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**Promotion of investment in energy
saving projects in Russian Federation
regions**

**Forecasts of greenhouse
gas emissions in Rostov,
Sverdlovsk and Tver
regions**

November 2009



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1. Introduction

Current report has been prepared within the framework of European Union project “*Promoting Investments in Energy Efficiency Projects in Russia’s Regions*”. The objective of this project stage is to assess the GHG emission trends for various economic scenarios, demonstrate potential effect of active energy efficiency increase activities on the trend and determine potential commitments of three Russian regions – Rostov, Sverdlovsk and Tver regions – in GHG emission control for the period through 2020.

Emission models for three GHGs (CO₂, CH₄ and N₂O) during fuel production, transportation and combustion are based on the concept and structure of integrated fuel and energy balance (IFEB), estimated for three regions in 2000-2007.¹ This report makes reference to 2008 IFEB balance and already reflects the impact of the economic recession. Scenarios with rapid energy efficiency increase used the results from previous project stages.² Anthropogenic GHG inventory served as the basis for the quantity and trend estimates of GHG emissions.³

Section 1 of this report represents the key findings. Sections 2-4 review GHG trends related to energy development for three Russian regions: Rostov, Sverdlovsk and Tver.

¹ See I.A. Bashmakov, M. G. Dzedzichuk, A.A. Lunin, O.V. Lebedev. Integrated fuel and energy balances of Rostov, Tver and Sverdlovsk regions. “Promoting Investments in Energy Efficiency Projects in Russia’s Regions” project. M., 2009.

² I.A. Bashmakov, M. G. Dzedzichuk, A.A. Lunin, O.V. Lebedev. Energy efficiency characteristics and indicators in Rostov, Tver and Sverdlovsk regions. CENEF. “Promoting Investments in Energy Efficiency Projects in Russia’s Regions” project. M., 2009; I.A. Bashmakov, M. G. Dzedzichuk, A.A. Lunin, O.V. Lebedev. Energy efficiency increase potential in Rostov, Tver and Sverdlovsk regions. CENEF. “Promoting Investments in Energy Efficiency Projects in Russia’s Regions” project. M., 2009.

³ I.A. Bashmakov, M. G. Dzedzichuk, A.A. Lunin, O.V. Lebedev. Anthropogenic GHG inventory for Rostov, Sverdlovsk and Tver regions (Energy sector). CENEF. “Promoting Investments in Energy Efficiency Projects in Russia’s Regions” project. M., 2009.

2. Summary

Three Russian regions – Rostov, Sverdlovsk and Tver regions – have significant capacity to control GHG emissions growth generated by the energy sector (see fig. 1.1). GHG emissions trend is defined by the recession development and scenarios of following economic growth recovery, including intensification of energy efficiency increase policy and delivery of power plants construction plans.

3 scenarios have been developed and executed on the models for the purpose of projecting the GHG emission trajectories in each region: “innovative development”; “innovative development with rapid energy efficiency increase”; “inert development” – scenario of the macroeconomic performance close to inert development scenario by the Ministry of Economic Development.

GHG emissions were on the upward trend in 2000-2008 in all three regions, but never exceeded 1990 levels (see fig. 1.1). GHG emissions have reduced significantly in all three regions as result of the economic recession. The emissions do not reach 1990 levels in any reviewed scenarios of post-crisis economic recovery through 2020.

The estimates indicate, **that during the Kyoto commitment period (2008-2012):**

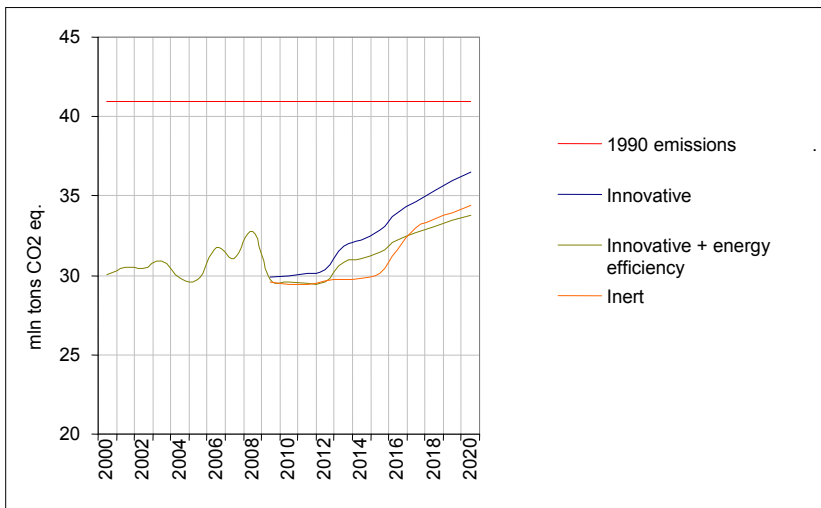
- Rostov region can sustain the average annual GHG emissions at 24-25% less than 1990 levels and accumulate 51.5-53.9 mln tons CO₂eq of emission offset credits;
- Sverdlovsk region can sustain the average annual GHG emissions at 16% less than 1990 levels and accumulate 87-95 mln tons CO₂eq of emission offset credits;
- Tver region can sustain the average annual GHG emissions at 28-30% less than 1990 levels and accumulate 24.9-26.7 mln tons CO₂eq of emission offset credits;

In the **post-Kyoto period**, with an active pursue of energy efficiency increase policy:

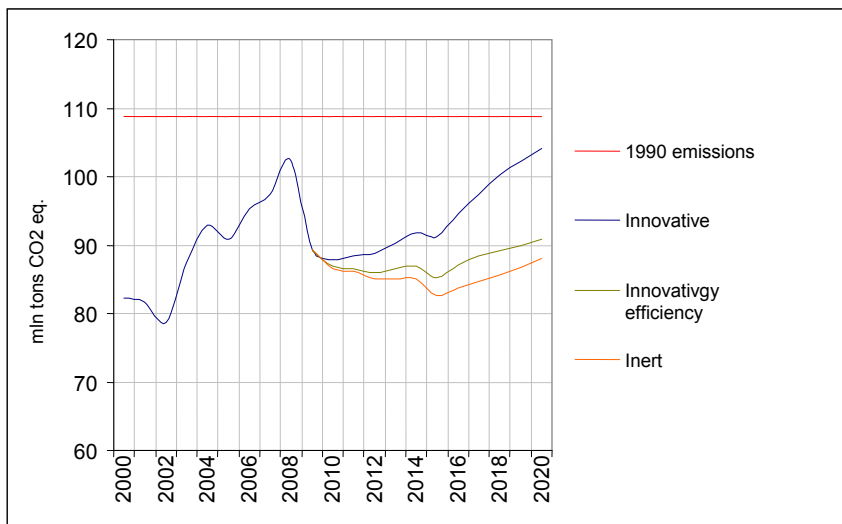
- Rostov region can commit to sustaining average annual GHG emissions in 2013-2020 at 20% below the 1990 levels;
- Sverdlovsk region can commit to sustaining average annual GHG emissions in 2013-2020 at 19% below the 1990 levels;
- Tver region can commit to sustaining average annual GHG emissions in 2013-2020 at 20% below the 1990 levels.

In other words, the three regions are able to commit to emission reduction targets which are just as ambitious as the commitments of for example the European Union.

Rostov region



Sverdlovsk region



Tver region

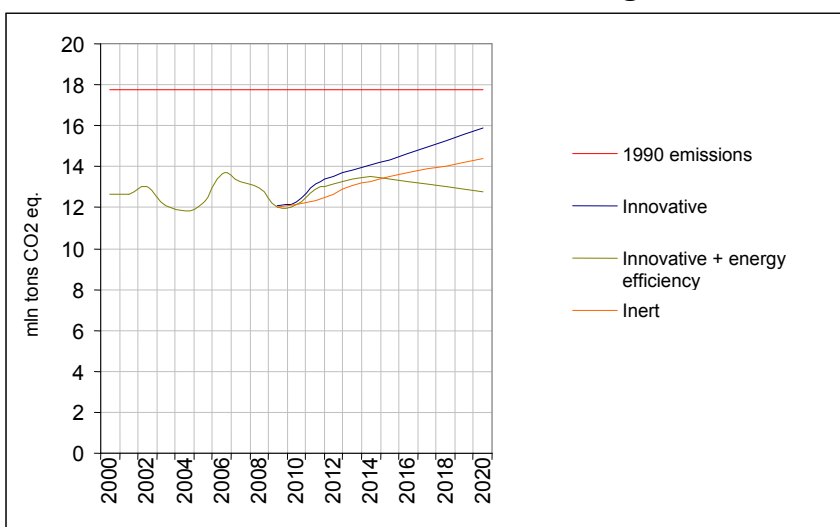


Figure 2.1. Estimate of GHG emissions trend in 2000-2020 in the Energy sector for various development scenarios in three regions

3. Rostov region

3.1 Key findings

The economic recession made some significant adjustments to all economic development projections both for Russia and Rostov region.

GHG emissions in Rostov region in 2008 were 80% of emission levels in 1990. CENEF estimates the emission will be 73% of 1990 levels in 2009-2010.

3 scenarios (see fig. 2.1) have been developed and executed to project the GHG emission trends in Rostov region based on ENERGYBAL-ROSTOV model:

- “Innovative development” – the macroeconomic performance scenario close to projected innovative development scenario by the Ministry of Economic Development;
- “Innovative development with rapid energy efficiency increase”;
- “Inert development” – the macroeconomic performance scenario close to projected inert development scenario by the Ministry of Economic Development.

Running these scenarios through ENERGYBAL-ROSTOV model made it possible to assess the potential Energy-related GHG emission trends in line with IPCC classifications (see fig. 2.1 and table 2.1).

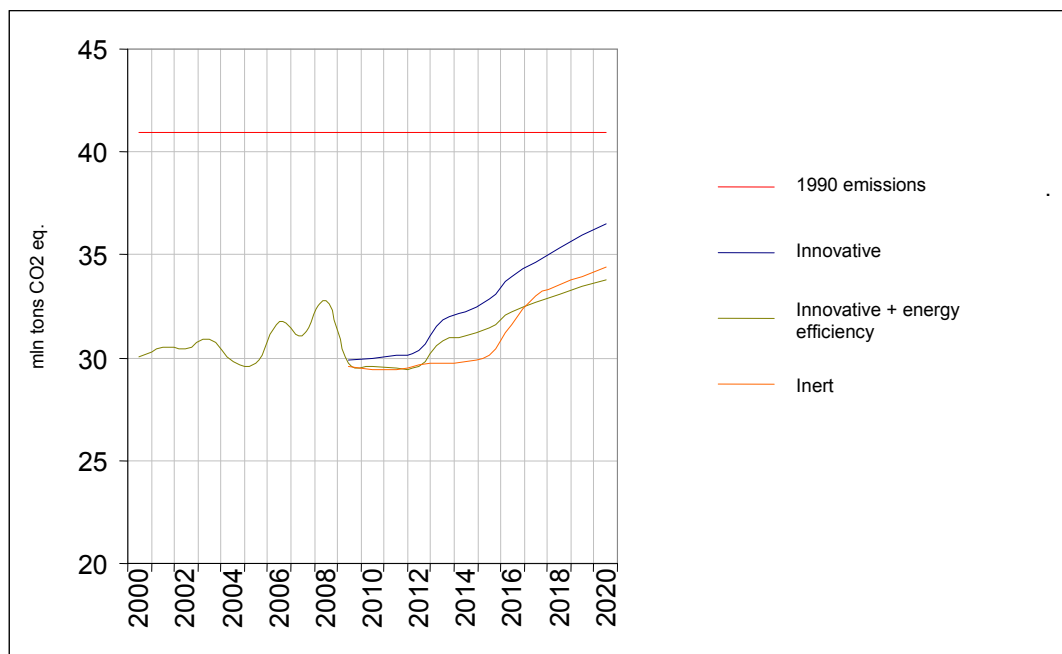


Figure 3.1. Comparison of trend scenarios for GHG emissions resulting from fuel combustion, production and transportation (Energy sector) in Rostov region

Review of the projections led to the following conclusions:

- GHG emissions in Rostov region can be placed in the following ranges with high degree of certainty:

- 29.4-30.0 mln tons CO₂ eq in 2010;
- 39.1-32.9 mln tons CO₂ eq in 2015;
- 33.8-36.5 mln tons CO₂ eq in 2020;
- Additional to the regional macroeconomic development performance, the uncertainty of emission trend depends on the uncertainty due to the delivery of the projects in electric-power industry. Unlike this type of uncertainty, various types of RES development scenarios do not have any significant impact on the emission trends;
- Implementation of planned Novocherkassk State Regional Power Plant (SRPP) expansion project could not curb the GHG emission growth neither in “innovative development” nor in “inert development” scenario in the post-recession economy;
- “Innovative development” scenario formed the upper limit of the projection;
- “Inert development” scenario has been making the lower limit of the projection through 2017, and “innovative development with rapid energy efficiency increase” scenario for the later period;
- Significant efforts in energy efficiency increase in Rostov region per “innovative development with rapid energy efficiency increase” scenario make it possible to keep GHG emissions in 2020 at 18% below the 1990 emission levels;
- In Kyoto commitment period (2008-2012), Rostov region is able to:
 - Maintain the average annual GHG emissions 24-25% below 1990 emissions level;
 - Accumulate GHG emission offset credits in amount of 51.5-53.9 mln tons CO₂ equivalent;
- In the post-Kyoto period, Rostov region can commit to targets only a little less ambitious than EU commitments:
 - Maintain the annual GHG emissions 11-19% below 1990 levels;
 - Maintain the average annual GHG emissions in 2013-2020 at the level 17-22% below 1990 emissions levels;
 - Maintain average annual GHG emissions in 2013-2020 at the level 32-38% below 1990 emissions levels, provided GHG emission offset credits accumulated in 2008-2012 are valid in post-Kyoto period (conventionally, since no actual credits were allocated to regions).

If the energy efficiency increase policy is actively pursued, Rostov region can commit to maintain the average annual GHG emissions in 2013-2020 at the level 20% below 1990 emission levels.

Table 3.1. GHG emissions projection for various development scenarios of Rostov region (mln tons CO_{2eq})

Year	1990 emission levels	Inert	Innovative	Innovative+ prices
2000	40.94	30.07	30.07	30.07
2001	40.94	30.51	30.51	30.51
2002	40.94	30.41	30.41	30.41
2003	40.94	30.94	30.94	30.94
2004	40.94	29.84	29.84	29.84
2005	40.94	29.74	29.74	29.74
2006	40.94	31.78	31.78	31.78
2007	40.94	31.04	31.04	31.04
2008	40.94	32.77	32.77	32.77
2009	40.94	29.88	29.70	29.56
2010	40.94	29.97	29.58	29.40
2011	40.94	30.12	29.52	29.44
2012	40.94	30.38	29.58	29.62
2013	40.94	31.81	30.80	29.77
2014	40.94	32.26	31.04	29.79
2015	40.94	32.87	31.41	30.15
2016	40.94	33.94	32.24	31.58
2017	40.94	34.65	32.69	33.01
2018	40.94	35.34	33.12	33.52
2019	40.94	35.93	33.46	33.95
2020	40.94	36.51	33.76	34.43

Source: CENEF estimate

3.2 Projection model

The energy forecast model and GHG emissions generated by the energy sector in the Rostov region – ENERGYBAL-Rostov – was developed based on the following reports that were prepared by CENEF and other experts, within the project on “Promoting Investments in Energy Efficiency Projects in Russia’s Regions” project:

- Integrated fuel and energy balance and energy efficiency indicators of Rostov, Tver and Sverdlovsk regions;
- Inventory of anthropogenic greenhouse gas emission for Rostov, Sverdlovsk and Tver regions;
- Energy efficiency increase potential in Rostov, Tver and Sverdlovsk regions.

The reports and forecasts in the model are based on the integrated fuel and energy balance concept. The model identified 28 energy consuming sectors for Rostov region, including the manufacture of 10 types of industrial products. The accumulated statistics served as the basis for IFEB assessment in 2000-2008 (see table 3.2).

Table 3.2. IFEB for Rostov region in 2008 (thousand tcf)

	Coal	Crude oil	Petroleum products	Natural gas	Hydro- and non-traditional RES	Nuclear power stations	Other solid fuel	Electric power	Heat energy	Total
1	2	3	4	5	6	7	8	9	10	11
Production	5112.3	2.3		0.0	78.5	3026.5	14.2			8233.7
Import (from outside the region)	0.0	0.0	4482.0	8492.6				703.3		13677.9
Export (to outside the region)	-2211.9	-2.3	0.0	0.0				-1424.2		-3638.5
Stock changes	67.3	0.0	-43.2	0.0			-0.1			24.0
Primary energy consumption	2833.0	0.0	4525.2	8491.6	78.5	3026.5	14.3	-720.9		18248.1
Imbalance	0.0	0.0	0.0	0.0			0.0	0.0	30.5	30.5
Power stations: total	-2199.5	0.0	-44.8	-2742.7	-78.5	-3026.5	0.0	2718.8	467.6	-4905.5
Electric power	-2180.9	0.0	-39.1	-2318.1	-78.5	-3026.5	0.0	2718.8		-4924.2
Existing power stations	-2180.9	0.0	-39.1	-2318.1	-78.5	-3026.5	0.0	2718.8		-4924.2
Heat energy	-271.8	0.0	-31.3	-2219.3			-12.5	-12.0	2372.0	-175.0
Existing power stations: heat energy	-18.5	0.0	-5.8	-424.7			0.0		467.6	18.6
Boilers	-253.3	0.0	-25.5	-1794.7			-12.5	-12.0	1864.2	-233.8
Waste-heat utilization plants								0.0	40.2	40.2
Fuel conversion	0.0	0.0	0.0	0.0			0.0	-2.4	-1.0	-3.5
Auxiliary consumption	0.0	0.0	0.0	0.0			0.0	-163.9	-0.2	-164.1
Distribution losses		0.0	0.0	0.0				-313.2	-214.6	-527.7
End consumers	380.3	0.0	4454.8	3954.2			1.8	1506.4	2125.7	12423.2
Industry	204.9	0.0	548.6	436.2			1.1	485.5	903.3	2579.7
Coal production	0.0	0.0	0.0	0.0			0.0	43.0	13.0	56.0
Electrical furnace steel	0.0	0.0	0.0	0.0			0.0	70.4	0.0	70.4
Steel pipes	6.2	0.0	0.0	105.6			0.0	24.7	19.1	155.6
Bread	1.1	0.0	0.3	13.8			0.0	3.1	4.6	22.9
Artificial yarn and fibers	0.0	0.0	0.0	0.0			0.0	3.2	11.3	14.6
Cotton textile	0.0	0.0	0.0	5.8			0.0	4.3	12.3	22.5
Meat	0.0	0.0	0.0	0.0			0.0	9.2	5.9	15.2
Other	197.6	0.0	548.3	311.0			1.1	327.4	837.0	2222.5
Construction	0.0	0.0	13.2	0.0			0.0	15.2	0.0	28.4
Transport	0.0	0.0	3 679.4	0.0			0.0	155.8	14.6	3849.8
Railroad transport			74.0	0.0			0.0	120.4	13.2	207.6
Pipeline transport			0.0	0.0				23.7	1.4	25.1
Road transport			3789.5	5.7				0.0	0.0	3795.1
Other transport			120.6	0.0				11.6	0.0	132.2

1	2	3	4	5	6	7	8	9	10	11
Agriculture	0.0		171.8	1.7			0.0	43.6	0.4	217.5
Municipal and household	0.0		5.5	0.0			0.0	100.4	0.0	106.0
Service sector	42.2		6.4	420.5			0.0	346.4	283.7	1099.2
Communities	123.7		28.2	2926.3			0.7	359.6	923.8	4362.2
Non-energy consumption	9.5	0.0	1.6	169.4			0.0			180.6

Source: CENEF estimate

The following base sources provided the economic statistics used in assessment of ENERGYBAL-ROSTOV model parameters:

- “Rostov region. 2007” Statistics digest. Rostov-on-Don. 2008;
- “Primary indicators of socio-economic development of Rostov region in January – December 2008”. Rostov-on-Don. 2009;
- “Socioeconomic status of Rostov region in January – September 2009”. Information and analysis news-letter. Rostov-on-Don. 2009;
- “Don area industry: 2002-2007”. Statistics digest. Rostov-on-Don. 2008;
- “Production and distribution of power, gas and water, production of fossil fuels in Rostov region in 2003-2007 and January – September 2008” Statistics digest. Rostov-on-Don. 2009;
- “Transport and communications in January – December 2007”. Statistics digest. Rostov-on-Don. 2008;
- “Housing facilities in Rostov region in 2003-2007”. Statistical bulletin. Rostov-on-Don. 2008;
- “Households (cash incomes, costs and consumption) in 2006-2007. Rostov-on-Don. 2008;
- "Socioeconomic status of Rostov region in 2008". Information and analysis news-letter. Rostov-on-Don. 2009.

