Electricity Scenarios in Russia – GHG Baseline Formation and Potential for Joint Implementation*

By Paul Steenhof, *Independent Consultant*

The author acknowledges this research has benefited from the generous support provided by Procter & Gamble (Canada), the Global Environmental Change & Human Security Project, Carleton University and Canada's Natural Science and Engineering Research Council.

Introduction

This article investigates the current and projected state of the Russian electricity sector and the need for international cooperation to reduce carbon dioxide (CO_2) emissions. Russia's electricity sector is characterized by highly inefficient generation capacity and transmission lines, demand that undertook a rapid decline after the collapse of the Soviet state, and emerging pressures to switch from natural gas to coal as a primary fuel. With increased economic growth since 1999 demand for electricity has once again begun to grow. However, since 1990, there has been virtually no capital investment or maintenance of the sector. Thus, increased demand has and will rely upon inadequate transmission lines and inefficient and outdated generation technology unless significant investment is made. The Russian government suggests that 40-60 billion USD will be required within the next 10 to 15 years for this, enormous for an economy in transition and with a fragile capital structure.

Presented is the construction of a quantitative electricity demand, supply and emission scenario to the year 2020. The presentation and application of this framework shows that emissions of CO_2 rise to approximately 120 percent of 1990 levels by the year 2010, the mid point of the first reporting period of the Kyoto Protocol. By 2020 it will far exceed targets stipulated under the Kyoto Protocol assuming a switch to coal from natural gas and minimal investment in generation efficiency and transmission infrastructure. This emphasizes the need for international cooperation to allow Russia to meet the investment requirements in the sector and avoid global environmental change. Here a potential significant source for investment comes from the Joint Implementation (JI) mechanism. JI can allow countries and multinational corporations to meet their own domestic GHG targets while undertaking initiatives in Russia at a lower relative marginal investment cost. Estimates that the financial benefits of carbon trading for Russia, of which JI represents a significant proportion, could be as high as (US) 25 billion in the period from 2008-2012.

There are numerous investment opportunities in both the electricity supply and demand sectors for JI projects. This is demonstrated through a description of the current state of Russia's electricity sector, and the projections into the future in terms of electricity demand, investment requirements and CO_2 emissions. In this context the article presents a discussion on how JI works in a general context. A step-by-step process is presented on the implementation of JI projects. Here, the majority of attention is given to the importance and relevance of baseline formation and calculation as this can give an indication to the investor of the financial return per unit of carbon sold on future carbon markets.

The report is written in context to potential users of JI. It is meant to act as an introduction to potential investors and developers who may be interested in investigating how JI can increase the profit margin of development projects or how it can be used as an investment source in itself.

Russia's Electricity Sector and Emissions of CO_2

IThe following sections discuss the evolution of Russia's electricity sector since 1990,

* For "Russia Power Conference", Moscow, March 2004

with particular attention given to the processes that influence the emissions of CO_2. We use this to explain and create a baseline of electricity demand and supply by region in Russia untill the year 2020, and construct a baseline of CO_2 emissions from this.

Russia's electricity sector

The Russian electrical infrastructure was largely built during the 1960's and 1970's, although there is significant generation capacity which exists even from as early as 1940 . During this time there was a rapid increase in demand for electricity due to economic expansion and government led initiatives. An impressive transmission network crisscrossed the country, led by the Stalinist expectations of such infrastructure investment promoting and strengthening the Soviet economy. In fact, this points out a unique feature of the system: its peak demand is greatly reduced due to the fact that the transmission network crosses 5 time zones. Thus users at one end may be sleeping while users on the other are at the peak of their power load curve.

By 1990, total capacity of the Russian electricity sector was approaching 230 GW, impressive by world standards as it placed it second only to the United States. However, in 1990 came the collapse of the Soviet economy, and the subsequent drop in demand from the sharp deceleration in the output from heavy and light industry. As such, electricity demand dropped by nearly 25 percent between 1990 and 1998, leading to capacity that was being utilized at less than 20 percent of the total available. Although electricity demand has increased during the last number of years, the Russian electricity sector is plagued by low utilization of capacity, which leads to low energy efficiency, a factor which is compounded by capacity that is old and in need of replacement. This situation led to a sharp drop in revenues for electricity generators, sharp falls in capital investment, and a massive crisis of broken contracts and unpaid bills emerged . In the 1980's approximately 6 GW of electric capacity was being added in Russia per annum. By the early 1990's this had fallen to 1 GW per year, with virtually no investment being put into maintenance of existing capital or infrastructure. Meanwhile, a series of non-payments by both electricity customers and generators, alongside ill placed tariffs and subsidies, has jeopardized the financial wellbeing of the sector. This is a significant factor in the industry as nonpayment and indebtedness have resulted in virtually no outlay towards investment or maintenance of existing capacity.

