A few regional utilities such as Irkutskenergo, Lenergo, and Dagenergo have some hydro capacity. However, for the most part, their plants are small thermal generators (below 1000 MW), which are in worse technical shape than the larger UES-operated facilities.

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[5] Valladares, M.R. 1999: "Reforming the Russian Electricity Market," p. 33.
[6] Foreign ownership currently exceeds the 25 percent legal limit.
[7] Unified Energy Systems < http://www.rao-ees.ru/en/info/sharecapital.htm >. (Last accessed: 04/24/01)
[8] Metropol Investment Financial Company, 2000: *Power Report*, pp. 3–4.

The Grid and FOREM

At present, UES owns 100 percent of Russia's high voltage transmission grid (330–550 kV). The grid connects most of Russia's regional electricity systems and helps balance the supply of power among those utilities producing more electricity than is consumed by their region ("surplus Energos") and the utilities that do not produce enough to supply their region ("deficit Energos"). UES also manages the dispatch of electric power through this transmission grid. Through a body called the Central Dispatching Authority (CDA), along with its seven regional branches (see figure 1), UES is in charge of assuring a steady supply of electricity to the entire country and determining the operating hours of the plants that supply the national grid. The Energos remain in charge of local dispatch and distribution.

Thanks to its full control of transmission and dispatching, UES owns and runs FOREM, Russia's wholesale electricity market.[9] The main participants in the wholesale market are large UES-operated power plants, AO Energos (buyers and sellers), nuclear power plants, and several large consumers of electricity such as railways and the defense industry. The wholesale market handles approximately 30 percent of Russia's electricity needs, while the Energos and captive (in-house) industrial power generators supply the rest. UES plants and the nuclear power plants account for 55 percent of the power supply to FOREM. The rest is provided by surplus Energos such as Mosenergo, Irkutskenergo, and Tyumenenergo.

Figure 2: Regions of the Unified Energy Systems of Russia

Source: RAO-UES (in Russian) "Unified Energy Systems of Russia" <http://www.rao-ees.ru/info/map>.

[9] FOREM stands for Federalniy Optoviy Rinok Electricheskoy Moshnosti, which literally means "Federal Wholesale Market of Electric Power."

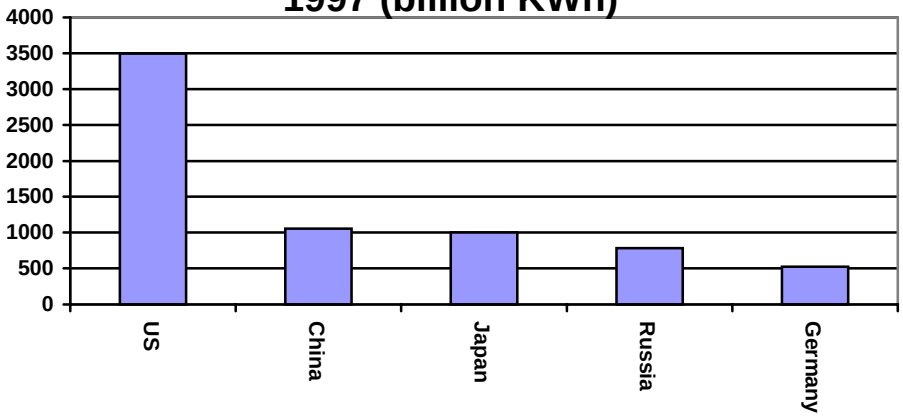
The Nuclear Power Industry

Russia has nine nuclear power plants, which generate 12 percent of Russia's electricity and have a total capacity of 21 GW. Eight of the nine plants are operated by a special nuclear utility called Rosenergoatom. The other — St. Petersburg's 3,600 MW plant — is directly subordinated to the Ministry of Atomic Energy (which also controls Rosenergoatom).[10]

Physical Characteristics of the Russian Electricity Sector

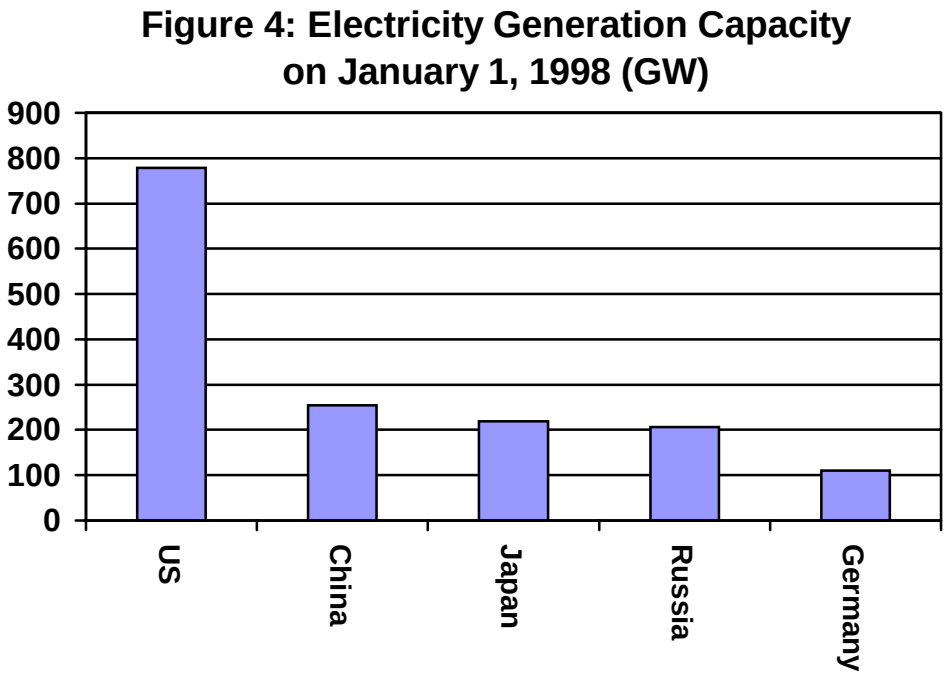
Once the pride of Soviet industrial policy, the electric power sector remains a true behemoth straddling Russia's economic landscape. At 204 GW, Russia's generating capacity is ranked fourth in the world, surpassed only by the United States, Japan, and China (see Figures 3 and 4).[11] Thanks to its enormous integrated national grid, Russia also has the largest power pool and the most extensive power transmission network in the world.

Figure 3: Electricity production in 1997 (billion KWh)



Source: U.S. Energy Information Agency, derived from"Table 6.3 World Total Net Electricity Generation, 1980 - 1999"
http://www.eia.doe.gov/pub/international/iealf/table63.xls

[10] Metropol Investment Financial Company. September 2000. *Power Report*, pp. 3–4.
[11] There are different estimates of Russia's generating capacity in 1998, ranging from Valladares' estimate of 216 GW to that of 198 GW by Expert Research Agency. The figure of 206 GW cited in the text is provided by the Energy Information Administration (EIA) of the U.S. Department of Energy, and can be found at *Country Analysis Brief: Russia* (December 2000) < http://www.eia.doe.gov/emeu/cabs/russia.html >, (Last accessed: 04/23/01)



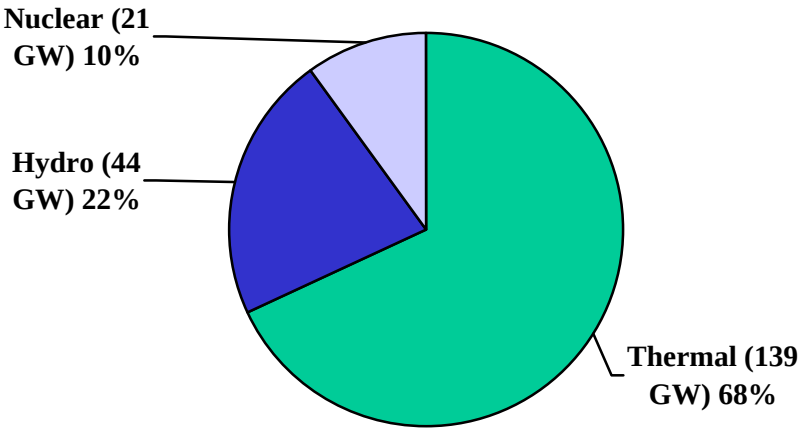
Source: U.S Energy Information Agency, derived from "Table 6.4: World Total Electricity Installed Capacity, January 1, 1980 - January 1, 1999" http://www.eia.doe.gov/pub/international/iealf/table64.xls

Capacity Structure and Fuel Mix

The Russian power system comprises approximately 600 thermal, 100 hydro, and 9 nuclear power stations. Thermal generation dominates Russia's electricity production, accounting for about 69 percent of the total electricity production (see Figure 5). Natural gas fuels 65 percent of this capacity (see Figure 6). Russia's gas reserves are the largest in the world, while its coal and oil industries have been hindered by declining productivity, labor problems, and logistical obstacles.[12]

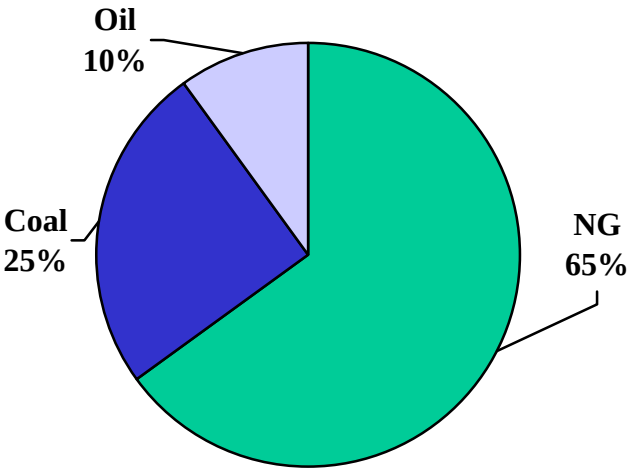
[12] For an excellent account of the Soviet energy crises and the introduction of large-scale gas consumption into the Soviet economy, see Gustafson, Thane, 1989: Crisis Amid Plenty: The politics of Soviet Energy Under Brezhnev and Gorbachov (Princeton, N.J.: Princeton University Press, 1989).

Figure 5: Capacity Structure in 1999



Source: U.S. Energy Information Agency, Derived from Table 6.4, http://www.eia.doe.gov/emeu/ieu/table64.html

Figure 6: Fuel Mix of Russia's Thermal Generation Plants (1999)



Source: Valladares, 1999, p. 41.

The structure of generating capacities differs substantially among regions. For instance, Russia's Northwest relies heavily on giant nuclear power plants concentrated in this area. Central Russia and the Urals mainly use the fuel they possess in abundance — natural gas — while East Siberia takes advantage of its extensive and relatively cheap hydro capacity. The rest of Siberia and the Far East, having almost no developed gas reserves, and little hydro capacity or nuclear power, are heavily dependent on coal-fired power generation.

Generation technology

Electricity generation in Russia bears the heavy imprint of Soviet central planning. The sector is dominated by thermal power plants of enormous size. For example, Tyumenenergo's Surugut 2 plant, at 4800 MW, boasts the largest thermal capacity in the world. Another distinguishing feature of Russia's power generating facilities is more than 50 percent of thermal power capacity consists of "co-generation" plants, which produce both electricity and heat.[13] This combined heat and power (CHP) technology is what often creates the appearance of high energy production efficiency. However, after years of poor maintenance and under-investment, Russia's electricity generating equipment is in disrepair, with low and declining efficiency rates.

