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INVENTORY OF ANTHROPOGENIC GREENHOUSE GAS EMISSIONS FOR ROSTOV, SVERDLOVSK AND TVER REGIONS

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1 Introduction

Current report has been prepared within the framework European Union project “*Promoting Investments in Energy Efficiency Projects in Russia’ Regions*”. Its objective is to create an inventory of greenhouse gas emission from “energy” sector for three Russian regions, Rostov, Sverdlovsk and Tver.

Many countries and regions, large and not that large cities are pursuing a policy of stable development for a number of years. The integral part of such a policy is the task of greenhouse gas (GHG) emission reduction. Separate groups of countries, states, regions and even cities undertake the obligation to reduce GHG emission by 20% till the year of 2020, and to reduce it 2-4 times till 2050¹. GHG inventory is the starting point of any emission reduction policy. The current report is dedicated to the solution of this particular task.

GHG anthropogenic emission inventory for Rostov, Sverdlovsk and Tver regions was developed in compliance with “Guidelines for National GHG inventories” (IPCC, 2006). In 2009, using this document as a basis, Federal Service for Hydrometeorology and Environmental Monitoring (Rosgidromet) also developed “The National Inventory Report on Anthropogenic Emissions from Sources and GHG absorption by the absorbers which are not regulated by the Montreal Protocol, 1990-2007”.

Russian Federation is preparing the inventory in compliance with the obligations under the UN Framework Convention on Climate Change and the Kyoto Protocol to the Framework Convention. The methodology for inventory generation for the country in general shaped up after it passed a certain development period. The methodology of inventory generation at the regional level is still being shaped. Provision of information at the country level and the level of its specific regions may differ considerably, which cannot help affecting specific features of methodology generation at the level of Russian Federation constituents.

The main sectors where GHG emission or absorption take place are “energy”, “industrial processes”, “use of solvents and other products”, “agriculture”, “land tenure, changes in land tenure, forestry”, “wastes”. According to Chapter 12 item 1a of United Nation Framework Convention on Climate Change, Russian National Inventory includes the data on the following GHG: carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), hydro fluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF₆). This inventory includes data only about three GHG, carbon dioxide (CO₂), methane (CH₄), and nitrous oxide (N₂O).

This report gives GHG emission inventory in “energy” sector for 9 years (2000-2008) and totally relies on official statistics. All indicators on the fuel consumption and other types of activity, which are required for GHG emission estimate have been either directly taken from statistical data or calculated based on original statistical reporting.

This project gives estimates of emission in the following subsectors of “energy” sector: power industry, heat power industry, industry, transport, other sectors, technological leaks and emissions. For some subsectors a more detailed description of emission sources is given. This makes it possible to create a basis for development and implementation of emission control in specific sectors in order to reach any final objective in emission limitation.

According to requirements of “Guidelines for National GHG inventories”, evaluation of information completeness used for generation of GHG emission inventory is given for each sector, as well as uncertainty assessment of received results.

2 Main results

2.1 Inventory scope and methodology

“Energy sector” in a general sense of the term includes the exploration and exploitation of primary energy sources; conversion of primary energy sources into more useable energy forms in refineries and power plants; transmission and distribution of fuels; use of fuels in stationary and mobile applications.

The sources and factors of the greenhouse gas emission produced by the energy industries (Section 1A1 in IPCC classification) have been determined based on the provisions in Chapter 1 “Introduction”, Chapter 2 “Stationary combustion” and Chapter 4 “Fugitive emissions” in Volume 2 “Energy” of “Guidelines for National Greenhouse Gas Inventories” (IPCC, 2006). See details of this method application in Russia in “The National Inventory Report on anthropogenic emissions from sources and absorption by the absorbers of greenhouse gases which are not regulated by the Montreal Protocol”¹.

The emission estimate used the methodology in Tier 1, which is based on fuel combustion from national energy statistics and average emission factors (default emission factors in IPCC methodology) and the similar estimate of the greenhouse emissions in the energy sector in general, in the form of the non-combustion fugitive gases. Tier 1 approach estimates the emissions by multiplying the burnt fuel by the base (“default”) IPCC emission factors. For each greenhouse gas, the approach is represented by the equation 1.1:

$$Emissions = \sum Fuel EF \quad (1.1)$$

Where: *Emissions* = Emissions;

Fuel = Fuel consumption;

E_{fa} = “default” Emission Factor (for CO₂ it is the carbon content in the fuel multiplied by 44/12);

a = type of fuel (for instance, gasoline, diesel fuel, natural gas, liquefied petroleum gas, etc.).

The higher analysis tiers (2 and 3) require additional data on the country-specific types of fuel and/or specific fuel combustion technology. Switching to Tier 2 is based on the available specific emission factors, determined in the course of tests, or the country-specific types of fuel. Since IPCC recommends setting the uncertainty ranges for the fossil fuel combustion emission estimate at plus or minus 5%, the upgrade to Tier 2 will not improve the accuracy in a significant way, especially at a regional level, where the statistics accuracy is inferior to the accuracy of the national statistics. This approach should be based on special measurement programs targeting the parameters of the specific emissions.

IPCC recommends two basic approaches for emission estimates: the Reference and Spectral Approaches. Reference Approach provides the methodology to produce a first-order estimate of the greenhouse gas emissions based on the country specific fuel consumption without further classification by the types and the purpose of the fuel consumption, but including the international fueling of the air and water-borne vessels and non-energy use of fuels. Its application requires only the statistics on the

fuel consumption and production, changes in the stocks, as well as the data on the fuel external trade, changes in stock and the non-energy consumption. In the Spectral Approach, emission sources are specified – economic activities of the sector and fuel use purposes.

2.2 Emission sources

The Reference Approach is applicable for emission inventory purposes, but could not be used to develop greenhouse emission control policies. Only the Spectral Approach is applicable for the purpose, which accounts the fuel combustion emissions and industrial process leaks by individual sectors. At the very least, the following types of combustion are distinguished: the stationary combustion in the energy industries and the manufacturing industries and construction, as well as other sectors, and the mobile combustion in transport sector.

Even higher level of detail is required to develop an efficient emission control policy. IPCC methodology assumes the sectors could be further sub-divided into the separate sub-sectors:

- Stationary Sources
- Energy Industries
 - Electricity and Heat production:
 - Electricity Generation (State Regional Power stations and Diesel Power stations);
 - Combined Heat and Power Generation (CHP);
 - Heat Plants;
 - Manufacture of Solid Fuels and Other Energy Industries:
 - Manufacture of Solid Fuels;
 - Other Energy Industries;
 - Manufacturing Industries and Construction:
 - Iron and steel;
 - Non-ferrous Metals;
 - Chemicals;
 - Pulp, Paper and Print;
 - Food Processing, Beverages and Tobacco;
 - Non-metallic Minerals;
 - Transport Equipment;
 - Machinery;
 - Mining (excluding fuels) and Quarrying;
 - Wood and Wood Products;
 - Textile and Leather;
 - Non-specified Industries;
 - Construction;
 - Other sectors:
 - Commercial/Institutional;
 - Residential;

- Agriculture/Forestry/Fishing/Fishing Farms;
- Off-road Vehicles and Other Machinery;
- Fishing (mobile combustion);
- Other Stationary Sources;
- Mobile Sources:
 - Mobile (aviation component);
 - Mobile (water-borne component);
 - Mobile (other).

Practically all types of fuel combustion could be covered by this approach. In the inventories of the three regions under investigation the following sectors can be identified:

- Power stations (for each station);
- Heat Plants (total for all boiler houses);
- Industry (in some cases with breakdown by types of production) and Construction;
- Other sectors (services, communal services, residential constructions);
- Transport (off-road, railroad, aviation, automobile, with the breakdown of trucks, buses, cars, and water-borne);
- Agriculture;
- Industrial leaks and emissions (transportation of liquid and natural gas, oil, oil products, natural gas distribution).

The greenhouse gas emissions from the transport have been estimated in accordance with the provisions in Chapter 3 “Mobile combustion”, Volume 2 “Energy” of “Guidelines for National Greenhouse Gas Inventories” (IPCC, 2006). Mobile sources produce direct greenhouse gas emissions of carbon dioxide (CO₂), methane (CH₄) and nitrous oxide (N₂O) from the combustion of various types of fuel, as well as several other pollutants such as carbon monoxide (CO), nonmethane Volatile Organic Compounds (NMVOCs), sulphur dioxide (SO₂), particulate matter (PM) and oxides of nitrate (NO_x), which contribute to local or regional air pollution. This Inventory covers the emissions of three greenhouse gases only: CO₂, CH₄ and N₂O.

Estimated emissions from mobile combustion sources can be based on fuel combustion sources (represented as the fuel sold) and on the distance traveled by the vehicles. In general, the first approach (fuel sold) is appropriate for CO₂ and the second (distance traveled by vehicle type and road type) is appropriate for CH₄ and N₂O. Emissions of CH₄ and N₂O are more difficult to estimate accurately than those for CO₂ because emission factors depend on vehicle technology, fuel and operating characteristics. Both distance-based activity data (e.g. vehicle kilometers traveled) and disaggregated fuel consumption may be considerably less certain than overall fuel sold. That is why the total consumed fuel estimate (where the statistics is available) or fuel sold (in other cases) estimate approach when dealing with the mobile sources.

In the reporting tables, emissions from combustion of biofuels are reported as information items but not included in the sectoral or national totals to avoid double counting. For biomass, only that part of the biomass that is combusted for energy

purposes should be estimated for inclusion as an information item in the Energy sector. The emissions of CH₄ and N₂O resulting from the biomass combustion, however, are estimated and included in the national totals. The emission inventory does not include the fuel used for non-energy purpose either.

The greenhouse gases inventory of the industrial emissions and leakages follows the provisions in Chapter 4 “Fugitive emissions”, Volume 2 “Energy” of “Guidelines for National Greenhouse Gas Inventories” (IPCC, 2006). The accidental or intentional industrial emissions and greenhouse gas leakages could happen during the production, processing and delivery of the fossil fuels and the transportation to the end-use site. The activity details, required to estimate the fugitive emissions, industrial emissions and the greenhouse gas leakages in the coal, oil and gas supply systems include the infrastructure data (e.g., inventories of facilities/installations, process units, pipelines, and equipment components), and reported emissions from spills, accidental releases, and third-party damages.

2.3 Economic growth and GHG emissions dynamics in Russia and three regions

According to GHG emissions national inventory Russia decreased emission of all GHGs from all sources in 1990-2007. Russia reduced emission of all GHGs from all sources (with consideration of off-flows) by 40% (see Fig.2.1), while in “energy” sector the reduction was 34 % (see Fig.2.2).

Russia is the world leader in the scale of emission reduction. It managed to practically rupture the connection between economic growth and GHG emissions. In 1998-2008 with the GDP growth by 97%, GHG emissions from energy industries increased by 12% only.

In spite of a wide spread opinion, that was not the result of economic decline in 90-s, but the outcome of the market transformation of centralized economy, its structural reconstruction and demilitarization, restructuring of the fuel balance in favor of natural gas, growth of prices for energy sources and growth of energy efficiency. In the end, even though the GDP in 2007 exceeded the level of 1990, GHG emissions in “energy” sector turned out to be 34% lower than the level in 1990. It is also true, that this was not a result of a special policy for GHG emission control. But it happened that for certain countries the implementation of “framework” activities, market transformations can produce great effect in terms of economic resources usage streamlining and GHG emission reduction up to the very rupture of connection between development of economy and GHG emission growth.

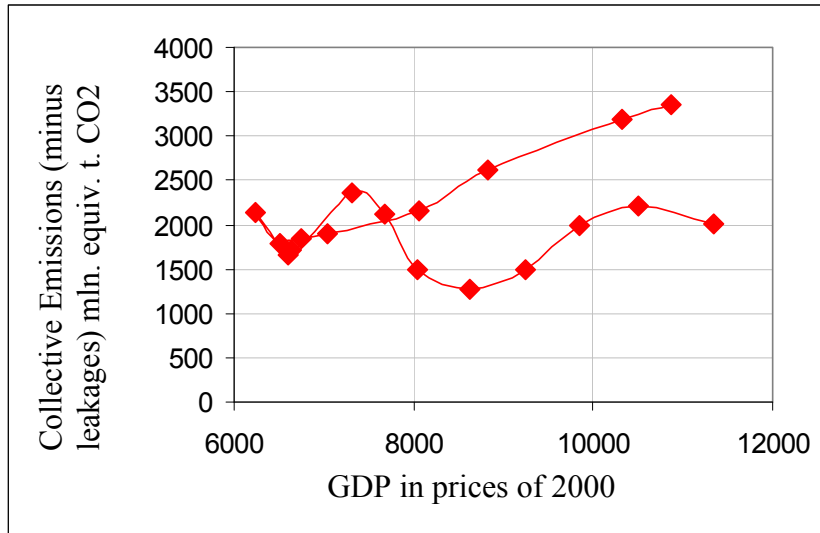


Fig. 2.1. Dynamics of all GHG emissions from all sources (with consideration of off flows) depending GDP growth in Russia in 1990-2007.

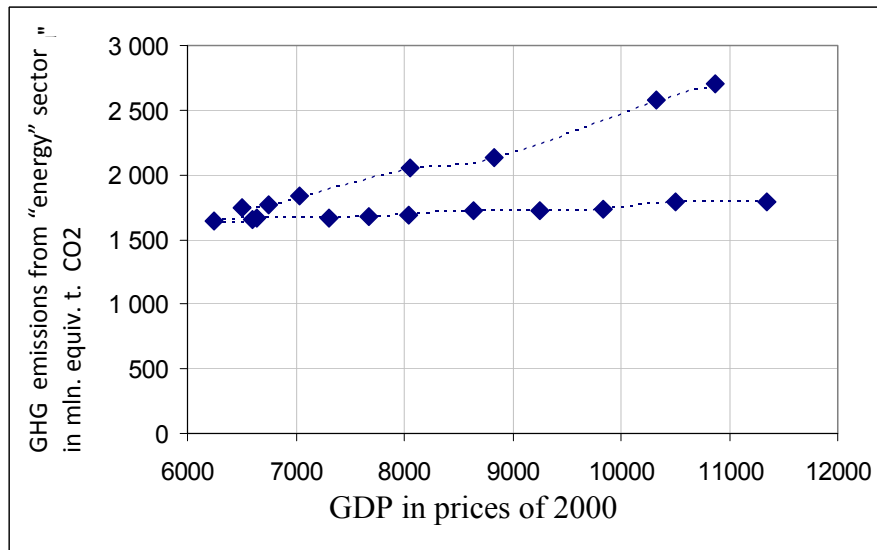


Fig. 2.2. «Crane wedge»: dynamics of GHG emission in "energy" sector and GDP in Russia in 1990-2007.

Naturally, it is important to understand how this connection appeared, using the example of three Russian regions. In general, a similar situation had place in all three regions.

In Rostov region, where GDP grew 2.1 times in 2000-2008, GHG emissions increased only by 7%. In Sverdlovsk region GDP grew by 93% and emissions increased by 26%; in Tver region GDP raised by 62% and there was no growth of emissions.

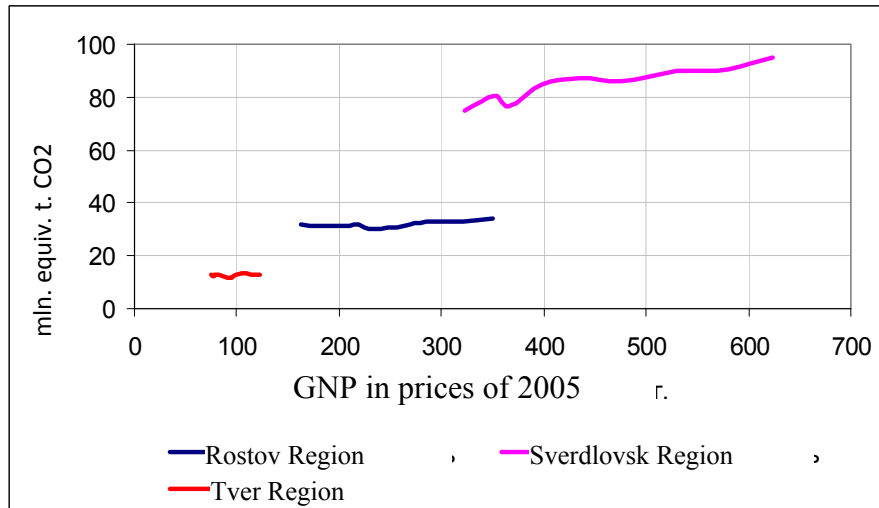


Fig. 2.3. GHG emission dynamics in "energy" sector depending Gross Regional Product in 2000-2008.

2.4 Inventory collective results

In 2008 Rostov region's share of all-Russia emission in "energy" sector was 1.8%, Sverdlovsk region had 5.4%, and Tver region had 0.7%. The main sources of emission in 2008 were the following: (see Fig.2.4-2.6)

Rostov region:

- power stations (31, 5%);
- Boilers (10, 8%);
- manufacturing industries and construction (5,6%);
- transport (26, 3%);
- other sectors (19,0%);
- technological emissions and leaks (6,8%).

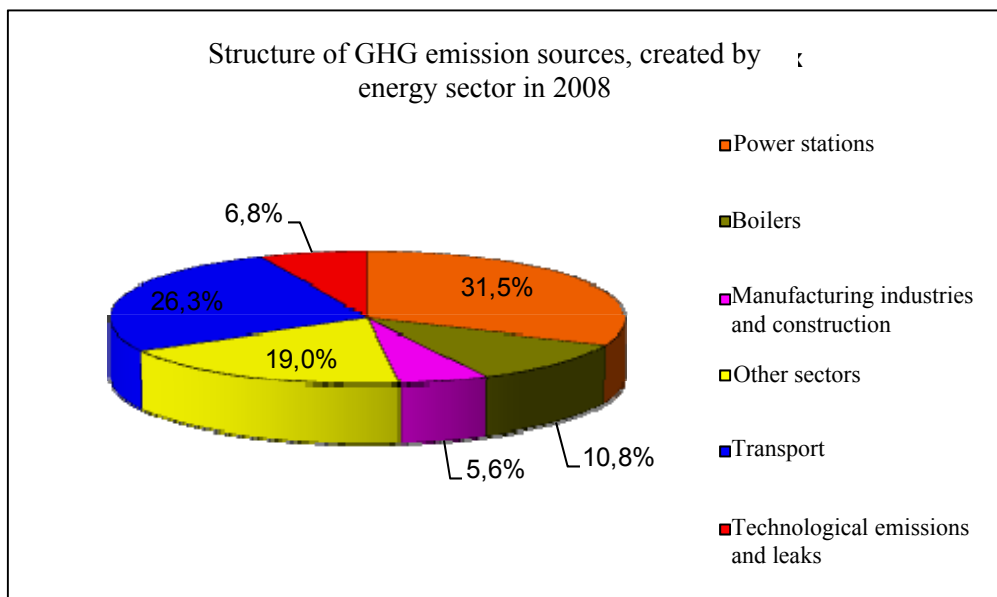


Fig. 2.4. Structure of GHG emission sources, created by Rostov region "energy" sector in 2008.

Sverdlovsk region:

- power stations (48,4%);
- boilers (8,2%);

- manufacturing industries and construction (30,1%);
- transport (9,0%);
- other sectors (4,0%);
- technological emissions and leaks (0,4%).

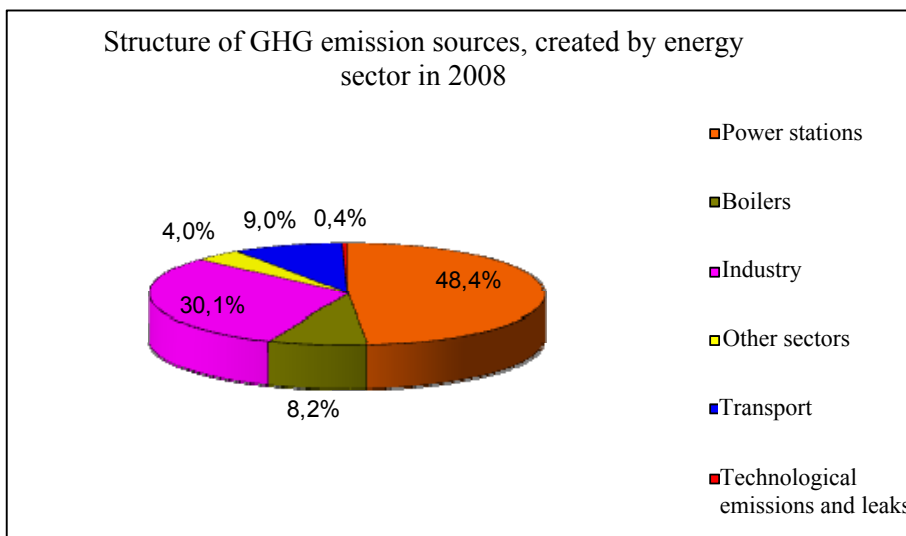


Fig. 2.5. Structure of GHG emission sources, created by Sverdlovsk region “energy” sector, in 2008.

Tver region:

- power stations (48,1%);
- boilers (17,3%);
- manufacturing industries and construction (3,6%);
- transport (22,8%);
- other sectors (7,4%);
- technological emissions and leaks (0,8%).

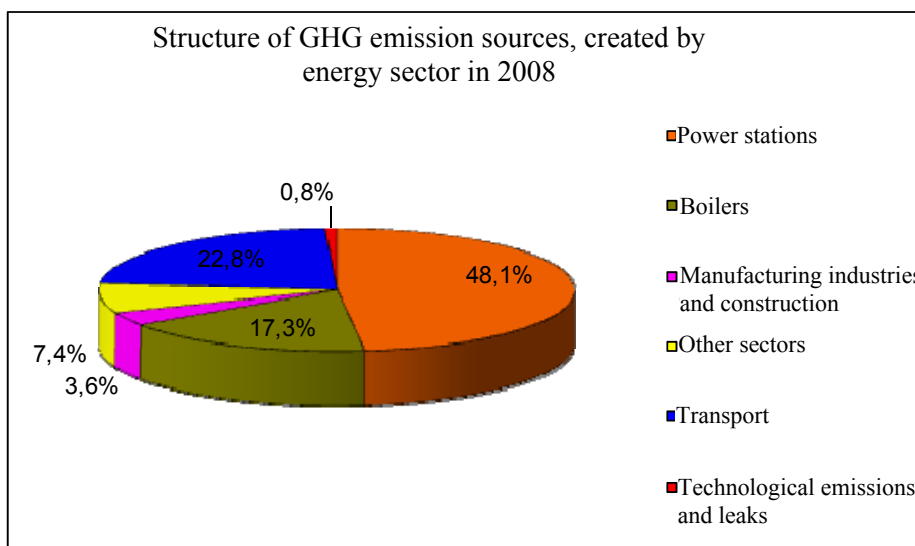


Fig. 2.6. Structure of GHG emission sources, created by Tver region “energy” sector in 2008.

In Rostov region in 2000-2008 collective emissions from “energy” sector increased by 6, 7%. The main source of the growth was emissions from power stations. GHG emission increase at power stations was equal to 61, 7% of the total emission growth; it was 58, 9% at transport; manufacturing industries and construction – 9, 2%; other sectors – 12,

4%. Reduction of emission from boilers and technological emissions and leaks partially neutralized the increase (see Fig. 2.7).

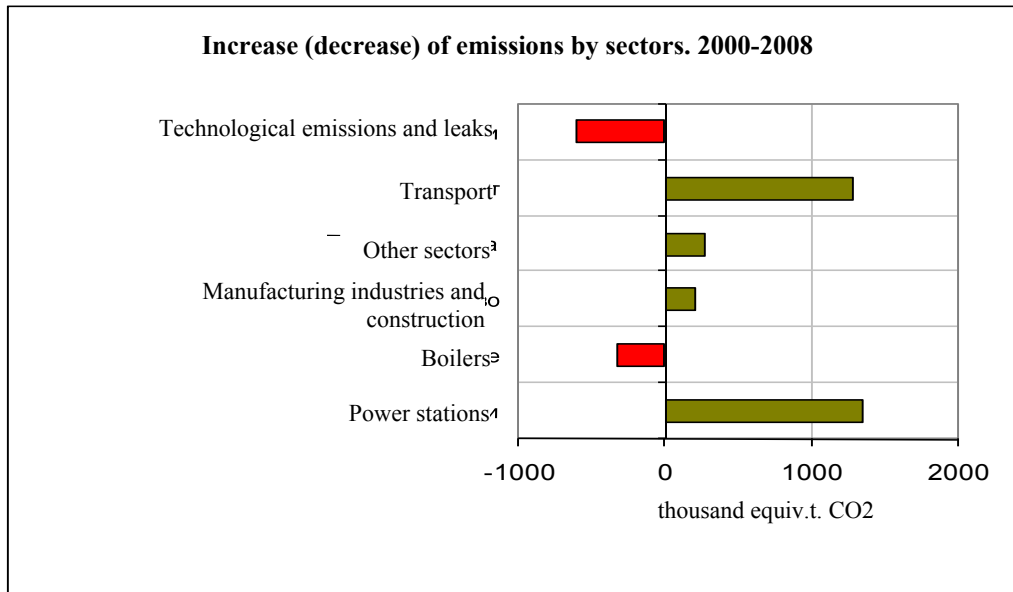


Fig. 2.7. Structure of GHG emissions in Rostov region “energy” sector

Even though emission trends in different sectors were alternating (see Fig.2.8), in general emissions in 2000-2009 increased only by 4.4% (see Fig. 2.9).

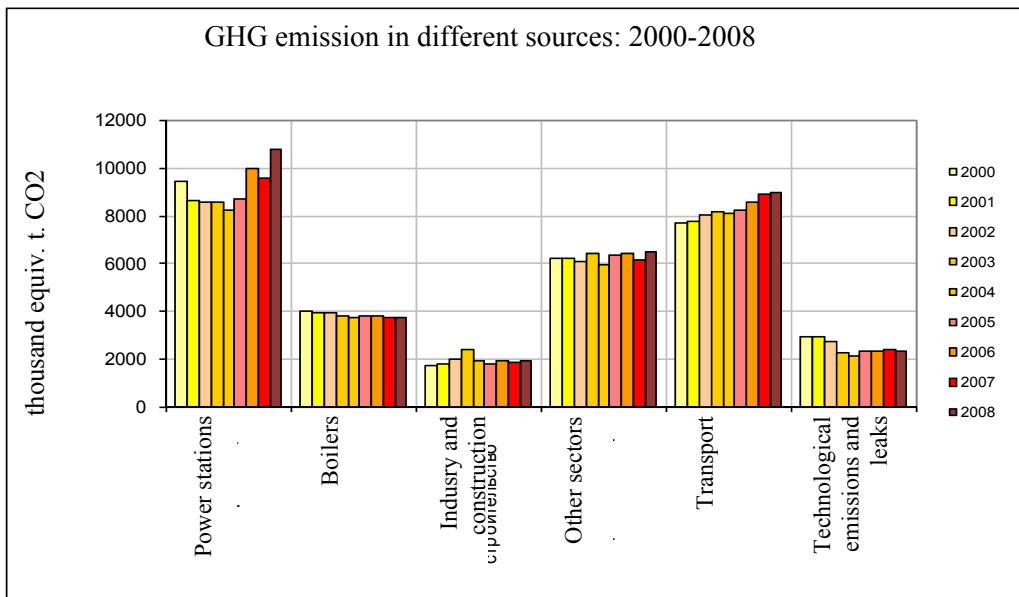


Fig. 2.8. GHG emissions dynamics in different sectors of Rostov region

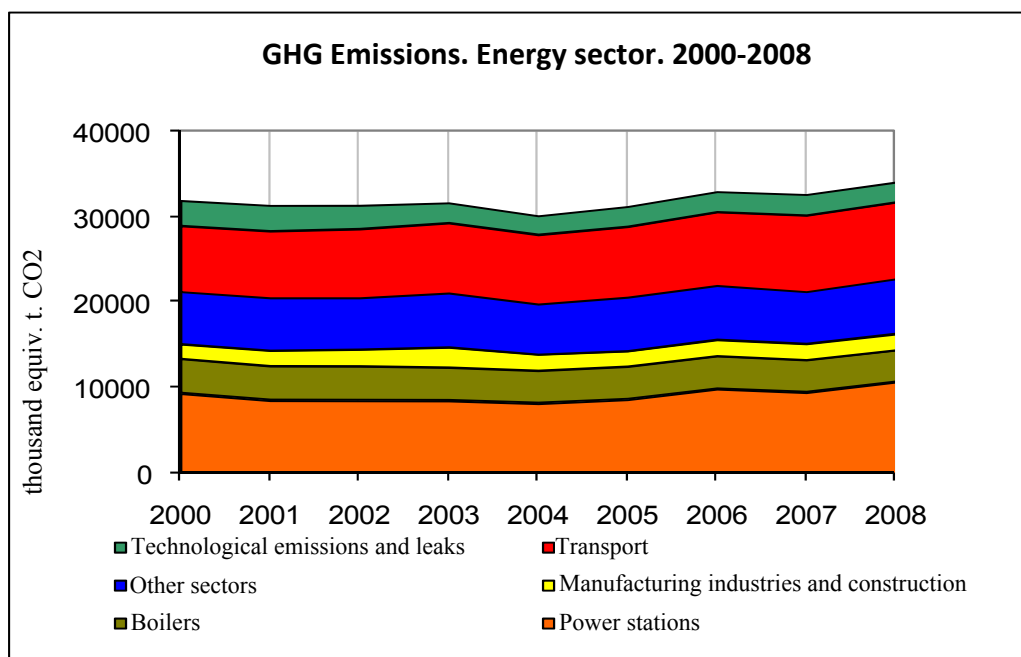


Fig.2.9. GHG emissions dynamics in Rostov region “energy” sector

Collective data of GHG emissions inventory for main sectors of Rostov region are given in Table 2.1. In 2008 the portion of CO₂ equaled 92.7% of the total for three GHGs.

Table2.1. Rostov region GHG emissions inventory from “energy” sector in 2000-2008 (thousand tons equiv. CO₂)

Types of fuel	Year	Consumption (thousand tsf)	Consumption (TJ)	Emission CO ₂ (Gg CO ₂)	Emission CH ₄ (Gg CH ₄)	Emission N ₂ O (Gg N ₂ O)	GHG emission: equiv. CO ₂ (Gg CO ₂)
1	2	3	4	5	6	7	8
“Energy” sector	2000	14232,2	417132,3	28936,5	140,967	0,343	32003,0
	2001	14114,1	413669,4	28312,2	142,776	0,349	31418,8
	2002	14496,0	424862,5	28560,2	131,166	0,359	31426,1
	2003	14986,5	439238,3	29267,6	111,431	0,369	31722,0
	2004	14324,8	419844,3	27880,6	104,825	0,363	30194,5
	2005	14856,2	435421,7	28822,9	111,708	0,371	31283,8
	2006	15475,6	453573,4	30546,1	113,414	0,389	33048,4
	2007	15346,3	449783,3	30143,6	116,152	0,404	32708,1
	2008	16284,0	477266,8	31669,0	112,772	0,410	34164,3
Power generation	2000	4108,2	120406,0	9432,8	0,005	0,004	9434,0
	2001	3885,7	113887,4	8616,8	0,004	0,003	8617,8
	2002	4013,7	117636,2	8594,9	0,004	0,003	8595,9
	2003	4033,5	118217,2	8571,9	0,004	0,003	8572,8
	2004	3971,6	116402,8	8253,8	0,004	0,003	8254,6
	2005	4131,4	121086,7	8712,3	0,004	0,003	8713,3
	2006	4505,5	132050,8	9961,5	0,005	0,004	9962,7
	2007	4383,8	128483,8	9553,1	0,004	0,003	9554,2
	2008	5016,3	147023,6	10776,8	0,005	0,004	10778,1
Boilers	2000	2133,2	62520,6	4015,6	0,002	0,000	4015,7
	2001	2125,7	62301,8	3947,5	0,002	0,000	3947,6
	2002	2148,8	62977,7	3949,0	0,002	0,000	3949,1
	2003	2104,0	61665,5	3822,4	0,002	0,000	3822,5
	2004	2079,9	60958,3	3753,3	0,002	0,000	3753,4
	2005	2113,0	61929,5	3802,6	0,002	0,000	3802,7
	2006	2121,0	62164,4	3807,7	0,002	0,000	3807,8

Types of fuel	Year	Consumption (thousand tsf)	Consumption (TJ)	Emission CO ₂ (Gg CO ₂)	Emission CH ₄ (Gg CH ₄)	Emission N ₂ O (Gg N ₂ O)	GHG emission: equiv. CO ₂ (Gg CO ₂)
Manufacturing Industries and Construction	2007	2082,1	61025,6	3738,2	0,002	0,000	3738,3
	2008	2136,2	62610,9	3697,7	0,002	0,000	3697,8
	2000	817,5	23958,7	1713,8	0,002	0,000	1714,0
	2001	872,9	25582,9	1833,7	0,003	0,000	1833,9
	2002	1018,5	29850,4	1979,5	0,002	0,000	1979,7
	2003	1161,7	34048,7	2392,4	0,004	0,001	2392,7
	2004	911,3	26710,2	1915,2	0,003	0,000	1915,4
	2005	901,0	26408,5	1814,3	0,003	0,000	1814,5
	2006	948,0	27786,1	1915,8	0,003	0,000	1916,0
	2007	943,3	27646,9	1907,5	0,003	0,000	1907,7
Transport	2008	945,4	27708,4	1899,0	0,003	0,000	1899,2
	2000	3555,3	104201,4	7563,3	1,315	0,336	7695,1
	2001	3598,8	105475,9	7653,3	1,343	0,343	7787,9
	2002	3723,7	109138,3	7909,4	1,441	0,354	8049,4
	2003	3792,6	111158,3	8052,2	1,488	0,363	8196,0
	2004	3750,0	109908,1	7960,1	1,466	0,358	8101,9
	2005	3813,6	111772,7	8094,6	1,471	0,365	8238,7
	2006	3991,7	116993,1	8455,6	1,654	0,383	8608,9
	2007	4142,5	121412,2	8770,2	1,741	0,398	8930,2
	2008	4167,2	122136,2	8814,0	1,795	0,404	8976,8
Other sectors	2000	3618,2	106045,6	6210,6	0,028	0,002	6211,9
	2001	3631,0	106421,4	6260,5	0,027	0,002	6261,8
	2002	3591,4	105259,9	6127,1	0,026	0,002	6128,3
	2003	3894,7	114148,7	6428,2	0,028	0,002	6429,5
	2004	3612,0	105864,9	5997,8	0,024	0,002	5998,9
	2005	3897,2	114224,3	6398,6	0,029	0,002	6400,0
	2006	3909,3	114579,1	6405,0	0,028	0,002	6406,3
	2007	3794,6	111214,9	6174,1	0,028	0,002	6175,4
	2008	4018,8	117787,7	6481,0	0,029	0,002	6482,3
Technological emissions and leaks	2000			0,3	139,615		2932,3
	2001			0,3	141,397		2969,7
	2002			0,3	129,690		2723,9
	2003			0,4	109,905		2308,4
	2004			0,4	103,326		2170,3
	2005			0,4	110,200		2314,6
	2006			0,4	111,723		2346,6
	2007			0,4	114,374		2402,3
	2008			0,5	110,938		2330,1

Source: CENEF estimates

In Sverdlovsk region in 2000-2008 emissions were growing gradually in all sectors, but for boilers. Manufacturing industries were in the lead. Their share was 69, 7% of total emission growth. More 16, 9% of the increase were contributed by power generation; 14, 5% – by transport, 6, 6% – by other sectors; 0, 4% – by technological emissions and leaks. Reduction of emissions from boilers neutralized the increase by 8, 2% (see Fig. 2.10 and Fig. 2.11). In general, emissions increased by 26, 4% in 2000-2008 (see Fig. 2.12).

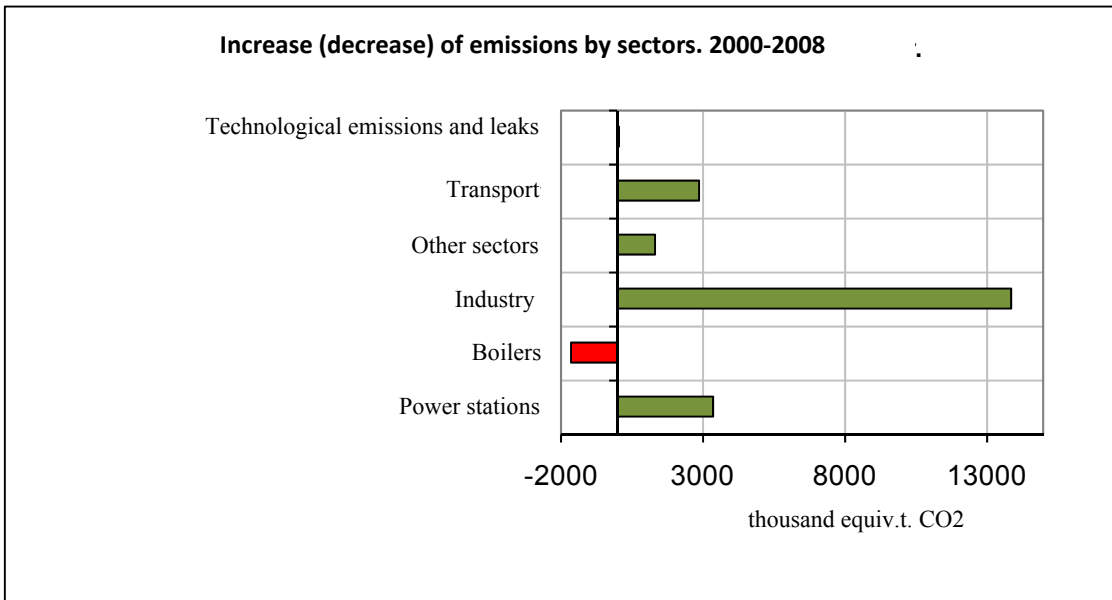


Fig. 2.10. Structure of GHG emissions from Sverdlovsk region "energy" sector

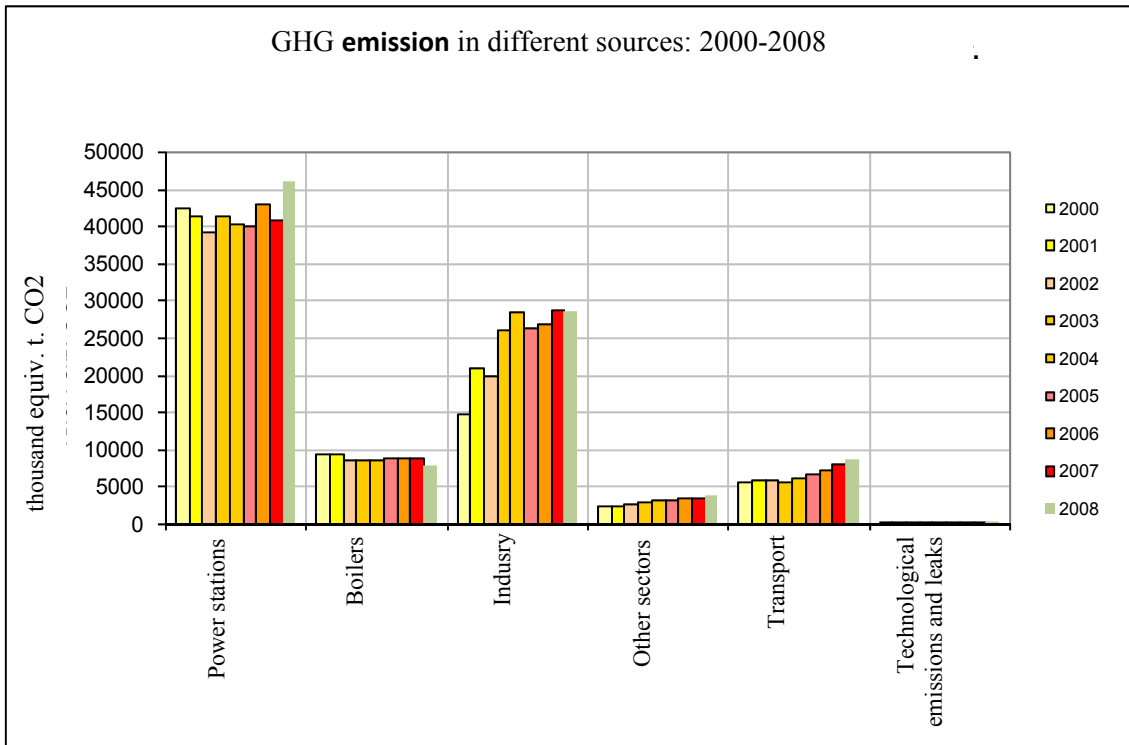


Fig. 2.11. GHG emissions dynamics from different sectors of Sverdlovsk region

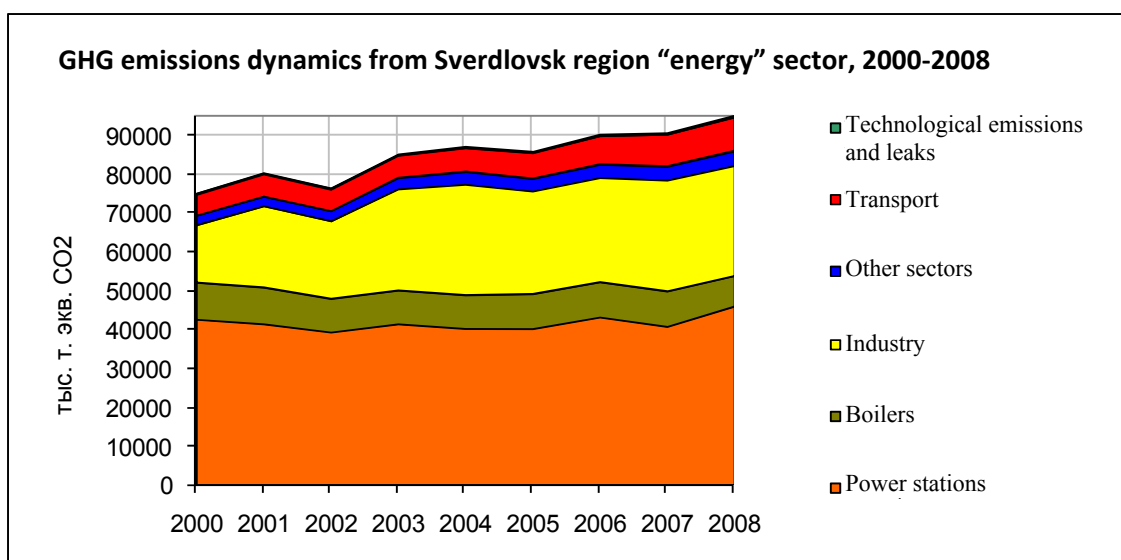


Fig. 2.12. GHG emissions dynamics from Sverdlovsk region "energy" sector

GHG emissions inventory collective data from main sectors for Sverdlovsk region are given in Table 2.2. Out of total emission of three GHGs the share of CO₂ in 2008 was 99%.

Table 2.2. Sverdlovsk region GHG emissions inventory from "energy" sector in 2000-2008 (thousand CO₂ equiv. tons)

Types of fuel	Year	Consumption (thousand tsf)	Consumption (TJ)	Emission CO ₂ (Gg CO ₂)	Emission CH ₄ (Gg CH ₄)	Emission N ₂ O (Gg N ₂ O)	GHG Emission : CO ₂ equiv. (Gg CO ₂)
1	2	3	4	5	6	7	8
"Energy" sector	2000	37933,8	1111800,8	74705,0	15,979	0,240	75115,0
	2001	37539,1	1100234,6	79942,2	15,278	0,240	80337,5
	2002	36793,4	1078378,6	76022,8	16,409	0,248	76444,1
	2003	39815,5	1166953,8	84665,8	16,385	0,250	85087,4
	2004	40991,4	1201418,0	86564,9	18,558	0,253	87033,1
	2005	40433,3	1185058,2	85303,1	18,157	0,263	85766,0
	2006	42696,4	1251387,9	89631,3	19,838	0,290	90137,7
	2007	42793,9	1254246,6	89984,2	20,453	0,305	90508,1
	2008	44505,6	1304416,0	94405,0	21,223	0,314	94948,2
Power generation	2000	18865,8	552936,6	42556,0	0,008	0,001	42556,5
	2001	18488,8	541889,6	41393,1	0,008	0,001	41393,6
	2002	18575,0	544415,9	39307,9	0,010	0,001	39308,4
	2003	19253,2	564293,3	41384,3	0,010	0,001	41384,8
	2004	19084,4	559344,2	40210,1	0,010	0,001	40210,7
	2005	19236,8	563811,6	40169,3	0,011	0,001	40169,8
	2006	20524,2	601544,0	43125,0	0,011	0,001	43125,6
	2007	19825,4	581063,2	40737,0	0,012	0,001	40737,6
	2008	21699,3	635984,4	45913,7	0,012	0,001	45914,3
Boilers	2000	5299,3	155317,5	9389,5	0,009	0,002	9390,3
	2001	5213,0	152786,9	9318,7	0,009	0,002	9319,4
	2002	4757,3	139430,7	8521,4	0,008	0,002	8522,1
	2003	4814,6	141111,8	8565,2	0,008	0,002	8565,9
	2004	4805,5	140845,4	8539,5	0,007	0,002	8540,2
	2005	4936,4	144681,2	8872,7	0,009	0,002	8873,4
	2006	5042,9	147801,5	8946,2	0,008	0,002	8946,9
	2007	4970,5	145679,6	8988,0	0,007	0,002	8988,7
	2008	4380,0	128372,1	7756,1	0,006	0,001	7756,6
Manufacturi	2000	9570,4	280500,0	14701,0	0,024	0,003	14702,5

Types of fuel	Year	Consumption (thousand tsf)	Consumption (TJ)	Emission CO ₂ (Gg CO ₂)	Emission CH ₄ (Gg CH ₄)	Emission N ₂ O (Gg N ₂ O)	GHG Emission : CO ₂ equiv. (Gg CO ₂)
ng Industries and Construction	2001	9523,8	279132,5	20893,5	0,026	0,004	20895,1
	2002	9095,1	266568,7	19841,2	0,021	0,003	19842,5
	2003	11272,2	330377,3	26108,8	0,045	0,006	26111,7
	2004	12233,8	358559,3	28527,7	0,051	0,007	28531,1
	2005	11151,0	326824,4	26435,6	0,045	0,007	26438,6
	2006	11610,6	340295,1	26965,8	0,047	0,007	26968,9
	2007	12008,8	351967,1	28641,6	0,053	0,008	28645,1
	2008	12150,6	356122,0	28532,5	0,052	0,007	28535,9
Transport	2000	2622,4	76860,1	5564,1	1,069	0,234	5658,9
	2001	2758,4	80846,2	5848,3	1,091	0,234	5943,7
	2002	2697,1	79049,7	5716,5	1,211	0,242	5816,8
	2003	2684,7	78686,8	5675,7	1,295	0,241	5777,5
	2004	2819,4	82632,8	5950,0	1,333	0,243	6053,3
	2005	3095,1	90715,2	6525,7	1,419	0,254	6634,2
	2006	3384,3	99189,5	7109,8	1,723	0,280	7232,8
	2007	3817,4	111883,6	8006,9	1,896	0,294	8137,9
Other sectors	2000	1575,8	46186,6	2494,3	0,008	0,000	2494,5
	2001	1555,1	45579,3	2488,4	0,008	0,000	2488,7
	2002	1668,9	48913,6	2635,6	0,008	0,000	2635,9
	2003	1790,7	52484,5	2931,6	0,009	0,000	2931,8
	2004	2048,4	60036,3	3337,2	0,010	0,000	3337,5
	2005	2013,9	59025,8	3299,5	0,010	0,000	3299,8
	2006	2134,4	62557,7	3484,3	0,011	0,000	3484,6
	2007	2171,8	63653,1	3610,4	0,011	0,000	3610,7
Technological emissions and leaks	2000			0,2	14,861		312,3
	2001			0,2	14,136		297,0
	2002			0,2	15,151		318,4
	2003			0,2	15,018		315,6
	2004			0,3	17,146		360,3
	2005			0,2	16,662		350,1
	2006			0,3	18,038		379,1
	2007			0,3	18,473		388,2
2008			0,3	19,096		401,3	

Source: CENEF estimates

GHG emission estimates by CENEF differ from estimates made earlier by UCEE LLC. UCEE estimates were made on the basis of previously operational *Revised guidelines dated 1996* and corresponding *Guidelines on effective practice* (see table 1.3). CENEF estimate for 2000 is 9% lower than that by UCEE LLC. If GHG emissions level in 2008 by CENEF estimate is compared to emissions estimate in 1990, made by UCEE LLC, it turns out that in 2008 the emission level was equal to 78.7% of 1990 level.