Since 1990, overall economic activity in Russia as measured by GDP decreased by nearly 37 percent, and industrial output by nearly 40 percent. Comparing the decrease in economic output, and the lower relative decrease in energy demand shows that the Russian economy experienced a remarkable increase in energy intensification since 1990 with this rising upwards of 8 percent per annum between 1990 and 1993. This helps to highlight an economy characterized by low efficiency. Industrial infrastructure has become outdated, and the electricity sector itself is facing generation capacity that is quickly approaching its typical lifespan. Seeing the room in the overall economy and the electricity sector for energy efficiency improvements, estimates are that energy demand may be cut in half by the year 2020 compared to a baseline scenario of no measures being undertaken. The Russian Energy Strategy, for example, suggests that 40-45 percent of current energy use can be saved through energy efficiency increases. They suggest that two thirds of these savings can be made in the industrial sector of the economy and one third can be saved from energy efficiency improvements in the residential sector. These figures point to the massive area of energy efficiency projects that exist, and the potential lucrative market for related JI projects in the future.

Within the electricity sector itself there is also much need for future investment to bring the sector to what may be considered standard energy efficiency. The International Energy Agency (2002) predicts that by 2020 between 147 and 217 billion (USD) will have to be invested into the electricity supply sector. The greatest proportion of this, at over 53 percent, will be investment in the energy inefficient thermal generating side of the industry. This comprises mainly large coal based thermal generators that were constructed during the 1960's and 1970's. Russia currently has an estimate 340 of such coal fired plants. Table 1 presents an over-

Table 1. **Investment in Russia's Electricity Sector till 2020**

Category	2001-2005	2006-2010	2011-2015	2016-2020	Total
Electricity	18-19	25-42	44-69	61-87	147-217
Nuclear	.4-5	.6-9	.6-11	.9-9	23-34
Hydro	3.00	5.00	.5-6	.6-8	19-21
Thermal	7.00	.8-19	.24-38	38-54	75-118
Transmission network	4.00	.6-9	.9-14	.12-17	30-43

Source: Expert magazine (No. 27-28 of 21.07.2003) view of the expected investments that will need to take place in the electricity sector between now and the year 2020.

Another significant component of Russia's electricity sector that requires significant investment is the transmission network, as indicated above. Currently transmission losses in Russia are as high as 15 percent. This is because much of the transmission lines were constructed in the 1950's and 1960's, with little maintenance occurring over the course of the last 10 years. This is another area for possible JI investments as reducing line loss will reduce the amount of electricity generation required, subsequently resulting in reducted emissions of CO_2.

Since 1999, Russia has reversed many of the trends seen in the rest of the 1990's, experiencing rapid economic growth, specifically in 1999 through out till 2001. In 1999 Russian GDP grew by an estimated 5.5 percent, in 2000 by a staggering 8.3 percent and in 2001 by 5.5 percent. In 2002 Russia's economy grew by 4.5 percent, and between 2003 and 2005 is expected to maintain growth rates of approximately 4 percent per year.

Electricity demand and supply by regional electricity systems

The Russia Energy Survey 2002 provides information of electricity demand by seven regional electricity systems in Russia and by generation type and primary fuel source. The seven considered are the Ural, Siberia, Central, Volga, Northwest, North Caucasas, and Far East systems. The generation types considered are hydro, nuclear, thermal and combustible renewables. The fuel sources considered for thermal electricity generation are natural gas, coal and coal products, and petroleum products. This information for the above variables varies by year between 1990 and 2020.

Constructing a baseline for CO_2 emissions

Using the above information in conjunction to data provided in other sources, a baseline consists of electricity demand, supply and CO_2 emissions. The steps undertaken for the construction of these emissions is explained in the paragraphs below.

Electricity demand

Unified Energy System, which generates more than seventy percent of Russia's power, said that electricity use is likely to grow at the lowest rate in four years during 2002, as the country's economic expansion slows down. Although economic growth is expected to average 4.1 percent per annum through out until 2005, and slowing down from that point towards 2010, electricity demand will likely be below this as the economy shifts to lesser energy intensive service based industries. As a result in 2004 it is expected to grow by less than 2 percent per annum, a steep decline from what was seen between 1999 and 2001 when Russia experienced an economic boom.