Grid

The "United Power Grid" of Russia is the world's largest centrally-managed power pool with. The grid is organized into seven dispatch zones: Northwest, Center, Middle Volga, North Caucasus, the Urals, Siberia, and the Far East. Of Russia's total 206 GW of capacity, 201 GW are part of Russia's Integrated Power System (IPS).[14]

CO_2 Emissions

Due to Russia's recent economic roller coaster ride, reliable CO_2 emissions figures are difficult to find. Estimates made by the UN Framework Convention on Climate Change (UNFCCC) and the World Bank in 1998 predicted emissions of 1750 million tons of CO_2 for the year 2000 (see Table 1).[15] There are various estimates of current CO_2 emissions by the power sector. Unified Energy Systems (UES) sources have suggested a figure of

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[13] Valladares, M.R., 1999: "Reforming the Russian Electricity Market," ," London: *Financial Times Energy*, p. 41.

[14] The remainder is almost all fossil-fuel plants at large industrial facilities, the facilities of Tatenergo in Tatarstan, and those of the utilities located in regions isolated geographically from the national grid, such as Kamchatka and Chukotka.

[15] Michaelowa, Axel, 1999, "Sector-level Greenhouse Gas Emissions," p. 1., <http://www.emissions.de/climate-ru/conferences/energy-and-climate-1999/papers/sectoral-emissions/index.htm> (Last accessed: 04/24/01)

518 million tons,[16] while Japan's New Energy and Industrial Technology Development Organization (NEDO) estimates a figure of 552 million tons of carbon dioxide.[17]

Thermal power plants are responsible for slightly more than one-third of Russia's atmospheric emissions.[18] They currently account for about 16 percent of all Russia's environmental pollutants and for approximately 30 percent of its CO_2 emissions,[19] or approximately 2 percent of the world's total.

Table 1: Estimates of Russia's CO_2 Emissions (million tons CO_2/year)

	1990	1995	1997	2000	2005	2010
Total	2372	1638	1522	1750	2000	2300
Electricity Sector	753*	517/551	493/525	518/552	558/598	N/A

Sources: Golub et al, 1999, "Study on Russian National Strategy of Greenhouse Gas Emissions Reduction"; U.S. Energy Information Agency <www.eia.doe.gov/emeu/iea/tableh1.htm>; Japan's New Energy and Industrial Technology Development Organization (NEDO) (d) 1999, " A study of CO_2 reduction at coal-fired electric power plants in Russia," p. 101-102.

Carbon emissions in Russia's power sector differ significantly depending on the geographic location of the plants. Each of the seven electricity zones has a different fuel mix, and thus CO_2 emissions per unit of power generated also differ. In Siberia, where coal accounts for 90 percent of thermal power generation, carbon intensity is as high as 1.381 tons/MWh; in the Central region, where gas is the dominant fuel for power generation, carbon intensity is significantly lower: 0.861 tons/MWh (see Table 2). Thus, while some of Russia's regions show carbon intensities far above average U.S. levels, others are equal or lower as a result of their extensive use of natural gas in power generation.

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[16] Yeryomin, L.V., 2000: "Electricity sector and protection of the atmosphere from pollution," p. 24.

[17] New Energy and Industrial Technology Development Organization (NEDO), 1999 (d): "A Study of CO_2 reduction at coal-fired electric power plants in Russia," p. 102. Japan has a strong interest in exploring opportunities for acquiring carbon credits (further improvements in its own, already modern, power-generating infrastructure would be extremely expensive). In response to a 1998 proposal by RAO UES, a semi-governmental Japanese organization called the New Energy and Industrial Technology Development Organization (NEDO) commissioned a number of leading Japanese electric power, steel, and energy consulting companies to conduct preliminary feasibility studies for upgrading old thermal power plants in Russia.

[18] Organization for Economic Cooperation and Development (OECD), 1999: *Environmental Performance Reviews: Russian Federation*, pp. 192–193.

[19] Yeryomin, 1999: "The development of the Russian electricity sector and its environmental efficiency," p. 1.

Table 2: Carbon Intensity of Russia's Electricity Zones (1997)

1997	Central	Northwest	Volga	South	Urals	Siberia	RFE	Russia	U.S.[20] (1999)
Tons of CO_2 per MW	3559.4	3227.3	3719.4	3556	3902.9	4730	4026	3862.9	N/A
Tons of CO_2 per MWh	0.861	1.2101	1.024	0.8127	0.8398	1.381	1.322	0.9783	0.8820

Source: Calculations based on regional fuel consumption figures provided in NEDO, 1999(d):): "A Study of CO_2 reduction at coal-fired electric power plants in Russia," p.140

Regulatory Structure

The Russian electricity sector is regulated at two levels: national and regional. At the national level two bodies — the Federal Energy Commission (FEC) and the Ministry of Energy — play the most important roles in establishing the framework for the generation, transmission, and distribution of electricity in Russia.[21]

Federal Energy Commission

The main regulatory responsibilities of the Federal Energy Commission are to control the grid transmission of electricity and heat and the pipeline transmission of oil and gas. In the electricity market, the FEC is responsible for setting wholesale market tariffs, the transmission fees charged by the grid operator (UES), and charges to nuclear power stations. Additionally, the FEC plays the role of arbiter in disputes between regional commissions, customers, and suppliers of electricity.[22]

Since its creation in 1992 (and its confirmation as an independent agency in 1995), the authority and the independence of the FEC have often been challenged by rival government agencies vying for control of the power sector. Thus far, attempts either to

[20] Figure for the carbon intensity of U.S. thermal plants is based on data in DOE, July 2000, "Carbon Dioxide Emissions from the Generation of Electric Power in the United States," p. 2 < http://www.eia.doe.gov/cneaf/electricity/page/co2_report/co2report.html >. (Last Accessed: 04/24/01)
[21] In May 2000, President Putin abolished the old Ministry of Fuel and Energy and divided its responsibilities between the new Ministry of Energy and the Ministry of Trade and Economic Development.
[22] National Association of Regulatory Utility Commissioners, U.S. Agency of International Development, Regional Energy Regulatory Program for Central and Eastern Europe/Eurasia "Federal Energy Commission (FEC) of the Russian Federation," <www.narucintl.org/CEE-NIS/Ras/Russia/index.htm>. (Last accessed: 04/24/01)

transform it into a service agency or to subsume it under a ministry have failed. Nevertheless, the FEC is not regarded as an entirely independent body. It is often said that UES has significant clout in the FEC. The power monopoly may, therefore, have undue influence over the final decisions on the pricing and the dispatch of electricity. Further, the eight members of this commission — appointed for four-year terms by the government — are not independent and impartial experts as they might be in the United States, but rather are the representatives of the energy sector, its customers, and key ministries. Thus, FEC's policies and rulings are often products of political bargaining rather than economic rationality.[23] Nevertheless, its authority over pricing and transmission make the FEC a key player.

Ministry of Energy

Although the Ministry of Energy is not officially charged with setting electricity tariffs, it nevertheless greatly influences thermal generation by UES and the Energos, since it directly controls all major issues affecting the production, distribution, and pricing of fossil fuels. The Ministry of Energy remains the main guarantor of gas supplies to the power sector, pushing Gazprom to keep supplying the electricity generation industry at below international market prices. For example, in the winter of 1999–2000, when UES and the Energos complained that Gazprom was reducing the supply of gas to thermal plants, the Ministry ordered a limit on the export of gas, forcing Gazprom to sell additional gas to domestic markets.[24] In the future, the Ministry's decisions on domestic fuel pricing and rules for gas exports will be crucial in determining the fuel mix (and thus the level of CO_2 emissions) available to the power sector.

Regional Energy Commissions (RECs)

While the FEC, the Ministry of Energy, and their main client (UES) set the broad agenda for the operation of Russia's electricity sector, at the regional level another group of agencies has a great deal of say in the day-to-day operations of Russia's 74 electricity utilities: the Regional Energy Commissions (RECs).

The main responsibility of the RECs is to set retail electricity tariffs charged by the Energos to their customers. RECs determine tariffs for industrial and commercial customers, while the "tariff caps" (the highest and lowest possible electricity prices) for residents are still set at the federal level by the FEC. Like the FEC, although the RECs are "evolving into more autonomous organizations by obtaining legal status and operating on a permanent rather than an as-needed status," they are not independent and impartial regulators.[25] To varying degrees, the Regional Energy Commissions are under the control of regional governments, which appoint their members. The commissioners

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[23] Opitz, Petra, 2000, "The (Pseudo-) Liberalization of Russia's Power Sector," p. 152.
[24] NewsBase, Energo FSU/CE Power Report, March 9, 2000: "UES gets its act together," <www.newsbase.com>
[25] Valladares, 1999: "Reforming the Russian Electricity Market," p. 77.

are usually representatives of the local government, industry, and the regional utility. While the RECs are legally required to follow directives from the FEC, they often ignore them and respond to local political interests. Despite what may appear on paper, regional governments remain very influential in the development of the electricity sector and have the political capability to determine the profitability of any power project. Therefore, their consent and participation will be crucial to the success of any CO_2 abatement projects involving the assets of regional utilities.

While the agencies discussed above are the most direct participants in the regulation and thus control of the sector, many others have some influence over how this sector functions. These include:

- The Ministry of Economics (Department of Energy), which works with other ministries on electricity supply and pricing issues;

- The Ministry of Finance, which exercises financial regulation and develops tax policy towards the power sector;

- The State Committee for the Management of State Property (GKI), which implements the privatization program for the electricity supply industry, and is the owner of UES's state charter (i.e., the Russian government's majority share of the company);

- The Ministry of Natural Resources, which influences the electricity sector by virtue of its authority over environmental policy in Russia (the Regional Committees on Environmental Protection coordinate their work with the Ministry and report to it, as detailed below).

Electricity and the Russian Transition

Along with everything else in Russia, the electric power sector was disrupted by the country's turbulent decade of economic and political transition. For Russia in general, and for the electricity industry in particular, the 1990s have proven to be a decade of economic contraction and incomplete market reforms.

As Russia's overall output precipitously declined, so too did electricity generation. Since 1992, Russia's GDP has declined by more than 30 percent, while power generation has fallen by nearly 20 percent (from 964 TWh in 1992 to 772 TWh in 1999). Investment in the sector has also collapsed: between 1981 and 1985, 6 GW of new plant capacity was added annually, but between 1995 and 2000 this figure had fallen to just 1 GW per year. By 2006, more than half of Russia's generating capacity will have exceeded its rated

service life.[26] According to UES calculations, the sector will need $40–60 billion in new investment over the next ten years.[27]

In spite of a partial privatization of the electric power sector in 1994, electricity has never been placed on a solid commercial footing in Russia. Instead, it often became a mechanism through which various government bodies continued to subsidize state agencies, "strategic industries," and the general population by allowing them not to pay their electricity bills. Thus, the electricity industry, like the oil and gas sectors, finds itself in a transitional no-man's-land. On the one hand, as a private entity, it is supposed to generate profits for its shareholders, while on the other, as the guarantor of the survival of Russia's impoverished industry and population, it is asked to supply power to "strategic customers" for little or no return. As a result, UES and the Energos have often been unable to pay their suppliers such as Gazprom and even sometimes their employees. Perhaps one of the greatest shortcomings of Russia's economic reforms has been its inability to commercialize the power sector, and treat electricity like a commodity instead of a social right or political obligation.

Since the shocks of the financial crisis in August 1998 sent the Russian economy into a nosedive, the country has seen a surprisingly rapid recovery. After expanding by 3.2 percent in 1999, GDP is projected to grow by 7 percent in 2000 and by 4 percent in 2001.[28] Industrial production and exports are up, while the ruble and the consumer price index have stabilized. Tax and energy bill collection have finally begun to grow, both in absolute terms and in the proportion of revenue collected in cash. Although this is good news for the government and for potential investors in Russia, major challenges lie ahead. Analysts seem to agree that thus far the Russian economy has been propelled by the short-term benefits of high oil prices and the 75 percent ruble devaluation. It remains to be seen whether ambitious structural reforms, including an overhaul of Russia's labyrinthine tax code and the rationalization of Russia's devastated financial sector, can be implemented and long-term growth secured.