These statistics formed the data arrays for 2000-2008 to assess the model parameters, all correspondence parameters were evaluated and, thus, ENERGYBAL-ROSTOV projection model was developed. Additionally, statistics were collected on recession progression in Rostov region economy in 2009.

Based on the anthropogenic GHG inventory for Rostov region, GHG emission unit was incorporated in ENERGYBAL-ROSTOV. The model breaks down GHG emissions by economic sectors slightly differently from the inventory breakdown, which was done in line with the “Guidelines for National Greenhouse Gas Inventories” (IPCC, 2006).⁴

3.3 Collection and analysis of projection information

In order to build the projection scenarios, we collected the information about the potential trends of primary variables in the model for the period of 2010-2020:

- “Projection of the social and economic development of Russian Federation for 2011 and 2012” (Ministry of Economic Development, September 2009);
- RF Government Executive Order # 1622-R as of November 2, 2009 on updates to major government activities through 2012;

⁴ See I.A. Bashmakov, M. G. Dzedzichuk, A.A. Lunin, O.V. Lebedev. Inventory of anthropogenic greenhouse gas emission for Rostov, Sverdlovsk and Tver regions (Energy sector). CENEF. “Promoting Investments in Energy Efficiency Projects in Russia’s Regions” project. M., 2009.

- “Primary indicators of projected socio-economic development of Rostov region for 2009 and for the period through 2011”, Government of Rostov region. December 2008;
- “Long-term socio-economic development strategy for Rostov region for the period through 2020”, approved by the Executive Order # 2067 issued by the Legislative Assembly Rostov region, dated October 30, 2007:
- Demographic projection for Rostov region through 2025 (prepared by Federal State Statistics Service). “Population projection for Russian Federation through 2025”. Statistical bulletin. Federal State Statistics Service. 2007;
- Executive Order # 2067 issued by Legislative Assembly Rostov region dated October 30, 2007 “Approval of socio-economic development strategy for Rostov region for the period through 2020”;
- Resolution by the Administration board of Rostov region “On socio-economic development projection for Rostov region for 2009 and for the period through 2011”. 09.06.2008;
- Information concerning the power plants modification and construction plans in Rostov region from major power generation companies, including “Agreement on co-operation between Rostov region Administration and “UES of Russia” RJC in developing electrical power system of Rostov region and ensuring sustainable power supply to the customers”, dated 30.06.2008;
- Regional target program “Public utility infrastructure upgrade in Rostov region for 2006-2010”;
- Investment projects expected to be implemented in energy intensive industry of Rostov region in 2010-2015

The recession hit the Rostov region economy very hard. According to “Socioeconomic status of Rostov region in January – September 2009” information and analysis news-letter, the output index of basic economic activities fell by 15% in January-September 2009, industrial production fell by 17%, retail turnover reduced by 13%, freight traffic – by 7%, and actual household disposable income – by 6%. Coal production shrank by 31%, pipe manufacture reduced by 18%, textile – by 28%; grain combines manufacture – by 33%; and power generation slumped by 12%.

This is the reason why when we developed the projection scenarios, the basic indicators of projected socio-economic development of Rostov region in 2009 and for the period through 2011, which were evaluated in summer 2008 and did not account for the recession, have been adjusted significantly. This projection maintained annual GRP growth at 9-10%. In 2009, according to CENEF estimates, GRP reduction could be 7.5% in the region, and the following growth will be slower than projected rates.

The projected socio-economic development of Rostov region was adjusted based on the estimates by the Ministry of Economic Development. The macroeconomic environment in Russia was determined by reviewing two recovery scenarios developed by the Ministry of Economic Development and published in “Economic performance Scenarios for Russian Federation, major parameters of socio-economic development of Russian Federation in 2010 and in the scheduling period 2011 and 2012” and in “Projected socio-economic development of Russian Federation in

2010 and in the scheduling period 2011 and 2012” (Ministry of Economic Development, September 2009). The first – conservative – economy growth scenario through 2012 with the following inert development scenario rates “The concept of long-term socio-economic development of Russian Federation”. The second – moderately optimistic – growth scenario through 2012 with following innovative development scenario rates “The concept of long-term socio-economic development of Russian Federation” post 2012.

The authors formed sets of scenario variables for the model based on these two data sources. All estimates in projection and strategic documents by the Rostov region administration have been adjusted to the recession parameters.

The scenario with the rapid energy efficiency increase and development of renewable energy sources has been developed based on the findings in the current project.⁵

3.4 Review of investment projects

The investment projects review is based on the data in “Long-term socio-economic development strategy for Rostov region for the period through 2020”, “Primary indicators of projected socio-economic development of Rostov region for 2009 and for the period through 2011”, as well as data collected by CENEF on potential investment projects identified on the web-site of Rostov regional government, and review of investment programs developed by a few dozens of industrial facilities in the region.

Power industry is an important industry sector of the region. The document “Agreement on co-operation between Rostov region Administration and “UES of Russia” RJSC in developing electrical power system of Rostov region and ensuring sustainable power supply to the customers” outlined the plans for developing the power generation in Rostov region. The delivery of the plans depends on the decisions by the federal state unitary enterprise “Energoatom” Concern (Rostov or Volgodonsk Nuclear power plant), OGK-6 (Novocherkassk SRPP), “YuGK TGK-8” (HeatPP in Rostov-on-Don and Volgodonsk, Tsimlyanskaya HydroPP, as well as other companies, including stand-alone power generating plants at the industrial facilities.

In line with the Federal Target Program “Development of Nuclear Industry of Russia in 2007-2010 and through 2015”, Rostov NPP is expected to commission the second power generating unit in 2010. The “hot phase” of cold and hot operational testing of the reactor unit started October 10, 2009. The original power plant design had 4 power generating units. According to the Federal Target Program “Development of Nuclear Industry of Russia in 2007-2010 and through 2015”, generating units 3 and 4 of Volgodonsk NPP were expected to be commissioned in 2014 and 2016 (adopted for the innovative scenario). There is discussion to move them to 2013 and 2014, respectively.

OGK-6 (owned by “Gazprom”): the plan was to commission 330 MW coal-fired generation unit #9 at Novocherkassk SRPP in 2011. The intention is to equip this generation unit with the circulating fluid bed boilers with specific consumption rate of 323.5 gcf/kW-h and efficiency rate 38%, which is far from the best world practices in coal fired power industry. The second similar generation unit (#10) was scheduled to be commissioned in 2016. However, due to financial issues, OGK-6 reported it intended to move the commissioning date for the new coal-fired generation unit at Novocherkassk SRPP from 2011 to 2012 or even to 2013. OGK-6 commissioned 300 MW

⁵ See I.A. Bashmakov, M. G. Dzedzichok, A.A. Lunin, O.V. Lebedev. Energy efficiency increase potential in Rostov, Sverdlovsk and Tver regions. CENEF. “Promoting Investments in Energy Efficiency Projects in Russia’s Regions” project. M., 2009.

generation unit #7 at Novocherkassk SRPP in summer 2009 following a two year long upgrade project. The project boosted the installed capacity of SRPP by 40 MW and reduced the specific fuel consumption. The unit can operate both on coal and gas.

The generation facilities commissioning schedule “General layout plan for power facilities through 2020” at Rostov HeatPP-2 (“YuGK TGK-8”) planned to commission 2 generation units, each 100 MW, in 2009 and 2010, however, only maintenance operations were carried out, and one 100 MW generation unit was expected for commissioning at the Regional boiler house RK-3 (“YuGK TGK-8”) in 2012. However, these plans have changed. “YuGK TGK-8” later planned to expand the Rostov HeatPP-2 by constructing a 165 MW CCGT unit in 2013-2015. The regional boiler house (RK-3) plans to commission four cogen turbines, 25 MW each, in 2010-2012, thus expanding the heat energy production and start modifying this boiler house into a HeatPP. Thus, the additional electric output of this boiler house will be 100 MW.

According to “General development and layout plan for power facilities” at Tsimlyanskaya HydroPP in 2011-2020 (“YuGK TGK-8”), the plan was to expand the plant capacity by 52 MW in 2009. In reality, they developed a plan to upgrade the hydroelectric generating set #4, which was originally build over 50 years ago. The completion of operations designed to improve the operational reliability of the generating set #4, which has been in continuous operation for over 50 years, boosted the installed output of the HydroPP from 209 to 211.5 MW.

In terms of the investment projects in energy consuming industries, we have reviewed the projects to construct a coal mine and coal preparation plant “Obukhovskaya-1”; plans to construct “Sadkinskaya-2” coal mine; construction project for a modern coal mining facility (based on B.F.Bratschenko coal mine” CJSC), projects by “Taganrog steelworks” OJSC; “Sulinsk steel works “Staks” OJSC; “Energoprom-Novocherkassk electrode production plant” OJSC; “Rostselmash” OJSC; “Salskselmash” OJSC; “Novocherkassk electric locomotive manufacturing plant” LLC, “Taganrog motor works” LLC and others.

GHG emission trend scenarios various combinations of above mentioned projects involving the power generation and industrial production within the Rostov region.

3.5 “Innovative” scenario

3.5.1 THE CONCEPT

“Long-term socio-economic development strategy for Rostov region for the period through 2020” was developed in 2007. This document assumed GRP would keep growing 9% average per year through 2015 and 6.5% a year in 2016-2020. The “competitive edge” in scenario should be: transport, trade, logistics and other types of services, energy sector, metal-fabricating industries (power engineering, automotive industry, railroad engineering, agricultural engineering, and defense industry); agriculture and food industry; service industry, including managerial, financial and other types of services. The assumption was that the share of agriculture and construction would reduce, the services industry would grow, and the industry, regardless of the significant industrial growth and upgrade of the major sectors, would remain the same. Rostov region’s GRP grew 10% annually in 2006-2008 exactly according to the “Strategy” assumptions.

The developers of the “Strategy” identified the deterioration of the national macroeconomic conditions as the major risk factor for the sustainable development of the regional economy. This was the exact reason why 2009 recession aborted the dynamic GRP growth in the region. The prospects of the economy growth recovery are not quite clear.

RF government decree # 1622-R, dated November 2, 2009, concerning the adjustment of major government activities through 2012, set the target to recover Russian GDP in 2012 to the level of

2008. The “innovative” scenario is essentially the assumptions of the same name scenario by the Ministry of Economic Development for the period after 2012, whereas for the period before 2012 – the data of the moderate-optimistic scenario by Ministry of Economic Development. The assumption is that the economy would recover through the real credit, and, consequently, the recovery of the consumer demand and intensified facilities modernization, improved efficiency and competitiveness of business.

The rate of change for the majority of the macroeconomic indicators in this scenario is close to the rates assumed in the projection by Ministry of Economic Development for moderate-optimistic scenario for the Southern Federal District. The assumption for the period post 2012 is the industry will be developing dynamically due to electrical energy industry, coal production industry, transport engineering and the food industry.

It is assumed that the major part of the investment projects planned before 2009 would be delivered, however, with a delay. The projection assessment for 2009 is based on the regional economy development in three quarters of 2009.

This scenario assumes commissioning of second generating unit at Volgodonsk NPP in 2010, and the third and fourth were expected for commissioning in 2014 and 2016, respectively, commissioning of 330 MW coal fired generation unit #9 at Novocherkassk SRPP in 2013, commissioning of 165 MW CCGT unit at Rostov HeatPP-2 in 2015 and commissioning of 100 MW gas turbine units at the regional boiler house in 2013.

Based on the above assumptions, CENEF developed a scenario for the basic governing variables in ENERGYBAL-ROSTOV model for 2010-2020 (see table 2.3-2.8).

Table 3.3. Primary macroeconomic assumptions in “Innovative” scenario.

Year	GRP growth rate	Population	Index of production in industry	Index of production in manufacturing industry	Index of work scope in construction	Agricultural production index	Retail and wholesale index	Index of paid public services	Population income index	Commissioning of residential buildings	Commissioning of service buildings	Number of medical facilities	Number of pre-school and general educational institutions	Railroad freight traffic	Pipeline traffic	Number of motor vehicles
	%	th.peo ple	%	%	%	%	%	%	%	th.sq.m	th.sq. m.	units	units	mln. t- km	mln.m3 /km	units
2007	112.4%	4254.4	119.2%	122.0%	106.5%	90.7%	123.0%	105.6%	116.1%	1706	911	571	2767	37514	3551	1029062
2008	109.2%	4246.3	105.5%	105.8%	106.3%	140.6%	116.2%	102.6%	109.1%	2008	586	569	2761	38264	3846	1049643
2009	92.5%	4221.0	85.0%	90.0%	90.0%	100.0%	90.0%	100.0%	95.0%	1868	560	565	2744	35997	5500	1054891
2010	103.8%	4198.3	102.6%	103.6%	112.7%	102.4%	105.2%	99.9%	100.4%	2015	605	561	2729	36357	5555	1057001
2011	105.2%	4179.1	104.7%	105.7%	107.3%	102.7%	106.7%	104.3%	102.8%	2126	638	558	2716	37084	5666	1071799
2012	105.5%	4161.1	105.5%	106.5%	107.0%	102.5%	107.8%	104.5%	104.0%	2284	685	555	2704	37826	5779	1093235
2013	105.6%	4142.0	103.9%	104.9%	110.0%	102.5%	107.6%	106.0%	106.6%	2329	699	552	2691	38582	5895	1129312
2014	105.6%	4119.4	104.3%	105.3%	111.6%	102.6%	106.9%	106.0%	106.8%	2376	713	548	2676	39354	6013	1167709
2015	105.7%	4096.8	105.1%	105.6%	112.2%	102.5%	106.8%	106.0%	106.9%	2423	727	544	2661	40141	6133	1207995
2016	105.6%	4074.2	105.1%	105.6%	111.8%	102.5%	106.6%	105.9%	106.8%	2472	742	540	2646	40944	6255	1248946
2017	105.4%	4046.8	105.0%	105.5%	110.8%	102.6%	106.5%	105.9%	106.7%	2521	756	536	2628	41763	6381	1290535
2018	105.2%	4019.4	104.7%	105.2%	110.2%	102.5%	106.3%	105.8%	106.5%	2572	771	532	2610	42598	6508	1332736
2019	105.1%	3992.0	104.6%	105.1%	110.2%	102.6%	106.2%	105.8%	106.4%	2623	787	528	2592	43450	6638	1375517
2020	104.9%	3964.6	104.6%	105.1%	109.5%	102.6%	106.0%	105.7%	106.3%	2676	803	524	2574	44319	6771	1418846

Source: CENEF estimate

Table 3.4. Basic production output in “Innovative” scenario

Years	Power generation	Coal conversion	Coal production	Electrical furnace steel	Steel pipes	Artificial fiber and yarn	Cotton fabric	Meat (including byproducts (1 cat.))	Bread and bakery products
	mln. kW·h	th. tons	th. tons	th. tons	th. tons	th. tons	th.m ²	th. tons	th. tons
2007	19895	4988	7403	188	708	8	12	63	150
2008	22103	3858	7084	609	614	8	11	72	135
2009	19451	2701	4959	426	522	8	9	79	135
2010	23820	2798	5137	500	570	9	9	81	136
2011	27506	2957	5430	600	614	9	10	86	138
2012	27891	3150	5783	700	654	10	10	92	139
2013	29861	4475	6783	900	686	10	11	96	140
2014	35125	5800	7142	909	723	11	11	101	142
2015	39057	6124	7285	960	763	11	12	107	143
2016	43190	6467	11285	1014	806	12	12	113	145
2017	47125	6823	12035	1069	850	13	13	119	146
2018	47261	7178	12785	1125	894	13	13	125	148
2019	47399	7545	13041	1183	940	14	14	132	149
2020	47539	7930	13302	1243	988	15	15	138	151

Source: CENEF estimate

Table 3.5. Energy generation pattern and efficiency of power and heat generation industry in “Innovative” scenario

Years	Power generation at existing power plants	Power generation at new power plants	Power generation at hydropower plants	Power generation at wind power plants	Power generation at Nuclear PP	Heat production at new plants	Heat production at existing HeatP P	Specific fuel rate for power generation at new plants	Specific fuel rate for power generation at existing plants	Specific fuel rate for heat generation at new plants	Specific fuel rate for heat generation at existing plants	Boiler efficiency	Line losses	Heat distribution system losses	Gas losses in mainlines	Auxiliary power consumption at power plants
	mln. kW•h	mln. kW•h	mln. kW•h	mln. kW•h	mln. kW•h	th. Gcal	th. Gcal	th. Gcal	gcf/kW•h	gcf/kW•h	kgcf/Gcal	kgcf/Gcal	%	%	%	%
2007	11550.2	0.0	672.5	0.0	7672.1	0	3289	323.7	339.2	143	137	88.8%	18.4%	8.2%	0.0%	6.3%
2008	13344.5	0.0	638.0	0.0	8120.4	0	3322	323.7	340.1	143	137	88.9%	18.7%	9.0%	0.0%	6.0%
2009	10593.5	70.0	574.2	0.0	8282.8	1	3223	323.7	335.0	143	137	89.1%	18.5%	8.9%	0.0%	6.1%
2010	10699.5	200.0	638.0	0.0	12282.8	2	3255	323.7	335.0	143	137	89.3%	18.3%	8.8%	0.0%	6.0%
2011	10806.5	200.0	700.0	0.0	15800.0	2	3287	323.7	335.0	143	137	89.5%	18.1%	8.7%	0.0%	6.0%
2012	10914.5	200.0	977.0	0.0	15800.0	2	3320	323.7	335.0	143	137	89.7%	17.9%	8.6%	0.0%	5.9%
2013	11023.7	2041.3	996.5	0.0	15800.0	591	3354	308.6	335.0	143	137	89.9%	17.7%	8.5%	0.0%	5.9%
2014	11133.9	3175.0	1016.4	0.0	19800.0	1672	3387	299.1	335.0	143	137	90.1%	17.5%	8.4%	0.0%	5.8%
2015	11245.2	3175.0	1036.8	0.0	23600.0	1672	3421	299.1	335.0	143	137	90.3%	17.3%	8.3%	0.0%	5.8%
2016	11357.7	3175.0	1057.5	0.0	27600.0	1672	3455	299.1	335.0	143	137	90.5%	17.1%	8.2%	0.0%	5.7%
2017	11471.3	3175.0	1078.6	0.0	31400.0	1672	3490	299.1	335.0	143	137	90.7%	16.9%	8.1%	0.0%	5.7%
2018	11586.0	3175.0	1100.2	0.0	31400.0	1672	3525	299.1	335.0	143	137	90.9%	16.7%	8.0%	0.0%	5.6%
2019	11701.8	3175.0	1122.2	0.0	31400.0	1672	3560	299.1	335.0	143	137	91.1%	16.5%	7.9%	0.0%	5.6%
2020	11818.9	3175.0	1144.7	0.0	31400.0	1672	3595	299.1	335.0	143	137	91.3%	16.3%	7.8%	0.0%	5.5%