Table 2.3. Sverdlovsk region GHG emissions inventory from “energy” sector in 1990-2006 (CO₂ equiv. tons) by UCEE LLC data

Year	Base emissions level	2001 inventory	2006-2007 inventory.
1990	120614	120614	120614,0
1991	120614	112522	
1992	120614	104277	
1993	120614	93378	

Year	Base emissions level	2001 inventory	2006-2007 inventory.
1994	120614	81741	
1995	120614	81992	
1996	120614	81044	
1997	120614	74255	
1998	120614	70482	
1999	120614	70004	
2000	120614	81653	81846
2001	120614		81704
2002	120614		77269
2003	120614		80068
2004	120614		80904
2005	120614		84313
2006	120614		87276

Source: Summary information report on GHG emissions inventory from Sverdlovsk region manufacturing industries in 1990-2006, by UCEE LLC. The inventory was performed on the basis of the previous IPCC methodology.

In Tver region in 2000-2008 transport became the main source of emission increase while power stations were in the second place. A minor increase also had place due to technological emissions and leaks. Rest of the sectors showed emissions decrease, more notable in other sectors and boilers. (see Fig.2.13 and 2.14).

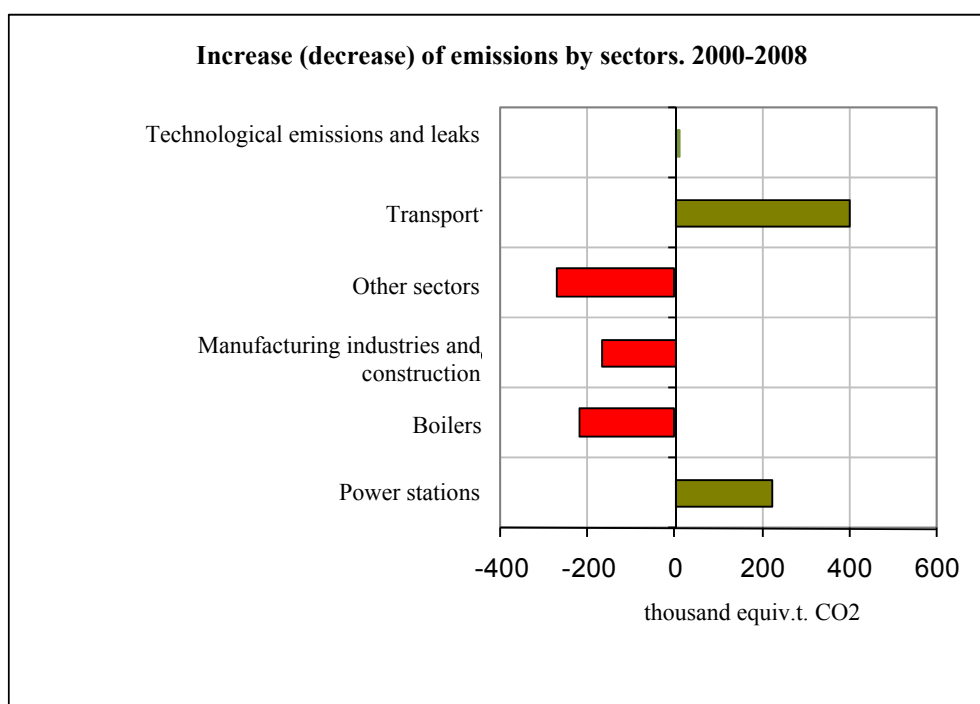


Fig. 2.13. Structure of GHG emissions from Tver region "energy" sector

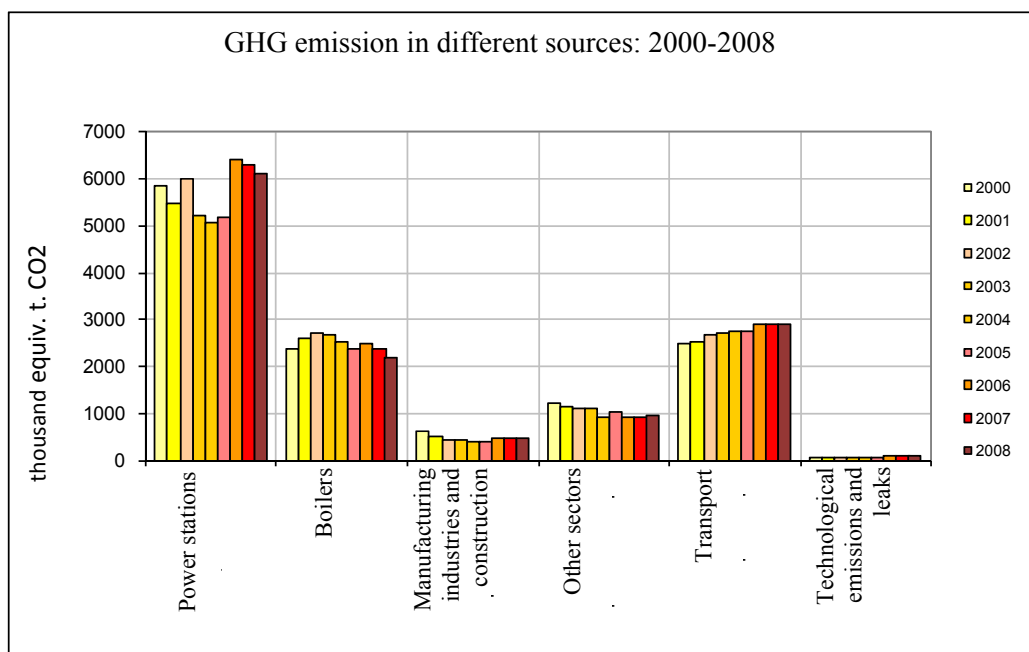


Fig 2.14. GHG emissions dynamics in Tver region specific sectors

All in all, in Tver region GHG emissions did not change radically (see Fig. 2.15 and Table 2.4).

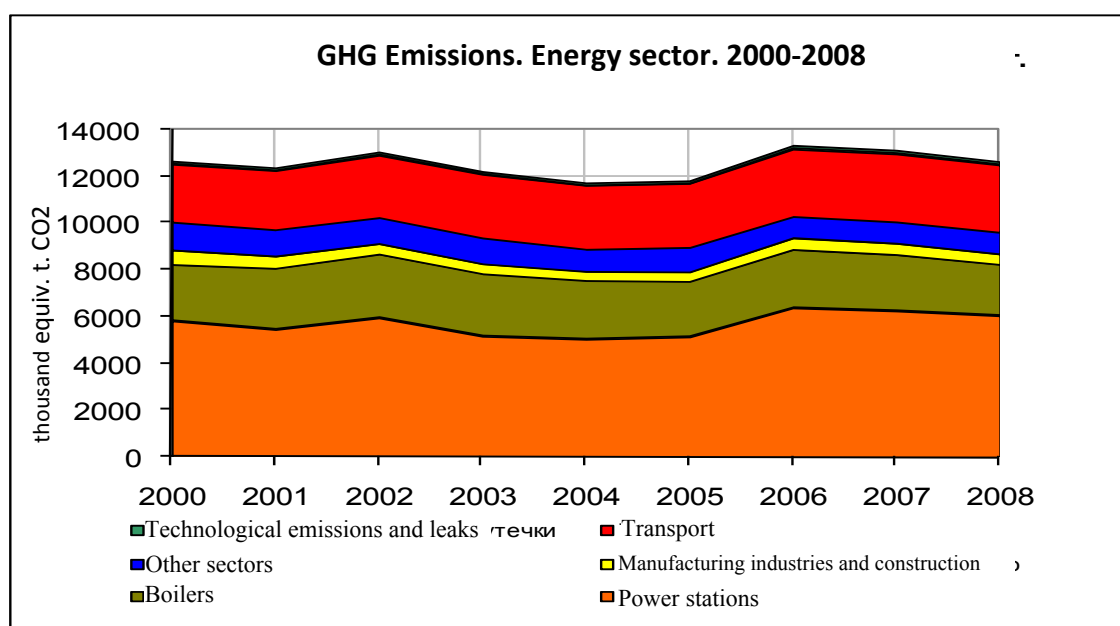


Fig. 2.15. GHG emissions dynamics in Tver region "energy" sectors

Table 2.4. Tver region "energy" sector GHG emissions inventory in 2000-2008 (thousand equiv. t. CO₂)

Types of fuel	Year	Consumption (thousand tons standard fuel)	Consumption (TJ)	Emission CO ₂ (Gg CO ₂)	Emission CH ₄ (Gg CH ₄)	Emission N ₂ O (Gg N ₂ O)	GHG Emission : CO ₂ equiv. (Gg CO ₂)
1	2	3	4	5	6	7	8
"Energy" sector	2000	7149,5	209544,0	12530,5	4,628	0,109	12661,5
	2001	7090,7	207820,3	12249,5	4,733	0,112	12383,5
	2002	7377,0	216211,2	12905,2	4,795	0,118	13042,6
	2003	6826,9	200090,5	12093,5	4,677	0,121	12229,2
	2004	6602,2	193504,6	11618,8	4,863	0,120	11758,3

Types of fuel	Year	Consumption (thousand tons standard fuel)	Consumption (TJ)	Emission CO ₂ (Gg CO ₂)	Emission CH ₄ (Gg CH ₄)	Emission N ₂ O (Gg N ₂ O)	GHG Emission : CO ₂ equiv. (Gg CO ₂)
	2005	6663,6	195304,2	11701,9	4,919	0,122	11843,0
	2006	7358,0	215654,7	13165,3	5,362	0,129	13317,9
	2007	7264,5	212914,2	12958,7	5,392	0,130	13112,2
	2008	7066,0	207097,8	12485,2	5,311	0,129	12636,7
Power generation	2000	3412,3	100012,1	5856,8	0,004	0,001	5857,1
	2001	3270,9	95868,1	5484,5	0,004	0,000	5484,8
	2002	3525,7	103333,4	5991,3	0,004	0,001	5991,6
	2003	3036,1	88985,5	5195,1	0,004	0,001	5195,3
	2004	3014,6	88355,2	5064,3	0,004	0,000	5064,5
	2005	3078,2	90219,0	5168,3	0,004	0,000	5168,5
	2006	3780,2	110795,2	6417,1	0,005	0,001	6417,3
	2007	3734,6	109456,7	6286,1	0,004	0,001	6286,4
	2008	3591,9	105273,6	6078,3	0,004	0,001	6078,6
Boilers	2000	1432,6	41988,1	2401,0	0,002	0,001	2401,2
	2001	1580,7	46330,1	2614,3	0,003	0,001	2614,5
	2002	1601,1	46927,7	2713,2	0,003	0,001	2713,4
	2003	1553,2	45524,0	2672,1	0,003	0,001	2672,3
	2004	1523,8	44662,2	2517,2	0,003	0,001	2517,4
	2005	1418,4	41572,6	2372,8	0,002	0,001	2373,0
	2006	1409,0	41295,9	2485,6	0,002	0,001	2485,8
	2007	1358,5	39817,5	2394,9	0,002	0,001	2395,1
	2008	1333,0	39068,6	2185,0	0,001	0,000	2185,1
Manufacturing industries and Construction	2000	291,5	8544,1	620,2	0,002	0,000	620,3
	2001	251,2	7363,8	524,2	0,001	0,000	524,3
	2002	199,3	5842,1	446,2	0,001	0,000	446,3
	2003	207,5	6081,6	434,2	0,001	0,000	434,2
	2004	182,4	5347,3	401,9	0,001	0,000	402,0
	2005	186,7	5472,0	419,1	0,001	0,000	419,2
	2006	220,5	6461,3	489,0	0,001	0,000	489,1
	2007	219,4	6431,2	480,9	0,001	0,000	481,0
	2008	201,2	5896,0	450,7	0,001	0,000	450,8
Transport	2000	1144,4	33541,8	2439,5	0,486	0,107	2483,0
	2001	1165,5	34160,3	2484,3	0,496	0,110	2528,9
	2002	1229,4	36031,6	2619,9	0,528	0,117	2667,1
	2003	1257,0	36842,8	2678,1	0,540	0,119	2726,4
	2004	1262,4	36998,4	2689,4	0,541	0,119	2737,7
	2005	1265,4	37088,5	2695,0	0,549	0,121	2743,9
	2006	1334,1	39102,1	2835,7	0,615	0,128	2888,1
	2007	1348,5	39523,6	2859,1	0,641	0,129	2912,4
	2008	1336,1	39160,9	2829,8	0,664	0,128	2883,4
Other sectors	2000	868,6	25457,9	1212,9	0,003	0,000	1213,1
	2001	822,2	24098,0	1142,1	0,003	0,000	1142,2
	2002	821,5	24076,5	1134,6	0,003	0,000	1134,7
	2003	773,0	22656,6	1114,0	0,003	0,000	1114,1
	2004	619,0	18141,5	945,9	0,003	0,000	946,1
	2005	714,9	20952,1	1046,6	0,003	0,000	1046,7
	2006	614,2	18000,2	937,8	0,003	0,000	937,9
	2007	603,4	17685,3	937,5	0,003	0,000	937,6
	2008	603,9	17698,7	941,3	0,003	0,000	941,3
Technological emissions and leaks	2000			0,10	4,13		86,8
	2001			0,10	4,23		88,9
	2002			0,10	4,26		89,5

Types of fuel	Year	Consumption (thousand tons standard fuel)	Consumption (TJ)	Emission CO ₂ (Gg CO ₂)	Emission CH ₄ (Gg CH ₄)	Emission N ₂ O (Gg N ₂ O)	GHG Emission : CO ₂ equiv. (Gg CO ₂)
	2003			0,11	4,13		86,8
	2004			0,11	4,31		90,6
	2005			0,11	4,36		91,7
	2006			0,11	4,74		99,6
	2007			0,12	4,74		99,7
	2008			0,11	4,64		97,5

Source: CENEF estimate

2.5 Completeness

GHG emissions from all sectors are taken into account and in this respect the estimate is complete. The characteristic of the level of comprehensiveness for emission sources registration in each sector is given in the corresponding sections of the report.

2.6 Uncertainty assessment

Spectrum of factors affects uncertainty assessment of GHG emissions: adequacy and completeness of statistical data, precision of emission factors determination and others. Within the framework of this report there were found discrepancies in statistical data on fuel consumption in power generation, low quality of statistical data on fuel consumption in automobile transport and services. Employment of alternative data on fuel consumption for GHG emission estimate helps to determine uncertainty level for total emission estimates. For Rostov region this value equals 19%, for Sverdlovsk region it is 2.9% and for Tver region it is 4.3%.

IPCC suggests an overall uncertainty value of 7% for CO₂ emission factors of Energy section. For Rostov region this value exceeds the limit. The main reason is low quality of statistical data on liquid fuel consumption by automobile transport.

3 Energy Industries

3.1 Main results

3.1.1 Rostov region

Under “Energy Industries” section for Rostov region two groups of sources have been identified: power stations and boilers. The results of GHG emission from energy industries in Rostov region in 2000-2008 are given in Table 3.1.

Table 3.1. Inventory of GHG emissions from Rostov region energy industries in 2000-2008 (mln equiv. t CO₂)

Types of fuel	Year	Consumption (thousand tons standard fuel)	Consumption (TJ)	Emission CO ₂ (Gg CO ₂)	Emission CH ₄ (Gg CH ₄)	Emission N ₂ O (Gg N ₂ O)	Emission GHG: equiv. CO ₂ (Gg CO ₂)
Energy industries	2000	6241,3	182926,5	13448,4	0,007	0,004	13449,7
	2001	6011,4	176189,2	12564,3	0,006	0,003	12565,4
	2002	6162,4	180613,9	12543,9	0,006	0,003	12545,0
	2003	6137,5	179882,6	12394,3	0,006	0,003	12395,4
	2004	6051,4	177361,1	12007,1	0,006	0,003	12008,0
	2005	6244,4	183016,2	12514,9	0,006	0,003	12516,0
	2006	6626,5	194215,2	13769,2	0,007	0,004	13770,5
	2007	6465,9	189509,4	13291,3	0,006	0,004	13292,5
	2008	7152,6	209634,5	14474,5	0,007	0,004	14475,8
Power generation	2000	4108,2	120406,0	9432,8	0,005	0,004	9434,0
	2001	3885,7	113887,4	8616,8	0,004	0,003	8617,8
	2002	4013,7	117636,2	8594,9	0,004	0,003	8595,9
	2003	4033,5	118217,2	8571,9	0,004	0,003	8572,8
	2004	3971,6	116402,8	8253,8	0,004	0,003	8254,6
	2005	4131,4	121086,7	8712,3	0,004	0,003	8713,3
	2006	4505,5	132050,8	9961,5	0,005	0,004	9962,7
	2007	4383,8	128483,8	9553,1	0,004	0,003	9554,2
	2008	5016,3	147023,6	10776,8	0,005	0,004	10778,1
Boilers	2000	2133,2	62520,6	4015,6	0,002	0,000	4015,7
	2001	2125,7	62301,8	3947,5	0,002	0,000	3947,6
	2002	2148,8	62977,7	3949,0	0,002	0,000	3949,1
	2003	2104,0	61665,5	3822,4	0,002	0,000	3822,5
	2004	2079,9	60958,3	3753,3	0,002	0,000	3753,4
	2005	2113,0	61929,5	3802,6	0,002	0,000	3802,7
	2006	2121,0	62164,4	3807,7	0,002	0,000	3807,8
	2007	2082,1	61025,6	3738,2	0,002	0,000	3738,3
	2008	2136,2	62610,9	3697,7	0,002	0,000	3697,8

Source: CENEF estimate

In 2008 45, 5% of the three GHGs were attributed to energy industries. Compared to 2000, in 2008 emissions from these sources increased by 5.8%. Nevertheless, the portion of energy industries emission decreased by 0.6% which is explained by leading growth of emissions in other sectors (see Fig. 2.1).

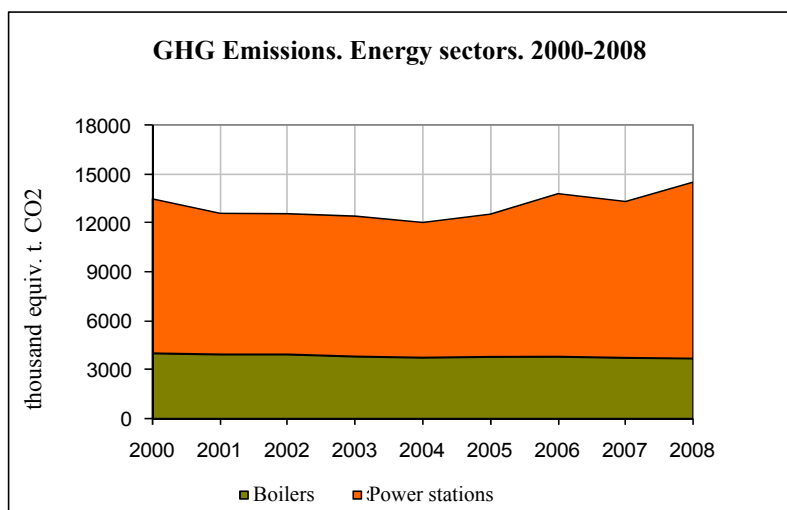


Fig 3.1. GHG emissions from energy industries in Rostov region in 2000-2008.

3.1.2 Sverdlovsk region

Two groups of emission sources have also been identified for Sverdlovsk region energy industries: power stations and boilers. The results of GHG emissions estimate from Sverdlovsk region energy industries in 2000-2008 are given in Table 3.2.

Table 3.2. Sverdlovsk region GHG emissions inventory from energy industries in 2000-2008 (mln equiv. t. CO₂)

Types of fuel	Year	Consumption (thousand tsf)	Consumption (TJ)	Emission CO ₂ (Gg CO ₂)	Emission CH ₄ (Gg CH ₄)	Emission N ₂ O (Gg N ₂ O)	Emission GHG: equiv. CO ₂ (Gg CO ₂)
Energy industries	2000	24165,1	708254,1	51945,5	0,0	0,0	51946,7
	2001	23701,8	694676,6	50711,8	0,0	0,0	50713,0
	2002	23332,3	683846,6	47829,3	0,0	0,0	47830,5
	2003	24067,9	705405,2	49949,6	0,0	0,0	49950,8
	2004	23889,9	700189,6	48749,7	0,0	0,0	48750,8
	2005	24173,2	708492,8	49041,9	0,0	0,0	49043,2
	2006	25567,1	749345,5	52071,2	0,0	0,0	52072,5
	2007	24795,9	726742,8	49725,0	0,0	0,0	49726,3
	2008	26079,2	764356,5	53669,8	0,0	0,0	53670,9
Power generation	2000	18865,8	552936,6	42556,0	0,008	0,001	42556,5
	2001	18488,8	541889,6	41393,1	0,008	0,001	41393,6
	2002	18575,0	544415,9	39307,9	0,010	0,001	39308,4
	2003	19253,2	564293,3	41384,3	0,010	0,001	41384,8
	2004	19084,4	559344,2	40210,1	0,010	0,001	40210,7
	2005	19236,8	563811,6	40169,3	0,011	0,001	40169,8
	2006	20524,2	601544,0	43125,0	0,011	0,001	43125,6
	2007	19825,4	581063,2	40737,0	0,012	0,001	40737,6
	2008	21699,3	635984,4	45913,7	0,012	0,001	45914,3
Boilers	2000	5299,3	155317,5	9389,5	0,009	0,002	9390,3
	2001	5213,0	152786,9	9318,7	0,009	0,002	9319,4
	2002	4757,3	139430,7	8521,4	0,008	0,002	8522,1
	2003	4814,6	141111,8	8565,2	0,008	0,002	8565,9
	2004	4805,5	140845,4	8539,5	0,007	0,002	8540,2
	2005	4936,4	144681,2	8872,7	0,009	0,002	8873,4
	2006	5042,9	147801,5	8946,2	0,008	0,002	8946,9
	2007	4970,5	145679,6	8988,0	0,007	0,002	8988,7
	2008	4380,0	128372,1	7756,1	0,006	0,001	7756,6

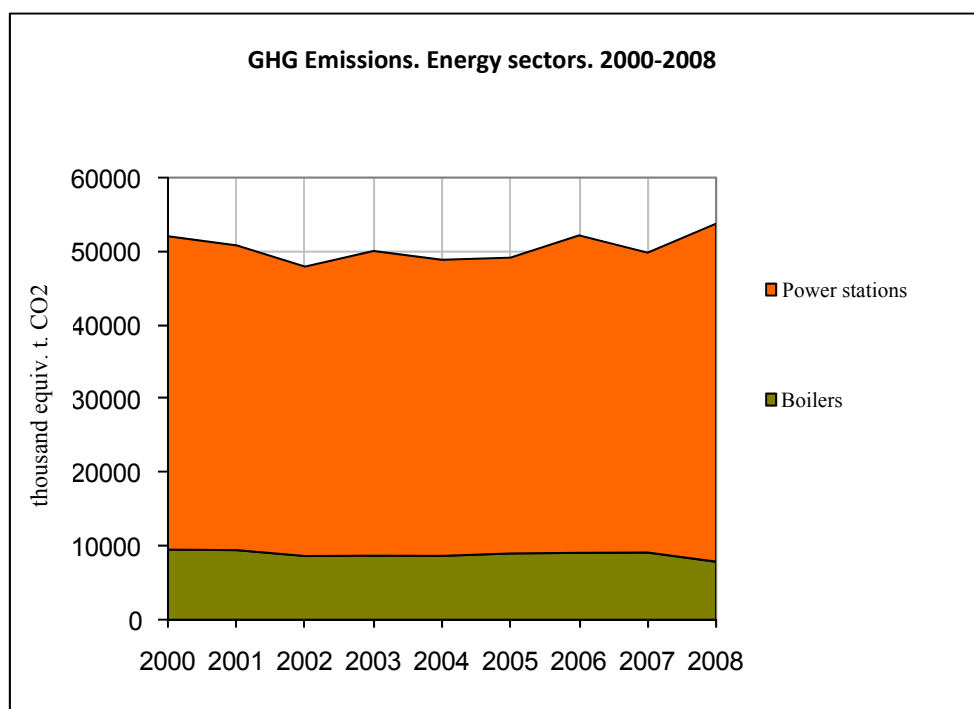


Fig. 3.2. GHG emissions from Sverdlovsk region energy industries in 2000-2008

3.1.3 Tver region

"Two groups of emission sources have also been identified for Tver region energy industries: power stations and boilers. The results of GHG emissions estimate from Tver region energy industries in 2000-2008 are given in Table 3.3.

Table 3.3. Tver region GHG emissions inventory from energy industries in 2000-2008 (mln equiv. t. CO₂)

Types of fuel	Year	Consumption (thousand tsf)	Consumption (TJ)	Emission CO ₂ (Gg CO ₂)	Emission CH ₄ (Gg CH ₄)	Emission N ₂ O (GG N ₂ O)	Emission GHG: equiv. CO ₂ (Gg CO ₂)
1	2	3	4	5	6	7	8
Energy industries	2000	4844,9	142000,2	8257,8	0,007	0,001	8258,3
	2001	4851,7	142198,2	8098,8	0,007	0,001	8099,3
	2002	5126,8	150261,1	8704,5	0,007	0,001	8705,0
	2003	4589,4	134509,5	7867,1	0,007	0,001	7867,7
	2004	4538,4	133017,4	7581,5	0,007	0,001	7581,9
	2005	4496,6	131791,6	7541,1	0,006	0,001	7541,5
	2006	5189,2	152091,1	8902,7	0,007	0,001	8903,2
	2007	5093,1	149274,2	8681,0	0,007	0,001	8681,5
	2008	4924,8	144342,2	8263,3	0,006	0,001	8263,7
Power generation	2000	3412,3	100012,1	5856,8	0,004	0,001	5857,1
	2001	3270,9	95868,1	5484,5	0,004	0,000	5484,8
	2002	3525,7	103333,4	5991,3	0,004	0,001	5991,6
	2003	3036,1	88985,5	5195,1	0,004	0,001	5195,3
	2004	3014,6	88355,2	5064,3	0,004	0,000	5064,5
	2005	3078,2	90219,0	5168,3	0,004	0,000	5168,5
	2006	3780,2	110795,2	6417,1	0,005	0,001	6417,3
	2007	3734,6	109456,7	6286,1	0,004	0,001	6286,4
	2008	3591,9	105273,6	6078,3	0,004	0,001	6078,6
Boilers	2000	1432,6	41988,1	2401,0	0,002	0,001	2401,2
	2001	1580,7	46330,1	2614,3	0,003	0,001	2614,5
	2002	1601,1	46927,7	2713,2	0,003	0,001	2713,4

Types of fuel	Year	Consumption (thousand tsf)	Consumption (TJ)	Emission CO ₂ (Gg CO ₂)	Emission CH ₄ (Gg CH ₄)	Emission N ₂ O (GG N ₂ O)	Emission GHG: equiv. CO ₂ (Gg CO ₂)
	2003	1553,2	45524,0	2672,1	0,003	0,001	2672,3
	2004	1523,8	44662,2	2517,2	0,003	0,001	2517,4
	2005	1418,4	41572,6	2372,8	0,002	0,001	2373,0
	2006	1409,0	41295,9	2485,6	0,002	0,001	2485,8
	2007	1358,5	39817,5	2394,9	0,002	0,001	2395,1
	2008	1333,0	39068,6	2185,0	0,001	0,000	2185,1

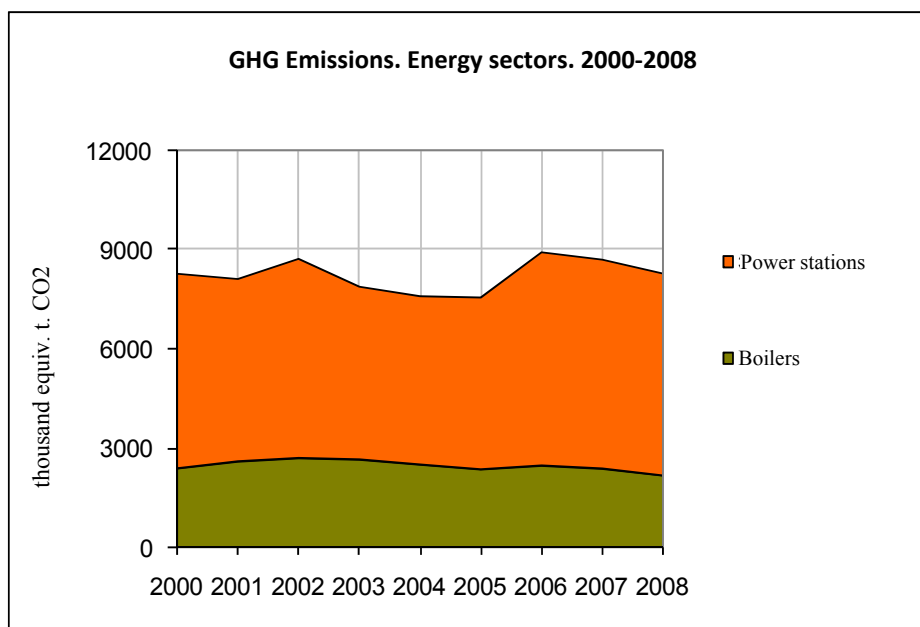


Fig. 3.3. GHG emissions from Tver region energy industries in 2000-2008

3.2 Inventory compilation methodology

The greenhouse gas emissions from the energy industries (Section 1.A.1 in IPCC classification) are estimated in accordance with the provisions in Chapter 1 “Introduction” and Chapter 2 “Stationary combustion”, Volume 2 “Energy” of “Guidelines for National Greenhouse Gas Inventories” (IPCC, 2006).

The stationary sources are all the fuel consumption sources included in the statistics. Emissions of each greenhouse gas from stationary sources are calculated by multiplying fuel consumption by the corresponding emission factor. In the Sectoral Approach, “Fuel Consumption” is estimated from energy use statistics and is measured in terajoules. Fuel consumption data in mass or volume units must first be converted into the equivalent fuel units representing the energy content of these fuels (tonnes of specific fuel (tsf)), to be then converted into the terajoules.

Under “Energy Industries” sector the following groups of sources have been identified in each region (see description in table 3.4).

Table 3.4. Types of Activities in “Energy Industries” Sector for Rostov, Sverdlovsk and Tver regions

Code number and name		Definitions	
1 A 1	<i>Energy Industries</i>	Comprises emissions from fuels combusted by the fuel extraction or energy-producing industries.	
1 A 1	a Main Activity Electricity and Heat Production	Sum of emissions from main activity at production of electricity and heat, combined heat and power generation, and heat plants. Main activity producers (formerly known as public utilities) are defined as those undertakings whose primary activity is to supply the public. They may be in public or private ownership. Emissions from own on-site use of fuel should be included. Emissions from autoproducers (undertakings which generate electricity/heat wholly or partly for their own use, as an activity that supports their primary activity) should be assigned to the sector where they were generated and not under 1 A 1 a. Autoproducers may be in public or private ownership.	
1 A 1	a i	<i>Electricity Generation</i>	Comprises emissions from all fuel use for electricity generation from main activity producers except those from combined heat and power plants.
	ii	<i>Combined Heat and Power Generation (CHP) Hear</i>	Emissions from production of both heat and electrical power from main activity producers for sale to the public, at a single CHP facility.
	iii	<i>Heat Plants</i>	Production of heat from main activity producers for sale by pipe network.

Source: Table 2.1 Chapter 2 «Stationary Combustion» vol. 2 “Energy “Guidelines for National Greenhouse Inventories”.

Emissions from industrial power stations and boilers are included into “Energy Industries” sector since (1) some of these stations sell considerable volumes of electric energy and heat to third-party consumers and (2) after 2006 fuel consumption by industrial ceased to be indicated separately. Therefore, here the “Energy Industries” sector includes the whole production of electric and heat energy at power stations and boilers. Fuel consumption estimate at the energy industry units is generated based on the regular statistical reports (see Table 3.5). These statistics can produce varying figures for the same parameter. Some of these discrepancies are either partly the result of varying coverage (only large and medium facilities or all facilities, etc.) and partially – because of the insufficiently reliable fuel consumption statistics. Hence, these statistical data is first compiled and processed, and then it is also compared, and only then the fuel consumption matrix is put together to evaluate the annual emission. As part of the effort to develop the integrated fuel and energy balance of the region, all fuel consumption data, heat and electricity generation data is verified, and only then the reliability of the fuel consumption data is finally defined.

Table 3.5. Major statistical reporting forms required to estimate the fuel consumption at various energy industry units

Forms of statistical reporting	Description
“6-TP” (electricity and heat generation and fuel consumption in electric power industry)	The form is used to develop the fuel balance for the power plants and regional boilers; it determines the distribution of the electric and heat power

Forms of statistical reporting	Description
"11-TER" (consumption of fuel, heat and electricity power)	The form is used to determine the fuel consumption for the fuel balance in electricity and heat production; for the plants and regional boilers; to compile the energy consumption in the industry, farming, construction, municipal services and the communities
"4-toplivo" ("Fuel") (Fuel stock, purchase and consumption of fuel, collection and consumption of the processed petroleum products)	The form is used to determine the totals for the various fuel consumption, fuel stock updates, fuel distribution to the communities
"22-ZhKKh" (Performance of Housing and Communal Services Enterprises under the reforms)	The form indicates the heat power consumption, consumer network gas and liquefied gas consumption, as well as the electric power consumption by the communities and public buildings.
«1-gas»	The form provides the data on consumer network gas and liquefied gas consumption by the communities, small-scale consumers and public sector organizations
"1-toplivo" ("Fuel") (consumption of fuel and energy by the organizations financed from federal budget resources)	The form provides the data on consumption of fuel and energy by the organizations financed from federal budget resources
"1-avto-benzin" (data on the petroleum production)	The form provides the data on the crude oil refining and petroleum production
"1-TEP" (Heat power supply)	The form provides the data on heat generation by the groups of the boilers, types of the fuel consumed at the boilers, heat energy losses to the environment and heat energy consumption in the communities, by the public sector and other organizations
"1-nefteprodukty" (petroleum products distribution to the consumers)	The form provides the data on the distribution of petroleum products and the geographical map of the exports
"1-vyvoz" (product exports (commodities))	Fuel exports outside the Russian Federation constituent
"4-zapasy (srochnaya)" (fuel stock)	The form provides the data on the fuel stock and consumption

The description of these forms is published at the Federal State Statistics Service site: <http://www.gks.ru/form/Page20.html>.

Tier 1 approach is used in the "Energy industries" sector, which means the calculation of CO₂ emissions applies CO₂, CH₄ and N₂O emission factors (See Table 2.3) defined by IPCC. The authors do not have any data or any special survey results to support the use of specific factors for three selected regions. Emission factors for CO₂ are defined in units of kg CO₂/TJ on a net calorific value basis and reflect the carbon content of the fuel and the assumption that the carbon oxidation factor is 1.

Table 3.6. Emission Factors for Stationary Combustion in Energy Industries Units (kg/TJ)

	CO ₂	CH ₄	N ₂ O
Crude Oil	73300	3	0,6
Orimulsion	77000	3	0,6
Natural Gas Liquids	64200	3	0,6
Motor Gasoline	69300	3	0,6
Aviation Gasoline	70000	3	0,6
Jet Gasoline	70000	3	0,6
Jet Kerosene	71500	3	0,6
Other Kerosene	71900	3	0,6
Shale Oil	73300	3	0,6
Gas/Diesel Oil	74100	3	0,6
Residual Fuel Oil	77400	3	0,6

	CO ₂	CH ₄	N ₂ O
Liquefied Petroleum Gases	63100	1	0,1
Ethane	61600	1	0,1
Naphtha	73300	3	0,6
Bitumen	80700	3	0,6
Lubricants	73300	3	0,6
Petroleum Coke	97500	3	0,6
Refinery Feedstocks	73300	3	0,6
Refinery Gas	57600	1	0,1
Paraffin Waxes	73300	3	0,6
White Spirit and SBP	73300	3	0,6
Other Petroleum Products	73300	3	0,6
Anthracite	98300	1	1,5
Coking Coal	94600	1	1,5
Other Bituminous Coal	94600	1	1,5
Sub- Bituminous Coal	96100	1	1,5
Lignite	101000	1	1,5
Oil Shale and Tar Sands	107000	1	1,5
Brown Coal Briquettes	97500	1	1,5
Patent Fuel	97500	1	1,5
Coke Oven Coke and Lignite Coke	107000	1	1,5
Gas Coke	107000	1	0,1
Coal Tar	80700	1	1,5
Gas Works Gas	44400	1	0,1
Coke Oven Gas	44400	1	0,1
Blast Furnace Gas	260000	1	0,1
Oxygen Steel Furnace Gas	182000	1	0,1
Natural Gas	56100	1	0,1
Municipal Wastes (non-biomass fraction)	91700	30	4
Industrial wastes	143000	30	4
Waste Oils	73300	30	4
Peat	106000	1	1,5
Wood/Wood Waste	112000	30	4
Sulphite lyes (Black Liquor)	95300	3	2
Other Primary Solid Biomass	100000	30	4
Charcoal	112000	200	4
Biogasoline	70800	3	0,6
Biodiesels	70800	3	0,6
Other Liquid Biofuels	79600	3	0,6
Landfill Gas	54600	1	0,1
Sludge Gas	54600	1	0,1
Other Biogas	54600	1	0,1
Municipal Wastes (biomass fraction)	100000	30	4

Source: Chapter 2 “Stationary Combustion” vol. 2 “Energy” “Guidelines for National Greenhouse Inventories”.

Emission factors for CH₄ and N₂O for different source categories differ due to differences in combustion technologies applied in the different source categories. Factors in Table 2.3 apply to technologies without emission controls. These emission factors were established using the expert judgment of a large group of inventory experts.

Tier 1 approach calculates the emissions by multiplying the fuel consumption by IPCC emission factors (See Table 3.6). The approach is represented in the Equation 2.1:

$$Emissions = \sum Fuel EF \quad (2.1)$$

Where: *Emissions* = Emissions;

Fuel_a = fuel consumption;

EF_a = emission factor. Represents the carbon content of the fuel multiplied by 44/12.

a = type of fuel (for example, gasoline, diesel fuel, natural gas, liquefied gas, etc.).

Emissions of CO₂ from biomass fuels are estimated and reported in the AFOLU sector as part of the AFOLU methodology. In the reporting tables, emissions from combustion of biofuels are reported as information items but not included in the sectoral or national totals to avoid double counting. In the emission factor tables presented in this Chapter, CO₂ emission factors are presented to enable the user to estimate these information items. For biomass, only that part of the biomass that is combusted for energy purposes should be estimated for inclusion as an information item in the Energy sector. The emissions of CH₄ and N₂O, however, are estimated and included in the sector and national totals because their effect is in addition to the stock changes estimated in the AFOLU sector.

Neither region uses CO₂ trap and store technology for gas emitted into atmosphere and its re-injection into the geological reservoirs and storage. That is why no aspects of capturing and storing the carbon dioxide are reviewed in this survey.

3.3 Power Plants

Power plants are a major GHG emission source. By the scale of emission some of them considerably exceed emission from other sectors. That is why this Inventory keeps CO₂, CH₄ and N₂O emission registration for each power plant.

In *Rostov region* (except for Tsimlyanska Hydroelectric Power Plant (HydroPP) and Volgodonsk Nuclear Power Plant (NPP)) they are: Volgodonsk Heat Power Plant-1 (HeatPP), Volgodonsk HeatPP-2, Novochoerkassk State Regional Power Plant (SRPP), Rostov HeatPP-2, Kamensk HeatPP, OJSC Experimentalnaya Thermal Power Plant (TPP) ТЭЦ» in the city of Krasny Sulin, ArtemShahtinskaya Heat PP in the city of Shahty, Shahtinskaya gas-vapor Heat PP, Rostselmashenergo LLC Heat PP, Heat PP of Novochoerkassk plant of synthetic products, Heat PP FL OJSC PK Baltika -Rostov, KGU LLC Primary Don, gas-piston power plant of Kamensk glass container plant OJSC, GDG-90 of Don-Tex CJSC in Shahty, gas-piston power plant of PKF Atlantis-Pas OJSC.

In *Sverdlovsk region* (except for Verkhoturinskaya HydroPP and Beloyarsk NPP) they are: Reftinskaya SRPP, Verkhne-Tagilskaya SRPP, Sredneuralskaya SRPP, Serovskaya SRPP, Nizhneturinskaya SRPP, Novo-Sverdlovskaya HeatPP, Bogoslovskaya HeatPP, Krasnogorskaya HeatPP, Kachkanarskaya HeatPP in Kachkanar, Sverdlovskaya HeatPP in Ekaterinburg, Pervouralskaya HeatPP in Pervouralsk, Artemovskaya HeatPP in Artemovskiy, Sverdlovsk heat networks, HeatPP of Nizhnetagilskiy iron-and-steel works, HeatPP of Dzerzhinskiy Uralvagonzavod, HeatPP Uralmetprom, HeatPP of Ural electrochemical works in Novouralsk, HeatPP of Turbine and Motor works, HeatPP of Synarskiy pipe works OJSC, HeatPP of Serov Metzavod OJSC, HeatPP of Tavdinskiy hydrolysis plant OJSC, HeatPP of IVGID OJSC, Novolyalinskiy pulp-and-paper plant LLC, HeatPP of Lobvinskiy biochemical plant OJSC, Akademenergo municipal works, HeatPP of Uraltransgas LLC, Uralskiy mechanical rubber goods plant OJSC, HeatPP of Uralskaya chemical company OJSC in Nizhniy Tagil, GD PP of Tyumentransgas LLC Ivdel LPUMG, GD

PP Tyumentransgas LLC Novo-Ivdel PU, DES of AB-239/5 enterprise in Puksinka, DES of AB-239/5 enterprise in Gary.

In *Tver region* (except Novotveretskaya HydroPP and Kalininskaya NPP) they are: Konakovskaya SRPP, Tverskaya HeatPP -3, Tverskaya HeatPP -4, Tverskaya HeatPP -1, V.Volotsakaya HeatPP, HeatPP of Nelidovo DOC OJSC, HeatPP of Ostashkov leather plant and HeatPP of Bologovskiy reinforcing steel plant OJSC.

As it is seen at Fig. 2.4-2.6, the biggest emissions are produced by the following enterprises:

In *Rostov region*: Novochoerkassk State Regional Power Plant (SRPP), Volgodosk HeatPP-2 and Rostov HeatPP-2. The influence of other sources is fairly insignificant.

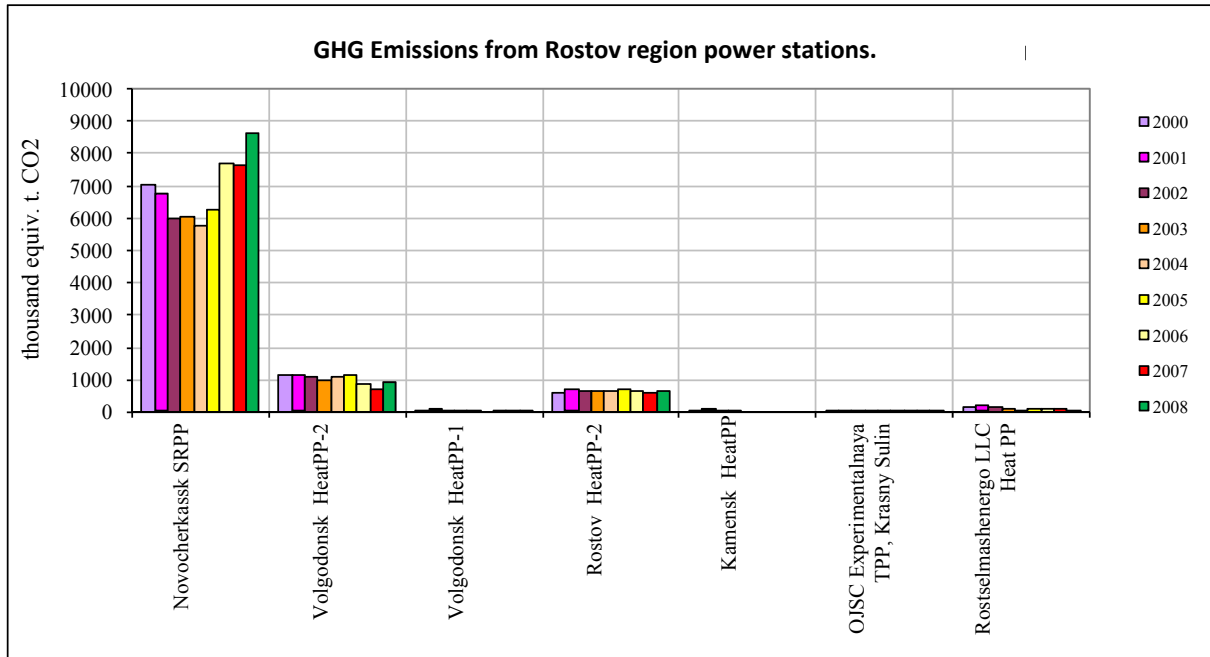


Fig. 3.4. GHG emissions from Rostov region power plants in 2000-2008.

In *Sverdlovsk region*: Reftinskaya SRPP, Verkhne-Tagilskaya SRPP, Sredneuralskaya SRPP, Serovskaya SRPP and HeatPP of Nizhnetagilskiy iron-and-steel works. The influence of other sources is less considerable.

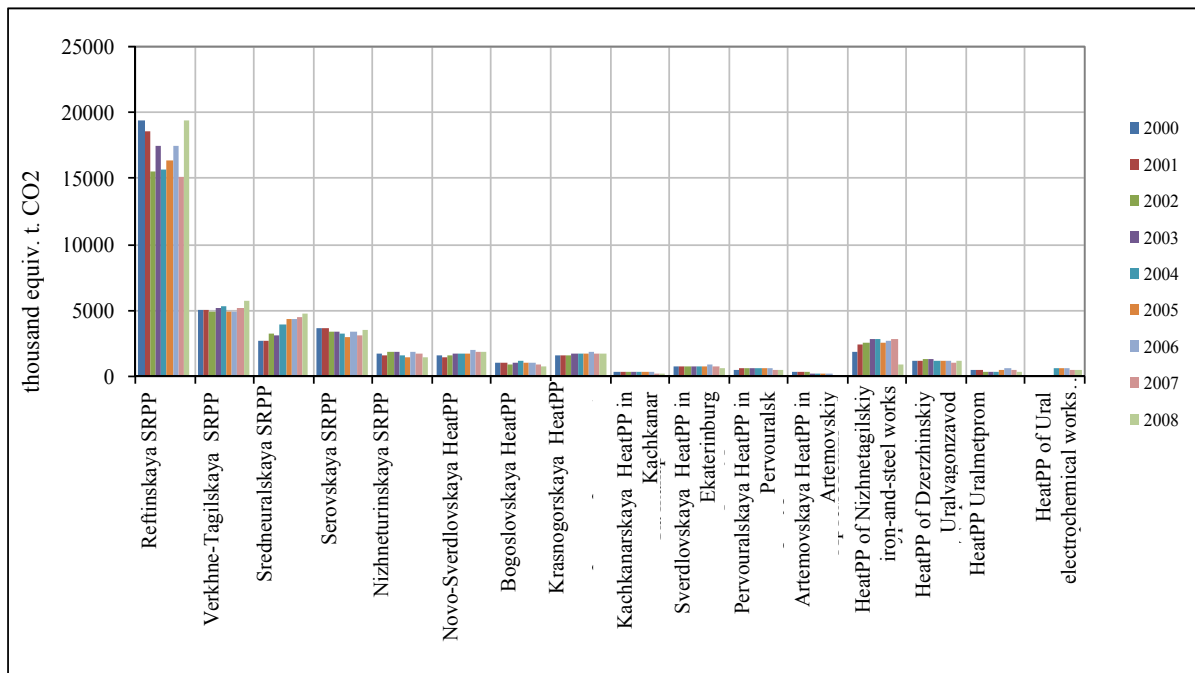


Fig. 3.5. GHG emissions from Sverdlovsk region power plants in 2000-2008.

