Monitoring Greenhouse Gas Emissions in Russia: A Foundation for Climate Accountability

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FOREWORD AND ACKNOWLEDGMENTS

International cooperation to mitigate greenhouse gas emissions requires rigorous methods of emission monitoring. This report addresses the situation with respect to monitoring in Russia, the world's third largest source of greenhouse gas emissions from fossil fuel production and use. And as a consequence of its transition from a planned to a market economy, emission monitoring represents a special challenge in that country.

We are fortunate to host the Russian scholar Ilya Popov as a visiting fellow at the Advanced International Studies Unit of Battelle to help us better understand Russian climate issues. We are grateful to Brian O'Neill of Brown University, where Popov is completing graduate study in environmental policy, for the opportunity to work with Ilya. We are also grateful to the many Russian and American experts who shared their knowledge about greenhouse gas monitoring and climate change mitigation policies and provided useful suggestions on earlier drafts. In particular, we would like to thank Alexey Kokorin, Evgeniy Dedikov, Lydia Popova, Bill Irving, Paul Gunning, Reid Harvey, Terry Keating, Virginia Gorsevsky, and Jeremy Schreifels.

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ACRONYMS

AAU	assigned amount units
ATS	allowance tracking system
CDM	Clean Development Mechanism
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
EU	European Union
FCCC	United Nations Framework Convention on Climate Change
Gazprom	Joint Stock Company "Gazprom"
GEF	Global Environmental Facility
GHG	greenhouse gas
Goscomecologia	Russian State Committee on Environmental Protection
Goscomstat	Russian State Committee on Statistics
GRI	U.S. Gas Research Institute
Hydromet	Russian Federal Service for Hydrometeorogy and Environmental Monitoring
IMS	industrial monitoring system
IPCC	Intergovernmental Panel on Climate Change
IPMVP	International Performance Measurement and Verification Protocol
JI	joint implementation
USSEM	Unified State System for Environmental Monitoring
URF	unified reporting format
USIJI	U.S. Initiative on Joint Implementation
PJ	petajoules
CH_4	methane
CO	carbon monoxide
CO_2	carbon dioxide
HF	hydrofluorides
H_2S	hydrogen sulfides
NO_x	nitrogen oxides
O_x	oxidants
SO_2	sulfur dioxide

EXECUTIVE SUMMARY

Russia ratified the United Nations Framework Convention on Climate Change (FCCC) in 1994. Under the FCCC, Russia must create "national inventories of anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol" (UNFCCC Article 4 1992). If Russia does not fulfill this requirement, it will not be able to comply with the FCCC, nor will it be able to participate in any flexible mechanisms for mitigation that may emerge. The Kyoto Protocol – which Russia signed but has not yet ratified – also requires the creation of a national system to estimate emissions (Kyoto Protocol Article 5 1997) and report information about emission to the FCCC Secretariat (Kyoto Protocol Article 7 1997). The Kyoto Protocol establishes several flexible mechanisms – the Clean Development Mechanism (CDM), Joint Implementation (JI) and international emission trading – which require careful estimation of emissions. Final rules and guidelines for implementing flexible mechanisms are yet to be defined. If the Kyoto Protocol is ratified, flexible mechanisms will actually allow the transfer of credits. In this case, some experts think that countries that want to participate in international emission trading and use credits to offset their emissions must be in compliance with Articles 5 and 7 of the Kyoto Protocol.[1] Participation in JI will probably not require compliance for a party that hosts a project but might require compliance for an investing party.[2] JI projects will involve careful estimation of emission reductions resulting from projects. This paper summarizes how Russia can meet these obligations in a practical and cost-effective way.

First, the paper identifies the basic requirements for a Russian greenhouse gas (GHG) monitoring[3] system. The most important of these are transparency, verification of results by independent parties, standardized data reporting, and relative cost-effectiveness.

The paper then describes existing monitoring systems in Russia and discusses how they can be extended to include GHGs. Russia could benefit from features of existing inventories and monitoring systems in other countries, and the paper presents the following five examples:

1. The Intergovernmental Panel on Climate Change (IPCC) guidelines to create inventories.

2. U.S. Environmental Protection Agency's (EPA) guidelines for monitoring Joint Implementation (JI) projects.

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[1] Jeremy Schreifels, EPA, Acid Rain Division – International Climate Change Branch, October 5, 1999. Personal communication.

[2] ibid.

[3] In a case of GHGs we can define monitoring not only as measuring actual emissions but also calculating emissions from fossil fuel consumption or any other relevant data.

3. Voluntary agreements to increase energy efficiency and decrease emissions in Europe.

4. EPA's Acid Rain Program.

5. EPA/Gas Research Institute (GRI) study of methane emissions from natural gas systems.

The paper then identifies the most useful and feasible features for Russia in each of these systems.

The review of the existing systems leads to several important policy recommendations. First, Russia should create sectoral inventories and use the IPCC guidelines to the extent possible. It is important to start with the simplest methods suggested in the guidelines. This approach will provide an initial picture of sectoral emissions. More rigorous methods can then be implemented in the future. However, even simple methods require the collection of good data at the facility level. Therefore, Russia should begin with sectors where data are easier to collect. Improved coordination among the local branches of federal ministries will be essential to better data collection.

In addition, Russia should increase the transparency of its existing monitoring systems and inventories. Reporting emissions in a standardized format and making all of the data available in one location will increase transparency substantially. Finally, independent reviewers should verify the monitoring results. This approach will increase the credibility of any future monitoring system in Russia.

The paper uses examples from two sectors of the Russian economy – steel and natural gas – to analyze monitoring issues. These sectors were selected because they cover a large share of Russian emissions and will allow Russia to test different monitoring designs. In addition both sectors have financial incentives for monitoring. Two future papers will describe these sectors in greater detail.

INTRODUCTION

The Kyoto Protocol, which was signed in 1997 during the third Conference of the Parties, requires developed countries to reduce or stabilize their GHG emissions during the first budget period (2008-2012), using 1990 as the baseline year.[4] The Protocol establishes several mechanisms for reducing GHG emissions that allow countries to reduce emissions jointly. These mechanisms are Joint Implementation (JI), a combined target for two or more countries (bubbling), the Clean Development Mechanism (CDM) and international emission trading. JI and CDM are project-based mechanisms that allow one country to implement an emission reduction project in another country and then count the reductions against its own domestic commitments. Bubbling and international emission trading work with total emission limits and do not necessary involve bilateral emission reduction projects.[5] They are also called flexible mechanisms because they allow countries to choose the most efficient ways of meeting their commitments. The CDM and international emission trading are new mechanisms[6], while the concept of JI was introduced in 1995 at the first Conference of the Parties. JI emerged from the FCCC requirement, which states that developed countries take the lead in mitigating climate change while allowing them to do this jointly with developing countries. The FCCC also requires developed countries to provide financial and technical assistance to developing countries. The FCCC established a pilot phase of JI, which does not allow countries to transfer credits. If the Kyoto Protocol enters into force, flexible mechanisms will allow countries to actually transfer credits.