Source: CENEF estimate

Table 3.6. Energy consumption rate during equipment replacement (without price variance and equipment utilization effect) in “Innovative” scenario

Years	Reduction of energy consumption in coal conversion	Reduction of energy consumption in coal production	Reduction of energy consumption in electric furnace steel production	Reduction of energy consumption in steel pipe manufacture	Reduction of energy consumption in bread and bakery goods production	Reduction of energy consumption in meat and 1 cat. meat byproducts production	Reduction of energy consumption in artificial fiber and yarn production	Reduction of energy consumption in cotton fabric production	Reduction of energy consumption in other types of production	Reduction of energy consumption in construction	Reduction of energy consumption in agriculture	Reduction of energy consumption by other transport	Reduction of energy consumption by railroad transport	Reduction of energy consumption by pipeline transport	Reduction of energy consumption by road transport	Reduction of energy consumption by municipal services	Reduction of energy consumption by service industry	Reduction of energy consumption by existing residential buildings	Specific energy consumption in new residential buildings (% of existing housing facilities)
	% per year	% per year	% per year	% per year	% per year	% per year	% per year	% per year	% per year	% per year	% per year	% per year	% per year	% per year	% per year	% per year	% per year	% per year	% per year
2007	2.0%	3.0%	0.0%	0.0%	1.0%	1.0%	0.0%	3.0%	0.0%	6.0%	10.0%	0.0%	5.0%	1.0%	1.0%	0.0%	1.0%	2.0%	90%
2008	2.0%	3.0%	0.0%	0.0%	1.0%	1.0%	0.0%	3.0%	0.0%	6.0%	10.0%	0.0%	5.0%	1.0%	1.0%	0.0%	1.0%	2.0%	90%
2009	1.0%	1.0%	0.0%	0.0%	1.0%	1.0%	0.0%	1.0%	0.0%	1.0%	2.0%	0.0%	2.0%	1.0%	1.0%	0.0%	1.0%	1.0%	80%
2010	1.0%	1.0%	0.0%	0.0%	1.0%	1.0%	0.0%	1.0%	0.0%	1.0%	2.0%	0.0%	2.0%	1.0%	1.0%	0.0%	1.0%	1.0%	80%
2011	1.0%	1.0%	0.0%	0.0%	1.0%	1.0%	0.0%	1.0%	0.0%	1.0%	2.0%	0.0%	2.0%	1.0%	1.0%	0.0%	1.0%	1.0%	80%
2012	1.0%	1.0%	0.0%	0.0%	1.0%	1.0%	0.0%	1.0%	0.0%	1.0%	2.0%	0.0%	2.0%	1.0%	1.0%	0.0%	1.0%	1.0%	80%
2013	1.0%	1.0%	0.0%	0.0%	1.0%	1.0%	0.0%	1.0%	0.0%	1.0%	2.0%	0.0%	2.0%	1.0%	1.0%	0.0%	1.0%	1.0%	80%
2014	1.0%	1.0%	0.0%	0.0%	1.0%	1.0%	0.0%	1.0%	0.0%	1.0%	2.0%	0.0%	2.0%	1.0%	1.0%	0.0%	1.0%	1.0%	80%
2015	1.0%	1.0%	0.0%	0.0%	1.0%	1.0%	0.0%	1.0%	0.0%	1.0%	2.0%	0.0%	2.0%	1.0%	1.0%	0.0%	1.0%	1.0%	80%
2016	1.0%	1.0%	0.0%	0.0%	1.0%	1.0%	0.0%	1.0%	0.0%	1.0%	2.0%	0.0%	2.0%	1.0%	1.0%	0.0%	1.0%	1.0%	80%
2017	1.0%	1.0%	0.0%	0.0%	1.0%	1.0%	0.0%	1.0%	0.0%	1.0%	2.0%	0.0%	2.0%	1.0%	1.0%	0.0%	1.0%	1.0%	80%
2018	1.0%	1.0%	0.0%	0.0%	1.0%	1.0%	0.0%	1.0%	0.0%	1.0%	2.0%	0.0%	2.0%	1.0%	1.0%	0.0%	1.0%	1.0%	80%
2019	1.0%	1.0%	0.0%	0.0%	1.0%	1.0%	0.0%	1.0%	0.0%	1.0%	2.0%	0.0%	2.0%	1.0%	1.0%	0.0%	1.0%	1.0%	80%
2020	1.0%	1.0%	0.0%	0.0%	1.0%	1.0%	0.0%	1.0%	0.0%	1.0%	2.0%	0.0%	2.0%	1.0%	1.0%	0.0%	1.0%	1.0%	80%

Source: CENEF estimate

Table 3.7. Energy prices in “Innovative” scenario

Years	Electric power					Gas		Heat energy		Petroleum	Diesel fuel	Fuel oil	Coal	Firewood
	Industry	Transport	Agriculture	Other	Public	Industry	Public	Industry	Public					
	RUB/kWh	RUB/kWh	RUB/kWh	RUB/kWh	RUB/kWh	RUB/th.m3	RUB/t	RUB/m ³	RUB/Gcal					
2007	1.50	1.55	1.92	1.92	1.69	2150	1699	658.1	854.6	18367	1152	650	1.50	1.55
2008	1.68	1.74	2.15	2.15	1.93	2687	2123	776.5	1008.5	21012	1318	744	1.68	1.74
2009	2.04	2.12	2.63	2.63	2.41	3112	2712	916.3	1190.0	23743	1489	840	2.04	2.12
2010	2.31	2.40	2.97	2.97	2.65	3940	3276	1007.9	1309.0	26284	1649	930	2.31	2.40
2011	2.68	2.78	3.44	3.44	2.91	4558	3957	1139.0	1479.2	28573	1792	1011	2.68	2.78
2012	3.05	3.17	3.92	3.92	3.21	5246	4550	1252.9	1627.1	30725	1927	1087	3.05	3.17
2013	3.31	3.43	4.25	4.25	3.81	6296	5688	1439.5	1869.5	32783	2056	1160	3.31	3.43
2014	3.52	3.65	4.52	4.52	4.65	6957	7110	1584.9	2058.3	34750	2180	1230	3.52	3.65
2015	3.73	3.87	4.79	4.79	5.18	7444	8546	1694.3	2200.4	36488	2289	1291	3.73	3.87
2016	3.93	4.08	5.05	5.05	5.73	7645	8777	1784.1	2317.0	37947	2380	1343	3.93	4.08
2017	4.13	4.29	5.30	5.30	6.29	7859	9023	1868.0	2425.9	39237	2461	1389	4.13	4.29
2018	4.33	4.49	5.56	5.56	6.59	8047	9239	1952.0	2535.0	40571	2545	1436	4.33	4.49
2019	4.52	4.69	5.80	5.80	6.88	8289	9517	2037.9	2646.6	41910	2629	1483	4.52	4.69
2020	4.71	4.89	6.05	6.05	7.18	8628	9907	2125.5	2760.4	43293	2716	1532	4.71	4.89

Source: CENEF estimate

Table 3.8. Inflation parameters in “Innovative” scenario

Years	Industrial producer price index	Price index in manufacturing sector	Price index in primary sector	Cargo transport rate change index	Construction product price index	Agricultural producer price index	Consumer Price Index	Price Index for paid services
	%	%	%	%	%	%	%	%
2007	115.9%	117.7%	119.7%	121.7%	103.8%	116.4%	153.6%	112.3%
2008	112.3%	112.9%	113.5%	98.5%	113.0%	117.9%	93.9%	114.4%
2009	103.0%	97.6%	74.0%	80.3%	119.7%	102.7%	98.7%	113.0%
2010	108.6%	105.7%	106.3%	107.2%	108.4%	101.9%	105.9%	110.7%
2011	107.6%	106.5%	110.4%	108.3%	112.0%	103.8%	107.1%	108.7%
2012	108.2%	107.1%	106.3%	105.3%	109.6%	106.2%	106.8%	107.5%
2013	107.3%	107.3%	107.3%	107.3%	114.5%	107.0%	104.7%	106.7%
2014	106.1%	106.1%	106.1%	106.1%	113.7%	105.5%	104.2%	106.0%
2015	106.1%	106.1%	106.1%	106.1%	111.0%	105.6%	104.2%	105.0%
2016	105.6%	105.6%	105.6%	105.6%	108.7%	105.1%	103.9%	104.0%
2017	105.1%	105.1%	105.1%	105.1%	107.9%	104.6%	103.6%	103.4%
2018	104.6%	104.6%	104.6%	104.6%	107.8%	104.1%	103.3%	103.4%
2019	104.1%	104.1%	104.1%	104.1%	107.7%	103.6%	103.0%	103.3%
2020	103.4%	103.4%	103.4%	103.4%	107.5%	103.3%	102.5%	103.3%

Source: CENEF estimate

3.5.2 PROJECTED ENERGY BALANCE

The “innovative” scenario assumes the regional GRP will grow 62% in 2008-2020, and primary energy consumption – by 58% (See fig. 2.2 and table 2.9). Energy intensity per GRP in terms of primary energy will reduce only 9% in 2007-2020. Slow reduction of energy consumption is due to significant expansion of power generation at Nuclear PP needed to meet the needs of other regions. Energy intensity per GRP in terms of end-use energy will reduce by 33% | in 2007-2020.

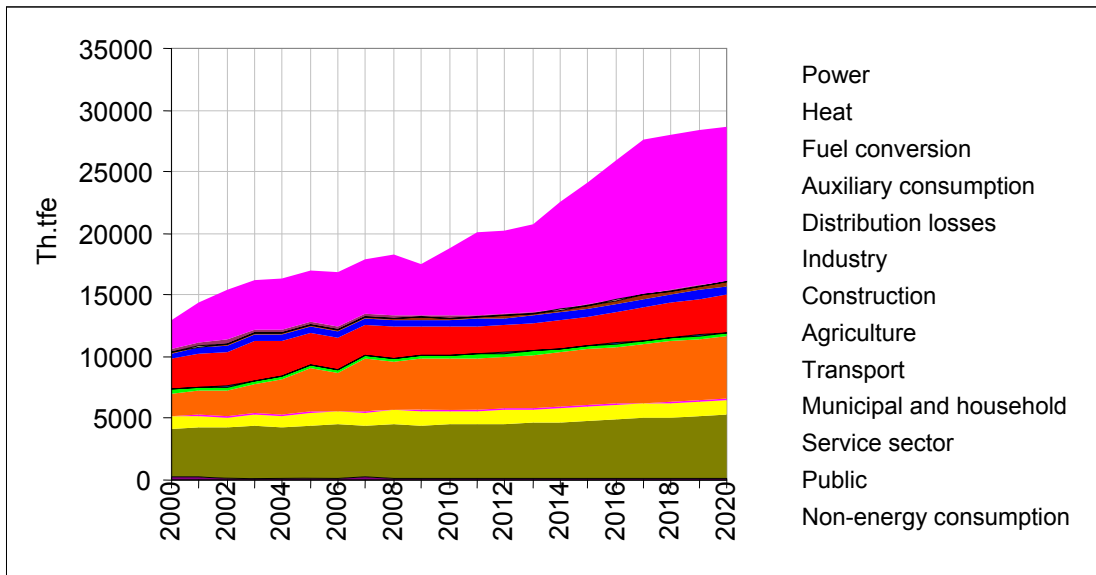


Figure 3.2. The trend of major power consumption indicators according to “Innovative” scenario

The loss of primary energy in the process of power generation is the major factor (75%) of energy demand growth. The next is transport (7,5%) and industry (5.2%). Over the whole period through 2020 Rostov region remains an energy-surplus region. The power export outside the region, according to this scenario, grow from 5.9 bln kW•h in 2008 to 33 bln kW•h in 2020.

Since Nuclear PP is responsible for the fair share of additional power generation, the organic fuel consumption grows at a much slower rate than the primary energy consumption: by 13% in 2008 -2020 (see fig. 2.3). The fuel consumption growth happens mostly at the power stations and the transport.

Table 3.9. Sectoral power consumption structure in “Innovative” scenario (thousand tcf)

Years	Power generation losses	Heat production losses	Fuel conversion	Auxiliary consumption	Distribution losses	Industry	Construction	Transport	Agriculture	Municipal and domestic	Service industry	Public	Non-energy demand
2005	4186.8	254.0	6.5	146.8	475.8	2563.0	26.4	3511.3	263.2	87.1	1069.3	4220.8	167.7
2006	4435.6	219.6	4.4	157.5	480.2	2570.3	26.9	3040.3	257.1	107.0	1028.7	4314.8	180.1
2007	4412.4	163.5	4.5	153.4	492.7	2520.9	28.4	4240.8	254.3	120.2	1067.9	4172.6	221.7
2008	4924.2	175.0	3.5	164.1	527.7	2579.7	28.4	3849.8	217.5	106.0	1099.2	4362.2	180.6
2009	4142.2	155.5	2.5	146.1	546.2	2334.3	25.1	4163.3	283.3	106.3	1116.2	4269.8	177.0
2010	5529.4	145.5	2.5	176.8	548.6	2262.3	26.9	4143.6	278.0	104.7	1115.1	4311.1	174.6
2011	6731.6	137.6	2.6	201.5	555.2	2260.7	27.7	4170.9	277.2	103.5	1117.6	4337.8	181.1
2012	6794.2	130.6	2.7	203.5	558.6	2267.1	28.8	4219.9	276.5	102.0	1119.9	4399.3	182.6
2013	7147.0	113.8	3.6	215.7	567.4	2285.7	31.0	4317.4	276.1	100.8	1119.8	4442.6	183.2
2014	8664.0	91.5	4.5	251.5	580.7	2299.4	34.2	4422.2	276.1	100.6	1131.4	4522.6	185.1
2015	9920.2	90.1	4.7	277.5	598.6	2388.1	38.0	4529.3	276.2	100.2	1140.8	4625.8	185.7
2016	11262.4	89.5	4.9	304.0	621.4	2531.8	42.1	4636.3	276.7	99.8	1149.5	4738.7	181.2
2017	12537.8	87.4	5.1	328.8	640.6	2675.9	46.2	4743.5	277.4	99.5	1161.2	4824.2	181.3
2018	12556.5	84.3	5.2	326.9	653.4	2815.7	50.4	4849.6	278.0	99.1	1171.1	4920.5	181.9
2019	12572.9	79.6	5.4	324.9	664.5	2951.1	55.0	4954.4	278.4	98.6	1180.0	5007.4	182.8
2020	12589.8	73.9	5.6	323.0	675.2	3086.0	59.5	5057.8	278.7	98.1	1188.8	5093.6	183.0

Source: CENEF estimate

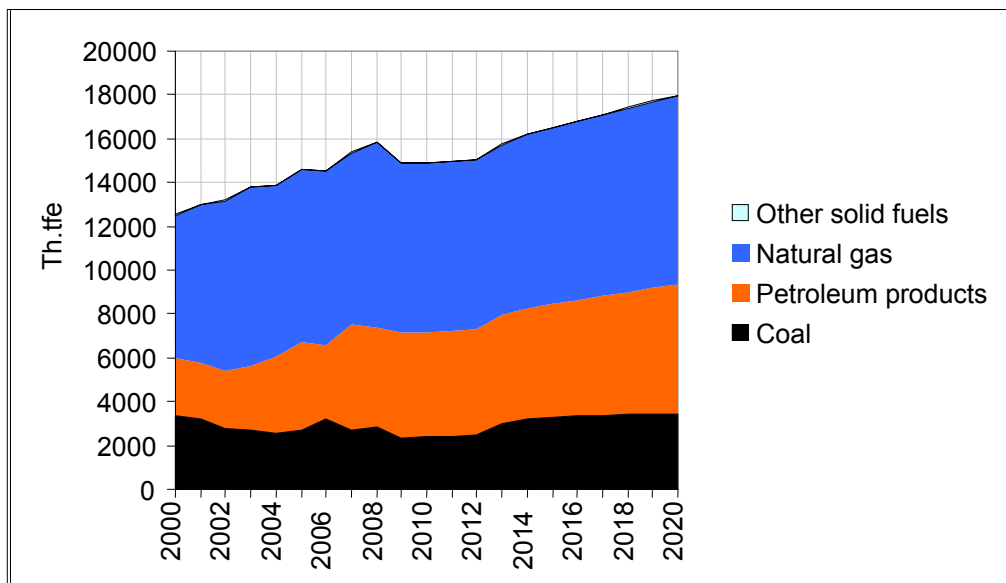


Figure 3.3. End user power consumption trend according to “Innovative” scenario

3.5.3 GHG EMISSIONS TREND

GHG emissions trend in Rostov region is primarily defined by CO₂ emissions. The share of CH₄ and N₂O in total emission was 2.2% and 0.02%, respectively, in 2008.

The year of 1990 was selected as the baseline year for the purpose of GHG emission trend assessment, for the region and Russia in general, in accordance with Kyoto protocol.⁶ According to the estimate CENEF made in 2000, CO₂ emission linked to consumption, production and transportation of fuel in Rostov region was 40.93 mln.t in 1990, whereas it reduced down to 30.49 mln.t in 1997.⁷ Emissions totaled 30.07 mln.t in 2000, 31.04 mln.t in 2007, and 32.77 mln.t in 2008, which is 20% below 1990 emissions level (see fig. 2.4).

The increase in power generation at fuel-fired power plants in 2008 led to a 6% increase in total emissions. According to CENEF estimate, the emissions in 2009 will be 9% less than in 2007 and 27% below 1990 emissions level.

The accumulated offset credits (delta between the emissions at 1990 level for 5 years and actual total GHG emission for this period) in Rostov region will be 51 mln tons CO₂ equivalent in the period of 2008-2012.

⁶ The methodology used in estimating the emissions in 1990 was somewhat different from the methodology applied in I.A. Bashmakov, M. G. Dzedzichuk, A.A. Lunin, O.V. Lebedev. Inventory of anthropogenic greenhouse gas emission for Rostov, Sverdlovsk and Tver regions (Energy sector). CENEF. “Promoting Investments in Energy Efficiency Projects in Russia’s Regions” project. M., 2009. However, the difference is not significant, and the results are consistent.

⁷ CENEF. Multi-regional project to develop monitoring and reporting capacity for multiple greenhouse gases in Russia. Implemented under the contract with PNNL. 2000.

