JOINT IMPLEMENTATION PROJECT DESIGN DOCUMENT FORM
Version 01 - in effect as of: 15 June 2006

CONTENTS

Annexes

SECTION A. General description of the project

A.1. Title of the project:

Project Title: Construction of new Air Separation Plant by Air Liquide Severstal, Russia.

The project belongs to Sectoral Scope (5): Chemical industry

This is version 7 of the Project Design Document dated March 2, 2010.

A.2. Description of the project:

Purpose of the Project:
The company CJSC Air Liquide Severstal (ALS) commissioned, in December 2007[1], a state-of-the-art cryogenic air separation plant on the premises of the Severstal steel production complex in Cherepovets in the Vologda Region of Russia. The plant's purpose is to produce technical gases, especially high pressure oxygen and nitrogen, and deliver them to the steel plant. The facility has a maximum design capacity of 90,000 Sm^3/hr[2] of high pressure purified oxygen. It can also produce other gases, such as high-pressure nitrogen (30,000 Sm^3/hr), low-pressure nitrogen (30,000 Sm^3/hr) and argon (1,470 Sm^3/hr).

Picture 1: View of the ALS Plant

Project Company:

[1] The Physical Completion Notice from ALS to EBRD dates from December 7, 2007. It confirms that all equipment has been installed, that all production tests have been successfully completed and that the start-up of the facility has occurred. The Physical Completion Notice has been made available to the verifier.

[2] All gas volumes are presented in Sm^3, i.e. under standard conditions of 20°C and 760 mmHg.

ALS is a Joint Venture between Air Liquide (75%) and OAO Severstal Steel Works (Severstal) (25%) with the special purpose to construct and operate the air separation plant.[3] ALS is also entitled to sell carbon credits generated by its operation.[4]

Air Liquide supplies oxygen, nitrogen, hydrogen and many other gases to a diverse set of industries (steel, oil refining, chemicals, electronics, pulp and paper, metallurgy, food-processing, glass, aerospace and healthcare). The Company also provides a wide variety of services that range from managing all gas-related operations at customer sites and finding new energy solutions for manufacturers, to providing healthcare services for treating patients at home.[5]

Severstal is Russia's largest steel company in terms of consolidated revenue and third largest in terms of domestic steel production. The company is operating as a vertically integrated full-production-cycle steel mill; it has secure sources of raw materials and is conveniently located on a juncture of railway and water transportation routes facilitating delivery to its domestic and export customers. In addition to its domestic operations, Severstal has acquired a major Italian steel company (Lucchini) and a major U.S. steel company (Rouge Steel).[6]

Air Liquide has provided the air separation technology for the facility. Air Liquide also provides the management and technical staff for the JV team in order to transfer the necessary technology and provide support in its implementation. Severstal provides the land and supplies utilities, such as compressed air, steam and water. Severstal also provides its power distribution network to deliver electricity from the public grid to the ALS facility. Finally, Severstal purchases the vast majority of the gases produced by ALS under a 15-year gas supply contract.[7]

Situation existing prior to the starting date of the project;
Before 2005 OAO Severstal Steel Works operated ten Russian-made low-pressure cryogenic air separation units on the premises of its steel production complex in Cherepovets. The units apply a low-pressure air separation process where the separated oxygen and nitrogen is compressed afterwards in dedicated product compressors.

Baseline Scenario:
In the absence of the project the most plausible scenario would have been the construction of additional Russian-made low-pressure cryogenic air separation units with a combined capacity of 90,000 Sm^3/hr. They would most likely have been installed on the premises (or in the immediate vicinity) of the steel production complex in Cherepovets. The facility would have used a low-pressure air separation process. It would have been provided with compressed air from a number of main air compressors, and the separated low-pressure oxygen and nitrogen would have been further compressed by product compressors.

Project Scenario
The air separation facility constructed and operated by ALS is a greenfield state-of-the-art facility that applies internal compression via a pumping cycle. As a result, the facility directly produces high-pressure oxygen and high-pressure nitrogen and does not need any further product compressors. The facility

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[3] The business purpose of ALS is documented in the ALS JV Charter. The Charter has been made available to the verifier.

[4] ALS was specifically empowered to sell carbon credits at the ALS Board Meeting on July 23, 2009. Minutes of the meeting have been made available to the verifier.

[5] http://www.airliquide.com/en/company.html

[6] http://www.severstal.com/eng/about/company_profile/

[7] The Gas Supply Contract between ALS and Severstal has been made available to the verifier.

includes two main air compressors and a booster air compressor, but the JV also purchases compressed air as well as steam.

The ALS facility provides additional capacity to produce 90,000 Sm^3/hr of high-pressure oxygen plus some other gases, such as high-pressure nitrogen (30,000 Sm^3/hr) and argon. The facility is almost 30% more energy-efficient than the baseline alternative.[8] Instead of compressing the separated gases with dedicated product compressors, the ALS facility liquefies the separated gases and uses pumps to increase the pressure of the liquid products before they are vaporized again and delivered as high-pressure gases to the customer. The energy efficiency gains are achieved because pumping liquids requires less power than compressing gases using standards Russian product compressors. The implementation of the project saves approximately 19 MW of electricity and some steam per year compared with the baseline. Estimated emission reductions are approx. 100,000 tonnes of CO_2e per year and more than 500,000 tonnes during the Kyoto period (2008-2012).[9]

History of the Project

The ALS Joint Venture was registered on August 31, 2005.[10] The loan agreement for the project with the European Bank for Reconstruction and Development (EBRD) was signed in December 2005. Trial production was launched in September 2007,[11] the overall commissioning phase lasted from May 2007 to November 2007, and the project was fully completed in December 2007.[12] The facility has been operating without any major technical problems since. The project's potential to generate CO_2 emission reductions was considered and estimated at an early stage of the decision-making process. The emission reduction potential was included in the EBRD Board Review Document[13] as a monitoring benchmark for the investment loan. The host country letter of approval is expected after completion of the determination process.

A.3. Project participants:

[8] The detailed emission reduction calculation has been made available to the verifier.

[9] The detailed emission reduction calculation has been made available to the verifier.

[10] The state registration number for ALS is 1053500285673. The registration certificate has been made available to the verifier.

[11] http://www.airliquide.com/en/press/press-releases/inauguration-de-lunite-air-liquide-severstal.html.

[12] The Physical Completion Notice from ALS to EBRD is dated December 7, 2007.

[13] The information is taken from page 15 of the EBRD Board Review Document, Russian Federation, Air Liquide Severstal JV. The document has been made available to the verifier. See also the EBRD Project Summary Document at http://www.ebrd.com/projects/psd/psd2005/35545.htm.

Party involved	Legal entity project participant (as applicable)	Please indicate if the Party involved wishes to be considered as project participant (Yes/No)
Russian Federation (host Party)	• CJSC Air Liquide Severstal	No
Netherlands, Spain, Switzerland	• Stichting Carbon Finance (SCF)	No

A.4. Technical description of the project:

A.4.1. Location of the project:

The ALS plant is located at ul. Ustyuzhenskaya, 97 in Cherepovets in the Vologda Region of Russia. Cherepovets is approx. 400 km north of Moscow and 440 km east of St. Petersburg. The geographic location of the project within the Russian Federation and within Vologda Region is shown on the map below.

A.4.1.1. Host Party(ies):

Russian Federation

A.4.1.2. Region/State/Province etc.:

Vologda Region

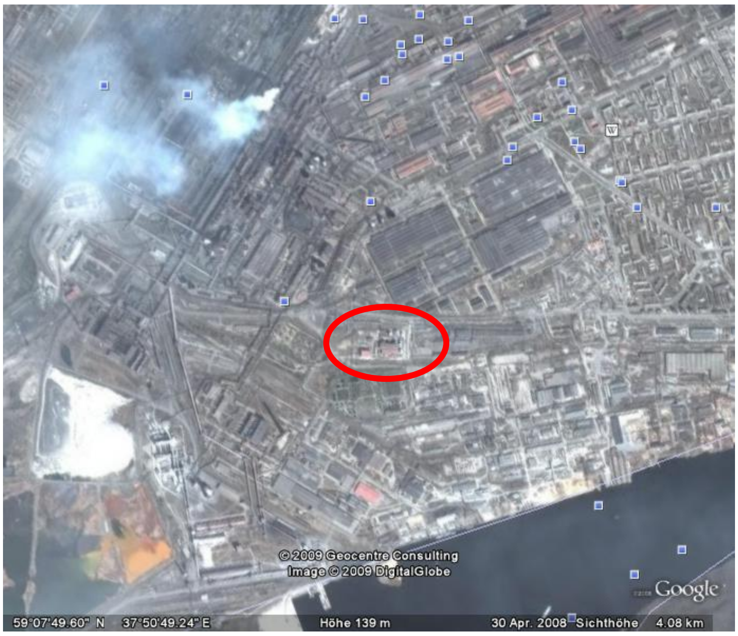
A.4.1.3. City/Town/Community etc.:

Cherepovets

A.4.1.4. Detail of physical location, including information allowing the unique identification of the project (maximum one page):

ALS is leasing two land plots with the cadastral numbers 35:21:0102001:679 and 35:21:0102001:680.[14]

The ALS plant has the GPS coordinates 59˚07'39" North and 37˚50'55" East. It is located at ul. Ustyuzhenskaya, 97 in the City of Cherepovets in the Vologda Region of the Russian Federation. Cherepovets lies approximately 400 km north of Moscow and 440 km east of St. Petersburg. The ALS facility is located within the premises of the Severstal steel making complex.



Picture 2: Location of ALS Plant within Severstal's steel making complex

[14] The Certificates of State Registration of the Property (679 and 680) and Cadastral Plans (679 and 680) have been made available to the verifier.

Picture 3: Location of ALS Plant within the City of Cherepovets, Vologda Region, Russian Federation.

A.4.2. Technology(ies) to be employed, or measures, operations or actions to be implemented by the project:

The technology for the ALS air separation facility has been developed by Air Liquide: a cryogenic air separation process with an internal pumping cycle for compression of the gas products. The energy inputs and gas outputs are shown in Figure 1 below.[15]

[15] A more detailed flow chart is included in the technical specification of the plant reference AL210TP-12-2. The title of the document is "Technical Proposal submitted by Air Liquide Engineering to JV Severstal-Air Liquide concerning new Air Separation Unit 90 000 Sm3/hr", dated May 2005. The detailed flow chart has been made available to the verifier.

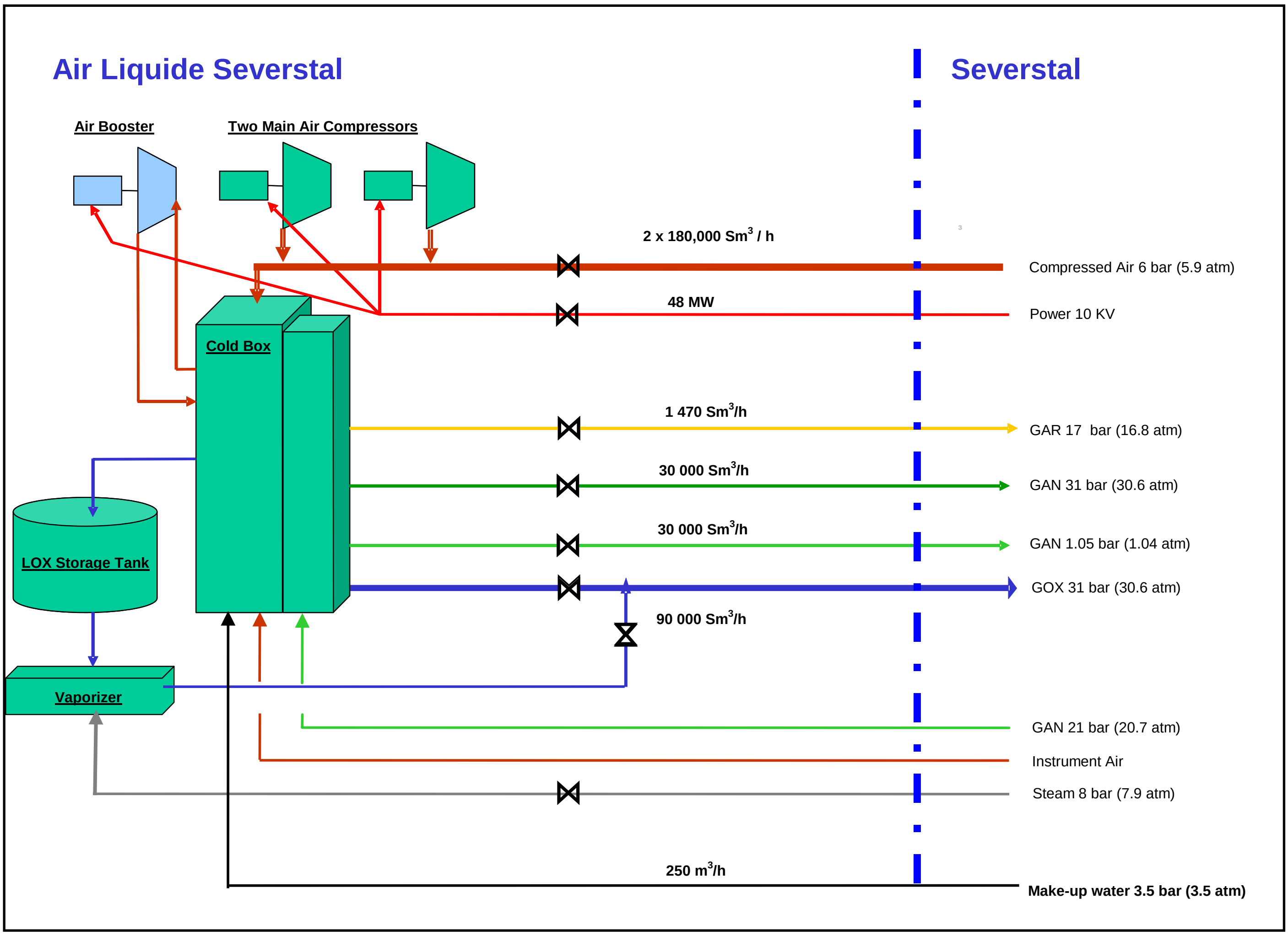


Figure 1: ALS Process Flow Chart

Legend:
GOX: Gaseous Oxygen
GAN: Gaseous Nitrogen
GAR: Gaseous Argon
LOX: Liquid Oxygen

Technical Equipment:
The key piece of equipment of the ALS facility is the cold box where the air separation takes place. The separated gases are liquefied, and the liquids are pumped to high pressure. Liquid oxygen and liquid nitrogen are pumped to a pressure of maximum 31 bar (30.6 atm), while Argon is pumped to a pressure of maximum 17 bar (16.8 atm). The project also includes the installation of three new air compressors, two of which are main air compressors that supplement the compressed air that ALS purchases, and one is a booster air compressor that recompresses the compressed air to a higher pressure.

Energy and Utilities Consumption:
The most important energy input for the ALS plant is electricity. More than 90% of the power is consumed by the two main air compressors and the booster air compressor, the remainder is consumed by the cold box, the internal pumping cycle and the utilities. In addition to electricity the ALS plant consumes

compressed air and a small amount of steam, which is used to vaporize liquid oxygen (LOX) from the LOX Storage Tank. Regarding other utilities ALS receives make-up water to compensate for evaporation losses, steam to vaporize liquid oxygen, instrument air and small amounts of high-pressure gaseous nitrogen when the ALS plant is shut down.

Only electricity, compressed air and steam are considered in calculating the project's GHG emissions, the other inputs are considered to have only a negligible effect.

Production Process:
The following sub-processes can be distinguished: Air Compression, Cooling, Purification, Air Separation and Gas Delivery.

1. Air Compression:

The ALS plant operates two main air compressors and also purchases compressed air at 6 bar (5.9 atm).

2. Cooling:

The compressed air is then cleaned (dust removal) and cooled down in a two-stage direct contact process air tower. In the lower section of the cooler, the air is pre-cooled with recycled cooling water. In the upper section of the cooler, the air is further cooled by chilled water. The water is chilled through the evaporation of waste nitrogen in the evaporative cooler.

3. Purification:

At the outlet of the process air tower, the air passes through an air purification unit, which removes water, CO_2 and some hydrocarbons. The air purification unit is composed of two vessels filled with alumina and molecular sieve. One of the two vessels is in operation, while the other is regenerated by gaseous nitrogen coming from the cold box. During the heating cycle, the regeneration gas is heated by an electrical heater.

4. Cold Box: Air Separation

After leaving the process air tower the stream of purified air is split between (i) the low-pressure column of the cold box (See 4.1), (ii) the medium-pressure column and (See 4.2) and (iii) the booster air compressor.

4.1 Air Separation: Low Pressure Column:

The incoming air is further cooled down and separated into component gases by distillation. The low-pressure column yields the following products:

1. at the bottom, liquid oxygen
2. at the top, waste (impure) nitrogen.

Some liquid oxygen is drawn from the bottom of the low pressure column and sent to the Liquid Oxygen (LOX) storage tank. Most of the liquid oxygen is pumped to high pressure, vaporized, warmed up to ambient temperature and constitutes the High Pressure Gaseous Oxygen (HPGOX - 31 bar / 30.6 atm) production.

The waste nitrogen is used as regeneration gas for the air purification vessels and for water chilling in the evaporative cooler.

4.2 Air Separation: Medium-Pressure Column:

After passing through the booster air compressor the air reaches a pressure of 45 to 60 bar (44.4 to 59.2 atm). It then passes a Joule-Thompson valve where the pressure is decreased to between 3.8 and 5.0 bar (3.5 to 4.9 atm) before it enters the medium pressure-column of the cold box. The incoming air is further cooled down and separated into component gases by distillation. From top to bottom, the medium pressure column yields the following products:

1. pure liquid nitrogen
2. a liquid called "lean liquid" with low oxygen content
3. a liquid called "rich liquid" with about 38 to 40% of oxygen

The liquid nitrogen is drawn from the top of the medium pressure column. One part is pumped to high pressure, vaporized, warmed up, and constitutes the High Pressure Gaseous Nitrogen (HPGAN – 31 bar / 30.6 atm) production. The remaining part is used as reflux for the pure nitrogen column ("minaret")

The rich liquid is used as reflux for the argon column and the low-pressure column.

The lean liquid is used as reflux for the low pressure column.

4.3 Air Separation: Pure Nitrogen Column:

Low-pressure gaseous nitrogen is withdrawn at the top of the pure nitrogen column. It is warmed up to the ambient temperature and constitutes the Low Pressure Gaseous Nitrogen (LPGAN – 1.05 bar / 1.04 atm) production.

4.4 Air Separation: Argon Columns:

A stream of gas from the intermediate level of the low pressure column is fed into the crude argon column, where it is stripped of its oxygen content. A liquid crude argon stream is fed into the pure argon column where it is stripped of its nitrogen content. Reflux is provided at the top of the column in the pure argon condenser by vaporization of nitrogen.

Pure liquid argon product is taken from the bottom of the column and stored. A part of the liquid is pumped to high pressure, vaporised, warmed up in main exchanger and constitutes the HPGAR production.

5. Gas Delivery

HPGOX, HPGAN, HPGAR and LPGAN are delivered at the outlet of the cold box. LOX is stored in the LOX Storage Tank and is vaporized when needed.

A.4.3. Brief explanation of how the anthropogenic emissions of greenhouse gases by sources are to be reduced by the proposed JI project, including why the emission reductions would not occur in the absence of the proposed project, taking into account national and/or sectoral policies and circumstances:

Project vs. Baseline:
The project is the construction of a greenfield state-of-the-art air separation plant, with a capacity of 90,000 Sm^3/hr of high-pressure oxygen. The ALS facility separates the compressed air with a cryogenic process, liquefies the separated gases and uses pumps to increase the pressure of the liquid products before they are vaporized again and delivered as high-pressure gases to the customer. In the absence of the project, the most plausible scenario would have been the construction of three new 30,000 Sm^3/hr air separation units with traditional low-pressure air separation technology.

The proposed project is almost 30% more energy efficient than the baseline alternative.[16] This is due to three factors:

1. The introduction of a high-pressure pumping cycle technology which replaces the compression of the separated oxygen and nitrogen. Instead of producing gaseous products (oxygen, nitrogen, argon) at low pressure and then compressing them with the dedicated Russian-made product compressors, the ALS facility creates pressure by pumping cryogenic liquid products before vaporization and delivery to the customer. The energy efficiency gains are achieved because pumping liquids requires much less power than compressing gases using low efficiency compressors technology.
2. An improved extraction ratio of oxygen from compressed air
3. The installation of more energy efficient air compressors that reduce the volume of compressed air that needs to be purchased.

The energy savings achieved by the project correspond to approximately 19 MW or more than 100,000 tons of CO_2e per year from 2008 to 2012.[17]

The emission reductions would not occur in the baseline scenario that is most likely to occur in the absence of the project, i.e. the production of the same amount of high-pressure oxygen with low-pressure air separation technology. By installing Air Liquide's state-of-the-art technology the JV went much beyond legal requirements and prevailing practice in Russia.[18] In addition, the project is not attractive on financial grounds without the inclusion of carbon credit revenue. [19]

A.4.3.1. Estimated amount of emission reductions over the crediting period:

The 2008 emission reductions are based on monitored data. The emission reductions for the years 2009 to 2017 are estimates.

[16] The detailed emission reduction calculation has been made available to the verifier.

[17] The detailed emission reduction calculation has been made available to the verifier.

[18] See section B.2.

[19] See Section B.2.

	Years
Length of the crediting period[20]	5
Year	Estimate of annual emission reductions in tonnes of CO_2 equivalent
2008	114,604
2009	102,045
2010	100,693
2011	99,354
2012	98,030
Total estimated emission reductions over the crediting period (tonnes of CO_2e)	514,726
Annual average of estimated emission reductions over the crediting period (tonnes of CO_2e)	102,945
2013	96,719
2014	95,422
2015	94,139
2016	92,868
2017	91,610
Total estimated emission reductions from 2013 to 2017 (tonnes of CO_2e)	470,759
Annual average of estimated emission reductions from 2013 to 2017 (tonnes of CO_2e)	94,152

A.5. Project approval by the Parties involved:

Host Country: Russian Federation

The host country Letter of Approval will be requested once a draft determination report is available, in accordance with the Russian JI procedures.