The Cobb-Douglas function is used to calculate electricity demand projections by region in Russia. This equation considers changes in GDP, income and price elasticity's and average energy efficiency intensity (AEEI). All of these variables are of extreme importance in governing changes in electricity supply. Russia is expected to increase the price of electricity over the next few years, a factor that might spur customers to conserve energy and also bring needed investment into the sector. On the flip side, income is also expected to increase with Presidents Putin's initiatives to ensure economic growth and gain, leading to an upward impetus on electricity demand. Meanwhile, average energy efficiency intensities, which measures the average energy intensity of the general economy, are expected to decrease under wide spread initiatives to invest in this area. The demand function can be applied to the economy as a whole or by individual economic sector. It is formulized as:

$$E_{2005} = [(GDP_{2005}/GDP_{2000})^{a} * (P_{2005}/P_{2000})^{B} * (1-y)^{2005-2000}] * E_{2000}, \quad (1)$$

where E_t is electricity consumption calculated, GDP_t – gross domestic production, P_t – electricity price, ^{a} – income elasticity of electricity demand, ^{B} – price elasticity of electricity demand, and y – the change in AEEI. In the example equation above, the years 2000 and 2005 are used to compute electricity demand in the year 2005.

There are ranges of assumptions that are made when using the above equation for projecting electricity demand. Temporally, Russia's economy experiences relatively moderate growth rates in the short term (i.e. to 2010) and lower growth thereafter to 2020. Russia since 1990 has become more energy intensive, as discussed in earlier sections. This means that for unit of GDP produced, more electricity is demanded. It is assumed this trend will not continue in the future, but to be conservative the baseline estimates made in this paper assume that energy efficiencies only improve by less than one percent per year till 2020. Meanwhile, price elasticity is held at –0.2 over the entire period. This was a common value found in the literature. Prices are increased at a conservative rate of 5 percent per annum. In 2003 Russia witnessed a nearly 20 percent increase in the price of electricity, while in 2000 it increased wholesale electricity prices by almost 35 percent.

Electricity supply

In calculating electricity supply we assume the proportion of primary energy sources (i.e. thermal, hydro, and nuclear) used by the Russian Energy Survey 2002. We vary this by year from 1990 as has been observed and given in the above source. Projections are based on qualitatively statements made in the above survey and primary fuel proportions change as suggested. Natural gas consumption for the purposes of electricity generation decreases in general at the expense of increases of coal. Nuclear increases in the Northwest of Russia, while hydroelectric generated electricity increases in the Far East. The Russian government has made hydroelectric generation a priority in the country's Far East. In June 2003, for example, a representative from the Unified Energy System of Russia (UES), released information that the company plans to invest $14 billion in the development of Russia's hydroelectric sector, particularly in Siberia and the Far East .

The steps to calculate changes in electricity supply are formulized as follows:

$$Elec^{GW} = ([(Elec^{T} * Elec^{P} * Elec^{PSF} * Gen^{CS})/8760]/Gen^{CF}) * 1000, \quad (2)$$

where $Elec^{GW}$ is the new required electricity capacity calculated (GW), $Elec^{T}$ — the total generation of electricity (TWh), $Elec^{P}$ — the proportion of electricity generated by electricity source (i.e. hydro, nuclear, thermal, etc), $Elec^{PSF}$ — the proportion of primary fuel used for electricity generation (only applicable in the case of thermal electricity), Gen^{CS} — the proportion of total capacity by each size considered (we consider units averaging >1,000, 500-1,000, 250-500, 100-250, and <100 MW), 8,760 the number of hours per year, Gen^{CF} — the capacity factor of generation. Gen^{CS} is based both on a survey of present day characteristics of the Russia's electrical system, as given in a survey of recent literature on the subject .

Primary fuel demand

Primary fuel demand is constructed as a function of the percentage of primary energy type categorized first into hydro, nuclear, and thermal in the base year of the analysis. Thermal sources are then further desegregated into coal, natural gas, and oil. These categorizations are based upon examination of the type of electricity consumed in Russia by primary fuel source as given in the Russia's Energy Survey and by associated projections made to the year 2020. This was specifically accomplished by converting the energy supply requirements into physical energy units for coal, natural gas and diesel. The entire process is formalized using the following equation:

$$Elec^{PS} \text{ x } Cap^{P}/Eff * EC, \quad (3)$$

where $Elec^{PS}$ represents the amount of electricity demand by source, Cap^{P} — the proportion of electricity generated by capacity size, **Eff** — the capacity size specific energy efficiency, and **EC** — being the energy constant that converts from energy to physical units.