In *Tver region*: Konakovskaya SRPP, Tverskaya HeatPP -3, Tverskaya HeatPP -4.

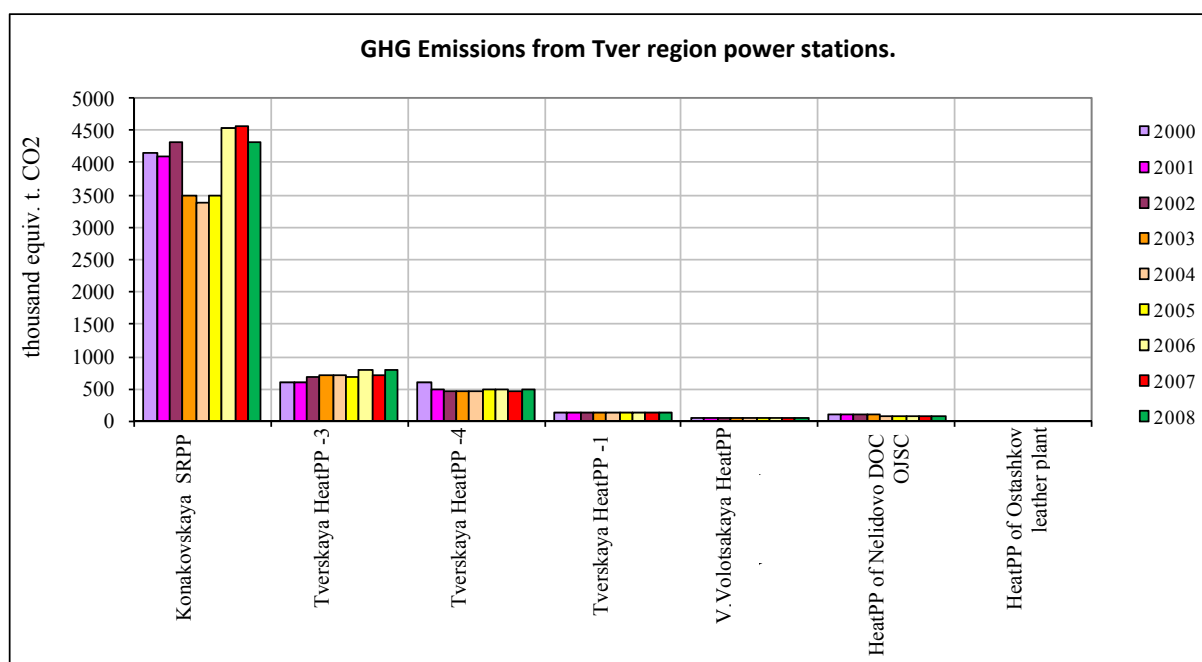


Fig. 3.6. GHG emissions from Tver region power plants in 2000-2008.

The main statistics sources for the fuel consumption at the power plants are the report forms “11-TER” (provides the summary for all power plants) and “6-TP” (breaks the data down by the individual power plants). The regional greenhouse gas inventory (MRI-EPG) focuses on the types of fuel specific for the power plant. Each year cell in the spreadsheet includes the link to the statistical report forms “11-TER” and “6-TP”, which are the source of the relevant data. Where possible, the data from the forms is compared to formulate the reliability of the data source which serves as an emission estimate data resource.

The results of compilation of GHG emissions inventory from power plants in Rostov, Sverdlovsk and Tver regions in 2000-2008 are given in Tables 37-3.9.

Power plants lead in the list of GHG emissions sources. Their share in 2008 was 31, 5% (Rostov region), 48, 6% (Sverdlovsk region) and 48, 1% (Tver region) of collective GHG emissions from energy sector.

Table 3.7. Rostov region GHG emissions inventory from power plants in 2000-2008 (thousand equiv. t. CO₂)

	Year	Consumption, thousand tsf	Consumption TJ	CO ₂ emission factor (kg CO ₂ /TJ)	Emission CO ₂ (Gg CO ₂)	CH ₄ emission factor (kg CH ₄ /TJ)	Emission CH ₄ (Gg CH ₄)	N ₂ O emission factor (kg N ₂ O/ TJ)	Emission N ₂ O (Gg N ₂ O)	GHG emission: equiv. CO ₂ (Gg CO ₂)
	1	2	3	4	5	6	7	8	9	10
Total for power generation	2000	4108,2	120406,0	78342	9432,8		0,005		0,004	9434,0
	2001	3885,7	113887,4	75661	8616,8		0,004		0,003	8617,8
	2002	4013,7	117636,2	73063	8594,9		0,004		0,003	8595,9
	2003	4033,5	118217,2	72510	8571,9		0,004		0,003	8572,8
	2004	3971,6	116402,8	70907	8253,8		0,004		0,003	8254,6
	2005	4131,4	121086,7	71951	8712,3		0,004		0,003	8713,3
	2006	4505,5	132050,8	75437	9961,5		0,005		0,004	9962,7
	2007	4383,8	128483,8	74353	9553,1		0,004		0,003	9554,2
	2008	5016,3	147023,6	73300	10776,8		0,005		0,004	10778,1
Liquid fuel	2000	301,4	8844,0		684,5		0,001		0,000	684,6
	2001	151,5	4462,7		345,3		0,000		0,000	345,4
	2002	62,2	1847,3		142,9		0,000		0,000	142,9
	2003	27,5	821,6		63,5		0,000		0,000	63,5
	2004	25,1	749,0		57,9		0,000		0,000	57,9
	2005	26,5	786,8		60,9		0,000		0,000	60,9
	2006	60,5	1780,7		137,8		0,000		0,000	137,8
	2007	16,6	492,5		38,1		0,000		0,000	38,1
	2008	44,1	1297,7		103,8		0,000		0,000	103,8
Diesel fuel	2000	0,3	10,0	74100	0,7	3	0,000	0,6	0,000	0,7
	2001	0,8	23,2	74100	1,7	3	0,000	0,6	0,000	1,7
	2002	0,8	23,5	74100	1,7	3	0,000	0,6	0,000	1,7
	2003	0,6	16,1	74100	1,2	3	0,000	0,6	0,000	1,2
	2004	0,4	13,2	74100	1,0	3	0,000	0,6	0,000	1,0
	2005	0,4	11,1	74100	0,8	3	0,000	0,6	0,000	0,8
	2006	0,2	6,1	74100	0,5	3	0,000	0,6	0,000	0,5
	2007	0,2	5,7	74100	0,4	3	0,000	0,6	0,000	0,4
	2008	0,2	6,2	74100	0,5	3	0,000	0,6	0,000	0,5
Residual Fuel Oil	2000	301,4	8834,1	77400	683,8	3	0,001	0,6	0,000	683,8
	2001	151,5	4439,5	77400	343,6	3	0,000	0,6	0,000	343,7
	2002	62,2	1823,9	77400	141,2	3	0,000	0,6	0,000	141,2
	2003	27,5	805,5	77400	62,3	3	0,000	0,6	0,000	62,4
	2004	25,1	735,8	77400	57,0	3	0,000	0,6	0,000	57,0

	Year	Consumption, thousand tsf	Consumption TJ	CO ₂ emission factor (kg CO ₂ /TJ)	Emission CO ₂ (Gg CO ₂)	CH ₄ emission factor (kg CH ₄ /TJ)	Emission CH ₄ (Gg CH ₄)	N ₂ O emission factor (kg N ₂ O/ TJ)	Emission N ₂ O (Gg N ₂ O)	GHG emission: equiv. CO ₂ (Gg CO ₂)	
	2005	26,5	775,7	77400	60,0	3	0,000	0,6	0,000	60,0	
	2006	60,5	1774,5	77400	137,3	3	0,000	0,6	0,000	137,4	
	2007	16,6	486,8	77400	37,7	3	0,000	0,6	0,000	37,7	
	2008	44,1	1335,6	77400	103,4	3	0,000	0,6	0,000	103,4	
Other petroleum products	2000	0,0	0,0	77400	0,0	3	0,000	0,6	0,000	0,0	
	2001	0,0	0,0	77400	0,0	3	0,000	0,6	0,000	0,0	
	2002	0,0	0,0	77400	0,0	3	0,000	0,6	0,000	0,0	
	2003	0,0	0,0	77400	0,0	3	0,000	0,6	0,000	0,0	
	2004	0,0	0,0	77400	0,0	3	0,000	0,6	0,000	0,0	
	2005	0,0	0,0	77400	0,0	3	0,000	0,6	0,000	0,0	
	2006	0,0	0,0	77400	0,0	3	0,000	0,6	0,000	0,0	
	2007	0,0	0,0	77400	0,0	3	0,000	0,6	0,000	0,0	
	2008	0,0	0,0	77400	0,0	3	0,000	0,6	0,000	0,0	
	Coke	2000	2205,9	64652,5		6116,1		0,002		0,003	6117,2
		2001	1888,9	55361,7		5237,2		0,002		0,003	5238,1
2002		1732,5	50777,5		4803,5		0,002		0,003	4804,4	
2003		1702,9	49910,4		4721,5		0,002		0,003	4722,3	
2004		1512,7	44335,7		4194,2		0,002		0,002	4194,9	
2005		1685,6	49403,3		4673,6		0,002		0,003	4674,4	
2006		2229,0	65329,9		6180,2		0,002		0,003	6181,3	
2007		2068,8	60633,2		5735,9		0,002		0,003	5736,9	
2008		2213,2	67081,3		6136,5		0,002		0,003	6137,6	
Coal	2000	2205,9	64652,5	94600	6116,1	1	0,002	1,5	0,003	6117,2	
	2001	1888,9	55361,7	94600	5237,2	1	0,002	1,5	0,003	5238,1	
	2002	1732,5	50777,5	94600	4803,5	1	0,002	1,5	0,003	4804,4	
	2003	1702,9	49910,4	94600	4721,5	1	0,002	1,5	0,003	4722,3	
	2004	1512,7	44335,7	94600	4194,2	1	0,002	1,5	0,002	4194,9	
	2005	1685,6	49403,3	94600	4673,6	1	0,002	1,5	0,003	4674,4	
	2006	2229,0	65329,9	94600	6180,2	1	0,002	1,5	0,003	6181,3	
	2007	2068,8	60633,2	94600	5735,9	1	0,002	1,5	0,003	5736,9	
	2008	2213,2	64868,1	94600	6136,5	1	0,002	1,5	0,003	6137,6	
Charcoal	2000	0,0	0,0	96100	0,0	1	0,000	1,5	0,000	0,0	
	2001	0,0	0,0	96100	0,0	1	0,000	1,5	0,000	0,0	
	2002	0,0	0,0	96100	0,0	1	0,000	1,5	0,000	0,0	

	Year	Consumption, thousand tsf	Consumption TJ	CO ₂ emission factor (kg CO ₂ /TJ)	Emission CO ₂ (Gg CO ₂)	CH ₄ emission factor (kg CH ₄ /TJ)	Emission CH ₄ (Gg CH ₄)	N ₂ O emission factor (kg N ₂ O/ TJ)	Emission N ₂ O (Gg N ₂ O)	GHG emission: equiv. CO ₂ (Gg CO ₂)
	2003	0,0	0,0	96100	0,0	1	0,000	1,5	0,000	0,0
	2004	0,0	0,0	96100	0,0	1	0,000	1,5	0,000	0,0
	2005	0,0	0,0	96100	0,0	1	0,000	1,5	0,000	0,0
	2006	0,0	0,0	96100	0,0	1	0,000	1,5	0,000	0,0
	2007	0,0	0,0	96100	0,0	1	0,000	1,5	0,000	0,0
	2008	0,0	0,0	96100	0,0	1	0,000	1,5	0,000	0,0
	2000	1600,9	46919,4	56100	2632,2	1	0,002	0,1	0,000	2632,3
	2001	1845,4	54086,2	56100	3034,2	1	0,002	0,1	0,000	3034,3
Natural gas	2002	2218,9	65034,9	56100	3648,5	1	0,002	0,1	0,000	3648,6
	2003	2303,1	67501,3	56100	3786,8	1	0,002	0,1	0,000	3786,9
	2004	2433,8	71331,3	56100	4001,7	1	0,002	0,1	0,000	4001,8
	2005	2419,3	70907,7	56100	3977,9	1	0,002	0,1	0,000	3978,0
	2006	2215,9	64946,3	56100	3643,5	1	0,002	0,1	0,000	3643,6
	2007	2298,4	67363,8	56100	3779,1	1	0,002	0,1	0,000	3779,2
	2008	2759,0	80864,0	56100	4536,5	1	0,003	0,1	0,000	4536,6

Source: CENEF estimate

Table 3.8. Sverdlovsk region GHG emissions inventory from power plants in 2000-2008 (thousand equiv. t. CO₂)

	Year	Consumption, thousand tsf	Consumption TJ	CO ₂ emission factor (kg CO ₂ /TJ)	Emission CO ₂ (Gg CO ₂)	CH ₄ emission factor (kg CH ₄ /TJ)	Emission CH ₄ (Gg CH ₄)	N ₂ O emission factor (kg N ₂ O/ TJ)	Emission N ₂ O (Gg N ₂ O)	GHG emission: equiv. CO ₂ (Gg CO ₂)
	1	2	3	4	5	6	7	8	9	10
Total for power generation	2000	18865,8	18865,8	76964	42556,0		0,008		0,001	42556,5
	2001	18488,8	18488,8	76387	41393,1		0,008		0,001	41393,6
	2002	18575,0	18575,0	72202	39307,9		0,010		0,001	39308,4
	2003	19253,2	19253,2	73338	41384,3		0,010		0,001	41384,8
	2004	19084,4	19084,4	71888	40210,1		0,010		0,001	40210,7
	2005	19236,8	19236,8	71246	40169,3		0,011		0,001	40169,8
	2006	20524,2	20524,2	71691	43125,0		0,011		0,001	43125,6
	2007	19825,4	19825,4	70108	40737,0		0,012		0,001	40737,6
	2008	21699,3	21699,3	72193	45913,7		0,012		0,001	45914,3
Liquid fuel	2000	144,6	144,6		328,0					328,0
	2001	209,1	209,1		474,3					474,3
	2002	178,4	178,4		404,6					404,6
	2003	165,1	165,1		374,5					374,5
	2004	124,1	124,1		281,3					281,3
	2005	113,3	113,3		256,9					256,9
	2006	129,5	129,5		293,8					293,8
	2007	93,8	93,8		212,8					212,8
	2008	69,9	69,9		158,3					158,3
Diesel fuel	2000	0,9	0,9	74100	2,0	3	0,000	0,6	0,000	2,0
	2001	0,6	0,6	74100	1,4	3	0,000	0,6	0,000	1,4
	2002	0,8	0,8	74100	1,7	3	0,000	0,6	0,000	1,7
	2003	1,4	1,4	74100	3,0	3	0,000	0,6	0,000	3,0
	2004	1,5	1,5	74100	3,3	3	0,000	0,6	0,000	3,3
	2005	0,7	0,7	74100	1,6	3	0,000	0,6	0,000	1,6
	2006	0,4	0,4	74100	0,9	3	0,000	0,6	0,000	0,9
	2007	0,6	0,6	74100	1,3	3	0,000	0,6	0,000	1,3
	2008	2,7	2,7	74100	5,8	3	0,000	0,6	0,000	5,8
Residual Fuel Oil	2000	143,7	143,7	77400	326,0	3	0,000	0,6	0,000	326,0
	2001	208,3	208,3	77400	472,6	3	0,001	0,6	0,000	472,6
	2002	177,6	177,6	77400	402,9	3	0,001	0,6	0,000	403,0
	2003	163,7	163,7	77400	371,4	3	0,000	0,6	0,000	371,5

	Year	Consumption, thousand tsf	Consumption TJ	CO ₂ emission factor (kg CO ₂ /TJ)	Emission CO ₂ (Gg CO ₂)	CH ₄ emission factor (kg CH ₄ /TJ)	Emission CH ₄ (Gg CH ₄)	N ₂ O emission factor (kg N ₂ O/ TJ)	Emission N ₂ O (Gg N ₂ O)	GHG emission: equiv. CO ₂ (Gg CO ₂)
	2004	122,5	122,5	77400	277,8	3	0,000	0,6	0,000	277,8
	2005	112,3	112,3	77400	254,8	3	0,000	0,6	0,000	254,9
	2006	128,7	128,7	77400	292,1	3	0,000	0,6	0,000	292,1
	2007	93,0	93,0	77400	211,1	3	0,000	0,6	0,000	211,1
	2008	67,0	67,0	77400	151,9	3	0,000	0,6	0,000	151,9
Other petroleum products	2000	0,0	0,0	77400	0,0	3	0,000	0,6	0,000	0,0
	2001	0,1	0,1	77400	0,3	3	0,000	0,6	0,000	0,3
	2002	0,0	0,0	77400	0,0	3	0,000	0,6	0,000	0,0
	2003	0,0	0,0	77400	0,0	3	0,000	0,6	0,000	0,0
	2004	0,1	0,1	77400	0,2	3	0,000	0,6	0,000	0,2
	2005	0,2	0,2	77400	0,4	3	0,000	0,6	0,000	0,4
	2006	0,4	0,4	77400	0,8	3	0,000	0,6	0,000	0,8
	2007	0,2	0,2	77400	0,4	3	0,000	0,6	0,000	0,4
	2008	0,3	0,3	77400	0,6	3	0,000	0,6	0,000	0,6
Coke	2000	10416,3	10416,3		28906,7					28906,7
	2001	10050,5	10050,5		27887,5					27887,5
	2002	8127,9	8127,9		22556,5					22556,5
	2003	9110,5	9110,5		25278,4					25278,4
	2004	8356,2	8356,2		23184,9					23184,9
	2005	7985,3	7985,3		22157,8					22157,8
	2006	8819,3	8819,3		24471,6					24471,6
	2007	7786,5	7786,5		21604,4					21604,4
C Coal	2000	9822,7	9822,7	94600	27234,8	1	0,010	1,5	0,015	27239,6
	2001	9567,4	9567,4	94600	26527,0	1	0,010	1,5	0,014	26531,6
	2002	7653,1	7653,1	94600	21219,1	1	0,008	1,5	0,011	21222,8
	2003	8693,3	8693,3	94600	24103,4	1	0,009	1,5	0,013	24107,6
	2004	7986,0	7986,0	94600	22142,3	1	0,008	1,5	0,012	22146,2
	2005	7584,8	7584,8	94600	21029,7	1	0,008	1,5	0,011	21033,4
	2006	8387,4	8387,4	94600	23255,2	1	0,008	1,5	0,013	23259,3
	2007	7439,2	7439,2	94600	20626,2	1	0,007	1,5	0,011	20629,8
	2008	9275,8	9275,8	94600	25718,4	1	0,009	1,5	0,014	25722,9
C H	2000	593,6	593,6	96100	1671,9	1	0,001	1,5	0,001	1672,2

	Year	Consumption, thousand tsf	Consumption TJ	CO ₂ emission factor (kg CO ₂ /TJ)	Emission CO ₂ (Gg CO ₂)	CH ₄ emission factor (kg CH ₄ /TJ)	Emission CH ₄ (Gg CH ₄)	N ₂ O emission factor (kg N ₂ O/ TJ)	Emission N ₂ O (Gg N ₂ O)	GHG emission: equiv. CO ₂ (Gg CO ₂)
	2001	483,0	483,0	96100	1360,5	1	0,000	1,5	0,001	1360,7
	2002	474,8	474,8	96100	1337,3	1	0,000	1,5	0,001	1337,6
	2003	417,2	417,2	96100	1175,0	1	0,000	1,5	0,001	1175,3
	2004	370,2	370,2	96100	1042,6	1	0,000	1,5	0,001	1042,8
	2005	400,5	400,5	96100	1128,1	1	0,000	1,5	0,001	1128,3
	2006	431,9	431,9	96100	1216,4	1	0,000	1,5	0,001	1216,6
	2007	347,3	347,3	96100	978,3	1	0,000	1,5	0,001	978,4
	2008	373,2	373,2	96100	1051,1	1	0,000	1,5	0,001	1051,3
Natural gas	2000	8101,9	8101,9	56100	13321,4	1	0,008	0,1	0,001	13321,8
	2001	7925,5	7925,5	56100	13031,4	1	0,008	0,1	0,001	13031,8
	2002	9941,9	9941,9	56100	16346,9	1	0,010	0,1	0,001	16347,4
	2003	9567,6	9567,6	56100	15731,4	1	0,010	0,1	0,001	15731,9
	2004	10183,4	10183,4	56100	16743,9	1	0,010	0,1	0,001	16744,4
	2005	10798,1	10798,1	56100	17754,6	1	0,011	0,1	0,001	17755,2
	2006	11166,0	11166,0	56100	18359,6	1	0,011	0,1	0,001	18360,2
	2007	11506,7	11506,7	56100	18919,8	1	0,012	0,1	0,001	18920,4
	2008	11547,0	11547,0	56100	18985,9	1	0,012	0,1	0,001	18986,5

Source: CENEF estimate

Table 3.9 Tver region GHG emissions inventory from power plants in 2000-2008 (thousand equiv. t. CO₂)

	Year	Consumption, thousand tsf	Consumption TJ	CO ₂ emission factor (kg CO ₂ /TJ)	Emission CO ₂ (Gg CO ₂)	CH ₄ emission factor (kg CH ₄ /TJ)	Emission CH ₄ (Gg CH ₄)	N ₂ O emission factor (kg N ₂ O/TJ)	Emission N ₂ O (Gg N ₂ O)	GHG emission: equiv. CO ₂ (Gg CO ₂)
	1	2	3	4	5	6	7	8	9	10
Total for power generation	2000	3412,3	100012,1	58561	5856,8		0,004		0,001	5857,1
	2001	3270,9	95868,1	57209	5484,5		0,004		0,000	5484,8
	2002	3525,7	103333,4	57980	5991,3		0,004		0,001	5991,6
	2003	3036,1	88985,5	58381	5195,1		0,004		0,001	5195,3
	2004	3014,6	88355,2	57317	5064,3		0,004		0,000	5064,5
	2005	3078,2	90219,0	57286	5168,3		0,004		0,000	5168,5
	2006	3780,2	110795,2	57918	6417,1		0,005		0,001	6417,3
	2007	3734,6	109456,7	57430	6286,1		0,004		0,001	6286,4
	2008	3591,9	105273,6	57738	6078,3		0,004		0,001	6078,6
Liquid fuel	2000	168,6	4940,0		382,4		0,001		0,000	382,4
	2001	40,9	1199,9		92,9		0,000		0,000	92,9
	2002	114,3	3350,0		259,3		0,000		0,000	259,3
	2003	158,2	4636,2		358,8		0,000		0,000	358,9
	2004	53,8	1578,1		122,1		0,000		0,000	122,2
	2005	38,4	1124,4		87,0		0,000		0,000	87,0
	2006	123,7	3626,8		280,7		0,000		0,000	280,7
	2007	68,4	2005,5		155,2		0,000		0,000	155,2
	2008	40,9	1197,4		95,8		0,000		0,000	95,9
Diesel fuel	2000	0,0	0,0	74100	0,0	3	0,000	0,6	0,000	0,0
	2001	0,0	0,0	74100	0,0	3	0,000	0,6	0,000	0,0
	2002	0,0	0,0	74100	0,0	3	0,000	0,6	0,000	0,0
	2003	0,0	0,0	74100	0,0	3	0,000	0,6	0,000	0,0
	2004	0,0	0,0	74100	0,0	3	0,000	0,6	0,000	0,0
	2005	0,0	0,0	74100	0,0	3	0,000	0,6	0,000	0,0
	2006	0,0	0,0	74100	0,0	3	0,000	0,6	0,000	0,0
	2007	0,0	0,0	74100	0,0	3	0,000	0,6	0,000	0,0
	2008	0,0	0,0	74100	0,0	3	0,000	0,6	0,000	0,0
Residual fuel oil	2000	168,6	4940,0	77400	382,4	3	0,001	0,6	0,000	382,4
	2001	40,9	1199,9	77400	92,9	3	0,000	0,6	0,000	92,9
	2002	114,3	3350,0	77400	259,3	3	0,000	0,6	0,000	259,3
	2003	158,2	4636,2	77400	358,8	3	0,000	0,6	0,000	358,9

	Year	Consumption, thousand tsf	Consumption TJ	CO ₂ emission factor (kg CO ₂ /TJ)	Emission CO ₂ (Gg CO ₂)	CH ₄ emission factor (kg CH ₄ /TJ)	Emission CH ₄ (Gg CH ₄)	N ₂ O emission factor (kg N ₂ O/ TJ)	Emission N ₂ O (Gg N ₂ O)	GHG emission: equiv. CO ₂ (Gg CO ₂)
	2004	53,8	1578,1	77400	122,1	3	0,000	0,6	0,000	122,2
	2005	38,4	1124,4	77400	87,0	3	0,000	0,6	0,000	87,0
	2006	123,7	3626,8	77400	280,7	3	0,000	0,6	0,000	280,7
	2007	68,4	2005,5	77400	155,2	3	0,000	0,6	0,000	155,2
	2008	40,9	1238,2	77400	95,8	3	0,000	0,6	0,000	95,9
Peat	2000	57,8	1694,0	106000	179,6	1	0,000	1,5	0,000	179,6
	2001	12,3	360,6	106000	38,2	1	0,000	1,5	0,000	38,2
	2002	40,8	1195,3	106000	126,7	1	0,000	1,5	0,000	126,7
	2003	31,1	910,4	106000	96,5	1	0,000	1,5	0,000	96,5
	2004	18,0	528,8	106000	56,1	1	0,000	1,5	0,000	56,1
	2005	15,7	459,6	106000	48,7	1	0,000	1,5	0,000	48,7
	2006	39,5	1157,4	106000	122,7	1	0,000	1,5	0,000	122,7
	2007	27,5	806,4	106000	85,5	1	0,000	1,5	0,000	85,5
	2008	28,8	842,8	106000	89,3	1	0,000	1,5	0,000	89,4
Wood	2000	0,0	0,0	112000	0,0	30	0,000	4	0,000	0,0
	2001	0,0	0,0	112000	0,0	30	0,000	4	0,000	0,0
	2002	14,8	434,9	112000	48,7	30	0,000	4	0,000	48,7
	2003	16,3	478,0	112000	53,5	30	0,000	4	0,000	53,6
	2004	13,2	385,8	112000	43,2	30	0,000	4	0,000	43,2
	2005	14,9	437,9	112000	49,0	30	0,000	4	0,000	49,1
	2006	16,2	475,8	112000	53,3	30	0,000	4	0,000	53,3
	2007	2,8	81,3	112000	9,1	30	0,000	4	0,000	9,1
	2008	0,0	0,0	112000	0,0	30	0,000	4	0,000	0,0
Other types of fuel	2000	24,4	714,6	112000	80,0	30	0,001	4	0,000	80,1
	2001	22,6	661,0	112000	74,0	30	0,001	4	0,000	74,1
	2002	9,2	268,6	112000	30,1	30	0,000	4	0,000	30,1
	2003	8,3	243,1	112000	27,2	30	0,000	4	0,000	27,2
	2004	7,6	223,0	112000	25,0	30	0,000	4	0,000	25,0
	2005	8,1	238,7	112000	26,7	30	0,000	4	0,000	26,7
	2006	8,5	250,5	112000	28,1	30	0,000	4	0,000	28,1
	2007	17,2	503,7	112000	56,4	30	0,001	4	0,000	56,5
	2008	25,2	737,4	112000	82,6	30	0,001	4	0,000	82,6
O t	2000	0,0	0,0	77400	0,0	3	0,000	0,6	0,000	0,0

	Year	Consumption, thousand tsf	Consumption TJ	CO ₂ emission factor (kg CO ₂ /TJ)	Emission CO ₂ (Gg CO ₂)	CH ₄ emission factor (kg CH ₄ /TJ)	Emission CH ₄ (Gg CH ₄)	N ₂ O emission factor (kg N ₂ O/ TJ)	Emission N ₂ O (Gg N ₂ O)	GHG emission: equiv. CO ₂ (Gg CO ₂)
	2001	0,0	0,0	77400	0,0	3	0,000	0,6	0,000	0,0
	2002	0,0	0,0	77400	0,0	3	0,000	0,6	0,000	0,0
	2003	0,0	0,0	77400	0,0	3	0,000	0,6	0,000	0,0
	2004	0,0	0,0	77400	0,0	3	0,000	0,6	0,000	0,0
	2005	0,0	0,0	77400	0,0	3	0,000	0,6	0,000	0,0
	2006	0,0	0,0	77400	0,0	3	0,000	0,6	0,000	0,0
	2007	0,0	0,0	77400	0,0	3	0,000	0,6	0,000	0,0
	2008	0,0	0,0	77400	0,0	3	0,000	0,6	0,000	0,0
Coke	2000	25,1	734,2		69,5		0,000		0,000	69,5
	2001	22,9	671,3		63,5		0,000		0,000	63,5
	2002	21,2	622,4		58,9		0,000		0,000	58,9
	2003	16,4	480,9		45,5		0,000		0,000	45,5
	2004	12,4	362,2		34,3		0,000		0,000	34,3
	2005	19,8	580,2		54,9		0,000		0,000	54,9
	2006	22,9	671,2		63,5		0,000		0,000	63,5
	2007	26,5	777,2		73,5		0,000		0,000	73,5
	2008	53,6	1571,4		148,7		0,000		0,000	148,7
Coal	2000	25,1	734,2	94600	69,5	1	0,000	1,5	0,000	69,5
	2001	22,9	671,3	94600	63,5	1	0,000	1,5	0,000	63,5
	2002	21,2	622,4	94600	58,9	1	0,000	1,5	0,000	58,9
	2003	16,4	480,9	94600	45,5	1	0,000	1,5	0,000	45,5
	2004	12,4	362,2	94600	34,3	1	0,000	1,5	0,000	34,3
	2005	19,8	580,2	94600	54,9	1	0,000	1,5	0,000	54,9
	2006	22,9	671,2	94600	63,5	1	0,000	1,5	0,000	63,5
	2007	26,5	777,2	94600	73,5	1	0,000	1,5	0,000	73,5
	2008	53,6	1571,4	94600	148,7	1	0,000	1,5	0,000	148,7
Charcoal	2000	0,0	0,0	96100	0,0	1	0,000	1,5	0,000	0,0
	2001	0,0	0,0	96100	0,0	1	0,000	1,5	0,000	0,0
	2002	0,0	0,0	96100	0,0	1	0,000	1,5	0,000	0,0
	2003	0,0	0,0	96100	0,0	1	0,000	1,5	0,000	0,0
	2004	0,0	0,0	96100	0,0	1	0,000	1,5	0,000	0,0
	2005	0,0	0,0	96100	0,0	1	0,000	1,5	0,000	0,0
	2006	0,0	0,0	96100	0,0	1	0,000	1,5	0,000	0,0

	Year	Consumption, thousand tsf	Consumption TJ	CO ₂ emission factor (kg CO ₂ /TJ)	Emission CO ₂ (Gg CO ₂)	CH ₄ emission factor (kg CH ₄ /TJ)	Emission CH ₄ (Gg CH ₄)	N ₂ O emission factor (kg N ₂ O/ TJ)	Emission N ₂ O (Gg N ₂ O)	GHG emission: equiv. CO ₂ (Gg CO ₂)
	2007	0,0	0,0	96100	0,0	1	0,000	1,5	0,000	0,0
	2008	0,0	0,0	96100	0,0	1	0,000	1,5	0,000	0,0
Natural gas	2000	3129,3	91717,7	56100	5145,4	1	0,003	0,1	0,000	5145,5
	2001	3172,2	92975,3	56100	5215,9	1	0,003	0,1	0,000	5216,1
	2002	3325,3	97462,2	56100	5467,6	1	0,003	0,1	0,000	5467,8
	2003	2805,9	82236,8	56100	4613,5	1	0,003	0,1	0,000	4613,6
	2004	2909,3	85269,7	56100	4783,6	1	0,003	0,1	0,000	4783,8
	2005	2981,3	87378,2	56100	4901,9	1	0,003	0,1	0,000	4902,1
	2006	3569,3	104613,5	56100	5868,8	1	0,004	0,1	0,000	5869,0
	2007	3592,2	105282,6	56100	5906,4	1	0,004	0,1	0,000	5906,5
	2008	3443,5	100924,6	56100	5661,9	1	0,003	0,1	0,000	5662,0

Source: CENEF estimate

3.4 Boilers

The vast number of the boilers precludes from supporting the inventory by individual boilers with the reasonable amount of effort and finance. Before 2007 statistical data made it possible to identify heat production and fuel consumption at industrial, regional, rural and electrical boilers. Form “11-TER” statistics does not allow breaking down the boilers into groups after 2007 since all boilers are grouped under one indicator.

Statistics imposes the division of boilers into three groups: big-scale boilers, small-scale boilers and electrical boilers. Consumption at big-scale boilers is defined on the basis of “11-TER” statistics form. According to instruction on its fill-out, it has to carry data about the consumption of only 23 types of fuel by the boilers over 20 Gcal/h capacity. But in reality this requirement is often violated and heat supplying companies also include in this form information about boilers of lesser capacity. In “11-TER” form fuel consumption by small-scale boilers is reflected in item “Municipal consumption”, but is not differentiated from the other types of “municipal consumption”, besides the heat generation by the small-scale boilers.

Consumption by small-scale boilers is evaluated according to the following procedure. The statistics does not compile the heat energy balance for the Russian Federation and Russian regions. That is why it was compiled as expert estimation the basis of a data base from different statistical forms. Statistics on production (with consideration of heat production at waste-heat utilization plant) and consumption of heat energy has limited accuracy. The first step is to minimize statistical discrepancy between heat balance debit and credit. For this purpose, the volumes of heat production at sources less than 3 Gcal/h capacity are defined on the basis of “1-TEP” form data. The second step is to define heat production at sources less than 20 Gcal/h capacity. The third step is to add these numbers into heat balance. The next step is to choose the option of heat production at small-scale boilers, which gives minimal statistical discrepancy in the heat balance. The volume of heat produced at small-scale boilers, defined in this way, is multiplied by the average specific fuel consumption to produce one Gcal, and then it is multiplied by the share of the boilers combusting this particular type of fuel.

This calculation has a few shortcomings: possible errors in determination of heat energy balance parameters and, therefore, determination of heat energy production at small-scale boilers; use of specific fuel consumption at all boilers for calculations at small-scale boilers, which operate on different types of fuel (and these can vary from the average valued at all boilers, but since natural gas dominates in the fuel balance of boilers, the error could be relatively insignificant); share of the boilers operating on a particular type of fuel, might not equal the share of the fuel in the fuel balance due to uneven distribution of the boilers by the capacity and the heat generation values on certain types of fuel.

Starting 2008, “1-TEP” form provides data about consumption of different types of fuel by all sources of heat supply. However, data on fuel consumption by all boilers in “1-TEP” form are lesser than data from “11-TER” form on fuel consumption by big-scale boilers only, while efficiency factor for heat energy production at boilers is higher than 100%. These data need to be ascertained.

3.4.1 Rostov region

GHG emission by Rostov region boilers was relatively stable in 2000-2008. The structure of GHG emissions was characterized by the increase of the share of emissions from boilers operating on natural gas and reduction of emissions from boilers operating on other types of fuel (see Fig. 3.7).

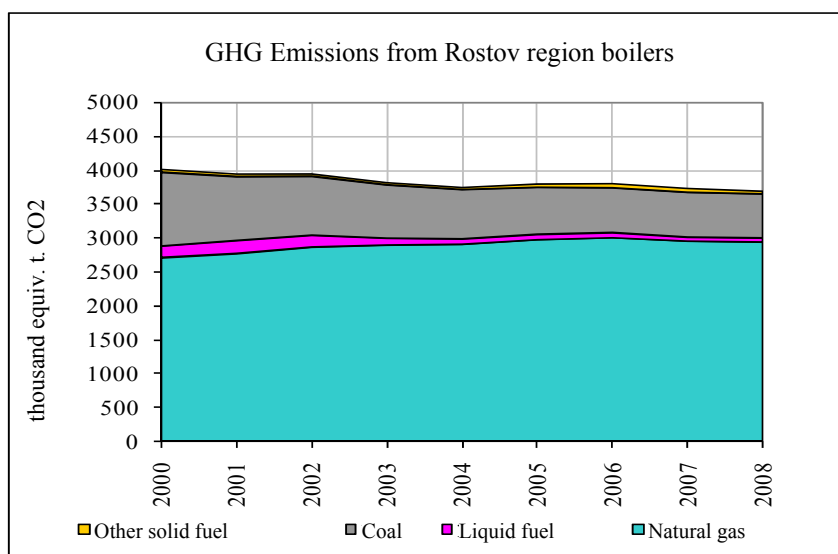


Fig. 3.7. GHG emissions from Rostov region boilers in 2000-2008.

The results of Rostov region boilers GHG emissions inventory compilation in 2000-2008 are given in Table 3.10.

Table 3.10. GHG emissions inventory from Rostov region boilers in 2000-2008 (thousand equiv. t. CO₂)

Types of fuel	Year	Consumption, thousand tsf	Consumption, TJ	Emission CO ₂ (Gg CO ₂)	Emission CH ₄ (Gg CH ₄)	Emission N ₂ O (Gg N ₂ O)	GHG Emission : equiv. CO ₂ (Gg CO ₂)
1	2	3	4	5	6	7	8
Boilers total	2000	2133,2	62520,6	4015,6	0,002	0,000	4015,7
	2001	2125,7	62301,8	3947,5	0,002	0,000	3947,6
	2002	2148,8	62977,7	3949,0	0,002	0,000	3949,1
	2003	2104,0	61665,5	3822,4	0,002	0,000	3822,5
	2004	2079,9	60958,3	3753,3	0,002	0,000	3753,4
	2005	2113,0	61929,5	3802,6	0,002	0,000	3802,7
	2006	2121,0	62164,4	3807,7	0,002	0,000	3807,8
	2007	2082,1	61025,6	3738,2	0,002	0,000	3738,3
	2008	2065,8	62610,9	3697,7	0,002	0,000	3697,8
Liquid fuel	2000	76,6	2246,2	169,9	0,000	0,000	169,9
	2001	86,1	2523,8	191,6	0,000	0,000	191,6
	2002	78,4	2299,2	175,2	0,000	0,000	175,2
	2003	44,1	1291,7	98,8	0,000	0,000	98,8
	2004	34,7	1017,8	77,8	0,000	0,000	77,8
	2005	34,4	1008,2	77,6	0,000	0,000	77,6
	2006	32,8	962,1	74,1	0,000	0,000	74,1
	2007	25,0	111,4	56,3	0,000	0,000	56,3
	2008	25,5	100,3	57,4	0,000	0,000	57,4
Natural gas	2000	1652,3	48428,4	2716,8	0,002	0,000	2716,9
	2001	1689,5	49517,3	2777,9	0,002	0,000	2778,0
	2002	1748,4	51242,6	2874,7	0,002	0,000	2874,8
	2003	1767,3	51796,4	2905,8	0,002	0,000	2905,9

Types of fuel	Year	Consumption, thousand tsf	Consumption, TJ	Emission CO ₂ (Gg CO ₂)	Emission CH ₄ (Gg CH ₄)	Emission N ₂ O (Gg N ₂ O)	GHG Emission : equiv. CO ₂ (Gg CO ₂)
	2004	1773,5	51981,0	2916,1	0,002	0,000	2916,2
	2005	1815,3	53205,6	2984,8	0,002	0,000	2984,9
	2006	1833,4	53735,0	3014,5	0,002	0,000	3014,6
	2007	1802,4	52825,5	2963,5	0,002	0,000	2963,6
	2008	1794,4	52591,5	2950,4	0,002	0,000	2950,5
Coal	2000	393,7	11537,7	1091,5			1091,5
	2001	340,7	9985,7	944,6			944,6
	2002	313,7	9193,3	869,7			869,7
	2003	284,4	8334,4	788,4			788,4
	2004	263,3	7716,6	730,0			730,0
	2005	250,2	7334,2	693,8			693,8
	2006	238,7	6997,2	661,9			661,9
	2007	239,5	7019,5	664,0			664,0
	2008	235,4	6900,6	652,8			652,8
Other solid fuel	2000	10,5	308,3	37,4			37,4
	2001	9,4	274,9	33,3			33,3
	2002	8,3	242,7	29,4			29,4
	2003	8,3	243,0	29,4			29,4
	2004	8,3	242,9	29,4			29,4
	2005	13,0	381,6	46,3			46,3
	2006	16,0	470,1	57,1			57,1
	2007	15,3	448,1	54,4			54,4
	2008	10,4	305,6	37,1			37,1

Source: CENEF estimate

3.4.2 Sverdlovsk region

GHG emission by Rostov region boilers was relatively stable in 2000-2008. The structure of GHG emissions was characterized by the increase of the share of emissions from boilers operating on natural gas and reduction of emissions from boilers operating on other types of fuel (see Fig. 3.8).

The results of Rostov region boilers GHG emissions inventory compilation in 2000-2008 are given in Table. 3.11.

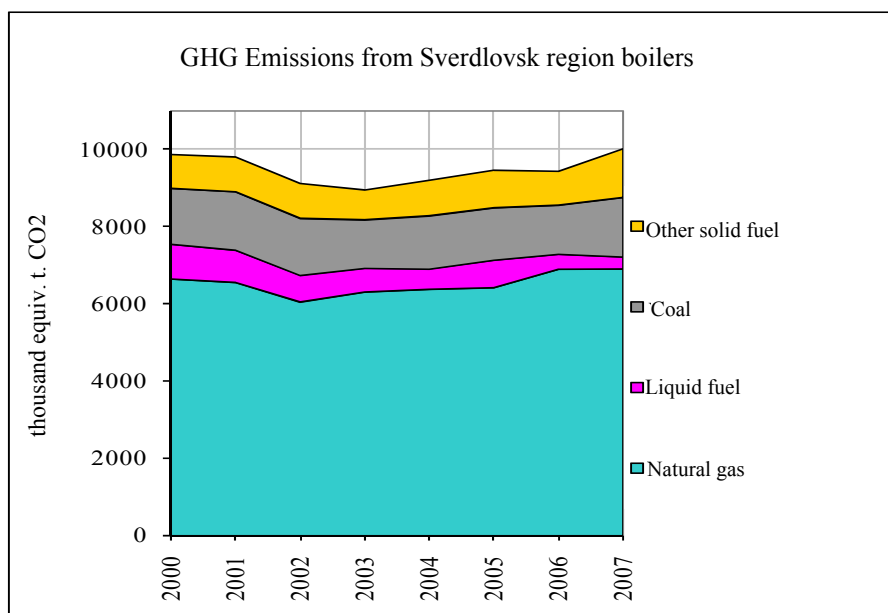


Fig. 3.8. GHG emissions from Sverdlovsk region boilers in 2000-2008.

Table 3.11. GHG emissions inventory from Sverdlovsk region boilers in 2000-2008. (thousand t. equiv. CO₂)

Types of fuel	Year	Consumption, thousand tsf	Consumption, TJ	Emission CO ₂ (Gg CO ₂)	Emission CH ₄ (Gg CH ₄)	Emission N ₂ O (Gg N ₂ O)	GHG Emission : equiv. CO ₂ (Gg CO ₂)
1	2	3	4	5	6	7	8
Boilers - total	2000	5299,3	155317,5	9389,5	0,009	0,002	9390,3
	2001	5213,0	152786,9	9318,7	0,009	0,002	9319,4
	2002	4757,3	139430,7	8521,4	0,008	0,002	8522,1
	2003	4814,6	141111,8	8565,2	0,008	0,002	8565,9
	2004	4805,5	140845,4	8539,5	0,007	0,002	8540,2
	2005	4936,4	144681,2	8872,7	0,009	0,002	8873,4
	2006	5042,9	147801,5	8946,2	0,008	0,002	8946,9
	2007	4970,5	145679,6	8988,0	0,007	0,002	8988,7
	2008	4380,0	128372,1	7756,1	0,006	0,001	7756,6
Liquid fuel	2000	401,7	11774,0	907,5	0,001	0,000	907,6
	2001	372,2	10910,0	845,5	0,001	0,000	845,6
	2002	313,4	9186,1	702,9	0,001	0,000	703,0
	2003	274,0	8030,4	625,5	0,001	0,000	625,5
	2004	235,6	6905,3	535,5	0,001	0,000	535,6
	2005	325,4	9537,6	721,3	0,001	0,000	721,4
	2006	177,9	5213,8	393,7	0,001	0,000	393,8
	2007	139,0	4073,0	318,7	0,000	0,000	318,7
	2008	127,4	3735,2	290,4	0,000	0,000	290,5
Natural gas	2000	4220,1	123686,9	6665,7	0,004	0,000	6665,9
	2001	4146,8	121539,4	6574,3	0,004	0,000	6574,5
	2002	3800,7	111395,7	6064,4	0,004	0,000	6064,6
	2003	3955,6	115934,9	6325,9	0,004	0,000	6326,1
	2004	3983,4	116750,7	6396,3	0,004	0,000	6396,5
	2005	4002,7	117315,0	6439,3	0,004	0,000	6439,5
	2006	4289,3	125716,6	6919,8	0,004	0,000	6920,0
	2007	4212,2	123456,6	6925,9	0,004	0,000	6926,1
	2008	3857,2	113049,8	6347,9	0,004	0,000	6348,1
Coal	2000	558,5	16370,0	1444,5	0,001	0,001	1444,7
	2001	569,2	16681,9	1509,1	0,001	0,001	1509,3
	2002	551,4	16160,6	1468,4	0,001	0,001	1468,6

Types of fuel	Year	Consumption, thousand tsf	Consumption, TJ	Emission CO ₂ (Gg CO ₂)	Emission CH ₄ (Gg CH ₄)	Emission N ₂ O (Gg N ₂ O)	GHG Emission : equiv. CO ₂ (Gg CO ₂)	
	2003	466,5	13671,3	1246,1	0,000	0,001	1246,4	
	2004	507,9	14887,3	1368,8	0,000	0,001	1369,1	
	2005	497,3	14574,5	1349,5	0,000	0,001	1349,7	
	2006	465,9	13656,4	1266,0	0,000	0,001	1266,3	
	2007	554,1	16241,3	1536,9	0,001	0,001	1537,2	
	2008	353,3	10354,7	979,7	0,000	0,001	979,9	
	Other solid fuel	2000	124,0	3634,6	889,2	0,000	0,000	889,3
		2001	132,4	3880,0	912,2	0,000	0,000	912,4
2002		96,3	2823,8	910,5	0,000	0,000	910,6	
2003		127,2	3728,9	778,0	0,000	0,000	778,1	
2004		83,2	2438,1	928,8	0,000	0,000	928,9	
2005		113,0	3311,4	982,7	0,000	0,000	982,9	
2006		111,0	3253,2	885,0	0,000	0,000	885,1	
2007		65,1	1908,8	1273,1	0,001	0,001	1273,3	
2008		43,3	1269,0	784,5	0,000	0,000	784,6	

Source: CENEF estimate

3.4.3 Tver region

The results of Tver region boilers GHG emissions inventory compilation in 2000-2008 are given in Table 3.12. GHG emissions from Tver region boilers after 2002 is decreasing in a stable way (see Fig. 3.9).