The Russian Government first issued its JI project approval procedures on January 28, 2007.[21] On October 28, 2009, it adopted two new documents relating to the development of JI projects under the Kyoto Protocol to UNFCCC in the Russian Federation. They have replaced two previous documents adopted by the Russian Government on May 28, 2007 (namely: Russian Government Resolution No. 332 "On the Procedure for Adopting, and Checking the Development of JI Projects" and the Regulations "On Adopting, and Checking the Development of JI Projects. The Ministry of Economic Development performs the role of Focal Point; OAO «Sberbank of Russia» performs the functions of Carbon Units Operator.

Investor Countries: Netherlands, Spain, Switzerland

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[20] Extension of crediting period beyond 2012 is subject to host party approval. See also Section C.3.

[21] The relevant orders include (1) Russian Government Resolution No. 843 "On Measures to Implement Article 6 of the Kyoto Protocol to the United Nations Framework Convention on Climate Change" (2) Regulations "On Implementation of Article 6 of the Kyoto Protocol to the United Nations Framework Convention on Climate Change"

Investor's country Letter of Approval will be requested from the three investor countries once host country approval from the Russian Authorities has been obtained.

SECTION B. Baseline

B.1. Description and justification of the baseline chosen:

Article 6 of the Kyoto Protocol establishes that a JI project provides “a reduction in emissions by sources, or an enhancement of removals by sinks, that is additional to any that would otherwise occur.” Appendix B of the Guidelines for the implementation of Article 6 of the Kyoto Protocol (the JI Guidelines)[22] states that the baseline is the scenario that “reasonably represents the anthropogenic emissions by sources or anthropogenic removals by sinks of greenhouse gases that would occur in the absence of the proposed project.” There is no approved CDM methodology that can be directly applied to the proposed project and a JI-specific approach is used. Therefore, according to Annex 1 of the JISC Guidance on Criteria for Baseline Setting and Monitoring (Version 2) “additionality can be proved by providing traceable and transparent information showing that the baseline was identified on the basis of conservative assumptions, that the project scenario is not part of the identified baseline scenario and that the project will lead to reductions of anthropogenic emissions by sources or enhancements of net anthropogenic removals by sinks of GHGs.”[23] The conservativeness of the baseline is justified in the remainder of Section B.1. In Section B.2. it is demonstrated that the project without being registered as a JI project is not a plausible baseline scenario. This is shown with an investment analysis that conforms with the CDM Executive Board’s Guidance on the Assessment of the Investment Analysis (version 3).[24] The results of the investment analysis are reinforced by a barrier analysis and a common practice analysis.

Identification of alternative baseline scenarios:

In accordance with Paragraph 21 of the JISC Guidance on Criteria for Baseline Setting and Monitoring the baseline is established on a project-specific basis. For any baseline alternative the following key factors affecting the choice of baseline have to be considered:

- Russian law and national policies are not relevant to the choice of baseline. There are no laws, policies or other circumstances in Russia that require a certain air separation technology to be applied. There are also no laws, policies or other circumstances in Russia that require air separation plants, air compressors or product compressors to achieve a certain level of energy efficiency. All three of the below baseline alternatives are fully compliant with Russian Law.
- The project meets incremental demand for high-pressure oxygen and high-pressure nitrogen at the Severstal Steel Works. The same level of HPGOX and HPGAN volume has to be delivered by the baseline alternative.
- Any economic consideration of baseline alternatives has to take into account not only the production cost of the gases but also the delivery costs. For large delivery volumes, such as those required by Severstal Steel Works, it is economically advantageous to locate the air separation plants in the immediate vicinity of the consumption site so that a direct pipe connection can be arranged.
- Cryogenic air separation was a well-established industrial process in Russia in 2005. Low-pressure air separation combined with dedicated project compressors was the prevailing practice.[25]

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[22] See the Annex to Decision 9, CMP1, 2005 in Montreal. The document is available at http://unfccc.int/resource/docs/2005/cmp1/eng/08a02.pdf#page=2

[23] See Section 2. (a) of Annex 1 of the JISC Guidance on Criteria for Baseline Setting and Monitoring. The document is available at http://ji.unfccc.int/Ref/Documents/Baseline_setting_and_monitoring.pdf

[24] The document is available at http://cdm.unfccc.int/EB/051/eb51_repan58.pdf

[25] See Section on Common Practice Analysis in Section B.2.

In the Cherepovets area there were a number of low-pressure air separation plants at the time, and there was a pool of local employees with a great deal of know-how and comfort with low-pressure air separation plants.
- Russian capital markets were not well developed at the time of decision-making in 2005.

The following three baseline alternatives have been identified. All of them comply with Russian law and national policies.

1. **Project:** The proposed project activity without being registered as a JI project

2. **Low-Pressure Air Separation:** Construction of low-pressure cryogenic air separation plants on the premises (or in the immediate vicinity) of the Severstal Steel Works. The plant would be provided with compressed air from air compressors and the separated low-pressure oxygen and nitrogen would be further compressed by product compressors. As shown in the Common Practice Analysis in Section B.2 low-pressure air separation technology was clearly the prevailing practice in Russia in 2005.

3. **Liquid Oxygen:** Utilization of off-site air separation capacity to produce liquid oxygen and liquid nitrogen. Transport them to the site where they are used in the production process.

Assessment of alternative scenarios:

1. **Project:** The proposed project is able to deliver the required volumes of high-pressure oxygen and high-pressure nitrogen to Severstal Steel Works. The project facility is located on the premises of the Severstal Steel Works so that the gases can be delivered via direct pipe connections. However the project is not financially attractive as shown in Section B.2. In addition, the project faced a number of barriers. The ALS facility was the first oxygen plant with Air Liquide technology in Russia, and it was about three times as large as the largest air separation facilities in the country. There were no large oxygen plants with similar technology in Russia. Local employees did not have experience with the technology.

2. **Low-Pressure Air Separation:** Low-pressure air separation plants would be able to deliver the required volumes of high pressure oxygen and high-pressure nitrogen to Severstal Steel Works. They could be located on the premises of the Severstal Steel Works or in the immediate vicinity so that the gases could be delivered via direct pipe connections. In 2005 low-pressure air separation technology were clearly economically feasible as they were the prevailing practice in Russia as shown in Section B.2.[26] At the time Severstal was actually operating ten such air separation units on its premises, the last of which was installed in 2004. As a result, there was a pool of local employees very familiar with the technology. There were also opportunities to generate economies of scale in the management of spare parts and maintenance operations.

3. **Liquid Oxygen & Nitrogen:** Off-site liquid oxygen & nitrogen plants would be able to deliver the required volumes of high-pressure oxygen and high-pressure nitrogen to Severstal Steel

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[26] The leading domestic manufacturer of air separation technology commissioned its first plant only in 2007. See http://www.cryogenmash.ru/en/content/news/index.php?news=2111. On its website Cryogenmash asserts that "Cryogenmash's plants for oxygen, nitrogen and other technical gases production are operated practically at all metallurgy and petrochemistry enterprises in Russia."
http://www.cryogenmash.c.om/en/content/news/index.php?news=2107

Works. However, transporting liquefied gases by truck does not realize the savings that direct pipe connections can achieve when high volumes of gases are delivered to a single facility in close proximity. It is economically inefficient to transport liquefied gases by truck if high volumes are consumed by a single facility, such as a large steel works, metallurgical or chemical plant. For illustration, the ALS facility produces 3,000 tons of HPGOX per day, which compares with a load of 17 tons for a regular truck. About 180 trucks would have to be loaded and unloaded every day. This would be much more costly than a direct pipeline connection between the air separation plant and the steel plant. This is clearly reflected in the prevailing practice in the steel industry[27]. As a result the alternative Liquid Oxygen is not considered as a plausible alternative.

Conclusion:

Only alternative "Project" and alternative "Low-Pressure Air Separation" are viable alternatives. However alternative "Project" is not attractive on economic grounds and faces barriers. This is demonstrated in Section B.2.

The alternative "Low-Pressure Air Separation" is the only remaining plausible alternative and is identified as the baseline scenario.

Key information and data used to establish the baseline:
The baseline emission rate is derived from a reference low-pressure air separation facility in Russia, which was commissioned in 2004. The reference facility operates under very similar conditions as the ALS plant and represents the technology most likely to be used in the absence of the project. The reference facility produces low-pressure oxygen and nitrogen, which is subsequently compressed by product compressors to high-pressure oxygen and nitrogen. The choice of baseline is conservative, since it is based on the most recently installed technology in Russia (build margin) and does not account for the fact that many air separation plants currently operating in Russia (operating margin) are of much lower efficiency.

[27] Please refer to the reference list of Cryogenmash which sells much of their equipment directly to steel, metallurgical and chemical plants in Russia and Ukraine. http://www.cryogenmash.ru/en/production/cryogenic_launches/vru.php

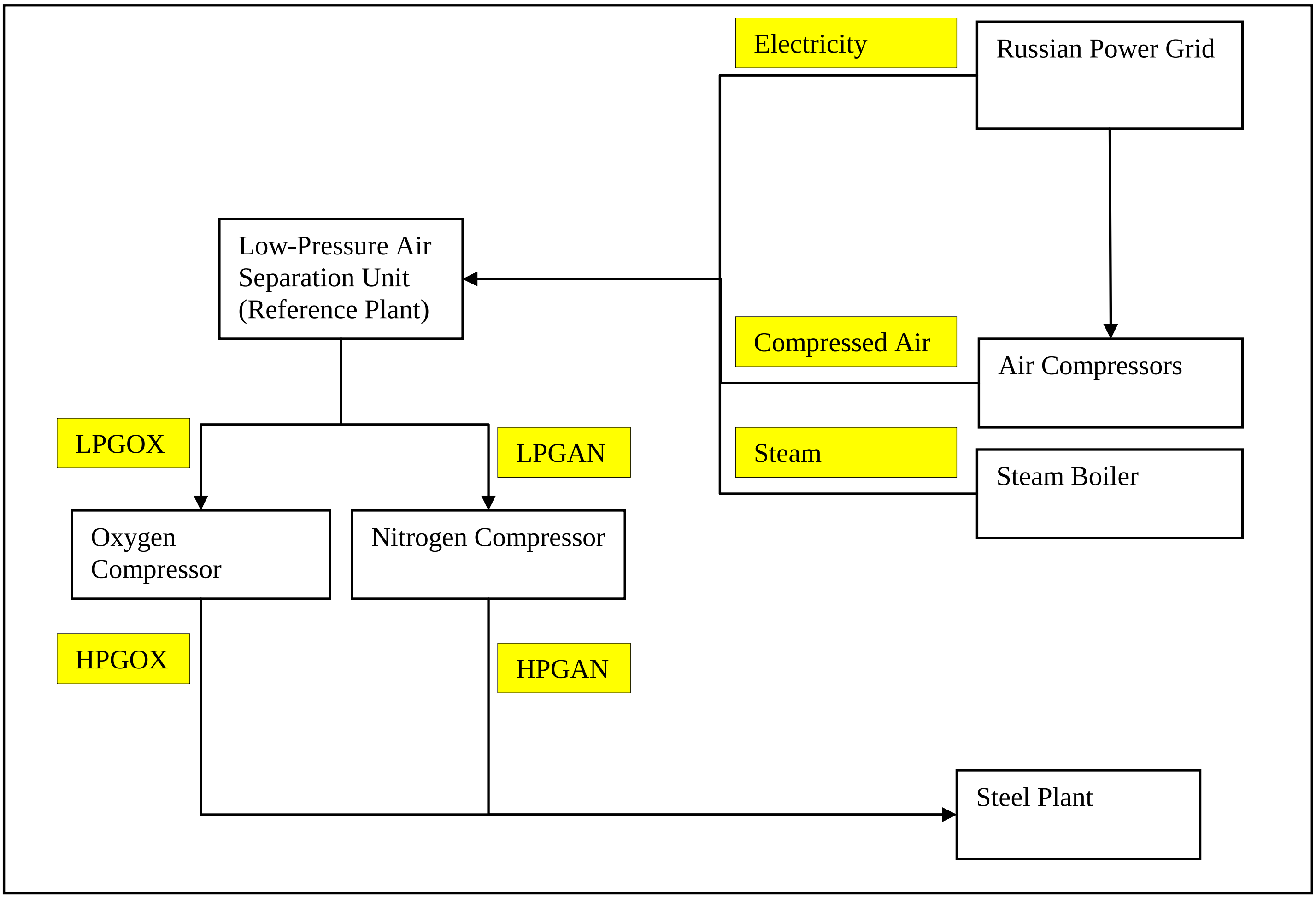

Figure 2: Baseline Description[28]

Low-pressure gaseous oxygen is the key output from the air separation unit, low-pressure gaseous nitrogen and argon are necessary by-products of the air separation process. In order to properly reflect this reality, all energy consumption for the air compression and air separation processes is attributed to the low-pressure oxygen production. No energy consumption is attributed to the low-pressure nitrogen or argon. By contrast, the energy consumption from the product compressors is attributed directly to the high-pressure oxygen and high-pressure nitrogen production, respectively.

The following baseline parameters have been calculated as averages of the 2005-2007 historical data contained in the energy balance document for the reference plant.[29] The ID numbers in parentheses refer to the table in Section D.1.1.3:

Data / Parameter	SC_{ST} (B5)
Data unit	Gcal / 1000 Sm^3 O_2
Description	Specific steam consumption

[28] White boxes represent key pieces of equipment, and yellow boxes represent material flows.

[29] See also Annex 2. The calculation of the parameters is further detailed in the emission reduction calculation that has been made available to the verifier.

Time of determination/monitoring	2005-2007
Source of data (to be) used	Energy balance document for the reference plant.
Value of data applied (for ex ante calculations/determinations)	0.060 Gcal / 1000 Sm^3 O_2
Justification of the choice of data or description of measurement methods and procedures (to be) applied	The data is from a recently commissioned reference plant that uses the baseline technology. 2005: 0.0741 Gcal / 1000 Sm^3 O_2 2006: 0.0590 Gcal / 1000 Sm^3 O_2 2007: 0.0611 Gcal / 1000 Sm^3 O_2 2005-2007 Average: 0.064 Gcal / 1000 Sm^3 O_2 2006-2007 Average: 0.060 Gcal / 1000 Sm^3 O_2 The 2006 to 2007 values show strong consistency over time, but the 2005 value is an outlier on the high side. Utilizing the 2006/2007 average is conservative because it eliminates the outlier and brings the average down. The 2007 value is also higher than the 2006 value.
QA/QC procedures to be applied	The coefficient is calculated as the ratio of total steam consumption and total high-pressure oxygen production at the reference facility. The steam consumption is measured by a CTP 961 – heat meter “Logika” (St. Petersburg). Oxygen production is measured by the following meters which are located in the turbine room of the reference facility: Diaphragm flow meter DBS, Pressure Differential Transmitter «Metran 22-DD», Pressure control device «Metran 22-DI», Resistance thermometer TSP-100P, Controller – Control Logix 1756 «Allen Bradley. The meters are included in the Automated Monitoring and Record System.
Any comment	

Data / Parameter	SC_{AIR} (B6)
Data unit	Sm^3 Air / Sm^3 O_2
Description	Specific compressed air consumption
Time of determination/monitoring	2005-2007
Source of data (to be) used	Energy balance document for the reference plant.
Value of data applied (for ex ante calculations/determinations)	6.3187 Sm^3 Air / Sm^3 O_2
Justification of the choice of data or description of measurement methods and procedures (to be) applied	The data is from a recently commissioned reference plant that uses the baseline technology. 2005: 6,3971 Sm^3 Air / Sm^3 O_2 2006: 5,9674 Sm^3 Air / Sm^3 O_2 2007: 6,6297 Sm^3 Air / Sm^3 O_2 2005-2007 Average: 6.3187 Sm^3 Air / Sm^3 O_2 Averaging of the 2005 to 2007 values is conservative since the

	values show consistency over time but no definite trend. The 2005 to 2007 values lie within a band of approx. 5% deviation from the average value. The 2007 value is higher than both the 2006 and the 2005 value.
QA/QC procedures to be applied	The coefficient is calculated as the ratio of the total compressed air consumption and the total oxygen production at the reference facility. The compressed air consumption is measured by the following meters, which are located in the turbine room of the reference facility: Diaphragm flow meter DBS, Pressure Differential Transmitter «Endress+Hauser» PMD 75, Pressure control device «Endress+Hauser» PMD 71, Resistance thermometer TCM-50M, Controller S7-400 «Siemens». Oxygen production is measured by the following meters, which are located in the turbine room of the reference facility: Diaphragm flow meter DBS, Pressure Differential Transmitter «Metran 22-DD», Pressure control device «Metran 22-DI», Resistance thermometer TSP-100P, Controller – Control Logix 1756 «Allen Bradley. All meters are included in the Automated Monitoring and Record System.
Any comment	

Data / Parameter	$SFC_{ELEC, AIR}$ (B7)
Data unit	MWh / 1000 Sm^3 Air
Description	Specific electricity consumption for compressed air
Time of determination/monitoring	2005-2007
Source of data (to be) used	Energy balance document for the reference plant.
Value of data applied (for ex ante calculations/determinations)	0.1041 MWh / 1000 Sm^3 Air
Justification of the choice of data or description of measurement methods and procedures (to be) applied	The data is from a recently commissioned reference plant that uses the baseline technology. 2005: 0.1038 MWh / 1000 Sm^3 Air 2006: 0.1048 MWh / 1000 Sm^3 Air 2007: 0.1037 MWh / 1000 Sm^3 Air 2005-2007 Average: 0.1041 MWh / 1000 Sm^3 Air Averaging of the 2005 to 2007 values is conservative since the values show great consistency over time but no definite trend. The 2005 to 2007 values lie within a band of less than 1% deviation from the average value. The 2006 value is higher than both the 2007 and the 2005 value.
QA/QC procedures to be applied	The coefficient is calculated as the ratio of the total power consumption by the air compressors and the total production of compressed air by the air compressors. The power consumption is measured separately for each compressor by meters of Model PM 175 (made in Israel) and Model 6805B (made in Stavropol). The total compressed air production is measured by air meter sets

	containing diaphragm DBS meters for each of the major consumers.
Any comment	

Data / Parameter	SFC_{ELEC} (B8)
Data unit	MWh / Sm^3 O_2
Description	Specific electricity consumption by the cold box
Time of determination/monitoring	2004
Source of data (to be) used	Technical specification by manufacturer of the cold box, Cryogenmash.
Value of data applied (for ex ante calculations/determinations)	0.0269 MWh / Sm^3 O_2
Justification of the choice of data or description of measurement methods and procedures (to be) applied	
QA/QC procedures to be applied	Not applicable
Any comment	

Data / Parameter	$SFC_{ELEC, HPGOX}$ (B9)
Data unit	MWh / Sm^3 O_2
Description	Specific electricity consumption by oxygen compressors
Time of determination/monitoring	2005-2007
Source of data (to be) used	Energy balance document for the reference plant.
Value of data applied (for ex ante calculations/determinations)	0.1941 MWh / Sm^3 O_2
Justification of the choice of data or description of measurement methods and procedures (to be) applied	The data is from a recently commissioned reference plant that uses the baseline technology. 2005: 0.1891 MWh / Sm^3 O_2 2006: 0.1906 MWh / Sm^3 O_2 2007: 0.2049 MWh / Sm^3 O_2 Average: 0.1941 MWh / Sm^3 O_2 Averaging of the 2005 to 2007 values is conservative since the values show consistency over time and even an upward trend. The 2005 to 2007 values lie within a band of approx. 5% around the average. The 2007 value is higher than both the 2006 and the 2005 value.
QA/QC procedures to be applied	The coefficient is calculated as the ratio of the power consumption and the high-pressure oxygen production at the oxygen compressor station. The station includes a number of oxygen compressors and is used to compress the low-pressure oxygen from a number of air separation units. Power consumption is measured separately at each oxygen compressor by meters of Model I670M (made in

	Moscow) that are installed in the substation cells. High-pressure oxygen production is measured by the following meters: Diaphragm flow meter DBS, Pressure Differential Transmitter «Sapfir 22M-DD», Secondary registration device RP-160. Each compressor is equipped with such a set of meters. The meters are located in the turbine room of the oxygen and nitrogen compression section. The meters are included in the Automated Monitoring and Record System.
Any comment	

Data / Parameter	$SFC_{ELEC,\ HPGAN}$ (B10)
Data unit	MWh / Sm^3 N_2
Description	Specific electricity consumption by nitrogen compressors
Time of determination/monitoring	2006
Source of data (to be) used	Calculated based on $SFC_{ELEC,\ HPGOX}$ (B9)
Value of data applied (for ex ante calculations/determinations)	0.1941 MWh / Sm^3 N_2
Justification of the choice of data or description of measurement methods and procedures (to be) applied	No data from the recently commissioned reference plant is available. The product compressors for nitrogen and oxygen are the same model, i.e. KTK 12,5/35, made by the Kazan compression plant. In the project scenario, i.e. the ALS plant, nitrogen and oxygen are compressed to the same pressure level (31 bar). It is therefore reasonable to assume that the specific power consumption in the baseline is the same for both gases.
QA/QC procedures to be applied	Not applicable
Any comment	

Data / Parameter	$EF_{Gas,\ ST}$ (B11)
Data unit	t of CO_2 / Gcal of steam
Description	Carbon emission factor for the consumption of steam
Time of determination/monitoring	2006
Source of data (to be) used	Calculated based on default values from 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Table 2.2
Value of data applied (for ex ante calculations/determinations)	0.1243 t CO_2/ Gcal of steam
Justification of the choice of data or description of measurement methods and procedures (to be)	No data from the recently commissioned reference plant is available. The value was calculated based on the assumption that the steam boilers are fired with natural gas and that the efficiency

applied	is 85%. The IPCC default value for the emission factor of natural gas is 0.0561 t CO_2 / GJ of fuel[30] or 0.235 t CO_2 / Gcal of fuel.[31] This is equivalent to 0.2764 t CO_2 / Gcal of steam.[32] The value has been multiplied by 0.45, since between 2005 and 2007 only 45% of the steam were generated at a combined heat and power plant (CHP). The remainder came from waste steam. The fuel at the CHP consists mostly of furnace gas and coke gas. Some natural gas and coal are also used. The calculation takes into account the carbon emission factor for natural gas because the steam is generated almost exclusively from gaseous fuels and natural gas is the fuel that is burned at the margin. Furnace gas and coke gas are coming from Severstal's steel operations. The value of the baseline parameter is conservative as it is based on natural gas-fired steam boiler with 85% efficiency and as such represents a best-practice estimate for steam production. According to IPCC figures the mix of furnace gas and coke gas has a much higher carbon emission factor than natural gas.[33] The 85% efficiency rating is also higher than the actual efficiency of the CHP.
QA/QC procedures to be applied	Not applicable
Any comment	

Data / Parameter	$EF_{ELEC, y}$ (B12)
Data unit	t CO_2 / MWh
Time of determination/monitoring	Based on 2006-2008 data.
Description	Carbon emission factor for the consumption of grid-based electricity
Source of data (to be) used	Calculated from (B13) and (B14). $EF_{ELEC, y} = EF_{ELEC, GEN, y} / (1 - TL_{ELEC, y} / 100)$
Value of data applied (for ex ante calculations/determinations)	0.613 t CO_2 per MWh in 2008, 0.603 t CO_2 per MWh in 2009, 0.594 t CO_2 per MWh in 2010, 0.586 t CO_2 per MWh in 2011, 0.578 t CO_2 per MWh in 2012, 0.570 t CO_2 per MWh in 2013, 0.562 t CO_2 per MWh in 2014, 0.554 t CO_2 per MWh in 2015, 0.546 t CO_2 per MWh in 2016, 0.538 t CO_2 per MWh in 2017.