Calculation of changes in CO_2 emissions

In this model emissions of CO_2 are calculated. These emissions are calculated using the standard guidelines as given by the Intergovernmental Panel on Climate Change . Emissions of CO_2 are calculated as simply a product of the amount of primary energy consumed (i.e. coal, natural gas, or diesel), and the emission coefficient for that particular type of fuel. In terms of coal, different grades vary according to the amount of carbon they contain. Anthracite, the hardest coal, chemically has the highest proportion of carbon in its structure, and therefore its emission coefficient for CO_2 is slightly higher than that of other grades. Currently the majority of coal combusted for electricity generation in Russia is of the bituminous grade. The calculation of CO_2 from the combustion of primary fuel is formalized as follows:

$$CO_2^{Emit} = Fuel * Emission^{F}, \quad (4)$$

where CO_2^{Emit} is the amount of carbon dioxide emissions calculated, **Fuel** is the amount of fuel combusted, and $Emission^{F}$ is the emission factor for that particular fuel.

Changes in electricity generated

Using the above method changes in electricity demand are calculated to the year 2020 by six electricity systems in Russia. The 'Other' electricity system is not considered due to lack of sufficient data. The trends in electricity generation are presented in the Fig. 1 in total TWh of electricity.

As shown in Fig.1, total electricity demand decreased from just less than 1,100 TWh in 1990 to a low of 827 TWh in 1998. This represents a decrease of approximately 25 percent, and reflects the general decrease in economic activity that resulted from the collapse of the Soviet Union in the early 1990's. Total electricity generation is not expected to reach levels seen in 1990 to about 2010. Electricity demand growth is expected to be strongest between 2000 and 2005 due to stronger economic growth over this period. Economic growth is then expected to fall to around 3 percent per annum between 2005 and 2010, and around 2.75 percent per annum thereafter.

CO_2 emissions from electricity generation

Using the above equations changes in CO_2 emissions are calculated by region for Russia. This is presented in Fig. 2.

Emissions of CO_2 from electricity generation were approximately 730 megatonnes in 1990. This decreased to 525 megatonnes by 1995, but by 2000 had risen up to 558 megatonnes. By 2005 it is expected that total CO_2 emissions will equal 722 megatonnes, and by 2010, the mid point of the first Kyoto Protocol reporting period, emissions will equal 845 Mtonnes. This is almost 125 megatonnes above the 1990 baseline, and represents a nearly 20 percent increase over the 1990 base year.

The reason for the more rapid increase in CO_2 emissions relative to electricity generation is that there is expected to be a significant shift in primary fuel supply in the Russian electricity system to coal over the next twenty years. The Russian central government has indicated its desire to increase the proportion of coal in order to free up more natural gas for exports. This scenario would mean much room in the electricity sector for emission reductions and specifically provides many market opportunities for projects that lead to emission reduction. As discussed below, these essentially fall into three categories. There are fuel switching projects which can be implemented in the electricity sector, most notably from coal to natural gas. There are many possibilities to also implement energy efficiency improvements in the electricity supply sector, such as implementing use of high efficiency boilers. One of the most promising areas is the use of what is termed clean coal technology, or such technology as fluidized coal bed combustion. A third area of JI projects is in the increase in end use efficiency. Decreasing a unit of electricity has the effect of decreasing the pollution associated with its generation. As the emission intensity of the average kilowatt hour of electricity generated in Russia increases, such projects become more valuable. As discussed in detail in the sections below, such energy efficiency projects have massive potential in Russia seeing the state of energy efficiency in the industrial, residential and commercial of the domestic economy. A forth area relates to transmission and distribution, where the current losses of upwards of 15 percent represent an opportunity for low cost emission reductions.