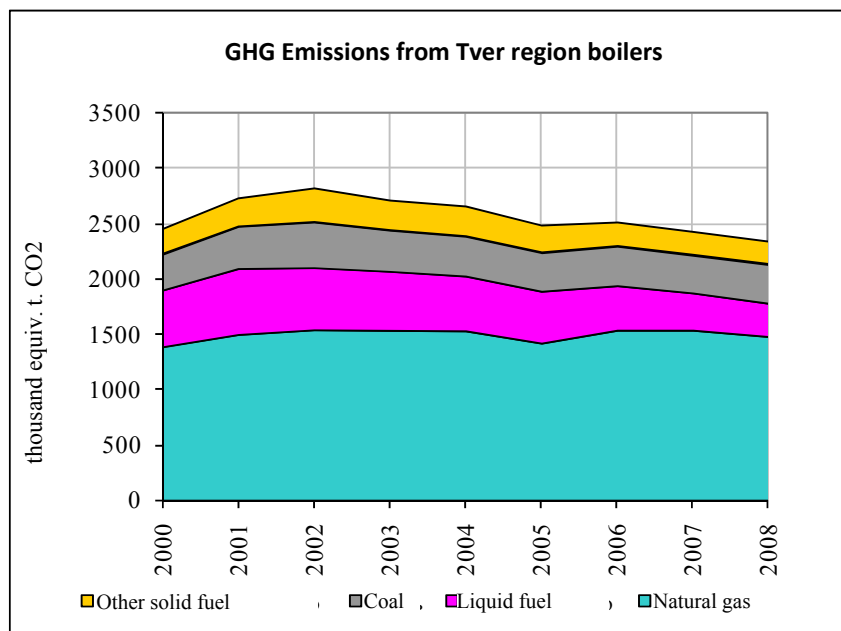


Fig. 3.9. GHG emissions from Tver region boilers in 2000-2008.

Table 3.92. GHG emissions inventory from Tver region boilers in 2000-2008. (thousand t. equiv. CO₂)

Types of fuel	Year	Consumption, (thousand tsf)	Consumption, TJ	Emission CO ₂ (Gg CO ₂)	Emission CH ₄ (Gg CH ₄)	Emission N ₂ O (Gg N ₂ O)	GHG Emission : equiv. CO ₂ (Gg CO ₂)
Boilers -total	2000	1432,6	41988,1	2401,0	0,002	0,001	2401,2
	2001	1580,7	46330,1	2614,3	0,003	0,001	2614,5
	2002	1601,1	46927,7	2713,2	0,003	0,001	2713,4
	2003	1553,2	45524,0	2672,1	0,003	0,001	2672,3
	2004	1523,8	44662,2	2517,2	0,003	0,001	2517,4
	2005	1418,4	41572,6	2372,8	0,002	0,001	2373,0
	2006	1409,0	41295,9	2485,6	0,002	0,001	2485,8
	2007	1358,5	39817,5	2394,9	0,002	0,001	2395,1
	2008	1289,0	39068,6	2185,0	0,001	0,000	2185,1
Liquid fuel	2000	225,1	6596,0	509,0	0,001	0,000	509,0
	2001	262,7	7699,0	593,4	0,001	0,000	593,5
	2002	248,2	7274,6	559,5	0,001	0,000	559,6
	2003	235,4	6899,2	531,1	0,001	0,000	531,2
	2004	218,1	6392,7	492,3	0,001	0,000	492,3
	2005	206,1	6039,1	465,2	0,001	0,000	465,2
	2006	177,0	5187,4	399,2	0,001	0,000	399,3
	2007	147,7	4327,8	333,5	0,000	0,000	333,5
	2008	131,6	3857,9	297,4	0,000	0,000	297,4
Natural gas	2000	848,2	24860,4	1394,7	0,001	0,000	1394,7
	2001	915,5	26832,2	1505,3	0,001	0,000	1505,3
	2002	941,1	27581,4	1547,3	0,001	0,000	1547,4
	2003	938,0	27492,9	1542,4	0,001	0,000	1542,4
	2004	935,4	27415,0	1538,0	0,001	0,000	1538,0
	2005	868,4	25450,9	1427,8	0,001	0,000	1427,8
	2006	939,1	27523,1	1544,0	0,001	0,000	1544,1
	2007	939,0	27520,0	1543,9	0,001	0,000	1543,9
	2008	904,0	26495,9	1486,4	0,001	0,000	1486,5
Coal	2000	274,7	8051,1	325,7			325,7
	2001	305,2	8944,8	382,6			382,6
	2002	294,3	8627,0	414,7			414,7
	2003	276,3	8097,8	373,1			373,1
	2004	267,3	7833,1	361,6			361,6
	2005	251,1	7359,0	349,9			349,9
	2006	211,3	6192,9	357,9			357,9
	2007	193,1	5659,4	342,4			342,4
	2008	176,7	5178,0	351,4			351,4
Other solid fuel	2000	84,6	2480,6	229,0			229,0
	2001	97,4	2854,2	258,7			258,7
	2002	117,5	3444,7	309,5			309,5
	2003	103,5	3034,0	272,2			272,2
	2004	103,1	3021,3	272,8			272,8
	2005	92,9	2723,5	246,1			246,1
	2006	81,6	2392,5	216,2			216,2
	2007	78,8	2310,4	211,0			211,0
	2008	76,7	2247,9	205,3			205,3

Source: CENEF estimate

3.5 Fuel conversion

Within energy industries, IPCC methodology also analyzes technological processes related to fuel conversion. “11-TER” form is the source of information about fuel combustion in oil, gas and coal processing. In regions under investigation fuel conversion is present only in Rostov region (coal processing and concentration). However, “11-TER” form does not provide data about fuel combustion in technological processes for coal processing and concentration. The form gives information about electrical and heat energy consumption only.

3.6 Completeness

There is a comprehensive data available to estimate the fuel combustion emission from the energy industry units. The statistics leaves no grounds to look for any gaps. This has been achieved with the follow-up fuel consumption assessment at the small-scale boilers. The statistics used in calculation deals with the combusted fuel only, not with the fuel purchase (in this case, an adjustment to the fuel stock delta is required).

When doing the estimates, it is important to take into consideration not only GHG emission from general purpose power stations, but also from industrial power stations and diesel power stations operating within decentralized systems of power supply.

Estimate of emissions from power stations was performed on the basis of the data from two forms of statistical reporting, “11-TER” and “6-TP”. Only the latter form allows estimating emissions by each station. But it includes data about heat energy delivery not only from power stations but from peak boilers as well. In “11-TER” form the fuel consumed by peak boilers is shown as consumed by boilers. To avoid double counting the following procedure was applied: whereon power stations had peak boilers, heat energy delivered by them has been multiplied by the average fuel consumption for heat production, intrinsic for this station over the year. After that the type of fuel for peak boiler was defined and deducted from the volume of fuel used at each station for heat production.

3.7 Uncertainty assessment

The data from two forms of statistics reporting for fuel consumption by power stations, “11-TER” and “6-TP”, can give mismatching results both for the volumes of electric energy and heat production and volumes of consumed fuel.

The comparison of emissions estimates on the basis of these two sources of statistical information makes it possible to define the uncertainty level of estimates for emissions from power stations (see Table 3.13).

The IPCC suggest an overall uncertainty value of 7% for the CO₂ emission factors of Energy section. For fossil fuel combustion, uncertainties in CO₂ emission factors are relatively low. These emission factors are determined by the carbon content of the fuel. However, there can be intrinsic differences in the uncertainties of CO₂ emission factors of coal. Coal can have a wide range of carbon contents and calorific values and is mostly supplied under contract to users who adapt their equipment to match the characteristics of the particular coal.

Mean root square errors of emission estimates from power stations equaled 2, 9% for Rostov region, 3, 4% for Sverdlovsk region and 4, 1% for Tver region, which

corresponds to acceptable uncertainty limits by IPCC. For Rostov region the uncertainty level exceeds 7% limit in 2001 only, while in 2007-2008 the deltas are lower than 1%. Sverdlovsk region the deltas throughout 2000-2007 period did not exceed 3% and only in 2008 they reached 8%. The reason for that are considerable differences in fuel consumption data in “11-TER” form and “6-TP” form. In Tver region maximum delta did not exceed 5%.

Relatively low accuracy of statistics about fuel consumption at power stations and boilers creates uncertainty of emission estimates.

Table 3.103. Uncertainty assessment of GHG emissions estimates from Rostov region power stations, depending the source of statistical data

Rostov region						
	Consumption			GHG emission (Gg CO ₂)		
	11-TER (thousand tons of standard fuel)	6-TP (thousand tons of standard fuel)	Uncertainty assessment (%)	11-TER (thousand t. equiv. CO ₂)	6-TP (thousand t. equiv. CO ₂)	Uncertainty assessment (%)
2000	4090,9	4108,2	0,42%	9404,0	9434,0	0,32%
2001	4233,9	3885,7	-8,22%	9280,8	8617,8	-7,14%
2002	4112,7	4013,7	-2,41%	8786,5	8595,9	-2,17%
2003	3952,5	4033,5	2,05%	8359,1	8572,8	2,56%
2004	3949,3	3971,6	0,57%	8217,2	8254,6	0,46%
2005	4036,7	4131,4	2,35%	8500,0	8713,3	2,51%
2006	4442,4	4505,5	1,42%	9762,9	9962,7	2,05%
2007	4356,1	4383,8	0,64%	9508,4	9554,2	0,48%
2008	4986,7	5016,3	0,59%	10714,3	10778,1	0,59%

Source: CENEF estimate

Table 3.114. Uncertainty assessment of GHG emissions estimates from Sverdlovsk region power stations, depending the source of statistical data

Sverdlovsk region						
	Consumption			GHG emission (Gg CO ₂)		
	11-TER (thousand tsf)	6-TP (thousand tsf)	Uncertainty assessment (%)	11-TER (thousand t. equiv. CO ₂)	6-TP (thousand t. equiv. CO ₂)	Uncertainty assessment (%)
2000	18865,8	19418,1	2,84	42556,5	43833,4	2,91
2001	18488,8	19089,4	3,15	41393,6	42160,7	1,82
2002	18575,0	18736,7	0,86	39308,4	39392,1	0,21
2003	19253,2	19470,9	1,12	41384,8	41505,3	0,29
2004	19084,4	19840,1	3,81	40210,7	41247,4	2,51
2005	19236,8	19917,9	3,42	40169,8	41102,1	2,27
2006	20524,2	21245,3	3,39	43125,6	44087,4	2,18
2007	19825,4	20473,7	3,17	40737,6	41509,8	1,86
2008	21699,3	19069,6	-13,79	45914,3	42339,9	-8,44

Source: CENEF estimate

Table 3.125. Uncertainty assessment of GHG emissions estimates from Tver region power stations, depending the source of statistical data

Tver region						
Consumption			GHG emission (Gg CO ₂)			
11-TER (thousand tons of standard fuel)	6-TP (thousand tons of standard fuel)	Uncertainty assessment (%)	11-TER (thousand t. equiv. CO ₂)	6-TP (thousand t. equiv. CO ₂)	Uncertainty assessment (%)	
2000	3307,2	3412,3	3,18%	5674,4	5857,1	3,22%
2001	3271,0	3270,9	0,00%	5494,2	5484,8	-0,17%
2002	3381,8	3525,7	4,26%	5727,0	5991,6	4,62%
2003	2897,4	3036,1	4,79%	4959,3	5195,3	4,76%
2004	2897,1	3014,6	4,06%	4832,0	5064,5	4,81%
2005	2961,3	3078,2	3,95%	4958,2	5168,5	4,24%
2006	3635,9	3780,2	3,97%	6182,3	6417,3	3,80%
2007	3601,2	3734,6	3,70%	6032,5	6286,4	4,21%
2008	3468,5	3591,9	3,56%	5792,6	6078,6	4,94%

Source: CENEF estimate

Emission factors for CH₄ and especially N₂O are highly uncertain. High uncertainties in emission factors may be ascribed to lack of relevant measurements and subsequent generalizations, uncertainties in measurements. Furthermore, due to stochastic variations in process conditions, a high variability of the real time emission factors for these gases might also occur. Such variability obviously will also contribute to the uncertainty in the emission estimates. However, the share of CH₄ and N₂O in the energy industries is less than 0.001% that is why even n-fold errors can not affect the result in a significant way.

4 Manufacturing industries and construction

4.1 Main results

4.1.1 Rostov region

The inventory of GHG emissions from Rostov region manufacturing industries and construction in 2000-2008 is given in Table 4.1. Available statistics data on activities generating fuel combustion allows estimating the contribution of a very limited number of types of activity into total emission in industry.

Table 4.1. GHG emissions inventory from Rostov region manufacturing industries and construction in 2000-2008

Year	Consumption (thousand tons of stand. fuel)	Consumption (TJ)	Emission on CO ₂ (Gg CO ₂)	Emission on CH ₄ (Gg CH ₄)	Emission on N ₂ O (Gg CH ₄)	Emission on GHG (Gg equiv. CO ₂)	Including steel pipes (Gg equiv. CO ₂)	Cotton fabric (Gg equiv. CO ₂)	Bread and bakery products (Gg equiv. CO ₂)
2000	1114,9	32677,5	1713,8	0,002	0,000	1714,0	151,1	6,0	47,2
2001	1141,0	33441,3	1833,7	0,003	0,000	1833,9	165,3	10,6	48,3
2002	1208,6	35422,9	1979,5	0,002	0,000	1979,7	139,2	15,3	44,9
2003	1402,5	41105,2	2392,4	0,004	0,001	2392,7	186,6	14,4	43,4
2004	1158,2	33944,4	1915,2	0,003	0,000	1915,4	198,9	10,0	39,8
2005	1134,9	33263,2	1814,3	0,003	0,000	1814,5	201,6	10,8	35,7
2006	1183,0	34673,4	1915,8	0,003	0,000	1916,0	215,8	13,5	34,4
2007	1180,3	34594,8	1907,5	0,003	0,000	1907,7	212,0	10,3	35,0
2008	1166,9	34200,4	1899,0	0,003	0,000	1899,2	190,8	9,6	26,3

Source: CENEF estimate

The tendency of emission growth which followed the growth of energy consumption in industry in 2000-2003, was replaced by the tendency to its decrease (see Fig. 4.1). As a result, in 2000-2008 emission in industry increased by 11% only while the growth of industrial output constituted 2.4 times.

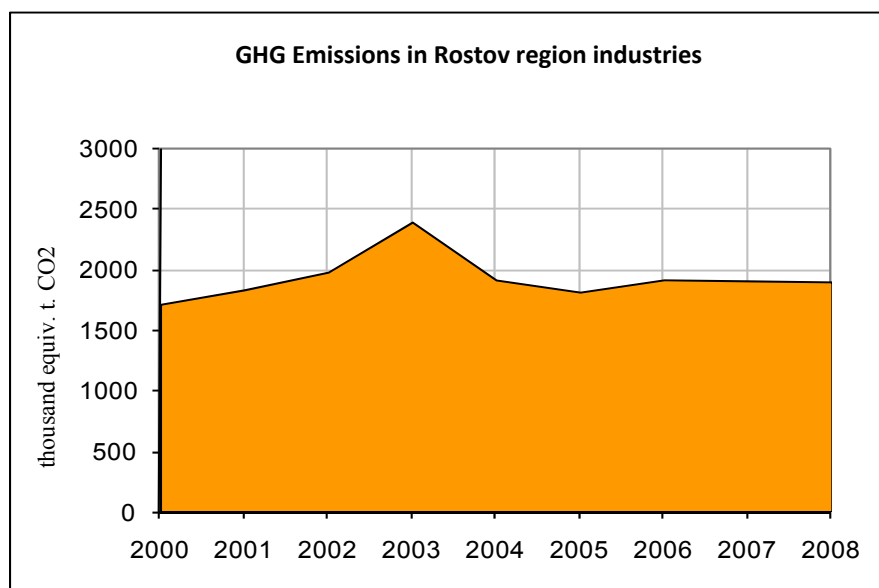


Fig. 4.1. GHG emissions in Rostov region manufacturing industries and construction in 2000-2008.

4.1.2 Sverdlovsk region

The inventory of GHG emissions from Rostov region manufacturing industries and construction in 2000-2008 is given in Table 4.2 and at Fig. 4.2. Overall emission growth in this sector in 2000-2008 was 94%, while the growth of industrial output was 73%. That means that carbon intensity of the industry over these years increased due to considerable growth of coal and coke usage (1.6 times) in ferrous industry. This growth was the biggest in 2000-2004. GHG stabilization followed the stabilization of coal consumption in industry. The level of GHG emissions in 2008 was practically at the level of 2004.

Table 4.2. GHG emissions inventory from Sverdlovsk region manufacturing industries and construction in 2000-2008

Year	Consumption (thousand tsf)	Consumption (TJ)	Emission CO2 (Gg CO2)	Emission CH4 (Gg CH4)	Emission N2O (Gg CH4)	Emission GHG: equiv. CO2 (Gg CO2)
2000	9570,4	280500,0	14701,0	0,024	0,003	14702,49
2001	9523,8	279132,5	20893,5	0,026	0,004	20895,10
2002	9095,1	266568,7	19841,2	0,021	0,003	19842,54
2003	11272,2	330377,3	26108,8	0,045	0,006	26111,68
2004	12233,8	358559,3	28527,7	0,051	0,007	28531,08
2005	11151,0	326824,4	26435,6	0,045	0,007	26438,63
2006	11610,6	340295,1	26965,8	0,047	0,007	26968,89
2007	12008,8	351967,1	28641,6	0,053	0,008	28645,09
2008	12150,6	356122,0	28532,5	0,052	0,007	28535,86

Source: CENEF estimate

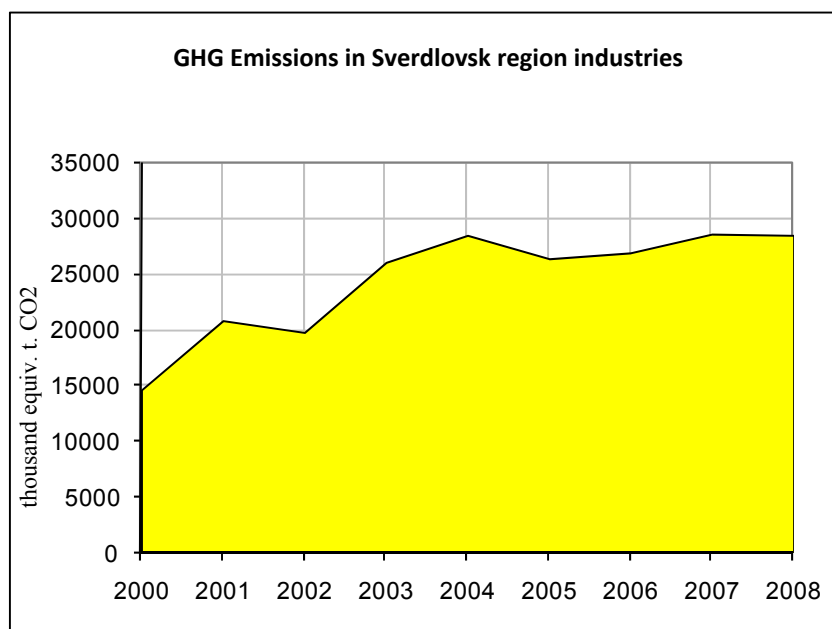


Fig. 4.2. GHG emissions in Sverdlovsk region manufacturing industries and construction in 2000-2008.

Almost half of GHG industrial emissions are attributed to production of iron. The oscillations in iron production in the last three years defined GHG emissions dynamics in industry in general (see Fig. 4.2). Ferrous metals roll products, sinter, cement, steel pipe production and other are considerably lagging behind. Evidently, reduction of GHG emissions growth in industry in 2008 already reflected the fall that started in ferrous industry at the end of the year.

Table 4.3. Contribution of certain industrial productions into GHG emissions inventory from Sverdlovsk region industry and construction in 2000-2008 (thousand tons equiv. CO₂)

Year	Iron ore and manganese ore sinter	Iron ore pellets	Iron	Coke	Open-hearth furnace steel	Oxygen-blown converter steel	Electric furnace steel	Steel pipes	Ferrous metals roll products	Cement and clinker	Electric ferro-alloys	Other industry
2000	893,8	238,2	8252,1	446,6	761,9	151,8	4,2	476,7	1155,5	647,2	261,3	1413,1
2001	853,7	235,2	8606,4	409,8	747,5	128,1	0,9	455,3	1160,5	657,5	239,6	7400,4
2002	862,4	244,0	8562,1	398,7	753,1	121,7	0,9	459,4	1071,1	677,4	234,2	6457,5
2003	895,2	246,7	8673,2	418,0	808,7	120,8	1,0	508,8	1059,9	697,3	276,3	12405,7
2004	973,1	255,8	8900,7	446,8	897,7	91,2	1,0	490,1	1041,5	737,9	300,4	14395,0
2005	1014,7	231,5	9108,5	401,8	832,7	80,0	17,9	512,0	963,0	826,3	289,5	12160,6
2006	890,1	240,9	8798,2	384,9	641,6	64,4	25,2	531,7	925,6	854,1	266,3	13345,9
2007	923,7	243,6	9288,6	414,8	557,8	57,4	70,2	574,2	971,0	863,6	331,8	14348,3
2008	878,1	210,4	8360,4	404,1	481,0	57,1	78,8	514,0	886,3	763,8	287,8	15613,9

Source: CENEF estimate

4.1.3 Tver region

The inventory of GHG emissions from Rostov region manufacturing industries and construction in 2000-2008 is given in Table 4.4. As in the case of Rostov region, available statistics data on activities generating fuel combustion allows estimating the contribution of a very limited number of types of activity into total emission in industry.

However, this contribution turned out to be extremely insignificant. For example, in 2008 emissions from meat and meat products production equaled only 6 thousand tons equivalent CO₂.

In general, the contribution of manufacturing industries and construction into total GHG emission in 2008 in Tver region constituted only 3, 6%. In 2000-2008 GHG emissions in this sector decreased by 28% (see Fig. 4.3) while the industrial growth index grew by 52%. That means that in this sector there were alternate trends for industry and emissions.

Table 4.4. GHG emissions inventory from Tver region manufacturing industries and construction in 2000-2008

Year	Consumption (thousand tons of standard fuel)	Consumption (TJ)	Emission CO ₂ (Gg CO ₂)	Emission CH ₄ (Gg CH ₄)	Emission N ₂ O (Gg CH ₄)	Emission GHG: equiv. CO ₂ (Gg CO ₂)
2000	313,7	8544,1	620,2	0,002	0,000	620,3
2001	269,2	7363,8	524,2	0,001	0,000	524,3
2002	228,7	5842,1	446,2	0,001	0,000	446,3
2003	225,3	6081,6	434,2	0,001	0,000	434,2
2004	205,2	5347,3	401,9	0,001	0,000	402,0
2005	208,9	5472,0	419,1	0,001	0,000	419,2
2006	248,0	6461,3	489,0	0,001	0,000	489,1
2007	244,3	6431,2	480,9	0,001	0,000	481,0
2008	227,4	5896,0	450,7	0,001	0,000	450,8

Source: CENEF estimate

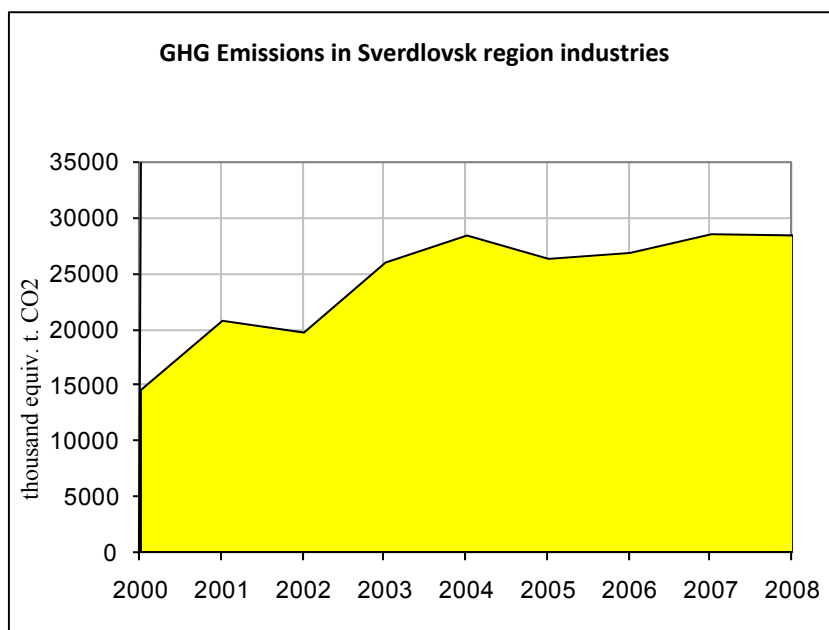


Fig. 4.3. GHG emissions in Tver region manufacturing industries and construction in 2000-2008.

4.2 Inventory compilation methodology

The inventory of greenhouse gas emissions produced by the fuel combustion at the manufacturing industries and construction (Section 1.A.2 in IPCC classification) in Moscow has been compiled in line with the provisions in Chapter 1 of “Introduction” and Chapter 2 of “Stationary combustion”, Volume 2 “Energy” of Guidelines for National Greenhouse Gas Inventories” (IPCC, 2006).

Types of activities, emissions from which are reviewed in this section, are given in Table 4.5.

Table 4.5. Types of activities in “Manufacturing Industries” and “Construction” sectors

Code number and name		Definitions
1 A 2	<i>Manufacturing Industries and Construction</i>	Emissions from combustion of fuels in industry. Also includes combustion for the generation of electricity and heat for own use in these industries. Emissions from fuel combustion in coke ovens within the iron and steel industry should be reported under 1 A 1 c and not within manufacturing industry. Emissions from the industry sector should be specified by sub-categories that correspond to the International Standard Industrial Classification of all Economic Activities (ISIC). Energy used for transport by industry should not be reported here but under Transport (1 A 3). Emissions arising from off-road and other mobile machinery in industry should, if possible, be broken out as a separate subcategory. For each country, the emissions from the largest fuel-consuming industrial categories ISIC should be reported, as well as those from significant emitters of pollutants. A suggested list of categories is outlined below.
1 A 2	a	Iron and Steel ISIC Group 271 and Class 2731
1 A 2	b	Non-Ferrous Metals ISIC Group 272 and Class 2732
1 A 2	c	Chemicals ISIC Division 24
1 A 2	d	Pulp, Paper and Print ISIC Divisions 21 and 22
1 A 2	e	Food Processing, Beverages and Tobacco ISIC Divisions 15 and 16
1 A 2	f	Non-Metallic Minerals Includes products such as glass, ceramic, cement, etc.; ISIC Division 26
1 A 2	g	Transport Equipment ISIC Divisions 34 and 35
1 A 2	h	Machinery Includes fabricated metal products, machinery and equipment other than transport equipment; ISIC Divisions 28, 29, 30, 31 and 32.
1 A 2	i	Minerals industry (but for fuel) ISIC Divisions 13 and 14
1 A 2	j	Wood and wood products ISIC Division 20
1 A 2	k	Construction ISIC Division 45
1 A 2	l	Textile and leather ISIC Divisions 17, 18 and 19
1 A 2	m	Other industries Any other industries/types of construction not included into above mentioned categories or for which there is no individual data. Includes ISIC Divisions 25, 33, 36 and 37.

Source: Table 2.1 Chapter 2 «“Stationary Combustion” vol. 2 “Energy” “Guidelines for National Greenhouse Inventories”.

Fuel consumption statistics in Rostov region (form “11-TER”) enables to identify the following groups of products: electrical furnace steel, steel pipes, bread and bakery products, chemical fibre and threads, cotton cloths, meat (including first category by-products) and other industrial consumption. Since industry and construction produce a relatively small amount of emissions from fuel combustion, it is not practical to estimate emission by specific types of production.

Fuel consumption statistics in Sverdlovsk region (form “11-TER”) enables to identify the following groups of products: merchantable iron ore (beneficiation and production of ore concentrate), iron ore and manganese ore sinter, iron ore pellets, iron, coke 6% humidity, open-hearth steel, oxygen convertor steel, electrical furnace steel, steel pipes, electrical Ferro-alloys, cement and clinker and other production consumption. Unlike two other regions, for Sverdlovsk region the contribution of 9 industrial products, represented in Table 4.3, into total GHG emissions from industry made 73%. That is why it is logic to estimate emission by specific types of production (see Table 4.3).

Fuel consumption statistics in Tver region (form “11-TER”) enables to identify the following groups of products: peat cutting, chemical fiber and threads, logging and primary processing, lumber drying, paper, cardboard, cotton, woolen and silk cloths, leather shoes, meat (including first category by-products), bread and bakery products . However, GHG emissions from these industries are so little compared to total industrial emissions that a more detailed estimate is not worth it.

Part of fuel used in manufacturing industries and construction is not combusted but rather used as raw material and for other non-energy purposes and do not produce GHG emissions. That is why the Regional GHG emission inventory identifies this amount of fuel consumption as a separate item.

In general, emissions of each greenhouse gas from stationary sources are calculated by multiplying fuel consumption by the corresponding emission factor. In the Sectoral Approach, “Fuel Consumption” is estimated from energy use statistics and is measured in terajoules. Fuel consumption data in mass or volume units are converted into the equivalent fuel units representing the energy content of these fuels (tonnes of specific fuel (tsf)), to be then converted into the terajoules.

Tier 1 approach is applied for “Manufacturing industries and construction”, which means the calculation of CO2 emissions applies CO2, CH4 and N2O emission factors, defined by IPCC. The latter for the Manufacturing industries and construction are the same as for the other Energy industries (See Table. 4.6).

Tier 1 approach calculates the Emissions by multiplying fuel consumption by the corresponding IPCC emission factors (See Table 4.6). The approach is represented in the Equation 3.1:

$$Emissions_{CO_2} = \sum_a Fuel_{uso_a} * EF_a \quad (3.1)$$

Where: Emissions = Emissions;

Fuel_a = fuel consumption;

EF_a = emission factor. Represents the carbon content of the fuel multiplied by 44/12.

a = type of fuel (for example, gasoline, diesel fuel, natural gas, liquefied gas, etc.).

Emissions of CO2 from biomass fuels are estimated and reported in the AFOLU sector as part of the AFOLU methodology. In the reporting tables, emissions from combustion of biofuels are reported as information items but not included in the sectoral or national totals to avoid double counting. In the emission factor tables presented in this Chapter, default CO2 emission factors are presented to enable the user to estimate these information items. For biomass, only that part of the biomass that is combusted for energy purposes should be estimated for inclusion as an information item in the Energy sector. The emissions of CH4 and N2O, however,

are estimated and included in the sector and national totals because their effect is in addition to the stock changes estimated in the AFOLU sector.

4.3 Emission estimate

“11-TER” form is the main source to provide information about fuel consumption in the industry. It carries detailed data about consumption of various types of fuel in the industry. Usage of emission factors from Table 2.6 allows emission estimating from combustion of each type of fuel. Usage of fuel by off-road transport (includes industrial self-propelled units like tractors and bulldozers, self-propelled cranes, excavators, loaders) refers to “off-road transport” and is accounted for in “Transport” sector (1 A 3). Combustion of fuel by diesel locomotives also refers to “railroad transport” under “Transport” category. Combustion of fuel by industrial boilers refers to “Energy industries” sector.

In “11-TER” form there is “Other petroleum products industrial combustion” parameter, which is not interpreted. When estimating emissions the assumption is that all this fuel is used in manufacturing industries and construction. It is fully combusted and by emission parameters corresponds to diesel fuel.

4.4 Completeness

Inventory provides a fairly complete representation of the fuel combustion at the industrial units.

Fuel consumption by industrial power stations is accounted for in corresponding sections for power stations and boilers. Fuel consumption by industrial off-road transport (bulldozers, cargo handling equipment, hoisting cranes, excavators, intra-industrial railroad transport, intra-industrial water transport, etc.) is reflected in “Transport” section under “railroad transport”, “water transport”, “off-road transport” items. Fuel consumption by commercial cars is reflected in “road transport” item. Therefore, the figures for industry mostly reflect the volumes of fuel consumption by stationary units for technological needs of large and medium enterprises.

There may be, however, certain error due to the fact that only large or medium size organization have to report many statistical forms. However, the share of the small-scale businesses in the three regions is very limited. Fuel consumption by small-scale enterprises is mostly referred to “Other sectors” (see below).

4.5 Uncertainty assessment

In Rostov region the share of industry and construction in collective emission from fuel combustion equals 5, 6%. That is why an essential error in the range $\pm 10\%$ in emission estimate for industry results in the error of not more than 0,6% in total emission estimate.

In Sverdlovsk region the share of industry in collective emission from fuel combustion equals 30, 2%. That is why errors in emission estimate in industry have greater value. However, since large and medium enterprises dominate in industry, the range of error in fuel consumption estimate, evidently, does not exceed $\pm 5\%$. This can result in an error of 1, 5% in total emission estimate.

In Tver region the share of industry in collective emission from fuel combustion equals 3,6% only. That is why an error in the range $\pm 10\%$ in emission estimate for industry results in the error of not more than 0,4% in total emission estimate.

In manufacturing industries, besides accuracy in fuel consumption reflection by small-scale enterprises, there are several more factors, which determine uncertainty of received values: low level of accuracy of data about fuel consumption (not all small-scale industrial gas consumers have measuring instruments) and uncertainty of emission factors.

5 Other sectors

5.1 Main results

5.1.1 Rostov region

In “Other sectors” section the following GHG emission sources have been identified: services, communal sector, residential sector and agriculture.

GHG emission estimates for Rostov region “other sectors” in 2000-2008 are given in Table 5.1. “Other sectors” contributed 19, 0% of GHG emission from fuel combustion in 2008. In spite of the residential buildings’ area growth by 10% and production index in the services growth by 53%, GHG emissions in “other sectors” in 2000-2008 increased only by 4,3% (see Fig. 5.1). Oscillations of GHG emissions in residential sector and services sector greatly depend on weather conditions (number of degree-days of cold season).

Table 5.1. GHG emissions inventory from Rostov region “other sectors” in 2000-2008

Types of fuel	Year	Consumption (thousand tsf)	Consumption (TJ)	Emission CO ₂ (Gg CO ₂)	Emission CH ₄ (Gg CH ₄)	Emission N ₂ O (Gg N ₂ O)	Emission GHG: equiv. CO ₂ (Gg CO ₂)
1	2	3	4	5	6	7	8
Other sectors - total	2000	3618,2	106045,6	6210,6	0,028	0,002	6211,9
	2001	3631,0	106421,4	6260,5	0,027	0,002	6261,8
	2002	3591,4	105259,9	6127,1	0,026	0,002	6128,3
	2003	3894,7	114148,7	6428,2	0,028	0,002	6429,5
	2004	3612,0	105864,9	5997,8	0,024	0,002	5998,9
	2005	3897,2	114224,3	6398,6	0,029	0,002	6400,0
	2006	3909,3	114579,1	6405,0	0,028	0,002	6406,3
	2007	3794,6	111214,9	6174,1	0,028	0,002	6175,4
	2008	4018,8	117787,7	6481,0	0,029	0,002	6482,3
Communal sector	2000	0,0	0,0	0,0	0,000	0,000	0,00
	2001	0,0	0,0	0,0	0,000	0,000	0,0
	2002	0,0	0,0	0,0	0,000	0,000	0,0
	2003	0,0	0,0	0,0	0,000	0,000	0,0
	2004	0,0	0,0	0,0	0,000	0,000	0,0
	2005	0,0	0,0	0,0	0,000	0,000	0,0
	2006	0,0	0,0	0,0	0,000	0,000	0,0
	2007	6,0	175,9	9,6	0,000	0,000	9,6
	2008	5,5	162,6	8,9	0,000	0,000	8,9
Services sector	2000	434,1	12722,8	1173,8	0,012	0,002	1174,5
	2001	383,8	11248,1	1038,5	0,010	0,001	1039,1
	2002	341,2	10000,3	921,4	0,009	0,001	922,0
	2003	416,6	12210,9	1126,2	0,011	0,001	1126,9
	2004	335,6	9835,6	909,0	0,009	0,001	909,5
	2005	461,5	13527,4	1246,7	0,013	0,002	1247,5
	2006	429,5	12588,4	1161,6	0,011	0,002	1162,4
	2007	456,3	13372,6	1233,4	0,013	0,002	1234,2
	2008	469,1	13747,8	1267,3	0,013	0,002	1268,2
Residential buildings	2000	2747,2	80518,8	5019,3	0,016	0,001	5019,9
	2001	2859,8	83818,9	5207,5	0,017	0,001	5208,2
	2002	2904,6	85131,5	5189,0	0,016	0,001	5189,6
	2003	3057,0	89597,5	5284,5	0,017	0,001	5285,0

Types of fuel	Year	Consumption (thousand tsf)	Consumption (TJ)	Emission CO ₂ (Gg CO ₂)	Emission CH ₄ (Gg CH ₄)	Emission N ₂ O (Gg N ₂ O)	Emission GHG: equiv. CO ₂ (Gg CO ₂)
	2004	2936,2	86057,9	5074,4	0,016	0,001	5074,9
	2005	2969,8	87040,4	5141,6	0,016	0,001	5142,2
	2006	3046,3	89284,3	5235,7	0,016	0,001	5236,3
	2007	2871,9	84173,6	4923,4	0,015	0,001	4923,8
	2008	3070,7	89998,6	5198,6	0,016	0,000	5199,1
Agriculture	2000	1,4	40,6	3,1	0,000	0,000	3,1
	2001	1,8	53,2	3,8	0,000	0,000	3,8
	2002	2,2	63,9	4,5	0,000	0,000	4,5
	2003	2,2	64,6	4,5	0,000	0,000	4,5
	2004	2,3	67,9	4,6	0,000	0,000	4,6
	2005	2,2	64,6	4,1	0,000	0,000	4,1
	2006	2,0	59,0	3,6	0,000	0,000	3,6
	2007	2,1	60,1	3,7	0,000	0,000	3,7
	2008	2,2	65,5	4,0	0,000	0,000	4,0

Source: CENEF estimate

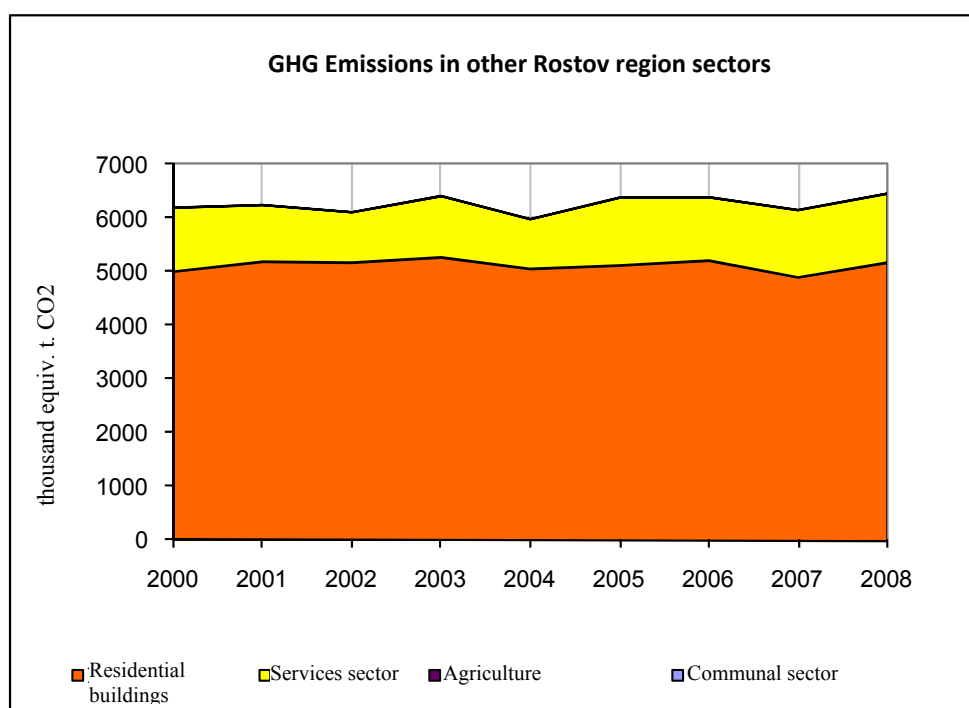


Fig. 5.1. GHG emissions from Rostov region "other sectors" in 2000-2008.

5.1.2 Sverdlovsk region

In "Other sectors" section the following GHG emission sources have been identified: communal sector, services, residential sector and agriculture (without farm machinery).

GHG emission estimates for Sverdlovsk region "other sectors" in 2000-2008 are given in Table 5.2. "Other sectors" contributed 4, 0% of three GHGs from fuel combustion in 2008. In 2000-2008 emissions from these sources increased by 52%, mostly due to services sector (see Fig. 5.2). Since energy consumption in the services sector is formed by residual method, data on emissions from the services sector cannot be considered reliable enough. GHG emission from residential sector increased by 39% while residential fund increased by 8% only. This happened due to partial replacement of centralized heat supply by natural gas.

Table 5.2. GHG emissions inventory from Sverdlovsk region “other sectors” in 2000-2008

Types of fuel	Year	Consumption (thousand tsf)	Consumption (TJ)	Emission CO ₂ (Gg CO ₂)	Emission CH ₄ (Gg CH ₄)	Emission N ₂ O (Gg N ₂ O)	Emission GHG: equiv. CO ₂ (Gg CO ₂)
Other sectors - total	2000	1575,8	46186,6	2494,3	0,008	0,000	2494,5
	2001	1555,1	45579,3	2488,4	0,008	0,000	2488,7
	2002	1668,9	48913,6	2635,6	0,008	0,000	2635,9
	2003	1790,7	52484,5	2931,6	0,009	0,000	2931,8
	2004	2048,4	60036,3	3337,2	0,010	0,000	3337,5
	2005	2013,9	59025,8	3299,5	0,010	0,000	3299,8
	2006	2134,4	62557,7	3484,3	0,011	0,000	3484,6
	2007	2171,8	63653,1	3610,4	0,011	0,000	3610,7
	2008	2266,7	66433,3	3808,8	0,012	0,000	3809,1
Communal sector	2000	0,0	0,0	0,0	0,0	0,0	0,00
	2001	0,0	0,0	0,0	0,0	0,0	0,0
	2002	0,0	0,0	0,0	0,0	0,0	0,0
	2003	0,0	0,0	0,0	0,0	0,0	0,0
	2004	0,0	0,0	0,0	0,0	0,0	0,0
	2005	0,0	0,0	0,0	0,0	0,0	0,0
	2006	0,0	0,0	0,0	0,0	0,0	0,0
	2007	4,0	116,6	8,6	0,0	0,0	8,6
	2008	0,0	0,0	0,0	0,0	0,0	0,0
Services sector	2000	983,5	28825,9	1612,6	0,0	0,0	1612,70
	2001	923,8	27075,8	1522,6	0,0	0,0	1522,7
	2002	936,3	27441,5	1528,8	0,0	0,0	1529,0
	2003	1078,9	31622,1	1829,8	0,0	0,0	1830,0
	2004	1246,4	36530,5	2115,4	0,0	0,0	2115,6
	2005	1234,5	36182,8	2131,1	0,0	0,0	2131,3
	2006	1352,1	39630,0	2277,5	0,0	0,0	2277,7
	2007	1390,1	40743,6	2401,5	0,0	0,0	2401,7
	2008	1493,0	43757,7	2589,6	0,0	0,0	2589,8
Residential buildings	2000	591,3	17331,2	879,6	0,003	0,000	879,71
	2001	630,0	18464,2	963,2	0,003	0,000	963,28
	2002	731,7	21446,6	1105,2	0,003	0,000	1105,25
	2003	710,7	20829,2	1099,7	0,003	0,000	1099,84
	2004	801,3	23484,1	1220,6	0,004	0,000	1220,70
	2005	779,0	22832,1	1167,8	0,004	0,000	1167,92
	2006	782,0	22918,6	1206,2	0,004	0,000	1206,32
	2007	777,5	22788,2	1199,9	0,004	0,000	1200,03
	2008	773,5	22671,3	1218,9	0,004	0,000	1219,03
Agriculture	2000	1,0	29,5	2,1	0,000	0,000	2,1
	2001	1,3	39,2	2,6	0,000	0,000	2,6
	2002	0,9	25,5	1,6	0,000	0,000	1,6
	2003	1,1	33,3	2,0	0,000	0,000	2,0
	2004	0,7	21,7	1,3	0,000	0,000	1,3
	2005	0,4	10,8	0,6	0,000	0,000	0,6
	2006	0,3	9,1	0,6	0,000	0,000	0,6
	2007	0,2	4,9	0,3	0,000	0,000	0,3
	2008	0,1	4,2	0,3	0,000	0,000	0,3

Source: CENEF estimate

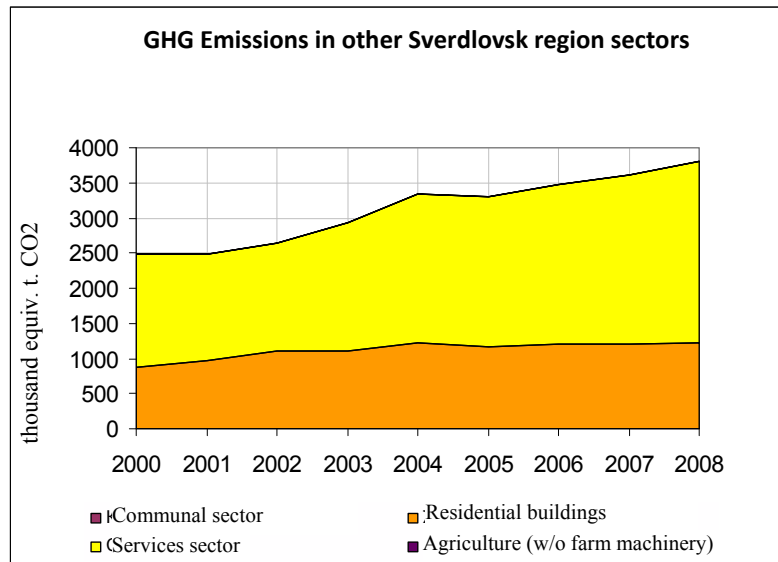


Fig. 5.2. GHG emissions from Sverdlovsk region “other sectors” in 2000-2008.

5.1.3 Tver region

In “Other sectors” section the following sources have been identified: communal sector, services, residential sector and agriculture (without farm machinery).

GHG emission estimates for Tver region “other sectors” in 2000-2008 are given in Table 5.3. These sectors accounted for 7, 4% of three GHGs emission from fuel combustion in 2008. Emissions from these sources decreased by 22% compared to 2000 (see Fig. 5.3). Mostly, this happened due to the services sector, but the data on this sector cannot be considered reliable enough. In residential sector emissions increased by 8%, while residential fund increased by 5, 6%. The main increase of emissions in residential sector had place in before 2003. After that the level became practically stable.

Table 5.3. GHG emissions inventory from Tver region “other sectors” in 2000-2008.