[30] 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Table 2.2: Default Emission Factors for Stationary Combustion in the Energy Industries, page 2.16. The document is available at http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_2_Ch2_Stationary_Combustion.pdf

[31] The conversion coefficient is 4.187 GJ/Gcal. 0.0561 t CO_2/GJ of fuel * 4.187 GJ/Gcal = 0.235 t CO_2/Gcal of fuel.

[32] 85% efficiency means that 0.85 Gcal of steam are generated by 1 Gcal of fuel. The calculation is as follows: (0.235 t CO_2/Gcal of fuel) / (0.85 Gcal of steam / Gcal of fuel) = 0.2764 t CO_2/Gcal of fuel

[33] Source: IPCC 2006 Guidelines for National GHG Inventories, Chapter 2: Stationary Combustion, Table 2.3. The document is available at http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_2_Ch2_Stationary_Combustion.pdf

Justification of the choice of data or description of measurement methods and procedures to be applied	The emission factor for consumed grid-based electricity has been adjusted for transmission losses. This reflects that more than one MWh of electricity has to be generated for each MWh that is actually consumed.
QA/QC procedures to be applied	Not applicable
Any comment	

Data / Parameter	$EF_{ELEC, GEN, y}$ (B13)
Data unit	t CO_2 / MWh
Time of determination/monitoring	2006-2008
Description	Carbon emission factor for the generation of grid-based electricity
Source of data (to be) used	See Annex 2.
Value of data applied (for ex ante calculations/determinations)	0.556 t CO_2 per MWh in 2008, 0.550 t CO_2 per MWh in 2009, 0.545 t CO_2 per MWh in 2010, 0.540 t CO_2 per MWh in 2011, 0.536 t CO_2 per MWh in 2012, 0.531 t CO_2 per MWh in 2013, 0.526 t CO_2 per MWh in 2014, 0.521 t CO_2 per MWh in 2015, 0.517 t CO_2 per MWh in 2016, 0.512 t CO_2 per MWh in 2017
Justification of the choice of data or description of measurement methods and procedures to be applied	2006: 0.565 t CO_2 / MWh 2007: 0.557 t CO_2 / MWh 2008: 0.556 t CO_2 / MWh Average: 0.559 t CO_2 / MWh The 2008 value is calculated based on actual 2008 data. The 2009 to 2012 values have been derived by linear regression to decrease at the same rate that was achieved from 2006 to 2008. The values are conservative because they are not only below the 2006-2008 average, but also below the minimum achieved in the 2006-2008 period.
QA/QC procedures to be applied	See Annex 2. The parameter values have been calculated based on official data.
Any comment	

Data / Parameter	$TL_{ELEC, y}$ (B14)
Data unit	%
Time of determination/monitoring	2006-2008
Description	Transmission losses for grid-based electricity
Source of data (to be) used	JSC Interregional Distribution Grid Company of the Center[34]
Value of data applied (for ex ante calculations/determinations)	9.40% in 2008, 8.79% in 2009, 8.31% in 2010, 7.82% in 2011, 7.34% in 2012, 6.85% in 2013, 6.37% in 2014, 5.88% in 2015, 5.40% in 2016, 4.91% in 2017.
Justification of the choice of data	2006: 10.37%

[34] The data is available at the following website. http://mrsk-1.ru

or description of measurement methods and procedures to be applied	2007: 9.52% 2008: 9.40% Average: 9.76% The 2008 value is based on actual data. The 2009 to 2012 values have been derived by linear regression to decrease at the same rate that was achieved from 2006 to 2008. The values are conservative because they are not only below the 2006-2008 average, but also below the minimum achieved in the 2006-2008 period.
QA/QC procedures to be applied	The parameter values are directly based on published data from the JSC Interregional Distribution Grid Company of the Center.
Any comment	

B.2. Description of how the anthropogenic emissions of greenhouse gases by sources are reduced below those that would have occurred in the absence of the JI project:

Indication of the approach applied to demonstrate the additionality of the project

Additionality of the project is demonstrated by following a JI-specific approach. Approach (a) in paragraph 2 of the Annex I to the "Guidance on Criteria for Baseline Setting and Monitoring (Version 2)" has been selected. According to the approach additionality can be proven by providing "traceable and transparent information showing that the baseline was identified on the basis of conservative assumptions, that the project scenario is not part of the identified baseline scenario and that the project will lead to reductions of anthropogenic emissions by sources or enhancements of net anthropogenic removals by sinks of GHGs."[35]

Description and justification of the approach applied demonstrate the additionality of the project

* Section B.1 and the supporting documentation provided to the validator provide transparent and traceable information to demonstrate that the baseline was indeed chosen on the basis of conservative assumptions. The baseline emission rate is derived from a reference low-pressure air separation facility in Russia, which was commissioned in 2004. The reference facility operates under very similar conditions as the ALS plant and represents the technology most likely to be used in the absence of the project. The choice of baseline is conservative, since it is based on the most recently installed technology in Russia (build margin) and does not account for the fact that many air separation plants currently operating in Russia (operating margin) are of much lower efficiency.

* In section B.2 it is demonstrated that the project is not a plausible baseline scenario without being registered as a JI project. This is shown with a four-step process.

(1) Identification of investment alternatives: It is demonstrated that the project company ALS does not have another investment alternative to achieve the same production of oxygen and nitrogen.

(2) Investment Analysis: It is demonstrated that the project does not meet the benchmark for profitability. The investment analysis conforms to the CDM Executive Board's Guidance on the Assessment of the Investment Analysis (version 3).[36]

[35] The document is available at http://ji.unfccc.int/Ref/Documents/Baseline_setting_and_monitoring.pdf

[36] The document is available at http://cdm.unfccc.int/EB/051/eb51_repan58.pdf

(3) Barrier Analysis: It is demonstrated that the project faces some technological barriers, as it is a first-of-a-kind facility in Russia.
(4) Common Practice Analysis: It is demonstrated that at the time of decision-making there were no similar project activities operational in Russia.

The four steps closely follow the key steps of the CDM Additionality Tool. In keeping with the JI-specific approach chosen above, the Tool is not applied in its entirety. By contrast, the steps are selectively applied in order to demonstrate that the project is not part of the baseline.

* In section E and the supporting documentation provided to the validator it is demonstrated that the project reduces GHG emissions by approx. 100,000 t CO_2e per year. Electricity is by far the most relevant energy input, as it is either directly consumed or indirectly embodied in the consumption of compressed air. At the targeted output rate of 72,000 Sm^3 / hr the ALS facility consumes approx. 48.7 MW of grid-based electricity. Under the baseline 67.4 MW would be consumed. The power savings of 18.7 MW are responsible for the bulk of the emission reductions generated by the project. A supporting spreadsheet containing all assumptions and the relevant data sources for the emission reduction calculation has been made available to the validator. The calculations are based on the following evidence:

- Baseline energy consumption and baseline emissions have been established based on the technical specification and historical data for the reference facility
- Emission factors for steam and electricity consumption have been justified in Section B.1
- Project energy consumption and project emissions have been established based on actual monitoring data for 2008 and the company's business case for years 2009 to 2012.

The emission reductions are being monitored according to the monitoring plan established in Section D of this document. The results for the year 2008 are already available and suggest that the emission reduction estimate of 100,000 t CO_2 per year is credible.

(1) Identification of alternatives to the project

In Section B.1 the following two scenarios have been identified as plausible alternatives to the proposed project. They are both consistent with mandatory laws and regulations.

1. **Project:** The proposed project activity without being registered as a JI project

2. **Low-Pressure Air Separation:** Construction of low-pressure cryogenic air separation plants on the premises (or in the immediate vicinity) of the Severstal Steel Works. The plant would be provided with compressed air from air compressors and the separated low-pressure oxygen and nitrogen would be further compressed by product compressors. As shown in the Common Practice Analysis below low-pressure air separation technology was clearly the prevailing practice in Russia in 2005.

(2) Investment analysis

(2a) Analysis Method

The proposed project will, apart from the JI benefits, generate economic benefits in the form of revenue from the sale of separated gases; therefore simple cost analysis is not applicable. Instead benchmark analysis is applied to the project, as the project participant (the Air Liquide-Severstal JV) does not have another alternative, in which they could have invested. While the baseline provides an alternative way of meeting the incremental oxygen demand, there are obvious barriers that would prevent a JV dominated by

Air Liquide to invest in the technology of a competitor. Therefore the baseline investment is out of the direct control of the project developer. The ALS decision is to invest or not to invest.

The pre-tax internal rate of return (IRR) is used as financial indicator in order to evaluate the project's attractiveness.

(2b) Choice and Justification of Benchmark IRR

The IRR benchmark can be calculated as the sum of two factors, the required rate of return on risk-free investments plus a project-specific risk factor adjustment. A minimum rate of return not including project specific risks is given by Russia's base inflation rate, which was 10.9% between December 2004 and December 2005.[37] Due to the lack of data for similar projects in Russia the risk factor adjustment can be identified only on the basis of expert opinion. In this case the risk premium needs to cover the set-up costs and the counterparty risk for the joint venture, the risk of introducing a new technical process and a facility of unprecedented scale to Russia and the uncertainty about future interest rates for financing. Based on a conservative approach we can estimate the risk factor adjustment to be at 8% following the official "Methodological Recommendations on Evaluation of Investment Projects Efficiency 21.06.1999 N ВК 477". The benchmark figure is therefore (1.109 * 1.08) - 1 = 19.8%.

Project finance for private sector projects remained scarce in Russia in 2004 and 2005, especially outside the oil & gas sector. This is all the more true for start-up companies, such as ALS. Maturities for commercial loans were typically in the range of 1-3 years, thus exposing private investors to the risk of having to refinance their original loans with part of the loan still outstanding.

(2c) Calculation of Project IRR

The internal rate of return for the proposed project has been calculated based on the following assumptions:

1. The investment analysis is based on the relevant information available at the time of the investment decision, June to December 2005. The analysis is completed in Russia's national currency.

2. The assessment period is not limited to the proposed crediting period of the JI activity 2008-2012 but extended to 15 years reflecting the expected period of operation of the investment project activity. ALS and Severstal have signed a Gas Supply Contract for the duration of 15 years. At the end of the 15 year period the residual value of the equipment is zero as the equipment is fully depreciated, and the gas supply contract with Severstal has ended. ALS will have to dismount the unit upon termination of the contract after 15 years. The value of the remaining materials and equipment will pay for the dismantling costs.

3. The investment analysis uses the following price assumption and inflation rates from 2005 to 2022.

[37] See The Central Bank of the Russian Federation, Quarterly Inflation Review, 2005 Q4. The document is available at http://www.cbr.ru/eng/publ/main.asp

ID	Description	Units	Inflation Rate per year
Infl	Official Inflation Index		10.9%
M	Salary Index Cherepovets	Rub / month	15%
E	Electricity Price	Rub / MWh	15%
A	Compressed Air Price	Rub / 1000 Sm^3	15%
V	Steam Price	Rub / Gcal	15%
	Price for Make-Up Water	Rub / 1000 m^3	10.9%
	Price for Purified Water	Rub / 1000 m^3	10.9%

The forecast for the Official Inflation Index (Infl) is based on Russia's base inflation rate, which was 10.9% between December 2004 and December 2005.[38] The same inflation rate is used for the price of water.

All energy-related prices are expected to rise faster than overall inflation. The expected inflation rate is 15% for electricity, compressed air and steam. Please note that compressed air is treated as an energy-related input as electricity is by far the most important input for the air compression process. Please note that the sensitivity analysis shows that the IRR is not very sensitive to changes in the inflation rate for these energy-related inputs.

Salaries are expected to increase faster than overall inflation as they also reflect real economic growth per capita. The expected salary growth rate is 15%. Please note that the sensitivity analysis shows that the IRR is not very sensitive to changes in the salary inflation rate.

4. The exchange rate forecast is based on EBRD's 2005 macroeconomic forecast. 2005 to 2015 figures are taken directly from the EBRD forecast. For the years 2016 to 2022 the forecast was extended.

5. The prices for high-pressure oxygen (PHPGOX) and nitrogen (PHPGAN) are determined by formulas in the Gas Supply Contract[39] between ALS and Severstal. The prices are linked to the input prices for electricity and compressed air.

6. The investment analysis uses the actual investment cost that were incurred by ALS.

7. The Gas Supply Contract also provides for the payment of a monthly fixed fee (MF) by Severstal to ALS. The amount of the fixed fee is revised according to officially published indexes such as salaries, inflation and the exchange rate.

8. Minimum hourly delivery volumes for high-pressure oxygen and nitrogen are determined by the Gas Supply Contract between ALS and Severstal.

9. Hourly consumption volumes of energy and materials, such as electricity, compressed air, make-up water and purified water are based on experience from similar Air Liquide plants. Steam is not considered as it is only used for the production of liquid oxygen (LOX), which is assumed to be zero.

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[38] See The Central Bank of the Russian Federation, Quarterly Inflation Review, 2005 Q4. The document is available at http://www.cbr.ru/eng/publ/main.asp

[39] The Gas Supply Contract has been made available to the verifier.

10. Operating hours: It is assumed that the facility will run 8585 hours per year, in line with the experience from other Air Liquide plants. Production inputs are consumed for 8648 hours per year, as during a period after a shut down the facility consumes energy to restart but cannot produce gases.

11. The investment analysis uses the following parameters in accordance with the Russian tax code:

Variable	Value
Property Tax	2.2% of book value
Depreciation Period	15 years
VAT on Capital Costs	18%

The property tax was set to zero from 2008 to 2012 in order to reflect the tax incentives that ALS had applied for at the time of decision-making.

12. Salaries and Services: The investment analysis uses starting values for Salaries and the Costs of Services that are based on the staffing and service needs from similar Air Liquide facilities and the salary level in the Cherepovets area. The cost for salaries and services is expected to rise in line with average salaries in the Cherepovets area, i.e. at a rate of 15% per year.

13. Insurance: Insurance cost are expected to be a fixed percentage of the initial capital costs , in line with the experience from other Air Liquide plants.

14. Rent: The cost for the lease of land is based on the Gas Supply Contract between ALS and Severstal.

15. In the investment analysis the cash flows for working capital are considered for the VAT on the capital expenditures, which is recovered in 2008.

16. In the investment analysis the cash flows for working capital are also considered for outstanding receivables. They are assumed to be one month of the difference between total revenues and total expenditures.

17. The cost of financing expenditures (i.e. loan interest payment) or depreciation is not included in the calculation of the project IRR.

Project IRR without Revenue from ERU Sales	18.64%
Benchmark Rate	19.80%

Conclusion: The profitability of the project is below the benchmark rate.

(2d) Sensitivity Analysis[40]

		Fluctuation	
Parameter	-10%	0%	+10%
Project IRR (without Revenue from ERU sales)			

[40] The detailed investment analysis has been made available to the verifier.

Production of HPGOX and HPGAN	18.63%	18.64%	18.64%
General Price Index	18.37%	18.64%	18.90%
Electricity Cost	18.64%	18.64%	18.64%
Investment Cost	18.54%	18.64%	18.71%

A sensitivity analysis with regard to the prices of oxygen and nitrogen cannot be performed because the prices are determined by a formula depending on the prices for inputs, such as electricity, compressed air, salary inflation and general inflation.

Conclusion: The sensitivity analysis confirms that the proposed project activity is unlikely to be financially attractive without the revenue from ERU sales.

(3) Barrier Analysis:

The project faces technological barriers.

At the time when the investment decision was made there were no air separation plants of similar size in Russia that used high-pressure air separation technology with an internal pumping cycle. The ALS facility was the first oxygen plant with Air Liquide technology in Russia. By deviating from the prevailing practice of low-pressure air separation, ALS incurred a substantial technical risk when introducing this new technology and doing so at almost three times the size of the largest Russian air separation plants at the time.[41] At time of commissioning the plant was not only the largest air separation unit in Russia but also the largest ever to be dedicated to a steel plant.[42] The nature of the project required a six-month commissioning phase (May 2007 to November 2007) until the formal start-up of operations. Local employees were not familiar with the new technology and prior to the start up of the facility the Production Manager underwent an extensive training at Air Liquide facilities in Europe. Other operators were trained by Air Liquide start-up specialists during the commissioning phase and an experienced AL Plant Manager was appointed to supervise ALS technical operations.

The ALS facility requires significant amounts of regular maintenance. For general maintenance ALS uses the following sub-contractors:

- Energoremount: mechanical supervision, maintenance and repairs.
- Stela: supervision, maintenance and repair of pressure vessels, pressure pipes and steam units.
- STEK: electrical supervision, maintenance and repair of electrical network and machines.
- STEK: supervision, maintenance and repair of instrumentation and gas analyzers.
- STOIK: vibrations measurement of the main machines (compressors, cryogenic pumps and cooling water pumps)

For major overhauls ALS uses the following subcontractors:

- Energoremount: mechanics
- Electroremount: motors

[41] In 2005 the maximum capacity of low-pressure air separation units in Russia was about 35,000 Sm^3 / hr, i.e. the largest reference plant size by the company Cryogenmash at the time.

[42] http://www.airliquide.com/en/rss/inauguration-de-lunite-air-liquide-severstal.html.

Except for repairs, the maintenance is done according to a yearly maintenance plan, which is approved during budget exercise. The maintenance plan takes into account: Manufacturers' Manuals for key components, Air Liquide Recommendations as well as Russian norms and laws.

The alternative of continuing the prevailing practice of low-pressure air separation technology would not have been affected by the technical barriers. The technology was well established in Cherepovets, as Severstal Steel Works was at the time operating ten such air separation units. In addition there is a pool of well-trained employees who had ample experience with this technology.

Conclusion: The project activity faced significant technical barriers compared with the baseline of continuing the prevailing practice. This finding adds to the result of the investment analysis that the project is unlikely to be attractive on its own. The availability of carbon credit revenue helps to offset this technological risk.

(4) Common Practice Analysis

Cryogenic air separation is a well-established industrial process in Russia.[43] In Cherepovets alone there were 10 air separation units in 2005, some of which were installed as early as 1964. In 2005 the prevailing practice for air separation technology clearly was low-pressure air separation technology. The Russian company Cryogenmash, which in 2006 supplied 90% of all industrial gases in Russia[44], did not have any reference facilities with high-pressure air separation based on internal compression at the time.[45]

There was only a single high-pressure air separation facility with internal compression operational in Russia at the time. The facility was delivered by Linde in 2005 to the Nishneserginskij Metallurgical Plant.[46] However there are important differences between the Linde plant and the ALS facility. First, the Linde facility only has a capacity of less than 15,000 Sm^3 of high-pressure oxygen per hour, less than one-sixth of the ALS facility. Second the Linde facility was implemented at a greenfield steel plant where there were no pre-existing air separation plants. By contrast, the Severstal steel production complex already had ten low-pressure air separation units in 2005 in operation. Among local employees there was a great amount of experience and comfort with the existing low-pressure plants.

Conclusion: Only one similar project activity can be observed in Russia. There are essential distinctions between the proposed JI project activity and the one similar activity that can be observed. By installing Air Liquide's state-of-the-art technology the JV went clearly beyond prevailing practice in Russia.

(5) Conclusion

[43] The company Cryogenmash was founded in 1949 and has been instrumental in enabling oxygen-based steelmaking in Russia. http://cryogenmash.ru/en/about/history/

[44] The market share information is taken from the Cryogenmash 2006 Investor Prospectus, which has been made available to the verifier. On its website Cryogenmash asserts that "Cryogenmash's plants for oxygen, nitrogen and other technical gases production are operated practically at all metallurgy and petrochemistry enterprises in Russia." See http://www.cryogenmash.com/en/content/news/index.php?news=2107.

[45] The leading domestic manufacturer of air separation technology commissioned its first plant only in 2007.See http://www.cryogenmash.ru/en/content/news/index.php?news=2111.

[46] See http://www.linde-kca.de/international/web/le/kca/likelekcacom.nsf/docbyalias/chemgas_airseparation.

The Barrier Analysis and Common Practice Analysis are supporting the result of the Investment Analysis that the project activity is additional.