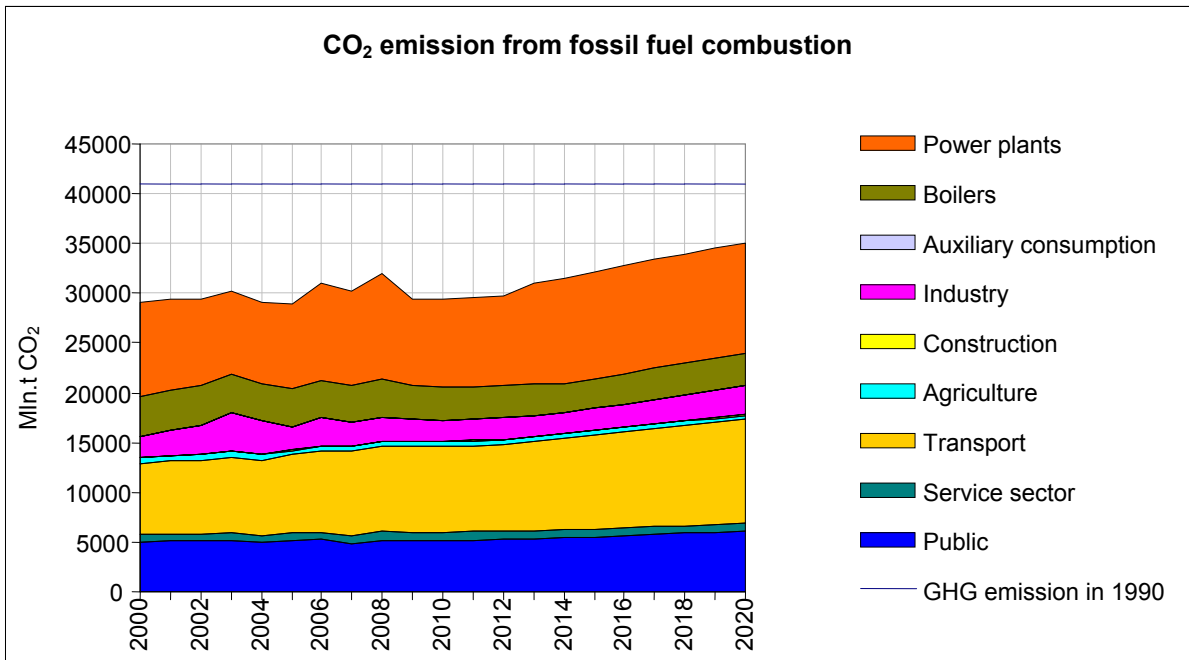


Figure 3.4. Sectoral trend of CO₂ emissions according to “Innovative” scenario

According to this scenario, GHG emissions will still be 11% below 1990 emissions level by 2020, whereas accumulated offset credits will be 106 mln tons CO₂ equivalent in 2008-2020, which is 2.9 times above the annual emissions in 2020 (see fig. 2.5).

The transport is responsible for the largest increment in emissions– 40% of total emission growth in 2007-2020. It is particularly problematic to ensure the emission control in this sector. The second largest contributor to the emission growth is the power generation industry, responsible for 33% increment.

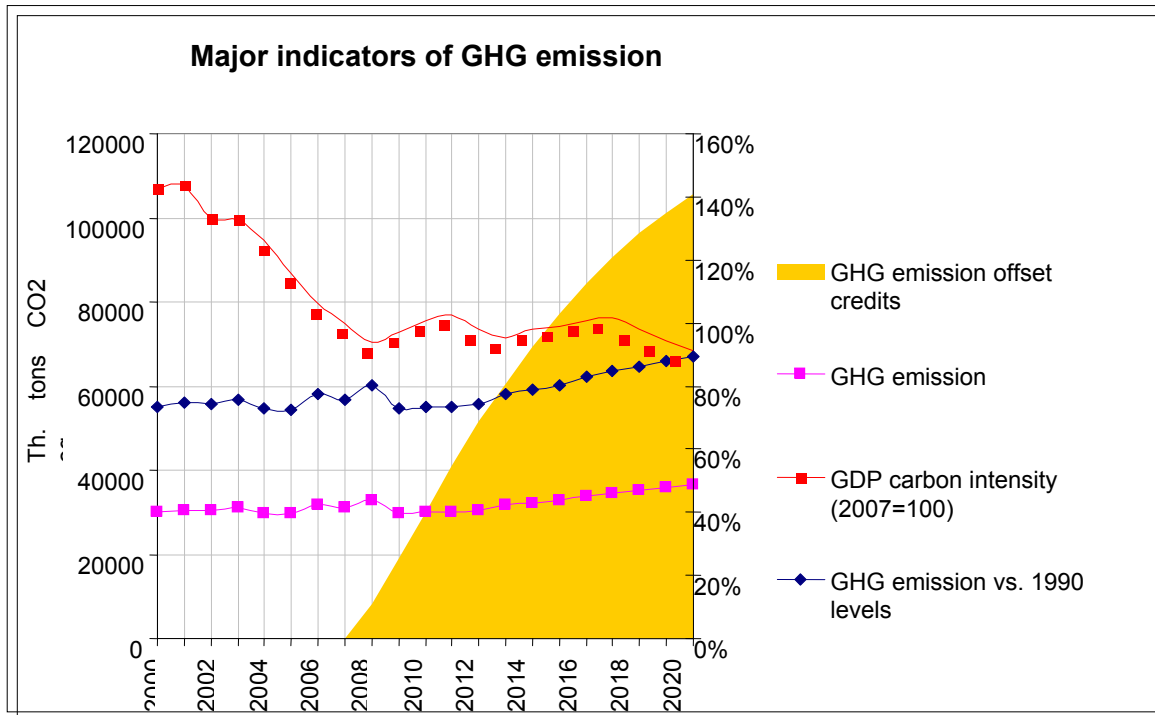


Figure 3.5. Trend of major GHG emission indicators according to “Innovative” scenario

Thus, this scenario:

- Cannot stunt growing GHG emissions by 2020. Annual GHG emissions pick up the growth after 2009, but remain 11% below 1990 level in 2020;
- Average annual GHG emissions in 2008-2012 appear to be 25% below 1990 emissions level;
- Accumulated GHG emission offset credits are 51.5 mln tons CO₂ equivalent in 2008-2012;
- Average annual GHG emissions appear to be 17% below 1990 emissions level in 2013-2020;
- Accumulated GHG emission offset credits are 54 mln tons CO₂ equivalent in 2013-2020.

According to this scenario, Rostov region can commit to following targets:

- Maintain the average annual GHG emissions 15% below 1990 emissions level in 2013-2020

If 2008-2012 emission offset credits are valid in the post-Kyoto period (conventionally, since no actual credits were allocated to regions) for GHG emissions (in average, 6.44 mln tons CO₂ equivalent annually in 2013-2020), then, with account to this “reserve”, Rostov region could commit to maintaining average annual GHG emissions 32% below level of emissions in 1990 in 2013-2020.

3.6 “Innovative scenario with rapid energy efficiency increase”

3.6.1 THE CONCEPT

This option of “Innovative scenario” keeps all conditions from the previous scenario, with an additional assumption of energy efficiency increase (see table 2.10 and 2.11). This assumption is largely based both on estimate of the existing energy efficiency, and CENEF estimate of the potential efficiency increase.⁸

3.6.2 PROJECTED ENERGY BALANCE

With the assumptions in this scenario, the primary energy consumption will grow 50% (see fig. 2.6). Energy efficiency per GRP in terms of the primary energy reduces 15% in 2007-2020, with 39.4% for the end use energy, which is consistent with the targets set for Russia. Similar to the previous scenario, slow reduction of energy consumption in terms of the primary energy is due to the incremented power generation at Nuclear PP, which is primarily exported to cover the demand in other regions.

Organic fuel consumption will grow only 4% in 2008-2020 (see fig. 2.7).

⁸ See I.A. Bashmakov, M. G. Dzedzichok, A.A. Lunin, O.V. Lebedev. Energy efficiency characteristics and indicators of energy efficiency in Rostov, Tver and Sverdlovsk regions. CENEF. “Promoting Investments in Energy Efficiency Projects in Russia’s Regions” project. M., 2009; I.A. Bashmakov, M. G. Dzedzichok, A.A. Lunin, O.V. Lebedev. Energy efficiency increase potential in Rostov, Sverdlovsk and Tver regions. CENEF. “Promoting Investments in Energy Efficiency Projects in Russia’s Regions” project. M., 2009.

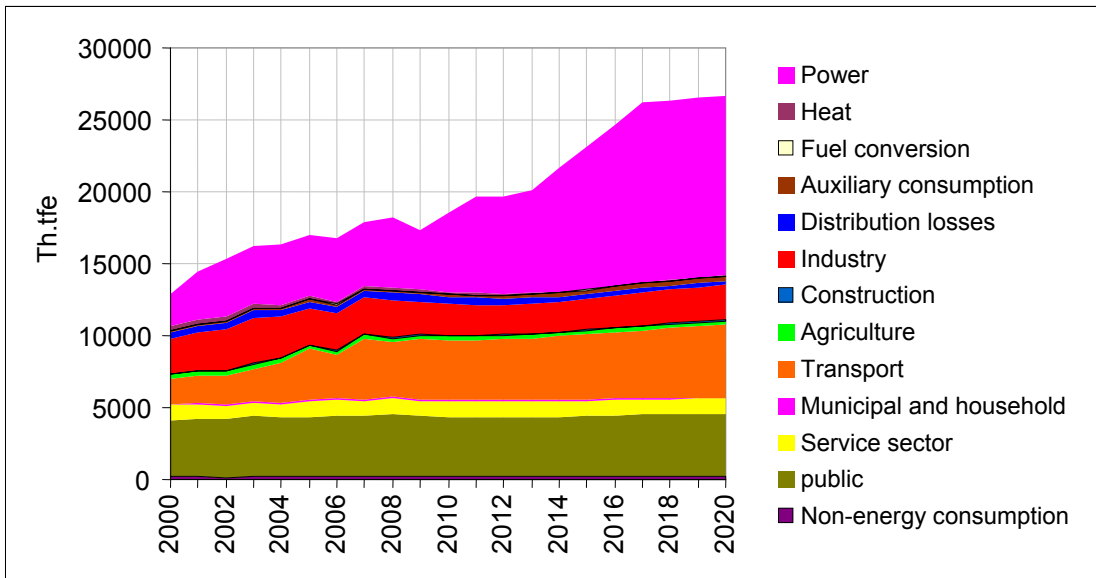


Figure 3.6. The trend of major power consumption indicators according to “Innovative” scenario

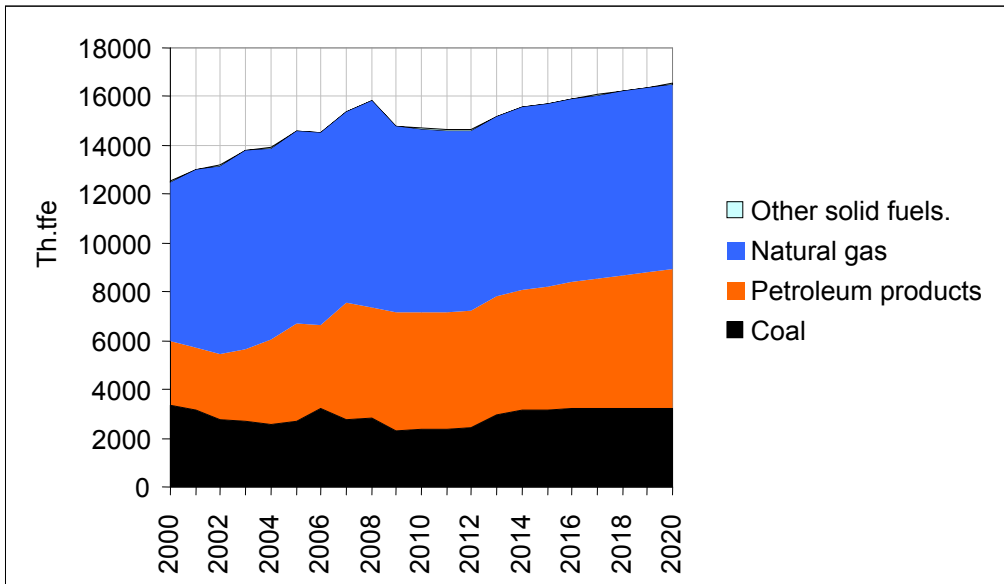


Figure 3.7. End user power consumption trend according to “Innovative” scenario

3.6.3 GHG EMISSION TREND

In this case, the trend of GHG emissions, as well as major GHG emission indicators, changes significantly and looks differently from the ones in “innovative development” scenario (see fig. 2.8 and 2.9 and table 2.12). GHG emissions in 2020 exceed emissions in 2008 by 3% only.

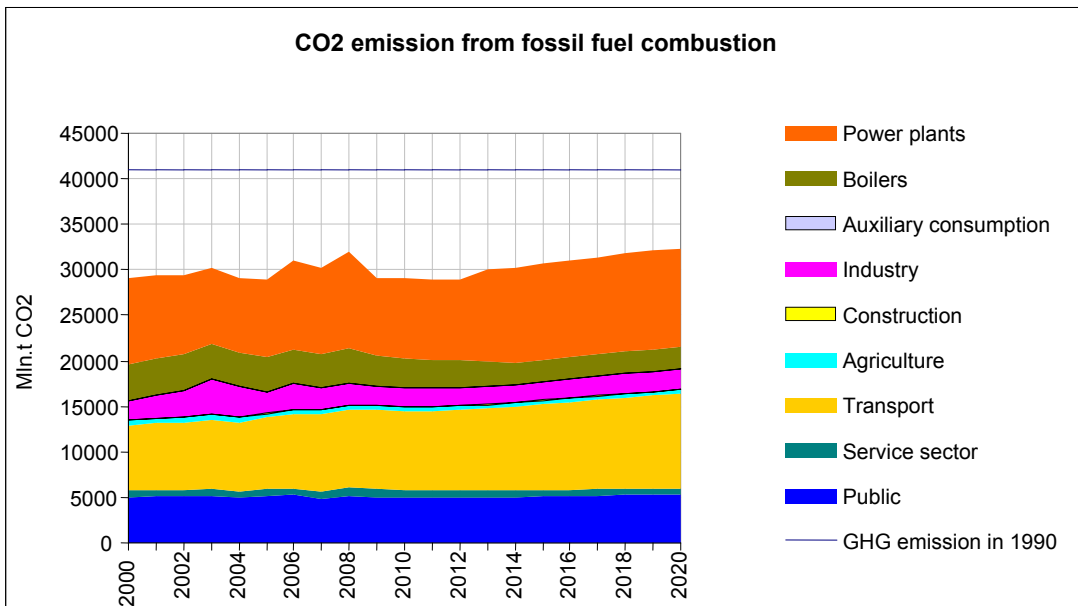


Figure 3.8. Trend of CO₂ emissions by economy sectors according to “Innovative scenario with rapid energy efficiency increase”

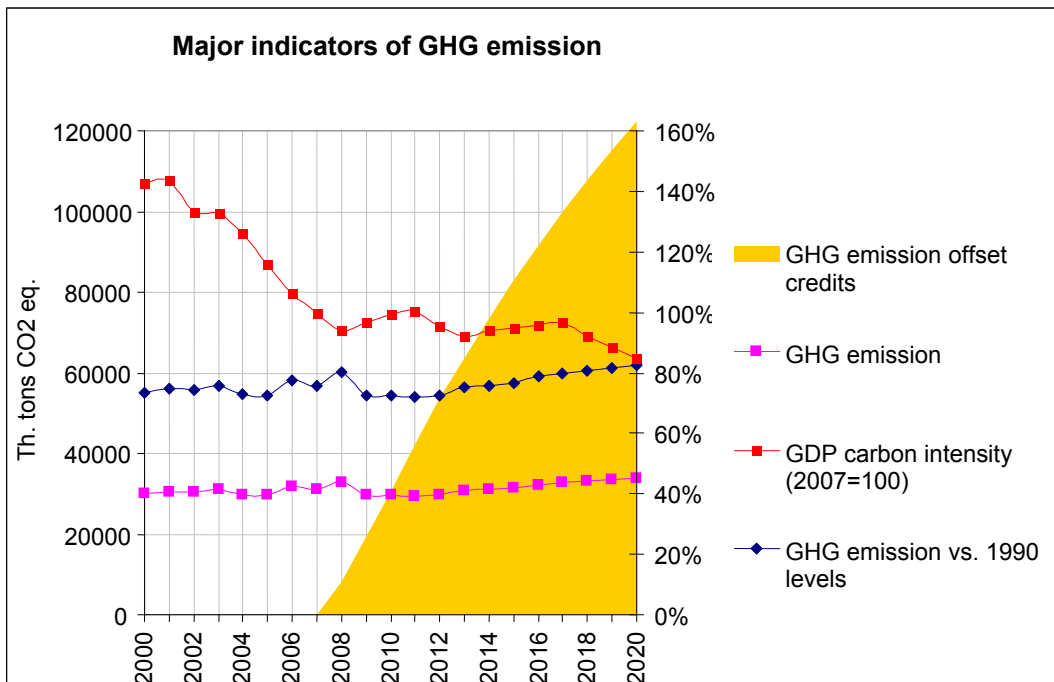


Figure 3.9. Trend of major GHG emission indicators according to “Innovative scenario with rapid energy efficiency increase”

Thus, in this scenario:

- Annual GHG emissions pick up growth after 2009, but remain 18% below 1990 levels in 2020. If no new facilities were to be commissioned under this scenario at SRPP and HeatPP, the emissions would remain 20% below 1990 levels;
- Average annual GHG emissions in 2008-2012 are 26% below 1990 emissions level;
- Accumulated GHG emission offset credits in 2008-2012 are 53.5 mln tons CO₂ equivalent;

- Average annual GHG emissions in 2013-2020 are 21% below 1990 emissions level;
- Accumulated GHG emission offset credits in 2013-2020 are 68.9 mln tons CO₂ equivalent.

According to this scenario, Rostov region could commit to maintain the average annual GHG emissions in 2013-2020 at 25% below 1990 emissions level.