Types of fuel	Year	Consumption (thousand tsf)	Consumption (TJ)	Emission CO ₂ (Gg CO ₂)	Emission CH ₄ (Gg CH ₄)	Emission N ₂ O (Gg N ₂ O)	Emission GHG: equiv. CO ₂ (Gg CO ₂)
1	2	3	4	5	6	7	8
Other sectors - total	2000	680,1	25457,9	1212,9	0,003	0,000	1213,1
	2001	655,6	24098,0	1142,1	0,003	0,000	1142,2
	2002	649,2	24076,5	1134,6	0,003	0,000	1134,7
	2003	650,8	22656,6	1114,0	0,003	0,000	1114,1
	2004	573,0	18141,5	945,9	0,003	0,000	946,1
	2005	613,3	20952,1	1046,6	0,003	0,000	1046,7
	2006	563,6	18000,2	937,8	0,003	0,000	937,9
	2007	560,9	17685,3	937,5	0,003	0,000	937,6
	2008	562,1	17698,7	941,3	0,003	0,000	941,3
Communal sector	2000	0,1	2,1	0,2	0,000	0,000	0,15
	2001	0,0	0,0	0,0	0,000	0,000	0,0
	2002	0,0	0,0	0,0	0,000	0,000	0,0
	2003	0,0	1,0	0,1	0,000	0,000	0,1
	2004	0,6	16,2	1,2	0,000	0,000	1,2
	2005	0,0	0,9	0,1	0,000	0,000	0,1
	2006	0,0	0,9	0,1	0,000	0,000	0,1
	2007	0,1	2,2	0,2	0,000	0,000	0,2
	2008	0,0	0,9	0,1	0,000	0,000	0,1

Types of fuel	Year	Consumption (thousand tsf)	Consumption (TJ)	Emission CO ₂ (Gg CO ₂)	Emission CH ₄ (Gg CH ₄)	Emission N ₂ O (Gg N ₂ O)	Emission GHG: equiv. CO ₂ (Gg CO ₂)
Services sector	2000	188,5	5525,2	422,8	0,000	0,000	422,79
	2001	166,6	4883,1	360,1	0,000	0,000	360,1
	2002	172,3	5050,5	372,7	0,000	0,000	372,7
	2003	122,3	3583,5	264,7	0,000	0,000	264,7
	2004	46,0	1347,8	100,8	0,000	0,000	100,8
	2005	101,6	2977,6	218,3	0,000	0,000	218,3
	2006	50,6	1482,8	108,7	0,000	0,000	108,7
	2007	42,5	1245,2	91,3	0,000	0,000	91,3
	2008	41,8	1225,6	89,9	0,000	0,000	89,9
Residential buildings	2000	491,5	13972,4	790,0	0,003	0,000	790,1
	2001	489,0	13818,8	782,0	0,003	0,000	782,1
	2002	476,8	13463,5	761,9	0,003	0,000	762,0
	2003	528,5	15022,5	849,2	0,003	0,000	849,3
	2004	526,5	14920,6	844,0	0,003	0,000	844,1
	2005	511,6	14605,9	828,2	0,003	0,000	828,3
	2006	512,9	14660,4	829,0	0,003	0,000	829,1
	2007	518,4	14999,7	846,1	0,003	0,000	846,1
	2008	520,2	15083,4	851,3	0,003	0,000	851,4
Agriculture	2000	0,000	0,000	0,000	0,000	0,000	0,000
	2001	0,000	0,000	0,000	0,000	0,000	0,000
	2002	0,000	0,000	0,000	0,000	0,000	0,000
	2003	0,000	0,000	0,000	0,000	0,000	0,000
	2004	0,000	0,000	0,000	0,000	0,000	0,000
	2005	0,000	0,000	0,000	0,000	0,000	0,000
	2006	0,000	0,000	0,000	0,000	0,000	0,000
	2007	0,000	0,000	0,000	0,000	0,000	0,000
	2008	0,000	0,000	0,000	0,000	0,000	0,000

Source: CENEF estimate

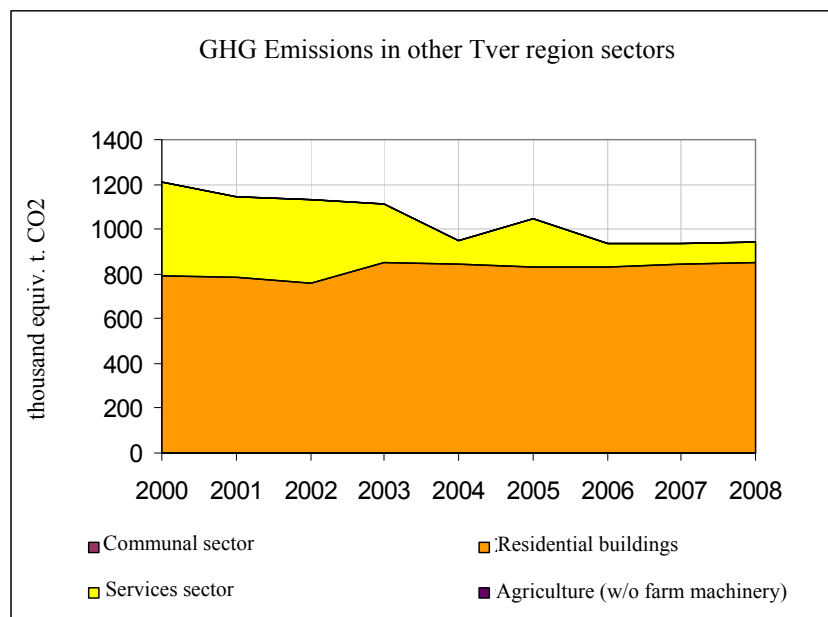


Fig. 5.3. GHG emissions from Tver region "other sectors" in 2000-2008.

5.2 Inventory compilation methodology

The greenhouse gas emissions from “other sectors” (Section 1.A.4 in IPCC classification) are estimated in accordance with the provisions in Chapter 1 “Introduction” and Chapter 2 “Stationary combustion”, Volume 2 “Energy” of “Guidelines for National Greenhouse Gas Inventories” (IPCC, 2006). Under the “Other sectors” IPCC methodology covers “Commercial/institutional sector”, “Residential sector” and “Agriculture / Forestry / Fishing / Fish farms” (See description in Table5.4).

Table 5.4. Types of Activities in “Other Sectors”

Code and name		Description
1 A 4	<i>Other Sectors</i>	Emissions from combustion activities as described below, including combustion for the generation of electricity and heat for own use in these sectors.
1 A 4	a Commercial / Institutional	Emissions from fuel combustion in commercial and institutional buildings; all activities included in ISIC Divisions ISIC 41, 51, 52, 55, 63-67, 70-75, 80, 85, 90-93 and 99.
1 A 4	b Residential	Emissions from fuel combustion in residential sector.
1 A 4	c Agriculture / Forestry / Fishing / Fish farms	Emissions from fuel combustion in agriculture, forestry, fishing and fishing industries such as fish farms. Activities included in ISIC Divisions 01, 02 and 05. Highway agricultural transportation is excluded.

Source: Table 2.1 Chapter 2 “Stationary Combustion” vol. 2 “Energy” “Guidelines for National Greenhouse Inventories”.

In general, emissions of each greenhouse gas from stationary sources in “Other sectors” are calculated by multiplying fuel consumption by the corresponding emission factor. In the Sectoral Approach, “Fuel Consumption” is estimated from energy use statistics and is measured in terajoules. Fuel consumption data in mass or volume units must first be converted into the equivalent fuel units representing the energy content of these fuels (tones of specific fuel (tsf)), to be then converted into the terajoules. Tier 1 approach is applied for “Other sectors” which means the calculation of CO₂ emissions applies CO₂, CH₄ and N₂O emission factors defined by IPCC (See Table 5.5). The authors do not have any data or any special survey results to support the use of region-specific factors. Emission factors for CO₂ are defined in units of kg CO₂/TJ on a net calorific value basis and reflect the carbon content of the fuel and the assumption that the carbon oxidation factor is 1. Emission factors for CH₄ and N₂O supplied in Table 5.5 apply to technologies without emission controls. These emission factors were established using the expert judgment of a large group of inventory experts.

Table 5.5. Emission Factors for Stationary Combustion in Energy Industries (kg/TJ)

	CO ₂	CH ₄	N ₂ O
Crude Oil	73300	10	0.6
Orimulsion	77000	10	0.6
Natural Gas Liquids	64200	10	0.6
Motor Gasoline	69300	10	0.6
Aviation Gasoline	70000	10	0.6
Jet Gasoline	70000	10	0.6
Jet Kerosene	71500	10	0.6
Other Kerosene	71900	10	0.6
Shale Oil	73300	10	0.6
Gas/Diesel Oil	74100	10	0.6
Residual Fuel Oil	77400	10	0.6
Liquefied Petroleum Gases	63100	5	0.1
Ethane	61600	5	0.1
Naphtha	73300	10	0.6
Bitumen	80700	10	0.6
Lubricants	73300	10	0.6
Petroleum Coke	97500	10	0.6
Refinery Feedstocks	73300	10	0.6
Refinery Gas	57600	5	0.1
Paraffin Waxes	73300	10	0.6
White Spirit and SBP	73300	10	0.6
Other Petroleum Products	73300	10	0.6
Anthracite	98300	10	1.5
Coking Coal	94600	10	1.5
Other Bituminous Coal	94600	10	1.5
Sub-Bituminous Coal	96100	10	1.5
Lignite	101000	10	1.5
Oil Shale and Tar Sands	107000	10	1.5
Brown Coal Briquettes	97500	10	1.5
Patent Fuel	97500	10	1.5
Coke Oven Coke and Lignite Coke	107000	10	1.5
Gas Coke	107000	5	0.1
Coal Tar	80700	10	1.5
Gas Works Gas	44400	5	0.1
Coke Oven Gas	44400	5	0.1
Blast Furnace Gas	260000	5	0.1
Oxygen Steel Furnace Gas	182000	5	0.1
Natural Gas	56100	5	0.1
Municipal Wastes (non-biomass fraction)	91700	300	4
Industrial Wastes	143000	300	4
Waste Oils	73300	300	4
Peat	106000	1	1.4
Wood/ Wood Waste	112000	300	4
Sulphite lyes (Black Liquor)	95300	3	2
Other Primary Solid Biomass	100000	300	4
Charcoal	112000	200	1
Biogasoline	70800	10	0.6
Biodiesels	70800	10	0.6
Other Liquid Biofuels	79600	10	0.6
Landfill Gas	54600	5	0.1
Sludge Gas	54600	5	0.1
Other Biogas	54600	5	0.1
Municipal Wastes (biomass fraction)	100000	300	4

Source: Chapter 2 “Stationary Combustion” vol. 2 “Energy” “Guidelines for National Greenhouse Inventories”.

Tier 1 approach calculates the emissions by multiplying the fuel consumption by IPCC emission factors (See Table 4.5). The approach is represented in the Equation 4.1:

$$\text{Emissions} = \sum_a (\text{Fuel}_a * EF_a) \quad (4.1)$$

Where: *Emissions* = Emissions;

Fuel_a = fuel consumption;

EF_a = emission factor. Represents the carbon content of the fuel multiplied by 44/12.

a = type of fuel (for example, gasoline, diesel fuel, natural gas, liquefied gas, etc.).

Emissions of CO₂ from biomass fuels are estimated and reported in the AFOLU sector as part of the AFOLU methodology. In the reporting tables, emissions from combustion of biofuels are reported as information items but not included in the sectoral or national totals to avoid double counting. In the emission factor tables presented in this Chapter, default CO₂ emission factors are presented to enable the user to estimate these information items. For biomass, only that part of the biomass that is combusted for energy purposes should be estimated for inclusion as an information item in the Energy sector. The emissions of CH₄ and N₂O, however, are estimated and included in the sector and national totals because their effect is in addition to the stockchanges estimated in the AFOLU sector.

The regions do not operate the technology that allows to capture and store the carbon dioxide emitted in the atmosphere and re-inject it into the geological reservoirs and storage. That is why no aspects of capturing and storing the carbon dioxide are reviewed in this survey.

5.3 Commercial / Institutional sector

This sector is often referred to as the “Service industries” and includes Emissions from fuel combustion in commercial and institutional buildings. Some Russian statistical reporting forms call it the municipal consumption. This sector usually includes the statistics not allocated to the other sectors. In other words, the energy consumption performance in this sector is determined on the residual principle basis.

Fuel consumption reporting in the sector is compiled based on the statistical forms “11-TER”, “22-ZhKKh” and “Balans Gaza”. The fuel allocated to the small-scale boiler consumption is (See Section 2.4) is subtracted from the Form “11-TER” item “Municipal consumption”. The remaining fuel is allocated to the Service.

For the purpose of this estimate, Commercial / Institutional sector was subdivided in two components: the municipal sector (water supply and street lighting) and service sector (service facilities and, to some extent, small industrial businesses). The small-scale boiler consumption was allocated to the “boiler” item. This sector covers the fuel consumption by individual heat generating units and fuel consumption by Commercial / Institutional sector (cooking, etc.).

5.3.1 Rostov region

The emissions of three greenhouse gases produced by fuel combustion at Commercial / Institutional sector facilities in 2008 were estimated to be 1277.1 thousand tones of CO₂ equivalents, or 3.7% total emissions. The trend is very unstable due to low quality data (See Table 5.6).

Table 5.6. Greenhouse gas emissions inventory in the Commercial / Institutional sector facilities of Rostov region in 2000-2008.

	Year	Consumption, thousand tsf	Consumption, TJ	CO2 emission factor (kg CO ₂ / TJ)	CO2 emissions (Gg CO ₂)	CH ₄ emission factor (kg CH ₄ / TJ)	CH ₄ emissions (Gg CH ₄)	N ₂ O emission factor (kg N ₂ O / TJ)	N ₂ O emissions (Gg N ₂ O)	GHG emissions: CO ₂ - eq. (Gg CO ₂)
	1	2	3	4	5	6	7	8	9	10
Residential sector	2000	0.0	0.0		0.0		0.000		0.000	0.00
	2001	0.0	0.0		0.0		0.000		0.000	0.0
	2002	0.0	0.0		0.0		0.000		0.000	0.0
	2003	0.0	0.0		0.0		0.000		0.000	0.0
	2004	0.0	0.0		0.0		0.000		0.000	0.0
	2005	0.0	0.0		0.0		0.000		0.000	0.0
	2006	0.0	0.0		0.0		0.000		0.000	0.0
	2007	6.0	175.9	54600	9.6		0.000		0.000	9.6
	2008	5.5	162.6	54600	8.9		0.000		0.000	8.9
Liquid fuel	2000	0.0	0.0	54600	0.0	1	0.000	0.1	0.000	0.0
	2001	0.0	0.0	54600	0.0	1	0.000	0.1	0.000	0.0
	2002	0.0	0.0	54600	0.0	1	0.000	0.1	0.000	0.0
	2003	0.0	0.0	54600	0.0	1	0.000	0.1	0.000	0.0
	2004	0.0	0.0	54600	0.0	1	0.000	0.1	0.000	0.0
	2005	0.0	0.0	54600	0.0	1	0.000	0.1	0.000	0.0
	2006	0.0	0.0	54600	0.0	1	0.000	0.1	0.000	0.0
	2007	6.0	175.9	54600	9.6	1	0.000	0.1	0.000	9.6
	2008	5.5	162.6	54600	8.9	1	0.000	0.1	0.000	8.9
Natural gas	2000	0.0	0.0	64200	0.0	3	0.000	0.6	0.000	0.0
	2001	0.0	0.0	64200	0.0	3	0.000	0.6	0.000	0.0
	2002	0.0	0.0	64200	0.0	3	0.000	0.6	0.000	0.0
	2003	0.0	0.0	64200	0.0	3	0.000	0.6	0.000	0.0
	2004	0.0	0.0	64200	0.0	3	0.000	0.6	0.000	0.0
	2005	0.0	0.0	64200	0.0	3	0.000	0.6	0.000	0.0
	2006	0.0	0.0	64200	0.0	3	0.000	0.6	0.000	0.0
	2007	0.0	0.0	64200	0.0	3	0.000	0.6	0.000	0.0
	2008	0.0	0.0	64200	0.0	3	0.000	0.6	0.000	0.0
Coal	2000	0.0	0.0	0	0.0	0	0.000	0	0.000	0.0
	2001	0.0	0.0	0	0.0	0	0.000	0	0.000	0.0
	2002	0.0	0.0	0	0.0	0	0.000	0	0.000	0.0
	2003	0.0	0.0	0	0.0	0	0.000	0	0.000	0.0
	2004	0.0	0.0	0	0.0	0	0.000	0	0.000	0.0

	Year	Consumption, thousand tsf	Consumption, TJ	CO2 emission factor (kg CO ₂ / TJ)	CO2 emissions (Gg CO ₂)	CH ₄ emission factor (kg CH ₄ / TJ)	CH ₄ emissions (Gg CH ₄)	N ₂ O emission factor (kg N ₂ O / TJ)	N ₂ O emissions (Gg N ₂ O)	GHG emissions: CO ₂ - eq. (Gg CO ₂)
	2005	0.0	0.0	0	0.0	0	0.000	0	0.000	0.0
	2006	0.0	0.0	0	0.0	0	0.000	0	0.000	0.0
	2007	0.0	0.0	0	0.0	0	0.000	0	0.000	0.0
	2008	0.0	0.0	0	0.0	0	0.000	0	0.000	0.0
Service sector	2000	434.1	12722.8	92261	1173.8		0.012		0.002	1174.5
	2001	383.8	11248.1	92329	1038.5		0.010		0.001	1039.1
	2002	341.2	10000.3	92136	921.4		0.009		0.001	922.0
	2003	416.6	12210.9	92229	1126.2		0.011		0.001	1126.9
	2004	335.6	9835.6	92418	909.0		0.009		0.001	909.5
	2005	461.5	13527.4	92162	1246.7		0.013		0.002	1247.5
	2006	429.5	12588.4	92278	1161.6		0.011		0.002	1162.4
	2007	456.3	13372.6	92235	1233.4		0.013		0.002	1234.2
	2008	469.1	13747.8	92185	1267.3		0.013		0.002	1268.2
Liquid fuel	2000	9.3	273.0	98300	26.8	10	0.000	1.5	0.000	26.8
	2001	8.9	260.7	98300	25.6	10	0.000	1.5	0.000	25.6
	2002	9.0	265.0	98300	26.1	10	0.000	1.5	0.000	26.1
	2003	9.3	271.2	98300	26.7	10	0.000	1.5	0.000	26.7
	2004	9.1	266.0	98300	26.1	10	0.000	1.5	0.000	26.2
	2005	7.6	224.0	98300	22.0	10	0.000	1.5	0.000	22.0
	2006	10.6	310.3	98300	30.5	10	0.000	1.5	0.000	30.5
	2007	7.3	213.4	98300	21.0	10	0.000	1.5	0.000	21.0
	2008	6.4	186.5	98300	18.3	10	0.000	1.5	0.000	18.3
Natural gas	2000	383.4	11238.4	91700	1030.6	30	0.012	4	0.002	1031.3
	2001	333.4	9771.4	91700	896.0	30	0.010	4	0.001	896.7
	2002	311.9	9140.9	91700	838.2	30	0.009	4	0.001	838.8
	2003	371.2	10878.3	91700	997.5	30	0.011	4	0.001	998.2
	2004	285.4	8364.4	91700	767.0	30	0.009	4	0.001	767.6
	2005	416.9	12217.8	91700	1120.4	30	0.013	4	0.002	1121.2
	2006	378.3	11088.7	91700	1016.8	30	0.011	4	0.002	1017.5
	2007	404.4	11852.2	91700	1086.8	30	0.012	4	0.002	1087.6
	2008	420.5	12325.6	91700	1130.3	30	0.013	4	0.002	1131.0
Coal	2000	41.3	1211.4	96100	116.4	10	0.000	1.5	0.000	116.4
	2001	41.5	1215.9	96100	116.9	10	0.000	1.5	0.000	116.9
	2002	20.3	594.4	96100	57.1	10	0.000	1.5	0.000	57.1
	2003	36.2	1061.5	96100	102.0	10	0.000	1.5	0.000	102.0

Year	Consumption, thousand tsf	Consumption, TJ	CO2 emission factor (kg CO ₂ / TJ)	CO2 emissions (Gg CO ₂)	CH ₄ emission factor (kg CH ₄ / TJ)	CH ₄ emissions (Gg CH ₄)	N ₂ O emission factor (kg N ₂ O / TJ)	N ₂ O emissions (Gg N ₂ O)	GHG emissions: CO ₂ - eq. (Gg CO ₂)
2004	41.1	1205.2	96100	115.8	10	0.000	1.5	0.000	115.8
2005	37.0	1085.6	96100	104.3	10	0.000	1.5	0.000	104.3
2006	40.6	1189.4	96100	114.3	10	0.000	1.5	0.000	114.3
2007	44.6	1307.0	96100	125.6	10	0.000	1.5	0.000	125.6
2008	42.2	1235.7	96100	118.8	10	0.000	1.5	0.000	118.8

Source: Estimates by CENef

5.3.2 Sverdlovsk Region

The emissions of three greenhouse gases produced by fuel combustion by Commercial / Institutional sector facilities in 2008 were estimated to be 2589.8 thousand tones of CO2 equivalents, or 2.7% total emissions. The trend is very unstable due to low quality data (See Table 5.7).

Table 5.7. Greenhouse gas emissions inventory in the Commercial / Institutional sector facilities of Sverdlovsk region in 2000-2008.

Year	Consumption, thousand tsf	Consumption, TJ	CO2 emission factor (kg CO2/TJ)	CO2 emissions (Gg CO2)	CH4 emission factor (kg CH4/TJ)	CH4 emissions (Gg CH4)	N2O emission factor (kg N2O / TJ)	N2O emissions (Gg N2O)	GHG emissions: CO2 equivalent (Gg CO2)	
1	2	3	4	5	6	7	8	9	10	11
Residential sector	2000	0.0	0.0		0.0		0.0		0.0	0.00
	2001	0.0	0.0		0.0		0.0		0.0	0.0
	2002	0.0	0.0		0.0		0.0		0.0	0.0
	2003	0.0	0.0		0.0		0.0		0.0	0.0
	2004	0.0	0.0		0.0		0.0		0.0	0.0
	2005	0.0	0.0		0.0		0.0		0.0	0.0
	2006	0.0	0.0		0.0		0.0		0.0	0.0
	2007	4.0	116.6		8.6		0.0		0.0	8.6
	2008	0.0	0.0		0.0		0.0		0.0	0.0
Liquid fuel	2000	0.0	0.0	74 100	0.0	10	0.000	0.6	0.000	0.00
	2001	0.0	0.0	74 100	0.0	10	0.000	0.6	0.000	0.00
	2002	0.0	0.0	74 100	0.0	10	0.000	0.6	0.000	0.00
	2003	0.0	0.0	74 100	0.0	10	0.000	0.6	0.000	0.00
	2004	0.0	0.0	74 100	0.0	10	0.000	0.6	0.000	0.00
	2005	0.0	0.0	74 100	0.0	10	0.000	0.6	0.000	0.00
	2006	0.0	0.0	74 100	0.0	10	0.000	0.6	0.000	0.00
	2007	4.0	116.6	74 100	8.6	10	0.000	0.6	0.000	8.64
	2008	0.0	0.0	74 100	0.0	10	0.000	0.6	0.000	0.00
Natural gas	2000	0.0	0.0	56 100	0.0	5	0.000	0.1	0.000	0.00
	2001	0.0	0.0	56 100	0.0	5	0.000	0.1	0.000	0.00
	2002	0.0	0.0	56 100	0.0	5	0.000	0.1	0.000	0.00
	2003	0.0	0.0	56 100	0.0	5	0.000	0.1	0.000	0.00
	2004	0.0	0.0	56 100	0.0	5	0.000	0.1	0.000	0.00
	2005	0.0	0.0	56 100	0.0	5	0.000	0.1	0.000	0.00
	2006	0.0	0.0	56 100	0.0	5	0.000	0.1	0.000	0.00
	2007	0.0	0.0	56 100	0.0	5	0.000	0.1	0.000	0.00
	2008	0.0	0.0	56 100	0.0	5	0.000	0.1	0.000	0.00
Coal	2000	0.0	0.0	94 600	0.0	10	0.000	1.5	0.000	0.00
	2001	0.0	0.0	94 600	0.0	10	0.000	1.5	0.000	0.00
	2002	0.0	0.0	94 600	0.0	10	0.000	1.5	0.000	0.00
	2003	0.0	0.0	94 600	0.0	10	0.000	1.5	0.000	0.00
	2004	0.0	0.0	94 600	0.0	10	0.000	1.5	0.000	0.00
	2005	0.0	0.0	94 600	0.0	10	0.000	1.5	0.000	0.00
	2006	0.0	0.0	94 600	0.0	10	0.000	1.5	0.000	0.00
	2007	0.0	0.0	94 600	0.0	10	0.000	1.5	0.000	0.00
	2008	0.0	0.0	94 600	0.0	10	0.000	1.5	0.000	0.00
Other solid	2000	0.0	0.0	112 000	0.0	300	0.000	4	0.000	0.00
	2001	0.0	0.0	112000	0.0	300	0.000	4	0.000	0.00

Year	Consumption, thousand tsf	Consumption, TJ	CO2 emission factor (kg CO2/ TJ)	CO2 emissions (Gg CO2)	CH4 emission factor (kg CH4/ TJ)	CH4 emissions (Gg CH4)	N2O emission factor (kg N2O / TJ)	N2O emissions (Gg N2O)	GHG emissions: CO2 equivalent (Gg CO2)
2002	0.0	0.0	112000	0.0	300	0.000	4	0.000	0.00
2003	0.0	0.0	112000	0.0	300	0.000	4	0.000	0.00
2004	0.0	0.0	112000	0.0	300	0.000	4	0.000	0.00
2005	0.0	0.0	112000	0.0	300	0.000	4	0.000	0.00
2006	0.0	0.0	112000	0.0	300	0.000	4	0.000	0.00
2007	0.0	0.0	112000	0.0	300	0.000	4	0.000	0.00
2008		0.0	121500	0.0	300	0.000	4	0.000	0.0
2000	983.5	28825.9	55941	1612.6		0.0		0.0	1612.70
2001	923.8	27075.8	56235	1522.6		0.0		0.0	1522.7
2002	936.3	27441.5	55712	1528.8		0.0		0.0	1529.0
2003	1078.9	31622.1	57865	1829.8		0.0		0.0	1830.0
2004	1246.4	36530.5	57908	2115.4		0.0		0.0	2115.6
2005	1234.5	36182.8	58899	2131.1		0.0		0.0	2131.3
2006	1352.1	39630.0	57469	2277.5		0.0		0.0	2277.7
2007	1390.1	40743.6	58943	2401.5		0.0		0.0	2401.7
2008	1493.0	43757.7	59180	2589.6		0.0		0.0	2589.8
2000	66.7	1955.2	74 100	144.9	10	0.001	0.6	0.000	144.91
2001	59.0	1728.5	74 100	128.1	10	0.001	0.6	0.000	128.10
2002	61.4	1798.7	74 100	133.3	10	0.001	0.6	0.000	133.31
2003	65.3	1913.4	74 100	141.8	10	0.001	0.6	0.000	141.81
2004	69.9	2047.3	74 100	151.7	10	0.001	0.6	0.000	151.74
2005	65.9	1930.9	74 100	143.1	10	0.001	0.6	0.000	143.10
2006	26.7	783.5	74 100	58.1	10	0.000	0.6	0.000	58.07
2007	26.9	788.8	74 100	58.4	10	0.000	0.6	0.000	58.46
2008	54.0	1584.1	74 100	117.4	10	0.001	0.6	0.000	117.40
2000	838.2	24565.9	56 100	1378.1	5	0.004	0.1	0.000	1378.26
2001	785.4	23019.6	56 100	1291.4	5	0.004	0.1	0.000	1291.51
2002	822.6	24108.7	56 100	1352.5	5	0.004	0.1	0.000	1352.61
2003	940.3	27560.1	56 100	1546.1	5	0.005	0.1	0.000	1546.25
2004	1096.3	32131.9	56 100	1802.6	5	0.005	0.1	0.000	1802.75
2005	1056.1	30951.8	56 100	1736.4	5	0.005	0.1	0.000	1736.54
2006	1259.4	36910.6	56 100	2070.7	5	0.006	0.1	0.000	2070.85
2007	1245.6	36507.5	56 100	2048.1	5	0.006	0.1	0.000	2048.24
2008	1306.0	38277.8	56 100	2147.4	5	0.007	0.1	0.000	2147.56
2000	32.3	946.3	94 600	89.5	10	0.000	1.5	0.000	89.53
2001	37.2	1090.1	94 600	103.1	10	0.000	1.5	0.000	103.13
2002	15.5	455.0	94 600	43.0	10	0.000	1.5	0.000	43.05
2003	51.2	1500.2	94 600	141.9	10	0.001	1.5	0.000	141.93
2004	58.1	1702.8	94 600	161.1	10	0.001	1.5	0.000	161.10
2005	90.8	2660.3	94 600	251.7	10	0.001	1.5	0.000	251.68

Year	Consumption, thousand tsf	Consumption, TJ	CO2 emission factor (kg CO2/ TJ)	CO2 emissions (Gg CO2)	CH4 emission factor (kg CH4/ TJ)	CH4 emissions (Gg CH4)	N2O emission factor (kg N2O / TJ)	N2O emissions (Gg N2O)	GHG emissions: CO2 equivalent (Gg CO2)	
2006	53.6	1572.3	94 600	148.7	10	0.001	1.5	0.000	148.75	
2007	106.4	3118.5	94 600	295.0	10	0.001	1.5	0.000	295.04	
2008	117.2	3433.7	94 600	324.8	10	0.001	1.5	0.000	324.85	
Other solid fuels	2000	46.3	1358.4	112 000		300	0.000	4	0.000	0.00
	2001	42.2	1237.6	112000		300	0.000	4	0.000	0.00
	2002	36.8	1079.2	112000		300	0.000	4	0.000	0.00
	2003	22.1	648.4	112000		300	0.000	4	0.000	0.00
	2004	22.1	648.4	112000		300	0.000	4	0.000	0.00
	2005	21.8	639.9	112000		300	0.000	4	0.000	0.00
	2006	12.4	363.6	112000		300	0.000	4	0.000	0.00
	2007	11.2	328.8	112000		300	0.000	4	0.000	0.00
	2008	15.8	462.1	112000		300	0.000	4	0.000	0.00

Source: Estimates by CENEF

5.3.3 Tver region

The emissions of three greenhouse gases produced by fuel combustion at Commercial / Institutional sector facilities in 2008 were estimated to be 90 thousand tones of CO2 equivalents, or 0.7% total emissions. The trend is very unstable due to low quality data (See Table 5.8).

Table 5.8. Greenhouse gas emissions inventory in the Commercial / Institutional sector facilities of Tver region in 2000-2008.

Year	Consumption, thousand tsf	Consumption, TJ	CO2 emission factor (kg CO2/ TJ)	CO2 emissions (Gg CO2)	CH4 emission factor (kg CH4/ TJ)	CH4 emissions (Gg CH4)	N2O emission factor (kg N2O / TJ)	N2O emissions (Gg N2O)	GHG emissions: CO2 equivalent (Gg CO2)	
1	2	3	4	5	6	7	8	9	10	11
Residential sector	2000	0.1	2.1	73300	0.2		0.000		0.000	0.15
	2001	0.0	0.0		0.0		0.000		0.000	0.0
	2002	0.0	0.0		0.0		0.000		0.000	0.0
	2003	0.0	1.0	73300	0.1		0.000		0.000	0.1
	2004	0.6	16.2	74081	1.2		0.000		0.000	1.2
	2005	0.0	0.9	73300	0.1		0.000		0.000	0.1
	2006	0.0	0.9	73300	0.1		0.000		0.000	0.1
	2007	0.1	2.2	73300	0.2		0.000		0.000	0.2
Liquid fuel	2000	0.0	0.0	74100	0.0	10	0.000	0.6	0.000	0.0
	2001	0.0	0.0	74100	0.0	10	0.000	0.6	0.000	0.0
	2002	0.0	0.0	74100	0.0	10	0.000	0.6	0.000	0.0
	2003	0.0	0.0	74100	0.0	10	0.000	0.6	0.000	0.0
	2004	0.5	15.9	74100	1.2	10	0.000	0.6	0.000	1.2
	2005	0.0	0.0	74100	0.0	10	0.000	0.6	0.000	0.0

	Year	Consumption, thousand tsf	Consumption, TJ	CO2 emission factor (kg CO2/ TJ)	CO2 emissions (Gg CO2)	CH4 emission factor (kg CH4/ TJ)	CH4 emissions (Gg CH4)	N2O emission factor (kg N2O / TJ)	N2O emissions (Gg N2O)	GHG emissions: CO2 equivalent (Gg CO2)
	2006	0.0	0.0	74100	0.0	10	0.000	0.6	0.000	0.0
	2007	0.0	0.0	74100	0.0	10	0.000	0.6	0.000	0.0
	2008	0.0	0.0	74100	0.0	10	0.000	0.6	0.000	0.0
Natural gas	2000	0.1	2.1	73 300	0.2	3	0.000	0.6	0.000	0.2
	2001	0.0	0.0	73300	0.0	3	0.000	0.6	0.000	0.0
	2002	0.0	0.0	73300	0.0	3	0.000	0.6	0.000	0.0
	2003	0.0	1.0	73300	0.1	3	0.000	0.6	0.000	0.1
	2004	0.0	0.4	73300	0.0	3	0.000	0.6	0.000	0.0
	2005	0.0	0.9	73300	0.1	3	0.000	0.6	0.000	0.1
	2006	0.0	0.9	73300	0.1	3	0.000	0.6	0.000	0.1
	2007	0.1	2.2	73300	0.2	3	0.000	0.6	0.000	0.2
	2008	0.0	0.9	73300	0.1	3	0.000	0.6	0.000	0.1
	Coal	2000	0.0	0.0	73 300	0.0	3	0.000	0.6	0.000
2001		0.0	0.0	73300	0.0	3	0.000	0.6	0.000	0.0
2002		0.0	0.0	73300	0.0	3	0.000	0.6	0.000	0.0
2003		0.0	0.0	73300	0.0	3	0.000	0.6	0.000	0.0
2004		0.0	0.0	73300	0.0	3	0.000	0.6	0.000	0.0
2005		0.0	0.0	73300	0.0	3	0.000	0.6	0.000	0.0
2006		0.0	0.0	73300	0.0	3	0.000	0.6	0.000	0.0
2007		0.0	0.0	73300	0.0	3	0.000	0.6	0.000	0.0
2008		0.0	0.0	73300	0.0	3	0.000	0.6	0.000	0.0
Other solid fuels	2000	0.0	0.0	112 000	0.0	30	0.000	4	0.000	0.0
	2001	0.0	0.0	112000	0.0	30	0.000	4	0.000	0.0
	2002	0.0	0.0	112000	0.0	30	0.000	4	0.000	0.0
	2003	0.0	0.0	112000	0.0	30	0.000	4	0.000	0.0
	2004	0.0	0.0	112000	0.0	30	0.000	4	0.000	0.0
	2005	0.0	0.0	112000	0.0	30	0.000	4	0.000	0.0
	2006	0.0	0.0	112000	0.0	30	0.000	4	0.000	0.0
	2007	0.0	0.0	112000	0.0	30	0.000	4	0.000	0.0
	2008	0.0	0.0	112000	0.0	30	0.000	4	0.000	0.0
Service sector	2000	188.5	5525.2	76513	422.8		0.000		0.000	422.8
	2001	166.6	4883.1	73738	360.1		0.000		0.000	360.1
	2002	172.3	5050.5	73785	372.7		0.000		0.000	372.7
	2003	122.3	3583.5	73858	264.7		0.000		0.000	264.7
	2004	46.0	1347.8	74771	100.8		0.000		0.000	100.8
	2005	101.6	2977.6	73326	218.3		0.000		0.000	218.3
	2006	50.6	1482.8	73332	108.7		0.000		0.000	108.7
	2007	42.5	1245.2	73332	91.3		0.000		0.000	91.3
	2008	41.8	1225.6	73330	89.9		0.000		0.000	89.9
Liquid fuel	2000	2.0	59.7	74100	4.4	10	0.000	0.6	0.000	4.4
	2001	1.8	52.5	74100	3.9	10	0.000	0.6	0.000	3.9
	2002	2.3	68.4	74100	5.1	10	0.000	0.6	0.000	5.1
	2003	1.8	53.2	74100	3.9	10	0.000	0.6	0.000	3.9
	2004	1.9	54.5	74100	4.0	10	0.000	0.6	0.000	4.0
	2005	1.7	50.2	74100	3.7	10	0.000	0.6	0.000	3.7
	2006	2.0	57.6	74100	4.3	10	0.000	0.6	0.000	4.3
	2007	1.7	49.2	74100	3.6	10	0.000	0.6	0.000	3.6
	2008	1.5	45.3	74100	3.4	10	0.000	0.6	0.000	3.4

	Year	Consumption, thousand tsf	Consumption, TJ	CO2 emission factor (kg CO2/ TJ)	CO2 emissions (Gg CO2)	CH4 emission factor (kg CH4/ TJ)	CH4 emissions (Gg CH4)	N2O emission factor (kg N2O / TJ)	N2O emissions (Gg N2O)	GHG emissions: CO2 equivalent (Gg CO2)
Natural gas	2000	170.9	5008.0	73300	367.1	3	0.000	0.6	0.000	367.1
	2001	163.0	4776.4	73300	350.1	3	0.000	0.6	0.000	350.1
	2002	167.9	4920.1	73300	360.6	3	0.000	0.6	0.000	360.6
	2003	118.7	3479.8	73300	255.1	3	0.000	0.6	0.000	255.1
	2004	42.4	1243.2	73300	91.1	3	0.000	0.6	0.000	91.1
	2005	99.9	2926.5	73300	214.5	3	0.000	0.6	0.000	214.5
	2006	48.6	1425.1	73300	104.5	3	0.000	0.6	0.000	104.5
	2007	40.8	1196.0	73300	87.7	3	0.000	0.6	0.000	87.7
	2008	40.3	1180.3	73300	86.5	3	0.000	0.6	0.000	86.5
Coal	2000	0.0	0.0	73300	0.0	3	0.000	0.6	0.000	0.0
	2001	0.0	0.0	73300	0.0	3	0.000	0.6	0.000	0.0
	2002	0.0	0.0	73300	0.0	3	0.000	0.6	0.000	0.0
	2003	0.0	0.0	73300	0.0	3	0.000	0.6	0.000	0.0
	2004	0.0	0.0	73300	0.0	3	0.000	0.6	0.000	0.0
	2005	0.0	0.0	73300	0.0	3	0.000	0.6	0.000	0.0
	2006	0.0	0.0	73300	0.0	3	0.000	0.6	0.000	0.0
	2007	0.0	0.0	73300	0.0	3	0.000	0.6	0.000	0.0
	2008	0.0	0.0	73300	0.0	3	0.000	0.6	0.000	0.0
Other solid fuels	2000	15.6	457.5	112000	51.2	30	0.000	4	0.000	51.3
	2001	1.8	54.2	112000	6.1	30	0.000	4	0.000	6.1
	2002	2.1	61.9	112000	6.9	30	0.000	4	0.000	6.9
	2003	1.7	50.6	112000	5.7	30	0.000	4	0.000	5.7
	2004	1.7	50.1	112000	5.6	30	0.000	4	0.000	5.6
	2005	0.0	0.9	112000	0.1	30	0.000	4	0.000	0.1
	2006	0.0	0.1	112000	0.0	30	0.000	4	0.000	0.0
	2007	0.0	0.0	112000	0.0	30	0.000	4	0.000	0.0
	2008	0.0	0.0	112000	0.0	30	0.000	4	0.000	0.0

Source: Estimates by Center for Energy Efficiency (CEE LLC)

5.4 Residential buildings

The Residential sector combusts fuel primarily for cooking, hot water supply and heating purposes. Residential fuel consumption data (“public distribution” or “public”) is provided in Forms “4-Toplivo” (“Fuel”), “22-ZhKKh” and “Balans Gaza” (“Gas Balance”). See emission factors in Table 5.5.

5.4.1 Rostov region

The residential sector in Rostov region produced 15.1% total greenhouse gas emissions in 2008. The emissions increased by 3.3% against 2000. See greenhouse gas emissions inventory for the residential sector in 2000-2008 in Table 5.9.

Table 5.9. Residential greenhouse gas emission inventory in Rostov region in 2000-2008.

Type of fuel	Year	Consumption, thousand tsf	Consumption, TJ	CO2 emission factor, kg CO ₂ /TJ	CO2 emissions, Gg CO ₂	CH4 emission factor, kg CH ₄ /TJ	CH4 emissions, Gg CH ₄	N2O emission factor, kg N ₂ O / TJ	N2O emissions, Gg N ₂ O	GHG emissions: CO2 equivalent, Gg CO ₂ equivalent
1	2	3	4	5	6	7	8	9	10	11
Residential buildings	2000	2747.2	80518.8	62337	5033.7		0.016		0.001	5034.4
	2001	2859.8	83818.9	62128	5218.3		0.017		0.001	5218.9
	2002	2904.6	85131.5	60953	5201.2		0.016		0.001	5201.8
	2003	3057.0	89597.5	58980	5297.5		0.016		0.001	5298.0
	2004	2936.2	86057.9	58965	5084.2		0.016		0.001	5084.7
	2005	2969.8	87040.4	59072	5147.8		0.016		0.001	5148.3
	2006	3046.3	89284.3	58641	5239.8		0.016		0.001	5240.3
	2007	2871.9	84173.6	58490	4927.4		0.015		0.001	4927.9
	2008	3070.7	89998.6	57763	5200.9		0.016		0.000	5201.4
Bituminous Coal	2000	445.0	13042.5	94600	1233.8	10	0.004	1.5	0.001	1234.1
	2001	445.7	13064.2	94600	1235.9	10	0.004	1.5	0.001	1236.2
	2002	365.1	10699.5	94600	1012.2	10	0.004	1.5	0.001	1012.4
	2003	227.9	6679.8	94600	631.9	10	0.002	1.5	0.000	632.1
	2004	218.2	6395.4	94600	605.0	10	0.002	1.5	0.000	605.2
	2005	225.4	6605.8	94600	624.9	10	0.002	1.5	0.000	625.1
	2006	197.3	5781.8	94600	547.0	10	0.002	1.5	0.000	547.1
	2007	168.5	4937.4	94600	467.1	10	0.002	1.5	0.000	467.2
2008	123.7	3625.3	94600	343.0	10	0.001	1.5	0.000	343.0	
Household stove fuel	2000	2.8	81.3	74100	6.0	10	0.000	0.6	0.000	6.0
	2001	1.9	57.0	74100	4.2	10	0.000	0.6	0.000	4.2
	2002	2.1	60.5	74100	4.5	10	0.000	0.6	0.000	4.5
	2003	2.1	62.9	74100	4.7	10	0.000	0.6	0.000	4.7
	2004	0.0	0.0	74100	0.0	10	0.000	0.6	0.000	0.0
	2005	0.0	0.0	74100	0.0	10	0.000	0.6	0.000	0.0
	2006	0.0	0.0	74100	0.0	10	0.000	0.6	0.000	0.0
	2007	0.0	0.0	74100	0.0	10	0.000	0.6	0.000	0.0
2008	0.0	0.0	74100	0.0	10	0.000	0.6	0.000	0.0	
Liquefied gas	2000	28.4	831.1	63100	52.4	5	0.000	0.1	0.000	52.4
	2001	32.5	953.0	63100	60.1	5	0.000	0.1	0.000	60.1
	2002	30.3	886.8	63100	56.0	5	0.000	0.1	0.000	56.0
	2003	30.6	897.0	63100	56.6	5	0.000	0.1	0.000	56.6
	2004	25.6	750.1	63100	47.3	5	0.000	0.1	0.000	47.3
	2005	36.3	1063.9	63100	67.1	5	0.000	0.1	0.000	67.1
	2006	30.8	902.1	63100	56.9	5	0.000	0.1	0.000	56.9
	2007	64.1	1879.9	63100	118.6	5	0.000	0.1	0.000	118.6
2008	54.8	1604.8	63100	101.3	5	0.000	0.1	0.000	101.3	
Natural gas	2000	2266.7	66434.8	56100	3727.0	5	0.011	0.1	0.000	3727.0

Type of fuel	Year	Consumption, thousand tsf	Consumption, TJ	CO2 emission factor, kg CO ₂ /TJ	CO2 emissions, Gg CO ₂	CH4 emission factor, kg CH ₄ / TJ	CH4 emissions, Gg CH ₄	N2O emission factor, kg N ₂ O / TJ	N2O emissions, Gg N ₂ O	GHG emissions: CO2 equivalent, Gg CO ₂
	2001	2376.4	69648.7	56100	3907.3	5	0.012	0.1	0.000	3907.3
	2002	2503.5	73375.9	56100	4116.4	5	0.013	0.1	0.000	4116.4
	2003	2792.4	81842.0	56100	4591.3	5	0.014	0.1	0.000	4591.3
	2004	2689.5	78825.1	56100	4422.1	5	0.013	0.1	0.000	4422.1
	2005	2706.2	79315.6	56100	4449.6	5	0.014	0.1	0.000	4450.0
	2006	2817.0	82564.3	56100	4631.9	5	0.014	0.1	0.000	4632.2
	2007	2638.1	77320.0	56100	4337.7	5	0.013	0.1	0.000	4338.0
	2008	2891.5	84748.0	56100	4754.4	5	0.014	0.1	0.000	4754.8
	Other solid fuels	2000	4.4	129.1	112 000	14.5	30	0.000	4	0.000
2001		3.3	95.9	112000	10.7	30	0.000	4	0.000	10.7
2002		3.7	108.7	112000	12.2	30	0.000	4	0.000	12.2
2003		4.0	115.9	112000	13.0	30	0.000	4	0.000	13.0
2004		3.0	87.3	112000	9.8	30	0.000	4	0.000	9.8
2005		1.9	55.2	112000	6.2	30	0.000	4	0.000	6.2
2006		1.2	36.1	112000	4.0	30	0.000	4	0.000	4.0
2007		1.2	36.3	112000	4.1	30	0.000	4	0.000	4.1
2008		0.7	20.4	112000	2.3	30	0.000	4	0.000	2.3

Source: Estimates by CENef

5.4.2 Sverdlovsk region

The residential sector in Sverdlovsk region produced 0.8% total greenhouse gas emission in 2008. The emissions increased by 35.8% against 2000. See greenhouse gas emissions inventory for the residential sector in 2000-2008 in Table 5.10.