In anticipation of a strong economic rebound, UES management recently announced a series of reform proposals to reorganize the electricity sector. UES argues that a reorganization of the sector is essential if it is going to attract $40–60 billion in new investment — much of which will have to come from abroad — that will be needed to meet Russia's electricity needs over the next decade. The argument is that without the creation of real markets and at least partial elimination of regional power monopolies, foreign investors will be reluctant to participate in the Russian electricity sector. While there is debate as to whether the reforms currently offered will provide sufficient incentive to attract investors, UES seems determined to improve its image within the

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[26] Energy Information Administration (EIA), 2000: *Country Report: Russia*, < http://www.eia.doe.gov/emeu/cabs/russia.html> (Last accessed: 04/24/01)
[27] UES estimate: see < http://www.rao-ees.ru/ru/reforming/ > (Last accessed: 04/24/01)
[28] International Monetary Fund (IMF), 2000: *World Economic Outlook*, p. 32.

investment community. And while determination by itself does not automatically translate into reforms, it is a necessary first step.

The experience of the past ten years, filled with shelved or stalled reform plans, suggests that there remains a significant degree of uncertainty about how rapidly Russia will be able to straighten out its power sector. However, the commercialization of the sector remains a prerequisite for its future growth and for any large-scale effort at emissions reductions investment in Russian electricity.

Part II: Opportunities for Carbon Dioxide Emissions Reduction in the Russian Power Sector

Although no agreement has been reached on how exactly the Russian electricity sector (and industry) could trade carbon emissions credits, two broad models are applicable. The first is Joint Implementation (JI), which would allow a foreign corporation, organization or individual to invest in a specific CO_2-reducing project in Russia and therefore to own the credits generated as a result of the reduction. The second model, usually referred to as emissions trading, envisions trading carbon credits at the international level, with some countries buying and others generating and selling credits produced by reducing their overall emissions levels below internationally agreed upon targets for a certain period. As of the spring of 2001, neither developed nor developing countries had adopted and ratified an international protocol. Hence, both of these models remain hypothetical, although judging from official statements by most of the countries participating in the negotiations, a version of both models will likely be approved at some future date.

If this occurs, there are legitimate opportunities for the Russian electricity sector to take part in an effective carbon trading regime. Indeed, many of the sector's physical and institutional shortcomings are in themselves opportunities for relatively inexpensive emissions reductions. For example, generation efficiency levels can be raised relatively easily through upgrading Russia's superannuated generation technology with modern equipment, thus lowering carbon emissions per unit of power produced. These types of upgrades could easily fit under the rubric of Joint Implementation (JI). The property rights to carbon emissions reductions could be sold in either domestic or international CO_2 emissions permit markets. Russia could also reduce its electricity-related emissions through market reforms to encourage fuel saving. This would reduce overall emissions of the electricity sector, and the resulting emissions credits could be traded by UES or the Russian government in an international CO_2 trading regime.

Carbon credits through upgrading generation technology efficiency

Russia's electricity generating technology is, for the most part, old and inefficient. In fact, as of early 1999, approximately 60 percent of Russia's total generating capacity and 45–50 percent of its thermal generating capacity needed replacing, and by 2010 as much as 80 percent of Russia's power generation assets will be over 25 years old.[29] The official UES figure of 34–35 percent for average thermal efficiency of electricity generation probably overstates the true picture.[30] At present, efficiencies of this magnitude are achieved mainly by the large and relatively modern thermal plants (over 1000 MW) that

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[29] Valladares, M.R., 1999: "Reforming the Russian Electricity Market," pp. 56–57.

[30] Estimate of approximately 35 percent given by UES CEO, Anatoliy Chubais, at the US-Russia Investment Symposium in Boston, October 8, 2000. A similar estimate can be found in the figures given by Expert Rating Agency, which estimates the average of 0.3381 kg of coal equivalent burned per 1 KWh produced (Expert RA, 1999: "Russia's Electricity Sector, p. 20).

are owned and operated exclusively by UES.[31] Totaling 38 GW of capacity, these industrial giants represent less than 30 percent of Russia's total thermal capacity. The vast majority of the smaller, Energo-operated thermal power stations most likely achieve efficiency levels of no more than 23–30 percent, while some show efficiencies below 23 percent.[32] Low thermal efficiency rates, in turn, suggest that high levels of carbon intensity are characteristic of the country's power generation.

There are two main reasons for the low efficiency rates shown by Russia's electricity generating plants. The first is the poor condition of generating equipment due to age (some of Russia's thermal capacity dates back to the 1930s and 1940s) and substandard maintenance over the past ten years as investment levels in the sector plummeted. The second reason has been suboptimal loading of generating equipment due to the fall in demand for power between 1990 and 1998, and dispatching that was motivated by political rather than economic considerations (discussed in more detail below). According to the former Chief Executive Officer of UES, Boris Brevnov, in 1999 the sector had excess capacity of nearly 50 percent.[33] In the first half of 1999, even large UES generators had average loads of just 30–40 percent, while numerous Energo-operated thermal plants in regions with excess capacity were utilized even less. These low loading rates, particularly in coal plants, sometimes tend to cause more fuel to be burned per unit of electricity produced; the rate would improve with investment in more efficient technology and higher rates of capacity utilization. At the same time, many "deficit" Energos prefer to run their own small and more inefficient facilities at excessively high rates of utilization, rather than having to buy wholesale power from UES. This is more a political decision than an economic one. As a result, the cleaner and more efficient plants owned by UES and surplus Energos are used less, while the less efficient and more polluting plants operate more.

The bottom line is that both the condition of the equipment and the manner in which it is used causes Russian power generation to be more carbon intensive than the OECD average. These shortcomings of the sector create significant opportunities for reducing carbon emissions and creating carbon credits through introducing state-of-the-art clean generating technology, upgrading existing equipment, and increasing capacity utilization.

Modern combined-cycle technology allows for plant efficiency of between 40 percent (using coal) and 52 percent (using natural gas).[34] Replacing antiquated technology in Russian thermal plants would thus allow for substantial increases in generating efficiency. Such projects could earn carbon credits, since new plants would be able to

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[31] Estimate based on energy consumption/output data for 1998–99 given by Expert Rating Agency (RA) for Russia's largest power stations, (Expert RA, 1999: Russia's Electricity Sector, pp. 617–689.)
[32] Estimate based on overview of energy consumption/output data for 1998–99 given by Expert RA for AO Energos, (Expert Rating Agency, 1999: Russia's Electricity Sector, pp. 127–607); see also Part IV for some examples of low thermal efficiencies at Energos in the Russian Far East.
[33] Brevnov, Boris, 2000: "From Monopoly to Market Maker? Reforming Russia's Power Sector" p. 6.
[34] International Energy Agency, Greenhouse Gas R&D Programme, "Greenhouse gas emissions from power stations," <www.ieagreen.org.uk/emis1.htm> (Last accessed: 04/26/01)

generate the same amount of electricity as before, while burning substantially less fuel and thus reducing emissions. As long as the cost savings from the improved efficiency plus the price of the carbon emission credits sold are greater than the cost of the incremental investment, Russia, and more particularly the Russian electricity sector, will benefit.

If existing modern equipment is upgraded so that it could safely function at higher average loads, the efficiency of the plant could grow while its carbon intensity would decline. Meanwhile, an equivalent amount of older capacity could be retired, and overall carbon emissions reduced. Increasing capacity utilization at existing emissions-free hydropower facilities at the expense of the old and inefficient thermal plants could achieve similar results.

Both of these methods could qualify as Joint Implementation projects, because both carbon reductions and credit ownership would be relatively easy to identify.

Carbon credits through fuel switching

While Russia is already one of the world's most prolific users of natural gas in power generation, there is scope for increasing the share of gas in the sector's fuel mix at the expense of the more polluting coal. Many of the opportunities for reducing carbon emissions in this manner are in East Siberia and areas of the Russian Far East (discussed in more detail in Part IV). While most of the current gas production in Russia takes place in West Siberia, and the gas is used for power generation in the Urals and Central regions, there are also extensive undeveloped gas reserves in East Siberia, Yakutia, and Sakhalin, regions where coal-fired power generation still predominates. Natural gas deposits in the Irkutsk region and the Sakhalin shelf are currently under development, with much of the gas slated for export to neighboring Northeast Asia. However, some "gasification" of East Siberia and the Russian Far East is also under consideration.

Feasibility studies were commissioned by Japan's New Energy and Industrial Technology Development Organization (NEDO) and carried out by several of Japan's leading companies with the cooperation of UES in 1998–99. They concluded that carbon projects that involved switching from old thermal power stations to modern combined-cycle gas technologies in Russia were less expensive than had been anticipated. Their cost estimated ranged from $3.20 to $17 per ton of CO_2 reduced.[35] Admittedly, the

[35] NEDO, 1999 (c):"Fuel Conversion Project at the No. 1 and No. 9 Combined Heat and Power Generation Plants in Irkutsk Oblast," p. 16; NEDO, 1999 (b): "Feasibility Study Report on Konakovo Combined Cycle Power Project in Russia," p. xv.; To calculate CO_2 reduction costs, the authors of the feasibility studies subtracted estimated CO2 emissions that would be generated by the proposed new technology from a baseline estimate of CO2 emissions from existing technology over a period of thirty years. The increment (or tons of CO2 saved) was then divided by fixed costs required for the upgrades. This yields the cost of US$/ton of CO2 reduced. These calculations, however ignore potential revenue as well as operations and

Japanese calculations are biased on the low side (see Appendix I), but even if they are off by a factor of three, these projects are still attractive compared with the abatement costs in Japan, which, at the margin, could be as high as $150 per ton.

Carbon credits through more efficient electricity markets

Both the retail and the wholesale electricity markets in Russia encourage waste and inefficiency (discussed in Part III). Reforming the current market regulatory system would not only give Russia a better functioning power sector, but could yield emissions credits as well. The most important steps would be to set fuel and wholesale power prices to reflect their market value as opposed to the cost-plus system currently used and to give consumers some direct access to cheaper wholesale power. If prices remain below costs, consumption is too high, investment in supply is too low and opportunities for a robust carbon credit market will be substantially reduced.

Those few Energos with surplus power (such as Irkutskenergo) should be allowed to compete freely in both wholesale and retail markets. Such reforms could help optimize dispatch by reducing the incentive of the utilities to run their inefficient and costly plants at the expense of industrial consumers, which at present have no power to choose their electricity supplier. Such changes could save the electricity generating industry $3–4 billion annually, largely from eliminating the 17–23 percent of estimated fuel consumption.[36]

The resultant carbon reduction credits would be inappropriate for direct trading through JI, due to uncertainty over their ownership. They could, nevertheless, be used in the international emissions trading regime as part of a broad Russian emissions reduction effort.

Other opportunities for creating carbon credits

Improvements in the transmission system provide another opportunity for creating carbon credits. At present, the transmission system loses around 12 percent of the power generated (up to 15 percent during the winter). Some utilities, such as Amurenergo, record losses of up to 25 percent.[37] Thus, transmission upgrades would save electricity, lower costs and ultimately reduce emissions.

Investing in the efficiency of the heating systems operated by the power sector is yet another relatively inexpensive way to save energy and create carbon credits. Around 40

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maintenance (O&M) and fuel costs, making the figures very approximate. Meanwhile, they are also silent as to how to discount the benefits of carbon credit sales (see Appendix I for details).