B.3. Description of how the definition of the project boundary is applied to the project:

According to the JISC's guidance on criteria for baseline setting and monitoring the project boundary encompasses all anthropogenic emissions by sources of GHGs which are:

(i) Under the control of the project participants;

(ii) Reasonably attributable to the project; and

(iii) Significant, i.e., each source accounts for more than 1% of the annual average anthropogenic project emissions by sources of GHGs, or exceeds an amount of 2,000 tonnes of CO_2 equivalent, whichever is lower.

The baseline boundary is described in Figure 3. The relevant emission sources are numbered SB1 to SB5.

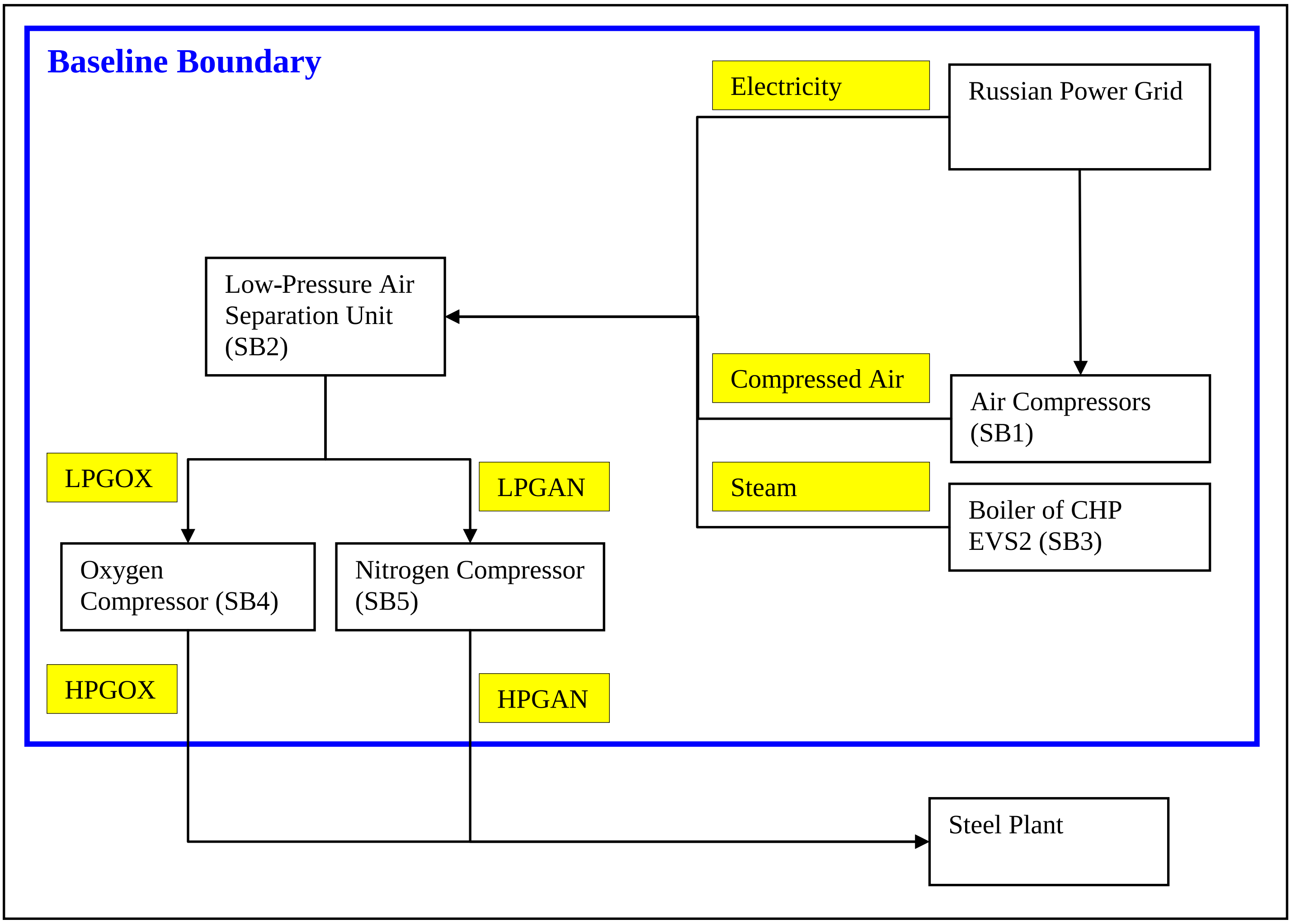

Figure 3: Baseline Boundary

The following emission sources are included in the baseline boundary:

Source No.	Source	Greenhouse Gas	Direct / Indirect	Included / Excluded	Justification / Explanation
SB1	Consumption of grid-based electricity for compressed air provided to the low-pressure air separation units.	CO_2	Indirect	Included	In the baseline scenario the oxygen production is increased by up to 90,000 Sm^3/hr. This results in additional power consumption for air compression.
SB2	Consumption of grid-based electricity by the low pressure air separation units.	CO_2	Indirect	Included	In the baseline scenario the oxygen production is increased by up to 90,000 Sm^3/hr. This results in additional power consumption by the low-pressure air separation units.
SB3	Fuel combustion for the production of steam provided to the low-pressure air separation units.	CO_2	Direct	Included	In the baseline scenario the oxygen production is increased by up to 90,000 Sm^3/hr. This results in additional steam consumption by the low pressure air separation units.
SB4	Consumption of grid-based electricity by the oxygen compressors	CO_2	Indirect	Included	In the baseline scenario the oxygen production is increased by up to 90,000 Sm^3/hr of high pressure oxygen. This results in additional power consumption by the oxygen compressors.
SB5	Consumption of grid-based electricity by the nitrogen compressors	CO_2	Indirect	Included	In the baseline scenario the nitrogen production is increased by up to 30,000 Sm3/hr. This results in additional power consumption by the nitrogen compressors.
SB6	Consumption of high-pressure nitrogen during the shut-down of the low-pressure air separation plants	CO_2	Indirect	Excluded	Not significant. The low-pressure air separation plants consume only insignificant amounts of high-pressure nitrogen.

The project boundary is described in Figure 4. The relevant emission sources are numbered SP1 to SP3.

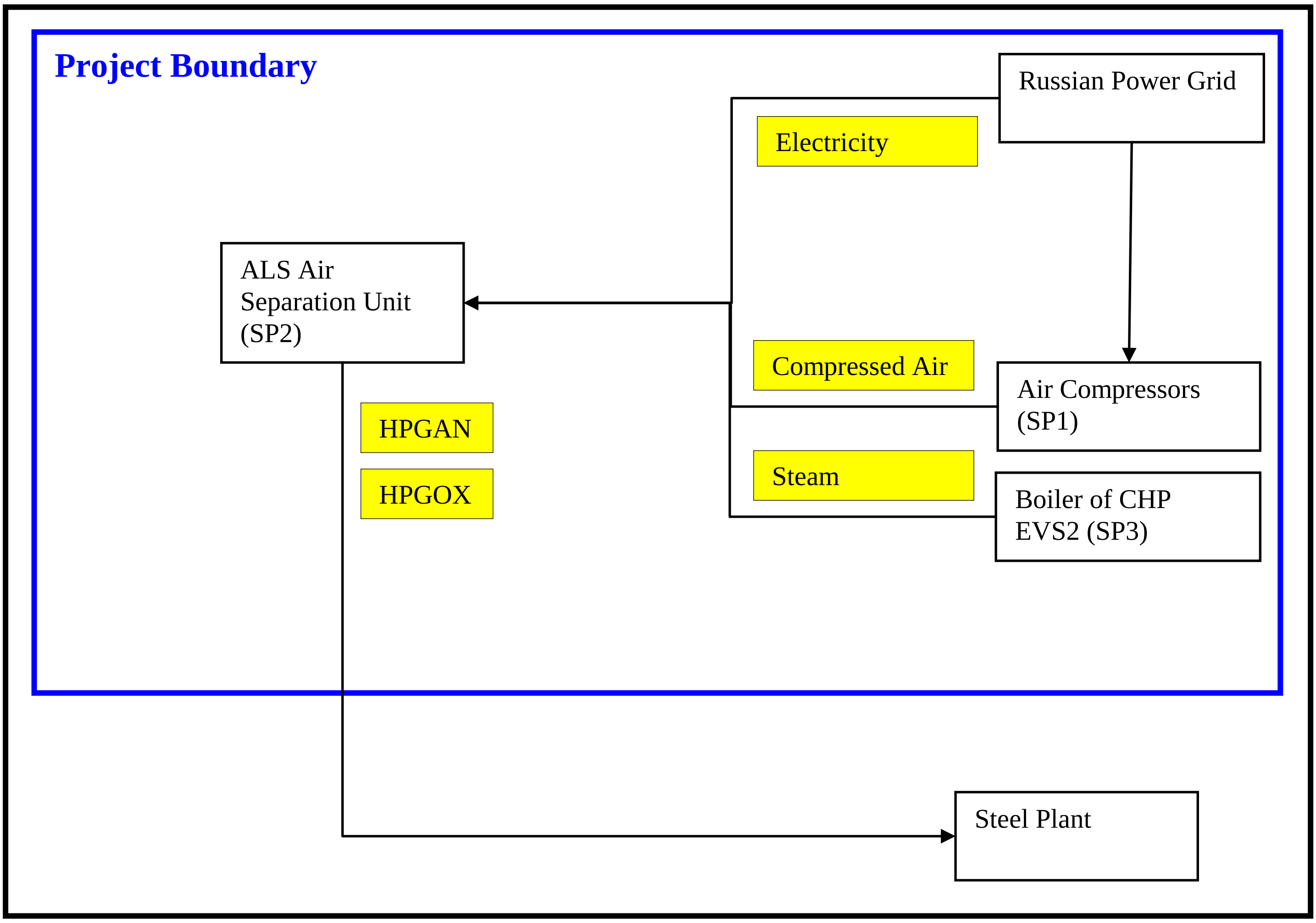

Figure 4: Project Boundary

The project boundary includes the following emission sources:

Source No.	Source	Greenhouse Gas	Direct / Indirect	Included / Excluded	Justification
SP1	Consumption of grid-based electricity by air compressors for compressed air provided to the ALS plant	CO_2	Indirect	Included	The ALS plant consumes compressed air
SP2	Consumption of grid-based electricity by ALS plant	CO_2	Indirect	Included	The ALS plant consumes grid-based electricity.
SP3	Fuel combustion by steam boiler for the production of steam provided to the ALS	CO_2	Direct	Included	The ALS plant consumes steam

	plant				
SP4	Consumption of High Pressure Nitrogen during shut down of ALS plant	CO_2	Indirect	Excluded	Insignificant. The ALS plant consumes only insignificant amounts of high-pressure nitrogen. The volumes are similar to those consumed by the low-pressure air separation plants in the baseline.

B.4. Further baseline information, including the date of baseline setting and the name(s) of the person(s)/entity(ies) setting the baseline:

Date: 09/11/2009

GreenStream Network Plc
Kluuvikatu 3
FI-00100 Helsinki
FINLAND
Tel: +358 20 743 7800
Fax: 358 20 743 7810
www.greenstream.net

GreenStream Network is not a Project Participant.

SECTION C. Duration of the project / crediting period

C.1. Starting date of the project:

The starting date of the project was December 6, 2005. This is when physical construction on-site was started.

C.2. Expected operational lifetime of the project:

Given proper maintenance the ALS facility can be operated for 15 years or 180 months. After 15 years the facility is fully depreciated, and the gas supply contract with Severstal ends.

C.3. Length of the crediting period:

The crediting period starts on January 1, 2008 and lasts for five years or 60 months until December 31, 2012. The crediting period will be extended until December 31, 2017, if approved by the host party. The life-time of the baseline is at least ten years.

SECTION D. Monitoring plan

D.1. Description of monitoring plan chosen:

There is no approved CDM methodology that directly applies to the project, therefore a JI-specific approach regarding monitoring is used.

As described in section B.3 the project activity leads to greenhouse gas emissions from the following emission sources:

- indirect consumption of grid-based electricity for the production of compressed air that is consumed by the ALS facility (SP1)
- consumption of grid-based electricity for the ALS facility (SP2)
- indirect fuel combustion for the production of steam that is consumed by the ALS facility (SP3)

In the absence of the project low-pressure air separation facilities and dedicated oxygen and nitrogen compressors would have been used. The project activity helps to avoid greenhouse gas emissions from the following baseline emission sources:

- indirect consumption of grid-based electricity for the production of compressed air that is consumed by the low-pressure air separation facilities (SB1)
- consumption of grid-based electricity by the low-pressure air separation facilities (SB2)
- indirect fuel combustion for the production of steam that is consumed by the low-pressure air separation facilities (SB3)
- consumption of grid-based electricity by the oxygen compressors (SB4)
- consumption of grid-based electricity by the nitrogen compressors (SB5)

All emission sources identified above have been included in the monitoring plan. The monitoring approach for the project emissions is detailed by source as follows:

SP1: the associated greenhouse gas emissions are a combination of three factors. (1) the consumption of compressed air ($Q_{AIR, ALS, y}$) by the ALS facility which is measured directly, (2) the specific electricity consumption (in MWh / 1000 Sm^3 O_2) at the main air compressors ($SFC_{ELEC, AIR}$), for which a coefficient has been established based on historical data from 2005 to 2007, (3) the carbon emission factor for grid-based electricity ($EF_{ELEC, y}$), which has been calculated ex-ante.

SP2: the associated greenhouse gas emissions are a combination of two factors. (1) the consumption of grid-based electricity by the ALS facility ($EC_{ALS, y}$), which is measured directly, (2) the carbon emission factor for grid-based electricity ($EF_{ELEC, y}$), which has been calculated ex-ante.

SP3: the associated greenhouse gas emissions are a combination of two factors. (1) the consumption of steam by the ALS facility ($Q_{ST, y}$), which is measured directly, (2) the carbon emission factor for steam generated by natural gas combustion ($EF_{GAS, ST}$), which has been calculated based on IPCC data.[47]

The monitoring approach for the baseline emissions is detailed by source as follows:

SB1: the associated greenhouse gas emissions are a combination of four factors. (1) the specific consumption of compressed air (in Sm^3 Air / Sm^3 O_2) by the reference facility (SC_{AIR}), for which a coefficient has been established based on historical data from 2005 to 2007[48], (2) the specific electricity consumption at the main air compressors ($SFC_{ELEC, AIR}$), for which a coefficient has been established based on historical data from 2005 to 2007[49], (3) the carbon emission factor for grid-based electricity ($EF_{ELEC, y}$), which has been calculated ex-ante and (4) the high-pressure oxygen delivery from the ALS facility ($P_{OX, y}$). This is the sum of the oxygen delivery from the cold box ($P_{GOX, y}$) and the oxygen delivery from the liquid oxygen tank ($P_{LOX, y}$), both of which are measured directly.

SB2: the associated greenhouse gas emissions are a combination of three factors. (1) the specific consumption of grid-based electricity (in MWh / 1000 Sm^3 O_2) by the reference facility (SFC_{ELEC}), for which a coefficient has been established based on the technical specifications provided by the equipment manufacturer, (2) the carbon emission factor for grid-based electricity ($EF_{ELEC, y}$), which has been calculated ex-ante and (3) the high-pressure oxygen delivery from the ALS facility ($P_{OX, y}$). This is the sum of the oxygen delivery from the cold box ($P_{GOX, y}$) and the oxygen delivery from the liquid oxygen tank ($P_{LOX, y}$), both of which are measured directly.

SP3: the associated greenhouse gas emissions are a combination of three factors. (1) the specific consumption of steam (in Gcal / 1000 Sm^3 O_2) by the reference facility (SC_{ST}), for which a coefficient has been established based on historical data from 2005-2007[50], (2) the carbon emission factor for steam generated by natural gas combustion ($EF_{GAS, ST}$), which has been calculated based on IPCC data[51] and (3) the high-pressure oxygen delivery from the ALS facility ($P_{OX, y}$). This is the sum of the oxygen delivery from the cold box ($P_{GOX, y}$) and the oxygen delivery from the liquid oxygen tank ($P_{LOX, y}$), both of which are measured directly.

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[47] See section B.1.

[48] See section B.1.

[49] See section B.1.

[50] See section B.1.

[51] See section B.1.

SB4: the associated greenhouse gas emissions are a combination of three factors. (1) the specific consumption of grid-based electricity by the oxygen compressors (in MWh / 1000 Sm^3 O_2) of the reference facility ($SFC_{ELEC, HPGOX}$), for which a coefficient has been established based on historical data from 2005 to 2007[52], (2) the carbon emission factor for grid-based electricity ($EF_{ELEC, y}$), which has been calculated ex-ante and (3) the high-pressure oxygen delivery from the ALS facility ($P_{OX, y}$). This is the sum of the oxygen delivery from the cold box ($P_{GOX, y}$) and the oxygen delivery from the liquid oxygen tank ($P_{LOX, y}$), both of which are measured directly.

SB5: the associated greenhouse gas emissions are a combination of three factors. (1) the specific consumption of grid-based electricity by the nitrogen compressors (in MWh / 1000 Sm^3 N_2) of the reference facility ($SFC_{ELEC, HPGAN}$), for which a coefficient has been established based on historical data from 2005 to 2007[53], (2) the carbon emission factor for grid-based electricity ($EF_{ELEC, y}$), which has been calculated ex-ante and (3) the high-pressure nitrogen delivery from the ALS facility ($P_{GAN, y}$), which is measured directly.

D.1.1. Option 1 – Monitoring of the emissions in the project scenario and the baseline scenario:

D.1.1.1. Data to be collected in order to monitor emissions from the project, and how these data will be archived:

ID number *(Please use numbers to ease cross-referencing to D.2.)*	Data variable	Source of data	Data unit	Measured (m), calculated (c), estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment
P1	$EC_{ALS, y}$: Electricity consumption by ALS plant	Invoice for electricity consumption	kWh	M	Monthly	100%	electronic and paper	
P2	$SFC_{ELEC, AIR}$: Specific electricity	Historical data 2005-2007. Energy balances	MWh / 000 Sm^3 Air	E	Fixed ex ante		electronic and paper	

[52] See section B.1.

[53] See section B.1.

	consumption for compressed air	of main energy department of Severstal						
P3	$Q_{AIR, ALS, y}$: Consumption of compressed air by ALS plant	Invoice for compressed air consumption	000 Sm^3 Air	M	Monthly	100%	electronic and paper	
P4	$EC_{AIR, y}$: Electricity consumption for compressed air consumed by ALS plant	Equation (V)	MWh	C	Monthly		electronic and paper	
P5	$Q_{ST, y}$: Steam consumption by ALS plant	Invoice for steam consumption	Gcal	M	Monthly	100%	electronic and paper	
P6	$EF_{GAS, ST}$: Carbon emission factor for steam generated by natural gas combustion	2006 IPCC Guidelines for National Greenhouse Gas Inventories. Table 2.2	t CO_2 / Gcal of Steam	E	Fixed ex ante		electronic and paper	See section B.1.
P7	$EF_{ELEC, y}$: Carbon emission factor for grid-based electricity	Equation (VI)	t CO_2 / MWh	E	Fixed ex ante		electronic and paper	See section B.1.
P8	$EF_{ELEC, GEN, y}$: Carbon emission factor for the generation of grid-based electricity	See Section B.1 and Annex II	t CO_2 / MWh	C	Fixed ex-ante		electronic and paper	See Section B.1 and Annex 2

P9	$TL_{ELEC, y}$: Transmission losses for grid-based electricity	JSC Interregional Distribution Grid Company of the Center. http://mrsk-1.ru	%	C	Fixed ex-ante		electronic and paper	See Section B.1
P10	$PE_{ST, y}$: Project emissions from consumption of steam by ALS plant	Equation (IV)	t CO_2	C	Monthly		electronic and paper	See section D.1.1.2.
P11	$PE_{AIR, y}$: Project emissions from consumption of compressed air by ALS plant	Equation (III)	t CO_2	C	Monthly		electronic and paper	See section D.1.1.2.
P12	$PE_{ELEC, y}$: Project emissions from electricity consumption by ALS plant	Equation (II)	t CO_2	C	Monthly		electronic and paper	See section D.1.1.2.
P13	PE_y: Total Project Emissions	Equation (I)	t CO_2	C	Monthly		electronic and paper	See section D.1.1.2.