Table 5.10. Residential greenhouse gas emission inventory in Sverdlovsk region in 2000-2008 (thousand tones CO2 equivalent)

Type of fuel	Year	Consumption, thousand tsf	Consumption, TJ	CO2 emission factor, kg CO ₂ /TJ	CO2 emissions, Gg CO ₂	CH4 emission factor, kg CH ₄ / TJ	CH4 emissions, Gg CH ₄	N2O emission factor, kg N ₂ O / TJ	N2O emissions, Gg N ₂ O	GHG emissions: CO2 equivalent, Gg CO ₂
1	2	3	4	5	6	7	8	9	10	11
Residential buildings	2000	591.3	17331.2	50754	879.6		0.003		0.000	879.71
	2001	630.0	18464.2	52165	963.2		0.003		0.000	963.28
	2002	731.7	21446.6	51530	1105.2		0.003		0.000	1105.25
	2003	710.7	20829.2	52798	1099.7		0.003		0.000	1099.84
	2004	801.3	23484.1	51975	1220.6		0.004		0.000	1220.70
	2005	779.0	22832.1	51148	1167.8		0.004		0.000	1167.92
	2006	782.0	22918.6	52631	1206.2		0.004		0.000	1206.32

Type of fuel	Year	Consumption, thousand tsf	Consumption, TJ	CO2 emission factor, kg CO ₂ /TJ	CO2 emissions, Gg CO ₂	CH4 emission factor, kg CH ₄ / TJ	CH4 emissions, Gg CH ₄	N2O emission factor, kg N ₂ O / TJ	N2O emissions, Gg N ₂ O	GHG emissions: CO2 equivalent, Gg CO ₂
	2007	777.5	22788.2	52656	1199.9		0.004		0.000	1200.04
	2008	773.5	22671.3	53765	1218.9		0.004		0.000	1219.03
Bituminous Coal	2000	20.35	596.3	94600	56.4	10	0.000	1.5	0.000	56.42
	2001	16.62	487.0	94600	46.1	10	0.000	1.5	0.000	46.08
	2002	16.79	492.0	94600	46.5	10	0.000	1.5	0.000	46.55
	2003	12.87	377.3	94600	35.7	10	0.000	1.5	0.000	35.70
	2004	13.40	392.6	94600	37.1	10	0.000	1.5	0.000	37.15
	2005	11.48	336.6	94600	31.8	10	0.000	1.5	0.000	31.85
	2006	7.83	229.4	94600	21.7	10	0.000	1.5	0.000	21.71
	2007	4.46	130.7	94600	12.4	10	0.000	1.5	0.000	12.37
	2008	4.64	135.9	94600	12.9	10	0.000	1.5	0.000	12.86
Household stove fuel	2000	0.00	0.0	74100	0.0	10	0.000	0.6	0.000	0.00
	2001	0.00	0.0	74100	0.0	10	0.000	0.6	0.000	0.00
	2002	0.00	0.0	74100	0.0	10	0.000	0.6	0.000	0.00
	2003	0.00	0.0	74100	0.0	10	0.000	0.6	0.000	0.00
	2004	0.00	0.0	74100	0.0	10	0.000	0.6	0.000	0.00
	2005	0.00	0.0	74100	0.0	10	0.000	0.6	0.000	0.00
	2006	0.00	0.0	74100	0.0	10	0.000	0.6	0.000	0.00
	2007	0.00	0.0	74100	0.0	10	0.000	0.6	0.000	0.00
	2008	0.00	0.0	74100	0.0	10	0.000	0.6	0.000	0.00
Liquefied gas	2000	24.83	727.7	63100	45.9	5.0	0.000	0.1	0.000	45.92
	2001	24.33	713.1	63100	45.0	5	0.000	0.1	0.000	45.00
	2002	22.65	663.8	63100	41.9	5	0.000	0.1	0.000	41.89
	2003	22.08	647.1	63100	40.8	5	0.000	0.1	0.000	40.83
	2004	21.62	633.7	63100	40.0	5	0.000	0.1	0.000	39.99
	2005	19.80	580.2	63100	36.6	5	0.000	0.1	0.000	36.61
	2006	17.04	499.5	63100	31.5	5	0.000	0.1	0.000	31.52
	2007	13.99	409.9	63100	25.9	5	0.000	0.1	0.000	25.87
	2008	13.28	389.3	63100	24.6	5	0.000	0.1	0.000	24.57
Natural gas	2000	472.74	13855.7	56100	777.3	5	0.002	0.1	0.000	777.37
	2001	530.42	15546.0	56100	872.1	5	0.003	0.1	0.000	872.20
	2002	618.36	18123.4	56100	1016.7	5	0.003	0.1	0.000	1016.81
	2003	622.31	18239.4	56100	1023.2	5	0.003	0.1	0.000	1023.31
	2004	695.43	20382.5	56100	1143.5	5	0.003	0.1	0.000	1143.55
	2005	668.62	19596.6	56100	1099.4	5	0.003	0.1	0.000	1099.46
	2006	701.23	20552.5	56100	1153.0	5	0.004	0.1	0.000	1153.09
	2007	706.53	20707.7	56100	1161.7	5	0.004	0.1	0.000	1161.80
	2008	718.58	21060.7	56100	1181.5	5	0.004	0.1	0.000	1181.60
Other solid fuels	2000	73.4	2151.5	112000		300	0.000	4	0.000	0.00
	2001	58.6	1718.2	112000		300	0.000	4	0.000	0.00
	2002	73.9	2167.4	112000		300	0.000	4	0.000	0.00
	2003	53.4	1565.5	112000		300	0.000	4	0.000	0.00
	2004	70.8	2075.2	112000		300	0.000	4	0.000	0.00
	2005	79.1	2318.8	112000		300	0.000	4	0.000	0.00
	2006	55.9	1637.2	112000		300	0.000	4	0.000	0.00
	2007	52.5	1539.8	112000		300	0.000	4	0.000	0.00
	2008	37.0	1085.5	112000		300	0.000	4	0.000	0.00

Source: Estimates by Center for Energy Efficiency (CEE LLC)

5.4.3 Tver region

The residential sector in Tver region produced 6.7% total greenhouse gas emissions in 2008. The emissions increased by 7.8% against 2000. See greenhouse gas emissions inventory for the residential sector in 2000-2008 in Table 5.11.

Table 5.11. Residential greenhouse gas emission inventory in Tver region in 2000-2008.

Type of fuel	Year	Consumption, thousand tsf	Consumption, TJ	CO2 emission factor, kg CO2/TJ	CO2 emissions, Gg CO2	CH4 emission factor, kg CH4/ TJ	CH4 emissions, Gg CH4	N2O emission factor, kg N2O / TJ	N2O emissions, Gg N2O	GHG emissions: CO2 equivalent, Gg CO2
1	2	3	4	5	6	7	8	9	10	11
Residential buildings	2000	491.5	13972.4	56541	790.0		0.003		0.000	790.1
	2001	489.0	13818.8	56589	782.0		0.003		0.000	782.1
	2002	476.8	13463.5	56590	761.9		0.003		0.000	762.0
	2003	528.5	15022.5	56530	849.2		0.003		0.000	849.3
	2004	526.5	14920.6	56564	844.0		0.003		0.000	844.1
	2005	511.6	14605.9	56703	828.2		0.003		0.000	828.3
	2006	512.9	14660.4	56550	829.0		0.003		0.000	829.1
	2007	518.4	14999.7	56405	846.1		0.003		0.000	846.1
	2008	520.2	15083.4	56441	851.3		0.003		0.000	851.4
Bituminous Coal	2000	2.9	85.8	94600	8.1	10	0.000	1.5	0.000	8.1
	2001	2.4	70.2	94600	6.6	10	0.000	1.5	0.000	6.6
	2002	1.7	50.0	94600	4.7	10	0.000	1.5	0.000	4.7
	2003	1.5	45.1	94600	4.3	10	0.000	1.5	0.000	4.3
	2004	1.9	56.5	94600	5.3	10	0.000	1.5	0.000	5.3
	2005	3.8	111.1	94600	10.5	10	0.000	1.5	0.000	10.5
	2006	2.0	59.9	94600	5.7	10	0.000	1.5	0.000	5.7
	2007	0.6	16.5	94600	1.6	10	0.000	1.5	0.000	1.6
	2008	1.2	34.8	94600	3.3	10	0.000	1.5	0.000	3.3
Household stove fuel	2000	0.0	0.0	74100	0.0	10	0.000	0.6	0.000	0.0
	2001	0.0	0.0	74100	0.0	10	0.000	0.6	0.000	0.0
	2002	0.0	0.0	74100	0.0	10	0.000	0.6	0.000	0.0
	2003	0.0	0.0	74100	0.0	10	0.000	0.6	0.000	0.0
	2004	0.0	0.0	74100	0.0	10	0.000	0.6	0.000	0.0
	2005	0.0	0.0	74100	0.0	10	0.000	0.6	0.000	0.0
	2006	0.0	0.0	74100	0.0	10	0.000	0.6	0.000	0.0
	2007	0.0	0.0	74100	0.0	10	0.000	0.6	0.000	0.0
	2008	0.0	0.0	74100	0.0	10	0.000	0.6	0.000	0.0
Liquefied gas	2000	14.0	409.4	63100	25.8	5	0.000	0.1	0.000	25.8
	2001	19.8	580.3	63100	36.6	5	0.000	0.1	0.000	36.6
	2002	22.8	667.9	63100	42.1	5	0.000	0.1	0.000	42.1
	2003	23.0	674.3	63100	42.5	5	0.000	0.1	0.000	42.5
	2004	23.1	678.4	63100	42.8	5	0.000	0.1	0.000	42.8
	2005	22.0	646.1	63100	40.8	5	0.000	0.1	0.000	40.8
	2006	20.9	612.6	63100	38.7	5	0.000	0.1	0.000	38.7
	2007	19.2	562.8	63100	35.5	5	0.000	0.1	0.000	35.5
	2008	18.5	543.2	63100	34.3	5	0.000	0.1	0.000	34.3
Natural gas	2000	459.8	13477.3	56100	756.1	5	0.002	0.1	0.000	756.1
	2001	449.3	13168.4	56100	738.7	5	0.002	0.1	0.000	738.8
	2002	434.9	12745.6	56100	715.0	5	0.002	0.1	0.000	715.1
	2003	488.0	14303.1	56100	802.4	5	0.002	0.1	0.000	802.5
	2004	484.0	14185.7	56100	795.8	5	0.002	0.1	0.000	795.9

Type of fuel	Year	Consumption, thousand tsf	Consumption, TJ	CO2 emission factor, kg CO2/TJ	CO2 emissions, Gg CO2	CH4 emission factor, kg CH4/ TJ	CH4 emissions, Gg CH4	N2O emission factor, kg N2O / TJ	N2O emissions, Gg N2O	GHG emissions: CO2 equivalent, Gg CO2
	2005	472.5	13848.7	56100	776.9	5	0.002	0.1	0.000	777.0
	2006	477.3	13987.8	56100	784.7	5	0.002	0.1	0.000	784.8
	2007	492.0	14420.4	56100	809.0	5	0.002	0.1	0.000	809.0
	2008	494.9	14505.5	56100	813.8	5	0.002	0.1	0.000	813.8
	2000	14.8	432.9	112000	0.0	30	0.000	4	0.000	0.0
	2001	17.5	512.9	112000	0.0	30	0.001	4	0.000	0.0
	2002	17.5	512.1	112000	0.0	30	0.001	4	0.000	0.0
	2003	15.9	466.0	112000	0.0	30	0.000	4	0.000	0.0
Other solid fuels	2004	17.4	509.2	112000	0.0	30	0.001	4	0.000	0.0
	2005	13.3	390.0	112000	0.0	30	0.000	4	0.000	0.0
	2006	12.7	373.3	112000	0.0	30	0.000	4	0.000	0.0
	2007	6.6	193.0	112000	0.0	30	0.000	4	0.000	0.0
	2008	5.6	163.2	112000	0.0	30	0.000	4	0.000	0.0

Source: Estimates by Center for Energy Efficiency (CEE LLC)

5.5 Agriculture / Forestry / Fishing / Fish farms

The fuel consumption by the off-road vehicles (tractors, mobile cranes, back hoes and loaders), is covered in the “Off-road vehicles” and is thus accounted for in “Transport” sector (1.A.3). The remaining insignificant fuel consumed in these sectors is reported in Form “11-TER”.

5.5.1 Rostov region

Agricultural sector in Rostov region produced a fairly insignificant amount of greenhouse gas emissions in 2008 (this is primarily emissions from natural gas combustion and fuel consumption by fishing companies). See greenhouse gas emissions inventory for “Agriculture” sector in 2000-2008 in Table 5.12.

Table 5.12. Greenhouse Gas Emission Inventory in “Agriculture” sector for Rostov region in 2000-2008.

Year	Consumption, thousand tsf	Consumption, TJ	CO2 emissions, Gg CO2	CH4 emissions, Gg CH4	N2O emissions, Gg N2O	GHG emissions: CO2 equivalent, Gg CO2
2000	1.4	40.6	3.1	0.000	0.000	3.1
2001	1.8	53.2	3.8	0.000	0.000	3.8
2002	2.2	63.9	4.5	0.000	0.000	4.5
2003	2.2	64.6	4.5	0.000	0.000	4.5
2004	2.3	67.9	4.6	0.000	0.000	4.6
2005	2.2	64.6	4.1	0.000	0.000	4.1
2006	2.0	59.0	3.6	0.000	0.000	3.6
2007	2.1	60.1	3.7	0.000	0.000	3.7
2008	2.2	65.5	4.0	0.000	0.000	4.0

Source: Estimates by Center for Energy Efficiency (CEE LLC)

5.5.2 Sverdlovsk region

Sverdlovsk region Agricultural sector also made an insignificant contribution of greenhouse gases in 2008 (this were primarily emissions from natural gas combustion). See greenhouse gas emissions inventory for the “Agriculture” sector in 2000-2008 in Table 5.13.

Table 5.13. Greenhouse Gas Emission Inventory for “Agriculture” sector of Sverdlovsk region in 2000-2008.

Year	Consumption, thousand tsf	Consumption, TJ	CO2 emissions, Gg CO2	CH4 emissions, Gg CH4	N2O emissions, Gg N2O	GHG emissions: CO2 equivalent, Gg CO2
2000	1.0	29.5	2.1	0.000	0.000	2.1
2001	1.3	39.2	2.6	0.000	0.000	2.6
2002	0.9	25.5	1.6	0.000	0.000	1.6
2003	1.1	33.3	2.0	0.000	0.000	2.0
2004	0.7	21.7	1.3	0.000	0.000	1.3
2005	0.4	10.8	0.6	0.000	0.000	0.6
2006	0.3	9.1	0.6	0.000	0.000	0.6
2007	0.2	4.9	0.3	0.000	0.000	0.3
2008	0.1	4.2	0.3	0.000	0.000	0.3

Source: Estimates by CENEF

5.5.3 Tver region

The agricultural industry in Tver region does not contribute to greenhouse gas emissions (agricultural transport operation is covered in other sections). See greenhouse gas emissions inventory for “Agriculture” sector in 2000-2008 in Table 5.14.

Table 5.14. Greenhouse Gas Emission Inventory in “Agriculture” sector for Tver region in 2000-2008.

Year	Consumption, thousand tsf	Consumption, TJ	CO2 emissions, Gg CO ₂	CH4 emissions, Gg CH ₄	N2O emissions, Gg N ₂ O	GHG emissions: CO2 equivalent, Gg CO ₂
2000	0.0	0.0	0.0	0.000	0.000	0.0
2001	0.0	0.0	0.0	0.000	0.000	0.0
2002	0.0	0.0	0.0	0.000	0.000	0.0
2003	0.0	0.0	0.0	0.000	0.000	0.0
2004	0.0	0.0	0.0	0.000	0.000	0.0
2005	0.0	0.0	0.0	0.000	0.000	0.0
2006	0.0	0.0	0.0	0.000	0.000	0.0
2007	0.0	0.0	0.0	0.000	0.000	0.0
2008	0.0	0.0	0.0	0.000	0.000	0.0

Source: Estimates by Center for Energy Efficiency (CEE LLC)

5.6 Completeness

Inventory provides a fairly complete representation of the fuel combustion at the residential units. However, the reliability of the data for individual years is questionable. As far as the Service is concerned, since this item is compiled on the residual principle basis in many statistical reporting forms, it is difficult to verify how well the fuel

combustion at the residential units is represented. Unfortunately, Russia does not maintain any statistics on the fuel consumption in various groups of the service industries as, for example, it is done in Japan.

5.7 Uncertainty assessment

The sector has the lowest accuracy of the estimates. There are a few factors in the sector which facilitate the uncertainty of the delivered estimates: potential noncoverage of all available emission sources (see above); low accuracy of the fuel consumption data (by no means all the residential gas consumers have the gas meters; the small businesses, which have a large share in the sector, do not report the fuel consumption) and the uncertainty of the emission factors. In general, the uncertainty of the emission estimates in the sector could be rated at least $\pm 10\%$.

6 Transport

6.1 Main results

The automobile transport greenhouse gas emissions have a tendency to grow, whereas the emissions from other types of transport remain stable or tend to decline. Maintaining such trends leads to an unmanaged growth of emissions, as controlling the greenhouse gas emissions produced by the automobile transport is the most complicated issue, both from technical and the institutional point of view, and Russia does not pursue any policy to improve the automobile fuel efficiency.

6.1.1 Rostov region

See Table 6.1 for the estimate of greenhouse gas emissions from the transport in Rostov region in 2000-2008.

Table 6.1. The transport emitted Greenhouse Gas inventory in Rostov region in 2000-2008 (thousand tones of CO₂ equivalents)

Type of fuel	Year	Consumption, thousand tsf	Consumption, TJ	CO ₂ emissions, (Gg CO ₂)	CH ₄ emissions, (Gg CH ₄)	N ₂ O emissions, (Gg N ₂ O)	GHG emissions: CO ₂ equivalent, (Gg CO ₂)
1	2	3	4	5	6	7	8
Transport	2000	3555.3	104201.4	7563.3	1.315	0.336	7695.1
	2001	3598.8	105475.9	7653.3	1.343	0.343	7787.9
	2002	3723.7	109138.3	7909.4	1.441	0.354	8049.4
	2003	3792.6	111158.3	8052.2	1.488	0.363	8196.0
	2004	3750.0	109908.1	7960.1	1.466	0.358	8101.9
	2005	3813.6	111772.7	8094.6	1.471	0.365	8238.7
	2006	3991.7	116993.1	8455.6	1.654	0.383	8608.9
	2007	4142.5	121412.2	8770.2	1.741	0.398	8930.2
	2008	4167.2	122136.2	8814.0	1.795	0.404	8976.8
Off-Road Transport	2000	281.4	8247.5	610.9	0.000	0.000	610.9
	2001	272.3	7981.7	591.2	0.000	0.000	591.2
	2002	277.4	8131.7	602.3	0.000	0.000	602.3
	2003	275.5	8073.3	597.9	0.000	0.000	597.9
	2004	274.2	8035.9	595.1	0.000	0.000	595.1
	2005	229.1	6715.6	497.4	0.000	0.000	497.4
	2006	220.2	6453.6	478.0	0.000	0.000	478.0
	2007	220.5	6464.1	478.8	0.000	0.000	478.8
	2008	185.0	5423.4	401.6	0.000	0.000	401.6
Railroads	2000	127.1	3726.4	276.1	0.001	0.004	277.3
	2001	103.4	3031.8	224.7	0.000	0.003	225.6
	2002	103.6	3035.4	224.9	0.000	0.003	225.9
	2003	78.9	2313.8	171.5	0.000	0.002	172.2
	2004	76.5	2241.5	166.1	0.000	0.002	166.8
	2005	76.1	2229.9	165.2	0.000	0.002	165.9
	2006	76.1	2230.2	165.3	0.000	0.002	165.9
	2007	78.3	2295.6	170.1	0.000	0.002	170.8
	2008	80.2	2351.5	174.2	0.000	0.002	175.0
Aviation	2000	35.0	1026.1	73.8	0.000	0.000	73.8
	2001	35.9	1053.1	75.7	0.000	0.000	75.7

Type of fuel	Year	Consumption, thousand tsf	Consumption, TJ	CO2 emissions, (Gg CO ₂)	CH4 emissions, (Gg CH ₄)	N2O emissions, (Gg N ₂ O)	GHG emissions: CO2 equivalent, (Gg CO ₂)
	2002	42.7	1252.8	90.0	0.000	0.000	90.1
	2003	48.0	1405.5	101.0	0.000	0.000	101.1
	2004	53.2	1559.9	112.1	0.000	0.000	112.1
	2005	102.0	2989.2	214.9	0.000	0.000	214.9
	2006	103.3	3027.8	217.6	0.000	0.000	217.7
	2007	99.4	2914.6	209.5	0.000	0.000	209.6
	2008	97.0	2842.7	204.3	0.000	0.000	204.4
	Road Transport	2000	3107.9	91088.6	6595.2	1.315	0.332
	2001	3181.8	93256.5	6751.7	1.343	0.340	6885.3
	2002	3294.1	96545.9	6980.8	1.441	0.351	7119.9
	2003	3385.9	99237.0	7173.4	1.488	0.361	7316.4
	2004	3341.5	97936.8	7078.0	1.465	0.356	7219.1
	2005	3402.0	99707.9	7208.7	1.470	0.363	7352.0
	2006	3588.1	105163.1	7587.2	1.653	0.380	7739.8
	2007	3737.2	109533.9	7899.8	1.740	0.396	8058.9
	2008	3795.1	111231.9	8017.0	1.794	0.401	8179.0
Water-Borne Transport	2000	2.0	58.1	4.3	0.000	0.000	4.3
	2001	2.9	84.7	6.3	0.000	0.000	6.3
	2002	3.1	90.5	6.7	0.000	0.000	6.7
	2003	2.4	71.3	5.3	0.000	0.000	5.3
	2004	2.3	67.5	5.0	0.000	0.000	5.0
	2005	2.2	63.2	4.7	0.000	0.000	4.7
	2006	1.6	47.7	3.5	0.000	0.000	3.5
	2007	1.3	37.4	2.8	0.000	0.000	2.8
	2008	1.3	38.9	2.9	0.000	0.000	2.9

Source: Estimates by CENEF

The transport in Rostov region is (a) second largest source of emissions after the power stations and (b) a rapidly growing source of emissions – the emissions of three greenhouse gases grew 16.7% in 2000-2008. The share of the automobile transport was 91.1% of total emissions produced by the Transport sector in 2008; Aviation – 2.3%; Railways – 1.9%; Water-borne transport – 0.1%, Off-road transport – 4.8% (See Figure 6.1).

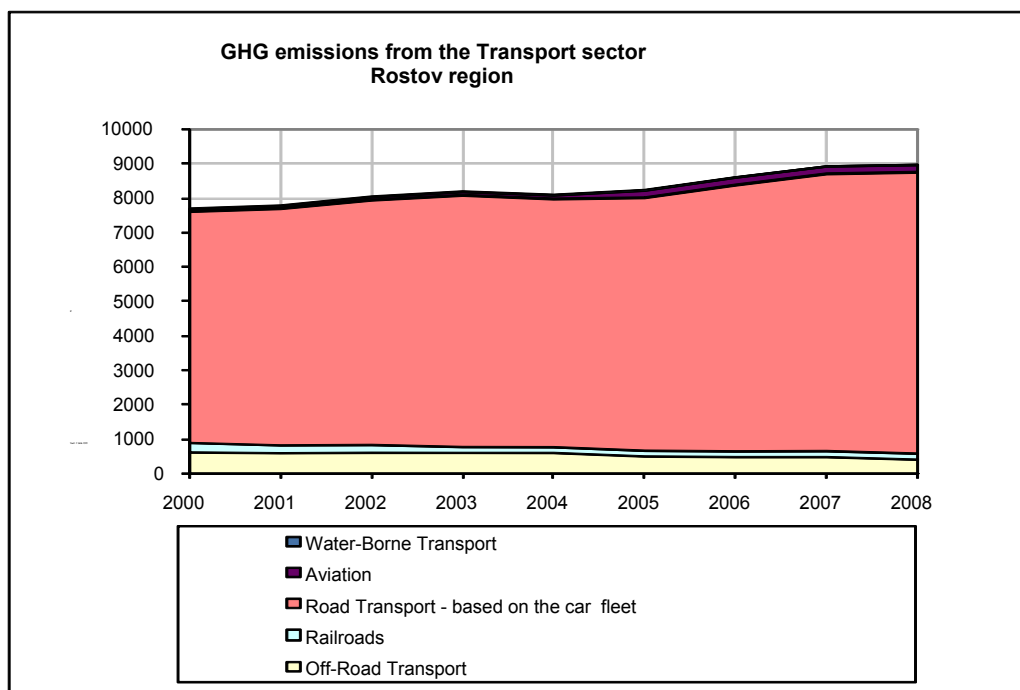


Figure 6.1. The trend of GHG emissions in Rostov region by the types of transport in 2000-2008.

6.1.2 Sverdlovsk region

See Table 6.2 for in Sverdlovsk region in 2000-2008.

Table 6.2. The transport emitted Greenhouse Gas inventory in Sverdlovsk region in 2000-2008 (thousand tones of CO₂ equivalents)

Type of fuel	Year	Consumption, thousand tsf	Consumption, TJ	CO ₂ emissions, (Gg CO ₂)	CH ₄ emissions, (Gg CH ₄)	N ₂ O emissions, (Gg N ₂ O)	GHG emissions: CO ₂ equivalent, (Gg CO ₂)
1	2	3	4	5	6	7	8
Transport	2000	2622.4	76860.1	5564.1	1.069	0.234	5658.94
	2001	2758.4	80846.2	5848.3	1.091	0.234	5943.69
	2002	2697.1	79049.7	5716.5	1.211	0.242	5816.81
	2003	2684.7	78686.8	5675.7	1.295	0.241	5777.53
	2004	2819.4	82632.8	5950.0	1.333	0.243	6053.29
	2005	3095.1	90715.2	6525.7	1.419	0.254	6634.17
	2006	3384.3	99189.5	7109.8	1.723	0.280	7232.76
	2007	3817.5	111883.6	8006.9	1.896	0.294	8137.86
	2008	4009.3	117504.2	8393.7	2.046	0.304	8531.00
Off-Road Transport	2000	166.8	4890.2	362.4	0.001	0.005	363.86
	2001	160.3	4697.7	348.1	0.001	0.005	349.53
	2002	207.7	6086.8	451.0	0.001	0.006	452.89
	2003	190.6	5587.6	414.0	0.001	0.005	415.74
	2004	170.9	5007.9	371.1	0.001	0.005	372.62
	2005	183.5	5378.8	398.6	0.001	0.005	400.21
	2006	175.0	5129.3	380.1	0.001	0.005	381.65
	2007	172.1	5043.0	373.7	0.001	0.005	375.23
	2008	177.5	5203.1	385.6	0.001	0.005	387.14
Railways	2000	128.9	3778.7	280.0	0.001	0.004	281.16
	2001	127.2	3726.7	276.2	0.001	0.004	277.29
	2002	128.8	3774.1	279.7	0.001	0.004	280.82
	2003	128.8	3774.6	279.7	0.001	0.004	280.85
	2004	126.0	3694.3	273.7	0.001	0.004	274.88

Type of fuel	Year	Consumption, thousand tsf	Consumption, TJ	CO2 emissions, (Gg CO ₂)	CH4 emissions, (Gg CH ₄)	N2O emissions, (Gg N ₂ O)	GHG emissions: CO2 equivalent, (Gg CO ₂)
Aviation	2005	132.4	3879.2	287.4	0.001	0.004	288.63
	2006	133.6	3914.8	290.1	0.001	0.004	291.28
	2007	141.7	4153.0	307.7	0.001	0.004	309.01
	2008	97.2	2848.8	211.1	0.000	0.003	211.97
	2000	166.0	4864.6	349.7	0.000	0.000	349.83
	2001	309.6	9073.7	652.3	0.000	0.001	652.53
	2002	127.4	3733.5	268.4	0.000	0.000	268.46
	2003	118.5	3473.3	249.7	0.000	0.000	249.75
	2004	243.0	7121.9	512.0	0.000	0.000	512.15
	2005	399.7	11715.6	842.3	0.000	0.001	842.54
	2006	408.2	11965.0	860.2	0.000	0.001	860.46
	2007	685.4	20088.1	1444.3	0.000	0.001	1444.73
2008	791.0	23183.7	1666.9	0.000	0.002	1667.39	
Water-Borne Transport	2000	0.0	0.0	0.0	0.0	0.0	0.0
	2001	0.0	0.0	0.0	0.0	0.0	0.0
	2002	0.0	0.0	0.0	0.0	0.0	0.0
	2003	0.0	0.0	0.0	0.0	0.0	0.0
	2004	0.0	0.0	0.0	0.0	0.0	0.0
	2005	0.0	0.0	0.0	0.0	0.0	0.0
	2006	0.0	0.0	0.0	0.0	0.0	0.0
	2007	0.2	4.9	0.3	0.0	0.0	0.34
2008	0.2	4.7	0.3	0.0	0.0	0.33	
Road Transport	2000	2139.7	62711.1	4537.4	1.065	0.225	4629.51
	2001	2144.2	62845.6	4543.5	1.088	0.225	4636.09
	2002	2229.1	65333.6	4710.5	1.209	0.232	4807.81
	2003	2242.6	65727.0	4725.3	1.293	0.231	4824.20
	2004	2271.8	66585.4	4780.6	1.331	0.234	4881.10
	2005	2375.1	69610.8	4990.1	1.417	0.244	5095.44
	2006	2662.5	78036.5	5571.4	1.721	0.270	5691.27
	2007	2812.9	82444.2	5872.4	1.895	0.284	6000.16
	2008	2939.3	86147.8	6123.4	2.044	0.295	6257.72

Source: Estimates by CENef

The transport in Sverdlovsk region is the fourth most important and rapidly growing emission source. The emissions of three greenhouse gases produced by transport increased by 50.7% in 2000-2008. The road transport contributed 73.3% of total transport sector emissions in 2008; Aviation - 19.5%; Railroads – 2.5%; Off-Road Transport – 4.5%, Water-borne – less than 0.1% (See Fig. 6.2).

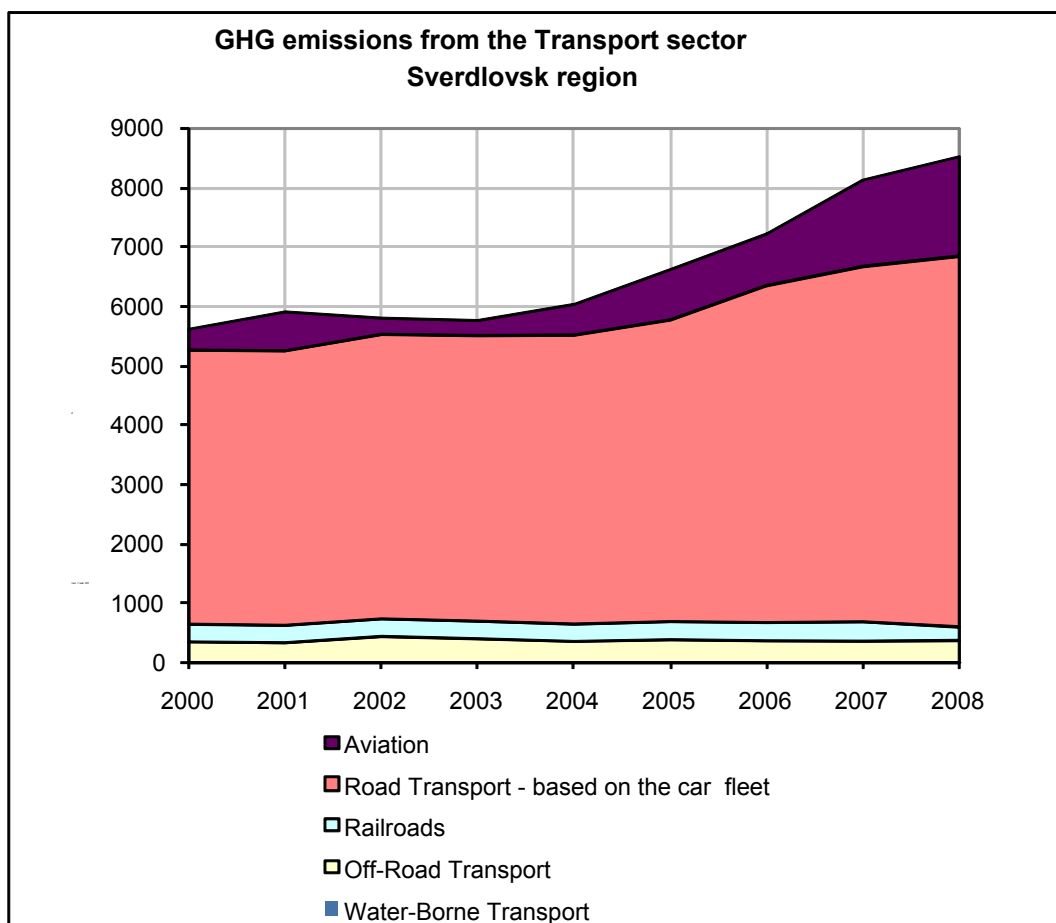


Figure 6.2. The trend of GHG emissions in Sverdlovsk region by the types of transport in 2000-2008

6.1.3 Tver region

See the Estimate of greenhouse gases emissions from the Transport in Tver region in 2000-2008 in Table 6.3.

Table 6.3. The transport emitted Greenhouse Gas inventory in Tver region in 2000-2008 (thousand tones of CO₂ equivalents)

Type of fuel	Year	Consumption, thousand tsf	Consumption, TJ	CO ₂ emissions, (Gg CO ₂)	CH ₄ emissions, (Gg CH ₄)	N ₂ O emissions, (Gg N ₂ O)	GHG emissions: CO ₂ equivalent, (Gg CO ₂)
1	2	3	4	5	6	7	8
Transport	2000	1144.4	33541.8	2439.5	0.486	0.107	2483.0
	2001	1165.5	34160.3	2484.3	0.496	0.110	2528.9
	2002	1229.4	36031.6	2619.9	0.528	0.117	2667.1
	2003	1257.0	36842.8	2678.1	0.540	0.119	2726.4
	2004	1262.4	36998.4	2689.4	0.541	0.119	2737.7
	2005	1265.4	37088.5	2695.0	0.549	0.121	2743.9
	2006	1334.1	39102.1	2835.7	0.615	0.128	2888.1
	2007	1348.5	39523.6	2859.1	0.641	0.129	2912.4
	2008	1336.1	39160.9	2829.8	0.664	0.128	2883.4
Off-Road Transport	2000	57.7	1691.3	125.5	0.000	0.000	125.5
	2001	51.4	1505.1	111.7	0.000	0.000	111.7
	2002	52.4	1534.7	114.0	0.000	0.000	114.0
	2003	47.6	1395.9	103.7	0.000	0.000	103.7

Type of fuel	Year	Consumption, thousand tsf	Consumption, TJ	CO2 emissions, (Gg CO ₂)	CH4 emissions, (Gg CH ₄)	N2O emissions, (Gg N ₂ O)	GHG emissions: CO2 equivalent, (Gg CO ₂)
	2004	45.7	1340.8	99.5	0.000	0.000	99.5
	2005	38.4	1125.7	83.6	0.000	0.000	83.6
	2006	38.8	1138.1	84.5	0.000	0.000	84.5
	2007	33.2	972.5	72.3	0.000	0.000	72.3
	2008	20.7	606.6	45.1	0.000	0.000	45.1
Railways	2000	87.4	2561.3	189.8	0.000	0.002	190.6
	2001	86.5	2534.7	187.8	0.000	0.002	188.6
	2002	91.3	2676.1	198.3	0.000	0.003	199.1
	2003	98.6	2891.1	214.2	0.000	0.003	215.1
	2004	110.8	3246.5	240.6	0.000	0.003	241.6
	2005	105.8	3101.9	229.9	0.000	0.003	230.8
	2006	101.3	2968.5	220.0	0.000	0.003	220.9
	2007	95.1	2788.7	206.6	0.000	0.003	207.5
	2008	89.0	2608.6	193.3	0.000	0.003	194.1
Aviation	2000	0.7	21.4	1.5	0.000	0.000	1.5
	2001	1.5	43.7	3.1	0.000	0.000	3.1
	2002	0.7	21.8	1.6	0.000	0.000	1.6
	2003	0.9	27.2	2.0	0.000	0.000	2.0
	2004	0.6	18.2	1.3	0.000	0.000	1.3
	2005	1.0	29.6	2.1	0.000	0.000	2.1
	2006	0.1	1.8	0.1	0.000	0.000	0.1
	2007	0.8	22.5	1.6	0.000	0.000	1.6
	2008	8.4	246.7	17.7	0.000	0.000	17.7
Road Transport	2000	995.3	29170.8	2115.7	0.486	0.105	2158.4
	2001	1023.2	29988.0	2175.3	0.495	0.108	2219.2
	2002	1082.8	31735.6	2301.3	0.527	0.114	2347.8
	2003	1106.6	32433.0	2351.5	0.539	0.117	2398.9
	2004	1101.7	32288.9	2340.6	0.541	0.116	2387.9
	2005	1116.8	32733.2	2372.3	0.549	0.118	2420.3
	2006	1190.9	34904.6	2524.9	0.615	0.125	2576.4
	2007	1207.2	35382.4	2557.4	0.640	0.126	2609.9
	2008	1207.0	35376.4	2553.9	0.663	0.125	2606.7
Water-Borne Transport	2000	2.8	80.9	6.0	0.0	0.0	6.0
	2001	2.4	71.6	5.3	0.0	0.0	5.3
	2002	2.2	63.4	4.7	0.0	0.0	4.7
	2003	2.7	79.0	5.9	0.0	0.0	5.9
	2004	2.9	85.2	6.3	0.0	0.0	6.3
	2005	3.1	91.2	6.8	0.0	0.0	6.8
	2006	2.3	66.1	4.9	0.0	0.0	4.9
	2007	2.1	62.4	4.6	0.0	0.0	4.6
	2008	3.3	96.3	7.1	0.0	0.0	7.1

Source: Estimates by CENEF

The Transport is the third most important (after the power stations and boilers) and the most rapidly growing source of emission in Tver region: The emissions of three greenhouse gases produced by transport increased by 16.1% in 2000-2008. The road transport contributed 90% of total transport sector emissions in 2008; Aviation - 1%; Railroads – 7%; Off-Road Transport – 2% (See Fig. 6.3).

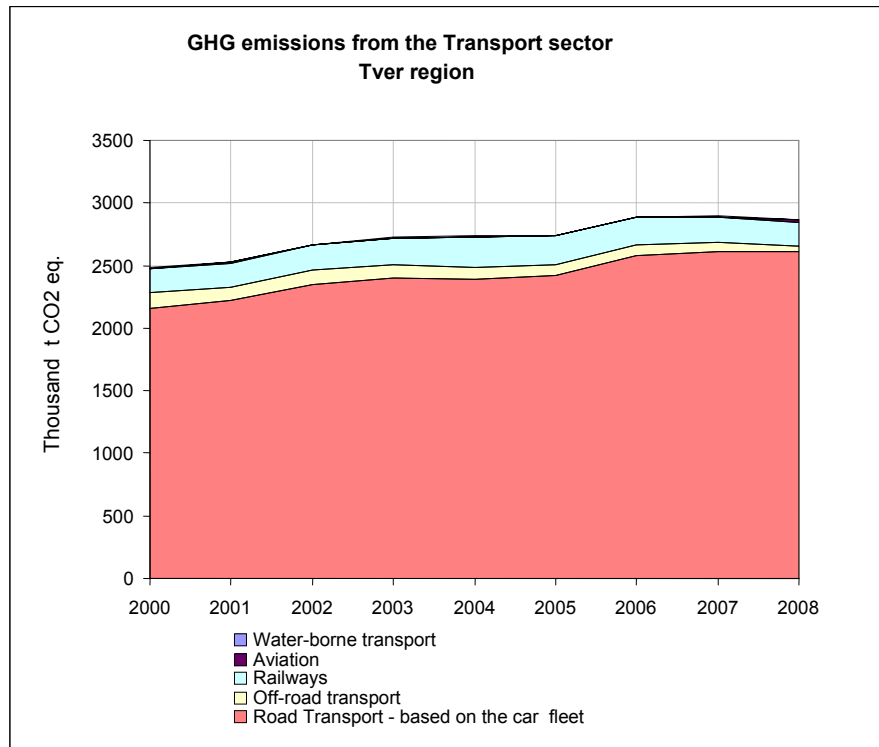


Figure 6.3. The trend of GHG emissions in Tver region by the types of transport in 2000-2008

6.2 Inventory Compilation Methodology for Transport

The transport emitted greenhouse gas inventory was completed on the basis of Chapter 3 “Mobile Combustion”, volume 2 “Energy” of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories”.

Mobile sources produce direct greenhouse gas emissions of carbon dioxide (CO₂), methane (CH₄) and nitrous oxide (N₂O) from the combustion of various fuel types, as well as several other pollutants such as carbon monoxide (CO), Non-methane Volatile Organic Compounds (NMVOCs), sulphur dioxide (SO₂), particulate matter (PM) and oxides of nitrate (NO_x), which cause or contribute to local or regional pollution. This study covers emissions of three greenhouse gases: CO₂, CH₄ and N₂O.

For the list of activities that cause greenhouse gas emission from transport, please refer to Table 6.4.

Table 6.4. Detailed Sector Split for the Transport Sector

Code and Name				Explanation
1 A 3	TRANSPORT			Emissions from the combustion and evaporation of fuel for all transport activity (excluding military transport), regardless of the sector, specified by sub-categories below. Emissions from fuel sold to any air or marine vessel engaged in international transport (1 A 3 a i and 1 A 3 d i) should as far as possible be excluded from the totals and subtotals in this category and should be reported separately.
1 A 3	a	Civil Aviation		Emissions from international and domestic civil aviation, including takeoffs and landings. Comprises civil commercial use of airplanes, including: scheduled and charter traffic for passengers and freight, air taxiing, and general aviation. The international/domestic split should be determined on the basis of departure and landing locations for each flight stage and not by the nationality of the airline. Exclude use of fuel at airports for ground transport which is reported under 1 A 3 e "Other Transportation". Also exclude fuel for stationary combustion at airports; report this information under the appropriate stationary combustion category.
1 A 3	a	i	International Aviation (International Bunkers)	Emissions from flights that depart in one country and arrive in a different country. Include take-offs and landings for these flight stages. Emissions from international military aviation can be included as a separate subcategory of international aviation provided that the same definitional distinction is applied and data are available to support the definition.
1 A 3	a	ii	Domestic Aviation	Emissions from civil domestic passenger and freight traffic that departs and arrives in the same country (commercial, private, agriculture, etc.), including take-offs and landings for these flight stages. Note that this may include journeys of considerable length between two airports in a country (e.g. San Francisco to Honolulu). Exclude military, which should be reported under 1 A 5 b.
1 A 3	B	Road Transportation		All combustion and evaporative emissions arising from fuel use in road vehicles, including the use of agricultural vehicles on paved roads.
1 A 3	b	i	Cars	Emissions from automobiles so designated in the vehicle registering country primarily for transport of persons and normally having a capacity of 12 persons or fewer.
1 A 3	b	i	1 Passenger cars with 3-way catalysts	Emissions from passenger car vehicles with 3-way catalysts.
1 A 3	b	i	2 Passenger cars without 3-way catalysts	Emissions from passenger car vehicles without 3-way catalysts.

Code and Name				Explanation
Code and Name				Explanation
1 A 3	b	ii	<i>Light duty trucks</i>	Emissions from vehicles so designated in the vehicle registering country primarily for transportation of lightweight cargo or which are equipped with special features such as four-wheel drive for off-road operation. The gross vehicle weight normally ranges up to 3500-3900 kg or less.
1 A 3	b	ii	1 <i>Light duty trucks with 3-way catalyts</i>	Emissions from light duty trucks with 3-way catalyts.
1 A 3	b	ii	2 <i>Light duty trucks without 3-way catalyts</i>	Emissions from light duty trucks without 3-way catalyts.
1 A 3	b	iii	<i>Heavy duty trucks and buses</i>	Emissions from any vehicles so designated in the vehicle registering country. Normally the gross vehicle weight ranges from 3500-3900 kg or more for heavy duty trucks and the buses are rated to carry more than 12 persons.
1 A 3	b	iv	<i>Motorcycles</i>	Emissions from any motor vehicle designed to travel with not more than three wheels in contact with the ground and weighing less than 680 kg.
1 A 3	b	v	<i>Evaporative emissions from vehicles</i>	Evaporative emissions from vehicles (e.g. hot soak, running losses) are included here. Emissions from loading fuel into vehicles are excluded.
1 A 3	b	vi	<i>Urea-based catalyts</i>	CO2 emissions from use of urea-based additives in catalytic converters (non-combustive emissions).
1 A 3	c	<i>Railways</i>		Emissions from railway transport for both freight and passenger traffic routes.
1 A 3	d	<i>Water-borne Navigation</i>		Emissions from fuels used to propel water-borne vessels, including hovercraft and hydrofoils, but excluding fishing vessels. The international/domestic split should be determined on the basis of port of departure and port of arrival, and not by the flag or nationality of the ship.
1 A 3	d	i	<i>International waterborne navigation (International bunkers)</i>	Emissions from fuels used by vessels of all flags that are engaged in international water-borne navigation. The international navigation may take place at sea, on inland lakes and waterways and in coastal waters. Includes emissions from journeys that depart in one country and arrive in a different country. Exclude consumption by fishing vessels (see Other Sector - Fishing). Emissions from international military water-borne navigation can be included as a separate sub-category of international water-borne navigation provided that the same definitional distinction is applied and data are available to support the definition.
1 A 3	d	ii	<i>Domestic waterborne Navigation</i>	Emissions from fuels used by vessels of all flags that depart and arrive in the same country (exclude fishing, which should be reported under 1 A 4 c iii, and military, which should be reported under 1 A 5 b). Note that this may include journeys of considerable length between two ports in a country (e.g. San Francisco to Honolulu).
1 A 3	e	Other Transportation		Combustion emissions from all remaining transport activities including pipeline transportation, ground activities in airports and harbours, and offroad activities not otherwise reported under 1 A 4 c Agriculture or 1 A 2. Manufacturing Industries and Construction. Military transport should be reported under 1 A 5 (see 1 A 5 Non-specified).

Code and Name				Explanation
1 A 3	e	i	<i>Pipeline Transport</i>	Combustion related emissions from the operation of pump stations and maintenance of pipelines. Transport via Consortium led by ICF 26 pipelines includes transport of gases, liquids, slurry and other commodities via pipelines. Distribution of natural or manufactured gas, water or steam from the distributor to final users is excluded and should be reported in 1 A 1 c ii or 1 A 4 a.
1 A 3	e	ii	<i>Off-road</i>	Combustion emissions from Other Transportation excluding Pipeline Transport.
1 A 4	c	iii	Fishing (mobile combustion)	Emissions from fuels combusted for inland, coastal and deep-sea fishing. Fishing should cover vessels of all flags that have refueled in the country (include international fishing).
1 A 5	a	<i>Non specified stationary</i>		Emissions from fuel combustion in stationary sources that are not specified elsewhere.
1 A 5	b	<i>Non specified mobile</i>		Mobile Emissions from vehicles and other machinery, marine and aviation (not included in 1 A 4 c ii or elsewhere). Includes emissions from fuel delivered for aviation and water-borne navigation to the country's military as well as fuel delivered within that country but used by the militaries of other countries that are not engaged in.
Multilateral Operations (Memo item)		Multilateral operations. Emissions from fuels used for aviation and waterborne navigation in multilateral operations pursuant to the Charter of the United Nations. Include emissions from fuel delivered to the military in the country and delivered to the military of other countries.		

Source: Table 3.1.1 Chapter 3 “Mobile Combustion”, Volume 2 of “Energy” “Guidelines for National Greenhouse Gas Inventories”.

Estimated emissions from transport can be based on both fuel combusted data (data provided on fuel sold) and vehicle kilometers travelled. In general the first approach (fuel sold) is suitable for estimating CO₂, and the second (distance traveled by vehicle type and road type) is appropriate for CH₄ and N₂O emissions.

However often information on fuel sold could be missing or unreliable. If that’s the case estimation of fuel consumption rates requires information on certain vehicle group comprising fleet, technically sound fleet, vehicle downtime percentage and average mileage per vehicle. This serves as a basis for estimation of total mileage. If operational fuel consumption rate per 100 kilometers is available total fuel consumption volume could be estimated. Application of this method is based on a number of statistically measured values as well as on a number of rated (operational fuel consumption rates) and expert evaluated values (average mileage of privately owned cars). Use of estimations indeed decreases calculation accuracy yet, as it is reviewed further in the document, it often yields more reliable assessments than fuel consumption statistics for the Transport.