[36] Brevnov, Boris, 2000: "From Monopoly to Market Maker? Reforming Russia's Power Sector," p.37

[37] Expert RA, 1999: Russia's Electricity Sector, p. 21; Integrated Dispatch Control (IDC) Far East, 1999: *Annual Report*, part 5, p. 7, table 5.2.1.

percent of Russia's heating systems are operated by electricity utilities, which use combined heat and power (CHP) technology extensively. However, the heating systems are antiquated, often contributing to the inefficiency of the electricity plants' fuel consumption and thus excessive carbon intensity.

UES and CO_2 Emissions Trading

Aside from the investment opportunities currently offered by the Russian power sector, the expressed desire by UES to participate in organizing a national CO_2 trading regime can itself be considered an opportunity because of the corporation's relatively good data collection capability, and its considerable influence in the sector. Furthermore, UES's intention to reform the Russian power markets, while not directly related to carbon reductions, should create an improved environment for all projects in this sector, including those involving carbon abatement.

Since the energy sector is better organized than most Russian industries, and is highly integrated, there are opportunities for implementing effective monitoring of emissions. For instance, UES already has the ability to collect data on fuel use (not only for its own plants, but also for those operated by the Energos), and with this data to construct a greenhouse gas emissions inventory. UES still retains a strong influence not only over its own facilities but also over those of the regional Energos. At a minimum, UES controls access to the national grid and thus has substantial leverage over any firm that would like to sell power on that grid. Thus it is in the position to secure a degree of cooperation in instituting a carbon trading system within the sector.

In addition, since 1997 UES has been cooperating with foreign governments and companies interested in taking advantage of Russia's CO_2 emissions reduction opportunities. While the results have not been made public, it has participated in numerous feasibility studies to ascertain the costs of emissions reduction. Recently, it completed a CO_2 emissions audit of its plants, [38] which, in turn, is now been independently reviewed by Environmental Defense. Finally, it has recently announced the creation of its own Carbon Fund, an internal department charged with coordinating and realizing CO_2 emissions abatement projects.[39]

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[38] Expert RA, 1999: Russia's Electricity Sector, pp. 36–38.

[39] Prime-TASS Economic News Agency, August 31, 2000: "UES directors give go-ahead to energy carbon foundation," Prime-TASS news wire, (available through Internet Securities, Inc. "ISI Emerging Markets" website <www.securities.com>.)

Part III: Challenges to emissions reduction projects in the Russian electricity sector

While Russia's electricity sector provides numerous opportunities for what could be cost-effective CO_2 credit creation activities, the conditions of the sector, Russia's economy, and its government present formidable obstacles to the realization of these opportunities on a significant scale. This section identifies three broad categories of such problems: profitability, sustainability, and predictability.

If Russia, along with its power sector, hopes to become a viable participant in CO_2 emissions credit markets, it will have to meet a number of basic preconditions. At a minimum, it must first provide private investors — the main source of capital for large-scale CO_2 abatement endeavors — some assurance of returns on their investment. Second, it must provide an independent and credible system for monitoring and enforcement that could guarantee compliance from emitters (such as thermal power plants), and thus guarantee real sustained CO_2 reductions over time. Finally, it must be able to offer reasonably reliable figures on future CO_2 emissions and reduction costs. At present, Russia and its power sector fall far short of these basic conditions.

Profitability: The Challenge of Russia's Power Markets

While the sale of CO_2 emissions credits could become a significant source of funds for Russian power plants in the future, it would not be realistic to assume that the proceeds from these sales could cover all or even a majority of the costs of the efficiency upgrades needed to create the necessary carbon emission reductions. Moreover, since currently we can only speculate about the price that will be paid for the right to emit a ton of CO_2, those investing in efficiency upgrades of Russia's electricity infrastructure must rely predominantly on the incremental revenue from the sale of electricity to recoup their investments. Thus, their investment decisions will largely be driven by a conventional risk-return analysis, and will depend on the conditions offered by Russia's power markets.

The absence of direct private investment in the electricity sector to date is an indicator that the electricity business has not been a profitable undertaking in Russia. Low tariffs and bill collection rates, and the highly politicized nature of the market, have kept most investors away. Meanwhile, since Russia has not experienced the potential of future electricity shortfalls heretofore there has been little incentive for the government to reform the system. The following section will outline the major problems faced by potential investors in the Russian electricity sector, and therefore by those who might be potentially be interested in emissions reduction projects.

Electricity tariff: Too low for comfort

Russia has some of the lowest electricity rates in the world, a major source of concern to potential investors in electricity projects. While OECD countries had an average industrial tariffs of $0.065/KWh, in the first half of 1999, Russia's average tariff was 0.27 rubles, or around $0.01/KWh.[40]. Thus potential investors are looking at retail prices less than one-sixth of those in more developed economies. A similar situation can be observed in the wholesale market. In 1999 the average wholesale price of power in Russia was around R 0.15 or $0.005/KWh,[41] while in OECD the average wholesale price was approximately $0.03–0.04/KWh.

Low tariff rates would not necessarily be a bad thing if they were high enough to cover the cost of operations and allow a reasonable rate-of-return on capital. However, for the most part, Russian utilities do not make money; many still practice "below-cost" pricing for the power and the heat that they produce. Thus, aside from the utilities that are located in the most economically dynamic areas with high electricity demand (such as Mosenergo) or have low operating cost hydroelectric generating facilities (such as Irkutskenergo), in many cases electric power generators in Russia do not earn rates sufficient to even cover their costs of operation, relying on subsidized fuel and capital costs. In May 2000, the FEC agreed to raise wholesale power tariffs by 35 percent. The management of UES argued that this increase did not even cover the company's operating costs, but a request for a larger increase was denied in September 2000. The government has been reluctant to raise rates, lest such increases have a negative impact on the country's current economic expansion and increase social tensions. Meanwhile, most of the Energos, still constrained by political considerations of the influential regional governments, have also been slow to increase their prices, particularly for the residential sector. This situation is exacerbated by inflation — 100 percent in 1999 — that swamped the tariff increases granted to date. Thus, the gap between costs and revenues continued to rise.[42]

From the perspective of potential investors in projects aiming to increase efficiency and reduce emissions through technological upgrades, this state of affairs is particularly disturbing. If existing utilities are losing money and do not have to worry about fixed costs (because their facilities have been fully depreciated), how can new plants, or plants with new and expensive foreign equipment, be expected to compete? Realizing that tariff reform is essential to attract investment, the Minister of Economic Development, German

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[40] Energy Information Administration <http://www.eia.doe.gov/emeu/international/elecprii.html> (last accessed: 04/26/01); Expert RA, 1999: Russia's Electricity Sector p. 107. We chose the first half of 1999 because of the fluctuations in the exchange rate in 1998. The prices for power in Russia and OECD did not change significantly between 1998 and 1999, so the comparison is still valid.
[41] Metropol Investment Financial Company, 2000: *Power Report*, p.14;
[42] Valladares, M.R., 1999: "Reforming the Russian Electricity Market," p. 72.

Gref, recently announced that prices are set to double by the end of the year.[43] Whether these increases actually occur remains to be seen.

The problem of non-payments

Problems for private investors in the sector do not end with low tariff rates. Until recently, a more serious threat to the cash flow of Russian utilities has been the ubiquitous non-payment crisis in the power sector and the economy at large. The situation has improved dramatically since mid-1999.

Russia has been dubbed a "virtual economy," in part because few cash payments are made for the goods that are produced. The electricity sector has been an example of this virtual economy. Since the product that it produces is considered to be a social good, cutting off its supply for whatever reason has been politically difficult. On top of that, federal decrees often make it impossible to cut electric service to state agencies or companies that don't pay their bills. Besides, if a producer nevertheless wanted to shut off electricity, more often than not he would find it technically impossible, since the existing technology only permits cutting power to a district or neighborhood, not an individual consumer. As a result, until recently, few electricity bills were paid, and when they were, no real money ever changed hands (see Figure 7). Instead, barter, various kinds of IOUs, and tax offsets were used in lieu of cash.

This led to a huge indebtedness. It was estimated that at the end of 1999, electricity generators owed Gazprom approximately R 115 billion ($4 billion), which is equivalent to more than a year's worth of UES's revenue.[44] The Energos also owe significant sums for their wholesale purchases from FOREM, to RAO UES, nuclear plants, or to other, surplus Energos.

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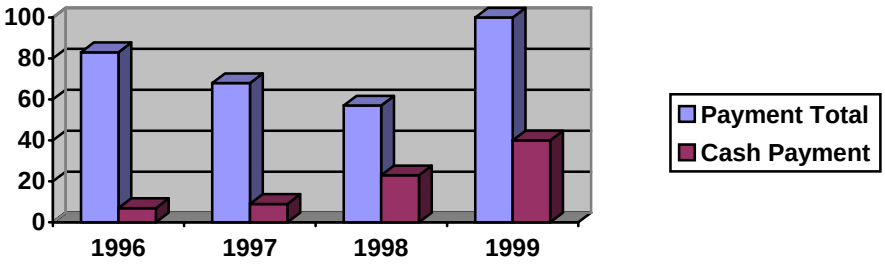
[43] Energy Economist, Reforming Russian Energy II: UES. July 2001, p. 9.

[44] International Energy Agency, 1999: *World Energy Outlook*, pp. 121–123.

Figure 7: Payment for electric power in Russia (percentage)



Source: AK&M Industry Survey, February 14, 2000, April 2000:Power Sector Report, No. 365.

Since mid-1999, the problem of non-payments has subsided significantly and progress in bill collection has improved the conditions of the sector. In 1997, bills collected in cash represented less than 10 percent of the total, but by 1999 this figure had gone up to 40 percent (see Figure 6). Improvements have continued: in the second quarter of 2000, UES reported cash payments of 62 percent, while the figures for September and October of 2000 were over 90 percent. During 2000, total bill collections in the power sector reached 120 percent as some past-due bills were finally collected. Although some "macro" factors have clearly been at play, such as the end of the "credit crunch" (resulting from prohibitively high interest rates, designed to make Russian debt attractive, that came with the devaluation of the ruble), the recent concerted efforts by UES to collect on unpaid bills (both past and present) and to settle its own arrears has also been crucial in mitigating this major problem. While official statistics have not been released, anecdotal evidence indicates that payment levels remain high. If Russia can maintain this trend, it will gradually remove a major obstacle to attracting future investments.

Politicized electricity markets

Excessively low electricity tariffs and chronic non-payment problems are in part the result of another obstacle faced by potential investors in Russia's power sector, that of heavily politicized retail markets. Retail power rates vary widely across the country. They depend less on the specific costs of power production than on the politics of the various regions. Since local and regional politicians and administrators are members of the local regulatory bodies (Regional Energy Commissions, or RECs), political motives often heavily influence rate setting and can make it very difficult for the Energos to make profits or even covered their costs.

In election periods, regional politics dominate the pricing decisions of the RECs. To keep voters' power bills low, Energos are frequently prevented from raising residential tariffs even to cover their short-term production costs. Energos also are pressured by regional governors to deliver cheap or free electricity to politically connected customers. They do

so because it is crucial for them to have a working relationship with the regional administrators and politicians who sit on the board of the Regional Energy Commission. Meanwhile, in order to somehow compensate for these energy subsidies, the Energos are forced to overcharge other, less well-connected industrial customers. The politics of cross-subsidization is a common feature of the Russian political landscape, and is one of the many sources of perpetual tensions between the federal government and the regions.

Meanwhile, the uncertainty of markets that are controlled by administrative fiat is a serious obstacle to attracting private investment. From the investor's perspective, as long as the control of the markets remains in the hands of local politicians (via RECs), rather than independent regulators, electric power projects are likely to remain risky financial undertakings.

Ineffective wholesale market

Russia's wholesale market and its rules are hardly reassuring to potential investors. Although a reform plan that includes the liberalization of the wholesale market is currently being developed by the government, Russia's wholesale power market (FOREM) is far from being a competitive power pool. In fact, its pricing discourages efficiency in generation, while its dispatching procedures favor certain participants over others. While FOREM is set up so that it could serve as a spot or clearing market, the existing system has a number of fundamental flaws.