Fig.1. **Electricity Generation in Russia from 1990 to 2030 (TWh)**

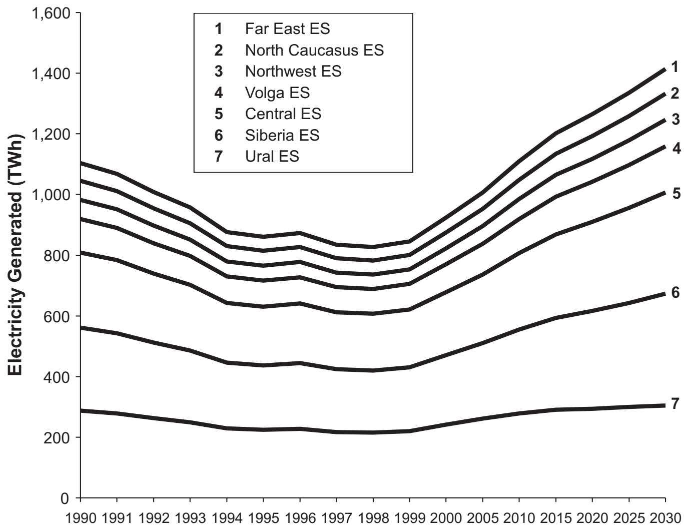
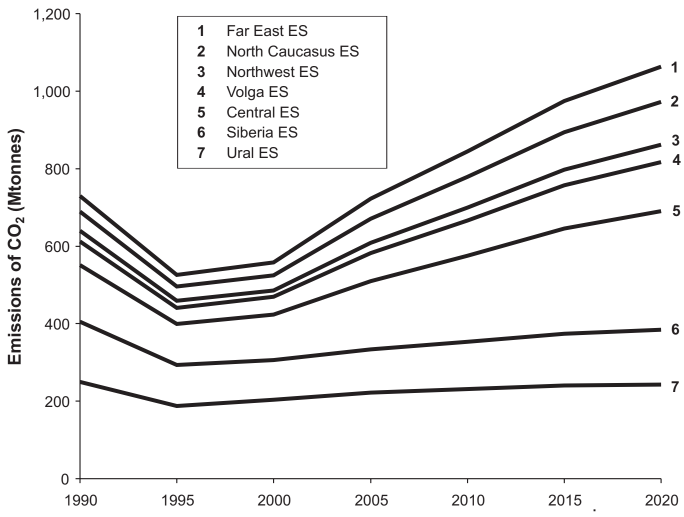


Fig.2. **CO_2 Emissions from Electricity Generation in Russia**



Joint Implementation and the Kyoto Protocol

JI is a mechanism that assists Annex I countries (i.e. countries which have signed the Kyoto Protocol and committed to reductions from an established baseline) in meeting their Kyoto targets by participating in projects with other Annex I countries. JI presents both the Russian government and individual companies and developers a unique and potential very large source for both emission reductions and investment in the electricity sector. Entities may participate in JI projects to generate emissions credits, known as Emission Reduction Units (ERU), in order to use them for compliance with their own targets or to sell on the international emissions trading market. Although the international trading market is in its developmental stages, there have been numerous trades made and a number of high profile companies established to help facilitate such activity. JI projects may begin as of the year 2000 but can only generate ERUs beginning in 2008. A pilot phase was established after the first session of the Conference of Parties in order for experience to be gained with JI projects. This was entitled Activities Implemented Jointly (AIJ), and is explained in more detail in later sections.

Two countries, or two entities from these countries, must be involved in order for JI to operate: an investing country and a host country. An investing country is the country or entity from a country which designs and develops a project in a host country. In this situation Russia would act as a host country since it is the focus of the investment project. There is a number of fundamental reasons for an investing and a host country to participate. The most important of these are that the project will enable the investing country to reduce emissions in a cost effective way compared to reducing emissions in the investing country: i.e. emissions are reduced at a cheaper rate per unit of emissions in the host country than in an investment country. Secondly, the emissions reduced in the investment country must be substantial enough to transfer to the investment country and either be used as investment to sell to other entities or to the government, or can be used to reduce emissions in the home investing country.

Joint Implementation in Russia’s Electricity Sector

The sections below describe the opportunities for JI in Russia’s electricity. First we describe the situation with Russia and the Kyoto Protocol, secondly, we discuss how JI would operate in the electricity sector, and thirdly, give a detailed description of the steps for implementation of JI projects.

Russia and the Kyoto Protocol

The Russian Federation signed the Kyoto Protocol on March 11, 1999 during Boris Yeltsin’s

Presidency. Recently at the World Summit on Sustainable Development numerous members of parliament indicated that the Kyoto Protocol would be signed imminently. However, in later comments at the World Climate Change Conference Russian President Putin is reported to have commented that Russia, as a northern country, might in fact benefit from global warming. Furthermore, Andrei Illarionov, a key economic advisor to Putin, on the same day in interviews suggested that the Kyoto Protocol would have significant negative impacts on Russia’s economy.

Nonetheless there is a number of significant reasons to suggest why Russia might ratify the Kyoto Protocol. Russia does have economic rationale to sign the Kyoto Protocol. It does have the possibility to generate large revenue sources from selling emission credits related to reductions in GHG emissions seen since the downturn in its economy since 1990. Russia is in the position to insist on a higher selling price. Secondly, there are some underlying political reasons why Russia may sign, including the fact that the US has made it clear of its apprehension of signing. Thirdly, Russia may gain from a windfall of investment in its energy sector as a result of JI projects initiated by parties in Europe, Japan and Canada.