This sector uses the Tier 1 approach, i.e. IPCC defined emission factors of CO₂, CH₄ and N₂O are used for CO₂ emission calculation. The authors don’t have grounds or results of special investigations to justify use of factors specific for the assessed regions.

The Tier 1 approach calculates CO₂ emissions by multiplying sold (estimated) fuel with IPCC emission factors. The approach is represented in Equation 5.1:

$$Emission = \sum_a (Fuel_a * EF_a) \quad (6.1),$$

where: **Emission** = emission;

$Fuel_a$ = fuel sold;

EF_a = emission factor. This is equal to the carbon content of the fuel multiplied by 44/12.

a = type of fuel (e.g. petrol, diesel, natural gas, LPG etc).

Based on the analysis of data provided by Chapter “Mobile Combustion”, Volume 2 of Energy” “2006 IPCC Guidelines for National Greenhouse Gas Inventories” the following emission factors were identified for the tier 1 (See Table 6.5).

Any carbon in the fuel derived from biomass should be reported as an informational item and not included in sectoral totals to avoid double counting. No data on biofuel usage by Transport in the regions are available. Calculation using equation 5.1 is modified provided urea-based catalytic converters are used (emissions differ from those of combustion), however there are no data available on the scope of utilization of such catalysts in three assessed regions.

Emissions of CH₄ and N₂O are more difficult to estimate accurately than those for CO₂ because emission factors depend on vehicle technology, fuel and operating characteristics. Both distance-based activity data (e.g. vehicle kilometres travelled) and disaggregated fuel consumption may be considerably less certain than overall fuel sold. CH₄ and N₂O emissions are significantly affected by the distribution of emission controls in the fleet. N₂O to a great extent depend of the catalyst type. However information on vehicle fleet structure and equipment of certain car makes with different catalyst types was nowhere to be found. Estimation of international water-borne transport fuel consumption (international bunkers) is also not possible.

Table 6.5. Emission Factors for Transport (kg/TJ)

Types of Transport	CO ₂	CH ₄	N ₂ O
Cars			
Motor Gasoline – Unmanaged (b)	69300	33	3.2
Motor Gasoline – Oxidation Catalyst (c)	69300	25	8
Motor Gasoline – Low Mileage Light Duty Vehicle Vintage 1995 or later (d)	69300	3.8	5.7
Gas/Diesel Oil	74100	3.9	3.9
Liquefied Petroleum Gas	63100	62	0.2
Kerosene	71900		
Lubricants	73300		
Compressed Natural Gas	56100	92	3
Liquefied Natural Gas	56100		
Railways	74100	4.15	28.6
Water-Borne Navigation		7	2
Aircraft		0.5	2
Off-road Transportation			
Diesel Oil	74100	4.15	28.60
Motor Gasoline	69300		
Four-stroke Engines			
Agriculture	69300	80	2.0
Forestry	69300		2.0
Industry	69300	50	2.0
Residential	69300	120	2.0
Two-stroke Engines			
Agriculture	69300	140	0.4
Forestry	69300	170	0.4
Industry	69300	130	0.4
Residential	69300	180	0.4

Source: Chapter 3 “Mobile Combustion”, Volume 2 of “Energy” “Guidelines for National Greenhouse Gas Inventories”.

Two approaches could be used to estimate CH₄ and N₂O from road vehicles: one is based on vehicle kilometers travelled (VKT) and the other is based on fuel sold. The IPCC Tier 3 approach requires detailed data to generate emission factors for individual vehicle subcategories. Tier 3 calculates emissions by multiplying emission factors by vehicle activity levels for each vehicle subcategory and possible road types. Vehicle subcategories are based on vehicle type, age and emissions control technology.

The Tier 2 approach uses fuel-based emission factors specific to vehicle subcategories. Tier 1, which uses fuel-based emission factors, may be used if it's not possible to estimate fuel consumption by vehicle type. This study uses the Tier 2 approach but fuel consumption estimations are based on data regarding vehicle fleet, technically sound fleet, average mileage per vehicle and operational fuel consumption rates for vehicle subcategories. Determination of operational fuel consumption rates took into account traffic complexity indicators, road types, vehicle age and their traffic characteristics.

The methodology for estimating road transport operational fuel consumption rates is provided in the Exhibit to the Instruction of the Russian Ministry of Transport dated March 14, 2008 #AM-23-p “The Recommended Practice. The Fuel and Lubricant Consumption Rates for Road Transport”. According to this methodology the following rate types have been established for general purpose vehicles:

base rate in liters per 100 km (l/100 km) of an unladen vehicle mileage. Base fuel consumption rate depends on design of a vehicle, its assemblies and systems, category, type and purpose of road transport vehicles (cars, buses, trucks, etc), type of fuels used, and takes into account vehicle unladen weight, typical itinerary and operation traffic mode within the bounds of “The Traffic Regulations”;

transportation rate in liters per 100 km (l/100 km) of transportation mileage: for a bus where unladen weight and rated bus purpose-related passenger load are taken into account; dump truck, where unladen weight and rated dump truck load (with the factor of 0.5) are taken into account. Transportation rate (rate for a transportation run) includes base rate and depends on load capacity or rated passenger load or on actual mass of transported cargo;

transportation rate in liters per 100 ton-kilometers (l/100 tkm) in a transportation run takes into account additional to the base rate fuel consumed by a vehicle traveling with cargo or road train traveling with trailer/semitrailer without cargo and with cargo or with application of pre-established factors per each ton of transported cargo, trailer or semitrailer mass – up to 1.3l/100km and up to 2.0l/100km for vehicles with gasoline and diesel engines respectively, or with application of accurate calculations performed following special programtechnique directly for each specific make, modification and type of road transport vehicle;

operational rate is established on operation site of a transport vehicle based on base or transportation rate with application of adjustment factors (overheads) taking into account local operating conditions and using equations provided in this document.

Operational rates of fuel consumption increase in the following conditions:

- Road transport operation in winter months depending on the country's climatic zones;

- In case of using an air conditioner or a climate control unit on the road – up to 7% of the base rate. Concerns only foreign makes for 2 months per year;
- Road transport operation in cities with population over 3 million people – up to 25%;
- Road transport operation with slower average traffic speed of 20 – 40km/h – up to 15%, with slower average traffic speed below 20 km/h – up to 35%.
- Road transport operation, which requires frequent process stops related to loading and unloading, passenger boarding and alighting including shuttle buses with fixed charge, cargo-passenger and cargo light-duty vehicles, light trucks, station wagon types of vehicles, etc, including food handling, mailbox services, money collection, retired, disabled and sick people care, etc (if there is more than one stop per 1 km of the trip on the average, stops at traffic lights, road and railroad crossings are ignored) – up to 10%.
- For vehicles with over 5 years of operation time and overall mileage over 100 thousand kilometers – up to 5%; over 8 years with overall mileage over 150 thousand kilometers – up to 10%.

For vehicle makes and modifications without considerable design variations from base models (same specifications of engine, transmission, main gear, tires, axle configuration and body) having the same unladen weight as base models it is allowed to establish base fuel consumption rate at the same level as that of the base model. With that for each ton over (below) the vehicle unladen weight it should be increased (decreased) by up to 2 l/100 km for vehicles with gasoline engines; up to 1.3l/100km for those with diesel engines; up to 2.64 l/100 km for vehicles operating on compressed gas; up to 2 cub.m./100km for vehicles operating on compressed natural gas; in case of gas-diesel engine operation – approximately up to 1.2 cub.m./100km of natural gas and up to 0.25 l/100km of diesel oil for each ton of vehicle unladen weight variation.

6.3 Off-Road Transport

Off-road transport includes self-propelled units used in industry, construction, agriculture and other sectors, such as tractors and bulldozers, self-propelled cranes, excavators and loaders. This category also includes chain saws, snowmobiles, etc. The form 11-ТЭР-1 provides statistics on fuel consumption in operation of tractors, lift-and-carry and road construction machines and mechanisms. Those mechanisms primarily use diesel fuel. No other information on this area of fuel use is available. These were the data, which were used in compiling emission cadastre for offroad transport.

- *In Rostov region*, the greenhouse gas emission from the off-road transport was 401.6 thousand tones of CO₂ equivalents in 2008, which is 34.2% less than in 2000.
- *In Sverdlovsk region*, the greenhouse gas emission from the off-road transport was 387.1 thousand tones of CO₂ equivalents in 2008, which is 6.4% more than in 2000.
- *In Tver region*, the greenhouse gas emission from the off-road transport was 45.1 thousand tones of CO₂ equivalents in 2008, which is 35.9% less than in 2000.

6.4 Railroads

The form 11-ТЭП-1 provides data on oil products consumption (primarily this is diesel fuel) to support operation of diesel-electric locomotives and diesel trains of the Ministry of Railways and operation of diesel-electric locomotives of industrial railroads. No other information for fuel consumption estimation for railroads is available. Form 11-ТЭП-1 provides the information for the total emission of CO₂, CH₄ and N₂O in 2008:

- in Rostov region – at a level of 175.0 thousand tones of CO₂ equivalents;
- in Sverdlovsk region – at a level of 212.0 thousand tones of CO₂ equivalents;
- in Tver region– at a level of 194.1 thousand tones of CO₂ equivalents.

6.5 Aviation

Aviation uses two types of fuel: aircraft motor gasoline (for small aircraft) and kerosene. Data on consumption of these fuel types are provided in the form 4-fuel. Kerosene could also be used for process needs in industry, therefore kerosene consumption for process needs per the form 11- ТЭП is deducted from its overall consumption per the form 4-fuel. The available data is used for the estimate of total emission of CO₂, CH₄ and N₂O from Aviation in 2008:

- in Rostov region – at a level of 204.4 thousand tones of CO₂ equivalents;
- in Sverdlovsk region – at a level of 1667.4 thousand tones of CO₂ equivalents;
- in Tver region– at a level of 17.7 thousand tones of CO₂ equivalents.

6.6 Water-Borne Transport

Statistical services in the regions provides the data on fuel utilization by the inland fleet and industrial vessels.

The available data is used to make the total estimate of CO₂, CH₄ and N₂O emission from the water-borne transport in 2008:

- in Rostov region – at a level of 2.9 thousand tones of CO₂ equivalents;
- in Sverdlovsk region – at a level of 0.3 thousand tones of CO₂ equivalents;
- in Tver region– at a level of 7.1 thousand tones of CO₂ equivalents.

6.7 Road Transport

6.7.1 General

Large volumes of greenhouse gas emissions result from fuel combustion in road transport. Estimation of fuel consumption presents the biggest concerns. Only the form “4-fuel” provides data on fuel consumption by road transport. In addition, gasoline and diesel oil wholesale and retail accounting forms could be used for estimating fuel consumption by road transport.

Road transport uses gasoline, diesel fuel, compressed natural gas and liquefied natural gas. The form “4-fuel” provides information on their consumption by road transport and sales to population (for private cars), however, these statistics are very unreliable, unstable and conflicting, that is why this report uses the estimate of the fuel

consumption by the road transport based on the on certain vehicle group comprising fleet, technically sound fleet, vehicle downtime percentage and average mileage per vehicle and operational fuel consumption rate per 100 kilometers. Subsequently, these estimates were used to estimate the emissions.

This resulted in the following data for 2008:

- In Rostov region, the fuel consumption by the road transport was 3795 thousand tsf, and the greenhouse gas emissions from the road transport were estimated to be 8.2 MM tones of CO2 equivalent;
- In Sverdlovsk region, the fuel consumption by the road transport was 2939 thousand tsf, and the greenhouse gas emissions from the road transport were estimated to be 6.3 MM tones of CO2 equivalent;
- in Tver region, the fuel consumption by the road transport was 1207 thousand tsf, and the greenhouse gas emissions from the road transport were estimated to be 2.6 MM tones of CO2 equivalent.

6.7.2 Cars

Cars were divided into two groups:

- cars in private ownership;
- taxi-cabs and company cars.

Transport statistics provides the data on the car fleet structure in Rostov, Sverdlovsk and Tver regions.

Base fuel consumption rates in liters per 100km were taken from “The Recommended Practice. The Fuel and Lubricant Consumption Rates for Road Transport” approved by the Instruction of the Russian Ministry of Transport dated March 14, 2008 #AM-23-p. The average daily mileage for taxi and company cars was taken 200 km, and 36 km for the privately owned cars (CEE LLC estimate based on the ODYSSEE data base). The technical availability of the cars was estimated based on the data for taxi-cabs and company cars (estimates taken from the books “Moscow transport” and “Moscow statistical yearbook”).

These assumptions formed the basis for the fuel consumption by cars in 2008:

- in Rostov region, cars consumed 1572.4 thousand tsf of fuel, and greenhouse gas emissions from cars were 3.3 MM tones of CO2 equivalent;
- in Sverdlovsk region, cars consumed 1902.1 thousand tsf of fuel, and greenhouse gas emissions from cars were 4.0 MM tones of CO2 equivalent;
- in Tver region, cars consumed 523.7 thousand tsf of fuel, and greenhouse gas emissions from cars were 1.1 MM tones of CO2 equivalent.

6.7.3 Busses

Buses are also divided into two groups:

- buses of large and medium enterprises;
- buses of small business and individual entrepreneurs.

Transport statistics for Rostov, Sverdlovsk and Tver regions provides this information. The logic behind estimation of fuel consumption by buses is similar to that of cars. The bus fleet structure of small business and individual entrepreneurs is assumed to be easier (lower tonnage). That is why the average specific fuel consumption for this sector of the passenger traffic was estimated to be 21.6 l/100 km against 46.18 l/100 km average for busses owned by large and medium size enterprises.

Data on bus fleet breakdown into operation life, technical availability of buses and their downtime at the large and medium size enterprises were taken from the “Moscow Transport” digest. They were used for buses of small business and individual entrepreneurs as is.

The average daily mileage was taken 90 km for busses of large and medium size enterprises and 110 km for buses of small business and individual entrepreneurs based on the average 102 km, as per Sverdlovsk statistics committee data for the busses of large and medium size enterprises in 2007.¹

6.7.4 Trucks

All trucks are divided into five groups:

- light duty trucks – pickup trucks and utility vans;
- heavy duty trucks – large and medium enterprises - gasoline;
- heavy duty trucks – large and medium enterprises – diesel fuel;
- heavy duty trucks – large and medium enterprises – compressed gas;
- trucks – small business and individual entrepreneurs.

Transport statistics provides these data for Rostov, Sverdlovsk and Tver regions. All trucks of large and medium enterprises were also divided on this basis into light duty and heavy duty, gasoline, diesel and compressed gas. The average operational rates were estimated with the use of data provided in “The Recommended Practice. The Fuel and Lubricant Consumption Rates for Road Transport”, approved by the Instruction of the Russian Ministry of Transport dated March 14, 2008 #AM-23-p.

Moscow data on technical availability, downtime and average daily running distance of trucks operated by

large and medium enterprises were used for all truck groups (“Moscow transport” digest).

The average daily mileage was taken 105 km based on average figure for trucks, as per Sverdlovsk statistics committee data for mileage of trucks of large and medium enterprises in 2007.²

6.7.5 Special vehicles

The special vehicles group includes ambulances, fire trucks, public cleansing vehicles, garbage trucks, etc. There are about 16 thousand vehicles of this type in Rostov region; 11 thousand – in Sverdlovsk region.; and about 1 thousand – in Tver region. High downtime is characteristic of these vehicles (taken as 60%). Moscow data on technical

¹ Road transport owned by large and medium enterprises in Sverdlovsk region in 2007: Statistics digest (code 12002). Federal State Statistics Service, local agency for Sverdlovsk region. – Yekaterinburg, 2008. – p.32.

² Road transport of large and medium enterprises in Sverdlovsk region in 2007: Statistics digest (code 12002). Local agency of Federal State Statistics Service in Sverdlovsk region. – Yekaterinburg, 2008. – p.32.

availability were also used for this group of vehicles (“Moscow Transport” digest). Average daily running distance was taken as 60 km.

6.8 Completeness

With regard to transport data completeness there is an issue with water-borne transport, but as its percentage is relatively small this issue could be neglected. The main problem with the statistics completeness, however, is inadequacy of the form “4-fuel” data on road transport. The procedures specified above enable solving this problem but cause another problem on estimate uncertainty.

6.9 Uncertainty Assessment

The uncertainty of estimates is connected with three sources: method of fuel consumption by transport; expert evaluation of a number of parameters without reliable data, which these estimates could be based on, lack of information on use of catalysts for more accurate estimation of N₂O emissions.

The first factor is critical for the road transport (See Table 6.6). the disagreement of the emission estimates based on the statistics reports for fuel consumption and vehicle fleet characterization produces significant disagreement in estimates. Only Tver region demonstrated close results for both estimates.

Statistical forms provide a fairly unstable trend and specific consumption for one vehicle, which undermines the confidence in such estimates. The estimates based on the fleet technical condition and fleet dynamics are more reliable.

The uncertainty of GHG emissions from transport in 2008 was 66% for Rostov region, 44% for Sverdlovsk region and 11% for Tver region. Relative to total GHG emissions by all sectors, the uncertainty for road transport was 16% for Rostov region, 3% for Sverdlovsk region and 2% for Tver region in 2008. Thus, the road transport estimates contribute to the uncertainty of the estimates of total GHG emissions and, consequently, will need a significant improvement, which will require providing the statistics to improve the accuracy of such estimates.

For CO₂, the uncertainty in the emission factor is typically less than 2 percent. Use of adulterated fuel increases the factor uncertainty.

The uncertainties in emission factors for CH₄ and N₂O are typically relatively high (especially for N₂O) and are likely to be a factor of 2-3. They depend on: uncertainties in fuel composition (including the possibility of fuel adulteration) and sulphur content; uncertainties in fleet age distribution and characterization of stock; uncertainties in combustion conditions and many other parameters, such as speed, proportion of running distance to cold starts or load factors (CH₄ and N₂O); uncertainties in application rates of post-combustion emission control technologies (for instance, three-way catalysts); uncertainties in the use of additives to minimize the ageing effect of catalysts, etc.

Table 6.6. The uncertainty of estimates of transport emitted GHG depending on the estimate methodology (kg/TJ)

	Rostov region		Sverdlovsk region		Tver region	
	By fleet	By type of fuel consumption	By fleet	By type of fuel consumption	By fleet	By type of fuel consumption
2000	6725.8	1751.1	4537.4	2603.6	2158.4	2483.0
2001	6885.3	1884.8	4543.5	2621.5	2219.2	2528.9
2002	7119.9	1795.0	4710.5	2624.4	2347.8	2667.1
2003	7316.4	1558.4	4725.3	2638.5	2398.9	2726.4
2004	7219.1	1853.3	4780.6	2517.6	2387.9	2737.7
2005	7352.0	2055.2	4990.1	2666.9	2420.3	2743.9
2006	7739.8	2195.4	5571.4	2797.5	2576.4	2888.1
2007	8058.9	2746.5	5872.4	3254.0	2609.9	2912.4
2008	8179.0	2761.6	6123.4	3425.3	2606.7	2883.4

Source: Estimates by Center for Energy Efficiency (CEE LLC)

CH₄ and N₂O contribution to transport related emissions was estimated as:

- *In Rostov region* – 1.8% of total transport sector emissions;
- *In Sverdlovsk region* – 2.7% of total transport sector emissions;
- *In Tver region* – 2.7% of total transport sector emissions.

If we assume, that CH₄ and N₂O emission factors are two times underestimated, the accuracy in emission estimation in transport will change in the same order.

Final result is considerably more sensitive to accuracy of assuming average daily running distance of a vehicle in private ownership. Decrease in uncertainty level requires more reliable data on vehicle fuel consumption and sales.

In addition there are no data on split of fuel consumed for domestic and international flights required for estimation of international bunkers parameter (emission from flights that depart in one country and arrive in different country).

7 Fugitive emissions

7.1 Main results

7.1.1 Rostov region

Greenhouse gas fugitive emission estimate for Rostov region in 2000-2008 is shown in Table 7.1. This type of emissions accounts for 6.8% of total emissions of three greenhouse gases in 2008. This were primarily methane emissions in coal mining. The emissions from this group of sources have reduced by 20.6% in 2008 against 2000 due to lower rates of coal production.

Table 7.1. Greenhouse Gas Emission Inventory for Fugitive Emissions in Rostov region in 2000-2008 (thousand tones of CO2 equivalents)

	Year	CO2 emissions	CH4 emissions	GHG emissions: CO2 equivalent
Total fugitive emissions	2000	0.33	139.62	2932.3
	2001	0.37	141.40	2969.7
	2002	0.37	129.69	2723.9
	2003	0.42	109.91	2308.4
	2004	0.42	103.33	2170.3
	2005	0.42	110.20	2314.6
	2006	0.44	111.72	2346.6
	2007	0.42	114.37	2402.3
	2008	0.45	110.94	2330.1
Liquefied gas – Transportation	2000	0.01		0.01
	2001	0.01		0.01
	2002	0.01		0.01
	2003	0.01		0.01
	2004	0.01		0.01
	2005	0.02		0.02
	2006	0.01		0.01
	2007	0.03		0.03
2008	0.02		0.02	
Natural Gas Transportation	2000	0.01	3.58	75.14
	2001	0.01	3.99	83.90
	2002	0.01	4.27	89.67
	2003	0.01	4.52	94.93
	2004	0.01	4.32	90.71
	2005	0.01	4.36	91.47
	2006	0.01	4.38	91.94
	2007	0.01	4.31	90.55
2008	0.01	4.69	98.50	
Natural Gas Distribution	2000	0.31	5.75	121.05
	2001	0.35	6.52	137.30
	2002	0.35	6.61	139.24
	2003	0.39	7.43	156.32
	2004	0.39	7.42	156.27
	2005	0.40	7.49	157.61
	2006	0.41	7.77	163.67
	2007	0.38	7.21	151.87
2008	0.42	7.87	165.70	
Coal Mining	2000		130.29	2736.0

	Year	CO2 emissions	CH4 emissions	GHG emissions: CO2 equivalent
	2001		130.88	2748.5
	2002		118.81	2494.9
	2003		97.96	2057.2
	2004		91.58	1923.3
	2005		98.36	2065.5
	2006		99.57	2091.0
	2007		102.85	2159.8
	2008		98.38	2065.9

Source: Estimates by Center for Energy Efficiency (CEE LLC)

7.1.2 Sverdlovsk region

Greenhouse gas fugitive emission estimate in Sverdlovsk region in 2000-2008 is shown in Table 7.2. This type of emissions accounts only for 0.4% of total emissions of three greenhouse gases in 2008. The emissions from this group of sources have increased by 28.5% in 2008 against 2000.

Table 7.2. Greenhouse Gas Emission Inventory for Fugitive Emissions in Sverdlovsk region in 2000-2008 (thousand tones of CO2 equivalents)

	Year	CO2 emissions	CH4 emissions	GHG emissions: CO2 equivalent
Total fugitive emissions	2000	0.18782	14.86145	312.28
	2001	0.18992	14.13602	297.05
	2002	0.20551	15.15133	318.38
	2003	0.22062	15.01843	315.61
	2004	0.25467	17.14587	360.32
	2005	0.23127	16.66248	350.14
	2006	0.25735	18.03779	379.05
	2007	0.26081	18.47333	388.20
	2008	0.27639	19.09637	401.30
Liquefied gas – Transportation	2000	0.0126		0.0126
	2001	0.0128		0.0128
	2002	0.0113		0.0113
	2003	0.0160		0.0160
	2004	0.0230		0.0230
	2005	0.0079		0.0079
	2006	0.0068		0.0068
	2007	0.0099		0.0099
	2008	0.0168		0.0168
Natural Gas Transportation	2000	0.0227	9.969	209.38
	2001	0.0224	9.851	206.90
	2002	0.0245	10.759	225.97
	2003	0.0241	10.586	222.33
	2004	0.0282	12.389	260.19
	2005	0.0271	11.931	250.57
	2006	0.0290	12.759	267.98
	2007	0.0304	13.382	281.05
	2008	0.0311	13.688	287.47
Natural Gas Distribution	2000	0.1526	2.875	60.54
	2001	0.1547	2.916	61.39
	2002	0.1698	3.200	67.37
	2003	0.1806	3.403	71.65
	2004	0.2035	3.835	80.74
	2005	0.1962	3.698	77.86
	2006	0.2215	4.174	87.89

	Year	CO2 emissions	CH4 emissions	GHG emissions: CO2 equivalent
Coal Mining	2007	0.2204	4.155	87.47
	2008	0.2285	4.306	90.65
	2000	0.00	2.02	42.4
	2001	0.00	1.37	28.7
	2002	0.00	1.19	25.0
	2003	0.00	1.03	21.6
	2004	0.00	0.92	19.4
	2005	0.00	1.03	21.7
	2006	0.00	1.10	23.2
	2007	0.00	0.94	19.7
	2008	0.00	1.10	23.2

Source: Estimates by Center for Energy Efficiency (CEE LLC)

7.1.3 Tver region

Greenhouse gas fugitive emission estimate for Tver region in 2000-2008 s shown in Table 7.3. This type of emissions accounts only for 0.8% of total emissions of three greenhouse gases in 2008. The emissions from this group of sources have increased by 12.3% in 2008 against 2000.

Table 7.3. Greenhouse Gas Emission Inventory for Fugitive Emissions in Tver region in 2000-2008 (thousand tones of CO2 equivalents)

	Year	CO2 emissions	CH4 emissions	GHG emissions: CO2 equivalent
Total fugitive emissions	2000	0.10	4.13	86.8
	2001	0.10	4.23	88.9
	2002	0.10	4.26	89.5
	2003	0.11	4.13	86.8
	2004	0.11	4.31	90.6
	2005	0.11	4.36	91.7
	2006	0.11	4.74	99.6
	2007	0.12	4.74	99.7
	2008	0.11	4.64	97.5
Liquefied gas – Transportation	2000	0.01	0.0	0.0
	2001	0.01	0.0	0.0
	2002	0.01	0.0	0.0
	2003	0.01	0.0	0.0
	2004	0.01	0.0	0.0
	2005	0.01	0.0	0.0
	2006	0.01	0.0	0.0
	2007	0.01	0.0	0.0
Natural Gas Transportation	2000	0.01	2.56	53.8
	2001	0.01	2.65	55.6
	2002	0.01	2.68	56.2
	2003	0.01	2.40	50.4
	2004	0.01	2.48	52.0
	2005	0.01	2.53	53.1
	2006	0.01	2.86	60.0
	2007	0.01	2.85	59.9
Natural Gas Distribution	2000	0.08	1.57	33.0
	2001	0.08	1.58	33.2
	2002	0.08	1.58	33.2
	2003	0.09	1.73	36.3

	Year	CO2 emissions	CH4 emissions	GHG emissions: CO2 equivalent
	2004	0.10	1.84	38.6
	2005	0.10	1.83	38.6
	2006	0.10	1.88	39.5
	2007	0.10	1.89	39.8
	2008	0.10	1.88	39.5

Source: Estimates by Center for Energy Efficiency (CEE LLC)

7.2 Assessment Methodology for Fugitive Emissions

Greenhouse gas fugitive emission inventory was compiled in accordance with Chapter 4 «Fugitive Emissions», Volume 2 “Energy” of “2006 IPCC Guidelines for National Greenhouse Gas Inventories”.

Intentional or unintentional release of greenhouse gases may occur during the extraction, processing and delivery of fossil fuels to the point of use. The sources of emissions in the assessed regions could be coal mining and processing, oil and gas production and processing, underground gas storage facilities, distribution of natural and liquefied gas.

This section uses the Tier 1 approach, i.e. CO2 emissions are estimated on the basis of IPCC defined emission factors for CO2, CH4 and N2O (Table 4.2.5 of Chapter 4 “Fugitive Emissions”, Volume 2 “Energy” of the “Guidelines for National Greenhouse Gas Inventories” for developing countries and countries with economy in transition).

The authors don’t have grounds or results of special investigations to justify use of factors specific for the regions. Factors used in the inventory for transportation and distribution of natural and compressed gas are shown in Table 7.4.

Table 7.4. Tier 1 Emission Factors for Fugitive Emissions in Gas Supply Systems in Developing Countries and Countries with Economy in Transition (Gg/10⁶ m³)

	CO2	CH4	N2O
Gas Transportation	0.0000014	0.000633	
Gas Distribution	0.0000955	0.001800	
Liquefied Petroleum Gas Transportation	0.0004300		

Source: Chapter 4 “Fugitive Emissions Volume 2 “Energy” “Guidelines for National Greenhouse Gas Inventories”

The activity data required to estimate fugitive emissions from oil and gas activities includes production statistics, infrastructure data (e.g., inventories of facilities/installations, process units, pipelines, and equipment components), and reported emissions from spills, accidental releases, and third-party damages. For bulk natural gas transport this means the volume of transported gas according to the gas balance data and the forms «11-ТЭП», «6-ТП», «4-fuel» and «22-ЖКХ», for its transport via LP distribution network – volume of consumption for public utility use (per gas balance data and the forms «11-ТЭП», «6-ТП», «4-fuel» and «22-ЖКХ»). The latter in this study includes consumption of natural gas by population, service sector and small boiler houses. Liquefied gas transport takes into account both its consumption by the population (the forms «4-fuel» and «22-ЖКХ»), and consumption for industrial needs (the form «11- ТЭП-2»).

7.2.1 Natural Gas Transportation

The volume of natural gas consumption in the regions can be estimated on the basis of the gas balance data and the forms «11-ТЭП», «6-ТП», «4-fuel» and «22-ЖКХ». Fugitive emissions of three greenhouse gases from gas transport facilities in 2008 have been estimated based on factors in Table 6.4:

- Rostov region - 98.5 thousand tones of CO2 equivalents (31.1% increase against 2000 or average 3.8% per year);
- Sverdlovsk region - 287.5 thousand tones of CO2 equivalents (37.3% increase against 2000 or average 4.7% per year);
- Tver region- 57.9 thousand tones of CO2 equivalents (7.6% increase against 2000 or average 0.8% per year).

7.2.2 Natural Gas Distribution

Considerable percentage of natural gas is consumed by power plants and major boiler houses where it is supplied through HP and LP pipelines. Small boiler houses, population and service sector receive gas via LP gas distribution network. Fugitive emissions are significantly higher in distribution systems (See Table 6.4). Fugitive emissions of three greenhouse gases from gas distribution systems in 2008 have been estimated based on factors in the table:

- Rostov region - 165.7 thousand tones of CO2 equivalents (36.9% increase against 2000 or average 4.6% per year);
- Sverdlovsk region - 90.6 thousand tones of CO2 equivalents (49.7% increase against 2000 or average 6.2% per year);
- Tver region - 39.5 thousand tones of CO2 equivalents (19.8% increase against 2000 or average 0.8% per year).

7.2.3 Liquefied Gas Transportation

Data on liquefied gas transport were taken from the forms «4-fuel» and «22-ЖКХ», and emission factors were listed in Table 6.4. The emission was estimated to be:

- Rostov region - 0.02 thousand tones of CO₂ equivalents;
- Sverdlovsk region - 0.02 thousand tones of CO₂ equivalents;
- Tver region - 0.01 thousand tones of CO₂ equivalents.

7.2.4 Coal Mining

Absence of detailed data to estimate greenhouse gas emissions resulting from coal mining operations does not allow to produce an adequate estimate, that is why the authors applied the approach and the factors used in “The National Inventory Report on anthropogenic emissions from sources and absorption by the absorbers of greenhouse gases which are not regulated by the Montreal Protocol, 1990-2007”.

The coal mining data was taken from the form «11-ТЭП», and emission factors were taken from The National Inventory Report on anthropogenic emissions from sources and absorption by the absorbers of greenhouse gases which are not regulated by the Montreal Protocol, 1990-2007. Methane emission factors in course of underground coal mining in Southern geographical region, which includes Donets basin, were used as emission factors for Rostov region; Methane emission factors in course of open pit coal mining in Ural geographical region, which includes Chelyabinsk coal basin, were used as emission factors for Sverdlovsk region.

As the result, the greenhouse gas emissions in 2008 were estimated to be:

- Rostov region –2065.9 thousand tones of CO₂ equivalents;
- Sverdlovsk region –23.2 thousand tones of CO₂ equivalents.

7.3 Completeness

Fugitive greenhouse gas emissions also occur in transportation (evaporation) of petroleum products. However Table 4.2.5 in Chapter 4 “Fugitive Emissions”, Volume 2 “Energy” of the “Guidelines for National Greenhouse Gas Inventories” does not list emission factors for developing countries and countries with economy in transition. However, since there are no oil processing facilities in the regions, and the hydrocarbons transportation is insignificant, it is safe to assume it has a insignificant effect on the assessment of fugitive emissions of greenhouse gases. There are no gas processing operations in the regions either. There are coal processing facilities in Rostov region only, however, due to insignificant capacity it does not affect the GHG emission estimate significantly either.³

The estimates of fugitive emissions from abandoned coal mines should include the emissions from all abandoned mines, which is closely related to the availability of reliable data on the mine closers, methods of conservation, the degree and time of closure, etc. Russian Federal statistics and Rostov region statistics do not provide this sort of data.

³ Besides, currently IPCC does not have any methodology to estimate emissions from solid fossil fuel conversion (Subsection 1.B.1.B CRF) or other sources (Subsection 1.B.1.C CRF).

7.4 Uncertainty Assessment

It should be noted that accuracy in development of natural gas balance in Russia generally and split by individual regions leaves much to be desired. Thus, for 2008, the gas balance for Rostov region gives the estimate of 7409 thousand tsf, the form «11-ТЭР» gives 4643 thousand tsf (excluding the residential natural gas consumption, which, as form «22-ЖКХ» indicates, is 2936 thousand tsf, which in total gives 7579 thousand tsf), whereas the form «4-fuel» estimates the consumption to be 8732 thousand tsf. Thus, the difference between the data is 1323 thousand tsf, or 15% of the data in the form «4-fuel». This value could serve as the measure of accuracy in estimating natural gas consumption in the regions. However, the gas consumption data in form «4-fuel» can not be considered reliable, as it can contain some double count in event there any natural gas resellers.

Another important source of uncertainty is presented by values of fugitive emission specific factors. They could considerably vary from those listed in Table 6.4 in the regions. In general, accuracy of the factor values is quite low due to physical nature of uncertainty in their measurements and their extension to the entire equipment fleet, as the technique is based on measuring concentrations in proximity to leaks. There are no data to estimate the emissions from abandoned coal mines in Rostov region, which also adds to the uncertainty.

8 Non-energy industry

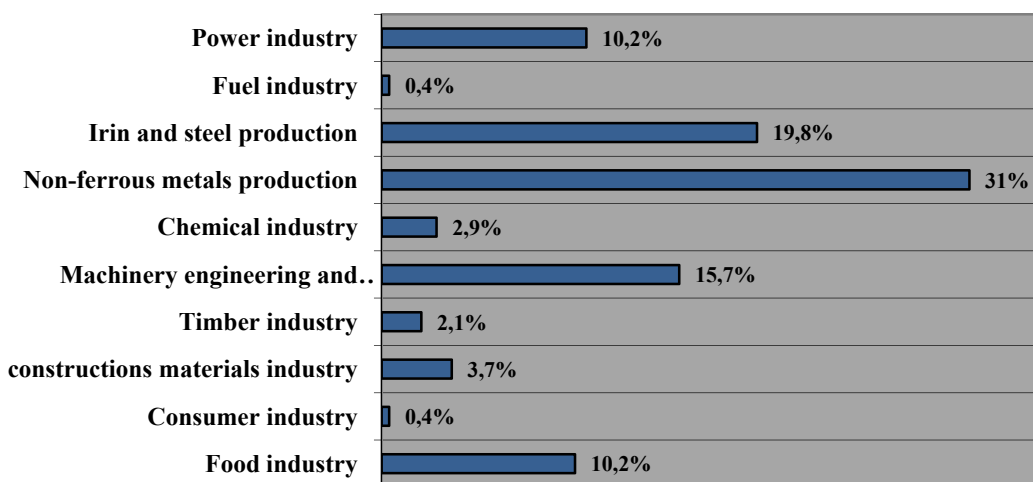
8.1 Main results

The project team has encountered certain difficulties in course of the project work in terms of access to the source data, due to a few reasons, among which are the confidentiality issue for the industrial sector and lack of data for the wastes sector at the regional level. The regions provided the best quality data for “Agriculture” sector. Sverdlovsk region provided the most comprehensive data among three regions.

8.2 Industrial Processes

Heavy industry has developed based on the use of exceptionally rich stock of mineral resources in Sverdlovsk region. The structure of the industry is dominated by iron and steel and nonferrous metals production, machinery engineering and metalwork, electric power industry and food industry. See below the sectoral structure of the industry in Sverdlovsk region.

Figure 8.1 Sectoral structure of the industry in Sverdlovsk region



The industry is one of the largest consumers of heat and power resources in Russia. The industry consumes 24 billion kWh of power and over 35 MM Gcal of heat annually. Efficient use of the energy can significantly improve the production efficiency. Saving 1 tone of specific fuel (tsf) is equivalent to an additional production of 0.7 t of steel, baking 1.4 t of bread or producing 300 m² textile. There is a huge energy saving potential here.

See below the energy resources consumption for a production unit (1996) in Sverdlovsk region compared to developed countries.

Table 8.1 Energy efficiency of the industrial sector in Sverdlovsk region

Industry	International (tsf/t of production)	Regional industry (tsf/t of production)	Exceedance versus the international rate
Steel production	0.850	1.100	29.4%
Cement Production	0.200	0.350	75%
Manufacture of plastics	0.465	0.510	10%
Tire manufacturing	0.820	1.400	68%
Paper production	0.900	1.600	78%
Glass Production	0.600	0.950	58%
Refractory ceramic production	0.225	0.500	122%
Aluminum Production	7.100	8.500	20%
Non-ferrous metals (copper)	0.500	1.400	180%
Textile production	2.600	3.100	19%

8.2.1 Source Data for the estimates

In accordance with the general approach to the greenhouse gas inventory (this approach is outlined in Revised IPCC Guidelines), this section covers the following:

- Estimate of emissions produced from a variety of industrial processes and activities;
- Estimate of emissions produced from hydrofluorocarbons use in industrial, commercial and residential sectors.

The Guidelines outline 17 categories of industrial emission sources. The inventory has identified and reviewed 4 of these categories in Sverdlovsk region:

- Steel Production emissions;
- Lime Production emissions;
- Ferrochrome Production emissions;
- Cement Production emissions.

See the estimate source data in the table below.

Table 8.2 Production output in Sverdlovsk region

Product	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Steel, thousand t	10547	8763	8117	7149	6476	6694	6532	5402	3874	5365	6473
Cement, thousand t	5472	4886	3810	3862	2775	2727	1909	1935	1589	1763	2413
Quick-slaking lime, thousand t	448.9	378.7	349.4	277.1	267.9	244.2	254.2	235.8	241.9	225.1	206.1
Dolomitic lime	116.7	136.0	91.8	99.6	50.9	49.9	55.7	49.6	67.4	69.2	80.2
Ferrochrome, thousand t	250.2 98	295.6 48	232.4 14	205.2 51	215.9 1	174.2 95	79.38 9	105.4 05	115.0 91	147.1 38	149.4 25

Product	2001	2002	2003	2004	2005	2006	2007
Steel, th. tonnes	8734	8791,5	9121,6	9333,5	9036,8	8666,5	8738,8
Cement, th. tonnes	2535,6	2593,6	2872,6	3101,3	3380,9	3434,7	3417,1
Quick-slaking lime, thousand t	315,9	298	293	303	293	331	402
Dolomitic lime							
Ferrochrome, thousand t	257,5	275,3	293,1	342,6	319,2	302,6	372

There are no data on Ferromanganese, Soda Ash and Ammonia Production in Sverdlovsk region. Line items "Silica" and "Aluminum" are reviewed individually and thus were not available as an input for the estimate.

See the estimate source data for Rostov oblast in the table 8.3.

Table 8.3. Production output in Rostov oblast 2000 - 2007

Product	2000	2001	2002	2003	2004	2005	2006	2007
Steel, th. tonnes	591	631	598	574	613	647	642	792
Cement, th. tonnes	НД ⁴	НД	НД	НД	НД	НД	НД	НД
Quick-slaking lime, thousand t	НД	14	15	13	14	10	10	7
Dolomitic lime								
Ferrochrome, thousand t								

Д
No data on Tver oblast

8.2.2 Greenhouse gas emission estimate

- CO2 emissions estimate from steel production.

CO2 emissions estimate is based on the steel production at the facilities in the region. To estimate the emissions based on the preferable method, which requires the data on the amount of reducing agent used in metal production, we need more information to be provided

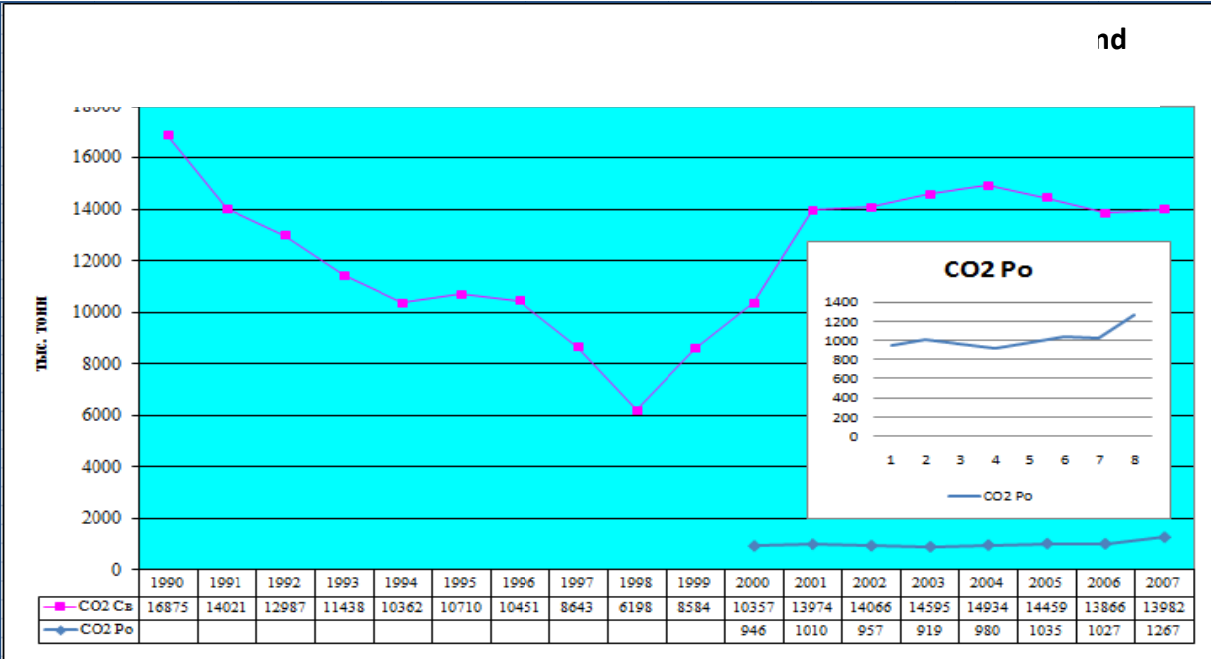
⁴ НД - Нет данных

directly by the production facilities. However, the mining and metal production sector of Sverdlovsk region includes 8 mining companies, 17 iron and steel making companies, 17 nonferrous metal production companies and 3 refractory ceramic production companies. Therefore, access to the information regarding the reducing agent use in steel production at each individual facility requires a more detailed approach to developing a monitoring and reporting system for greenhouse gas emissions in metal production sector of Sverdlovsk region. CO2 emissions from steel production is graphically represented below.

Method of calculation

Assessment of CO2 in production iron and steel was carried out in accordance with the methodology, described the “Guidelines guidelines on good practices and Uncertainty Management in National Greenhouse Gases» (IPCC, 2000). In the calculation method was used IPCC second level, which provides for separate assessment of CO2 for domestic production for the smelting iron and steel. Assessment of CO2 in Steel is based on different carbon content of products of cast iron steel, metallic pellets and scrap steel. According to data of the Ministry of Industry and Trade of the Russian Federation the carbon content of iron and steel is 4,3 per cent and 0,25 percent, respectively. In the calculation of CO2 emissions from steel in an inventory of greenhouse gas emissions the GHG emission coefficient (IPCC, 1997) of 1, 6 kg CO2/t was used.

The CO2 emissions from steel production in Sverdlovsk and Rostov is presented in the table below.



- CO2 emissions from cement production.

In cement manufacture, CO2 is produced during the production of clinker, an intermediate product which is the basis for cement production. The raw product is heated and the calcium carbonate in it breaks to form CaO and CO2. To produce cement from the resulting clinker it is finely ground with some gypsum, mineral additives, etc. Since there are no clinker production data for Sverdlovsk region, cement production statistics were used instead. CO2 emissions from cement production is graphically represented below.

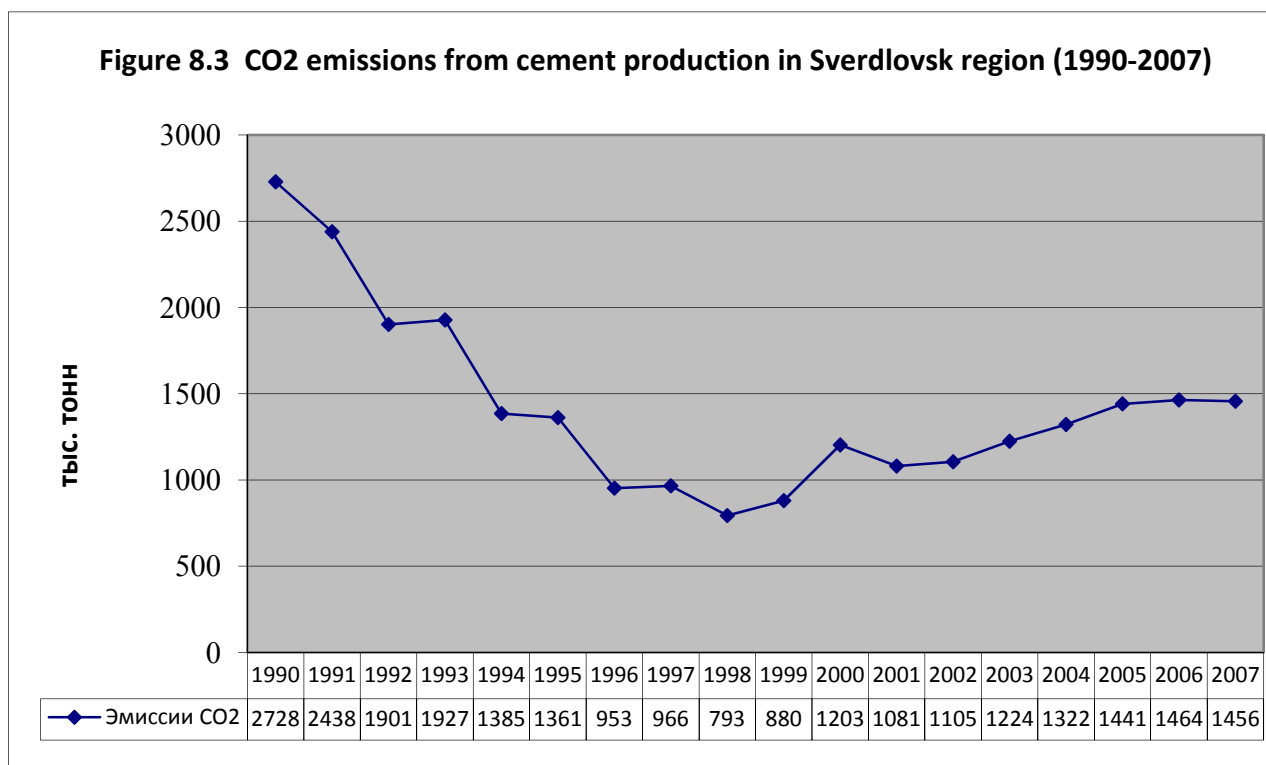
Method of calculation.