First of all, it provides few incentives for participants to raise efficiency and lower costs or, in other words, to compete. The suppliers to the FOREM market are selling electricity based on a Federal Energy Commission (FEC)-approved two-part tariff (fixed and variable costs), which is basically a cost-plus scheme. The FEC sets a different tariff for each facility based on the agency's assessment of their historical costs. As a result, producers have little incentive to cut their costs. Meanwhile, FOREM buyers are not allowed to choose the cheapest producer from among FOREM sellers, but are instead dependent on RAO UES allocation. Thus high-cost producers supply to the FOREM, as long as they reach their assigned allocation volume and their costs do not exceed the agreed cost-plus tariff. Consequently, the system is not designed to promote low-cost production or efficient generation. At the same time, by relying on a relatively arbitrary cost-of-service calculation the price mechanism of the FOREM is neither transparent nor economically efficient. It is almost never based on marginal cost, but is instead based on some rough type of cost-of-service calculation.

The dispatching system favors UES - affiliated plants. UES - itself a major power generator - completely controls FOREM and with it the power dispatch. This conflict puts RAO UES in position to favor its own generation entities over Energo plants that attempt to sell into the FOREM market.[45]

[45] Valladares, M.R., 1999: "Reforming the Russian Electricity Market," pp. 62–63.

Limited access for consumers further restricts FOREM participants. While several large industries (such as the railways) have the ability to buy cheaper wholesale electricity directly from UES and bypass the higher-priced Energos others do not. Further liberalization in the sector might allow this access, but the Energos are strongly opposed to providing their main customers access to other generators.

Regional authorities interfere with the effective functioning of the wholesale market, just as they do at the retail level. Tensions between the Energos and the UES-controlled Central Dispatch Authority (CDA) have occurred frequently in the past. Energos and regional power bodies routinely ignore central dispatch orders to reduce or suspend electricity generation. This is because regional and local politicians influence their Energos, and have their own priorities (such as supporting the regional economy, or ensuring their own re-election).

At the moment, the Russian electricity sector does not offer an environment in which potential investors in power-plant efficiency upgrades feel that their potential rewards are commensurate with the risks that they are being asked to take. The Putin Administration, concerned that the electric sector needs $60 billion in development funds over the next ten years is committed to restructuring the industry over the next four years. There is substantial controversy over the details and actual timetable, but it is becoming increasingly likely that UES will be unbundled and its generating assets divested. These reforms are a necessary first step, since without them it is hard to see where CO_2 credits will come from.

Russian Environmental Regulation and Electricity

The capacity for effective monitoring and regulation of the electricity sector's emissions by the state or an independent body is crucial to the working of any emissions trading system. All participants in such a market will need impartial and reliable verification of actual carbon reductions. They will want some assurance that Russia's environmental, legal, and regulatory mechanisms will work. Ultimately, everybody committing significant amounts of money to these projects will want to know whether the existing environmental regulation system can be trusted.

In the last ten years, numerous laws directed at environmental protection and energy conservation have been passed in Russia. The 1991 Law on Environmental Protection and the updated version of the Law on the Protection of the Atmosphere of April 1999 provide a legal foundation for controlling emissions of harmful gases.[46] They focus on keeping emission levels below the point at which they become harmful to human health and to the environment. They also give sweeping powers to both federal and regional governmental agencies to set, monitor, and enforce environmental standards.

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[46] Ecoline <cci.glasnet.ru/mc/legis/index.html#1-1> (last accessed: 04/27/01).

Until May 2000, the principal federal agency that formulated emissions control policy in Russia was the State Committee for Environmental Protection (SCEP). With the help of its regional equivalents — Regional Committees for Environmental Protection — it was also the primary gatherer of information, as well as enforcer and monitor of emissions levels in the country.[47] Several other government bodies also participate in the formulation and implementation of environmental policies affecting climate change, including the Ministry of Energy, the Ministry of Finance, and the Ministry of Natural Resources. In 1994 a special Interagency Commission of the Russian Federation on Climate Change Problems was established to coordinate their activities with respect to climate change.[48] However, while it exists on paper, this committee has been rather passive, reflecting the low priority given to climate change issues by many of these agencies.

In May 2000, President Putin signed a decree eliminating the State Committee for Environmental Protection along with the Committee on Forestry, and charging the Ministry of Natural Resources with the oversight of the country's environmental policies.[49] This move has been strongly criticized by environmentalists both inside and outside Russia as an indicator of the administration's intent to give the environment low priority. Whether their fears are justified only time will tell. In the meantime, the reorganization does not seem to have led to any immediate change in policy or practice pertaining to emissions either at the federal or the regional levels.

At present, emissions in Russia (including greenhouse gases) are regulated on the basis of the so-called "Recommendations for Controlling the Sources of Air Pollution."[50] This government directive establishes the basic procedures for measuring air pollution, including greenhouse gas emissions. It requires all facilities that emit airborne pollutants to report their emissions to the Regional Environmental Committees for review. The Regional Committees report to the regional statistical boards, which in turn report to the Federal Committee on Statistics (Goskomstat). Based on the assembled pollutant "inventories," each polluter receives a special "ecological passport," which identifies its major pollutants and sets caps on their emissions.[51]

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[47] Ministry of Natural Resources, Russian Federation, The decree on the State Committee of the Russian Federation for Environmental Protection, <www.ecocom.ru/official/regulation.htm>. (last accessed: 2/15/0)

[48] Royal Institute of International Affairs, Climate Russia: "Statute on the Interagency Commission of the Russian Federation on Climate Change Problems" <www.climate.ru/regulations/>. (last accessed 04/27/01)

[49] BBC Monitoring, May 22, 2000:, 220950 GMT "Confusion over Environment in Russian Government Structure,"<www.securities.com>.

[50] Kurayev, S., S. Markin, E. Strukova, 1998::"Domestic regulation of greenhouse gases and problems of initial allocation of emission quotas," p.1, < ceeri.ecoinfo.ru/climate/english/seminars/strukova.htm> (last accessed; 04/27/01)

[51] Russia's emissions norm-setting system is based on health standards called Maximum Allowable Concentrations (MACs), which are set for hundreds of pollutants. Based on the calculated MAC level each emitter gets a special emissions permit. This permit constitutes the basis of the emissions monitoring system in Russia. (Kurayev, Markin, and Strukova.)

Thus, broadly speaking, a legal and regulatory system that controls industrial emissions does exist and, in theory, could serve as a framework for monitoring carbon emissions. Although CO_2 monitoring is legally within the purview of the Regional Committees, it is not yet done in Russia. If the current regulatory system were more reliable and better funded, it would be relatively easy to add CO_2 to the current list of pollutants. This would obviate the necessity of creating a separate body for the purpose, a time-consuming and expensive proposition. However, the present system is badly flawed. The legal prerogatives of environmental agencies are still not clearly defined. Although the law grants federal and regional environmental bodies broad powers over emissions regulation, their authority and responsibility vis-à-vis one another and their "clients" remains vague.

In addition, the orientation of Russia's regulatory policy is inappropriate for CO_2 monitoring. Until very recently, the central goal of emissions monitoring in Russia had been to curtail immediate threats to human health. Since greenhouse gases such as carbon pose no immediate threat, existing environmental bodies have paid no attention to them. The regulatory practice of emissions monitoring is based upon keeping a check on emissions concentrations at the source, rather than keeping inventories of aggregate amounts. As a result, only two GHGs — methane and freon — are monitored in Russia, and the permissible levels of emission for these gases are very lax.

Monitoring practices also need strengthening. Since their establishment in 1997, the regional committees for environmental protection have been active in identifying environmental offenders. In 1998 alone, they conducted 268,282 inspections and identified 243,588 instances of illegal pollution.[52] However, local environmental bodies have relatively limited powers to enforce environmental laws. In many cases they have no authority to impose penalties, but must instead take the offender to court, which might or might not side with the agency.[53] Thus, in spite of the 243,588 identified instances of environment-related offences in 1998, the committees collected a paltry total of 90,000 rubles ($3000) in fines, or one cent per violation.[54]

There are three main reasons for this dismal record: the low priority given to pollution abatement; the lack of federal funding for environmental regulation; and the over-reliance on self-regulatory practices in such key industries as electricity.

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[52] State Committee for Environmental Protection, Russian Federation, 1998: The results of inspections conducted by the regional branches of the State Committee for Environmental Protection <www.eccom.ru/ecocontrol/Gec98.htm>.(last accessed: 08/15/00)

[53] See, for example, Regional Business News, June 8, 2000: "The State Committee on Environment files a suit against RAO UES," <www.securities.com>.

[54] State Committee for Environmental Protection, Russian Federation, 1998: The results of inspections conducted by the regional branches of the State Committee for Environmental Protection <www.eccom.ru/ecocontrol/Gec98.htm>.(last accessed: 08/15/00)

In a country with as many pressing social and economic problems as Russia, it is hardly surprising that the limited funds available to the federal government are for the most part not targeted for environmental regulation. As a result, all environmental bodies are severely weakened by a chronic lack of funds, leaving them understaffed and exposed to corruption.

Moreover, the independence and thus the integrity of local environmental bodies in Russia have been compromised. In spite of the fact that regional and local environmental committees in Russia are technically subordinate to the federal government and have the responsibility to enforce federal law, as opposed to regional law, they have come to be overly dependent on municipal and regional budgets.[55] This has often led to a *de facto* subordination of their duties and powers to the interests of local authorities. Such subordination compromises the impartiality of such bodies, which might side with the interests of the local authorities and industry and against those of outside investors.

Finally, the largest industrial polluters, such as the electric power sector, are effectively self-regulating The rules for organizing the control of emissions at thermal power plants and heating boilers are broadly defined by the Ministry of the Environment and Natural Resources, while specifics on emissions caps and monitoring are negotiated between the regional environmental committee and the utility responsible for the plant.[56] However, for the past twenty years, all ecological issues in the power sector have been largely under the control of the sector's own management and administration. In compliance with Russia's environmental laws, UES has adopted various ecological programs, such as the 1996 "Ecological Program for the Development of the Electric Power Sector." This ambitious program promised to reduce GHG emissions through such measures as increased use of natural gas and replacing old and inefficient equipment with clean technologies.[57] However, these programs are internal to UES, and there is no federal or judicial oversight or enforcement.

Thus, both environmental legislation and its enforcement in Russia still leave much to be desired, especially from the perspective of establishing a reliable CO_2 monitoring and compliance system. Laws dealing with GHG emissions have been overly general and have, for the most part, ignored CO_2 emissions, while the bodies set up to enforce the laws lack independence, effective coordination, or any real authority over the powerful electricity industry. Nevertheless, the apparent desire on the part of UES to participate actively in CO_2 reduction projects does offer potential investors some hope that this situation will improve.

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[55] *Vremya*, June 6, 2000: "Mi zhivyom po printsipu: vzyat u prirodi — nasha," ("We live by the principle: Take from nature, it's ours"), <www.securities.com>.
[56] Yeryomin, Lev, 2000: "Electricity sector and protection of the atmosphere from pollution," p. 21.
[57] *Ibid.*

Predictability and other problems associated with carbon trading

Since 1990, Russia's overall CO_2 emissions have declined as a result of the country's extreme economic contraction during the decade. Emissions from the electric power sector have declined in tandem with those of the economy as a whole, as electric power demand, and thus power generation, have fallen. In fact, according to UES sources, not only has there been an absolute decline in all main forms of emissions but, due primarily to an increase in the share of natural gas in the fuel mix (from 60 percent to 65 percent in the last ten years), there has been a decline in overall "pollution intensity" of thermal power generation.[58]

However, this situation may be turning around. UES is now predicting that by 2005, generation is expected to reach 1018 TWh per year — a rise of over 30 percent over current levels —while carbon emission levels are also expected to increase.