Table 3.10. Energy consumption rate during equipment replacement (without price variance and equipment utilization effect) in “Innovative + energy efficiency” scenario

Years	Reduction of energy consumption in coal conversion	Reduction of energy consumption in coal production	Reduction of energy consumption in electric furnace steel production	Reduction of energy consumption in steel pipe manufacture	Reduction of energy consumption in bread and bakery goods production	Reduction of energy consumption in meat and 1 cat. meat byproducts production	Reduction of energy consumption in artificial fiber and yarn production	Reduction of energy consumption in cotton fabric production	Reduction of energy consumption in other types of production	Reduction of energy consumption in construction	Reduction of energy consumption in agriculture	Reduction of energy consumption by other transport	Reduction of energy consumption by railroad transport	Reduction of energy consumption by pipeline transport	Reduction of energy consumption by road transport	Reduction of energy consumption by municipal services	Reduction of energy consumption by service industry	Reduction of energy consumption by existing residential buildings	Specific energy consumption in new residential buildings (% of existing housing facilities)
	% per year	% per year	% per year	% per year	% per year	% per year	% per year	% per year	% per year	% per year	% per year	% per year	% per year	% per year	% per year	% per year	% per year	% per year	% per year
2007	2.0%	3.0%	0.0%	0.0%	1.0%	1.0%	0.0%	3.0%	0.0%	6.0%	10.0%	0.0%	5.0%	1.0%	1.0%	0.0%	1.0%	2.0%	90%
2008	2.0%	3.0%	0.0%	0.0%	1.0%	1.0%	0.0%	3.0%	0.0%	6.0%	10.0%	0.0%	5.0%	1.0%	1.0%	0.0%	1.0%	2.0%	90%
2009	2.0%	2.0%	1.0%	1.0%	2.0%	2.0%	1.0%	2.0%	2.0%	1.0%	2.0%	0.0%	3.0%	1.0%	1.0%	1.0%	2.0%	2.0%	70%
2010	2.0%	2.0%	1.0%	1.0%	2.0%	2.0%	1.0%	2.0%	2.0%	1.0%	2.0%	0.0%	3.0%	1.0%	1.0%	1.0%	2.0%	2.0%	70%
2011	2.0%	2.0%	1.0%	1.0%	2.0%	2.0%	1.0%	2.0%	2.0%	1.0%	2.0%	0.0%	3.0%	1.0%	1.0%	1.0%	2.0%	2.0%	70%
2012	2.0%	2.0%	1.0%	1.0%	2.0%	2.0%	1.0%	2.0%	2.0%	1.0%	2.0%	0.0%	3.0%	1.0%	1.0%	1.0%	2.0%	2.0%	70%
2013	2.0%	2.0%	1.0%	1.0%	2.0%	2.0%	1.0%	2.0%	2.0%	1.0%	2.0%	0.0%	3.0%	1.0%	1.0%	1.0%	2.0%	2.0%	70%
2014	2.0%	2.0%	1.0%	1.0%	2.0%	2.0%	1.0%	2.0%	2.0%	1.0%	2.0%	0.0%	3.0%	1.0%	1.0%	1.0%	2.0%	2.0%	70%
2015	2.0%	2.0%	1.0%	1.0%	2.0%	2.0%	1.0%	2.0%	2.0%	1.0%	2.0%	0.0%	3.0%	1.0%	1.0%	1.0%	2.0%	2.0%	70%
2016	2.0%	2.0%	1.0%	1.0%	2.0%	2.0%	1.0%	2.0%	2.0%	1.0%	2.0%	0.0%	3.0%	1.0%	1.0%	1.0%	2.0%	2.0%	70%
2017	2.0%	2.0%	1.0%	1.0%	2.0%	2.0%	1.0%	2.0%	2.0%	1.0%	2.0%	0.0%	3.0%	1.0%	1.0%	1.0%	2.0%	2.0%	70%
2018	2.0%	2.0%	1.0%	1.0%	2.0%	2.0%	1.0%	2.0%	2.0%	1.0%	2.0%	0.0%	3.0%	1.0%	1.0%	1.0%	2.0%	2.0%	70%
2019	2.0%	2.0%	1.0%	1.0%	2.0%	2.0%	1.0%	2.0%	2.0%	1.0%	2.0%	0.0%	3.0%	1.0%	1.0%	1.0%	2.0%	2.0%	70%
2020	2.0%	2.0%	1.0%	1.0%	2.0%	2.0%	1.0%	2.0%	2.0%	1.0%	2.0%	0.0%	3.0%	1.0%	1.0%	1.0%	2.0%	2.0%	70%

Source: CENEF estimate

Table 3.11. Energy generation pattern and efficiency of power and heat generation industry in “Innovative + energy efficiency” scenario

Years	Power generation at existing power plants	Power generation at new power plants	Power generation at hydropower plants	Power generation at wind power plants	Power generation at Nuclear PP	Heat production at new plants	Heat production at existing HeatPP	Specific fuel rate for power generation at new plants	Specific fuel rate for power generation at existing plants	Specific fuel rate for heat generation at new plants	Specific fuel rate for heat generation at existing plants	Boiler efficiency	Line losses	Heat distribution system losses	Gas losses in mainlines	Auxiliary power consumption at power plants
	mln. kW•h	mln. kW•h	mln. kW•h	mln. kW•h	mln. kW•h	th. Gcal	th. Gcal	th. Gcal	gcf/kWh	gcf/kWh	kgcf/Gcal	kgcf/Gcal	%	%	%	%
2007	11550.2	0.0	672.5	0.0	7672.1	0	3289	323.7	339.2	143	137	88.8%	18.4%	8.2%	0.0%	6.3%
2008	13344.5	0.0	638.0	0.0	8120.4	0	3322	323.7	340.1	143	137	88.9%	18.7%	9.0%	0.0%	6.0%
2009	10593.5	70.0	574.2	0.0	8282.8	1	3223	323.7	335.0	143	137	89.1%	17.7%	8.9%	0.0%	6.1%
2010	10699.5	200.0	638.0	0.0	12282.8	2	3255	323.7	334.0	143	137	89.3%	16.7%	8.6%	0.0%	6.0%
2011	10806.5	200.0	700.0	0.0	15800.0	2	3287	323.7	333.0	143	137	89.5%	15.7%	8.3%	0.0%	6.0%
2012	10914.5	200.0	977.0	0.0	15800.0	2	3320	323.7	332.0	143	137	89.7%	14.7%	8.0%	0.0%	5.9%
2013	11023.7	2041.3	996.5	0.0	15800.0	591	3354	308.6	331.0	143	137	89.9%	13.7%	7.7%	0.0%	5.9%
2014	11133.9	3175.0	1016.4	0.0	19800.0	1672	3387	299.1	330.0	143	137	90.2%	12.7%	7.4%	0.0%	5.8%
2015	11245.2	3175.0	1036.8	0.0	23600.0	1672	3421	299.1	329.0	143	137	90.5%	11.7%	7.1%	0.0%	5.8%
2016	11357.7	3175.0	1057.5	0.0	27600.0	1672	3455	299.1	328.0	143	137	90.8%	10.7%	6.8%	0.0%	5.7%
2017	11471.3	3175.0	1078.6	0.0	31400.0	1672	3490	299.1	327.0	143	137	91.1%	9.7%	6.5%	0.0%	5.7%
2018	11586.0	3175.0	1100.2	0.0	31400.0	1672	3525	299.1	326.0	143	137	91.4%	8.7%	6.2%	0.0%	5.6%
2019	11701.8	3175.0	1122.2	0.0	31400.0	1672	3560	299.1	325.0	143	137	91.7%	7.7%	5.9%	0.0%	5.6%
2020	11818.9	3175.0	1144.7	0.0	31400.0	1672	3595	299.1	324.0	143	137	92.0%	6.7%	5.6%	0.0%	5.5%

Source: CENEF estimate

Table 3.12. Sectoral energy consumption in “Innovative + energy efficiency” scenario (thousand tcf)

Years	Power generation losses	Heat production losses	Fuel conversion	Auxiliary consumption	Distribution losses	Industry	Construction	Transport	Agriculture	Municipal and domestic	Service industry	Public	Non-energy demand
2005	11525.3	4435.6	219.6	4.4	157.5	480.2	2570.3	26.9	3040.3	257.1	107.0	1028.7	4314.8
2006	12626.6	4412.4	163.5	4.5	153.4	492.7	2520.9	28.4	4240.8	254.3	120.2	1067.9	4172.6
2007	12423.2	4924.2	175.0	3.5	164.1	527.7	2579.7	28.4	3849.8	217.5	106.0	1099.2	4362.2
2008	12365.9	4142.2	151.5	2.4	146.1	520.7	2291.4	25.1	4161.4	283.3	105.2	1105.1	4217.4
2009	12197.8	5525.3	137.3	2.4	176.8	493.6	2176.4	26.9	4139.5	278.0	102.6	1092.7	4207.1
2010	12149.2	6723.3	125.4	2.5	201.5	470.2	2132.4	27.7	4164.6	277.2	100.4	1084.1	4181.8
2011	12158.8	6781.5	114.6	2.6	203.5	444.0	2097.1	28.8	4211.2	276.5	98.0	1075.2	4189.5
2012	12210.4	7129.9	94.3	3.4	215.7	421.7	2074.9	31.0	4306.2	276.1	95.9	1064.1	4179.0
2013	12313.7	8642.4	67.1	4.2	251.5	402.2	2048.1	34.2	4408.4	276.1	94.7	1064.3	4202.7
2014	12503.4	9894.3	60.5	4.3	277.5	384.8	2088.0	38.0	4513.0	276.2	93.4	1062.3	4246.8
2015	12741.1	11231.8	54.6	4.5	304.0	368.7	2174.1	42.1	4617.3	276.7	92.1	1059.6	4298.0
2016	12955.9	12502.4	47.4	4.6	328.8	348.7	2256.1	46.2	4721.8	277.4	90.9	1059.6	4322.6
2017	13169.3	12516.2	39.4	4.7	326.9	324.0	2331.0	50.4	4825.2	278.0	89.6	1057.8	4355.5
2018	13363.9	12527.8	30.2	4.9	324.9	297.5	2398.5	55.0	4927.3	278.4	88.3	1055.0	4378.6
2019	13550.8	12539.7	20.4	5.0	323.0	270.0	2462.3	59.5	5028.2	278.7	87.0	1052.2	4400.0
2020	11525.3	4435.6	219.6	4.4	157.5	480.2	2570.3	26.9	3040.3	257.1	107.0	1028.7	4314.8

Source: CENEF estimate

3.7 “Inertia” scenario

3.7.1 THE CONCEPT

This scenario used macroeconomic growth rates from the “inert” scenario by Ministry of Economic Development for the period after 2012, whereas for the period before 2012 – the data from the conservative scenario by the Ministry of Economic Development. It assumes the stagnation of Russian economy and Rostov regional economy due to government demand contraction as the turnaround programs are completed, bank lending stagnation and low investment in the infrastructural sectors.

The rate of change for the majority of macroeconomic indicators in this scenario in 2010-2012 is close to the rate incorporated in the projection developed by the Ministry of Economic Development for the conservative scenario.

The assumption is that the bulk of the planned investment projects will be completed, however, with a larger delay, than in the “innovative” scenario.

In terms of power generation industry the assumption is Nuclear PP construction plans will be fully delivered. Since the risk of delaying the delivery of NPP construction plans only effects the power exports outside the regional borders, the sensitivity of the emission trend to delivery of the NPP construction plans is insignificant.

The “inert” scenario assumes that CCGT unit at Rostov HeatPP-2 will only be commissioned in 2016, and the cogen units of the boiler #3 will be commissioned by 25MW increments in 2015-2018.

Based on the above assumptions, CENEF developed a scenario for the basic governing variables in ENERGYBAL-ROSTOV model for 2010 -2020 (see table 2.13-2.15).

3.7.2 PROJECTED ENERGY BALANCE

This scenario projects GRP will grow 35% in 2008-2020, primary energy consumption will grow 47%, (see fig. 2.10 and table 2.16), which means GRP energy intensity would be on the rise. Power generation industry is responsible for 91% growth in primary energy consumption in 2008-2020; whereas the transport will add 4% growth in 2008-2020. The energy intensity in terms of end-use energy consumption reduces by 20%. The growth of primary energy consumption in power generation sector is due to the commissioning of new facilities at NPP.

The fuel consumption will reduce after 2009 and remain at the levels below 2008 all the way through 2017. Later, after new facilities are commissioned at heat power plants, it is the upward trend again, but it still is only 3% above 2008 level (see fig. 2.11). The rapid natural gas price surge in this scenario leads to a significant increase in coal use and partial substitution of natural gas.

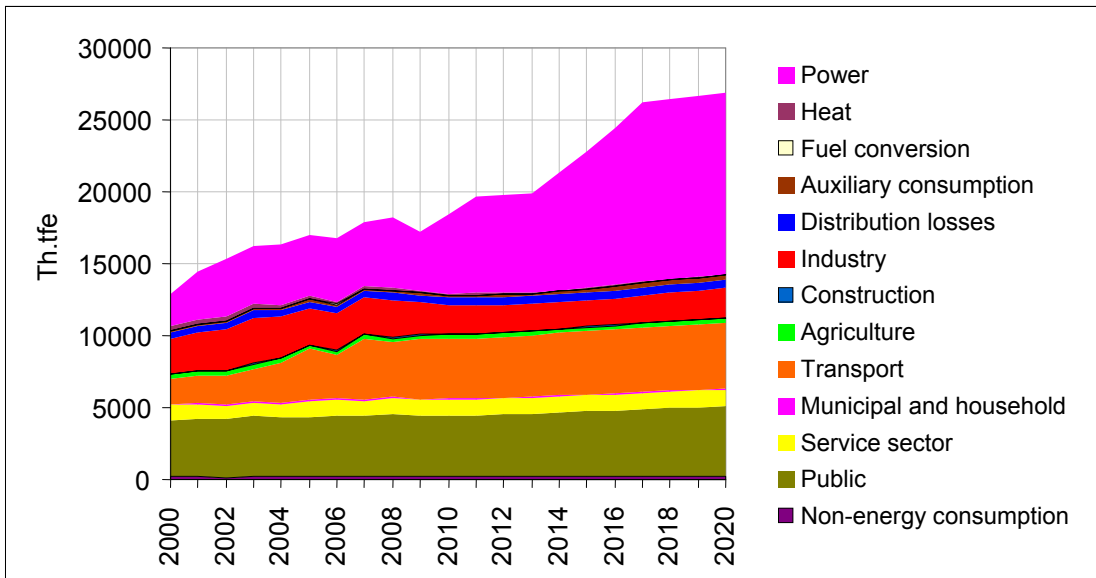


Figure 3.10. Energy consumption trend in various sectors according to “Innovative” scenario

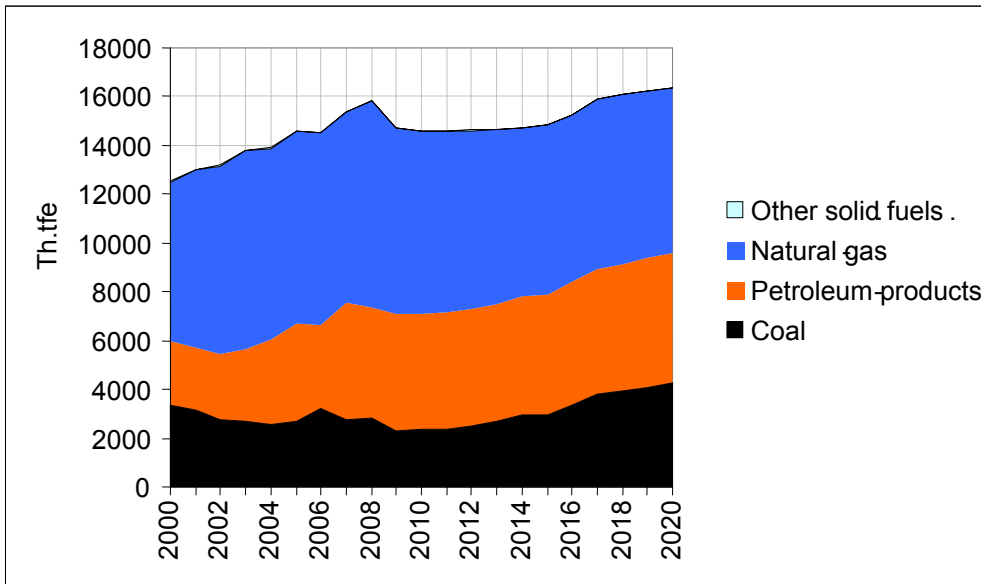


Figure 3.11. Fuel consumption trend according to “Innovative” scenario

3.7.3 GHG EMISSIONS TREND

This scenario projects GHG emission grows to 34.4 mln tons CO₂ equivalent by 2020, which is 5% more than 2008 level, but still 16% below 1990 emission level (see fig. 2.12). Accumulated offset credits in 2008-2020 will be 125 mln tons CO₂ equivalent, which is 3.6 times more than the annual emission in 2020.

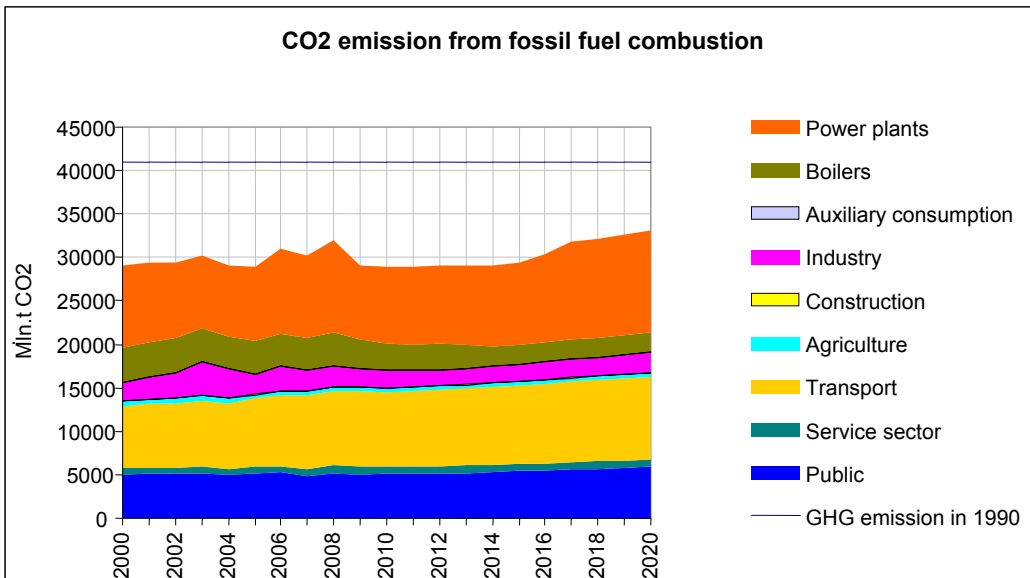


Figure 3.12. Sectoral trend of CO₂ emissions according to “Innovative” scenario

The accumulated offset credits (delta between the emissions at 1990 level for 5 years and actual total GHG emission for this period) in Rostov region will be 53.9 mln tons CO₂ equivalent in the period of 2008-2012 (see fig. 2.13). Transport and power generation sectors will be the primary contributors to emission growth.

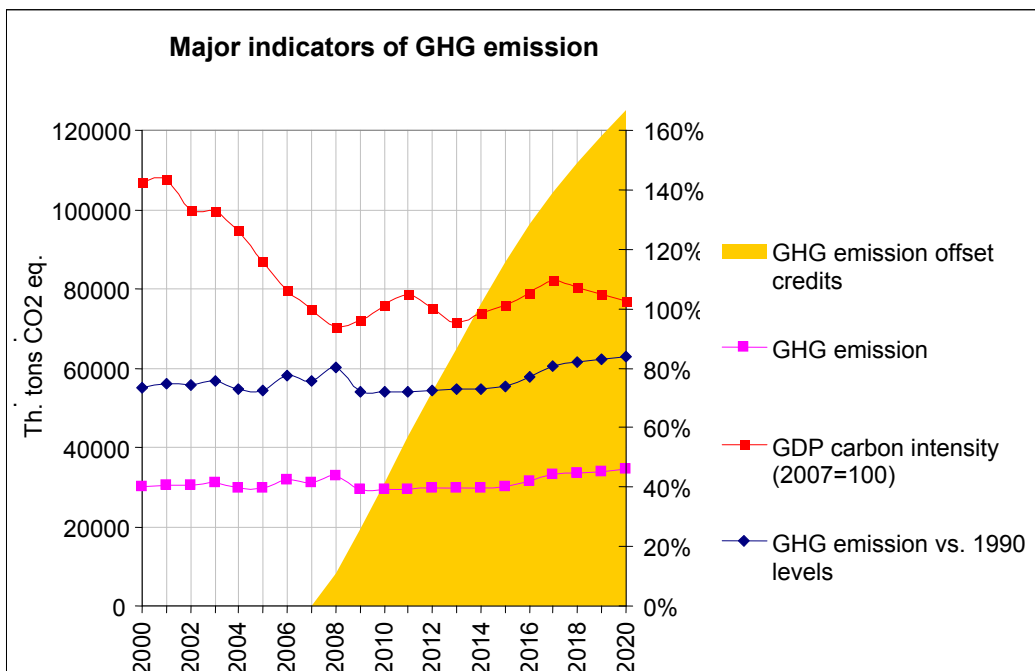


Figure 3.13. Trend of major GHG emission indicators according to “Innovative” scenario

In this scenario:

- Annual GHG emissions will reduce after 2009 and remain at the level below 2008 all the way through 2017. Later, after new facilities are commissioned at heat power plants, the emissions grow, but still remain 16% below 1990 levels in 2020;
- Average annual GHG emissions in 2008-2012 are 26% below 1990 emissions level;

- Accumulated GHG emission offset credits are 53.9 mln tons CO₂ equivalent 2008-2012;
- Average annual GHG emissions in 2013-2020 are 21.8% below 1990 emissions level;
- Accumulated GHG emission offset credits are 71.3 mln tons CO₂ equivalent in 2013-2020.

According to this scenario, Rostov region can commit to maintaining average annual 2013-2020 GHG emissions at 20% below 1990 emissions level.