Joint Implementation in the Electricity Sector

There have been a number of projects in Russia’s electricity sector implemented through the AIJ program that was established after COP 1 to allow experience to be gained with both JI and the CDM. In Russia there have been 9 project officially registered through the UNFCC by three host countries: the United States, the Netherlands, and Germany. There have also been numerous non-official and unregistered projects in Russia, with this number approaching 25. Table 2 presents a number of the unregistered AIJ projects in Russia for illustrative purposes (Korppoo 2004).

As shown in Table 2, there has been a range of JI projects attempted in Russia. Experience has been however that there are large difficulties in implementing JI projects in the past, largely due to institutional barriers. It is expected here that Russia will work to create a more favorable investment climate for investors and developers in the future.

A range of potentially lucrative opportunities exists for JI projects in the future. In the generation sector, the installation of higher efficient boilers of fluidized bed combustors offers a unique investment opportunity as generators can establish these more efficient systems and sell the emission reductions associated with energy saved in the combustion cycle. The capital costs of such systems generally runs in excess of 500 USD per KW of capacity installed as compared to lower cost but more inefficient boilers. However, here generators will both save on variable costs through a decrease in coal consumed and an increase in potential revenue attributed to the carbon credits tied to the various installations. Energy service companies may also become more active in the end use market, much as has been the case in North American energy markets throughout the 1980's and 1990's. Here low cost energy efficiency projects, such as the retrofit of buildings, installation of high efficiency lighting, or retrofit of inefficient industrial operational equipment, will create a stream of emission credits.

Steps and Processes for Implementation of JI Projects

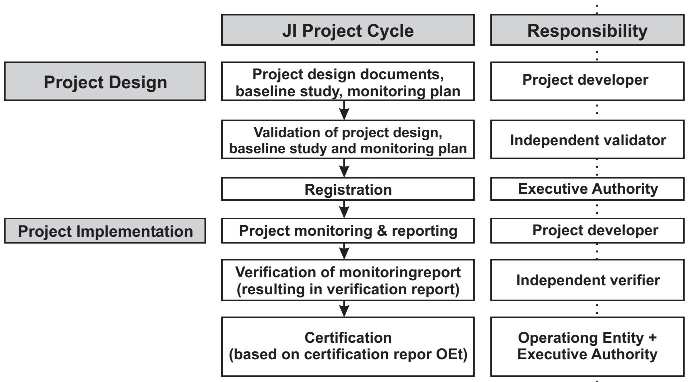
In order for JI to be utilized as a potential revenue source, a number of steps must be undertaken. Laroui gives a description of the project life cycle of a JI project. This starts off with the project design and baseline study, and validation of these. After implementation of a project, the impacts of the project are monitored and reported, which is in turn verified by a third party source. Following, certification can be made of the reduction in GHG emissions. The responsibilities of these steps are shared between the project developer, third party verifiers, and entities established within the reporting environment at the UNFCCC. This is presented in Fig. 3 (from Laroui, 2003).

The most important of the above mentioned processes from the perspective of the developer is perhaps the development of the baseline study and development of the expected emission reductions associated with the project. In combination to the expected costs of the project, this can give the potential investor an indication of the return of the investment in financial terms. This is especially the case when the selling price of the ERU's is known. With the development of this market in the future, and with increased trades made bilaterally between countries, this price will become established.

Table 2. **Examples of Activities Implemented Jointly in Russia**

Project title	Project type	Investor country	Emissions CO_2 Reduced
Polessk ZKX	Fuel switching	Sweden	2,472
Polessk regional hospital	Energy efficiency, energy saving	Sweden	5,781
Infection hospital	Energy efficiency	Sweden	1,760
Pravdinsk district heating	Fuel switching, energy saving	Sweden	283,125
Specialist hospital	Energy efficiency, energy saving	Sweden	6,735
Driada Wood Processing Company	Fuel switching	Sweden	14,050
Children's Hospital No.1	Energy efficiency	Sweden	14,344
Krasnyi Bor district heating	Fuel switching, district heating	Sweden	106,924
Lisino Forest College	Fuel switching, energy efficiency	Sweden	52,118
Pysochny fuel switching	Fuel switching	Sweden	30,052
Ilyansky Lesozavod boiler conversion	Fuel switching	Sweden	58,215
Derevyanka & Derevyannoe fuel switching	Fuel switching	Sweden	20,225
District heating renovation Lytkarino	Energy efficiency	USA	485,670
Cheliabinsk district heating	Fuel switching	USA	N/A
CO_2 reduction in Nigny Novgorod Region	N/A	The Netherlands	N/A
Energy Saving in Tatar Industry	Energy Saving	The Netherlands	N/A
Nizhny Novgorod JI I I	Energy Saving	The Netherlands	N/A
JI in Gatchina	N/A	The Netherlands	N/A
Streamer boiler house in Nizhpharm	N/A	The Netherlands	N/A
Energy efficient street lightning	Energy efficiency	The Netherlands	N/A
Clean air to city centre	N/A	The Netherlands	N/A
Karelia	N/A	Finland	N/A
Pravdinsk, Kaliningrad	Renewable energy	Finland	N/A