Russian commitments under the climate change treaties

Russia must complete two tasks in order to meet its commitments under the FCCC. First, Russia needs to know how much it is emitting overall in order to meet its international commitments. Under the FCCC, Russia must regularly update national inventories of GHG emissions by sources and removals and submit this information to the FCCC Secretariat (UNFCCC Article 4 1992). The Kyoto Protocol – which Russia has signed but not yet ratified – also requires the creation of a national system to estimate emissions no later than one year before the first budget period (Kyoto Protocol Article 5 1997). Inventories must be created in accordance with guidelines established by the IPCC. Creating thorough inventories in different sectors will help Russia to set baselines for domestic or international emission trading programs. In addition, Russia must create a system to monitor GHG emissions from individual sources because the flexible

[4] Countries with economies in transition might choose a baseline year different from 1990.

[5] Jeremy Schreifels, EPA, Acid Rain Division – International Climate Change Branch, October 5, 1999. Personal communication.

[6] The concept of the CDM is the same as JI. The only difference between them is that projects undertaken in non-Annex I countries are considered CDM while JI projects occur between Annex I countries. The distinction between CDM and JI was made during the third Conference of the Parties. Many current pilot JI projects may be considered as CDM projects because they are between an Annex I and a non-Annex I countries.

mechanisms in the Kyoto Protocol require monitoring. JI project sponsors must prove that their projects have actually reduced emissions (Kyoto Protocol Article 6 1997). In the case of emission trading, it is possible, that parties will not have to prove reductions have occurred before they can trade Assigned Amount Units (AAUs). Because emission trading is based on a country baseline, a country may trade any extra AAUs that it does not think it needs. If it trades too many it may be out of compliance and will likely suffer penalties to be determined by the Conference of the Parties.[7]

Finally, the existence of thorough inventories and a reliable monitoring system in Russia will be important for global climate change mitigation efforts. Russian emissions have dropped substantially over the past several years, and Russia has the potential to be the single biggest seller in a future world market. If Russia is not able to estimate its emissions, it may end up selling emissions that have not been actually reduced. This will have negative consequences for climate change mitigation and undermine trust to the negotiations process.

Taking these requirements into account, Russia has two primary responsibilities. First, it needs to build emission inventories for different sectors and create a GHG monitoring system. It makes sense to do these tasks simultaneously because they have many common features. Inventories measure emissions directly or define emission or activity factors when direct measurement is not possible. For example, Russia should measure methane emissions from natural gas systems, where the range of uncertainty is high and default emission factors are not well defined. Emission monitoring also involves some of the same techniques used to create inventories. In many cases, especially for carbon dioxide (CO_2) emissions, it would be too difficult or time-consuming to measure emissions, so it is easier to calculate them indirectly. In the industrial sector, such as the steel industry, there are many emission sources. It would be too expensive to measure all of them with CO_2 monitors. Energy efficiency projects aimed at reducing CO_2 emissions instead estimate the energy saved as a result of project implementation and then calculate emission reductions using emission factors recommended by the IPCC.

Monitoring systems for JI projects and emission trading programs

Monitoring systems for JI projects and emission trading programs will be very different. JI project monitoring must verify that emission reductions are in addition to what might happen without a project[8], which requires substantial monitoring at the facility level or in one component of a sector (such as pipelines in the natural gas sector) before and after a project. This process requires a project baseline that considers what would happen without the project. Monitoring may be done by project participants, and verification should be done by a third party.

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[7] Jeremy Schreifels, EPA, Acid Rain Division - International Climate Change Branch, October 5, 1999. Personal communication.

[8] This concept is called “additionality”. Project participants should prove that emission reductions from the project will be larger than those that would occur without the project. Because additionality is not very well defined it causes a lot of debates between climate change experts.

In international emission trading programs, it will only be necessary to prove that current country-wide emissions are lower than a given baseline level by a certain amount. Liability issues arise when a seller of emission reduction credits has total emissions greater than those allowed by the Kyoto Protocol. Assignment of liability for non-compliance will be defined in international negotiations on the rules for flexible mechanisms. Several options exist for assigning liability, including buyer and seller liability. In the case of buyer liability for a country buying emissions, it will be enough if the country selling emissions is able to prove that this reduction has occurred. In this situation, the availability of thorough sectoral inventories might suffice. If a buyer purchases emission reductions that have not actually occurred and by the end of a commitment period is out of compliance, the buyer will be responsible for having more emissions than allowances, not the seller. It will be important for the buyer to be sure that actual emission reductions are purchased. Seller liability suggests that the seller is responsible for emission reductions sold and it is in the seller's interest to estimate emissions thoroughly. Otherwise, the seller pays the fines. For a more comprehensive discussion on liability issues, an interested reader may refer to (Tietenberg et al. 1999) and (Baron 1999).

A country that plans to sell emissions for credits may decide to distribute its emission credits among sectors or regions, depending on what kind of emission trading system is used.[9] Another possibility is that the Russian Government could keep all credits. In this case it is very possible that neither regions nor industrial sectors will have any incentive to participate in emission trading programs. Distribution of credits among regions or industrial facilities can lead to further emission reductions and bring more money to Russia. This money could go into new emission reduction projects. Credits may eventually be distributed among facilities, which would require monitoring at the site level. Monitoring may be done by a facility, but a third party should verify results. This type of system might work in the steel sector. An advantage of the steel sector for monitoring is that there are not many steel manufacturers in Russia. It would be relatively easy to cover all of them or a subset of the largest emitters. Under this arrangement, techniques used in monitoring JI projects will be valuable for emission trading programs at the sectoral level. In the gas sector, it will be easier to allocate emission credits, as there is only one company with only several regional branches. Monitoring in this case will involve measuring emissions from a segment, which belong to a regional company. Local Gazprom branches can take these measurements.

[9] A concept of international emission trading is widely discussed by both international and Russian experts and policy makers. Since a detailed description of emission trading is outside of the scope of the paper, an interested reader may refer to following documents: Ministry for Fuel and Energy of the Russian Federation 1998; Bureau of Economic Analysis 1998; Center for Clean Air Policy 1998; Joshua et al 1998.

Monitoring the steel and natural gas sectors

This paper uses examples from two sectors of the Russian economy – steel and natural gas – to analyze monitoring issues. Two papers, which analyze these two sectors exclusively, will be prepared in the future. These sectors were selected for three reasons:

1. They cover a large share of Russian emissions. The natural gas sector produces 60% of anthropogenic methane emissions (Russian Federal Service for Hydrometereology and Environmental Monitoring 1997). While detailed information about emissions from the steel sector is not available, this sector is one of the biggest industrial energy consumers, and probably the main source of industrial CO_2 emissions from fossil fuel combustion.

2. They will allow Russia to test different monitoring designs. Each industry has different gases that are most important.[10] Monitoring methane emissions from the natural gas sector will involve many measurements, while monitoring CO_2 emissions in the steel sector will be calculated from fuel mix data. When better and cheaper technologies for GHG monitoring are designed, direct CO_2 measurement may be possible. In addition, in each sector the organization responsible for monitoring will vary. The natural gas sector is owned by Gazprom, a state monopoly that will be responsible for monitoring. Metallurgical facilities, on the other hand, have been privatized for the most part. They will conduct monitoring, while regulatory agencies will aggregate and verify the data.

3. Both sectors have financial incentives to monitor. The steel sector in Russia is inefficient and energy intensive. It holds great potential to improve energy use and reduce corresponding GHG emissions. In the gas sector, reductions in methane emissions will result from reductions in natural gas losses, which will provide Gazprom with more natural gas to sell.