Table 3.13. Primary macroeconomic assumptions in "Inert" scenario

Years	GRP growth rate	Population	Index of production in industry	Index of production in manufacturing industry	Index of work scope in construction	Agricultural production index	Retail and wholesale index	Index of paid public services	Population income index	Commissioning of residential buildings	Commissioning of service buildings	Number of medical facilities	Number of pre-school and general educational institutions	Railroad freight traffic	Pipeline traffic	Number of motor vehicles
	%	th.peo ple	%	%	%	%	%	%	%	th.sq.m	th.sq. m.	units	units	mln. t- km	mln.m3 /km	units
2007	112.4%	4254.4	119.2%	122.0%	106.5%	90.7%	123.0%	105.6%	116.1%	1706	911	571	2767	37514	37514	1029062
2008	109.2%	4246.3	105.5%	105.8%	106.3%	140.6%	116.2%	102.6%	109.1%	2008	586	569	2761	38655	38264	1049643
2009	92.5%	4221.0	85.0%	90.0%	90.0%	100.0%	90.0%	100.0%	95.0%	1868	560	565	2744	35949	35997	1054891
2010	101.7%	4198.3	101.6%	101.9%	100.0%	100.4%	100.4%	102.0%	100.4%	2015	605	561	2729	38825	36357	1057001
2011	103.0%	4179.1	102.2%	102.5%	103.6%	102.0%	101.6%	104.0%	102.8%	2126	638	558	2716	41543	37084	1071799
2012	104.6%	4161.1	105.9%	104.0%	108.6%	101.6%	103.0%	104.8%	104.0%	2284	685	555	2704	44160	37826	1093235
2013	105.8%	4142.0	108.5%	102.7%	106.3%	103.0%	105.9%	104.5%	103.8%	2329	699	552	2691	46633	38582	1114007
2014	104.0%	4119.4	102.3%	103.1%	106.1%	103.2%	105.4%	104.3%	104.3%	2376	713	548	2676	48965	39354	1137958
2015	103.8%	4096.8	102.7%	103.5%	106.1%	103.4%	104.8%	103.8%	104.6%	2423	727	544	2661	50923	40141	1164131
2016	103.5%	4074.2	102.2%	103.1%	105.6%	103.4%	104.6%	103.6%	104.2%	2472	742	540	2646	52808	40944	1188578
2017	103.3%	4046.8	102.0%	102.9%	105.2%	103.3%	104.3%	103.5%	103.8%	2521	756	536	2628	54603	41763	1211161
2018	103.0%	4019.4	101.7%	102.4%	104.7%	103.2%	104.1%	103.3%	103.7%	2572	771	532	2610	56241	42598	1233567
2019	102.8%	3992.0	101.6%	102.2%	104.3%	103.1%	103.8%	103.2%	103.5%	2623	787	528	2592	57647	43450	1255155
2020	102.9%	3964.6	102.5%	103.5%	103.8%	103.1%	103.6%	103.0%	103.4%	2676	803	524	2574	58800	44319	1276492

Source: CENEF estimate

Table 3.14. Basic production output in "Inert" scenario

Years	Power generation	Coal conversion	Coal production	Electrical furnace steel	Steel pipes	Artificial fiber and yarn	Cotton fabric	Meat (including byproducts (1 cat.))	Bread and bakery products
	mln. kW•h	th. tons	th. tons	th. tons	th. tons	th. tons	th.m2	th. tons	th. tons
2007	19895	4988	7403	188	708	8	12	63	150
2008	22103	3858	7084	609	614	8	11	72	135
2009	19451	2701	4959	426	522	8	9	79	135
2010	23820	2752	5053	500	570	9	9	80	136
2011	27506	2821	5179	600	614	9	9	82	138
2012	27891	2934	5387	700	639	9	10	85	139
2013	28020	4259	6387	900	656	9	11	88	140
2014	32150	5584	6585	909	677	10	11	90	142
2015	36126	5779	6717	941	700	10	11	94	143
2016	41331	5959	10717	970	722	10	11	96	145
2017	47000	6132	11467	998	743	11	12	99	146
2018	47261	6280	12217	1022	761	11	12	102	148
2019	47399	6420	12461	1045	778	11	12	104	149
2020	47539	6644	12711	1082	805	11	12	108	151

Source: CENEF estimate

Table 3.15. Energy generation pattern and efficiency of power and heat generation industry in “Inert” scenario

Years	Power generation at existing power plants	Power generation at new power plants	Power generation at hydropower plants	Power generation at wind power plants	Power generation at Nuclear PP	Heat production at new plants	Heat production at existing HeatP	Specific fuel rate for power generation at new plants	Specific fuel rate for power generation at existing plants	Specific fuel rate for heat generation at new plants	Specific fuel rate for heat generation at existing plants	Boiler efficiency	Line losses	Heat distribution system losses	Gas losses in mainlines	Auxiliary power consumption at power plants
	mln. kW•h	mln. kW•h	mln. kW•h	mln. kW•h	mln. kW•h	th. Gcal	th. Gcal	th. Gcal	gcf/kWh	gcf/kWh	kgcf/Gcal	kgcf/Gcal	%	%	%	%
2007	11550.2	0.0	672.5	0.0	7672.1	0	3289	323.7	339.2	143	137	88.8%	18.4%	8.2%	0.0%	6.3%
2008	13344.5	0.0	638.0	0.0	8120.4	0	3322	323.7	340.1	143	137	88.9%	18.7%	9.0%	0.0%	6.0%
2009	10593.5	70.0	574.2	0.0	8282.8	1	3223	323.7	335.0	143	137	89.1%	18.5%	8.9%	0.0%	6.1%
2010	10699.5	200.0	638.0	0.0	12282.8	2	3255	323.7	335.0	143	137	89.3%	18.3%	8.8%	0.0%	6.0%
2011	10806.5	200.0	700.0	0.0	15800.0	2	3287	323.7	335.0	143	137	89.5%	18.1%	8.7%	0.0%	6.0%
2012	10914.5	200.0	977.0	0.0	15800.0	2	3320	323.7	335.0	143	137	89.7%	17.9%	8.6%	0.0%	5.9%
2013	11023.7	200.0	996.5	0.0	15800.0	572	3354	323.7	335.0	143	137	89.9%	17.7%	8.5%	0.0%	5.9%
2014	11133.9	200.0	1016.4	0.0	19800.0	1609	3387	323.7	335.0	143	137	90.1%	17.5%	8.4%	0.0%	5.8%
2015	11245.2	243.8	1036.8	0.0	23600.0	1609	3421	334.4	335.0	143	137	90.3%	17.3%	8.3%	0.0%	5.8%
2016	11357.7	1316.3	1057.5	0.0	27600.0	1609	3455	294.6	335.0	143	137	90.5%	17.1%	8.2%	0.0%	5.7%
2017	11471.3	3050.0	1078.6	0.0	31400.0	1609	3490	296.9	335.0	143	137	90.7%	16.9%	8.1%	0.0%	5.7%
2018	11586.0	3175.0	1100.2	0.0	31400.0	1609	3525	299.1	335.0	143	137	90.9%	16.7%	8.0%	0.0%	5.6%
2019	11701.8	3175.0	1122.2	0.0	31400.0	1609	3560	299.1	335.0	143	137	91.1%	16.5%	7.9%	0.0%	5.6%
2020	11818.9	3175.0	1144.7	0.0	31400.0	1609	3595	299.1	335.0	143	137	91.3%	16.3%	7.8%	0.0%	5.5%

Source: CENEF estimate

Table 3.16. Sectoral power consumption structure in "Inert" (thousand tcf)

Years	Power generation losses	Heat production losses	Fuel conversion	Auxiliary consumption	Distribution losses	Industry	Construction	Transport	Agriculture	Municipal and household	Service industry	Public	Non-energy demand
2005	4186.8	254.0	6.5	146.8	475.8	2563.0	26.4	3511.3	263.2	87.1	1069.3	4220.8	167.7
2006	4435.6	219.6	4.4	157.5	480.2	2570.3	26.9	3040.3	257.1	107.0	1028.7	4314.8	180.1
2007	4412.4	163.5	4.5	153.4	492.7	2520.9	28.4	4240.8	254.3	120.2	1067.9	4172.6	221.7
2008	4924.2	175.0	3.5	164.1	527.7	2579.7	28.4	3849.8	217.5	106.0	1099.2	4362.2	180.6
2009	4142.2	146.4	2.4	146.1	534.7	2218.2	24.3	4163.2	283.3	102.9	1112.7	4216.0	177.0
2010	5529.4	129.7	2.4	176.8	526.1	2023.1	22.3	4143.4	272.6	97.7	1107.6	4263.0	174.6
2011	6731.6	119.8	2.4	201.5	527.9	1968.2	22.0	4170.6	269.9	95.6	1108.7	4276.9	181.1
2012	6794.2	109.3	2.4	203.5	526.7	1905.7	23.1	4219.5	266.8	94.1	1108.6	4330.7	182.6
2013	6808.2	90.5	3.3	202.4	529.1	1865.4	24.0	4264.2	267.5	92.5	1106.2	4397.4	183.2
2014	8145.2	65.6	4.1	230.2	535.4	1837.1	25.0	4320.3	269.0	91.5	1116.6	4453.6	185.1
2015	9412.8	59.0	4.2	256.6	544.8	1832.0	26.2	4380.8	271.3	90.7	1125.3	4537.1	185.7
2016	10929.3	53.9	4.2	291.0	559.9	1863.2	27.4	4434.1	274.0	90.1	1134.3	4598.3	181.2
2017	12509.3	49.6	4.3	328.0	574.9	1896.3	28.6	4480.5	276.7	89.8	1146.8	4681.7	181.3
2018	12556.5	44.8	4.4	326.9	581.0	1929.4	29.8	4524.5	279.1	89.4	1157.8	4765.6	181.9
2019	12572.9	39.3	4.4	324.9	584.9	1972.3	30.8	4563.9	281.1	89.1	1168.0	4825.3	182.8
2020	12589.8	33.4	4.5	323.0	589.9	2050.2	31.8	4600.8	283.0	88.9	1178.3	4882.5	183.0

Source: CENEF estimate

4. Sverdlovsk region

4.1 Key findings

The economic recession made some significant adjustments to all economic development projections for Sverdlovsk region.

2008 GHG emissions in Sverdlovsk region were 94% of emission levels in 1990. CENEF estimates the emission will be 80-82% of 1990 emission levels.

3 scenarios (see fig. 4.1) have been developed and executed to project the GHG emission trends in Sverdlovsk region based on ENERGYBAL-SVERDL model:

- “Innovative development” – the macroeconomic performance scenario close to projected innovative development scenario by the Ministry of Economic Development;
- “Innovative development with rapid energy efficiency increase”;
- “Inert development” – the macroeconomic performance scenario close to innovative development scenario by the Ministry of Economic Development.

Running these scenarios through ENERGYBAL-SVERDL model made it possible to assess the potential GHG emission trend linked to energy sector in line with IPCC classifications (see fig. 4.1 and table 4.1).

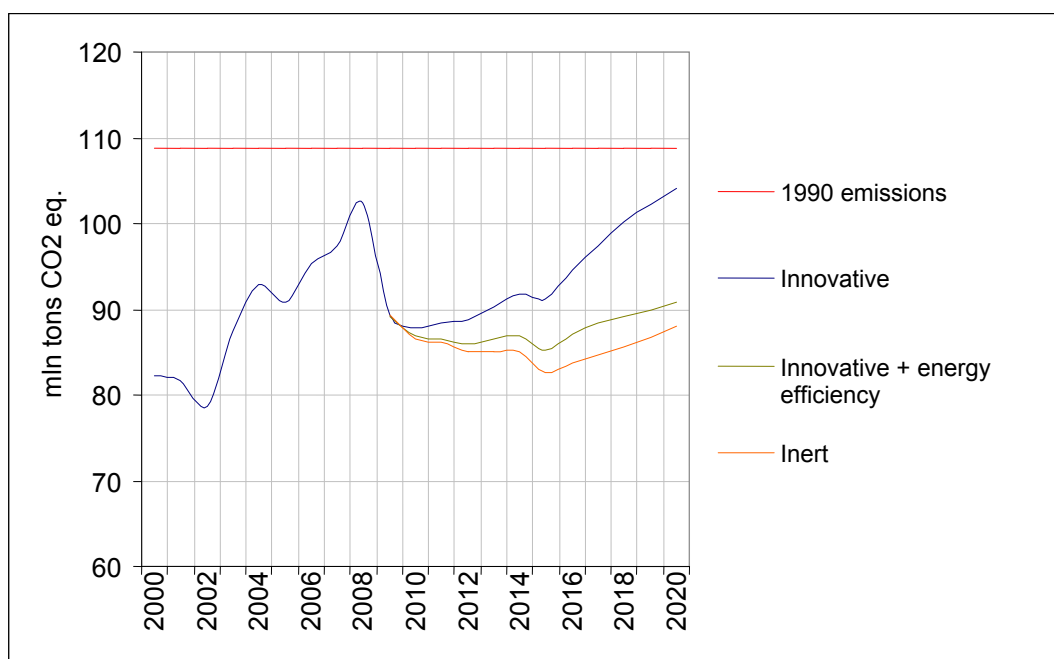


Figure 4.1. Comparison of trend scenarios for GHG emissions resulting from fuel combustion, production and transportation (Energy sector) in Sverdlovsk region

Review of the projections led to the following conclusions:

- GHG emissions in Sverdlovsk region can be placed in the following ranges with high degree of certainty:
 - 86.6-87.9 mln tons CO₂ equivalent in 2010;

- 82.7-91.2 mln tons CO₂ equivalent in 2015;
- 88.0-104.1 mln tons CO₂ equivalent in 2020;
- Besides the regional macroeconomic development performance, uncertainty of emission trend is further determined by the uncertainty of projects delivery in the electric power industry. Unlike this type of uncertainty, various types of non-traditional RES development scenarios do not have any significant impact on the emission trends;
- “Innovative development” scenario formed the upper limit of the projection;
- “Inert development” scenario has been making the lower limit of the projection;
- Significant efforts in energy efficiency increase in Sverdlovsk region per “innovative development with rapid energy efficiency increase” scenario make it possible to keep GHG emissions in 2020 at 17% below 1990 emissions levels;
- In Kyoto commitment period (2008-2012) Sverdlovsk region is able to:
 - Maintain the average annual GHG emissions at 16% below 1990 emissions level;
 - Accumulate GHG emission offset credits in amount of 87-95 mln tons CO₂ equivalent;
- In the post-Kyoto period Sverdlovsk region can commit to targets only a little less ambitious than European Union commitments:
 - Maintain the annual GHG emissions 11-22% below 1990 levels;
 - Maintain the average annual GHG emissions in 2013-2020 at 17% below 1990 emissions level;
 - Maintain average annual GHG emissions at 21-33% below 1990 emissions level in 2013-2020 provided GHG emission offset credits accumulated in 2008-2012 are valid in post-Kyoto period (conventionally, since no actual credits were allocated to regions).

If the energy efficiency increase policy is actively pursued, Sverdlovsk region can commit to maintain the average annual GHG emissions in 2013-2020 at the level 19% below 1990 emissions levels.

Table 4.1. GHG emissions projection for various development scenarios of Sverdlovsk region (mln. tons CO2 equivalent)

Year	1990 emission levels	Inert development	Innovative development	Innovative development + energy efficiency
2000	108.8	82.30	82.30	82.30
2001	108.8	81.74	81.74	81.74
2002	108.8	78.60	78.60	78.60
2003	108.8	87.54	87.54	87.54
2004	108.8	92.82	92.82	92.82
2005	108.8	90.93	90.93	90.93
2006	108.8	95.28	95.28	95.28
2007	108.8	97.45	97.45	97.45
2008	108.8	102.46	102.46	102.46
2009	108.8	89.26	89.25	89.26
2010	108.8	87.90	86.98	86.63
2011	108.8	88.41	86.58	86.12
2012	108.8	88.71	85.95	85.01
2013	108.8	90.35	86.60	84.97
2014	108.8	91.76	86.96	84.99
2015	108.8	91.22	85.15	82.69
2016	108.8	94.57	87.03	83.75
2017	108.8	97.44	88.49	84.77
2018	108.8	100.17	89.12	85.58
2019	108.8	102.21	89.99	86.68
2020	108.8	104.14	90.80	88.03

Source: CENEF estimate

4.2 Projection model

The energy forecast model and GHG emissions generated by the energy sector in the Sverdlovsk region – ENERGYBAL-SVERDL – was developed based on the following reports that were prepared by CENEF and other experts, within the project on “Promoting Investments in Energy Efficiency Projects in Russia’s Regions” project:

- Integrated fuel and energy balance and energy efficiency indicators of Rostov, Tver and Sverdlovsk regions;
- Inventory of anthropogenic greenhouse gas emission for Rostov, Sverdlovsk and Tver regions;
- Energy efficiency increase potential in Rostov, Tver and Sverdlovsk regions.

The reports and forecasts in the model are based on the integrated fuel and energy balance concept. The model identified 33 energy consuming sectors for Sverdlovsk region, including the manufacture of 15 types of industrial products. The accumulated statistics served as the basis for IFEB assessment in 2000-2008 (see table 4.2).