Fig.3. **Steps and processes for JI projects in Russia**



Baseline Development

One of the major steps in the establishment of a JI project is the creation of an accurate baseline for which emission reductions can be measured. This is an imperative part of the process to establish emission reductions, and is applied on a project-by-project basis. Typically it will be up to the project developer to develop a baseline and to have this verified by a third party. In this section we describe some of the important aspects of baselines that require attention.

There is an essential requirement in an emission reduction and abatement project that emission reductions are additional to what otherwise would have taken place. In this case, a reliable forecast of future emissions under a base line, no action case is required. Establishment of a reliable baseline is therefore an important prerequisite for a JI project.

A project baseline must establish a temporal trajectory of expected emissions under baseline conditions out to the year 2008 to 2012. This is the window for which emission reductions will be measured and applied against the actual baseline emissions that would be expected to occur if the project had not been implemented. There is a number of general steps that must be followed in preparing a report on emissions of GHGs associated with a project, and includes:

! In general, emissions can either be monitored by the basis of calculation or on the basis of measurement.

! If emissions are measured, the basic formula is as follows:

$$(FCT * EF * OF) \qquad (5)$$

where **FC** - represents fuel consumption; **EF** - represents emission factor; **OF** - represents oxidation factor.

Table 3. **Carbon intensities of generated electricity by region (Tonnes CO_2/MWh)**

	Ural ES	Siberia ES	Central ES	Volga ES	North West ES	North Caucasus ES	Far East ES
2000	0.85	0.45	0.56	0.50	0.31	0.76	0.67
2005	0.85	0.45	0.78	0.72	0.44	1.10	0.97
2010	0.85	0.45	0.90	0.83	0.51	1.26	1.11
2015	0.85	0.45	1.00	0.92	0.57	1.41	1.24
2020	0.85	0.45	1.07	0.98	0.61	1.51	1.32

! There are internationally excepted emission factors that must be used in calculation of emissions. The primary source is from the Intergovernmental Panel on Climate Change (IPCC), although activity specific factors can be used as well. A good source for these emission factors is the AP-42 database provided by the Environmental Protection Agency in the United States:

! Separate emission calculations must be made for each activity and each fuel.

There is a number of factors that must be considered when these emissions are reported. These are summarized as follows:

! For each installation considered, a separate report must be drawn up.

! When emissions are calculated the emission report should include total emissions, activity data, the emission factors used, oxidation factors used, and the inherent uncertainties of the calculations.

! Where emissions are measured the report should include total emissions, information on reliability and uncertainty associated with measurement methods.

To generate CO_2 reduction costs, estimated CO_2 emissions that would be generated by a proposed new technology, generation capacity, or resulting from an end service can be subtracted from a baseline estimate of CO_2 emissions resulting from the same technology, capacity, or end use. The increment (or tonnes of CO_2 saved) can then be divided by the fixed costs associated with the project. This yields the cost of $/tonne of CO_2 reduced. This can be used in conjunction to the potential revenue from the project as well as and changes in operation and maintenance costs.

For investors interested in pursuing end use efficiency projects, the basic method to compute emission reductions and CO_2 reduction costs is to multiply the amount of energy saved in KWh by the standard emission coefficient of the particular grid in which it operates. Here, what is important to realize is that each electricity system in Russia has a unique emission coefficient, and that this is changing over time with changes in the underlying mix of primary fuels. This is presented in Table 3.

As can be seen, the North Causasus and Far East electricity systems have the highest emission coefficients in Russia, and these are increasing the most rapidly over time. This illustrates that these areas present more lucrative end use JI projects on a cost of tonne CO_2 basis.

Baseline Verification

Parties that undertake JI projects in Russia must follow a verification procedure. Project participants must submit a Project Design Document to an Accredited Independent Entity (AIE) with the information needed for the determination of whether a project:

! Is approved by parties involved.