CO2 emissions from production of cement was estimated on a level 2 method (IPCC, 2000), using production data on cement clinker – an intermediate product in the production of cement, in obtaining CO2 emissions. Estimated evaluation of CO2 emissions were carried out by the formula 3.1 (IPCC, 2000). The following default calculation parameters (IPCC, 2000): the CaO in the clinker mass is 64.6 per cent; the correction factor (CKD correction factor) is 1.02. Used emission coefficient equals 1.6 kg CO2/t of produced cement (IPCC, 1996).

Uncertainty in the baseline data of Rosstat on the production of clinker is 3 per cent. Uncertainties associated with the result of using default parameters for calculating CO2 emissions are 6 percent for assumptions about the content of CaO in clinker equals 64.6 per cent, and 2 per cent for the proposition that the entire CaO in clinker comes from burning limestone (IPCC, 2000).

Assigned by default value, losses of cement dust in the production of clinker equals 2% (IPCC, 2000), but with the old equipment at Russian cement plants it can be a much higher uncertainty This parameter may reach 200 per cent. The resulting calculations give a general uncertainty assessments of CO2 emissions from cement production of 10 per cent.

The figure below shows the CO2 emissions from cement production in Sverdlovsk oblast.



- CO2 emissions from lime production.

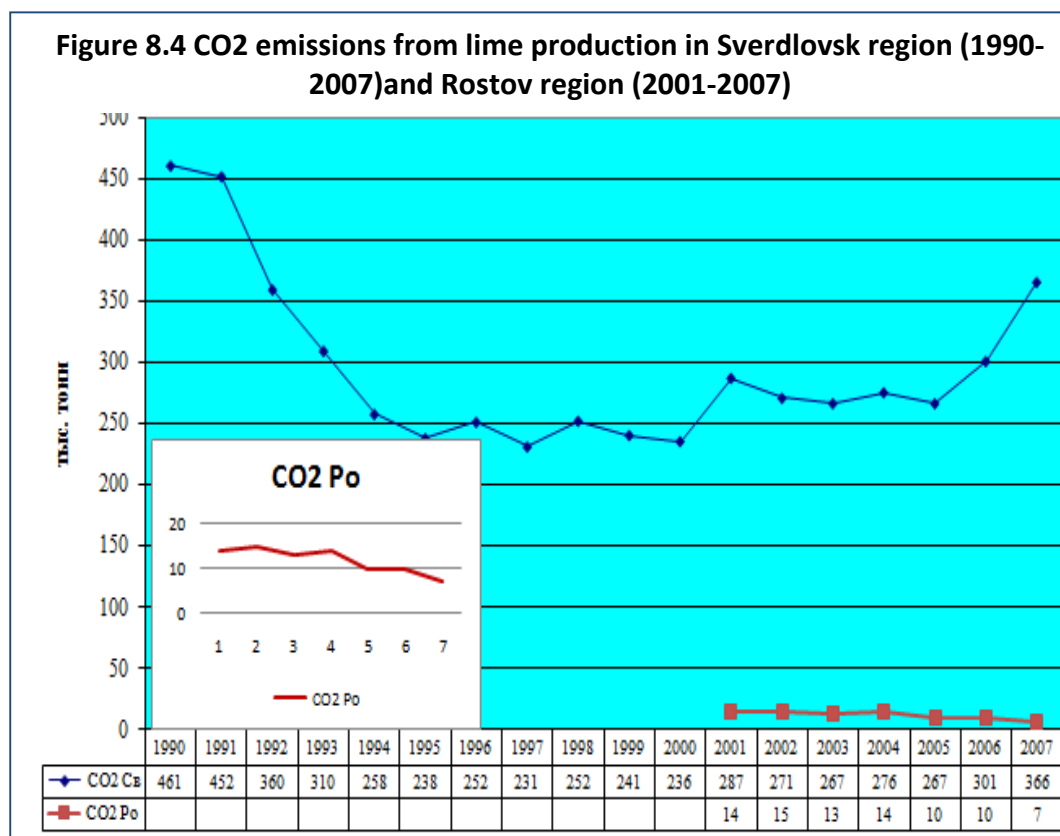
Lime production involves a series of processes similar to clinker production activities. These activities include the raw material mining, crushing and screening, calcination (for example, high temperature calcining at approximately 1100⁰), lime hydration to calcium hydroxide. The mortars are manufactured both with the hydrated and unhydrated lime. CO2 emissions from lime production is based on emission factor represented as tonnes of CO2 per tonne of lime produced per year.

Method of calculation.

The CO₂ emissions from production, engineering and technological lime were judged by the IPCC by using formula 3.4 (IPCC, 2000). For greasy lime and for dolomitic lime, the CO₂ emissions coefficient equals 0.91 tCO₂/t of produced lime (IPCC, 2000).

Building and the technological lime is made by many, including small-scale enterprises, primarily for their own needs and are not always taken into account by the State statistical bodies. The uncertainty on quantities produced in the data of Rosstat on construction and technology is 30%.

CO₂ emissions from lime production are shown in the figure below.



- CO₂ emissions from ferroalloy production.

Ferroalloy production is a metallurgical reduction process which produces a large amount of CO₂ emissions. The primary emissions in closed arc furnaces are almost exclusively CO and not CO₂, having a significant impact on the environment. However, in a few days all CO emitted in the atmosphere turns into CO₂.

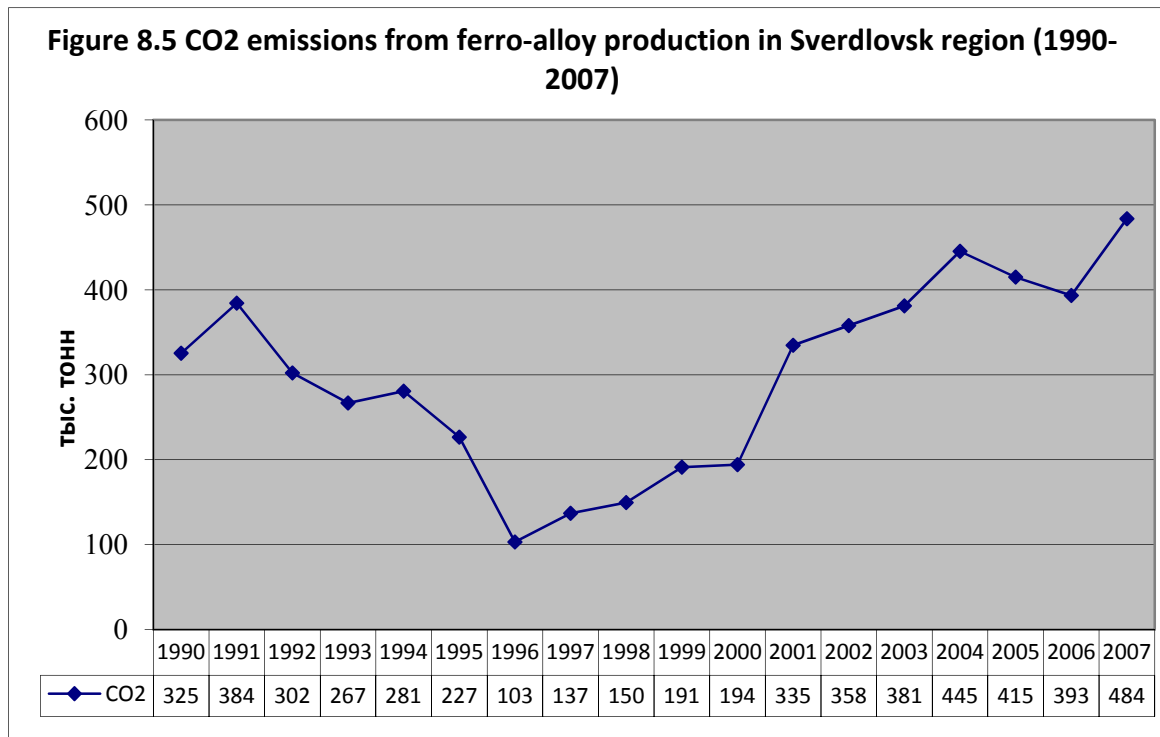
Method of calculation.

Assessment of CO₂ emissions from producing ferroalloys was made in the manner described in IPCC, 1996. Emissions were calculated with method 1B of the data on production volumes of ferroalloys. Evaluation has been implemented for industries domain ферромарганца, ferrosilicon, ferrochrome and силикомарганца. Production quantities were received from the database of Rosstat. Data on production of metallic silicon is not available.

As data become available, emissions will take into consideration the next cadastre version. For the emission estimates was used the default emission coefficient (IPCC, 1996) of 1,3 tCO₂/t. Of ferrochrome.

Uncertainty in Rosstat data on production volumes of ferroalloys is 3 per cent. Uncertainty associated with using the default multipliers of CO₂ emissions is significantly higher and are 37.5% (IPCC, 2006). Total uncertainty of calculated estimates of emissions from production of ferroalloys is from 24 to 30 percent.

Ferroalloys CO₂ emissions are shown below for the Sverdlovsk oblast.



- Estimate of “new” GHG-gas emissions.

Such substances, as hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF₆) are very important, as they have a high greenhouse effect potential and can stay in the atmosphere for extended periods of time.

Russia has not been using a lot of hydrofluorocarbons. Hydrofluorocarbons are not used as foaming agents in fire extinguishers, solvents and other forms at all. Other Ozone Depleting Substances not regulated by Kyoto protocol are used in these devices. Emissions from disposed hydrofluorocarbons in refrigerators are negligibly small, as most of the equipment has been operating less than 10 years and has not been replaced yet. HFCs and PFCs use in Sverdlovsk region is even more limited. There is no production of “new” gases or refrigeration units where they are used. There are two large aluminum producers in the region: Urals Aluminum Smelter and Bogoslovsk Aluminum Smelter. However, the estimate of new gases requires aluminum production data.

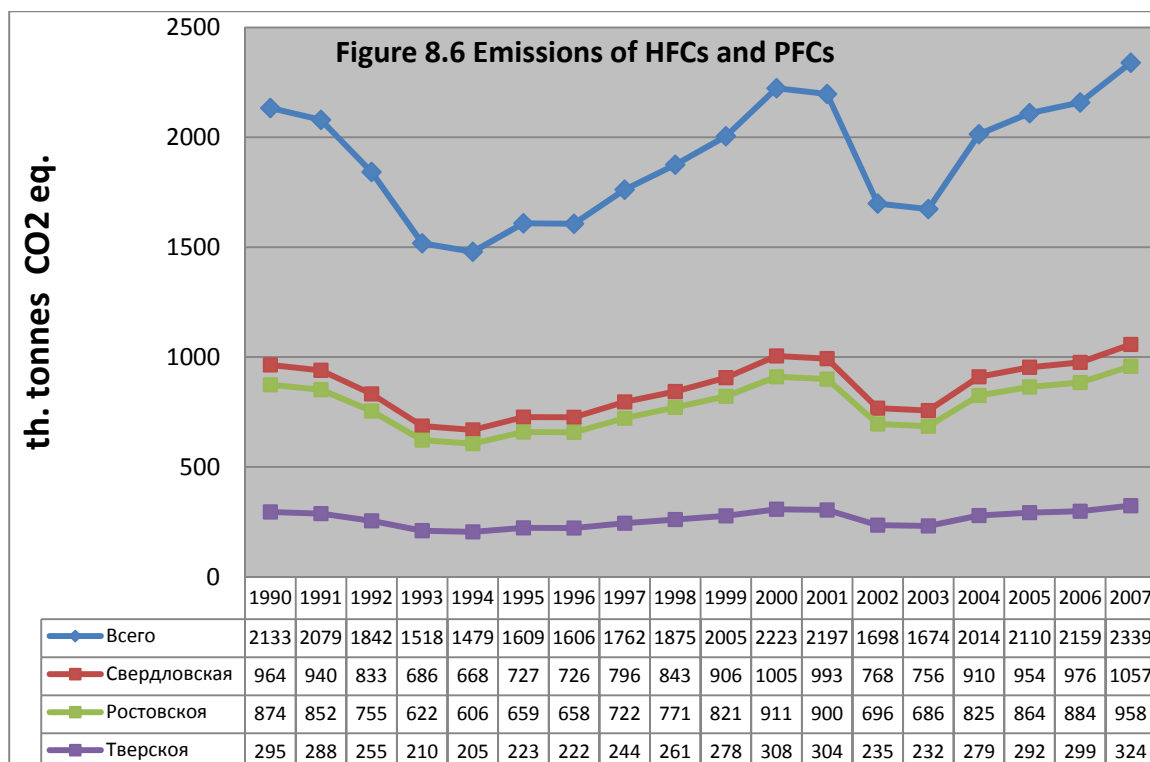
Because of the issues of illegal trade in nonferrous metals in the regions this information is “restricted”, and was not available for the project purposes. Hence, emissions of new gases were not estimated. Due to absence of data on the new generation commercial and household refrigeration units (where HFC-134a or other new gas combinations are used), HFC-134a emissions was estimated based on NII Atmosphere research, proportional to Sverdlovsk region population against the total Russian population:

Table 8.4. Emissions from the use of HFCs, PFCs and SF6 (1990-2007), th. tonnes CO₂-eq

	1990	1991	1992	1993	1994	1995	1996	1997	1998
Russian HFCs and PFCs	30130	29370	26020	21440	20890	22720	22690	24880	26600
Sverdlovsk oblast 3,2 % population	964	940	833	686	668	727	726	796	843
Rostov oblast 2,9 % population	874	852	755	622	606	659	658	722	771
Tver oblast 0,98 % population	295	288	255	210	205	223	222	244	261

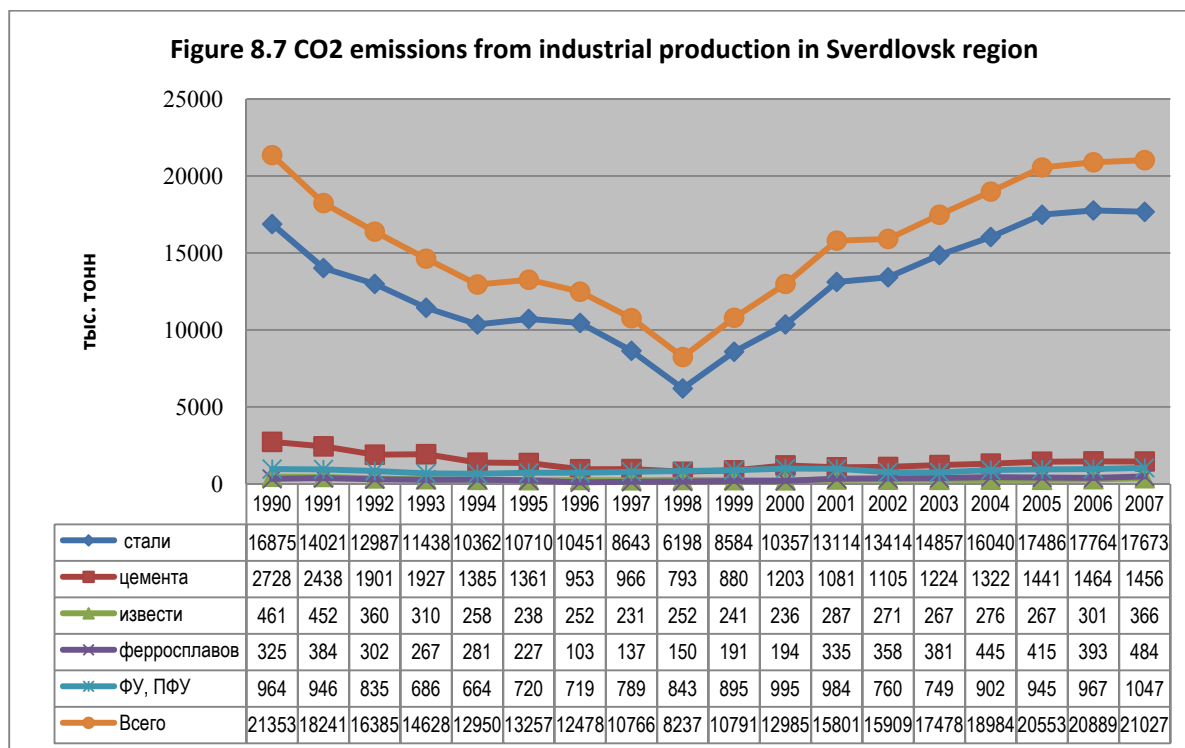
	1999	2000	2001	2002	2003	2004	2005	2006	2007
Russian HFCs and PFCs	28320	31400	31030	23990	23640	28450	29800	30490	33040
Sverdlovsk oblast 3,2 % population	906	1005	993	768	756	910	954	976	1057
Rostov oblast 2,9 % population	821	911	900	696	686	825	864	884	958
Tver oblast 0,98 % population	278	308	304	235	232	279	292	299	324

Approximate HFC and PFC emissions in Sverdlovsk, Rostov and Tver regions are shown below.



The estimates indicate that, under the current conditions in Sverdlovsk region, greenhouse gas emissions from industrial processes are determined by the carbondioxide emissions. Production of methane and “new” gases in industrial processes are negligible at this stage. Total CO₂ emissions are represented below:

Figure 8.7 CO2 emissions from industrial production in Sverdlovsk region



CO2 emissions have reduced almost twice in 1990-2000 and was 11990 Gg (thousand t) by 2000. However, there has been a tendency toward the increase in the emissions in recent years, which is due to certain increase in industrial production in the region, especially growth of metal production. Metal industry is the main contributor of CO2 emissions.

8.3 Waste in Sverdlovsk region

Per the requirements of the Waste section of the Revised 2006 IPCC Guidelines for National Greenhouse Gas Inventories, this section comprises the following chapters:

- Estimate of CH4 emissions from Solid Waste Disposal,
- Estimate of CH4 emissions from Wastewater Treatment and Discharge,
- Estimate of N2O emissions from human sewage

Methane emissions from solid waste disposal municipal sewage treatment represent the major greenhouse gas emission source. Anaerobic digestion of organics by methanogenic bacteria at the solid waste disposal sites produces methane emissions in atmosphere. Biological Treatment of Solid Waste water also results in considerable methane emissions.

Per the Guideline requirements, the source data are:

- Data on waste generation and disposal in the region,
- Data on waste disposal at managed and unmanaged landfills, depending on the nature and the volume of operations.

Greenhouse gas emissions from the solid waste disposal were estimated based on the data provided by SOGU "Environmental control and monitoring center" with Sverdlovsk region government and data in State reports "Environmental conditions and environmental impact on the health of the population in Sverdlovsk region". The amount of deposited solid waste has been exceeding the amount of waste generated, starting from 1996, which is due to the changes in waste reporting system and the fact, that some municipal unitary enterprises and private enterprises have their own vehicles to collect and deposit the waste at the landfills.

See the pattern in waste generation and disposal in Tables 1 and 2.

Table 8.5 Data on the dynamics of waste generation and disposal

	unit	1996	1998	1999	2000
The number of population producing the waste deposited at the landfills	person	4104936	4074000	4078400	4101936
Amount of solid waste generated (excluding the industrial waste generation).	M ³	4855000	5194000	5348762	4989500

Table 8.6 Determination of methane correction factor.

	unit	Share of waste (by weight) for each type of landfill			
		1996	1998	1999	2000
Managed		0,8835	0,9235	0,9419	0,9569
Unmanaged		0,1165	0,0765	0,0581	0,0431
Total		1	1	1	1

The city by-law (1989) determined the standard rate of solid waste generation for the population at 1.07 m³/(person*year). However, the recent research indicates the most probable waste production rate could be estimated to be 1.4 m³/(person*year). This parameter has a major impact on the number of vehicles at the landfill, as well as the frequency and regularity pattern of waste collection appropriate to the conditions. As the data indicate, Yekaterinburg produces about 770 Gg of total waste (61%) (data as of 2000).

The data for the region are very scattered. However, in terms of Yekaterinburg city, which is largest contributor of the solid waste, the residents living outside the centralized waste collection system in the private houses (8% of the city population) either burn the waste, or deposit in the compost pits, or deposit it in the nearby areas (about 30 Gg.)

In view of the above, and also with account to the absence of waste processing or incineration facilities in the region, the amount of deposited waste was used as the waste disposed at the landfills, for the purpose of the estimate.

The exact estimate and information about the waste production, as well as forecasting for the future, are critical elements in developing a realistic waste management strategy and improving the health and environment.

The default method produced the estimate based on three parameters:

- Amount of waste deposited at the landfills of various categories,
- Share of organic, biodegradable and decomposed waste,
- Share of methane in the biogas produced at the landfills.

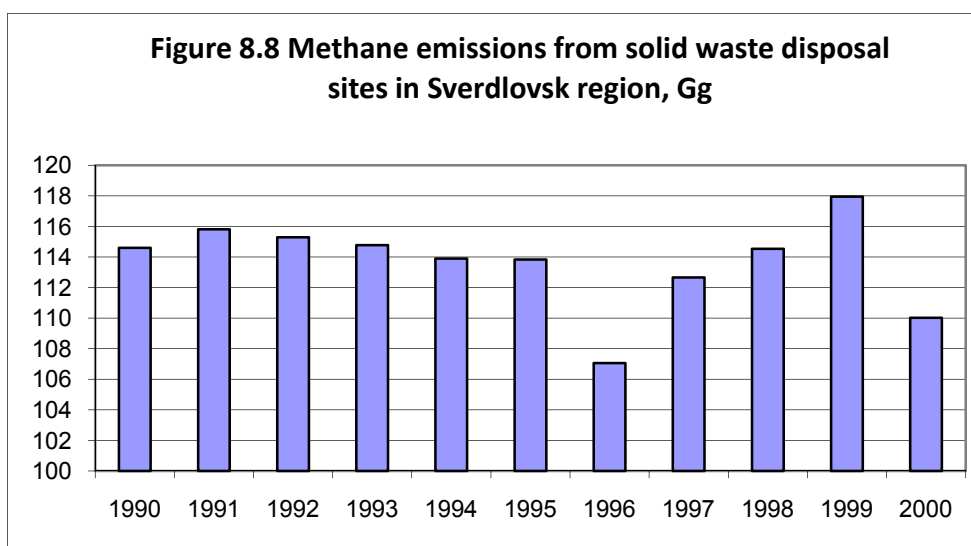
The municipal waste production has reduced significantly in 2000 against 1999, and was 91.2% of 1999. Some waste is used or deposited at the enterprises, and the majority of municipal waste is deposited at the industrial and domestic waste disposal sites, with only a fraction going to domestic waste disposal sites. The region still has the issue with the liquid domestic waste. There is the issue even with the term “Liquid domestic waste”. The concept of managed and unmanaged waste disposal sites. Sverdlovsk region uses the concept of Licensed and Unlicensed waste disposal sites, respectively. State Committee for Environmental Protection has registered 1253 production and consumption waste disposal sites in Sverdlovsk region in 1999, of which 42 were abandoned. Additionally, 18 reclaimed sites have been registered with data records on the accumulated waste. 8 sites have been closed down in 1999. There are 720 sites of industrial and domestic waste disposal. The situation with the domestic waste disposal

sites is far from satisfactory. Only 25% of 450 owners have the license with the proper type of activity code. 80.7 5 sites do not have the hydrogeological survey statement. Only 7% of sites have met the main requirement for operation, which is the availability of the project design.

2108 enterprises and organizations provided official reports on domestic waste production in 2000, which is 78.7% of all businesses that provide the reports.

The data were converted from volume units to mass units with factor 0.25 (0.25 t/m³). The content of degradable organic carbon was taken from the guideline standard – 0.17. All unmanaged waste disposal sites were assigned the standard value 0.6 due to insufficient information about the unmanaged waste disposal sites at the methane correction factor determination stage. According to the regional reports, approximately 90% of waste is deposited at managed waste disposal sites. In 1999-2000 major operating waste disposal sites were located in such cities as Yekaterinburg, Nizhny Tagil, Pervouralsk and Kamensk-Uralsky. According to the methodology of the Guidelines, CH₄ emissions for each year were estimated based on the amount of waste deposited during the year.

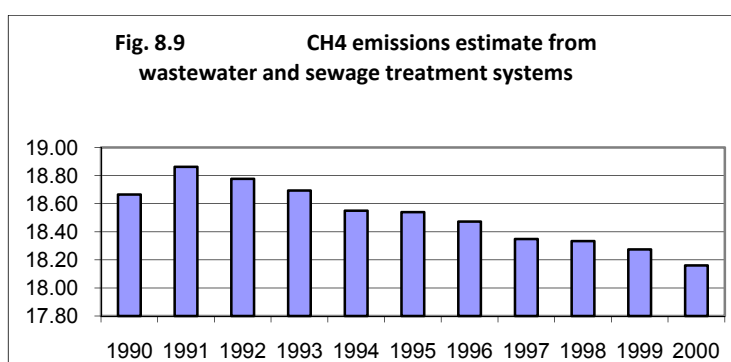
CH₄ emissions pattern is shown below in Fig.8.8.



Methane emissions from domestic wastewater treatment systems and sludge handling were estimated based on the population using domestic wastewater treatment systems (based on the urban population in the region). The estimate used standard rates, however, the uncertainty of the estimates is very high.

Table 8.7 Methane emissions from domestic wastewater treatment systems, Gg

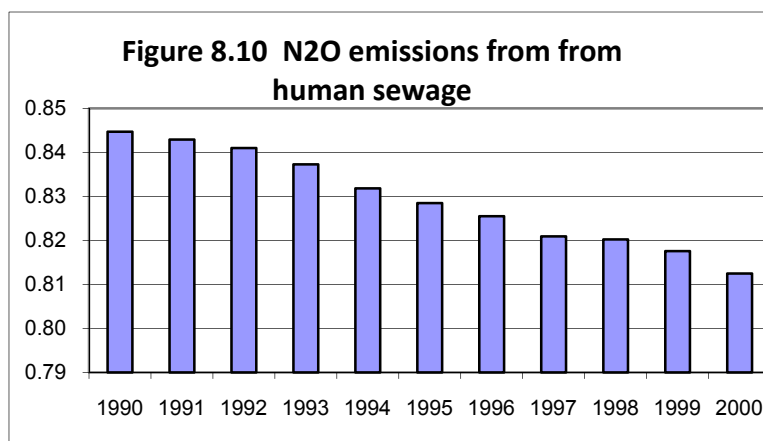
year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
emission	18.66	18.86	18.78	18.69	18.55	18.54	18.47	18.35	18.33	18.27	18.16



N₂O emissions from human sewage were determined based on the population of the region and standard protein consumption rate of 30 kg/(person year) (Table 8.7).

Table 8.8 Nitrous Oxide from Human Sewage, Gg.

year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
emission	0.84	0.84	0.84	0.84	0.83	0.83	0.83	0.82	0.82	0.82	0.81



The uncertainty of the emission estimate is very high due to absence of national emission factors and inaccurate data used in the estimate. The major issue for inventory compilation is a lack of reliable data on the waste disposal site and treatment facilities management practices in the region. That is why the most acceptable method of estimating the emissions from domestic wastewater and sewage was the urban population number in the region.

8.4 Agriculture in Sverdlovsk region

Agricultural production emit such greenhouse gas as methane (CH₄) and nitrous oxide (N₂O). Methane is produced by livestock enteric fermentation and at various stages of manure or poultry droppings management. Nitrous oxide is produced at various stages of manure or poultry droppings management and by the farming soils where nitrogen from organic or mineral fertilizers is added, the crop remains are plowed, and where the nitrogen from nitrogen fixers remains. Additionally, anthropogenic nitrogen compounds are deposited with atmospheric precipitation.

For the purpose of estimating the nitrous oxide emissions from livestock and poultry breeding in Sverdlovsk region, the nitrogen producing livestock population in various Animal Waste Management Systems (AWMS) should be determined. Knowledge of total population of livestock of a certain category and its share kept in a specific AWMS as well as the amount of nitrogen produced by each type of animal, will allow to estimate the nitrogen produced in each AWMS, which meets the requirements of the inventory methodology.

Livestock and poultry population data were used to estimate methane emissions, as well as emission factors in *Guidelines for greenhouse gas emissions estimate in Russian regions*.

Table 8.9 CH₄ Emission coefficients from навоза and internal fermentation (t CH₄ per 1000 head)

Livestock	Internal fermentation-CH ₄ emission (t CH ₄ per 1000 head)	CH ₄ emission from manure (t CH ₄ per 1000 head)
Cows	81,0	6,00
Sheep	8,0	4,00
Goats	5,0	0,19
Camels	46,0	0,12
Horses	18,0	1,59
Mules and Asses	10,0	1,39
Pigs	1,5	0,76
Poultry	Not estimated	0,08

Table 8.10. N₂O content in animal manure (kg/animal/yr).

Non-dairy cattle;	Dairy cattle;	Poultry;	Sheep	Swine	Others
50	70	0.6	16	20	25

Rates release methane from systems for collection, storage and use of manure and pigs are based on level 2 IPCC methodology (Guidelines on good practices, 2000). The volatile substances (VS) assessed at equation 11.1. Ash content in manure adopted the default (8%).

$$VS = (GE * (1 - DE\% / 100) + UE * GE) * (1 - ASH) / 18.4, \quad (11.1)$$

где:

VS – Allocation dry matter volatile substances, kg/day; GE – gross energy, MJ/day; de-factor fodder,%; urine, faction gross energy (0.04 for JRC and 0, 02 for pigs); Ash-Ash content in dry substance, when it is manure.

8.4.1 Summary of data in agriculture

During the period 1990-2007, direct N₂O emissions from agricultural land has been reduced to 48.3 per cent and emission of methane from internal fermentation processes of animals to 60.2 per cent. Reduced emissions of greenhouse gases connected with a reduction of the livestock and the size of poultry in agriculture as well as reduced crop land in the country and rules regarding the use of mineral nitrogen fertilizers, are a result of the economic transformation of the agricultural sector and the country as a whole. On average, livestock and poultry numbers have fallen to 47.8% compared to the 1990 level. The area of cultivated land in Russia for the period from 1990 to 2007, has declined by 31.4% or 41.6 million. ha. The mineral nitrogen fertilizers have been reduced by 85.6 per cent, that is consistent with a reduced nitrogen input in agricultural soils of 8, 5 million. tons. All the figures of the agro-industrial activities have a tendency to gradually decrease during the period under review, including recent years.

Sverdlovsk oblast

The Agricultural sector of Sverdlovsk region is represented by 759 businesses in various types of ownership, of which 345 are farming companies, 155 Food and Processing Industry companies and 259 companies providing services for the agricultural sector. Additionally, the region hosts over 2.7 thousand farms and 760 families practicing collective gardening. Sverdlovsk region has

an area of 19 480 thousand hectares. As of 1990, the agricultural land area was 1 516.3 thousand hectares or 7.8% of total region area. The agricultural land area reduced by 317.8 thousand hectares in 2000 against 1990. There is 0.3 ha of farmland for each resident of the region, which is 3 times less than average in Russia.

The Agriculture of Sverdlovsk region has a distinct suburban pattern and specializes in dairy cattle, vegetable and potato production. Fairly small areas produce spring wheat and rye in the south of the region. The in-house production meets the demand in potatoes, vegetables grown locally and eggs. Total annual farming production in the region is 900 - 1200 thousand tones of grain, 1100 - 1300 thousand tones of potatoes, 270 - 310 thousand tones of vegetables, 750 - 900 thousand tones of milk, 135 - 150 thousand tones of meat and over 1.2 billion eggs.

The following source data were used for GHG emission estimate in Sverdlovsk region:

- Total mineral nitrogen fertilizers applied for crops in the region in the reporting year converted to 100% mineral substance.
- Livestock inventory by the following categories: dairy and beef cattle, pigs, sheep and goats, as well as total count of poultry in the region.
- Regional data on the total yield of grain legumes and soya converted to the dry weight after processing.
- Regional data on the total yield of other crops (except legumes and soya) converted to the dry weight after processing.
- Area of worked peat soils.

See crops and grain legumes production in Table 1. Total crop production includes production of grain, potatoes and vegetables as the dry weight after processing. Additionally, Table 8.11 shows the use of mineral nitrogen fertilizers in the fields of Sverdlovsk region, as converted to the active substance.

Table 8.11. Pattern of crops production and mineral nitrogen fertilizers use in Sverdlovsk region.

		Years										
		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Crop production (except grain)	kton	984,4	1183,3	929,2	751,2	950,5	1290,9	1189,7	1160,2	1055,7	1203,8	1116,6
Grain production	kton	795,0	605,9	862,8	632,6	622,6	808,9	805,0	864,5	506,4	582,8	542,1
Use of mineral N-fertilizers	kton	183,8	163,0	120,9	95,4	32,9	39,7	39,6	51,1	41,6	40,5	39,7

Population of cattle, pigs, poultry, sheep and goats in Table 2 has been taken from regional statistical reports (Russian regions, 2000; Agriculture of Sverdlovsk region, 2000, etc.). some figures were calculated by determining the average between two other years, based on the general development trend of any given value, as some data (e.g., the grain legumes production is shown for 1986 and not for 1990) have not been included in the statistics and determining their true value is fairly problematic.

Table 8.12. Pattern of total livestock and poultry population variation in Sverdlovsk region (farms with all types of ownership), thousand heads

		Years										
		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Cattle,	Th. head.	846,5	845,2	823,2	787,3	750	644,3	596,2	551,5	507,1	476,6	478,7
Incl. cows	Th. head.	342,6	338,8	359,5	348,6	362,1	317,2	291,9	265,5	245,9	245,9	249,6
Pigs	Th. head	627,3	606,3	641,9	599,5	556,5	420,3	365,5	287,4	296,4	297,8	285,7
Sheep and goats	Th. head.	198,3	207,3	228	245,4	242,5	222,3	189,3	171,8	152,2	132,2	122,1
Poultry	Th. head.	177,8	182,8	175,6	167,6	158,1	139,6	134,2	122,5	120,7	115,2	111,5

Table 8.13 shows nitrogen production from manure and poultry droppings in Russian agricultural sector. Nitrogen from the cattle, pigs and poultry was determined based on “National process engineering standards for designing animal waste management systems” (ONTP 17-86, ONTP 17-81), which outlines average standard nitrogen production and content in the manure and poultry droppings as converted to dry excretions. Nitrogen production rates from other animals were taken as average for Eastern Europe from *Revised IPCC Guidelines*.

Table 8.13. Nitrogen production from livestock manure and poultry droppings in Russian agricultural sector (kg/head/year)

Livestock categories					
Non-dairy Cattle ^a	Dairy Cattle ^a	Poultry ^b	Sheep ^c	Pigs ^a	Other ^c
65.4	74.5	1.7	16	24.4	25

^a Mature livestock regardless of the herd age structure. *Source*: ONTP 17-86;
^b Average for chicken, turkeys and ducks. *Source*: ONTP 17-81;
^c Average for Eastern Europe. *Sources*: Ecetoc (1994), Vetter et. al. (1988), Steffens and Vetter (1990).

Nitrous oxide emissions depend on the AWMS in the region, as well as livestock population kept in certain AWMS. In general, animal waste management system fell under the category “solid waste collection at special lots in dry systems” in *Revised IPCC Guidelines*.

Additionally, agricultural enterprises, commercial and private farms in Russian Federation practice cattle, sheep, goats and horses ranging in the summer. Thus, the same categories of livestock could be kept in different waste management systems through the year, as indicated in *Revised IPCC Guidelines*. Poultry in private farms usually free-ranges in summer. That means the poultry droppings are not collected during the day in summer, but is left in the free-range area and can be categorized as “manure at pastures, paddocks and grazing” in *Revised IPCC Guidelines*. Thus, the livestock manure was collected and stored in liquid systems, solid systems and left at pasture ranges and paddocks in 1990-2000 in Sverdlovsk region.

The start, termination and average summertime daily ranging of the cattle, sheep, goats and horses depend on the climate. However, it is possible to generally assume, that the summer ranging starts on 20 May and continues through 1 October. The average daily ranging for cows would be 10 hours (between 7 am and 7 pm except for 2 hour day milking when the cows are herded back to the farm). Average daily ranging for beef cattle, sheep and horses is 12 hours. This means the summer ranging is 55.8 days for cows and 67 days for other types of livestock as converted to 24 hour day, which equals 15.3 and 18.4% time in the year, respectively. Thus, all cow population spends 15.3% time in the year in the summer range and 84.7% time in the stall.

The cattle and sheep spend 18.4% me in the year in the summer range and 81.6% time in the stall. If we assume that the nitrogen is universally produced from the livestock manure throughout the year, it is safe to assume that 15.3% cow population is kept in the conditions, when the manure is left in the fields and ranges, whereas 84.7% population is kept in stalls and their manure is kept in a dry system. The similar approach is used for sheep and goats.

Pigs free-ranging is not practiced in Sverdlovsk region, i.e. pigs are kept at the farms or other enclosures. However, this type of stock management also assumes keeping them in breeding enclosures with the farms, which is equivalent to the dry systems. Some pigs are kept in liquid systems. This means the pig farms in the regions use two animal waste management systems as per the classification in *Revised IPCC Guidelines*: liquid and dry systems.

The share of livestock kept in various type of animal waste management systems was estimated individually for each inventory year based on their population, methane and nitrous oxide emission factors taken from *Revised IPCC Guidelines*, as well as correction factors above (estimating nitrous oxide emissions from various types of animal waste management systems). See estimates in inventory Tables. Tables 7.14 and 7.15 show final estimates of CH₄ and N₂O emissions in the agricultural sector of Sverdlovsk region.

Table 8.14. Consolidated methane emissions in the agricultural sector of Sverdlovsk region

	Methane (kton)									
	1990	1991	1992	1993	1994	1995	1996	1997	1998	
Total	65,04	64,59	64,15	61,60	59,46	51,02	46,93	42,99	39,71	
Enteric fermentation	58,41	58,06	57,53	55,30	53,46	46,09	42,46	39,07	35,98	
Animal waste management	6,63	6,53	6,62	6,30	6,00	4,93	4,47	3,92	3,73	
Agricultural soils	-	-	-	-	-	-	-	-	-	

	Methane (kton)									
	1999	2000	2001	2002	2003	2004	2005	2006	2007	
Total	37,76	37,85	40,0	38,9	36,3	32,2	28,4	28,1	27,1	
Enteric fermentation	34,14	34,23	36,9	35,9	33,6	29,8	26,2	25,9	25,0	
Animal waste management	3,62	3,62	3,1	3,0	2,8	2,5	2,2	2,2	2,1	
Agricultural soils	-	-	-	-	-	-	-	-	-	

Table 8.15. Consolidated nitrous oxide emissions in the agricultural sector of Sverdlovsk region

	N2O (kton)									
	1990	1991	1992	1993	1994	1995	1996	1997	1998	
Total	6,98	6,48	5,55	4,3	2,4	3,04	3	3,45	2,49	
Enteric fermentation	-	-	-	-	-	-	-	-	-	
Animal waste management	-	-	-	-	-	-	-	-	-	
Agricultural soils	6,98	6,48	5,55	4,3	2,4	1,03	3	3,45	2,49	

	Закись азота Гг (тыс. т)									
	1999	2000	2001	2002	2003	2004	2005	2006	2007	
Total	2,64	2,52	0,56	0,54	0,51	0,45	0,40	0,40	0,39	
Enteric fermentation	-	-	-	-	-	-	-	-	-	
Animal waste management	-	-	-	-	-	-	-	-	-	
Agricultural soils	2,64	2,52	0,56	0,54	0,51	0,45	0,40	0,40	0,39	

8.5 Greenhouse gas inventories for non-energy sectors

8.5.1 Industrial Processes

Sverdlovsk region

Greenhouse Gas Emission Inventory in 2000-2007, thousand tonnes of CO₂

Emission source	2000	2001	2002	2003	2004	2005	2006	2007
Clinker	1026.8	1080.5	1105.2	1224.1	1321.6	1440.7	1463.6	1456.1
Construction lime	N/A	287.5	271.2	266.8	275.7	266.8	301.2	365.8
Iron	7542.7	8156.5	8262.0	8472.1	8723.3	8406.6	8818.6	9402.8
Steel	5382.9	5382.9	5817.8	6122.4	6526.9	5735.6	5047.8	4579.3
Ferroalloys	1036.7	1004.1	1073.7	1143.2	1336.1	1244.9	1180.0	1450.9
Ferromanganese	N/A	1.0110	0.0083	0.0000	0.0005	0.0208	N/A	N/A

Rostov region

Greenhouse Gas Emission Inventory in 2000-2007, thousand tones of CO₂

Emission source	2000	2001	2002	2003	2004	2005	2006	2007
Construction lime	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3548.9
Steel	946.1	1010.2	956.7	918.8	980.3	1035.2	1027.0	1267.4

8.5.2 Waste

Rostov region

Greenhouse Gas Emission Inventory in 2000-2007, thousand tones of CO₂

Emission source	2000	2001	2002	2003	2004	2005	2006	2007
CH ₄ emissions from collected solid domestic waste	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3548.9
CH ₄ emissions from liquid domestic waste	20.253	20.130	20.007	19.883	19.760	19.637	19.632	19.505

8.5.3 Agriculture

Sverdlovsk region

Greenhouse Gas Emission Inventory in 2000-2007.

Emission source	2000	2001	2002	2003	2004	2005	2006	2007
CH ₄ emissions from enteric fermentation								
Cows, tonnes of CH ₄	37810.8	35874.9	34911.0	32610.6	28908.9	25434.0	25037.1	24105.6
Sheep, tonnes of CH ₄	864.8	787.2	740.0	694.4	613.6	573.6	599.2	592.8
Pigs, tonnes of CH ₄	347.9	279.0	277.2	264.0	237.9	233.6	269.9	297.5
CH ₄ emissions from manure								
Cows, tonnes of CH ₄	2800.8	2657.4	2586.0	2415.6	2141.4	1884.0	1854.6	1785.6
Sheep, tonnes of CH ₄	20.5	18.7	17.6	16.5	14.6	13.6	14.2	14.1
Pigs, tonnes of CH ₄	432.4	393.6	370.0	347.2	306.8	286.8	299.6	296.4
N ₂ O emissions from manure								
Cows, tonnes of N ₂ O	528.7	501.6	488.2	456.0	404.2	355.6	350.1	337.1
Sheep, tonnes of N ₂ O	27.6	25.1	23.6	22.2	19.6	18.3	19.1	18.9
Pigs, tonnes of N ₂ O	36.8	29.5	29.3	27.9	25.2	24.7	28.6	31.5

Rostov region

Greenhouse Gas Emission Inventory in 2000-2007.

Emission source	2000	2001	2002	2003	2004	2005	2006	2007
CH ₄ emissions from enteric fermentation								
Cows, tonnes of CH ₄	50356.9	51945.1	54163.3	50379.4	46906.9	43968.3	44127.3	44427.9
Sheep, tonnes of CH ₄	3559.0	3724.3	4038.7	4240.0	4613.5	4708.8	5204.1	5379.3
Pigs, tonnes of CH ₄	992.8	1138.8	1385.4	1172.2	1041.9	1119.2	1344.2	1308.5
Goats, tonnes of CH ₄	327.3	339.3	347.8	385.5	407.7	378.9	436.0	409.9
Horses, tonnes of CH ₄	431.2	416.4	416.1	389.9	344.1	321.2	297.9	276.3
Rabbits, tonnes of CH ₄	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Poultry, tonnes of CH ₄	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
CH ₄ emissions from manure								
Cows, tonnes of CH ₄	3730.1	3847.8	4012.1	3731.8	3474.6	3256.9	3268.7	3291.0
Sheep, tonnes of CH ₄	84.5	88.5	95.9	100.7	109.6	111.8	123.6	127.8
Pigs, tonnes of CH ₄	2647.6	3036.8	3694.5	3125.8	2778.4	2984.4	3584.6	3489.4
Goats, tonnes of CH ₄	7.9	8.1	8.3	9.3	9.8	9.1	10.5	9.8
Horses, tonnes of CH ₄	33.3	32.2	32.1	30.1	26.6	24.8	23.0	21.3
Rabbits, tonnes of CH ₄	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Emission source	2000	2001	2002	2003	2004	2005	2006	2007
Poultry, tonnes of CH ₄	379.9	424.8	405.6	429.6	449.7	473.9	527.9	550.2
N ₂ O emissions from manure								
Cows, tonnes of N ₂ O	704.1	726.3	757.4	704.4	655.9	614.8	617.0	621.2
Sheep, tonnes of N ₂ O	113.5	118.8	128.8	135.3	147.2	150.2	166.0	171.6
Pigs, tonnes of N ₂ O	105.1	120.6	146.7	124.1	110.3	118.5	142.3	138.5
Goats, tonnes of N ₂ O	30.8	31.9	32.7	36.2	38.3	35.6	41.0	38.5
Horses, tonnes of N ₂ O	11.3	10.9	10.9	10.2	9.0	8.4	7.8	7.2
Rabbits, tonnes of N ₂ O	30.1	41.8	50.1	47.4	45.9	42.1	45.3	46.4
Poultry, tonnes of N ₂ O	10.9	12.2	11.7	12.3	12.9	13.6	15.2	15.8

Tver region

Greenhouse Gas Emission Inventory in 2000-2007.

Emission source	2000	2001	2002	2003	2004	2005	2006	2007
CH ₄ emissions from enteric fermentation								
Cows, tonnes of CH ₄	29662.2	28657.8	27702.0	23854.5	21270.6	19569.6	1881.1	17682.3
Sheep, tonnes of CH ₄	510.4	510.4	488.0	416.0	369.6	325.6	340.8	318.4
Pigs, tonnes of CH ₄	208.7	203.7	208.2	187.1	159.9	156.5	163.4	170.0
Goats, tonnes of CH ₄	122.5	120.5	113.0	98.0	91.0	78.5	74.0	71.0
Horses, tonnes of CH ₄	169.2	156.6	138.6	118.8	104.4	90.0	99.0	91.8
Rabbits, tonnes of CH ₄	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Poultry, tonnes of CH ₄	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
CH ₄ emissions from manure								
Cows, tonnes of CH ₄	2197.2	2122.8	2052.0	1767.0	1575.6	1449.6	1398.6	1309.8
Sheep, tonnes of CH ₄	12.1	12.1	11.6	9.9	8.8	7.7	8.1	7.6
Pigs, tonnes of CH ₄	556.4	543.2	555.2	498.8	426.4	417.2	435.6	453.2
Goats, tonnes of CH ₄	2.9	2.9	2.7	2.4	2.2	1.9	1.8	1.7
Horses, tonnes of CH ₄	13.1	12.1	10.7	9.2	8.1	7.0	7.6	7.1
Rabbits, tonnes of CH ₄	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Poultry, tonnes of CH ₄	285.9	270.5	270.7	233.3	196.0	192.8	168.1	159.4
N ₂ O emissions from manure								
Cows, tonnes of N ₂ O	414.8	400.7	387.3	333.6	297.4	273.6	264.0	247.2
Sheep, tonnes of N ₂ O	16.3	16.3	15.6	13.3	11.8	10.4	10.9	10.2
Pigs, tonnes of N ₂ O	22.1	21.6	22.0	19.8	16.9	16.6	17.3	18.0

Emission source	2000	2001	2002	2003	2004	2005	2006	2007
Goats, tonnes of N ₂ O	11.5	11.3	10.6	9.2	8.6	7.4	7.0	6.7
Horses, tonnes of N ₂ O	4.4	4.1	3.6	3.1	2.7	2.4	2.6	2.4
Rabbits, tonnes of N ₂ O	11.6	14.9	18.4	18.3	17.3	13.3	14.8	16.2
Poultry, tonnes of N ₂ O	8.2	7.8	7.8	6.7	5.6	5.5	4.8	4.6