There are many differences between monitoring in the steel and gas sectors. The steel sector primarily produces CO_2 emissions. Currently, CO_2 emissions in the steel sector are estimated by calculating energy consumption, secondary heat consumption, and fuel mix at individual plants for all processes involving fuel combustion. Accounting for coke used in the process is also important. Energy consumption is then multiplied by emission factors. The gas sector mainly produces methane emissions. Methane emissions are often measured directly. Because the gas sector is widely distributed geographically and many sources of methane are difficult to measure, monitoring involves many extrapolation techniques, and the level of uncertainty is higher than that for other GHG estimates.

[10] The paper considers emissions only from the natural gas sector, which is defined as production, transmission and distribution. Besides methane emissions the sectors also produces CO_2 emissions, mainly from combustion of gas at compressor stations, but their share is relatively small. Burning natural gas by industries and power plants produces CO_2 emissions but their monitoring is out of scope of the paper.

Requirements for a monitoring system

Regardless of its ultimate purpose in meeting climate obligations, an effective monitoring system should include several features:

1. The ability to monitor emissions continuously or at least over regular periods of time;

2. The ability to estimate uncertainties in measuring or calculating emissions;

3. Electronic collection and exchange of data;

4. Regular reporting in a standardized, internationally accepted format;

5. Verification of results by an independent reviewer;

6. Transparency of data and availability of results to all interested parties;

7. Measures to prevent non-compliance; and

8. Relatively low costs in design and implementation.

Cost-effectiveness, transparency, verification, regular and clear reporting, and public availability of information are all particularly important for Russia. To create a system quickly, Russia should draw upon existing experience in other countries and decide what might be useful and feasible for a future monitoring system in Russia. It is also possible to use Russian experiences in monitoring other substances and the existing capabilities of agencies that currently conduct monitoring.

The following section provides information about current Russian monitoring systems. The subsequent section provides information about existing systems in other countries and discusses how their features might be applied in Russia.

RUSSIAN MONITORING SYSTEMS

Unified State System for Environmental Monitoring

Several agencies are responsible for conducting monitoring in Russia. The Russian Federal Service for Hydrometeorology and Monitoring (Hydromet) is responsible for monitoring atmospheric, water and soil pollution. The State Service for Monitoring and Control of the Environment was created to conduct this monitoring in 1970. It is a hierarchical structure with several levels. At the local level, monitoring stations conduct monitoring and collect initial data. At the regional level, centers collect, process and analyze data from stations. They are also responsible for publishing information about the state of the environment in the regions. At the federal level, Hydromet aggregates data from regions and analyzes information on the national level and publishes regular reports about the state of the Russian environment as a whole. The State Service for Monitoring and Control of the Environment also includes the State Network for Monitoring Atmospheric Pollution in the cities. This network includes not only Hydromet monitoring stations but also monitoring stations that belong to other agencies and the largest industrial facilities in a city. It is a common practice in Russia that the biggest polluter in a city regularly measures pollution in residential areas.

This system is still in place, although some monitoring stations in the regions have been closed due to the lack of money. For example, between 1992 and 1996, Hydromet stopped measuring emissions in 4% of cities and closed 4% of its stations (Bezuglaya et al 1998).

In addition to Hydromet, regional departments of the Russian State Committee on Environmental Protection (Goscomecologia) are responsible for monitoring industrial facilities. This monitoring includes atmospheric, soil and water pollution. Sulfur dioxide (SO_2), oxides of nitrogen (NO_x), carbon monoxide (CO), oxidants (O_x), hydrogen sulfides (H_2S), hydrofluorides (HF), hydrocarbons, and volatile organic compounds are all considered criteria pollutants.[11]

Many industrial facilities conduct their own monitoring. All facilities have strict norms for toxic pollutants and must report results of monitoring to regional branches of Goscomecologia. Several other agencies also conduct monitoring. For example, the Ministry for Natural Resources conducts hydrological and geological monitoring; the Ministry for Health is responsible for monitoring drinking water and food.

In 1993 the Russian government created a Unified State System for Environmental Monitoring (USSEM) to improve coordination between agencies, collect information in one place, increase the quality of information, and computerize it. USSEM is based on

[11] Criteria pollutants are chemicals harmful for human health, for which government agencies have established maximum permissible levels.

the existing hierarchical structure adopted by Hydromet. Goscomecologia is responsible for coordination of all activities and collection of all information under USSEM. It uses USSEM to do the following (Ecoline 1998a):

- Coordinate efforts of all agencies responsible for monitoring;
- Collect, control and electronically store all collected data; provide electronic exchange of data between different agencies;
- Create databases for all controlled pollutants; ensure compatibility of these databases with international databases;
- Create and publish prognosis about the state of the Russian environment; and
- Provide information to the public on all criteria emissions.

USSEM includes monitoring of anthropogenic sources of pollution and monitoring pollution by chemicals and radioactivity of the environment (e.g. soil, air, and water). Under USSEM provisions to monitor anthropogenic sources, all industrial facilities should establish environmental services, which conduct monitoring of all discharges and provide information to Goscomecologia. Goscomecologia, in turn, analyzes all information, summarizes it, and prepares reports for the State Committee for Statistics (Goscomstat) (Ecoline 1998b).

It is difficult to say if all provisions of USSEM are already in place, but this system is already being partially implemented. Currently, regional branches of USSEM are being created in several Russian regions. In 1996, 20 regions created information and analytical centers and set up databases to create inventories of atmospheric pollutants (Russian State Committee on Environmental Protection 1997). Under the rules established by Goscomecologia all power plants must monitor and report SO_2 and NO_x atmospheric emissions (Eryomin 1999). Goscomecologia has also developed rules and regulations for industrial facilities. For example, Gazprom facilities must comply with approximately 60 regulatory acts (Dedikov 1998).

The current status of USSEM and its future development are unclear. In 1997 Goscomecologia planned to continue creating regional branches of USSEM, create better information exchange between regional and federal branches of Goscomecologia, and continue integrating USSEM into international monitoring systems (Russian State Committee on Environmental Protection 1997).

Environmental statistics collection

Both Goscomecologia and Goscomstat publish annual statistics on environmental protection in Russia. These publications provide information about atmospheric, water and soil pollution in all sectors. Goscomecologia provides more detailed information

about pollution from specific industries and provides data about more pollutants than Goscomstat. For example, Goscomecologia names facilities with the highest level of pollution in each sector. It also publishes information about the state of the environment in different regions, but these publications are available only from local branches. Neither agency provides detailed statistics about discharges from specific facilities. Goscomstat regularly publishes information about the Russian industrial complex in addition to publications about environmental protection. These publications include information about energy and fuel consumption by different industries and pollution from industries, but do not provide details about specific facilities.

To collect statistics about atmospheric pollution, local branches of Goscomstat and Goscomecologia require all industrial facilities and power plants, either private or state, to annually fill in a special form about atmospheric pollutants. This information includes data about CO, SO_2, VOC, NO_x, and hydrocarbons. In addition to these data, facilities are required to provide information about the volume of discharges processed at treatment facilities. Besides this form, many facilities create their own inventories and Goscomecologia collects data from these inventories. This information is available to the general public, including environmental organizations. Sometimes Goscomecologia verifies the legally mandated information. All industrial facilities that use fossil fuels, heat, and energy for production purposes, and all power plants are also required to fill in a form that has questions about all kinds of fossil fuels a facility uses and how much energy and heat it consumes. This form also has a question about coke consumption. This information goes to Goscomstat, to the agency responsible for coordination of this facility, and to the Ministry for Fuel and Energy in the case of power plants (CENEF 1998). This information is for official use and is not usually available to the general public.