There are at least three factors that will seriously affect the power sector's future emissions trends: energy efficiency levels, the relationship between economic growth and electricity demand, and a potential reversion from gas back to coal.

Energy efficiency levels

During the 1990s, Russia's energy consumption efficiency levels — and thus the carbon intensity of its economy — continued to deteriorate. Carbon intensity levels in 1996 were 6.8 percent higher than in 1990. At 2.2 tons of CO_2 per $1000 of GDP (at 1991 prices and purchasing power parities), Russia's carbon intensity is three times higher than the European average of 0.66 tons.[59] Given the state of Russia's superannuated power-generating technology, and a glaring lack of funds to replace this technology, this trend could continue for some time to come.

Relationship between economic growth and electricity demand

The Soviet and now the Russian economy's high energy intensity (and resulting high carbon intensity) have been, in part, the result of domination by energy-intensive heavy industry. Thus a shift in Russia's economic structure towards services and high-tech industry could result in the reduction of energy intensity and of carbon emissions. Russia is currently experiencing such a shift, and in fact, between 1999 and 2000, electricity demand did not grow nearly as fast as industrial production and the overall economy. For instance, in spite of nearly 7 percent annualized GDP growth in the first quarter of 2000 (and 11.9 percent growth in industrial production) compared to the first quarter of 1999,

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[58] Yeryomin, Lev, 1999: "The development of the Russian electricity sector and its environmental efficiency," pp. 2–3.
[59] OECD, 1999: *Environmental Performance Reviews: Russian Federation*, p. 192.

Russia's electricity consumption only increased by 4.4 percent.[60] This may be due to a structural shift in the economy towards less energy-intensive sectors.

From gas back to coal?

In the last few years, Russia's gas monopoly, Gazprom, has been making concerted efforts to reduce the amount of gas consumed in Russia in order to increase its exports to more lucrative markets in Western Europe.[61] It has been pushing the electric power sector to reduce its heavy consumption of gas and shift to coal. UES is increasing its reliance on emissions-free nuclear and hydro power stations, but it is also currently planning to start using coal in plants that were originally designed for coal but refitted for gas in the 1980s.[62] If growth in the share of coal in Russia's power generation increases by more than increases in nuclear and hydro, carbon emissions will rise even faster than they would under current economic conditions. In September 2000, UES reported that in the past year the share of coal in the fuel mix of the power sector had grown from 27.3 percent to 32.3 percent, while the share of natural gas had dropped from 64.1 percent to 60.1 percent, a shift that is clearly unfavorable to efforts at reducing carbon emissions.[63]

The politics of emissions reduction in Russia

Aside from the technical problems involved in organizing a carbon trading system for the Russian power sector, potential conflicts of interest between the Russian government and the electricity industry could also derail the process. While UES has expressed an active interest in carbon trading, its vision of how this should be organized differs with those of some environmental experts. For example, several officials have suggested a national, state-run CO_2 trading system with the net proceeds invested in a pollution abatement fund that would finance still more CO_2 reduction projects. However, UES wants full ownership of credits generated as a result of emissions reductions, both past and future, and has opposed such a government-run system.

UES might, instead, be more inclined to go along with a private fund model, arguing, not without foundation, that the Russian state would prove unable to run a carbon fund. Meanwhile, UES alone possesses the necessary information on emissions and reduction potential, obtained through its recent internal carbon emissions audit. Thus, while the plan for carbon trading in Russia is still in an embryonic stage, a major conflict between

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[60] AK&M Industry Surveys: Power Production April 2000: *Power Sector Report*, No. 365, pp. 4–5 <www.securities.com>.

[61] At present, Gazprom receives $14/thousand cubic meters in the domestic market, while in Europe Russian gas fetches between $85 and $100. The incentive to divert gas from domestic consumption is thus clear.

[62] Kucherov, U.N. 2000. "The main problems and patterns in the development of the electric power sector in Russia," p. 18.

[63] News Base, September 14, 2000. "UES gets its act together," FSU/CE Power Report, p. 5.

the commercial interests of UES and the environmental and social interests of Russia could be on the horizon.

Part IV: Russian Far East Electricity and Carbon Trading: A Regional Investment Case Study

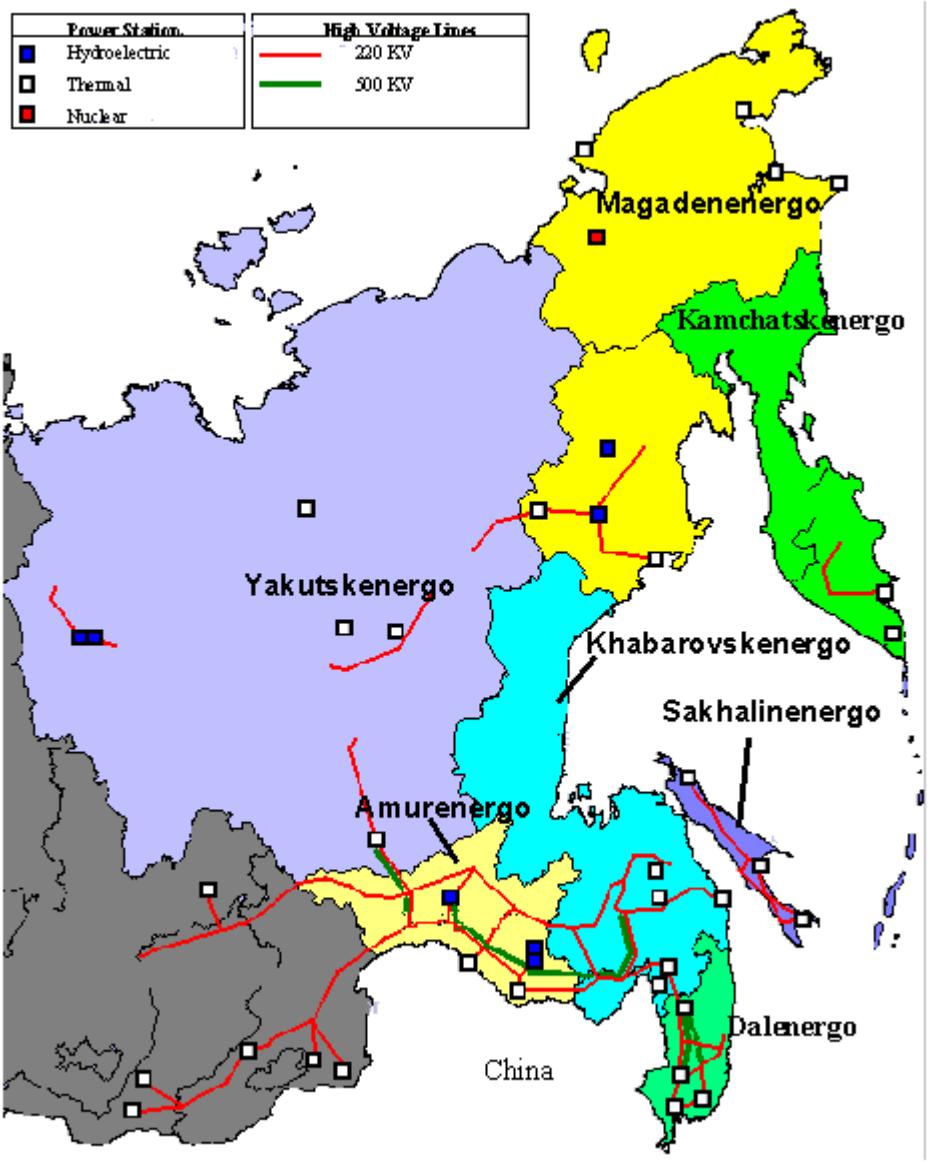
In the earlier sections of this report, we examined the Russian power sector and some of the obstacles and opportunities it might present for carbon reduction efforts and carbon trading. This section looks at how these broad patterns play out in one of the seven electricity regions of the Russian Federation: the Russian Far East (RFE). This region was chosen because its displays extremes of some of the patterns afflicting Russia's entire power sector, and because it has considerable room for improvement. It is also somewhat more amenable to analysis because it is one of the smallest of Russia's electricity regions, and recent data is available that provides useful understanding of its particular conditions. Finally, during the cold winter of 2000-2001 the region was struck with a severe energy crisis caused by the financial difficulties of its utilities and by failing generation equipment. The consequent political backlash mobilized the Russian government to deal with the problem. Since generation equipment upgrades via carbon abatement projects could help the region rid itself of persistent heating and electricity systems' breakdowns proposals for efforts to implement JI projects in the region are now more likely to find a receptive ear in Moscow. Thus, this section examines both the opportunities for investment in carbon abatement projects and the issues particular to this region that might concern potential investors.

The Russian Far East is a remote, thinly populated region of enormous size and vast natural resources (see Figure 8).[64] A closed off, militarized territory in Soviet times, during the 1990s the RFE saw a partial liberalization of its economy, which had been geared primarily towards natural resource extraction and the military industrial complex. It had hopes of integration with the neighboring Asian economies and a stable transition to the market economy. However, having lost most of its generous subsidies from Moscow, in1996 the RFE suffered an even more serious economic contraction than the rest of the country in the 1990s. Worse still, several of its territories have experienced and continue to experience periodic energy crises. The region's power sector has thus not fared well, even when compared to the less than impressive record for Russia as a whole. The Far Eastern subdivision of the Russian power sector consists of seven local electric utilities: Amurenergo, Dalenergo, Kamchatskenergo, Sakhalinenergo, Magadanenergo, Khabarovskenergo, and Yakutskenergo. In addition, three UES-owned power plants also operate in the region: two hydro plants — Zeiskaya (Amursk) and Kolimskaya (Magadan) — and one thermal plant, LuTEK (Primorye). The RFE's utilities are owned by UES, regional governments, and private investors. UES owns stakes of 34–64 percent in each of the seven Energos, which gives it at the very least veto power. UES's ownership share in local Energos is below 50 percent (aside from Magadanenergo, in

[64] The Russian Far East includes the Republic of Sakha (Yakutia), Primorskiy region, Khabarovsk region (including the Jewish Autonomous region), Amursk region, Kamchatka region (including the Koriak Autonomous region), Magadan region (including the Chukotka Autonomous region), and the Sakhalin region (including the Kurile islands).

which its stake is 64 percent). The rest of the ownership is divided between local government and the private sector, along with small foreign stakes (which do not exceed 17 percent). Two bodies are responsible for the operation of the electricity sector in the RFE: Vostokenergo, which administers all UES assets in the Far East, and the so-called Integrated Dispatch Control (ODU Vostoka), which supervises technical operations of the regional power system.

Figure 8: Electricity in the Russian Far East



Source: Integrated Dispatch Control, East. (translated from Russian) http://www.oduv.ru/cgi-bin/page?ok&schem (accessed 6/20/01)

Power generation in the Russian Far East differs from most of Russia in one key respect: coal is its dominant primary fuel. There are few hydro, gas, or nuclear-fired power stations in the region, nor are renewables in use. The substantial use of coal, as well as the poor state of the electricity generating facilities, makes the RFE's power stations some of the biggest carbon emitters in Russia.

Meanwhile, the large natural gas reserves of Sakhalin and Yakutia, as yet undeveloped, along with the enormous hydro potential of the region, provide possible alternatives to coal as primary sources of electric power generation. While the potential for carbon reduction projects may be great, the electricity industry faces some problems familiar in the rest of Russia as well, such as persistent non-payment of bills, below-cost tariffs, and sluggish demand growth.