Table 4.2. IFEB for Sverdlovsk region in 2008 (thousand tcf)

	Coal	Crude oil	Petroleum products	Natural gas	Hydro- and non-traditional RES	Hydro- and non-traditional RES	Other solid fuel	Electric power	Heat energy	Total
1	2	3	4	5	6	7	8	9	10	11
Production	746.5	0.0	0.0	0.0	2.6	1522.1	258.2			2529.4
Import (from outside the region)	17879.3	0.2	4656.5	24467.0			0.0	0.0		47003.0
Export (to outside the region)	0.0	1.3	0.0	0.0				-373.4		-372.2
Stock changes	520.5	0.0	-20.6	0.0			-11.0			489.0
Primary energy consumption	18105.2	0.0	4677.1	24363.5	2.6	1666.6	269.1	-371.6		48712.6
Imbalance								0.0	-106.9	-106.9
Power stations: total	-10082.4	0.0	-69.6	-11547.0	-2.6	-1666.6	0.0	6464.7	5670.9	-11232.7
Electric power	-9153.0	0.0	-61.1	-6842.8	-2.6	-1522.1	0.0	6464.7		-11117.0
Heat energy	-1282.8	0.0	-130.1	-8540.1		-144.5	-155.0	-93.1	9988.2	-118.1
Existing power stations: heat energy	-929.4	0.0	-8.5	-4704.2		0.0	0.0	0.0	5260.3	-381.8
Boilers	-353.4	-3.4	-121.7	-3836.0			-155.0	-91.3	3886.9	-673.8
NPP and non-traditional RES						-144.5			47.7	-96.8
Waste-heat utilization plants	0.0	0.0	0.0	0.0			0.0	-1.8	430.4	428.6
Fuel conversion	0.0	0.0	0.0	0.0			0.0	0.0	0.0	0.0
Auxiliary consumption	0.0	0.0	0.0	0.0			0.0	-436.9	-450.1	-887.0
Distribution losses	0.0	0.0	0.0	-4.3			0.0	-490.9	-535.3	-1030.5
End consumers	7669.4	0.0	4485.9	8976.3			114.1	5072.2	9109.7	35427.6
Industry	7525.3	0.0	161.5	4305.6			27.4	3324.4	4859.7	20203.9
Commercial iron ore	0.0	0.0	0.0	0.0			0.0	163.9	32.2	196.1
Sintered iron and manganese ore	262.3	0.0	0.0	0.0			0.0	29.2	9.3	300.8
Iron-ore pellets	0.0	0.0	0.0	128.0			0.0	32.7	12.3	173.0
Cast iron	2412.9	0.0	0.0	678.2			0.0	17.4	31.0	3139.5
6% humidity coke	310.5	0.0	0.0	0.0			0.0	18.5	143.1	472.1
Siemens-Martin steel	0.0	0.0	98.4	290.7			0.0	10.1	13.1	412.3
Basic oxygen steel	0.0	0.0	0.0	34.7			0.0	106.2	7.3	148.2

Electrical furnace steel	0.7	0.0	0.0	46.7	0.0	165.7	0.0	213.1
Steel pipes	0.0	0.0	0.0	312.6	0.0	83.2	83.5	479.4
Ferrous metal roll	294.4	0.0	0.0	306.0	0.0	133.7	82.1	816.2
Electric ferroalloys	64.7	0.0	0.0	5.7	23.3	144.6	3.8	242.1
Cement and clinker	0.0	0.0	0.0	464.5	0.0	53.1	0.0	517.6
Other	4179.8	0.0	304.2	2038.6	5.0	2379.7	4480.9	13388.1
Construction	0.0	0.0	62.9	0.0	0.0	121.2	0.0	184.1
Transport	0.0	0.0	4088.6	2639.8	0.0	400.5	88.9	7217.8
Railroad transport	0.0	0.0	97.2	0.0	0.0	279.5	53.0	429.7
Pipeline transport	0.0	0.0	0.0	2639.8	0.0	68.7	35.9	2744.4
Road transport	0.0	0.0	2949.9	4.1	0.0	0.0	0.0	2954.1
Other transport	0.0	0.0	1041.4	0.0	0.0	52.3	0.0	1093.8
Agriculture	0.0	0.0	104.0	0.1	0.0	57.9	17.4	179.3
Municipal and household	0.0	0.0	0.0	0.0	0.0	95.5	2.6	98.1
Service industry	117.2	0.0	54.0	1306.0	15.8	553.6	668.4	2714.9
Public	4.6	0.0	13.3	718.6	37.0	519.0	3472.8	4765.3
Non-energy demand	22.3	0.0	1.6	6.2	34.0	0.0	0.0	64.1

Source: CENEF estimate

The following base sources provided the economic statistics used in assessing the ENERGYBAL-SVERDL model parameters:

- “Sverdlovsk region in 2003-2007” Statistics digest. Yekaterinburg. 2008;
- “Socioeconomic status of Sverdlovsk region. January -December 2008”. Yekaterinburg. 2009;
- “Socioeconomic status of Sverdlovsk region in January-September 2009”. Information and analysis news-letter. Yekaterinburg. 2009;
- “Sverdlovsk region industry in 2007”. Statistical bulletin. Yekaterinburg, 2008;
- “The status of Housing and Utilities of Sverdlovsk region in 2003-2007” Information memorandum. Yekaterinburg, 2008;
- “Municipal facilities in Sverdlovsk region”. Statistical bulletin. Yekaterinburg, 2008;
- “Road transport of large and medium businesses in Sverdlovsk region in 2007”. Statistical bulletin. Yekaterinburg, 2008;
- “Housing facilities in Sverdlovsk region”. Statistical bulletin. Yekaterinburg, 2008;
- “Articles of a cultural and social nature in the households of Sverdlovsk region in 2007”. Statistical bulletin. Yekaterinburg, 2008;
- “Logistical infrastructure of educational institutions in Sverdlovsk region. 2007”. Statistical bulletin. Yekaterinburg, 2008;

The following data sources were used for the purpose of estimating the economy development of Sverdlovsk region in 2010-2020:

- “Projection of the social and economic development of Sverdlovsk region in 2010-2012. Executive Order #1123-PP issued by the government of Sverdlovsk region, dated September 29, 2009;
- “Projection of the social and economic development of Russian Federation for 2010 and in the scheduling period 2011 and 2012” (Ministry of Economic Development, September 2009);
- RF Government Executive Order # 1622-R as of November 2, 2009 on updates to major government activities through 2012;
- “Long-term socio-economic development strategy for Sverdlovsk region for the period through 2020”;
- Demographic projection Sverdlovsk region through 2025 (prepared by Federal State Statistics Service). “Population projection of Russian Federation through 2025”. Statistical bulletin. Federal State Statistics Service. 2007;
- Information concerning the upgrade and construction of power plants in Sverdlovsk region, including “Agreement on co-operation with energy companies to ensure a reliable power supply and create the conditions for connecting the consumers to power systems in Sverdlovsk region”. 2006;
- Investment projects expected to be implemented in energy intensive industry of Sverdlovsk region in 2010-2015

The recession hit the Sverdlovsk region economy very hard. According to “Projected socio-economic development of Sverdlovsk region for 2010-2012”, the regional GRP is expected to reduce by 16.7% in 2009, industrial production will reduce by 23.2%, including 26.5% reduction of manufacturing industry, 25.4% reduction in fixed capital investments. Iron ore production dropped 18% in January-September, cast iron production slumped 24%, steel production - by 29%, ferrous metal roll - by 25%, primary aluminum and rolled aluminum – by 33%, machinery and equipment - by 29%, and cement production also slumped by 29%.

The projected socio-economic development Sverdlovsk region for the period through 2012 is based on “Projected socio-economic development of Sverdlovsk region for 2010-2012”, which reflects the recession progression in the full extent and two potential recovery scenarios before 2012. The first scenario – “Inert” – corresponds to the conservative scenario by the Ministry of Economic Development, represented in “Economic performance Scenarios for Russian Federation, major parameters of socio-economic development of Russian Federation in 2010 and in the scheduling period 2011 and 2012” and in “Projected socio-economic development of Russian Federation in 2010 and in the scheduling period 2011 and 2012” (Ministry of Economic Development, September 2009). The economy is expected to enter the inert scenario development rate after 2012 “The concept of long-term socio-economic development of Russian Federation”. The second scenario – “Innovative” – is based on a more dynamic recovery scenario for the period through 2012, and has been developed by the government of Sverdlovsk region and up to 2012 matches the moderately optimistic growth scenario developed by the Ministry of Economic Development, and assumes the economy would pick up the innovative scenario growth rates identified in “The concept of long-term socio-economic development of Russian Federation” post 2012.

Both scenarios indicate the slow “ascent” trajectory for the regional economy before 2012: the regional GRP region would only reach the size of 2008 in 2015. The “Innovative” scenario with rapid energy efficiency increase was reviewed as a third scenario.

4.3 Review of investment projects

The investment projects review is based on the data in “Long-term socio-economic development strategy for Sverdlovsk region for the period through 2020”, as well as data collected by CENEF on potential investment projects identified on the web-site of Sverdlovsk regional government, and review of investment programs developed by a few dozens of industrial facilities in the region.

The key industries in the regional economy are the ferrous and non-ferrous metals production, which have suffered heavily from the recession. Therefore, the plans to expand the iron ore mining facilities and iron ore pellet and agglomerate production facilities, earlier announced by KGOK Vanadium for the period after 2016, could be suspended until after 2020. We have also reviewed and assessed the investments programs by Nizhniy Tagil Iron and Steel Works OJSC (NTMK OJSC); A.K.Serov Steelworks OJSC; “Verkhnesinyachihinsky steelworks” OJSC (“VSMZ” OJSC); “Nizhneserginsky hardware and steelworks” CJSC (“NSMMZ” CJSC); “Pervouralsky Novotrubny Works” OJSC (“PNTZ” OJSC); “Seversky Tube Works” OJSC (“STZ” OJSC); “Kluchevsky Ferroalloys Plant” OJSC (“KZF” OJSC); “Kamensk Uralsky Metallurgical Works” OJSC (“KUMZ” OJSC); Bogoslovsk Aluminium Smelter (subsidiary of “SUAL” OJSC); Ural Aluminium Smelter (subsidiary of “SUAL” OJSC); “Uralelectromed” OJSC; “Verkhnyaya Salda Metallurgical Production Association” OJSC (“VSMPO-AVISMA Corporation” OJSC); “Sukholozhskcement” OJSC and other large companies.

The plans for Power generation development in Sverdlovsk region were defined in “Agreement on co-operation between Sverdlovsk region administration and OJSC and “UES of Russia” RJSC in developing electrical power system of Sverdlovsk region and ensuring sustainable power supply to the customers” and in “General layout plan for power facilities through 2020”. However, the economic recession made it necessary to reconsider these plans.

Beloyarsk NPP operates the only industrial-type capacity fast-neutron reactor power-generating unit in the world (#3) BN-600 (first two slow-neutron power generating units AMB-100 and AMB-200 completed their service life at Beloyarsk NPP). BN-800, fast-neutron reactor power-generating unit #4 is currently under construction. It was initially scheduled for commissioning in 2012. However, due to sequestering of Rosatom investment program, commissioning was moved to 2014. The current projection used this date in assumptions. Front End Engineering design of BN-1800 reactor power generating unit started in 2007, with the construction completion scheduled for 2018-2020

“General layout plan for power facilities through 2020” assumed “OGK-1” OJSC would upgrade and expand Verkhnetagilskaya SRPP in 2011 by adding a 330 MW CCGT unit. However, recession pushed commissioning of the power generation unit (#12) not earlier than 2014.

“OGK-2” OJSC initially planned to build two 330 MW coal-fired power generation units at Serovskaya SRPP in 2011 and 2012. It was later decided to commission two CCGT units with common output 600 MW in 2011-2012. “OGK-2” appealed to RF Ministry of Energy in 2009 with a proposal to modify the investment program and build a single 300 MW CCGT unit and commission it in 2015. This proposal has not been finally approved yet.

“ENEL-OGK-5” is working on upgrading Sredneuralskaya SRPP and Reftinskaya SRPP. In line with the targets set in “General layout plan for power facilities through 2020”, current construction operations at Sredneuralskaya SRPP include construction of CCGT unit-410 (power generation

unit #12) with an efficiency rate over 57% and expected commissioning in late 2010 (gas turbine with 270 MW General Electric generator, the steam turbine and generator manufactured by Skoda Power a.s. with 140 MW output, and waste heat boiler manufactured by Nooter/Eriksen, Inc. with heat energy output 200 Gcal/h).

The latest edition of "General layout plan for power facilities through 2020" indicated commissioning of 660 MW facility in 2012 for Reftinskaya SRPP ("ENEL-OGK-5"). Executive order # 638-PP "Power generation policy of Sverdlovsk region for 2006-2015" issued by Sverdlovsk regional government on 26.07.2006 does not identify any new facilities to be commissioned before 2015. Over the last few years this power plant has been under a massive modifications and upgrade. A dry ash and slag removal system is under construction. Power generation unit # 5 at Reftinskaya SRPP will be shutdown for a turnaround in 2010. The turbine output will expand by 25 MW. There is a discussion to build the power generation unit #11 at Reftinskaya SRPP. However, the recession will make this highly controversial plan unachievable within the 2020 timeframe.

"General layout plan for power facilities through 2020" identified commissioning of three coal-fired units at "TGK-9" OJSC (IES-Holding) power plants – Nizhneturinskaya SRPP (115 MW) in 2009 and two pulverized-coal fired units, each 330 MW, in 2011-2013, three gas units at Novo-Bogoslovskaya HeatPP 200 MW CCGT unit in 2010 and four CCGT units, each 208 MW, in 2011-2014), expansion of Novo-Sverdlovskaya HeatPP with new 150 MW gas turbine in 2010 and expansion of Krasnogorskaya HeatPP with commissioning of 200 MW gas turbine unit. The investment board of "IES" CJSC made a decision to suspend a few investment projects, including the upgrade of Nizhneturinskaya SRPP, Novo-Sverdlovskaya HeatPP and expansion of Novo-Sverdlovskaya HeatPP until further notice. In other words, the timing of these projects is unclear. OJSC "TGK-9" planned to build a new state of the art Novo-Bogoslovskaya CCGT HeatPP. 5 CCGT -208 units and 2 power generating boilers were expected to be installed. The installed capacity of the power plants should have been 1040 MW in terms of power generation, and 600 Gcal/h in terms of heat generation, with staged commissioning in 2012-2014. However, since RUSAL rolled back the plans to construct BAZ-2, and due to lack of guaranteed long term heat energy consumption commitments, as well as the slump in power consumption, only 440 MW is expected to be commissioned by 2015. An alternative site is currently being selected to commission 600 MW facility to deliver the 2nd stage commitments of output expansion plans. Unlike "General layout plan for power facilities through 2020", "Power generation policy of Sverdlovsk region for 2006-2015" also assumed a 200 MW expansion of Krasnogorskaya HeatPP by 2015 with a GTU construction. "TGK-9" OJSC does not show this project on the investment program.

"Power generation policy of Sverdlovsk region for 2006-2015" also assumed a few projects to expand the output of independent energy producers and industrial facilities. "Interchelectro – New Generation" LLC, in partnership with "NGK ITERA" LLC planned to commission new facilities in Serov, Polevskoy and Pervouralsk. These sites were missing from the 2009 list of company projects. The fate of 234 MW CCGT unit-HeatPP construction at "Asbestovskiy magnesium plant" OJSC also remains obscure.

Power generating company "GT TEC ENERGO" (subsidiary of "Energomash (YuK) Limited" is constructing two gas turbine HeatPPs in Revda with total production output 72 MW, to be commissioned in 2010-2011, and also designing two HeatPPs for Yekaterinburg city with total

output 72 MW and another two HeatPPs for Serov city with total output 72 MW. Their commissioning is expected in 2011-2013

Another project is the upgrade of Akademenergo boiler with a 150 MW CCGT unit and gas turbine by 2015. The authors could not find any information regarding the status of 32 MW gas turbine power plants at Ural works of civil aviation.

The work also reviewed the plans identified in “Power generation policy of Sverdlovsk region for 2006-2015” to decommission the outdated generating facilities or shut them down for an extended upgrade: 90 MW at Servskaya SRPP; 800 MW at Reftinskaya SRPP; 100 MW at Nizhneturinskaya SRPP and 260 MW at Verkhnetagilskaya SRPP.

GHG emission trend scenarios included various combinations of above mentioned projects involving the power generation and industrial production within the Sverdlovsk region.

4.4 “Innovative” scenario

4.4.1 THE CONCEPT

“Socio-economic development strategy for Sverdlovsk region through 2020” was developed in 2007 (approved by the Executive Order #873-PP as of 27.08.2008, issued by Sverdlovsk regional government). The Strategy assumed the regional GRP would grow 3.7-4 times according to the “innovative” scenario, and 2.8-3 times according to “inert” scenario. The Strategy also assumed this growth would be due to innovative upgrade of traditional sectors of economy, introduction of environmentally friendly technology, formation of “new economy” sector in mechanical engineering industry, high-level processing of natural resources, use of energy saving, IT and telecom technologies and use of new materials.

However, 2008-2009 recession interrupted the dynamic GRP growth of the region. The recovery prospects have been outlined in “Projected socio-economic development of Sverdlovsk region in 2010-2012”. Two projected scenarios have been developed. According to a more dynamic scenario, 2008 GRP will not be exceeded until 2012 (86%), and industrial production in 2012 will be 23% below the levels in 2008. In other words, it assumes a slow “ascent” scenario for the regional economy. For the period through 2012, the “innovative” scenario used high level scenario developed by Sverdlovsk regional government, whereas the assumption in the same name scenario by Ministry of Economic Development have been used for the later period. The assumption is the economy will recover due to a growing demand on traditional commodities produced in the region – metals, machinery and equipment thanks to intensive upgrade of facilities as well as development of power generation industry.

It is assumed that the major part of the investment projects planned before 2009 would be delivered, however, with a delay. The projection assessment for 2009 is based on the regional economy development in three quarters of 2009.

This scenario assumes commissioning of BN-800 at Beloyarskaya NPP in 2014, and BN-1800 unit – in 2018. Reftinskaya SRPP would expand by 25MW in 2012, and Sredneural'skaya SRPP would have CCGT unit-410 commissioned in 2010; CCGT units in 2014 and 2016 (each 330 MW) would be commissioned at Verkhnetagil'skaya SRPP; two CCGT units would be commissioned at Serovskaya SRPP in 2015 and 2017; 115 MW coal-fired generating unit would be commissioned at Nizhneturinskaya SRPP in 2015; and three CCGT units, each 208 MW, would be commissioned at Novo-Bogoslovskaya HeatPP in 2012, 2013 and 2017.

Based on the above assumptions, CENEF developed a scenario for the basic governing variables in ENERGYBAL-SVERDL model for 2010-2020 (see table 4.3-4.8).

Table 4.3. Primary macroeconomic assumptions in “Innovative” scenario.

Years	GRP growth rate	Population	Index of production in industry	Index of production in manufacturing industry	Index of work scope in construction	Agricultural production index	Retail and wholesale index	Index of paid public services	Population income index	Commissioning of residential buildings	Commissioning of service buildings	Number of medical facilities	Number of pre-school and general educational institutions	Railroad freight traffic	Pipeline traffic	Number of motor vehicles
	%	th.peo ple	%	%	%	%	%	%	%	th.sq.m.	th.sq. m.	units	units	mln. t- km	mln.m3 /km	units
2007	109.2%	4395.6	111.7%	113.9%	118.6%	95.8%	123.1%	104.6%	107.2%	1913.0	910.8	821	1344	2764	72503	1300000
2008	102.5%	4392.3	98.0%	96.6%	101.1%	97.9%	114.2%	104.7%	101.9%	1702.0	585.6	821	1320	2828	72576	1326000
2009	83.3%	4392.8	76.8%	73.5%	74.6%	99.5%	94.4%	94.5%	96.0%	1550.0	465.0	821	1303	2816	66435	1352520
2010	99.9%	4389.2	97.7%	97.5%	96.0%	103.8%	101.4%	100.8%	100.4%	1600.0	480.0	821	1303	2802	64894	1379570
2011	101.1%	4385.6	100.6%	100.2%	104.9%	103.8%	102.5%	103.6%	102.8%	1730.0	519.0	821	1303	2819	64719	1407162
2012	102.6%	4378.7	102.5%	102.4%	109.0%	103.8%	103.8%	103.8%	104.0%	1937.0	581.1	821	1303	2873	63760	1435305
2013	105.9%	4377.3	104.9%	105.9%	110.0%	103.0%	107.6%	106.0%	106.6%	2130.5	639.2	821	1303	3013	63883	1482670
2014	106.0%	4376.3	105.3%	106.3%	111.6%	103.0%	106.9%	106.0%	106.8%	2377.8	713.3	821	1303	3173	63798	1533081
2015	106.1%	4375.5	105.6%	106.6%	112.2%	103.0%	106.8%	106.0%	106.9%	2667.9	800.4	821	1303	3351	62596	1585972
2016	106.1%	4375.0	105.6%	106.6%	111.8%	103.0%	106.6%	105.9%	106.8%	2982.6	894.8	821	1303	3538	63816	1639737
2017	105.9%	4374.5	105.5%	106.5%	110.8%	103.0%	106.5%	105.9%	106.7%	3304.6	991.4	821	1303	3733	65545	1694340
2018	105.7%	4374.0	105.2%	106.2%	110.2%	103.0%	106.3%	105.8%	106.5%	3641.3	1092.4	821	1303	3927	66699	1749745
2019	105.6%	4373.5	105.1%	106.1%	110.2%	103.0%	106.2%	105.8%	106.4%	4012.4	1203.7	821	1303	4128	66818	1805912
2020	105.5%	4372.9	105.1%	106.1%	109.5%	103.0%	106.0%	105.7%	106.3%	4393.6	1318.1	821	1303	4338	67306	1862798