D.1.1.2. Description of formulae used to estimate project emissions (for each gas, source etc.; emissions in units of CO_2 equivalent):

(I) $PE_y = PE_{ELEC, y} + PE_{AIR, y} + PE_{ST, y}$

Where

PE_y Total Project Emissions in year y
$PE_{ELEC, y}$ Project emissions from electricity consumption by ALS plant in year y
$PE_{AIR, y}$ Project emissions from consumption of compressed air by ALS plant in year y

$PE_{ST,\,y}$ Project emissions from consumption of steam by ALS plant in year y

(II) $PE_{ELEC,\,y} = EC_{ALS,y} * EF_{ELEC,\,y}$

Where

$PE_{ELEC,\,y}$ Project emissions from electricity consumption by ALS plant in year y
$EC_{ALS,y}$ Electricity consumption by ALS plant in year y
$EF_{ELEC,\,y}$ Carbon emission factor for grid-based electricity in year y

(III) $PE_{AIR,\,y} = EC_{AIR,\,y} * EF_{ELEC,\,y}$

Where

$PE_{AIR,\,y}$ Project emissions from consumption of compressed air by ALS plant in year y
$EC_{AIR,\,y}$ Electricity consumption for compressed air consumed by ALS plant in year y
$EF_{ELEC,\,y}$ Carbon emission factor for grid-based electricity in year y

(IV) $PE_{ST,\,y} = Q_{ST,\,y} * EF_{GAS,\,ST}$

Where

$PE_{ST,\,y}$ Project emissions from consumption of steam by ALS plant in year y
$Q_{ST,\,y}$ Steam consumption by ALS plant in year y
$EF_{GAS,\,ST}$ Carbon emission factor for steam generated by natural gas combustion

(V) $EC_{AIR,\,y} = Q_{AIR,\,ALS,\,y} * SFC_{ELEC,\,AIR}$

Where

$EC_{AIR, y}$ Electricity consumption for compressed air consumed by ALS plant in year y
$Q_{AIR, ALS, y}$ Consumption of compressed air by ALS plant in year y
$SFC_{ELEC, AIR}$ Specific electricity consumption for compressed air

(VI) $\mathbf{EF_{ELEC, y} = EF_{ELEC, GEN, y} / (1 - TL_{ELEC, y} / 100)}$

Where

$EF_{ELEC, y}$ Carbon emission factor for consumption of grid-based electricity in year y
$EF_{ELEC, GEN, y}$ Carbon emission factor for generation of grid-based electricity in year y
$TL_{ELEC, y}$ Transmission losses for grid-based electricity in year y

D.1.1.3. Relevant data necessary for determining the baseline of anthropogenic emissions of greenhouse gases by sources within the project boundary, and how such data will be collected and archived:

ID number *(Please use numbers to ease cross-referencing to D.2.)*	Data variable	Source of data	Data unit	Measured (m), calculated (c), estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment
B1	$P_{GOX, y}$: Delivery of high-pressure oxygen from ALS cold box	Flow meter readings, meter tag FI001	1000 Sm^3 O_2	M	Monthly	100%	electronic and paper	
B2	$P_{LOX, y}$: Delivery of high pressure oxygen from ALS liquid oxygen storage tank	Flow meter readings, meter tag FI002	1000 Sm^3 O_2	M	Monthly	100%	electronic and paper	

B3	$P_{OX, y}$: Total Delivery of high pressure oxygen from ALS plant	Equation (VII)	1000 Sm^3 O_2	C	Monthly		electronic and paper	
B4	$P_{GAN, y}$: Total delivery of high pressure gaseous nitrogen from ALS plant	Flow meter readings, meter tag FI010	1000 Sm^3 N_2	M	Monthly	100%	electronic and paper	
B5	SC_{ST}: Specific steam consumption by reference plant	Historical data 2005-2007. Energy balance document for the reference plant	Gcal / 1000 Sm^3 O_2	E	Fixed ex ante		electronic and paper	See Section B.1.
B6	SC_{AIR}: Specific compressed air consumption of the reference plant	Historical data 2005-2007. Energy balance document for the reference plant	Sm^3 Air / Sm^3 O_2	E	Fixed ex ante		electronic and paper	See Section B.1.
B7	$SFC_{ELEC, AIR}$: Specific electricity consumption for compressed air	Historical data 2005-2007. Energy balance document for the reference plant	MWh / 1000 Sm^3 Air	E	Fixed ex ante		electronic and paper	See Section B.1.
B8	SFC_{ELEC}: Specific electricity consumption of the reference plant	Technical specifications document for the cold box of the reference plant.	MWh / 1000 Sm^3O_2	E	Fixed ex ante		electronic and paper	See Section B.1.

B9	$SFC_{ELEC, HPGOX}$: Specific electricity consumption by oxygen compressors	Historical data 2005-2007. Energy balance document for the reference plant	MWh / 1000 Sm^3 O_2	E	Fixed ex ante		electronic and paper	See Section B.1.
B10	$SFC_{ELEC, HPGAN}$: Specific electricity consumption by nitrogen compressors	The coefficient for the nitrogen product compressors is set equal to the specific electricity consumption for oxygen product compressors.	MWh / 1000 Sm^3 N_2	E	Fixed ex ante		electronic and paper	See Section B.1.
B11	$EF_{GAS, ST}$: Carbon emission factor for steam generated by natural gas combustion	2006 IPCC Guidelines for National Greenhouse Gas Inventories. Table 2.2	t CO_2 / Gcal Steam	E	Fixed ex-ante		electronic and paper	See Section B.1
B12	$EF_{ELEC, y}$: Carbon emission factor for the consumption of grid-based electricity	Equation (VIII)	t CO_2 / MWh	C	Fixed ex-ante		electronic and paper	See Section B.1
B13	$EF_{ELEC, GEN, y}$: Carbon emission factor for the generation of grid-based electricity	See Section B.1 and Annex II	t CO_2 / MWh	C	Fixed ex-ante		electronic and paper	See Section B.1 and Annex 2

B14	$TL_{ELEC, y}$: Transmission losses for grid-based electricity	JSC Interregional Distribution Grid Company of the Center. http://mrsk-1.ru	%	C	Fixed ex-ante		electronic and paper	See Section B.1
B15	$BE_{ST, y}$: Baseline emissions from steam consumption by reference plant	Equation (IV)	t CO_2	C	Monthly		electronic and paper	See Section D.1.1.4.
B16	$BE_{AIR, y}$: Baseline emissions from consumption of compressed air by reference plant	Equation (III)	t CO_2	C	Monthly		electronic and paper	See Section D.1.1.4.
B17	$BE_{ELEC, y}$: Baseline emissions from electricity consumption by reference plant	Equation (II)	t CO_2	C	Monthly		electronic and paper	See Section D.1.1.4.
B18	$BE_{HPGOX, y}$: Baseline emissions from electricity consumption by oxygen compressors	Equation (V)	t CO_2	C	Monthly		electronic and paper	See Section D.1.1.4.

B19	$BE_{HPGAN, y}$: Baseline emissions from electricity consumption by nitrogen compressors	Equation (VI)	t CO_2	C	Monthly		electronic and paper	See Section D.1.1.4.
B20	BE_y: Total baseline emissions	Equation (I)	t CO_2	C	Monthly		electronic and paper	See Section D.1.1.4.

D.1.1.4. Description of formulae used to estimate baseline emissions (for each gas, source etc.; emissions in units of CO_2 equivalent):

(I) $BE_y = BE_{ELEC, y} + BE_{AIR, y} + BE_{ST, y} + BE_{HPGOX, y} + BE_{HPGAN, y}$

Where

BE_y Total baseline emissions in year y
$BE_{ELEC, y}$ Baseline emissions from electricity consumption in reference facility in year y
$BE_{AIR, y}$ Baseline emissions from consumption of compressed air in reference facility in year y
$BE_{ST, y}$ Baseline emissions from steam consumption in reference facility year y
$BE_{HPGOX, y}$ Baseline emissions from electricity consumption by oxygen compressors in year y
$BE_{HPGAN, y}$ Baseline emissions from electricity consumption by nitrogen compressors in year y

(II) $BE_{ELEC, y} = P_{OX, y} * SFC_{ELEC} * EF_{ELEC, y}$

Where

$BE_{ELEC, y}$ Baseline emissions from electricity consumption in reference facility in year y
$P_{OX, y}$ Total delivery of high pressure oxygen from ALS plant in year y
SFC_{ELEC} Specific electricity consumption of the reference plant

$EF_{ELEC,\ y}$ Carbon emission factor for grid-based electricity in year y

(III) $\mathbf{BE_{AIR,\ y} = P_{OX,\ y} * SC_{AIR} * SFC_{ELEC,\ AIR} * EF_{ELEC,\ y}}$

Where

$BE_{AIR,\ y}$ Baseline emissions from consumption of compressed air in reference facility in year y
$P_{OX,\ y}$ Total delivery of high pressure oxygen from ALS plant in year y
SC_{AIR} Specific compressed air consumption of the reference plant
$SFC_{ELEC,\ AIR}$ Specific electricity consumption for compressed air
$EF_{ELEC,\ y}$ Carbon emission factor for grid-based electricity in year y

(IV) $\mathbf{BE_{ST,\ y} = P_{OX,\ y} * SC_{ST} * EF_{GAS,\ ST}}$

Where

$BE_{ST,\ y}$ Baseline emissions from steam consumption in reference facility year y
$P_{OX,\ y}$ Total delivery of high pressure oxygen from ALS plant in year y
SC_{ST} Specific steam consumption by reference plant
$EF_{GAS,\ ST}$ Carbon emission factor for steam generated by natural gas combustion

(V) $\mathbf{BE_{HPGOX,\ y} = P_{OX,\ y} * SFC_{ELEC,\ HPGOX} * EF_{ELEC,\ y}}$

Where

$BE_{HPGOX,\ y}$ Baseline emissions from electricity consumption by oxygen compressors in year y
$P_{OX,\ y}$ Total delivery of high pressure oxygen from ALS plant in year y
$SFC_{ELEC,\ HPGOX}$ Specific electricity consumption by oxygen compressors
$EF_{ELEC,\ y}$ Carbon emission factor for grid-based electricity in year y

(VI) $BE_{HPGAN, y} = P_{GAN, y} * SFC_{ELEC, HPGAN} * EF_{ELEC, y}$

Where

$BE_{HPGAN, y}$ Baseline emissions from electricity consumption by nitrogen compressors in year y
$P_{GAN, y}$ Total delivery of high pressure gaseous nitrogen from ALS plant in year y
$SFC_{ELEC, HPGAN}$ Specific electricity consumption by nitrogen compressors
$EF_{ELEC, y}$ Carbon emission factor for grid-based electricity in year y

(VII) $P_{OX, y} = P_{GOX, y} + P_{LOX, y}$

Where

$P_{OX, y}$ Total delivery of high pressure oxygen from ALS plant in year y
$P_{GOX, y}$ Delivery of high-pressure oxygen from ALS cold box in year y
$P_{LOX, y}$ Delivery of high pressure oxygen from ALS liquid oxygen storage tank in year y

(VIII) $EF_{ELEC, y} = EF_{ELEC, GEN, y} / (1 - TL_{ELEC, y} / 100)$

Where

$EF_{ELEC, y}$ Carbon emission factor for consumption of grid-based electricity in year y
$EF_{ELEC, GEN, y}$ Carbon emission factor for generation of grid-based electricity in year y
$TL_{ELEC, y}$ Transmission losses for grid-based electricity in year y

D. 1.2. Option 2 – Direct monitoring of emission reductions from the project (values should be consistent with those in section E.):

D.1.2.1. Data to be collected in order to monitor emission reductions from the project, and how these data will be archived:								
ID number *(Please use numbers to ease cross-referencing to D.2.)*	Data variable	Source of data	Data unit	Measured (m), calculated (c), estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment

D.1.2.2. Description of formulae used to calculate emission reductions from the project (for each gas, source etc.; emissions/emission reductions in units of CO_2 equivalent):

This section is left blank on purpose.

D.1.3. Treatment of leakage in the monitoring plan:

The proposed project could potentially cause leakage in (a) the air separation industry, (b) in the steel industry to which the produced gases are delivered or (c) in the electric power industry, which provides the key production input.

(a) Air separation industry:
The proposed project serves to meet incremental demand for high-pressure oxygen and high pressure-nitrogen in Cherepovets, Russia. In the absence of the project the same volumes of gases would have been provided by air separation plants with a different technology with a higher emissions profile. The oxygen and nitrogen would have been required in the baseline case because the production increase was necessary to meet a market demand. Therefore compared with the baseline the project does not lead to a production increase in the Russian or worldwide air separation industry.

The proposed project and the baseline are both greenfield projects. No used equipment will be sold to other companies in the Russian or worldwide air separation industry.

Conclusion: the project does not lead to an increase in emissions outside the project boundary in comparison to the baseline situation and therefore does not cause leakage in the air separation industry.

(b) Steel industry:

The proposed project serves to meet incremental demand for high-pressure oxygen and high pressure-nitrogen from the Severstal Steel Works to meet the market demands for steel. In the absence of the project the same volumes of gases would have been provided by air separation plants with a different technology with a higher emissions profile. Compared with the baseline the project does not lead to a production increase in the Russian or worldwide steel industry.

Conclusion: the proposed project does not lead to an increase in emissions outside the project boundary in comparison to the baseline situation and therefore does not cause leakage in the steel industry.

(c) Electric power industry:
The key energy input for the proposed project is from the electric power industry. The proposed project and the baseline consume electric power both directly for the air separation process and indirectly for the production of compressed air. The direct and indirect power consumption is fully included in the project and baseline boundaries and no additional power would be required for other purposes outside the project boundary.
Conclusion: the proposed project does not lead to an increase in emissions outside the project boundary in comparison to the baseline situation and therefore does not cause leakage in the electric power industry.

Conclusion: The proposed project does not cause any leakage.

D.1.3.1. If applicable, please describe the data and information that will be collected in order to monitor leakage effects of the project:

ID number *(Please use numbers to ease cross-referencing to D.2.)*	Data variable	Source of data	Data unit	Measured (m), calculated (c), estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment

According to Section D.1.3. the proposed project does not cause any leakage.

D.1.3.2. Description of formulae used to estimate leakage (for each gas, source etc.; emissions in units of CO_2 equivalent):

According to Section D.1.3. the proposed project does not cause any leakage.

D.1.4. Description of formulae used to estimate emission reductions for the project (for each gas, source etc.; emissions/emission reductions in units of CO_2 equivalent):

$ER_y = BE_y – PE_y – LE_y$

where

ER_y	Emission reduction in year y
BE_y	Total Baseline Emissions in year y
PE_y	Total Project Emissions in year y
LE_y	Leakage Emissions in year y, with $LE_y = 0$ for all years.

D.1.5. Where applicable, in accordance with procedures as required by the host Party, information on the collection and archiving of information on the environmental impacts of the project:

The environmental impacts of the ALS facility are not considered to be significant. Oxygen plants typically do not have big negative impact on the local environment given the absence of any combustion processes. The key inputs and outputs of the production process are all natural components of the ambient air.

ALS is subject to Article 30 of the Law of the Russian Federation «Ambient Air Protection». In accordance with the law ALS contracted OOO «Ecolog» on 09.06.2008 to develop standards for the maximum permissible air emissions.

ALS is also subject to the Government Standard GOST 17.2.3.02-78, Nature Preservation, Air, Rules on the determination of allowable emissions of harmful substances by production facilities. OOO «Ecolog» has prepared the emission inventory for ALS and identified the following potential sources of air pollution:

1) Stationary sources of air emissions:
- Oil reservoir of main air compressors;
- Oil reservoir of booster compressor;
- Oil reservoir of turboexpander;

2) Fugitive source of air emissions:
- Parking of nine cars.

Based on samples analyzed by the Severstal Laboratory ALS is emitting the following polluting substances. Their emission level is monitored by ALS or an outside company once every five years. Mineral oil is sampled by a certified company once every five years.

- Nitrogen dioxide (IV)
- Nitrogen dioxide (II)
- Carbon soot
- Sulfur dioxides[54]
- Petrol (in-equivalent carbon)
- Kerosene
- Mineral oil

In addition to the air pollutants, ALS is also monitoring the following environmental impacts once every five years. The monitoring takes place in accordance with the work place certification due to labour conditions according to article 212 of the Russian Federation Labour Code, the Russian Federation Labour and Social Development Department Regulation № 12 «About working place certification execution due to labour conditions» from March 14, 1997 and the Russian Federation Health and Social Development Department Order № 569 «About approval of order of working place certification execution due to labour conditions» from the August 31, 2007.

- Noise
- Vibration
- Electric intensity
- Magnetic flux density

All monitoring results are archived in electronic form and as hard copy by the Health-Safety-Environment (HSE) Manager.

D.2. Quality control (QC) and quality assurance (QA) procedures undertaken for data monitored:		
Data *(Indicate table and ID number)*	Uncertainty level of data (high/medium/low)	Explain QA/QC procedures planned for these data, or why such procedures are not necessary.
Table D1.1.1		

[54] Two types of sulfur dioxide are being monitored. They are distinguished by their respective chemical valence.

P1 $EC_{ALS, y}$	Low (0.5%)	Invoice, Vologda Energo. The official electricity meter (manufacturer Energomera, model C6850, location GPP14) that is used for invoicing does not belong to ALS and is located on the Severstal premises. Vologda Energo checks the meter once a year. ALS has a meter (Model SEPAM, location RP113/RP114) on its premises and is able to contest the power consumption figures if deviations are observed.
P3 $Q_{AIR, ALS, y}$	Low (0.5%)	Invoice, Severstal. The invoice is based on Deltafluid flow meter readings. Meter tag FI030, EMERSON - ROSEMOUNT - Model3051. Calibration takes place at least every two years and was last done in May 2009. In order to calibrate the meter it is necessary to stop the plant and empty the connected pipes.
P5 $Q_{ST, y}$	Low	Invoice, Severstal. The invoice is based on heat meter readings (manufacturer “Logika”, St. Petersburg, model CTP 961). The meter readings are included in the automated record system.
Table D1.1.3		
B1 $P_{GOX, y}$	Low (0.5%)	Deltafluid flow meter readings. Meter tag FI1510, Diaphragm meter, EMERSON - ROSEMOUNT - Model3051. Calibration takes place at least every two years and was last done in May 2009. In order to calibrate the meter it is necessary to stop the plant and empty the connected pipes.
B2 $P_{LOX, y}$	Low (0.5%)	Deltafluid flow meter readings. Meter tag FI002, Diaphragm meter, EMERSON - ROSEMOUNT - Model3051. Calibration takes place at least every two years and was last done in May 2009. In order to calibrate the meter it is necessary to stop the plant and empty the connected pipes.
B4 $P_{GAN, y}$	Low (0.5%)	Deltafluid flow meter readings. Meter tag FI1500, Diaphragm meter, EMERSON - ROSEMOUNT - Model3051. Calibration takes place at least every two years and was last done in May 2009. In order to calibrate the meter it is necessary to stop the plant and empty the connected pipes.

D.3. Please describe the operational and management structure that the project operator will apply in implementing the monitoring plan:

(a) Data Collection

$EC_{ALS,y}$ (P1): Electricity consumption by ALS plant

- ALS works closely with the sub-contractor STEK. STEK is in charge of daily operations, technical maintenance and projects in the area of electricity and instrumentation.
- On the first working day of a given month, a STEK employee calls the Energy Department of Severstal in order to obtain the Total Electricity Consumption by ALS during the previous month.
- STEK employee up-dates an excel file with:
    - Monthly Electricity Consumption provided by Energy Department of Severstal.

  - Monthly Electricity Consumption measured at the ALS plant
- The file is sent to the ALS Electrical & Instrumentation Manager who checks the values.
- Then, the information is given to Maintenance Manager and Plant Manager.
- The ALS Accounting Department receives the invoice from Severstal around the middle of the month. The invoice is based on the consumption measured by Severstal and the electricity price charged by Vologda Energo. Before payment, the invoice is again checked by the ALS Maintenance Manager.

$Q_{AIR, ALS, y}$ (P3): Consumption of compressed air by ALS plant

- The air volumes are measured by diaphragm flow meters. The data (gas flow, temperature, pressure) are automatically recorded in two systems: ASCUE and DCS (Yokogawa). ASCUE is the system used for invoicing and audited by the customer Severstal.
- During the first working day of a given month, an ALS operator extracts the data from the ASCUE System and prepares reports for each group of gases.
- The ALS Production Manager approves the reports and signs the printed version
- The reports are sent by e-mail to the Energy Department in Severstal in order to be cross-checked.
- Severstal sends an invoice to the ALS Accounting Department.

$Q_{ST, y}$ (P5): Steam consumption by ALS plant

- The heat meter is located on Severstal premises.
- Severstal sends the invoice to the ALS Accounting Department
- The invoice shows the volume of steam (in Gcal) consumed by the plant during the month.
- Before payment, the steam volume is checked by the Production Manager.

$P_{GOX, y}$ (B1), $P_{LOX, y}$ (B2), $P_{GAN, y}$ (B4): Deliveries of HPGOX, LOX and HPGAN from ALS Plant

- The gas volumes are measured by diaphragm flow meters. The data (gas flow, temperature, pressure) are automatically recorded in two systems: ASCUE and DCS (Yokogawa). ASCUE is the system used for invoicing and audited by the customer Severstal.
- During the first working day of a given month, an ALS operator extracts the data from the ASCUE System and prepares reports for each group of gases.
- The ALS Production Manager approves the reports and signs the printed version
- The reports are sent by e-mail to the Energy Department in Severstal in order to be cross-checked. When the Energy Department of Severstal has accepted the volumes, the ALS Accounting Department prepares the invoices for Severstal. The invoices are signed by the ALS Plant Manager.

(b) Data Retention:

$EC_{ALS, y}$ (P1): Electricity consumption by ALS plant
The ALS Accounting Department retains the original invoice. The Excel file that is maintained by the STEK employee and scanned copies of the invoices are retained electronically on the server.

$Q_{AIR, ALS, y}$ (P3): Consumption of compressed air by ALS plant
The ALS Accounting Department retains the original invoice and the reports signed by the ALS Production Manager. The reports prepared by ALS Instrumentation Operator are retained electronically on the server.

$Q_{ST, y}$ (P5): Steam consumption by ALS plant
The ALS Accounting Department retains the original invoice.

$P_{GOX, y}$ (B1), $P_{LOX, y}$ (B2), $P_{GAN, y}$ (B4): Deliveries of HPGOX, LOX and HPGAN from ALS Plant
The ALS Accounting Department retains the original invoice and the reports signed by the ALS Production Manager. The reports prepared by ALS Instrumentation Operators are retained electronically on the server.

(c) Quality Control:

$EC_{ALS, y}$ (P1): Electricity consumption by ALS plant
The official electricity meter that is used for invoicing is not under control of ALS and is located on the Severstal premises. Vologda Energo checks the meter once a year. ALS has an electricity meter on its premises and is able to contest the power consumption figures if deviations are observed.

$Q_{ST, y}$ (P5): Steam consumption by ALS plant
The heat meter that is used for invoicing is not under control of ALS and is located on Severstal premises.

$Q_{AIR, ALS, y}$ (P3): Consumption of compressed air by ALS plant
and $P_{GOX, y}$ (B1), $P_{LOX, y}$ (B2), $P_{GAN, y}$ (B4): Deliveries of HPGOX, LOX and HPGAN from ALS Plant:

The calibration of the flow meters is done at least once every two years. The ALS Instrumentation Service is responsible to schedule and organize the calibration. Since no by-pass exists, it is necessary to stop the ALS plant and empty the pipes. This is possible only if Severstal authorizes a stop of the plant.