Gazprom Industrial Monitoring System

Besides USSEM, some industries create their own monitoring systems. For example, Gazprom is creating an Industrial Monitoring System, which will monitor all pollution sources and discharges into the atmosphere and water. It will have a hierarchical structure with the main monitoring center in Moscow, three regional monitoring centers, and monitoring centers at Gazprom facilities. The system will include electronic exchange of data between centers, and it will be compatible with USSEM (Yarygin 1998). There are no provisions to monitor GHG emissions in the system. In 1996-1997 this system was introduced at an Astrakhan gas processing plant. It allows users to automatically measure SO_2, H_2S and hydrocarbons and includes a computer center to process and store the data (Koltypin and Petrulevich, 1997). Gazprom is also planning to create a monitoring system at compressor stations which will allow it to monitor CO, NO_x and NO_2 emissions (Akopova and Solovyova 1998).

Neither the USSEM nor monitoring systems adopted by other industries include provisions to monitor GHG emissions. However, when a monitoring system is created, it should be done under USSEM, and Goscomecologia should collect information about all

emissions through its regional centers. These regional centers will have better data than federal agencies about local emission sources. It is very important that data is collected electronically by using standardized forms and is stored in one place.

Several regional centers could serve as repositories for local information, and one federal center could collect this information from them. It will be impossible to computerize data collection for all industries immediately, and the transition will take time. However, industries with international ties, such as the steel industry, are already creating electronic systems for their accounting and financial auditing systems. In these industries, it will be easier to create an electronic exchange for environmental data. In addition, there are only a small number of metallurgical facilities in Russia, so it will be relatively easy to equip all of them with computer systems.

INTERNATIONAL EXPERIENCE WITH MONITORING

No international GHG monitoring system currently exists. Different countries have created their own monitoring systems, which include some of the provisions listed above for a monitoring system. Some provisions, like continuous emission monitoring, are not realized in any GHG monitoring systems because of the expense. Measures against non-compliance are not included in these monitoring systems because it is still impossible to transfer credits and there is little control of real emission reductions. Therefore, it is important to take a look not only at existing monitoring systems adopted either by the FCCC Secretariat or other countries but also at monitoring systems for other pollutants. These systems have many important features that Russia could imitate. Information on these monitoring systems, guidelines for creating inventories, and assessment of their applicability to Russian conditions is described below:

1. **The IPCC guidelines**. The guidelines provide clear emission calculation methods, reporting and verifying instructions, and estimations of uncertainties. Using these guidelines for estimating sectoral emissions will help Russia to have better information about its emissions from different sectors and lay a foundation for creating monitoring systems for emission trading programs. Currently, Russia only has estimations for CO_2 emissions from fossil fuel burning on a country-wide basis without desegregating these data between sectors. It has just started to create sectoral inventories. All monitoring provisions recommend calculating emission reductions based on estimations of energy saved by applying IPCC default coefficients.

2. **Guidelines for monitoring JI projects**. All JI projects require monitoring, but no comprehensive and standardized guidelines for monitoring exist. No countries that provide reports about JI projects describe how they conduct monitoring but instead briefly explain what will be emission reduction because of a project implementation. Only this year Lawrence Berkeley National Laboratory prepared guidelines for monitoring energy efficiency projects. The guidelines clearly describe techniques that can be used to estimate energy saved as a result of a project and then emissions reduced. They also require verification of monitoring results and clear reporting emission reductions and energy saved. These techniques might be useful for monitoring emission trading programs in the steel sector.

3. **European voluntary agreement programs**. Experience in monitoring GHG emissions exists in the United States and European Union (EU) countries both for pilot trading programs and JI projects. However, this experience is mostly related to monitoring individual projects or energy efficiency measures at individual facilities. Also, because emission credits currently cannot be transferred, rules for monitoring are not very strict and verification is almost non-existent. Several voluntary agreement programs between industries and governments to reduce emissions by implementing energy efficiency measures were adopted in the United States and

Europe. They require monitoring and verification of energy saved and emissions reduced. They cannot be considered emission trading programs but experience gained by these programs might be useful for the steel sector in Russia, as most projects in the steel sector will be oriented to improving its energy efficiency.

4. **EPA's Acid Rain Program** is the only full-scale emission trading program existing in the United States. It allows U.S. utilities to trade SO_2 allowances. It includes provisions to monitor CO_2 emissions but does not require reductions. Currently it appears to be the only program that includes all provisions of a monitoring system. Although its experience is not entirely applicable for future emission trading programs, some provisions of the program might be useful.

5. **EPA/Gas Research Institute (GRI) study** of methane emissions from natural gas systems. Some countries have created methodologies for emission sources, which are not fully covered by the IPCC. A good example is work done by EPA and the Gas Research Institute to estimate methane emissions from natural gas systems in the United States. Using this experience could be helpful for Russia. It is also important that EPA has and has had several projects in Russia, including measurements of methane emissions; EPA's experience will be useful for Russia in creating monitoring systems in the future.

The following section describes each of these monitoring systems in greater detail.

The IPCC guidelines

In preparing inventories, Russia should use procedures recommended by the IPCC (IPCC 1996). To assist countries in fulfilling their commitments and harmonizing methodologies to estimate emissions, in 1994 the IPCC published guidelines to estimate national emissions and report emissions in a transparent and clear way. These guidelines provide methodologies for calculating emissions from all sources and provide instructions for reporting and verifying inventories. There are several methodologies for emission estimates, which allow countries to calculate emissions with different degrees of thoroughness, depending on the data quality and availability. All FCCC parties are required to use these guidelines when they create inventories. Every year, the IPCC works with experts from different countries to improve methods for calculating and estimating emissions. Currently, the IPCC guidelines are the best source for estimating emissions, especially from different sectors, and all international organizations use them for estimating emissions from different countries. The IPCC also sees development of good inventories for different sectors as the first step to develop reliable GHG monitoring systems in countries.

The IPCC guidelines consist of three volumes. The first volume provides an outline of the main principles used in the guidelines, step-by-step instructions for compiling a national inventory, reporting forms for sectoral emissions and procedures for measuring uncertainties, and classifies all emission sources. To harmonize estimations of emissions,

the IPCC divides all emission sources into several categories: the energy complex, industrial processes, solvent and other product use, agriculture, land use change and forestry, and waste. Emissions from each of these sources are divided into smaller categories. For example, emissions from the energy complex are divided into emissions from fuel combustion activities (with separate categories for industrial and fugitive emissions) and transport. To avoid double counting, there is a clear description of which emissions should be considered under what sources. For example, the energy category should consider emissions from fossil fuel burning, including industrial processes. To classify all emissions sources, the IPCC uses the international standard industrial classification adopted by the United Nations. Besides emission sources the IPCC provides classification of fuels. The IPCC provides a reporting table for each emission source and summary reporting tables for different sectors. All countries compile and send data according to these tables. Countries also should provide all supporting documentation, descriptions of methods used to estimate emissions, and references to all data sources. To facilitate a process of emission calculations and reporting, the IPCC provides software, which includes a program to calculate emissions and all reporting forms. The IPCC also requires estimating uncertainties of emission calculations.