Main Characteristics of the Electric Power Sector in the RFE

As in the rest of the country, power generation and power consumption in the RFE declined in the 1990s. From peaks of 45.3 GWh and 44.6 GWh in 1991, electricity production and consumption fell by as much as 25 percent as of 1998, then rose by 5 percent in 1999. Meanwhile, overall installed capacity has remained almost unchanged: in 1990 it was 11,300 MW; it had dropped to 11,221 MW in 1996, and was 11,330 MW in 1999.

Table 3: RFE Energos, generation type and utilization rates (1999)

	Total MW	MW by Type of Generation			Production	Peak Load	
		Thermal	Hydro	Nuclear	GWh		
						MW	Peak %
Amurskenergo including Zeiskaya hydro	1837	507	1330		5.648	1079	58.7
Dalenergo including LuTEK thermal	2633.6	2633.6			6.313	1780	67.6
Kamchatsk-energo	530.3	528.1	2.2		1.474	288	54.3
Magadanenergo including Kolymskaya hydro	1467.3	519.3	900	48	3.107	580	39.5
Sakhalinenergo	678	678			2.305	428	63.1
Khabarovskenergo	2188.1	2188.1			7.905	1405	64
Yakutskenergo	1996.5	1316.5	680		7.075	1456	72.9
RFE	**11330.8**	**8370.6**	**2911.7**	**48**	**36.08**		

Source: Data based on information provided by Integrated Dispatch Control, Far East (ODU Vostoka), 1999, Annual Report.

The electric power system can further be characterized by four features: it is a fragmented power system; it is a small system, dominated by coal-fired thermal plants; its generating facilities are deteriorating; and its transmission system is in desperate need of improvement**.**

A fragmented power system

The electric power system of the RFE can be divided into two parts: the South, which has several integrated and interconnected systems, and the rest of the region, which contains a multitude of isolated networks of varying sizes. Khabarovskenergo, Dalenergo, and Amurenergo, along with Zeiskaya and LuTEK plants, as well as the South Yakutia power system, are all part of the so-called Eastern United Power Grid (OES Vostoka). They are connected by transmission lines of 220–500kV, have unified operations and integrated load, and are all participants in the national grid (FOREM). Of the region's total power capacity, 63 percent (7146.7 MW) is part of the OES Vostoka. The rest of Yakutskenergo, Magadanenergo, Kamchatskenergo, and Sakhalinenergo, as well as the Kalimskaya hydro plant, are isolated from the national grid.

A small system dominated by thermal plants

The RFE is geographically enormous, but its population is small and scattered. Thus, it is not surprising that it has the second smallest generating capacity of Russia's seven electricity zones. As of January 1, 2000, the RFE had a total installed capacity of 11,330.8 MW. Of these, 7487.4 MW belonged to the seven regional Energos, 3697.4 MW was controlled by UES, and 146.4 MW was operated by other entities. Thermal power generation accounts for about 74 percent of the region's generating capacity. There are nearly 300 thermal power stations in the region, although only 30 are larger than 20 MW, and these have a total capacity of 8370.6 MW. Three hydro plants contribute the other 25 percent. The only nuclear power station in the region — Bylybinskaya NPP — is integrated into the system of Magadanenergo and contributes about 48 MW (0.4 percent) to the regional power system.[65] In addition, Kamchatskenergo and Vostokenergo each have a wind-powered generator with a capacity of 0.5 MW each, while a very small geothermal plant is also operated by Kamchatskenergo.

Deteriorating generating facilities

Not surprisingly, the state of power generating facilities in the region is poor. The Russian Far East is home to some of the oldest electrical plants in Russia; for example, some of the Dalenergo facilities came on line in the 1930s. At the end of 1999, at least 857 MW (10.5 percent) of the region's thermal generating facilities had long passed their

[65] Integrated Dispatch Control, Far East (ODU Vostoka), 1999:, part 1, p .1.

retirement age, and over 60 percent are due for retirement in the next 10 years. As a result, the efficiency of the local coal plants is low, even by Russia's unspectacular standards. For example, 1998 fuel consumption and power production figures at Amurenergo suggest average efficiency rates of just 21.8 percent.[66] Khabarovskenergo presently shows a better average thermal efficiency (30 percent), but some of its smaller plants, such as Nikolayevskaya and Maiskaya, are currently at only 14–19 percent efficiency.[67] Other regional utilities, particularly Yakutskenergo, Dalenergo, and Sakhalinenergo, show similarly low efficiency rates, and could also benefit substantially from generation-equipment upgrades for their coal-burning plants.

A transmissions system in need of improvement

Electricity transmission in the RFE is arguably in as bad a shape as its generating facilities. In December 1999, transmission losses throughout the region were as high as 17.3 percent (up from 14.8 percent in 1997). Losses in the grid by Amurenergo were a staggering 25.8 percent.[68] Investment in transmission equipment could therefore be just as effective in increasing the efficiency of the regional power system and in creating carbon credits. Large-scale transmission projects, such as the restoration of connections to the Siberian grid, and further establishment of links with Chinese, Japanese, and Korean power systems,[69] could also increase potential markets for RFE's power and thereby increase the region's attractiveness to electricity investors. The prospect of accessing the lucrative electricity markets of RFE's neighbors – particularly China and Japan – is already attracting the attention of Japanese and Russian companies.

Better interconnections with neighboring power grids could also improve the efficiency of the region's system. Instead of building extra capacity to meet demand during peak periods (especially during the winter months), the RFE utilities could import power from China or Siberia. Another option would be to build gas-fired or hydro capacity targeted at China's Northeast. This "clean power" might actually earn credits through the Clean Development Mechanism (CDM), by supplanting some of China's existing inefficient and carbon intensive coal-burning generators.

Primary Fuels: From Coal to Gas

Coal has been by far the dominant fuel used for power generation in the Russian Far East, at 71 percent, followed by natural gas (16 percent) and oil-based fuels, including diesel and gasoline (13 percent) (as shown in Table 4). The most significant change in regional fuel consumption during the 1990s has been a reduction in the amount of (mostly

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[66] Expert RA, 1999: Russia's Electricity Sector, pp. 134–139.
[67] Calculations made on the basis of figures provided by Khabarovskenergo at <khabenergo.kht.ru/rus/finance/pokaz.html>. (last accessed: 04/27/01)
[68] IDC Far East, 1999: *Annual Report*, table 5.2.1.
[69] The first such power bridge began operation in 1992 when the Blagoveshsk (Amurenergo)–Haihe line began operations.

imported) fuel oil used — from 21.6 percent in 1990 to 12.5 percent in 1996 — and a concurrent increase in the use of coal (from 67.5 percent to 71 percent) and natural gas (from 10.9 percent to 16.3 percent).[70] Nevertheless, to this day the RFE remains an overall importer of primary fuel, purchasing approximately 25 million metric tons of fuel equivalent[71]a year from Siberia and China.

Table 4. RFE power sector fuel consumption, 1995–97

(Thousand tons of coal equivalent)

	Coal (Ktons)	Gas	Fuel oil	Total
1995	9641.4, 72%	2124.5, 16%	1586.3, 12%	13, 352.2
1996	9910.3, 72%	2286.0, 17%	1519.3, 11%	13, 715.6
1997	9531.8, 69%	2269.6, 16%	2040.1, 15%	13,823.50

Source: Calculations based on data provided at NEDO, 1999(d):): "A Study of CO_2 reduction at coal-fired electric power plants in Russia," p.140

The regional coal-burning power stations use at least a dozen different types of coal. Most comes from local mines at places such as Riachinsk, Urgalsk, and Azeisk, although some is imported from Siberia and even from China. The price of the coal varies depending both on its origin (quality) and destination (transport costs). Unfortunately, there is little reliable data available on RFE's coal. The markets for it are not transparent and its distribution is grossly inefficient. Non-payments crises have repeatedly paralyzed the industry (most glaringly in the Primorye territory), causing frequent energy shortages throughout the region. Meanwhile, although the region's recoverable coal reserves are considerable (30 billion tons in 1992), its "effective reserves" (those within acceptable economic and quality parameters) are only about 0.6 billion tons.[72] Hence, a great deal of investment would have to be made in the next few years in RFE's coal industry if coal-fired power generation is to remain economically viable.

In spite of large gas reserves, the use of natural gas for power generation is currently limited to four power plants. Two are located in Yakutsk and use local gas. One of the three large plants that power Sakhalin also use natural gas found on the island, while one of the Khabarovskenergo plants run off Sakhalin gas delivered via an antiquated pipeline. However, the potential for greater use of this relatively clean fuel is enormous since the region is home to around 2.3 trillion cubic meters (81.23 trillion cubic feet) of proven natural gas reserves[73]. At present the most promising area is Sakhalin, where large-scale multinational hydrocarbon development is well underway. (The Sakhalin II consortium

[70] NEDO, 1999 (d) "A study of CO_2 reduction at coal-fired electric power plants in Russia" p. 107.
[71] This is a Russian fuel measure. It is roughly equal to "coal equivalent" used in the West.
[72] Kalashnikov, Victor, 1997: "Electric Power Industry of the Russian Far East: Status and Prerequisites for Cooperation with Northeast Asia," p.3-4
[73] Kalashnikov, Victor, 1997, "Electric Power Industry of the Russian Far East: Status and Prerequisites for Cooperation with Northeast Asia," pg. 5.

began oil production in July 1999, while the first gas is expected to become available by 2006.) Yakutia's enormous gas reserves are still waiting to be tapped, while Khabarovsk and Primorye can expect to receive a substantial amount of gas if large export pipelines to China (such as the one currently under consideration by the Sakhalin I consortium) are ever realized.

Electricity Markets

Along with the rest of Russia's electricity sector, in the latter part of 1999 the utilities of the RFE began to increase the collection of debts in general, and of cash payments in particular. The regional power companies also managed to improve their performance relative to other regions. Thus, in the first quarter of 2000, the utilities in the region had managed to procure 72 percent of total payments owed to them, receiving 36 percent of the total owed in cash --the worst performance out of all of Russia's electricity regions — but in the second quarter these numbers had jumped to 117 percent and 71 percent respectively. However, while Kamchatskenergo was one of Russia's best performers in debt collection for the second quarter (118 percent of total debt collected in cash), Yakutskenergo and Dalenergo remain some of the worst. In sum, although the power sector of the RFE has seen its previously abysmal financial performance pick up somewhat in 2000, it still remains one of the least hospitable areas of the Russian power industry's unfriendly investment environment.[74] In fact, poor financial performance of the regional utilities and their consequent inability to pay their fuel suppliers was one of the fundamental causes of the paralyzing energy crisis that struck parts of the RFE during the winter of 2000-2001.

Power sector carbon emissions and reduction potential

Before any assessment can be made of the potential of RFE's power sector to participate in Joint Implementation projects, it is necessary to come up with some reasonably accurate estimates of the sector's total carbon emissions. However, the poor state of statistics on fuel consumption by power stations makes this a difficult task. There are at least 12 different types of local coal used in the region's power generation, each with its own carbon content and heat rates; they can range from the relatively low heat rates and high carbon contents of Raichinsky coal (3,070 Kcal/kg, 60 percent carbon) to the higher quality Urgalsk coal (4,448 Kcal/kg, 45.6 percent carbon).[75] If we assume standard heat rates and carbon content for coal, gas, and heating oil,[76] and that for every ton of carbon burned, 3.7 tons of CO_2 is emitted, the total CO_2 emissions for power plants of the region for 1995–97 can be estimated as shown in Table 5.

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[74] UES; <www.rao-ees.ru/ru/energo_sbit/> (last accessed: 04/27/01)

[75] NEDO, 1999 (e) "Modernization of power plants in Khabarovsk," p. 106; NEDO, 1999 (a) "Study of the conversion of coal-fired power plants to natural gas in Amursk, Russia," p. 5.5.