Under ALS supervision, the calibration proceeds as follows:

- STEK employees dismantle, clean and prepare pressure and temperature meters for an inspection by the official metrological company in Cherepovets ЦСМ.
- Energoremount removes diaphragms from pipes. STEK cleans them and prepares them for an inspection by ЦСМ.
- STEK, Energoremount replace all elements after the inspection is completed.
- ЦСМ provides certificates of the completed calibration.[55]
- Control of ASCUE. The first inspection is done by ЦСМ within 8 years after start-up; subsequent inspections are performed every three years.

(d) Reporting:
The Monitoring Report will be prepared by the Plant Manager. Currently this position is filled by Mr. Vincent Pozzo.

D.4. Name of person(s)/entity(ies) establishing the monitoring plan:

GreenStream Network Plc
Kluuvikatu 3
FI-00100 Helsinki
FINLAND
Tel: +358 20 743 7800
Fax: 358 20 743 7810
www.greenstream.net

GreenStream Network is not a Project Participant.

[55] The Certificates of Calibration for gas and compressed air flow meters have been made available to the verifier.

SECTION E. Estimation of greenhouse gas emission reductions

E.1. Estimated project emissions:

The 2008 project emissions are based on monitored data. The project emissions for the years 2009 to 2012 are estimates.

Year	Estimate of Annual Emissions (tonnes of CO_2e)
2008	267,958
2009	254,032
2010	250,506
2011	247,016
2012	243,563
2008-2012	1,263,075
2013	240,146
2014	236,746
2015	233,418
2016	230,105
2017	226,826
2013-2017	1,167,260
2008-2017	2,430,335

E.2. Estimated leakage:

No leakage was identified in section D.1.3.

E.3. The sum of E.1. and E.2.:

Year	Estimate of Annual Emissions (tonnes of CO_2e)
2008	267,958
2009	254,032
2010	250,506
2011	247,016
2012	243,563
2008-2012	1,263,075
2013	240,146
2014	236,746
2015	233,418
2016	230,105
2017	226,826
2013-2017	1,167,260
2008-2017	2,430,335

E.4. Estimated baseline emissions:

The 2008 baseline emissions are based on monitored data. The baseline emissions for the years 2009 to 2012 are estimates.

Year	Estimate of Annual Emissions (tonnes of CO_2e)
2008	382,561
2009	356,078
2010	351,199
2011	346,371
2012	341,593
2008-2012	1,777,802
2013	336,865
2014	332,187
2015	327,556
2016	322,973
2017	318,437
2013-2017	1,638,018
2008-2017	3,415,820

E.5. Difference between E.4. and E.3. representing the emission reductions of the project:

The 2008 emission reductions are based on monitored data. The emission reductions for the years 2009 to 2012 are estimates.

Year	Estimate of Annual Emission Reductions (tonnes of CO_2e)
2008	114,604
2009	102,045
2010	100,693
2011	99,354
2012	98,030
2008-2012	514,726
2013	96,719
2014	95,422
2015	94,139
2016	92,868
2017	91,610
2013-2017	470,759
2008-2017	985,485

E.6. Table providing values obtained when applying formulae above:

The 2008 emission reductions are based on monitored data. The emission reductions for the years 2009 to 2017 are estimates.

Overview of project, baseline and emission reductions

Year	Estimated project emissions (tonnes of CO_2 equivalent)	Estimated leakage (tonnes of CO_2 equivalent)	Estimated baseline emissions (tonnes of CO_2 equivalent)	Estimated emission reductions (tonnes of CO_2 equivalent)
2008	267,958	0	382,561	114,604
2009	254,032	0	356,078	102,045
2010	250,506	0	351,199	100,693
2011	247,016	0	346,371	99,354
2012	243,563	0	341,593	98,030
2012-2018	1,263,075	0	1,777,802	514,726
2013	240,146	0	336,865	96,719
2014	236,746	0	332,187	95,422
2015	233,418	0	327,556	94,139
2016	230,105	0	322,973	92,868
2017	226,826	0	318,437	91,610
2013-2017	1,167,260	0	1,638,018	470,759
2008-2017	2,430,335	0	3,415,820	985,485

The provided emission reduction figures are estimates. Actual emission reductions depend mostly on the following variables:

1. Production volume of separated gases HPGOX and HPGAN

2. Specific electric power consumption for compression and air separation processes

SECTION F. Environmental impacts

F.1. Documentation on the analysis of the environmental impacts of the project, including transboundary impacts, in accordance with procedures as determined by the host Party:

The environmental issues associated with the project and relevant mitigation measures were addressed in the Environmental Impact Assessment of the project which was prepared by ZAO "Petroteknip", OOO "City Ecological Examination Centre", St. Petersburg in 2006.[56]

The environmental impacts of the ALS facility are not considered to be significant. Oxygen plants typically do not have big negative impact on the local environment given the absence of any combustion processes. The key inputs and outputs of the production process are all natural components of the ambient air. Moreover, the new installation is constructed within the existing steel plant complex and employs state-of-the-art technology with an internationally proven performance record. The plant is operated in accordance with Air Liquide's environmental best practices, which are based on EU environmental standards and requirements.

The air separation products – nitrogen, oxygen and argon – are not subject to regulations relating to toxic pollutants. Given the absence of any combustion processes the project does not result in any emissions of SO_2, H_2S, NO_x, CO or particulate matter. Project emissions of the main air pollutants (mineral oil-mist, transport emissions and solvent-mist) are within the permissible standards. Water supply and drainage are provided by the existing water supply and sewer systems. A highly efficient water circulation system is introduced to provide water to cool the equipment. The project's impact on the quality of the surface and underground water is considered to be immaterial. The spent basalt packing of regenerators, zeolite and other renewal adsorbents are the only solid wastes from the oxygen plant. The volume of these materials is very minor, and usually they are used in road construction.

The ALS facility belongs to the Group III of facilities which are required to establish a 300-meter sanitary buffer zone[57]. This zone is located within the 1000-meter buffer zone established for the Severstal Steel Works. The air separation plant does not have any considerable air pollution impacts. The major negative impact of the plant relates to the significant level of noise generated by compressor equipment, pumps, electric fans and other electric driven equipment. The calculations provided in the project documentation demonstrate that the level of noise in the closest residential area located 1200-1300 meters from the plant does not exceed the existing sanitary standards. The project documentation has been approved by the Sanitary- Epidemiological Center in the Vologda Region, City of Cherepovets.[58] Given that the plant is located 440 km from the Russian border at Saint Petersburg, it does not have any negative trans-boundary environmental impacts on the territories of foreign countries.

The hazardous wastes generated by the project include mercury tubes and compressor and industrial oils, which are transferred to specialized waste treatment facilities. Potential environmental risks associated with the new installation could be caused by the equipment decompression. Even though the separated

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[56] The title of the study is "Construction of Air Separation Plant for Air Liquide-Severstal JV, Russia located in the Vologda region, City of Cherepovets, 30 Mira Str., Environmental Impact Assessment". The Environmental Impact assessment has been made available to the verifier.

[57] This information is taken from page 52 of the Environmental Impact Assessment.

[58] The title of the study is "Expert Conclusion on the project documentation "Working Project: Construction of Air Separation Plant for Air Liquide-Severstal JV, Russia located in the Vologda region, City of Cherepovets, 30 Mira Street".# 407-T, July 31, 2006. The analysis was done by the "Sanitary-Epidemiological Center in the Vologda Region, City of Cherepovets", a branch of the Federal Public Health Agency "Sanitary-Epidemiological Center in the Vologda Region", Federal Service for the Oversight of Consumer Rights and Human Well-Being. The Expert Conclusion has been made available to the verifier.

air products are not toxic, the liquid oxygen that is produced and stored at the facility is an oxidizing agent which is could cause fire and explosions. The Environmental Protection section of the Working Project Design Document includes relevant measures to prevent emergencies and to mitigate the consequences of actual emergency situations.[59] The proposed mitigation measures ensure that emergency situations are sufficiently managed and that the potential negative impacts on the plant's staff, local population and the environment are minimised. In compliance with the Russian Federation law "About Dangerous Production Facilities", the Declaration of Industrial Safety was prepared by ALS, reviewed by the St. Petersburg Ecological Examination Centre and approved by the Russian Federation Ministry of Emergency Situations (June 2007).[60] The Declaration of Industrial Safety and the Expert Conclusion of the Centre are in compliance with the existing federal standards and were registered by the Federal Ecological, Technological and Nuclear Inspectorate in August 2007.[61]

F.2. If environmental impacts are considered significant by the project participants or the host Party, please provide conclusions and all references to supporting documentation of an environmental impact assessment undertaken in accordance with the procedures as required by the host Party:

In compliance with the Russian Federation legislation and the Construction Norms and Rules, ALS has obtained the required environmental and sanitary-epidemiological permits from the regulatory agencies of the Vologda Region and the City of Cherepovets including: Expert Conclusion on the State Ecological Examination of the Project, Department of Technological and Ecological Oversight, Vologda Region, November 10, 2006; Expert Conclusion on the State Ecological Examination of the Project Location, January 30, 2006 and Expert Conclusion of the Hygiene and Epidemiology Centre, Vologda Region, July 31, 2006.[62]

The project environmental documents are in compliance with the state environmental and sanitary-epidemiological standards. The State Ecological Examination of the project did not identify any non-compliance issues with regards to the Russian Federation legislation and normative documents relating to the environmental protection. The project complies with all environmental laws, and emissions are well within legal limits.

SECTION G. Stakeholders' comments

G.1. Information on stakeholders' comments on the project, as appropriate:

The intention to carry out the ALS investment project and the start of construction were made public in various local newspapers including "The Red North" and "The Voice of Cherepovets". The information

[59] The Environmental Protection Section of the Working Project Design Document was prepared by ZAO "Petroteknip", OOO "City Ecological Examination Centre", St. Petersburg, 2006. The section has been made available to the verifier.

[60] The approval was issued by the Department of Emergency Situations Prevention, Ministry of Emergency Situations of the Russian Federation. The document is titled "Declaration of Industrial Safety of Air Separation Plant for Air Liquide-Severstal JV (Block #11, Oxygen Station #3)", June 18, 2007. The Declaration has been made available to the verifier.

[61] The Industrial Safety Declaration is registered under the number # 13-13/1875, August 1, 2007. The registration of the Industrial Safety Declaration has been made available to the verifier.

[62] The Expert Conclusion on Sanitary-Epidemiological Issues has been made available to the verifier.

was also disseminated through other mass communication media including TV, radio and Internet.[63] No objections to the project implementation were expressed by the public.

[63] The meeting was held in the Department of Architecture and Town-Planning, Administration of the City of Cherepovets, on April 5, 2006. The minutes of the meeting have been made available to the verifier.

Annex 1

CONTACT INFORMATION ON PROJECT PARTICIPANTS

Organisation:	Air Liquide Severstal CJSC
Street/P.O.Box:	ul. Ustyuzhenskaya, 97
Building:	
City:	Cherepovets
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Postal code:	162600
Country:	Russian Federation
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E-mail:	
URL:	www.airliquide.ru
Represented by:	
Title:	General Director
Salutation:	Mr.
Last name:	Shuvalov
Middle name:	
First name:	Alexei
Department:	
Phone (direct):	+ 7 (495) 641 28 98
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Street/P.O.Box:	c/- Fortis Intertrust (Netherlands) B.V., Prins Bernhardplein 200
Building:	
City:	Amsterdam
State/Region:	
Postal code:	1000 AZ
Country:	The Netherlands
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Represented by:	Mr. Jaap C.M. Veerman
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Annex 2

BASELINE INFORMATION

(1) Baseline Description

In the absence of the project the most plausible scenario would have been the construction of additional Russian-made low-pressure cryogenic air separation units with a combined capacity of 90,000 Sm^3/hr.They would most likely have been installed on the premises (or in the immediate vicinity) of the steel production complex in Cherepovets. The facility would have used a low-pressure air separation process. It would have been provided with compressed air from a number of main air compressors, and the separated low-pressure oxygen and nitrogen would have been further compressed by product compressors.

(2) Key information and data used to establish the baseline:

The baseline emission rate is derived from a reference low-pressure air separation facility recently commissioned in Russia.. The reference facility operates under very similar conditions as the ALS plant and represents the technology most likely to be used in the absence of the project.

ID number	Parameter / Variable	Description	Units	Values	Source
B5	SC_{ST}	Specific steam consumption by reference plant	Gcal / 1000 Sm^3 O_2	0.060	Based on historical data for the reference facility, 2005-2007
B6	SC_{AIR}	Specific compressed air consumption of the reference plant	Sm^3 Air / Sm^3 O_2	6.3187	Based on historical data for the reference facility, 2005-2007
B7	$SFC_{ELEC, AIR}$	Specific electricity consumption for compressed air	MWh / 1000 Sm^3 Air	0.1041	Based on historical data for the reference facility, 2005-2007
B8	SFC_{ELEC}	Specific electricity consumption of the cold box of the reference plant	MWh / 1000 Sm^3 O_2	0.0269	Technical specification by manufacturer of cold box
B9	$SFC_{ELEC, HPGOX}$	Specific electricity consumption by oxygen compressors	MWh / 1000 Sm^3 O_2	0.1941	Based on historical data for the reference facility, 2005-2007
B10	$SFC_{ELEC, HPGAN}$	Specific electricity consumption by nitrogen compressors	MWh / 1000 Sm^3 N_2	0.1941	Based on historical data for the reference facility, 2005-2007
B11	$EF_{GAS, ST}$	Carbon emission factor for steam generated by natural gas combustion	t CO_2 / Gcal	0.1243	Calculated based on default value from 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Table 2.2[64]
B12	$EF_{ELEC, y}$	Carbon emission factor for consumption of grid-based electricity	t CO_2 / MWh	0.614 (2008)	See Section B.1. Calculated from B13 and B14
B13	$EF_{ELEC, GEN, y}$	Carbon emission factor for generation of grid-based electricity	t CO_2 / MWh	0.556 (2008)	See Section B.1 and Annex 2, Section (3) “Carbon Emission Factor for the Generation of

[64] See Section B.1.

B14	$TL_{ELEC, y}$	Transmission losses for grid-based electricity	%	9.40 (2008)	Grid-Based Electricity." See section B.1. Based on published data from JSC Interregional Distribution Grid Company of the Center[65]

(3) Carbon Emission Factor for the Generation of Grid-Based Electricity

The GHG emission factor for the Consolidated Electricity System (CES) of The Central Zone of Russia is determined based on the «Tool to calculate the emission factor for an electricity system» (Version 02) ("Tool") and the "Practical Baseline Recommendations for GHG Mitigation Projects in the Electric Power Sector" by the OECD Environment Directorate and International Energy Agency (2002).

Justification of application of EF_{OM} for the project case ("demand-side energy efficiency project").

The Tool determines the CO_2 emission factor for the displacement of electricity generated by power plants in the electricity system, by calculating the "combined margin" (CM) emission factor of the electricity system. The CM is the result of a weighted average of two emission factors pertaining to the electricity system: the "operating margin" (OM) and the "the build margin" (BM). The OM emission factor refers to the group of existing power plants whose current electricity generation would be affected by the proposed project activity. The BM emission factor refers to a cohort of power units that reflect the type of power units whose construction would be affected by the proposed CDM/JI project activity. The Tool may be applied to estimate the OM, the BM **and/or** the CM when calculating baseline emissions for a project activity that substitutes grid electricity, i.e. where a project activity that results in savings of electricity that would have been provided by the grid (i.e. demand side energy efficiency projects)."

The CM emission factor is calculated as $EF_{CM} = EF_{OM} * w_{OM} + EF_{BM} \times w_{BM}$, where in most cases it is recommended to apply $w_{OM} = w_{BM} = 0.5$ for the first crediting period. But "alternative weights can be proposed as long as $w_{OM} + w_{BM} = 1$", in cases where the default weights do not reflect the situation; explanations must be presented.

From the quotations and explanations taken from the Tool and presented above it is still not quite clear what "build margin" exactly means and in what way it can be applied for a case of a demand-side energy efficiency project. In the Information Paper "Practical Baseline Recommendations for GHG Mitigation Projects in the Electric Power Sector" issued by OECD Environment Directorate and International Energy Agency (2002) BM is explained in the following way. A power project activity that is additional to the business-as-usual scenario causes "avoided generation" in the power system either by means of a "delay effect" or a "cancelled effect" of the planned new plants. Most electricity projects are likely to affect the OM in the short run and the BM in the long run. As stated in the Paper different types of projects can affect either the BM (new capacity additions) or the operating margin. Additional projects which reduce electricity consumption from the grid cannot cause the delay or cancellation of new capacities, and they are quite unlikely to affect the existing plans to construct new plants or capacity additions. This is especially obvious when power savings caused by a project activity are comparatively small in comparison with the capacity of the relevant project electricity system. In the short run demand side energy efficiency project activities will just reduce the load of existing power plants, so that the OM is applicable.

[65] The data is available at the following website. http://mrsk-1.ru

According to the Tool EF_{OM} can be calculated ex-ante (which is most common) using data of the most recent 3 years, EF_{OM} is fixed once for the 1st commitment period without any update and monitoring. This method if applied without BM means that there is no change of efficiency in the project electricity system in coming 3-4 years which is not correct. New plants will be commissioned according to business-as-usual plans and they will partly substitute some old ones and partly increase system's capacity (depends on the demand). In any way system's efficiency will be improved and specific emissions reduced. In what way to take into account this effect? Applying $w_{OM} = w_{BM} = 0.5$ in the case of demand-side energy efficiency projects means that half of the power plants of the electricity system has the same efficiency as newly constructed ones (which in many cases is neither right nor realistic for a short period of time). In addition it is implied that the load of new plants and old plants is reduced to the same extent, even though it is rational to reduce the load of the older plants. In reality the existing plants will dominate the load reductions. The approach of OM domination for demand side energy efficiency projects was used in the Dutch Emission Reduction Units Purchase Tender (ERUPT) documents.[66] Two sets of Emission Factors (EFs) were proposed: one for projects with new capacities and/or for those that lead to larger power consumption from a grid (with BM and finally with CM) and the other set (with higher level of EFs) which refers to projects which reduce power consumption from a grid (based on only OM). To take into account an increase of system's efficiency the ERUPT developers kept annually decreasing values without averaging.

The same approach was applied to the proposed project. As shown in Step 1 below the Consolidated Power System of the Center was identified as the relevant power system for the project. Total annual electricity production of the System is 218,892,000 MWh while electricity savings from the project activity constitute less than 200,000 MWh per year. It is unlikely that the decrease of electricity demand from the System by less than 0.1% can affect the plans to build new power plants. Moreover, the ALS plant's capacity is 47 MW, which represents only 0.04% of the Central System's capacity.

In Russia it is officially accepted to use the specific fuel consumption of a power plant (tons of coal equivalents per 1 kWh of electricity output) in order to evaluate the efficiency of electricity production. These indicators are officially published by utilities and state entities, analyzed and monitored. For a power system these indicators absorb such measures as new capacities commissioned and old stopped, refurbishment of existing equipment and local measures of energy efficiency implemented. Use of such indicators seems very convincing not only for calculating historical values of EF_{OM} but also for extrapolating them for the 1st crediting period up to 2013.

Conclusion.

Under the above justification the developers proposed alternative weights of OM and BM: $w_{OM} = 1$ and $w_{BM} = 0$ since the commonly used weightage $w_{OM} = w_{BM} = 0.5$ does not reflect the situation for the case of demand-side energy efficiency projects. At the same time the decrease of EF_{OM} reflects energy efficiency improvements of the power system and thus conservative values are proposed for application in the PDD. Since $w_{BM} = 0$, only the first 4 steps of 7 from the Tool were followed in the development of the emission factors.

Calculation of EF under the Tool

<u>Step 1: Identify the relevant electricity systems</u>

[66] See Operational Guidelines for Baseline Studies, Validation, Monitoring and Verification of JI Projects. (Volume 2a, Baseline Studies, Monitoring and Reporting. A Guide for project developers. Version 2.0, October 2001, Ministry of Economic Affairs of the Netherlands.

The project activity will takes place in Vologda Province. The available capacity of all electricity sources of the Vologda Power System constitutes 1399.7 MW including the Vologda CHP (34 MW), the Cherepovetsk GRES (TPP, 630 MW) and 9 block-plants (e.g. those that are acting as shops of industrial enterprises. The CHP plant of JSC "Severstal" is one of these block-plants. Its 674.6 MW capacity does not cover the demands of the Severstal steel works, and the lack of electricity is compensated by purchasing from the Vologda Power System. In its turn Vologda Power System covers only about a half the provincial electricity demand, approx. 13.4 billion kWh.[67] The dynamics of electricity production and consumption are shown in Figure 1 below.

From a commercial point of view Vologda power system purchases missing electricity at the wholesale market of the Russian Federation (NOREM). However in a physical sense the Vologda system is a part of a larger power system, the Consolidated Electricity System (CES) of the Center, from which the electricity shortage in the region is compensated.

For the above reasons the CES of the Center is identified as the relevant power system which is affected by the project activity. The decision corresponds to the Tool's recommendations, which suggest to "use a regional grid definition in the case of large countries with layered dispatch systems (e.g. provincial/regional/national). A provincial grid definition may indeed in many cases be too narrow given significant electricity trade among provinces that might be affected, directly or indirectly, by a CDM project activity. In other countries the national (or other largest) grid definition should be used by default" (quoted from the Tool).

The CES of the Center is one of seven integrated power systems on the territory of the Russian Federation, which comprise 75 provincial power systems. The power systems are dispatched by regional or provincial dispatch departments of the National System's Operator, respectively. Six integrated power systems of Russia: The CES' of the Center, the Middle Volga, the Urals, the North-West and the Siberia are working in parallel mode. The CES of the East is an isolated system.