The IPCC pays special attention to managing uncertainties. First of all, the IPCC clearly defines all source and fuel categories, and all other terminology it uses, and it describes units and conversion factors. Secondly, it provides methodologies that were agreed upon by many experts from different countries. It also provides a range of uncertainties for emission and activity factors. For example, the overall uncertainty of calculations for CO_2 emissions from fuel combustion is 10%, but for methane emissions from oil and gas activities, it is 60%. For some countries this uncertainty is even greater. The lowest and the highest estimates for emission factors for the former USSR and Eastern Europe are several times different. Such a large uncertainty in estimating methane emissions means that if a country reports, for example, 100 tons of CH_4 emissions, its actual emissions might be either 160 tons or 40 tons. It is evident that for emission trading programs or JI projects it will be almost impossible to carefully monitor emissions using the IPCC data and more local measurements should be done.

The second and third volumes describe methods that could be used to calculate emissions for different categories and provide default emission and activity factors for each source category. These methods allow for quick calculations of sectoral CO_2 emissions and might be used to calculate emissions from fuel combustion at single facilities. The IPCC presents a very simple method for estimating CO_2 emissions from fuel combustion:

1. Estimating sectoral fuel consumption for each fuel;

2. Converting to a common energy unit (e.g., a terajoule) by multiplying the consumption by relevant conversion factor;

3. Multiplying by carbon emission factors;

4. Calculating carbon stored;

5. Correcting for carbon that is not oxidized; and

6. Converting to CO_2 emissions.

This method could be used in monitoring emission trading programs in industrial sectors. It does not require many statistics, and it can be adjusted for individual facilities. Nonetheless, it might still be difficult to obtain reliable statistics for individual facilities or even for different sectors. For example, data about fuel consumption at the Metallurgical Combine in Magnitogorsk is confidential (Nikiforov 1999).

Estimates of methane emissions from natural gas systems are not very well developed by the IPCC because of lack of data about emission factors and very high range of uncertainties. The IPCC suggests that countries use local data whenever possible. Only a few world regions–the United States and Canada, Eastern Europe and the former Soviet Union, and Western Europe–have emission factors available and provided by the IPCC. Even in these regions, the uncertainties are very large. Specific country emission factors do not currently exist. In addition, the IPCC divides emissions from all gas operations into three categories: from production/processing, from transmission/distribution, and other leakage. Venting and flaring from oil/gas production is considered separately. For each category, emissions are calculated by multiplying an activity factor (the amount of gas produced or consumed in petajoules) by an emission factor (kg CH_4/PJ). The range of uncertainty for emission factors is enormous. For example, for the former Soviet Union and Eastern and Central Europe, the emission factor for processing, transmission and distribution is in the range 288,000 – 628,000 kg CH_4/PJ. Clearly, more accurate estimates should be developed for emission trading programs, or it will be impossible to guarantee program credibility.

The IPCC guidelines have several important features that should be used in a future Russian monitoring system. They accomplish the following:

- Provide simple and rather inexpensive methods to calculate sectoral emissions;

- Require reporting in a clear and transparent way;

- Include estimations of uncertainties;

- Allow electronic calculation and reporting of emissions; and

- Require verification of results by third parties.

All of these features will be essential for Russia. Even simple calculation methods will require good sectoral statistics, which often do not exist in Russia. Therefore, Russia

should start to create inventories in sectors where it is easier to collect the necessary data. The steel sector is a good example. Unfortunately, the IPCC guidelines cannot be used to create inventories in the gas sector because reliable information about emission and activity factors does not exist for Russia. Russian agencies should conduct this work on their own or work in conjunction with other countries who have this experience.

EPA's Guidelines for Monitoring, Evaluation, Reporting, Verification and Certification of Energy-Efficiency Projects for Climate Change Mitigation

These guidelines were prepared as a part of a three-phase EPA project to create usable guidelines for monitoring JI projects (Vine and Sathaye 1999). During the first phase, an overview of all existing protocols to estimate energy savings was prepared. Developing the guidelines was the second phase of the project. During the third stage, a procedural handbook will be prepared that describes how the guidelines can be implemented in practice.

The main goal of these guidelines is to provide initial methodologies for emission reduction estimations as a result of joint implementation projects and assist participants in reporting and verifying energy efficiency projects. These guidelines also have a goal to standardize approaches for monitoring, provide a clear way of reporting of emission reductions and help to reduce monitoring cost. The guidelines develop standard forms for reporting which are based on a Uniform Reporting Format (URF) approved by the FCCC Secretariat for reporting JI projects.

Although these guidelines cannot fully be used for monitoring emission trading programs, they provide a good overview of existing methods to measure energy savings adopted by many energy efficiency programs in the United States and provide many practical examples of how these methods were used. The guidelines also incorporate methodologies used in many existing protocols adopted by both American agencies and companies – EPA, the Department of Energy (DOE), the U.S. Initiative on Joint Implementation (USIJI), Californian utilities – and international multilateral agencies (World Bank, Global Environmental Fund) for evaluating energy efficiency programs. These guidelines also help to emphasize the difference between monitoring JI projects and monitoring emission trading programs. It is suggested that the guidelines might be used for monitoring end-use energy efficiency projects both in the residential and industrial sectors.

The guidelines suggest calculating emissions by multiplying amount of energy saved by default emission factors suggested by the IPCC. Therefore, the main emphasis of the guidelines is how to calculate energy savings as a result of project implementation. Several methods are suggested for calculating energy use:[12]

[12] These methods are largely based on the methodology suggested by the International Performance Measurement and Verification Protocol (IPMVP). The IPMVP was adopted by DOE to estimate energy savings from implementing energy efficiency projects. Many countries now use the

- *Engineering methods.* Allow calculation of energy savings based on technical information from equipment manufacturers. These methods might be used for monitoring buildings and groups of buildings. They are most useful when implementing with other methods.

- *Statistical methods.* Include comparison of energy consumption before and after the implementation of energy efficiency measures by analyzing energy bills. Statistical methods are better when implemented for groups of buildings. They are relatively inexpensive and easy to explain, but assumptions need to be confirmed with survey data.

- *Measuring methods.* Allow measuring energy consumption by end-use metering. These are the most accurate methods for measuring energy use both in individual buildings and groups of buildings but not very useful for data analysis. They can be very costly and require using special equipment.

For each method, the guidelines provide information on which energy efficiency improvements are most suitable and provide practical examples from different agencies. However, the guidelines mostly give examples for monitoring energy efficiency improvements in the residential sector. Improvements in the industrial sector are almost left untreated. In the future, it would be useful to extend these guidelines by providing more information about industrial projects. New guidelines could also be designed for the natural gas sector.

Because the guidelines were prepared for monitoring JI projects, they pay special attention to estimating the additionality of a project. This includes careful estimation of a project baseline and then re-estimation of the baseline during project implementation. Results of estimation and re-estimation should be carefully reported by using special formats. This part will not be necessary in emission trading programs.

The guidelines require reporting of energy savings and emissions reduced by using standard forms that are compatible with URF. The guidelines also require providing estimations of uncertainties. It is also required that project participants report description of methods they use to calculate emission reductions and energy saved and provide quality assessment of these methods.

The guidelines also require verification of energy saved and emissions reduced by a third party. Verifiers should check all information provided by participants and report it to the FCCC Secretariat.