[76] The low heat value (LHV) of gas is 8,300 Kcal/m^3 (kilocalories per cubic meter) with a carbon content of 15.7 kgC/GJ (kilograms of carbon per gigajoule). The LHV of heating oil is 9,800 Kcal/kg with 83.96 percent carbon content. Coal has an LHV of 7000 Mcal/t (megacalories per ton) with a carbon content of 24 kgC/GJ.

Table 5. Estimated CO_2 emissions from RFE power plants, 1995–96 (million tons of CO_2)

	CO_2 from Coal	CO_2 from Gas	CO_2 from Heating Oil	Total CO_2
1995	25.1	3.6	6.3	35.04
1996	25.8	3.9	4.7	34.4
1997	24.8	3.9	4.5	33.2

Source: Calculations based on data provided at NEDO, 1999(d):): "A Study of CO_2 reduction at coal-fired electric power plants in Russia," p.140

Of Russia's total CO_2 emissions produced through power generation for 1997 — 510 million tons — the RFE is responsible for 33.5 million, or 6.5 percent. Given the thermal capacity of 8243 MW in the RFE in 1997, the CO_2 emissions per MW of thermal power in the region can be estimated at 4026 tons/MW/year. This makes the RFE's power sector the second biggest polluter in Russia in terms of tons/MW/year (after Siberia). Table 6 compares this figure to other Russian regions.

Table 6. Power generation and CO_2 emissions, Russia's seven electricity regions, 1997

	Central	North-west	Volga	South	Urals	Siberia	RFE	Total
Capacity GW	33.456	10.066	13.300	7.984	37.361	21.547	8.243	131.960
Generation GWh	138,254	27,044	48,294	34,936	173,637	73,790	25,097	521,052
Total CO_2 Mtons	119	33	50	28	146	102	34	510
TCO_2/MW	3559.4	3,227.3	3719.4	3556	3902.9	4730	4026	3862.9
TCO_2/MWh	0.861	1.2101	1.024	0.8127	0.8398	1.381	1.322	0.9783

Source: Calculations based on data provided at NEDO, 1999(d): "A Study of CO_2 reduction at coal-fired electric power plants in Russia," p.140.

Thus, improving the efficiency of power generation in the RFE through generation equipment upgrades, fuel switching and other means have the potential to earn a significant amount of carbon credits. NEDO estimates that the cost of such upgrades could be rather modest - between $4 and $20 per ton of CO_2. These estimates compare

very favorably to reduction cost figures in other OECD countries that at the margin could range from between $30-$150 per ton.[77]

Unfortunately, cost estimates of this sort are highly unreliable, since they depend on factors that are very hard to predict such as the future ruble/dollar exchange rate, electricity rates (and rates of debt collection), volatility of power demand, and the condition of transmission facilities. A change in any of them — a likely prospect in a country like Russia — will have a serious impact on the final cost of reducing carbon emissions (see Appendix I) Nevertheless, the key lesson that can be drawn from these figures is that a carbon emissions market even with a relatively low price for a ton of CO_2 (in the range of $5–10) could finance a portion of the RFE's infrastructural upgrading costs.

Potential Carbon Abatement Projects in the Power Sector of the RFE

The information presented in the case study suggests five preliminary conclusions about the potential of carbon emissions reductions in the RFE and the trading of credits generated as a result of those reductions.

Opportunities to reduce CO_2 emissions could be significant

Most of the region's large coal-burning plants are currently showing efficiencies on average of 28–29 percent, with some as low as 18 percent, which gives plenty of room for improvement. RFE's power sector is also the second most carbon-intensive in Russia after Siberia (4,026 tons of CO2/MW/year; 1.32 tons/MWh) (see Table 6). The costs of coal plant upgrades to combined-cycle technology in the region seem to be comparatively attractive.

The RFE is home to enormous undeveloped gas reserves. Current large-scale exploration and development of hydrocarbon reserves off the coast of Sakhalin island, as well as plans to develop Yakutia's enormous reserves, could lead to more extensive use of natural gas in the region in the near future (although large-scale gas development is still in the planning stages, and it is not clear which parts of the region will have access to the new gas). The region's gas and unused hydro potential could provide alternatives to coal-fired power and thus are possibilities for significant carbon emissions reduction. These opportunities will only be tapped if a market for CO_2 emission reduction credits emerges. If this occurs, these abatement opportunities will begin to look very attractive to Russia (if CO_2 credit prices are within a $5-20 per ton range).

[77] Actual figures will depend on the amount of CO_2 reductions targeted, the extent emission reduction trading is allowed, and the cost of emission reduction options, all of which are and will continue to be uncertain and in flux.

The local incentive to participate should be strong

With the RFE's on-going energy crisis, caused by shortages of primary fuel (gas, coal, oil), it is in dire need of energy savings and alternative fuel development, and thus has an incentive to participate in programs to shift to gas and increase efficiency if the prices for these investments plus the CO_2 credits are competitive. The RFE currently imports about 35 percent of its needs each year — 25 million tce of primary fuel — over long distances, and it has the highest energy prices in Russia. Meanwhile, declining local coal production and lack of investment in the local power sector threaten to perpetuate the region's constant energy shortages and its resulting economic backwardness. Energy efficiency projects and reorientation of the region's fuel mix to gas is therefore advantageous not just from an environmental and entrepreneurial but also from a developmental perspective. It thus warrants the involvement of international development agencies.

V. Conclusion

Russia's electric power sector clearly has the potential to provide substantial opportunities for investment in energy efficiency and CO_2 emissions reduction. Whether in the form of plant-specific investments aimed at maximizing technological efficiency on the basis of Joint Implementation, or through economic reforms to increase the system's fuel efficiency conducted on the basis of an international emissions trading regime, the Russian power sector provides a great deal of scope for low-cost emissions abatement projects. Such projects could benefit the climate and an internationally sanctioned emissions trading system, bring investors positive returns, and help Russia construct an efficient and reliable electricity system to secure steady economic development in the future.

However, the Russian power sector suffers from numerous structural, regulatory, and financial problems that will not be easily surmounted. Poor market conditions and a heavily politicized regulatory regime are two among a multitude of problems plaguing this industry. If the electricity sector is to attract private investors for, among other things, carbon reduction projects, the current deficiencies in the sector and the market must be corrected.

There are further problems on the "demand side," that is, from the perspective of those who hope to purchase carbon credits created by the Russian power sector. A credible carbon trading regime requires a reliable monitoring and compliance system. At present Russia's environmental regulatory system in general, and environmental regulation of the power sector in particular, cannot guarantee the authenticity and sustainability of carbon reductions made by the power sector. Environmental legislation for and regulation of the power sector needs to be improved. This could be done on the basis of the old regulatory system, but the legal foundations need to be clarified and enforcement mechanisms strengthened. The alternative would be the creation of an entirely new institutional system to facilitate carbon trading and JI projects, a task that would be both costly and difficult to realize.

Finally, Russia's transitional economy makes it hard to estimate future carbon emissions and reduction costs, among other things. The volatile politics of the Russian energy sector, including the uncertainty of future availability of gas and a possible struggle between industry and government for control over emissions markets, further increase this uncertainty and reduce the attractiveness of Russia and its electricity sector to potential investors in carbon abatement projects.

The creation of a credible carbon trading system in Russia will be no easy task. Many of the fundamental problems that currently stand in the way of such a system are beyond the control of outsiders. Ultimately, it is up to Russia's government and industry to complete the economic, institutional, and political reforms (including those aimed at electricity

restructuring) that were started ten years ago, and to set up a more reliable and trustworthy regime for monitoring the country's environmental performance.

If the Russian electricity sector is to participate effectively in a carbon trading regime, three specific actions must be pursued:

a) Pace the reforms, do not overreach: Given the scope and magnitude of the international barriers and challenges that will have to be overcome, Russia is unlikely to be able to manage a full-blown carbon trading regime within the next five years, at least in a way that would be credible to the European countries and the United States. Developing the appropriate institutions, the human capital and the appropriate legal structure are critical steps and none can or will happen quickly. Attempts to accelerate the pace of change are likely to stimulate opposition within Russia, which may in fact slow down the process. Efforts to sequence reforms, with each reform building a foundation for the next has a much greater probability of gaining the confidence of investors and the Russia public.

b) Improve the effectiveness of the regulatory system: Reforming the Russian system of electric regulation is an essential step, not only to gaining investor confidence, but also to any effort to restructure the electricity sector. Such reforms should have two key ingredients: 1) the transfer of more authority and responsibility to the Federal Energy Commission and away from the Regional Energy Commission, and 2) the introduction of greater transparency into the regulatory process.

c) Implement an effective system of verification and monitoring: Without strong and transparent verification and monitoring capabilities, an emission trading or reduction program will lack international credibility. Russian officials must work with international officials to develop these capabilities and to commit the resources, both financial and human, to implement them.

While most of the essential reforms can only be made by Russia and foreign intervention in these areas may be resented, there are two actions that the United States and other OECD countries might consider.

1) Training: Russian regulators and their staffs at both the federal and regional level do not have a solid understanding of the fundamental concepts of emission trading, environmental reforms, or carbon rights, nor are they well-versed in the science of global

climate change. These issues have not been on their proverbial radar screen. Hence, Western assistance to educate and train regulators, both economic and environmental, as well as federal and regional public officials, could be extremely valuable.

2) Pilot Projects: Emission trading programs, especially those involving carbon dioxide and greenhouse gases, represent a significant departure from the existing Russian environmental policies. Officials are not familiar with these programs and lack of familiarity often breeds distrust. The best way to overcome this barrier is to demonstrate their operation on a small-scale, where successes can be transferred to other communities and regions. Hence, we urge international organizations to design, develop, and fund pilot carbon abatement and trading programs, preferably in concert with UES officials so that participants have an opportunity to “learn by doing”.

Appendix I: Calculating the Costs of CO_2 Reductions in Russia's Power Sector

Figures showing the costs of CO_2 reduction at Russian power plants provided by various Japanese companies are derived using the following methodology. A baseline for yearly emissions at the target plant is established. From this baseline the projected yearly emissions of the plant using new generation technology (and/or fuel) are subtracted. This figure is then multiplied by the number of years the modernized plant is expected to operate (usually 25-30 years), thus yielding the total expected reductions in tons of CO_2. To ascertain the cost of reductions the total figure for expected CO_2 reductions is then divided by the total fixed cost of the project.

Unfortunately, this methodology is extremely broad, and while all the calculations by Japanese investigators on behalf of the New Energy and Industrial Technology Development Organization (NEDO) were made within its parameters, their individual assessments sometimes differed in approach. The feasibility study for the replacement of the Khabarovsk Thermal Power Plants No.1 (TPP 1), used current emissions at current average loading rates (42.2%) as the baseline, while assuming emissions of the new plant – TPP 4 - with larger capacity and assumed average loads of up to 70% as the "new emissions."[78] Meanwhile, the feasibility study for the upgrading of the Konokovo power plant near Moscow, defines the baseline as "the amount of CO_2 emitted when the existing power plant is so operated as to supply the same amount of electricity and heat as the new power plant would generated in the future."[79] Clearly, the second method would produce higher levels of emissions reduction than the first.

Even if the current methodology were harmonized between the various Japanese assessments, the numbers it produces are hampered by the large uncertainties surrounding these projects. Future fuel costs, exchange rates, CO_2 credit values and electricity prices can not be predicted with any confidence over the next five years, let alone thirty. Furthermore, the assessments use excessively low discount rates, thus overestimating the net present value of revenue flows from the sale of CO_2 credits.

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[78] NEDO, 1999 (e): "Modernization of power plants in Khabarovsk," p.15

[79] NEDO, 1999 (b): "Feasibility Study Report on Konakovo Combined Cycle Power Project in Russia," p. xv

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