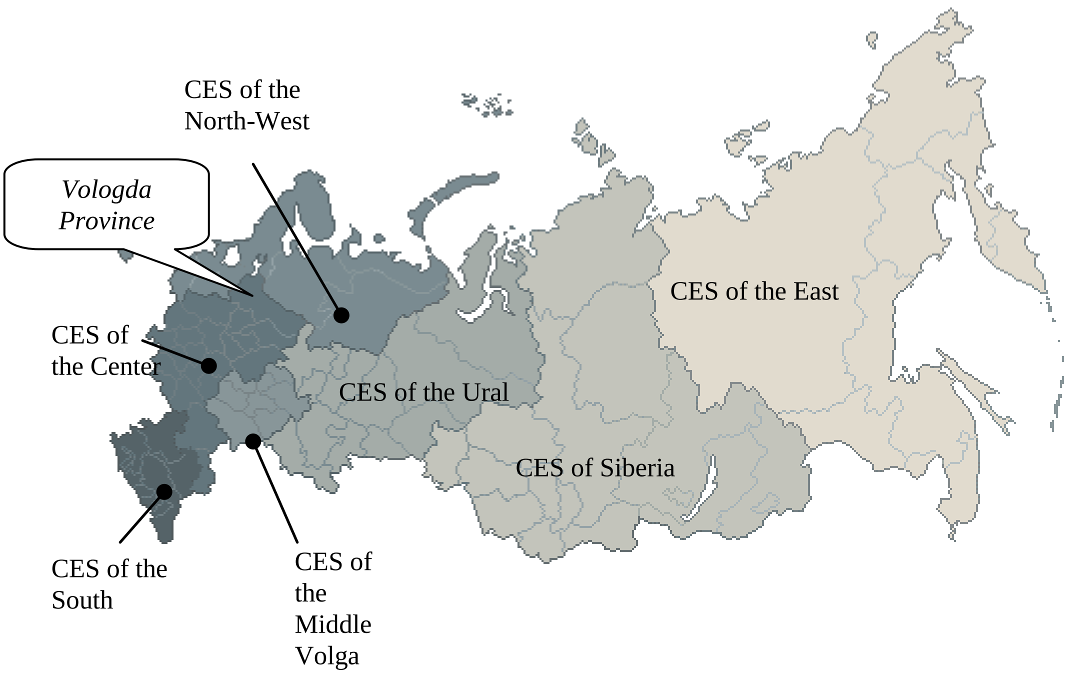

Figure 1 Structure of Unified Energy System of Russia by CESs

[67] Government of Vologda Region. The data is available at the following website: http://vologda-oblast.ru/

The CES of the Center is the largest consolidated electricity system in Russia. Its power plants are located in the territories of Moscow, Yaroslavl, Tver, Smolensk, Moscow, Ivanovo, Vladimir, Vologda, Kostroma, Ryazan, Tambov, Bryansk, Kaluga, Tula, Orel, Kursk, Belgorod, Voronezh and Lipetsk provinces and Moscow city. The System's generating capacity constitutes about 25% of the total generating capacity of Unified Energy System of Russia.

Characteristic features of CES of the Center are as follows:

- Its location at the cross-roads of other CES' (of North-West, Middle Volga, Ural and South as well as power systems of Ukraine and Belarus);
- The highest share of nuclear power plants;
- A number of huge power consumers such as metallurgy plants in Cherepovets, Belgorod, Lipetsk;
- Moscow city and Moscow region with population of approx. 15 mln. require highest rate of reliability of the System;
- The necessity in high share of thermal power plants to provide frequency and power transfers control.
- The share of natural gas constitutes more than 90% in the fuel mix. Some coal-fired power plants are in Tula, Ryazan, Ivanovo and Vologda provinces.

Table 1. Installed capacity and fuel mix in the CES of the Center in 2008

#	Region	Installed capacity, MW	Structure of fuel balance, %		
			Natural gas	Fuel oil	Coal
1	Belgorod province	286.0	99.9	0.0	0.1
2	Bryansk province	68.5	99.6	0.1	0.3
3	Vladimir province	421.7	99.8	0.2	0.0
4	Voronezh province	2 136.6	94.0	4.3	1.7
5	Ivanovo province	958.0	82.5	0.2	17.3
6	Kaluga province	85.0	100.0	0.0	0.0
7	Kostroma province	3 826.5	98.1	1.9	0.0
8	Kursk province	4 276.8	96.3	3.2	0.5
9	Lipetsk province	923.8	99.6	0.4	0.0
10	Moscow province	7 409.6	90.2	0.3	9.5
11	Orel province	390.0	100.0	0.0	0.0
12	Ryazan province	3 485.0	75.3	1.3	23.4
13	Smolensk province	4 033.0	92.0	0.1	7.9
14	Tambov province	393.7	99.4	0.6	0.0
15	Tver province	5 746.2	97.3	1.2	1.5
16	Tula province	2 449.5	61.9	3.0	35.1
17	Yaroslavl province	1 306.2	97.1	0.3	2.6
18	City Moscow	8 989.9	99.7	0.3	0.0
19	Vologda province	1 425.1	84.2	0.2	15.6
∑	**CES of the Center**	**48 611.2**	**92.7**	**0.8**	**6.5**

Source: IT Rosstat

The CES of the Center has surplus capacity and is performing as an electricity exporter.

Table 2. Import/export of electricity of the Consolidated Electricity System of the Center

Indicators	2008	2009
Electricity production (million kWh)	236 762.8	224 708.0
Electricity consumption (million kWh)	220 513.7	211 709.0
Export from CES of the Center	**16 249.1**	**12 999.0**

Source: JSC "CO IES" www.so-ups.ru. «Report on functioning of IES in Russia in 2009»

For the purpose of determining of OM emission factors option (a) for a connected electricity system is chosen, i.e. the emission factor for net electricity imports from a connected system are set equal to zero t CO_2/MWh.

Step 2: Choose whether to include off-grid power plants in the project electricity system (optional)

Option I has been chosen: only grid power plants are included in the calculation. The project facility under consideration is located at the site of the big metallurgy plant "Severstal" where there are no off-grid power plants.

Step 3: Select a method to determine the operating margin (OM)

The calculation of $EF_{grid,OM,y}$ may be based on one of the following methods:

(a) "Simple OM; or
(b) Simple adjusted OM; or
(c) Dispatch data analysis OM; or
(d) Average OM

When the operating margin is determined by "simple OM" (a), the low-cost/must run resources are not included in the calculation. Such method can be used, if the share of low-cost/must run resources constitutes less than 50% from the total electricity production by all system sources. The low-cost/must run sources are understood in the "Tool" as the electric power stations with the least expenses for electricity production or the power plant, the dispatching management of which does not depend on the daily or seasonal load of the system. Only hydro and nuclear power plants are included in this category in Russia since other renewables contribute less than 1% of net generation.
Method (a) "Simple OM" was chosen for CES of the Center, because the share of hydro and nuclear plants in CES's generation constitute only 36% of the 5-year average.

Table 3. Share of low-cost/must-run sources in power production of CES of the Center

Type of source	2004		2005		2006		2007		2008		Average value
	million kWh	Share (%)	million kWh	Share (%)	million kWh	Share (%)	million kWh	Share (%)	million kWh	Share (%)	Share (%)
CES of the Center	184371	100%	193147	100%	214319	100%	217693	100%	218892	100%	100%
TPP	118168	64%	122107	63%	137910	64%	138401	64%	140700	64%	**64%**
Hydro	3980	2%	3582	2%	3208	1%	3438	2%	3522	2%	**2%**
Nuclear	62223	34%	67458	35%	73202	34%	75854	35%	74669	34%	**34%**

Source: data of ID of Rosstat

For the «Simple OM» method (a) the EFs can be calculated using Ex-ante option: the EFs are determined once at the validation stage, thus no monitoring and recalculation of the EFs during the crediting period is required. A 3-year generation-weighted average can be used for the purpose.

Conservativeness of Including CHP plants

The grid emission factor has been calculated based on operational data for the pool of (i) power plants working in condensing mode and (ii) combined heat and power (CHP) plants working in heat supply mode. During the heating season the electricity production of the CHP plants is directly tied to the heat production. As such the CHP plants cannot cover peak electricity demands and one might exclude them as must-run resources. Including the CHP plants was done for practical reasons, such as data availability, it is demonstrated below that the choice is conservative.

Combined heat and power plants (CHP) which are working in different modes are an integral part of the electricity system, both physically and commercially. The CES of the Center has a very well developed transmission and distribution lines network where CHP plants are connected to a local grid which in turn is connected to the overall grid of the CES of the Center. As soon as electricity from a power plant, regardless of whether it is operating as a CHP or in condensed-mode enters a local power grid it becomes an integral part of the larger system's electricity flows and distribution. It can no longer be identified which specific consumer or locality is being served. Even though a power plant may be located side by side with a large consumer, the consumer receives the power from the local power system rather than from the individual plant.

In order to demonstrate the conservativeness of including the CHPs it is shown that the CHPs have a lower CO2 emission factor (t CO2 / MWh) than the thermal power plants operating in condensing mode. Including the CHPs then lowers the emission factor, and the factor is therefore conservative.

(a) As shown in Annex 2, 6.5% of the thermal power generation capacity is coal-fired, and almost all of it is consumed by high-capacity condensing type thermal power plants (Ryazan, Kashira, Shatura, Cherepet, Cherepovetsk). As a result, the CHPs consume almost exclusively natural gas.

(b) CHPs have a slightly higher gas consumption than the gas-fired TPPs. However they have much lower specific fuel consumption (in t c.e. / MWh) than the coal-fired TPPs. Given that coal has a significantly higher EF (t CO2 per GJ) than gas, the difference in greenhouse gas emissions is even bigger. As a result, the average emission factor of the plants working in condensing mode is bigger than that for the CHPs.

Table 4. Emission factors for power plants in condensing mode and CHP

	Units	Power Plants in condensing mode			CHP	Source
		Gas	Coal	Mix		
Percentage	%	93.5	6.5[68]	100		IT Rosstat[69]
Specific fuel consumption	kg c.e. / MWh	327	360	329	330	Technical Concept of EUS of Russia[70]
EF	t CO2 / t c.e.	1.644	2.817	1.727	1.644	IPCC[71]
EF	t CO2 / MWh	0.538	1.014	0.569	0.543	Calculated

[68]This is conservative since CHPs are almost 100% gas-fired, while some thermal power plants working in condensed mode are coal-fired. As a result, the share of coal among the thermal power plants working in condensed mode is higher than 6.5 %, and the share of natural gas is lower than 93.5%.

[69] See Table 2 in this Annex.

[70] Technical Concept of EUS of Russia. The data is given for the year 2005 and it can be found at the following website: http://www.rao-ees.ru/

[71] See Table 4 in this Annex.

Conclusion: the emission factor for CHP plants is lower than the average emission factor for thermal power plants operating in condensing mode. The calculated emission factors are therefore conservative.

Step 4: Calculate the operating margin emission factor according to the selected method

The «simple OM» EF can be is calculated as the generation-weighted emissions per unit net electricity generation of all power plants serving the system, not including low-cost/must run plants/units by means of:

- option A1 (or A2) which is based on the net electricity generation and an emission factor of each unit;
- option B is based on the total net electricity generation of all power plants serving the system and the fuel types and total fuel consumption of the project power system.

Data available from the Informational Department of the National Service of Statistics "Rosstat" for the public use represents averaged weighted data for a region/province which comply with those established by option B. The EF is determined by the following formula:

$$EF_{grid,OMsimple,y} = \frac{\sum_i (FC_{i,y} \times NCV_{i,y} \times EF_{CO2,i,y})}{EG_y}; \quad \left[\frac{tCO_2}{MWh}\right]$$

Where

$EF_{grid, OMsimple, y}$	«simple OM» emission factor in year y (tCO_2/MWh);
$FC_{i, y}$	quantity of fossil fuel i consumed in design power system in year y (in mass or volume units)
$NCV_{i. y}$	net calorific value of fossil fuel i in year y (GJ/mass or volume unit)
$EF_{CO2, i, y}$	emission factor for fossil fuel of type i in year y (tCO_2/GJ)
EG_y	net electricity generation supplied to the grid by all power plants of project power system excluding nuclear and hydro in year y (MWh)
i	the types of fossil fuel burned at the electric power stations of design power system in year y
y	three most recent years.

The product $\sum FC_{i. y} * NCV_{i, y}$ in formula (1) can be also expressed as the fuel consumption in tons of coal equivalent $FC_{i, c.e., y}$ with net calorific value $NCV_{c.e., y}$=7000 kcal/kg c.e. (or 29.31 GJ/t c.e.):

$$\sum_i (FC_{i,y} \times NCV_{i,y}) = \sum_i (FC_{i,c.e.y} \times 29{,}31); \quad [GJ]$$

The ratio $\sum FC_{i,\ c.e.,\ y} / EG_y$ for Russian electric power stations is called the specific consumption of standard coal (specific fuel consumption in coal equivalents per 1 kWh) and is denoted as '*b*'.

$$b_y = \frac{\sum_i FC_{i,c.e.y}}{EG_y}; \quad \left[\frac{t\ c.e}{MWh}\right]$$

The specific fuel consumption ‘b’ is one of the main indicators of power plant operation efficiency and is included in the official annual reports for the Federal Service of State Statistics «Rosstat» (No. 6-tp). The introduction of indicator ‘b’ simplifies substantially the EF calculation while maintaining reliability and accuracy.

Three main types of fuel, i.e. natural gas, residual oil and coal, are consumed by the power plants of CES of the Center. A considerable amount of brown coal (15-20%) is burned in the Ryazan and Vologda regions. The emission factor of fossil fuel $EF_{CO2,\ i}$ can be presented in the following form:

$$\sum_i EF_{CO2,i,y} = EF_{CO2,average,y} = a_{g,y} \times EF_{CO2,g,y} + a_{o,y} \times EF_{CO2,o,y} + a_{c,y} \times EF_{CO2,c,y} + a_{l,y} \times EF_{CO2,l,y}$$

where

$a_{g.\ y}$, $a_{o.\ y}$, $a_{c.\ y}$, $a_{l.\ y}$ shares of natural gas, mazut, coal and lignite in the structure of fuel balance of design power system;

$EF_{CO2,\ g,\ y}$, $EF_{CO2,\ o,\ y}$, $EF_{CO2,\ c,\ y}$, $EF_{CO2,\ l,\ y}$ CO_2 emission factors or IPCC default emission factors for natural gas, mazut, coal and lignite (tCO_2/GJ)

Table 4. Default emission factors for stationary combustion in the energy industries expressed in tCO_2/GJ and equivalent unit tCO_2/t c.e.

Fuel	tCO_2/GJ	tCO_2/t c.e.[72]
Natural gas	0.0561	1.644
Mazut (residual oil)	0.0774	2.269
Coal	0.0961	2.817
Lignite (brown coal)	0.1010	2.960

Source: 2006 IPCC Guidelines for National Greenhouse Gas Inventories

The substitution of expressions (3) and (4) in formula (1) allowed receiving the formula for calculating the emission factor OM:

Formula 5

$$EF_{grid,OMsimple,y} = b_y \times EF_{CO2,average,y}$$

where

$EF_{grid,\ Omsimple,\ y}$ OM emission factor in year **y** (tCO_2/MWh);

b_y Specific consumption of fuel per 1 kWh of electricity output in grid (t c.e. / MWh);

$EF_{CO2,\ average}$ Weighted average emission factor of fossil fuel (t CO_2 / t c.e.).

The calculated values for $EF_{grid,\ OMsimple,\ y}$ for the CES of the Center are presented in Tables 6 and 7. The underlying data were obtained from Rosstat, which has already carried out the processing of data from the reports No. 6-TP and calculated the weighted average b_y for each region or province. The shares of

[72] Note that 1 tCO_2 / t c.e. = 29.31 tCO_2 / GJ

the different types of fuels $a_{i.y}$ for the regions and provinces were calculated by using the fuel consumption data (in t c.e.) obtained from Rosstat.[73]

Table 5: Simple operating margin CO2 emission factor

#	Parameters	Unit	2006	2007	2008
1	Shares of natural gas. $a_{g.y}$	-	0.896	0.929	0.927
2	fuel oil, $a_{o.y}$	-	0.029	0.009	0.008
3	Coal, $a_{c.y}$	-	0.049	0.038	0.039
4	Lignite, $a_{l.y}$	-	0.026	0.024	0.026
5	Weighted fuel emission factor. $EF_{CO2.average}$	tCO_2/GJ	0.0598	0.0589	0.0590
6	Weighted fuel emission factor. $EF_{CO2.average}$	tCO_2/t c.e	1.753	1.726	1.729
7	Specific fuel consumption, b_y	t c. e/MWh	0.322	0.323	0.321
8	Simple OM emission factor	tCO_2/MWh	0.565	0.557	0.556
9	Net generation by TPPs	MWh	214 318 964	217 693 203	218 891 603
10	***3 years average electricity weighted EF_{OM}***	***tCO_2/MWh***	***0.559***		

Table 7 contains the values for the years 2009 to 2012 which were obtained via linear regression using the ordinary least-square method.

Table 6: Values of EF_{OM} extrapolated for the period 2009-2012

Year	2009	2010	2011	2012
EF_{OM} (t CO_2 / MWh)	0.550	0.545	0.540	0.536

Year	2013	2014	2015	2016	2017
EF_{OM} (t CO_2 / MWh)	0.531	0.526	0.521	0.517	0.512

Steps 5, 6 and 7 of the "Tool" are not applied as explained above in the section "Justification of application of EF_{OM} for the project case (demand-side energy efficiency project)".

Formula to be applied to calculate the emission reductions of the project

From equation expressing electricity consumption (*EC*) net electricity generation (EG) and technical transmission and distribution losses in the grid (TDL): $EC_y = EG_y (1-TDL_y)$ it follows that having calculated electricity savings (ES_y) from the project activity the following formula must be applied to calculate emission reductions that take place at power plants of the system:

[73] The supporting Excel files with the details of the calculations can be made available to the validator.

$$ER_{EC,y} = \frac{ES_y \times EF_{grid,OM,y}}{1 - TDL_y}$$

where:

$ER_{EC.y}$	Emission reductions that take place at power plants of the system due to the project activity during year ***y***;
$ES_{PJ.y}$	Electricity savings due to the project activity;
$EF_{grid.OM.y}$	OM emission factor for the grid (operating margin as substantiated above);
TDL_y	Average technical transmission and distribution losses in the grid.

ROSSTAT DATA

Table 7: All generating capacities of the CES of the Center

	Operating zone	Code of line (of Rosstat)	Installed capacity, kW			Electricity output, thous. kWh			Consumption of standard coal for electricity and heat production, t c. E		
			2006	2007	2008	2006	2007	2008	2006	2007	2008
#	A	B	1	1	1	4	4	4	5	5	5
	Central Federal District	a	45 416 290	46 289 730	47 186 110	207 987 624	210 908 742	211 956 797	63 480 289	62 336 659	65 420 381
1	Belgorod province	a	242 100	312 100	286 000	649 570	762 464	870 031	1 186 710	1 027 342	1 018 923
2	Bryansk province	a	68 500	68 500	68 500	133 536	175 589	169 660	149 419	165 184	169 815
3	Vladimir province	a	418 500	421 700	421 700	1 942 286	1 882 147	1 900 850	925 686	895 577	897 651
4	Voronezh province	a	2 137 250	2 137 250	2 136 650	13 457 271	11 445 248	12 904 956	1 469 153	1 430 447	1 378 194
5	Ivanovo province	a	633 000	633 000	958 000	1 714 006	1 877 396	2 268 490	1 023 721	1 055 570	1 144 264
6	Kaluga province	a	85 000	85 000	85 000	187 088	172 775	173 849	239 339	225 811	217 521
7	Kostroma province	a	3 817 500	3 826 500	3 826 500	13 452 392	14 000 052	14 280 346	4 593 616	4 693 575	4 756 695
8	Kursk province	a	4 276 800	4 276 800	4 276 800	23 559 872	26 474 691	22 159 778	912 095	884 235	820 549
9	Lipetsk province	a	925 300	900 300	923 800	3 794 599	3 766 680	3 882 188	3 341 517	3 306 774	3 275 644
10	Moscow province	a	6 352 610	7 047 930	7 409 610	23 402 597	23 206 746	25 586 389	9 370 453	9 156 459	9 652 892
11	Orel province	a	370 000	390 000	390 000	1 272 748	1 341 066	1 309 708	660 236	697 186	668 130
12	Ryazan province	a	3 470 000	3 470 000	3 485 000	11 455 366	11 900 166	12 723 416	4 668 745	4 754 340	5 060 879
13	Smolensk province	a	4 033 000	4 033 000	4 033 000	21 801 231	21 796 749	23 306 359	1 718 517	1 602 652	1 653 538
14	Tambov province	a	394 800	394 800	393 700	1 245 614	1 108 173	1 139 476	917 536	842 614	833 046
15	Tver province	a	5 685 200	5 686 200	5 746 200	29 655 423	31 051 032	30 875 673	3 780 244	3 734 575	3 591 853
16	Tula province	a	2 589 500	2 589 500	2 449 500	6 691 481	6 380 420	6 470 342	4 134 273	4 036 498	3 945 935
1	Yaroslavl province	a	1 194 400	1 312 220	1 306 220	3 420 600	3 802 208	4 006 047	2 010 430	2 008 426	2 015 914

17											
18	City Moscow	a	8 722 830	8 704 930	8 989 930	50 151 944	49 765 140	47 929 239	22 378 599	21 819 394	24 318 938
19	Vologda province	a	1 389 880	1 421 130	1 425 130	6 331 340	6 784 461	6 934 806	3 795 863	3 882 233	3 800 069
∑	**CES of the Center**	**x**	**46 806 170**	**47 710 860**	**48 611 240**	**214 318 964**	**217 693 203**	**218 891 603**	**67 276 152**	**66 218 892**	**69 220 450**