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protocol for evaluating their projects. The paper does not discuss the IPMVP in greater detail because it was not designed for estimating GHG reductions.

Although the guidelines cannot be fully used to monitor emission trading programs, they include four important provisions: 1) transparency, 2) verification of results by a third party, 3) careful reporting using a standardized format, and 4) estimation of uncertainties. These features will be essential for a future Russian monitoring system.

Voluntary Agreements in Europe

Voluntary agreements between industries and governments for reducing CO_2 emissions by implementing energy efficiency measures have been adopted in many EU countries. Although voluntary agreements in different countries have different provisions, they also have many common features regarding requirements for monitoring and covering participating industries. This section is based on an article prepared for the European Union (Chidiak 1999), which provides an excellent overview of voluntary agreements in five European countries.

Voluntary agreements were first adopted in 1990 in Europe, and they have been renegotiated on a regular basis since. The agreements were formulated as an attempt to introduce a new policy instrument to reduce CO_2 emissions cheaply and improve energy efficiency in industry. Initially, member countries proposed a carbon tax, but because of resistance from industry it was decided to exempt industries from this tax in Sweden, the Netherlands and France. Denmark introduced a carbon tax, but industries participating in voluntary agreements were taxed at a reduced rate.

All voluntary agreements involve an agreement between a government and an industrial sector or a company to improve energy efficiency and as a result stabilize or reduce CO_2 emissions during certain period of time. In Denmark, Germany and France this agreement covers only energy intensive branches; in other countries all industries may participate in an agreement. Commitments are set either on a branch level (Germany) or a firm level (Sweden, Denmark) or both (the Netherlands, France). Voluntary agreement parameters might be a subject of negotiations between a government and industries as it was in France and Germany, where a timetable, goals of the voluntary agreement, and coverage of industries were negotiated, or might be preset by a government, as it was in Denmark and Sweden. For example, in Denmark a firm signing an agreement should undertake energy efficiency improvements, conduct an energy audit (undertaken by a third party at the firm's expense), and regularly report progress. In exchange a company receives a big reduction in the carbon tax rate.

Regarding monitoring and verifying emissions, in most cases governments rely on firms' self-reporting. In the German case, individual firms report progress to their branch associations, which in turn provide information to an independent institute responsible for verification. Similarly, in France each individual firm reports to a steering committee and then the steering committee assesses progress made. In Denmark and Sweden, a firm's commitments include self-reporting of progress without monitoring and verification provisions. Only in the Netherlands do local authorities conduct periodic reviews in the framework of the permitting system that reinforces monitoring and verification, although

evaluation of a company's progress, by a collective governmental panel and industry representatives, is based on firms' self-reporting.

Regardless of the fact that in some cases commitments are set up on a sectoral level, monitoring is conducted at the firm level. When the Kyoto Protocol is ratified, requirements for monitoring and verification likely will be even stricter. Even if monitoring is conducted by companies, verification will be done by third parties.

Voluntary agreements have been successful in Europe. For example, in the Netherlands it was estimated that 25–45% of the achieved energy efficiency improvements between 1995 and 1998 were attributable to these agreements, and they were more cost effective than other regulation schemes.

Voluntary agreements might work in Russia; the steel sector is suitable for them because it is very inefficient and energy efficiency improvements might be done cheaply. The steel sector is one of the sectors that is still economically active in Russia. Steel manufacturers are interested in expanding their markets in the future and introducing new technologies. Voluntary agreements in most European countries cover energy intensive sectors, including the steel industry. It makes sense to start with one sector in the beginning because it will be difficult to work with many sectors at the same time, taking into account the large number of industries. There are relatively few steel facilities in Russia and it will be easy to cover most of them.

But in the case of Russia, several considerations should be taken into account. In Europe industrial companies have a strong incentive to increase energy efficiency because otherwise they pay a carbon tax. In Russia a carbon tax doesn't exist and cannot be an incentive to reduce emissions. Emissions in Russia, including industrial emissions, have dropped substantially. Therefore companies have few incentives to decrease them further. At the same time by implementing energy efficiency measures the steel sector can substantially decrease its energy expenses that represent a big part of its production cost. The Russian government would probably sign an agreement with the sector and promise a tax break if it implements energy efficiency measures.

Voluntary agreements could serve as an important first step in creating a pilot emission trading program between facilities. Facilities will have an incentive to further decrease emissions and get more credits when it will be possible to transfer credits. A special committee with representatives from the industry and the government could be created to collect information from facilities about their emissions. Goscomecologia or Hydromet could verify the implementation of these agreements.

Environmental Protection Agency's Acid Rain Program

EPA's Acid Rain Program, which is designed to decrease SO_2 and NOx emissions from power plants and large industrial sources by trading emission allowances, is the only full-scale emission trading program in existence. It requires continuous monitoring of

emissions and sets up clear rules for allocation, issuing and trading emission allowances. The program also requires careful tracking of all issued allowances through an electronic system. The program does not require reductions in CO_2 emissions, but it has provisions for monitoring these emissions. Currently, the program covers only power plants, which belong to energy utilities, but it also allows industrial facilities to participate voluntarily.

The Acid Rain Program is based on Title IV of the Clean Air Act, which requires reducing annual SO_2 emissions by 10 million tons below the 1980 level. To achieve this goal the Clean Air Act establishes a two-phase tightening of the restrictions placed on fossil fuel burning by power plants (EPA 1998).

Phase I started in 1995 and included 445 units of mostly coal burning plants located in eastern and mid-western states. During this phase, emissions were decreased by almost 40% below the required level.

Phase II will start in 2000 and will tighten the emission reduction goal imposed on these plants. It also will set restrictions on smaller coal, oil and natural gas fueled plants. Phase II of the program will affect all existing units with a capacity of more than 25 megawatts and all new utility units. The total number of units included will be more than 2,000.

The Clean Air Act also requires reducing NO_x emissions by 2 million tons by the year 2000. A substantial portion of this reduction will be achieved by coal-fired utility boilers that will be required to implement more modern technologies to meet new NO_x standards.

To achieve emission reductions cheaply, the Acid Rain Program introduced a market-based mechanism that allows affected units to obtain emission allowances. Under this provision each unit was allocated allowances based on its historic fuel consumption level and a specific emission rate. Each allowance permits a unit to emit 1 ton of SO_2 during or after a specified year. For each ton emitted in a given year, one allowance is retired or cannot be used again in that year. Allowances can be bought, sold or banked.[13] Any organization or individual can participate in trading. However, regardless of the number of allowances a unit has, it cannot emit at levels that violate federal or state limits set under Title I of the Clean Air Act (EPA 1998).

To control the number of allowances issued, EPA created a special electronic Allowance Tracking System (ATS), which tracks all allowance transactions. Any unit interested in participating in emission trading may open an ATS account by submitting an application to EPA. The account contains information on the number of allowances held by a unit, account representatives (who must be appointed by each trading party), and serial numbers of allowances. ATS is computerized to facilitate the data flow and have more reliable accounting of allowances (EPA 1998).

[13] A power plant that emits less than its emission objectives and doesn't sell its surplus allowances can use them in the next commitment period.