! Results in a reduction of anthropogenic emissions by sources or an enhancement of removals by sinks.

! Has an appropriate baseline and monitoring plan. JI project baselines shall be established on a project specific basis and/or using a multi-project emission factor.

The Project Design Document (PDD) shall be made publicly available. A period of 30 days is provided for comment by Parties, stakeholders and UNFCCC accredited observers. The Accredited Independent Entities (AIE) should then determine whether in fact the Project Design Document meets the above criteria and whether project participants have submitted an analysis of the environmental impact of the project activity, as required. The Accredited Independent Entity shall make their determination publicly available. The determination will be deemed final 45 days after the date it was submitted unless a review is requested by a Party involved, or three members of the Article 6 Supervisory Committee. Such a review should be completed as soon as possible but no later than six months after the Accredited Independent Entity's determination was made public. The Accredited Independent Entities will also make a determination regarding the reductions of anthropogenic emissions by sources or removals by sinks upon receipt of a report prepared by the project participants. At this stage as well, if neither of the Parties involved, nor at least three members of the Article 6 Supervisory Committee, request a review of this determination, it will be deemed final 15 days after its publication. If Article 6 Supervisory Committee decides to perform a review, it should be completed within 30 days.

ERUs may be issued and transferred by the host Party once reductions have been verified. The host Party must still be a Party to the Protocol and have established an assigned amount and have in place a national registry for tracking the assigned amount. Any transfers of ERUs resulting from JI activity that are verified under this verification procedure are not subject to the commitment period reserve requirements. Typically verification is undertaken on a yearly basis and involves creation of a separate report.

Barriers to JI in Russia

Korppoo (2004) presents an excellent overview of what project developers have experienced thus far in trying to establish JI projects in Russia. First and foremost are institutional barriers. At this point nowadays Russia does not have an established program to deal with JI projects. Potential investors so far have complained of very high institutional barriers in implementation of JI projects in terms of the amount of co funding available and the inadequate energy policies in place in Russia. They suggest that these will significantly retard use of JI in Russia's energy sector into the future.

Conclusions

The above discussion has presented a baseline of electricity demand and supply out to the year for six different regions in Russia. Based on this analysis, a baseline of CO_2 emissions has been calculated. It is clear that the electricity sector in Russia will be in excess of its Kyoto targets by the year 2010, the mid point of the Kyoto reporting period. JI has been introduced as a potential source to help reduce these emissions. One of the reasons which makes JI particularly attractive to potential investors and developers is that it can be used as a revenue source by selling its associated emission reductions on international emission markets. There is a number of areas for potential JI projects. Most notably are those increasing energy efficiency in the industrial and residential sectors of the Russian economy. The Russian economy is hugely energy inefficient, and such projects would offer a low cost way to generate emission reductions. The barriers to the JI market in Russia however are considerable. Groundwork still needs to be laid out for the rules of JI, the reporting of emission reductions. The market price for emission reductions also must be more firmly established. This will allow potential investors to better understand their return of investment when completing baseline and emission reduction studies associated with different projects.

References

1. Anon, cited 2004. Russia's Economy 1999-2001: Strong Growth, But Exhausting Its Foundation. [Available online from http://www.larouchepub.com/eiw,.

2. Anon, cited 2003. Client Alert: Timeline for Russian Federation Ratification of Kyoto Protocol, 4 pp.

3. Anon, cited 2004. UES Expects 2002 Electricity Demand Growth To Halve. [Available online from http://english.pravda.ru/economics/2002/04/10/27475.html].

4. EIA, cited 2004. Russia Country Analysis Brief. [Available online from http://www.eia.doe.gov/emeu/cabs/russia.html].

5. Hill, M., 2002. Russian power generation: between a rock and a hard place? Environment and Planning B: Planning and Design, 29, 819-839.

6. IEA, 2002. Russia Energy Survey 2002, 278 pp.

7. IPCC, 1996. Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories.

8. Korppoo, A., 2004. Russian energy ef.ciency projects: lessons learnt from Activities Implemented Jointly pilot phase. Energy Policy, In press.

9. Larouia, F., E. Tellegenb, and K. Tourilovac, 2003. Joint implementation in energy between the EU and Russia Outlook and potential. Energy Policy.

10. Lee, H., P. Vorobyov, and C. Breznik, 2001. Entering Russia's Power Sector – Challenges in Creating a Credible Carbon Trading System, 1-59 pp.

11. Palamarchuk, S., S. Podkovalnikov, and N. Voropai, 2001. Getting the Electricity Sector on Track in Russia. The Electricity Journal, October. ☐