Table 8: Thermal power plants

	Operating zone	Code of line (of Rosstat)	Installed capacity, kW			Electricity output, thous.kWh			Consumption of standard coal for electricity and heat production, t c. E		
			2006	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**
#	A	B	1	1	1	4	4	4	3	3	3
	Central Federal Disrict	b	31 856 130	32 729 150	33 625 850	131 676 101	131 717 255	133 904 081	321.2	320.4	319.3
1	Belgorod province	b	242 100	312 100	286 000	649 570	762 464	870 031	263.5	256.4	252.4
2	Bryansk province	b	68 500	68 500	68 500	133 536	175 589	169 660	437.8	456.2	467.8
3	Vladimir province	b	418 500	421 700	421 700	1 942 286	1 882 147	1 900 850	309.5	309.0	309.4
4	Voronezh province	b	303 250	303 250	302 650	990 341	953 089	929 323	359.0	352.4	342.2
5	Ivanovo province	b	633 000	633 000	958 000	1 714 006	1 877 396	2 268 490	345.1	337.5	323.7
6	Kaluga province	b	85 000	85 000	85 000	187 088	172 775	173 849	519.3	505.2	485.8
7	Kostroma province	b	3 817 500	3 826 500	3 826 500	13 452 392	14 000 052	14 280 346	312.1	308.8	307.3
8	Kursk province	b	276 800	276 800	276 800	879 265	854 156	780 912	323.3	309.7	316.2
9	Lipetsk province	b	925 300	900 300	923 800	3 794 599	3 766 680	3 882 188	404.6	390.8	391.5
10	Moscow province	b	5 121 080	5 816 080	6 178 080	21 366 345	21 180 835	23 538 970	331.8	332.5	322.8
11	Orel province	b	370 000	390 000	390 000	1 272 748	1 341 066	1 309 708	304.4	300.1	301.2
12	Ryazan province	b	3 470 000	3 470 000	3 485 000	11 455 366	11 900 166	12 723 416	337.2	334.3	338.3
13	Smolensk province	b	1 033 000	1 033 000	1 033 000	3 835 221	3 608 152	3 740 069	340.2	338.8	340.9
1	Tambov	b	394 800	394 800	393 700	1 245 614	1 108 173	1 139 476	353.2	338.0	348.6

4	province										
15	Tver province	b	2 682 800	2 683 800	2 743 800	9 560 710	9 492 078	9 117 712	325.9	327.2	326.5
16	Tula province	b	2 589 500	2 589 500	2 449 500	6 691 481	6 380 420	6 470 342	395.0	399.3	400.8
17	Yaroslavl province	b	738 000	855 820	849 820	2 414 827	2 567 951	2 738 951	378.2	362.4	364.3
18	City Moscow	b	8 687 000	8 669 000	8 954 000	50 090 706	49 694 066	47 869 788	292.3	294.3	293.2
19	Vologda province	b	1 303 600	1 334 850	1 338 850	6 233 593	6 684 222	6 796 005	346.7	367.4	364.2
∑	**CES of the Center**	**x**	**33 159 730**	**34 064 000**	**34 964 700**	**137 909 694**	**138 401 477**	**140 700 086**	**322.3**	**322.7**	**321.4**

Table 9: Hydroelectric stations

	Operating zone	Code of line (of Rosstat)	Installed capacity, kW			Electricity output, thous.kWh		
			2006	**2007**	**2008**	**2006**	**2007**	**2008**
#	A	B	1	1	1	4	4	4
	Central Federal District	c	526 160	526 580	526260	1 208 216	1 425 495	1 471 812
10	Moscow province	c	31 530	31 850	31 530	134 508	113 645	135 760
15	Tver province	c	2 400	2 400	2 400	6 697	6 519	9 505
17	Yaroslavl province	c	456 400	456 400	456 400	1 005 773	1 234 257	1 267 096
18	City Moscow	c	35 830	35 930	35 930	61 238	71 074	59 451
19	Vologda province	c	86 280	86 280	86 280	97 747	100 239	138 801
∑	**CES of the Center**	**x**	**612 440**	**612 860**	**612 540**	**1 305 963**	**1 525 734**	**1 610 613**

Table 10: Hydroelecric pumped storage power plants

	Operating zone	Code of line (of Rosstat)	Installed capacity, kW			Electricity output, thous.kWh		
			2006	**2007**	**2008**	**2006**	**2007**	**2008**
#	A	B	1	1	1	4	4	4
	Central Federal District	d	1 200 000	1 200 000	1 200 000	1 901 744	1 912 266	1 911 659
10	Moscow region	d	1 200 000	1 200 000	1 200 000	1 901 744	1 912 266	1 911 659
∑	**CES of the Center**	**x**	**1 200 000**	**1 200 000**	**1 200 000**	**1 901 744**	**1 912 266**	**1 911 659**

Table 11: Nuclear power plants

	Operating zone	Code of line (of Rosstat)	Installed capacity, kW			Electricity output, thous.kWh		
			2006	**2007**	**2008**	**2006**	**2007**	**2008**
#	A	B	1	1	1	4	4	4
	Central Federal District	m	11 834 000	11 834 000	11 834 000	73 201 563	75 853 726	74 669 245
4	Voronezh province	m	1 834 000	1 834 000	1 834 000	12 466 930	10 492 159	11 975 633
8	Kursk province	m	4 000 000	4 000 000	4 000 000	22 680 607	25 620 535	21 378 866
13	Smolensk province	m	3 000 000	3 000 000	3 000 000	17 966 010	18 188 597	19 566 290
15	Tver province	m	3 000 000	3 000 000	3 000 000	20 088 016	21 552 435	21 748 456
∑	**CES of the Center**	**x**	**11 834 000**	**11 834 000**	**11 834 000**	**73 201 563**	**75 853 726**	**74 669 245**

Table 12: Consumption of standard coal (ton)

	Operating zone	Code of line (of Rosstat)	Total consumption of standard coal for production of electricity of heat, t c.e.			Natural gas, t c.e.		
			2006	2007	2008	2006	2007	2008
#	A	Б	5	5	5	6	6	6
	Central Federal District	a	63 480 289	62 336 659	65 420 381	55 087 779	56 129 937	58 894 619
1	Belgorod province	a	1 186 710	1 027 342	1 018 923	1 182 761	1 009 464	1 017 471
2	Bryansk province	a	149 419	165 184	169 815	147 000	164 060	169 177
3	Vladimir province	a	925 686	895 577	897 651	899 048	894 828	896 073
4	Voronezh province	a	1 469 153	1 430 447	1 378 194	1 324 080	1 316 468	1 295 835
5	Ivanovo province	a	1 023 721	1 055 570	1 144 264	889 806	886 982	944 159
6	Kaluga province	a	239 339	225 811	217 521	236 271	225 231	217 457
7	Kostroma province	a	4 593 616	4 693 575	4 756 695	4 250 918	4 576 709	4 593 931
8	Kursk province	a	912 095	884 235	820 549	873 414	855 906	789 930
9	Lipetsk province	a	3 341 517	3 306 774	3 275 644	1 731 241	1 740 517	1 805 782
10	Moscow province	a	9 370 453	9 156 459	9 652 892	7 439 607	8 053 318	8 655 984
11	Orel province	a	660 236	697 186	668 130	648 580	697 118	668 130
12	Ryazan province	a	4 668 745	4 754 340	5 060 879	3 605 704	3 845 503	3 811 077
13	Smolensk province	a	1 718 517	1 602 652	1 653 538	1 457 184	1 561 728	1 521 296
14	Tambov province	a	917 536	842 614	833 046	885 999	836 457	827 847
15	Tver province	a	3 780 244	3 734 575	3 591 853	3 569 330	3 592 158	3 443 468
16	Tula province	a	4 134 273	4 036 498	3 945 935	2 256 059	2 269 131	2 142 021
17	Yaroslavl province	a	2 010 430	2 008 426	2 015 914	1 767 933	1 865 683	1 845 273
18	City Moscow	a	22 378 599	21 819 394	24 318 938	21 922 844	21 738 676	24 249 708
19	Vologda province	a	3 795 863	3 882 233	3 800 069	2 989 625	3 134 596	3 113 898
∑	**CES of the Center**	**x**	**67 276 152**	**66 218 892**	**69 220 450**	**58 077 404**	**59 264 533**	**62 008 517**

Table 13: Consumption of oil fuel

	Operating zone	Code of a line (of Rosstat)	Total oil fuel, t c.e.			Incl., mazute, t c.e.		
			2006	2007	2008	2006	2007	2008
#	A	B	7	7	7	8	8	8
	Central Federal District	a	1 907 571	594 780	508 804	1 889 695	578 625	504 829
1	Belgorod province	a	1 735	16 396	93	1 735	16 396	86
2	Bryansk province	a	1 727	439	188	1 727	439	188
3	Vladimir province	a	26 638	749	1 578	26 638	749	1 578
4	Voronezh province	a	120 981	80 735	59 067	120 981	80 735	59 067
5	Ivanovo province	a	998	1 237	1 867	998	771	1 867
6	Kaluga province	a	3 068	580	64	3 068	580	64
7	Kostroma province	a	290 012	67 514	88 332	290 012	67 514	88 332
8	Kursk province	a	23 989	25 986	26 422	23 845	25 871	26 422
9	Lipetsk province	a	54 543	8 003	6 494	54 543	8 003	6 494
10	Moscow province	a	323 592	53 311	34 188	305 860	37 737	30 220
11	Orel province	a	11 656	68	0	11 656	68	0
12	Ryazan province	a	121 275	11 871	64 166	121 275	11 871	64 166
13	Smolensk province	a	18 449	4 270	1 649	18 449	4 270	1 649
14	Tambov province	a	31 537	6 157	5 199	31 537	6 157	5 199
15	Tver province	a	123 743	68 426	40 854	123 743	68 426	40 854
16	Tula province	a	191 333	151 850	102 781	191 333	151 850	102 781
17	Yaroslavl province	a	106 540	16 470	6 632	106 540	16 470	6 632
18	City Moscow	a	455 755	80 718	69 230	455 755	80 718	69 230
19	Vologda province	a	13 934	3 323	6 688	13 934	3 323	6 688
∑	**CES of the Center**	**x**	**1 921 505**	**598 103**	**515 492**	**1 903 629**	**581 948**	**511 517**

Table 14: Coal consumption

	Operating zone	Code of a line (of Rosstat)	Coal, total, t c.e.			incl. black coal, t c.e.		
			2006	2007	2008	2006	2007	2008
#	А	Б	9	9	9	10	10	10
	Central Federal District	a	4 044 805	3 227 934	3 767 629	3 151 762	2 412 396	2 584 009
1	Belgorod province	a	2 175	1 435	1 328	2 123	1 385	1 288
2	Bryansk province	a	692	685	450	0	0	450
3	Vladimir province	a	0	0	0	0	0	0
4	Voronezh province	a	24 084	33 244	23 292	24 084	33 244	23 292
5	Ivanovo province	a	132 917	167 351	198 238	132 917	167 351	198 238
6	Kaluga province	a	0	0	0	0	0	0
7	Kostroma province	a	0	2 084	348	0	0	0
8	Kursk province	a	14 692	2 343	4 196	14 692	2 343	4 196
9	Lipetsk province	a	0	185	324	0	185	324
10	Moscow province	a	1 461 588	918 399	907 142	1 436 872	900 857	888 183
11	Orel province	a	0	0	0	0	0	0
12	Ryazan province	a	925 081	892 562	1 185 116	89 286	123 667	23 029
13	Smolensk province	a	242 884	36 654	130 593	242 884	36 654	130 593
14	Tambov province	a	0	0	0	0	0	0
15	Tver province	a	22 901	26 517	53 615	22 901	26 517	53 615
16	Tula province	a	1 185 139	1 122 680	1 214 495	1 153 351	1 096 398	1 212 309
17	Yaroslavl province	a	32 652	23 795	48 492	32 652	23 795	48 492
18	City Moscow	a	0	0	0	0	0	0
19	Vologda province	a	769 389	707 305	577 307	0	0	0
∑	**CES of the Center**	**x**	**4 814 194**	**3 935 239**	**4 344 936**	**3 151 762**	**2 412 396**	**2 584 009**

Table 15: Comsumption of other types of fuel

	Operating zone	Code of line (of Rosstat)	Peat, t c.e.			Another fuels, t c.e.		
			2006	2007	2008	2006	2007	2008
#	A	B	11	11	11	13+14	13+14	13+14
	Central Federal District	a	216 780	182 223	134 089	2 223 354	2 201 785	2 115 240
1	Belgorod province	a	0	0	0	39	47	31
2	Bryansk province	a	0	0	0	0	0	0
3	Vladimir province	a	0	0	0	0	0	0
4	Voronezh province	a	0	0	0	8	0	0
5	Ivanovo province	a	0	0	0	0	0	0
6	Kaluga province	a	0	0	0	0	0	0
7	Kostroma province	a	40 114	34 744	58 658	12 572	12 524	15 426
8	Kursk province	a	0	0	0	0	0	1
9	Lipetsk province	a	0	0	0	1 555 733	1 558 069	1 463 044
10	Moscow province	a	137 176	119 965	46 675	8 490	11 466	8 903
11	Orel province	a	0	0	0	0	0	0
12	Ryazan province	a	0	0	0	16 685	4 404	520
13	Smolensk province	a	0	0	0	0	0	0
14	Tambov province	a	0	0	0	0	0	0
15	Tver province	a	39 490	27 514	28 756	24 780	19 960	25 160
16	Tula province	a	0	0	0	501 742	492 837	486 638
17	Yaroslavl province	a	0	0	0	103 305	102 478	115 517
18	City Moscow	a	0	0	0	0	0	0
19	Vologda province	a	0	0	0	22 915	37 009	102 176
∑		**x**	**216 780**	**182 223**	**134 089**	**2 246 269**	**2 238 794**	**2 217 416**

Table 16: Shares of natural gas. fuel oil and coal

#	Power system	natural gas. $a_{g.y}$			fuel oil. $a_{o.y}$			coal. $a_{c.y}$			lignit. $a_{l.y}$		
		2006	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**
1	Belgorod province	0.997	0.983	0.999	0.001	0.016	0.000	0.002	0.001	0.001	0.000	0.000	0.000
2	Bryansk province	0.984	0.993	0.996	0.012	0.003	0.001	0.000	0.000	0.003	0.005	0.004	0.000
3	Vladimir province	0.971	0.999	0.998	0.029	0.001	0.002	0.000	0.000	0.000	0.000	0.000	0.000
4	Voronezh province	0.901	0.920	0.940	0.082	0.056	0.043	0.016	0.023	0.017	0.000	0.000	0.000
5	Ivanovo province	0.869	0.841	0.825	0.001	0.001	0.002	0.130	0.159	0.173	0.000	0.000	0.000
6	Kaluga province	0.987	0.997	1.000	0.013	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000
7	Kostroma province	0.936	0.985	0.981	0.064	0.015	0.019	0.000	0.000	0.000	0.000	0.000	0.000
8	Kursk province	0.958	0.968	0.963	0.026	0.029	0.032	0.016	0.003	0.005	0.000	0.000	0.000
9	Lipetsk province	0.969	0.995	0.996	0.031	0.005	0.004	0.000	0.000	0.000	0.000	0.000	0.000
10	Moscow province	0.808	0.894	0.902	0.033	0.004	0.003	0.156	0.100	0.093	0.003	0.002	0.002
11	Orel province	0.982	1.000	1.000	0.018	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12	Ryazan province	0.775	0.810	0.753	0.026	0.002	0.013	0.019	0.026	0.005	0.180	0.162	0.230
13	Smolensk province	0.848	0.974	0.920	0.011	0.003	0.001	0.141	0.023	0.079	0.000	0.000	0.000
14	Tambov province	0.966	0.993	0.994	0.034	0.007	0.006	0.000	0.000	0.000	0.000	0.000	0.000
15	Tver province	0.961	0.974	0.973	0.033	0.019	0.012	0.006	0.007	0.015	0.000	0.000	0.000
16	Tula province	0.621	0.640	0.619	0.053	0.043	0.030	0.318	0.309	0.350	0.009	0.007	0.001
17	Yaroslavl province	0.927	0.979	0.971	0.056	0.009	0.003	0.017	0.012	0.026	0.000	0.000	0.000
18	City Moscow	0.980	0.996	0.997	0.020	0.004	0.003	0.000	0.000	0.000	0.000	0.000	0.000
19	Vologda province	0.792	0.815	0.842	0.004	0.001	0.002	0.000	0.000	0.000	0.204	0.184	0.156
∑	***CES of the Center***	**0.896**	**0.929**	**0.927**	**0.029**	**0.009**	**0.008**	**0.049**	**0.038**	**0.039**	**0.026**	**0.024**	**0.026**

Table 17: Weighted fuel emission factor and specific fuel consumption

#	Power system	$EF_{CO2.average}$ tCO_2/GJ			$EF_{CO2.average}$ tCO_2/t c.e.			b_y t c.e./MWh		
		2006	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**
1	Belgorod province	0.0562	0.0565	0.0562	1.647	1.656	1.646	0.264	0.256	0.252
2	Bryansk province	0.0566	0.0563	0.0562	1.658	1.651	1.648	0.438	0.456	0.468
3	Vladimir province	0.0567	0.0561	0.0561	1.662	1.645	1.645	0.310	0.309	0.309
4	Voronezh province	0.0585	0.0582	0.0577	1.715	1.707	1.691	0.359	0.352	0.342
5	Ivanovo province	0.0613	0.0625	0.0631	1.797	1.831	1.848	0.345	0.338	0.324
6	Kaluga province	0.0564	0.0562	0.0561	1.652	1.646	1.644	0.519	0.505	0.486
7	Kostroma province	0.0575	0.0564	0.0565	1.684	1.654	1.656	0.312	0.309	0.307
8	Kursk province	0.0573	0.0568	0.0570	1.680	1.666	1.670	0.323	0.310	0.316
9	Lipetsk province	0.0568	0.0562	0.0562	1.663	1.647	1.647	0.405	0.391	0.392
10	Moscow province	0.0632	0.0603	0.0600	1.852	1.767	1.757	0.332	0.333	0.323
11	Orel province	0.0565	0.0561	0.0561	1.655	1.644	1.644	0.304	0.300	0.301
12	Ryazan province	0.0655	0.0645	0.0669	1.920	1.889	1.960	0.337	0.334	0.338
13	Smolensk province	0.0620	0.0571	0.0593	1.817	1.673	1.738	0.340	0.339	0.341
14	Tambov province	0.0568	0.0563	0.0562	1.666	1.649	1.648	0.353	0.338	0.349
15	Tver province	0.0571	0.0568	0.0570	1.672	1.664	1.669	0.326	0.327	0.327
16	Tula province	0.0703	0.0697	0.0708	2.061	2.044	2.075	0.395	0.399	0.401
17	Yaroslavl province	0.0580	0.0568	0.0572	1.699	1.664	1.676	0.378	0.362	0.364
18	City Moscow	0.0565	0.0562	0.0562	1.657	1.647	1.646	0.292	0.294	0.293
19	Vologda province	0.0653	0.0644	0.0631	1.915	1.887	1.851	0.347	0.367	0.364
∑	***CES of the Center***	***0.0598***	***0.0589***	***0.0590***	***1.753***	***1.726***	***1.729***	***0.322***	***0.323***	***0.321***

Table 18 Simple operating margin CO_2 emission factor

tCO_2/MWh

#	Power system	2006	2007	2008	Mean values	Trend	2009	2010	2011	2012
1	Belgorod province	0.434	0.425	0.415	0.425s	Values of linear regression by least-squares method	0.406	0.397	0.387	0.378
2	Bryansk province	0.726	0.753	0.771	0.750		0.795	0.818	0.841	0.863
3	Vladimir province	0.514	0.508	0.509	0.511		0.505	0.503	0.500	0.497
4	Voronezh province	0.616	0.601	0.579	0.599		0.562	0.543	0.524	0.506
5	Ivanovo province	0.620	0.618	0.598	0.612		0.590	0.579	0.568	0.557
6	Kaluga province	0.858	0.832	0.799	0.829		0.770	0.741	0.711	0.682
7	Kostroma province	0.526	0.511	0.509	0.515		0.498	0.490	0.482	0.473
8	Kursk province	0.543	0.516	0.528	0.529		0.514	0.507	0.499	0.492
9	Lipetsk province	0.673	0.644	0.645	0.654		0.626	0.611	0.597	0.583
10	Moscow province	0.614	0.587	0.567	0.590		0.543	0.519	0.496	0.472
11	Orel province	0.504	0.493	0.495	0.498		0.489	0.485	0.480	0.476
12	Ryazan province	0.647	0.632	0.663	0.647		0.663	0.671	0.679	0.687
13	Smolensk province	0.618	0.567	0.592	0.592		0.567	0.554	0.541	0.528
14	Tambov province	0.588	0.557	0.575	0.573		0.560	0.553	0.546	0.539
15	Tver province	0.545	0.545	0.545	0.545		0.545	0.545	0.545	0.545
16	Tula province	0.814	0.816	0.831	0.821		0.838	0.847	0.855	0.864
17	Yaroslavl province	0.643	0.603	0.611	0.619		0.587	0.571	0.555	0.539
18	City Moscow	0.484	0.485	0.483	0.484		0.482	0.481	0.480	0.480
19	Vologda province	0.664	0.693	0.674	0.677		0.687	0.692	0.697	0.703
∑	***CES of the Center***	***0.565***	***0.557***	***0.556***	***0.559***		***0.550***	***0.545***	***0.540***	***0.536***

Annex 3

MONITORING PLAN

Variable		Description	Units	2008	2009	2010	2011	2012
P1	$EC_{ALS, y}$	Electricity consumption by ALS plant	MWh	372,660				
P3	$Q_{AIR,ALS, y}$	Consumption of compressed air by ALS plant	1000 Sm^3	586,605				
P5	$Q_{ST, y}$	Steam consumption by ALS plant	Gcal	16,376				
B1	$P_{GOX, y}$	Delivery of high-pressure oxygen from ALS cold box	1000 Sm^3	650,566				
B2	$P_{LOX, y}$	Delivery of high-pressure oxygen from ALS liquid oxygen storage tank	1000 Sm^3	10,483				
B4	$P_{GAN, y}$	Delivery of high-pressure gaseous nitrogen from ALS plant	1000 Sm^3	181,082				

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