To encourage additional sources of SO_2 emissions to join the program, the Clean Air Act established the Opt-In Program. This program allows industrial facilities to enter the Acid Rain Program voluntarily, reduce their emissions, get their own allowances and participate in trading. It was estimated that the participation of additional units would reduce the cost of emission reduction (EPA 1998). In 1997, 160 units joined the program voluntarily.[14]

To make the Acid Rain Program credible, EPA requires all units to conduct continuous emission monitoring (CEM) of SO_2, NO_x and CO_2 emissions and report results to EPA. Monitoring rules are strictly set. There are provisions for initial equipment certification process, quality assurance and quality control procedures, and keeping records and reporting. EPA also provides rules for calculating emissions for periods of missing data. Emissions are reported on an hourly basis in tons and sent through the Emission Tracking System to EPA. Then EPA compares the results of monitoring with the number of allowances the facilities have and decides if they are in compliance. If a unit's emissions exceed the number of allowances it has, it pays a penalty of $2,000 per excess ton of SO_2 or NO_x emissions. In addition violating units are to offset excess SO_2 emissions with allowances in an amount equivalent to the excess (EPA 1998).

Monitoring emissions, reporting results, and careful verifying of emissions are the most crucial components of the Acid Rain Program because they provide the system credibility. It is useful to have a closer look at monitoring requirements.

All units over 25 megawatts and new units under 25 megawatts that use fuel with a sulfur content greater than 0.05% are required to measure and report emissions under the program. The following equipment should be installed:

1. SO_2 pollutant monitor;

2. NO_x pollutant monitor;

3. Diluent gas (O_2 or CO_2) monitor; and

4. Computer-based data acquisition and handling system for recording and making calculations.

The current rules do not require using CEM to monitor CO_2 emissions, but if utilities decide to do so, the CO_2 monitor allows calculating emissions in tons per hour. All units should install a data acquisition and handling system for reporting. All equipment should be in continuous operation and record data every 15 minutes. EPA must certify all

[14] Terry Keating, Office of Air & Radiation, the U.S. Environmental Protection Agency, personal communication, July 27, 1999

equipment before units can use it. All units should submit to EPA monitoring plans and hourly emission data in a standard electronic format available from EPA (EPA 1998).

Another important feature of the program is that all information concerning rules, data about emissions, and number of traded allowances is available from EPA's website. Anyone with access to the Internet can view the information (http://www.epa.gov/acidrain).

The Acid Rain Program is the most developed and highly credible emission trading program in use today. It includes all features of an ideal monitoring system. It cannot be fully used for emission trading programs because in most cases it is impossible to measure emissions – they are instead calculated from fuel consumption. Even if it is possible to monitor emissions, many industrial facilities have too many emission sources, which is especially the case for metallurgical plants, and it would be too costly to monitor all of them. However, electronic tracking of allowances can be used in any emission trading program. It is impossible under current conditions in Russia to develop an electronic system, at least in the next five years. At the same time, however, many industrial facilities already use modern computer systems, and these can serve as a foundation for future electronic systems. It is also important to have information available in a single place that is accessible to the public.

The Acid Rain Program is also important in that it creates an incentive for utilities to participate. It is cheaper for companies to set up a monitoring system and hold enough allowances to cover their emissions than to break rules and pay fines. The opportunity to trade allowances gives participants an incentive to cut emissions further by implementing additional measures and selling their excess allowances.

EPA/Gas Research Institute Study

From 1991 to 1996, EPA and GRI conducted a comprehensive study of methane emissions from the U.S. natural gas sector (EPA/GRI 1996). The main goal of the study was to estimate methane emissions from the whole natural gas sector for the base year of 1992 with an overall accuracy goal of 0.5% of natural gas production based on a 90% confidence level. The study also has a goal to support the IPCC strategy for fuel switching from coal and oil to natural gas. As a result of this study, emission and activity factors were calculated for all segments of the gas industry: production, processing, transmission (including storage), and distribution. The study identified approximately 100 components of natural gas systems, which are sources of methane emissions. For each component the study developed an emission factor. The study reached its goal in estimating baseline emissions and proved the IPCC strategy of fuel switching. In addition, results from the study are being used by the natural gas companies to reduce operating costs while reducing methane emissions.

Although not all methods and techniques developed by this study might be used by Gazprom, the general methodology can be applied for estimating methane emissions from the natural gas systems in Russia. It is also important to emphasize that in Russia's

case it will be easier to estimate emissions because there is only one company responsible for all natural gas operations. For example, in Russia there are only 14 gas transportation companies and they all belong to Gazprom, whereas in the United States there are several hundred independent companies responsible for natural gas distribution and transportation. Gazprom also uses more standard equipment. For example, 70% of compressor stations use the same three types of gas compressors (Dedikov 1998).

The methodology used in the study consisted of several steps. In the first step, EPA/GRI characterized the natural gas sector by breaking it into four segments (production, processing, transmission, and storage and distribution). Special attention was paid to exclude methane emissions from gas produced by oil wells. It was done to set a clear border between the oil and gas industries and avoid double counting. For each segment of the sector, the study identified all methane emission sources. For example, for the transmission sector more than nine components were defined. For each segment and each component the study produced a worksheet with estimations of emission and activity factors. Emissions were estimated for the whole segment and each component within the segment on the country scale. The study also estimated a range of uncertainty for each source of emissions.

In the second step, all sources were characterized as steady or unsteady emitters. EPA/GRI defined unsteady emitters as emitters with highly variable emissions, such as pneumatic devices or a maintenance activity that requires blowdown. Steady emitters were defined as emitters with a relatively constant rate of methane leaks. All emissions were characterized as fugitive, vented or combusted. The study also classified emissions in accordance to the time they occur: startup, normal operations, maintenance, upsets and mishaps emissions. After all emissions were classified, steady emissions were estimated by measuring emissions from different components. Different measurement techniques were used for different components. Emissions from a large number of components were measured and an average emission factor per component defined for each component type. Unsteady emissions were calculated or, in a case of maintenance emissions, calculations were taken from companies.

In the third step of the study, emission and activity factors were estimated. Because data were collected for a small percentage of sources, these data were extrapolated to obtain nationwide estimates of emissions.

EPA/GRI gave special attention to estimating the accuracy of the overall emission rate. By implementing different statistical methods the study estimated the accuracy of emissions calculated as ± 0.5% of gross natural gas production for the 90% upper confidence bound of the annual national emission rate. This was equivalent to an absolute accuracy target of approximately ± 111 billion standard cubic feet. For an estimated 307 billion standard cubic feet, this translates into a range of uncertainty of ± 33%.

The study also identified a range of uncertainty of emission calculations for each segment of the natural gas sector. The smallest range of 52% was for compressor stations.[15] For some segments, such as metering and control stations at transmission pipelines, the range of uncertainty was several hundred percent.

The methodology suggested by EPA/GRI might be very useful in estimating emissions from Gazprom. Specific estimates are important, because the existing IPCC methodology does not provide good techniques for estimating methane emissions and doesn't have good information on activity and emission factors. The emission and activity factors for Russia are largely unknown. In fact, it will be easier to implement this methodology and to collect data in Russia, because the Russian natural gas sector is less diverse than the American. In addition, EPA has already made several measurements at compressor stations in Russia. Initially, it would make the most sense to cover not the whole sector, but segments producing the largest share of emissions where the range of uncertainty is rather small.

[15] It is possible that the overall uncertainty for the whole system is lower than uncertainties for different components. Sophisticated statistical methods can decrease the overall uncertainty of data.

POLICY RECOMMENDATIONS

Russia is at a good starting point for creating a monitoring system for GHG emissions and sectoral inventories. It has institutions responsible for monitoring in place and is creating a monitoring system for other air pollutants, which can be extended to include GHGs. No global GHG emission monitoring system is currently in place, but some experience with monitoring already exists on both domestic and international levels. Russia could use this experience to speed the design of its future system. International bodies have already designed guidelines for GHG inventories, and Russia should use them. Several recommendations both for creating inventories and designing a system might be useful for Russia:

1. **Use standard IPCC guidelines to the extent possible.** Russia should create inventories for sectoral emissions. The IPCC provides different methodologies to calculate emissions. In Russia it is important to start with simple methods. It is useful to begin with sectors that have the biggest share of emissions or have limited sources of emissions. The steel sector is one example. It produces the largest share of industrial CO_2 emissions. There are not many facilities and it will be easier to cover all of them. In the future, when initial information about emissions are collected and the biggest sources identified, it will be possible to use more rigorous and expensive methods for calculating emissions especially for these sources.

2. **Use methodologies accepted by other countries for sectors not covered by the IPCC**. For some categories, the IPCC does not provide well-defined techniques. The natural gas sector is one example. The IPCC does not provide reliable information about emission and activity factors for Russia. To create a reliable inventory Russia might draw from American experience. EPA already has experience in conducting projects with Gazprom and is willing to cooperate in the future. It will be too expensive to cover the whole natural gas sector at the beginning and it makes sense to start with a segment that produces the biggest share of emissions. Transmission pipelines and compressor stations are a good place to start.

3. **Improve data collection methods.** Although the IPCC guidelines provide simple methods, they require using a facility level statistics. These statistics should be carefully collected and published by regional Goscomstat and Goscomecologia branches.

4. **Improve coordination between regional ministries.** Several ministries are responsible for collecting statistics on a regional level. Both Goscomecologia and Goscomstat collect data about air pollution. The Ministry for Fuel and Energy and Goscomstat compile information about fuel consumption. One ministry should be responsible for storing all collected information.

5. **Increase quality of reporting**. All reporting should be done using standard forms suggested by international bodies. This will increase the transparency of the system and facilitate data collection. Electronic reporting helps to facilitate data exchange between users and to standardize information. It will be difficult to computerize data collection and reporting for all sectors at the same time but it should be possible for some sectors. For example, many steel factories already use computers for managing financial information. All information should be collected in one place. Electronic reporting also facilitates the process of verification. If all information is presented in a standard format and data collection methods are clearly described for verifiers, it will be easier to check this information.

6. **Increase the transparency of monitoring**. Information about emissions should be available for all interested parties. Ultimately, this could be done through a website where all information is readily available.

7. **Include verification of monitoring**. Results of monitoring should be verified by a third party. Monitoring might be conducted by facilities, which submit information to Goscomecologia or to a special center created for data collection. International bodies or independent Russian agency should do the verification.

8. **Create incentives for monitoring**. It is important that facilities have incentives to monitor. Both EPA's Acid Rain Program and Voluntary Agreements in Europe are successful because participating entities have incentives to monitor and submit reliable information. In EPA's program, utilities can benefit from implementing additional measures to limit SO_2 emissions because they can sell more allowances. Under Voluntary Agreements, facilities that implement energy efficiency measures are exempted from the carbon tax. In Russia, signing a voluntary agreement between the steel industry and the government may be a first step in establishing a pilot emission trading program. Although emissions have already been reduced in Russia, reducing them further facilities will generate more credits. It is important that the Russian government allows industries to take part in emission trading for this reason.

9. **Design guidelines with a varying levels of detail.** It is important that guidelines for monitoring are not too complicated and do not take too much time to follow. It makes sense to create more complicated guidelines for JI projects when it is necessary to estimate and re-estimate baselines. Guidelines should be simpler for emission trading programs. It is also important for Russia that guidelines are not very expensive to follow. Reporting about emission reductions should not be very complicated. It will be a trade-off between credibility of a system for which it is important to have as much information as possible and cost-effectiveness of a system. Starting with simple methods at the beginning and then implementing more precise and complicated methods may be a solution to this problem. If companies spend too much time on monitoring, verification, and reporting, they will be less willing to participate in any flexible mechanisms.

10. **Provide information about monitoring for JI projects.** This recommendation is relevant not only for Russia but all FCCC parties. Currently, the FCCC reports about JI projects do not include information about monitoring. It is highly recommended that such information be included and available to all interested parties. The availability of such information helps to better estimate emission reductions due to project implementation and therefore increases the credibility of climate change mitigation through JI projects.

CONCLUSIONS

Russia must create a GHG emission monitoring system and inventories for different sectors in order to be eligible for participation in flexible mechanisms. As the findings of this study indicate, this is a challenging though feasible task.

Guidelines for creating inventories were developed by the IPCC and Russia should follow them. They allow users to calculate emissions from all sources and have several important features:

- Provide simple methods to calculate sectoral emissions;
- Require reporting in a transparent way;
- Include estimations of uncertainties; and
- Require verification of results.

All of these features are essential for Russia. Russia still lacks sectoral inventories, and it must create them. Existing guidelines provide Russia with techniques to do this. Starting with the steel sector will be relatively easy for Russia because there are only a few facilities and it will not be extremely difficult to collect necessary data. By covering the steel sector, Russia also will be covering a significant part of its industrial emissions.

The IPCC guidelines do not provide well-defined methods for calculating methane emissions from the natural gas sector. EPA and GRI have completed a comprehensive study on identifying emission sources and estimating emissions from the U.S. natural gas sector. Using the methodology of these institutions, Russia could create a thorough inventory of methane emissions.

A monitoring system for GHGs does not currently exist in Russia. Therefore, Russia may want to adapt monitoring systems adopted in other countries or recommended by international bodies under the FCCC. American agencies are developing monitoring systems for flexible mechanisms for the FCCC. Recently, EPA has developed guidelines for monitoring energy efficiency projects. Rules for monitoring emission trading programs do not yet exist because this is a new and untested mechanism. Although monitoring schemes for JI projects and emission trading programs will be different, some features will be similar, such as transparency, verification of results, clear reporting; and measurement of uncertainties. All these features will be crucial for the credibility of a Russian system.

Currently, GHG monitoring does not include provisions for noncompliance because it is still impossible to transfer emission reduction credits. It also does not require measuring

emissions. To understand how these provisions might be included into a future monitoring system it is useful to look at the full-scale SO_2 emission trading program designed by EPA. This program requires continuous emission monitoring, including voluntary measurement of CO_2 emissions. It also requires electronic tracking of allowances and includes strict rules for noncompliance. These last features will be extremely important for the credibility of future Russian emission trading programs.

Russia already has a monitoring system for other substances. The Unified State System for Environmental Monitoring was created in Russia in 1993. This system should coordinate efforts of all agencies responsible for monitoring and provide electronic collection of data. It has a hierarchical structure with regional centers. There is one agency – Goscomecologia – that is responsible for collecting and storing all data. This system does not have provisions to monitor GHG emissions, but it should definitely be considered for this purpose.

In summary, Russia is capable of constructing a reliable monitoring system. It will not be an easy task, and it will require a great deal of effort, but the basis for this system already exists within Russia's borders.

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