Source: CENEF estimate

Table 4.4. Basic production output in “Innovative” scenario

Years	Power generation	Commercial iron ore	Sintered iron and manganese ore	Iron-ore pellets	Cast iron	Coke	Siemens-Martin steel	Basic-oxygen steel	Electrical furnace steel	Steel pipes	Ferrous metal roll	Electric ferro-alloys	Cement
	mln. kWh	th. tons			th. tons		th. tons		th. tons	th. tons	th.m ²	th. tons	th. tons
2007	47083	12436	6436	6029	5877	2909	2862	3817	2484	2309	7051	372	3417
2008	52558	11302	5836	5304	5292	2791	2577	3330	2857	2080	6720	311	3263
2009	45725	9607	5369	4880	4181	2204	1546	2331	2301	1664	5376	187	2447
2010	45880	9262	5177	4705	4001	2110	1480	2277	2279	1623	5242	183	2349
2011	46834	9200	5142	4673	3945	2080	1459	2291	2323	1626	5252	184	2464
2012	46322	9313	5205	4731	3965	2091	1466	2348	2410	1665	5378	190	2686
2013	46957	9483	5300	4817	3965	2091	1466	2463	2600	1763	5695	202	2955
2014	48231	9676	5408	4915	3965	2091	1466	2594	2815	1874	6054	216	3298
2015	48744	9890	5527	5024	3965	2091	1466	2739	3055	1998	6454	231	3700
2016	52032	10116	5654	5139	3965	2091	1466	2892	3308	2130	6880	247	4136
2017	54732	10351	5785	5258	3965	2091	1466	3052	3571	2268	7327	265	4477
2018	58130	10585	5916	5377	3965	2091	1466	3210	3833	2409	7782	282	4477
2019	63765	10827	6051	5500	3965	2091	1466	3374	4104	2556	8257	301	4477
2020	71956	11081	6193	5629	3965	2091	1466	3546	4388	2712	8760	321	4477

Source: CENEF estimate

Table 4.5. Energy generation pattern and efficiency of power and heat generation industry in “Innovative” scenario

Years	Power generation at existing power plants	Power generation at new power plants	Power generation at Nuclear PP	Power generation at hydropower plants	Power generation at wind power plants	Heat production at new plants	Heat production at NPP	Heat production at existing HeatPP	Specific fuel rate for heat generation at new plants	Specific fuel rate for power generation at existing plants	Specific fuel rate for heat generation at new plants	Specific fuel rate for heat generation at existing plants	Boiler efficiency	Line losses	Heat distribution system losses	Auxiliary heat consumption at power plants
	mln. kW•h	mln. kW•h	mln. kW•h	mln. kW•h	mln. kW•h	th. Gcal	th. Gcal	th. Gcal	gcf/kW•h	gcf/kW•h	kgcf/Gcal	kgcf/Gcal	%	%	%	%
2007	42970	0	4 088	24.20	0	0	344	36775	216.0	332.4	143.0	154.3	81.0%	6.5%	6.5%	5.5%
2008	48453	0	4 084	21.12	0	0	333	36785	216.0	331.4	143.0	152.3	87.0%	8.1%	5.5%	4.5%
2009	41331	0	4 370	24.20	0	0	357	33000	216.0	331.4	143.0	152.3	87.1%	7.3%	6.0%	5.0%
2010	40856	819	4 181	24.68	0	700	341	32886	216.0	331.4	143.0	152.3	87.2%	7.2%	5.9%	5.0%
2011	40256	2341	4 212	25.18	0	700	344	32742	216.0	331.4	143.0	152.3	87.3%	7.1%	5.8%	5.0%
2012	39143	2899	4 254	25.68	0	1120	347	32470	219.4	331.4	143.0	152.3	87.4%	7.0%	5.7%	5.0%
2013	38629	4087	4 215	26.19	0	1540	344	32342	218.4	331.4	143.0	152.3	87.5%	6.9%	5.6%	5.0%
2014	37111	5518	5 575	26.72	0	1560	455	31961	217.8	331.4	143.0	152.3	87.6%	6.8%	5.5%	5.0%
2015	32578	7572	8 567	27.25	0	1603	700	30790	219.4	331.4	143.0	152.3	87.7%	6.7%	5.4%	5.0%
2016	32578	9771	9 655	27.80	0	1636	788	30790	221.7	331.4	143.0	152.3	87.8%	6.6%	5.3%	5.0%
2017	32378	12011	9 655	28.35	0	2723	788	30733	220.7	331.4	143.0	152.3	87.9%	6.5%	5.2%	5.0%
2018	32007	13896	9 655	28.92	0	2723	788	30627	220.0	331.4	143.0	152.3	88.0%	6.4%	5.1%	5.0%
2019	32007	13896	14 065	29.50	0	2723	1 148	30627	220.0	331.4	143.0	152.3	88.1%	6.3%	5.0%	5.0%
2020	32007	13896	22 255	30.09	0	2723	1 817	30627	220.0	331.4	143.0	152.3	88.2%	6.2%	4.9%	5.0%

Source: CENEF estimate

Table 4.6. Trend of energy intensity during equipment replacement process (without influence from price changes and machine loading) in Innovation Scenario

Years	Reduction of energy intensity in iron ore production	Reduction of energy intensity in sintered iron ore production	Reduction of energy intensity in pellets production	Reduction of energy intensity in pig iron production	Reduction of energy intensity in coke production	Reduction of energy intensity in open-hearth steel production	Reduction of energy intensity in converter steel production	Reduction of energy intensity in electric furnace steel production	Reduction of energy intensity in steel pipes production	Reduction of energy intensity in rolled metals production	Reduction of energy intensity in electric ferroalloys production	Reduction of energy intensity in cement and clinker production	Reduction of energy intensity in other productions	Reduction of energy intensity in construction	Reduction of energy intensity in railway transport	Reduction of energy intensity in pipeline transport	Reduction of energy intensity in auto transport	Reduction of energy intensity in other transport	Reduction of energy intensity in agriculture	Reduction of energy intensity in community facilities	Reduction of energy intensity in services sector	Reduction of energy intensity in existing residential facilities	Specific energy consumption in new resid. facil. (in % to exist. resid. accomod.)
a	% per year	% per year	% per year	% per year	% per year	% per year	% per year	% per year	% per year	% per year	% per year	% per year	% per year	% per year	% per year	% per year	% per year	% per year	% per year	% per year	% per year	% per year	% per year
2007	1,0%	-1,0%	1,0%	1,0%	0,0%	2,0%	0,0%	1,0%	0,0%	1,0%	0,0%	2,0%	-1,0%	0,0%	-2,0%	0,0%	-1,0%	-2,0%	3,0%	0,0%	1,0%	1,0%	90%
2008	1,0%	-1,0%	1,0%	1,0%	0,0%	2,0%	0,0%	1,0%	0,0%	1,0%	0,0%	2,0%	-1,0%	0,0%	-2,0%	0,0%	-1,0%	-2,0%	3,0%	0,0%	1,0%	1,0%	90%
2009	1,0%	0,0%	1,0%	1,0%	0,0%	1,0%	0,0%	1,0%	0,0%	1,0%	0,0%	1,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-1,0%	2,0%	0,0%	1,0%	1,0%	90%
2010	1,0%	0,0%	1,0%	1,0%	0,0%	1,0%	0,0%	1,0%	0,0%	1,0%	0,0%	1,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-1,0%	2,0%	0,0%	1,0%	1,0%	90%
2011	1,0%	0,0%	1,0%	1,0%	0,0%	1,0%	0,0%	1,0%	0,0%	1,0%	0,0%	1,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-1,0%	2,0%	0,0%	1,0%	1,0%	90%
2012	1,0%	0,0%	1,0%	1,0%	0,0%	1,0%	0,0%	1,0%	0,0%	1,0%	0,0%	1,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-1,0%	2,0%	0,0%	1,0%	1,0%	90%
2013	1,0%	0,0%	1,0%	1,0%	0,0%	1,0%	0,0%	1,0%	0,0%	1,0%	0,0%	1,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-1,0%	2,0%	0,0%	1,0%	1,0%	90%
2014	1,0%	0,0%	1,0%	1,0%	0,0%	1,0%	0,0%	1,0%	0,0%	1,0%	0,0%	1,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-1,0%	2,0%	0,0%	1,0%	1,0%	90%
2015	1,0%	0,0%	1,0%	1,0%	0,0%	1,0%	0,0%	1,0%	0,0%	1,0%	0,0%	1,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-1,0%	2,0%	0,0%	1,0%	1,0%	90%
2016	1,0%	0,0%	1,0%	1,0%	0,0%	1,0%	0,0%	1,0%	0,0%	1,0%	0,0%	1,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-1,0%	2,0%	0,0%	1,0%	1,0%	90%
2017	1,0%	0,0%	1,0%	1,0%	0,0%	1,0%	0,0%	1,0%	0,0%	1,0%	0,0%	1,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-1,0%	2,0%	0,0%	1,0%	1,0%	90%
2018	1,0%	0,0%	1,0%	1,0%	0,0%	1,0%	0,0%	1,0%	0,0%	1,0%	0,0%	1,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-1,0%	2,0%	0,0%	1,0%	1,0%	90%
2019	1,0%	0,0%	1,0%	1,0%	0,0%	1,0%	0,0%	1,0%	0,0%	1,0%	0,0%	1,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-1,0%	2,0%	0,0%	1,0%	1,0%	90%
2020	1,0%	0,0%	1,0%	1,0%	0,0%	1,0%	0,0%	1,0%	0,0%	1,0%	0,0%	1,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-1,0%	2,0%	0,0%	1,0%	1,0%	90%

Source: CENef estimates

Table4.7. Prices for power carriers in Innovation Scenario

Years	Electric energy					Gas		Heat		Gasoline	Diesel oil	Fuel oil	Coal	Fire-wood
	Industry	Transport	Agriculture	Other	Population	Industry	Population	Industry	Population					
	Rub KWh/h	Rub KWh/h	Rub KWh/h	Rub KWh/h	Rub KWh/h	Rub/th.m ³	Rub/t	Rub/m ³	Rub/GCal					
2007	0,84	0,84	1,47	1,47	1,40	1782	1623	390	667	18486	16204	5571	761	243
2008	1,03	1,03	1,80	1,80	1,58	2227	2013	460	836	20723	18164	6245	853	272
2009	1,25	1,25	2,19	2,19	1,98	2579	2571	543	986	19355	16966	5833	797	254
2010	1,42	1,42	2,48	2,48	2,17	3265	3105	597	1085	20632	18085	6218	850	271
2011	1,64	1,64	2,88	2,88	2,39	3778	3751	674	1226	21994	19279	6629	906	289
2012	1,87	1,87	3,28	3,28	2,63	4349	4314	742	1349	23446	20551	7066	966	308
2013	2,03	2,03	3,55	3,55	3,13	5218	5392	852	1550	25157	22052	7582	1036	331
2014	2,16	2,16	3,77	3,77	3,81	5766	6740	939	1706	26692	23397	8044	1099	351
2015	2,29	2,29	4,00	4,00	4,25	6170	8102	1003	1824	28320	24824	8535	1166	372
2016	2,41	2,41	4,22	4,22	4,70	6336	8321	1057	1921	29906	26214	9013	1232	393
2017	2,53	2,53	4,43	4,43	5,16	6514	8554	1106	2011	31431	27551	9473	1294	413
2018	2,65	2,65	4,64	4,64	5,41	6670	8759	1156	2101	32877	28818	9909	1354	432
2019	2,77	2,77	4,85	4,85	5,64	6870	9022	1207	2194	34225	30000	10315	1409	450
2020	2,89	2,89	5,06	5,06	5,89	7152	9392	1259	2288	35389	31020	10665	1457	465

Source: CENef estimates

Table 4.8. Inflation parameters in “Innovative” Scenario

Year	Price index (industrial goods production)	Price index (processing industry)	Price index (extraction industry)	Tariffs index (freight traffic)	Price index (construction production)	Price index (agriculture production)	Consumption prices index	Paid services price index
	%	%	%	%	%	%	%	%
2007	110,7%	110,5%	106,1%	110,3%	120,4%	119,0%	112,8%	115,1%
2008	112,1%	111,5%	96,4%	120,8%	116,7%	119,3%	114,8%	120,7%
2009	93,4%	107,1%	107,1%	113,3%	105,9%	104,3%	112,0%	113,7%
2010	106,6%	106,6%	106,6%	114,0%	105,3%	104,1%	110,0%	122,6%
2011	106,6%	106,6%	106,6%	109,0%	105,1%	104,1%	108,0%	123,3%
2012	106,6%	106,6%	106,6%	108,4%	105,6%	104,1%	107,0%	110,6%
2013	107,3%	107,3%	107,3%	114,5%	107,0%	104,1%	106,7%	108,2%
2014	106,1%	106,1%	106,1%	113,7%	105,5%	104,1%	106,0%	107,0%
2015	106,1%	106,1%	106,1%	111,0%	105,6%	104,1%	105,0%	107,0%
2016	105,6%	105,6%	105,6%	108,7%	105,1%	104,1%	104,0%	106,7%
2017	105,1%	105,1%	105,1%	107,9%	104,6%	104,1%	103,4%	106,4%
2018	104,6%	104,6%	104,6%	107,8%	104,1%	104,1%	103,4%	106,1%
2019	104,1%	104,1%	104,1%	107,7%	103,6%	104,1%	103,3%	105,8%
2020	103,4%	103,4%	103,4%	107,5%	103,3%	104,0%	103,3%	105,3%

Source: CENef estimates

4.4.2 PROJECTED ENERGY BALANCE

With the assumption of “Innovative” Scenario, Gross Regional Product (GRP) in the region will grow by 36% in 2008-2020, and the consumption of prime energy will grow by 13,5% (see Fig. 3.2 and Table 3.9). Consumption of prime energy decreases in 2008-2011. Later it starts growing but till 2017 it stays lower than the level of 2008.

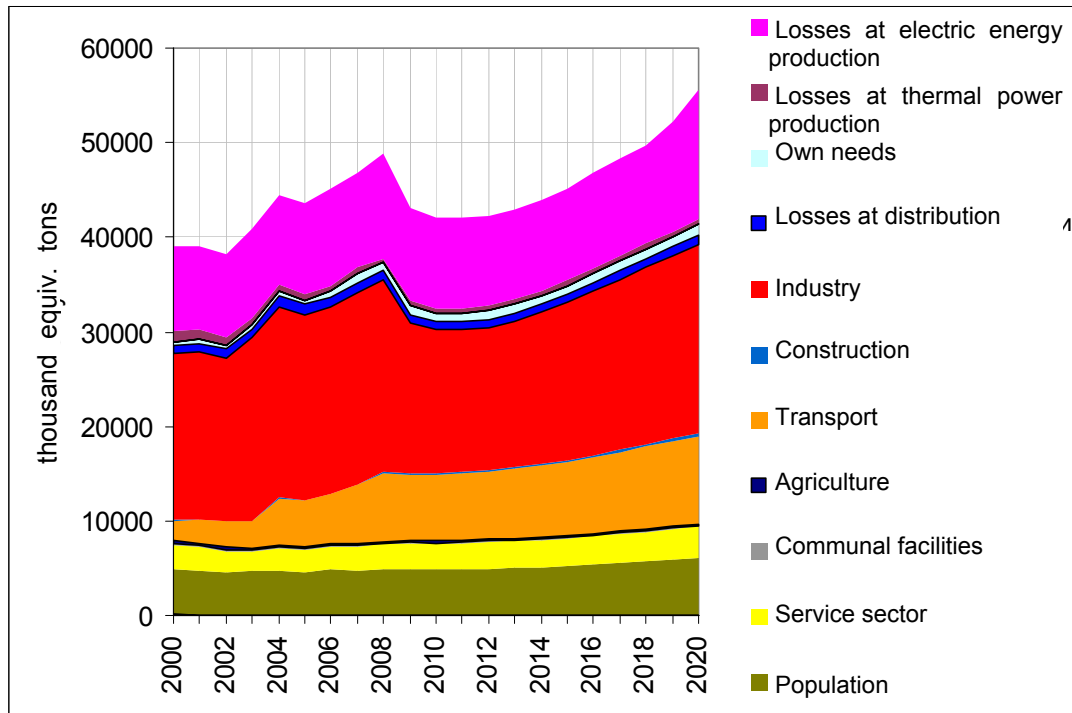


Fig. 4.2. Trend of basic electricity consumption indicators in “Innovative” Scenario

The increment of primary energy consumption in 2008-2020 is formed up due to the growth of electric energy production (36,5%), growth of energy consumption at transport (31%); growth of consumption by population (18%) and service sector (10%). Energy consumption in industry in 2020 still does not reach the level of 2008.

Commissioning of power production facilities was planned in such a way that throughout the whole period till 2020 Sverdlovsk region continued to be a power excessive region. Since part of the increment of electric energy production was caused by production at nuclear power plants, the consumption of organic fuel in 2020 just barely reaches the level of 2008 (see Fig. 4.3). Fuel consumption grows at power stations and transport, mostly.

In 2009 energy intensity of GRP increase and later starts gradually decreasing and by 2012 reaches the level of 2008. In 2013-2020 GRP energy intensity in primary energy decreases by 16,5%. GRP energy intensity in final energy decreases by 18,4% in 2008-2020.

Table 4.9. Structure of energy consumption by sectors in “Innovative” Scenario (thousand equivalent tons)

Year	Losses in electric energy production	Losses in heat power production	Fuel conversion	Auxiliaries	Losses in distribution	Industry	Construction	Transport	Agriculture	Community facilities	Services sector	Population	Non-energy needs
2005	9661,4	692,0	0,0	387,0	1088,3	19594,6	81,3	4934,3	205,1	146,0	2337,1	4474,2	68,5
2006	10219,9	524,6	0,0	715,0	1026,2	19692,5	96,1	5085,6	195,4	140,6	2526,1	4767,0	57,7
2007	9844,6	683,2	0,0	1010,3	1051,6	20251,8	100,8	6252,2	184,2	141,5	2472,3	4715,5	64,2
2008	11117,0	357,4	0,0	887,0	1030,5	20203,9	184,1	7217,8	179,3	98,1	2714,9	4765,3	64,1
2009	9704,2	631,8	0,0	885,5	904,2	15843,8	138,6	7065,5	176,5	102,0	2761,2	4795,6	49,2
2010	9634,1	581,6	0,0	873,5	864,7	15136,8	132,2	7067,5	178,4	101,1	2749,0	4789,5	48,1
2011	9658,3	570,9	0,0	880,4	849,0	14962,9	138,4	7133,2	180,4	102,6	2791,5	4846,3	48,4
2012	9488,9	558,3	0,0	878,4	839,4	15067,9	150,4	7186,7	182,4	103,0	2830,6	4909,4	49,6
2013	9482,6	547,4	0,0	891,2	843,7	15448,2	164,9	7380,2	182,9	102,5	2857,6	4977,9	52,0
2014	9657,9	550,0	0,0	911,6	853,7	15963,6	184,0	7596,5	184,0	102,6	2897,6	5066,4	54,8
2015	9650,8	562,0	0,0	926,7	870,2	16590,1	206,5	7794,6	185,3	102,7	2949,6	5176,0	57,9
2016	10126,2	566,4	0,0	969,3	888,6	17287,8	230,8	8083,1	186,5	102,9	3012,3	5304,1	61,1
2017	10316,6	553,3	0,0	1002,1	910,6	17999,9	255,7	8406,7	188,0	103,2	3086,9	5451,3	64,5
2018	10452,7	560,8	0,0	1029,8	930,3	18640,0	281,7	8723,3	189,5	103,5	3169,2	5612,7	67,8
2019	11539,1	558,5	0,0	1081,1	953,5	19289,1	310,4	8996,7	191,1	103,7	3260,0	5790,6	71,3
2020	13575,3	548,6	0,0	1164,4	980,4	19949,6	339,7	9283,1	192,7	104,0	3358,7	5985,5	74,9

Source: CENef estimates

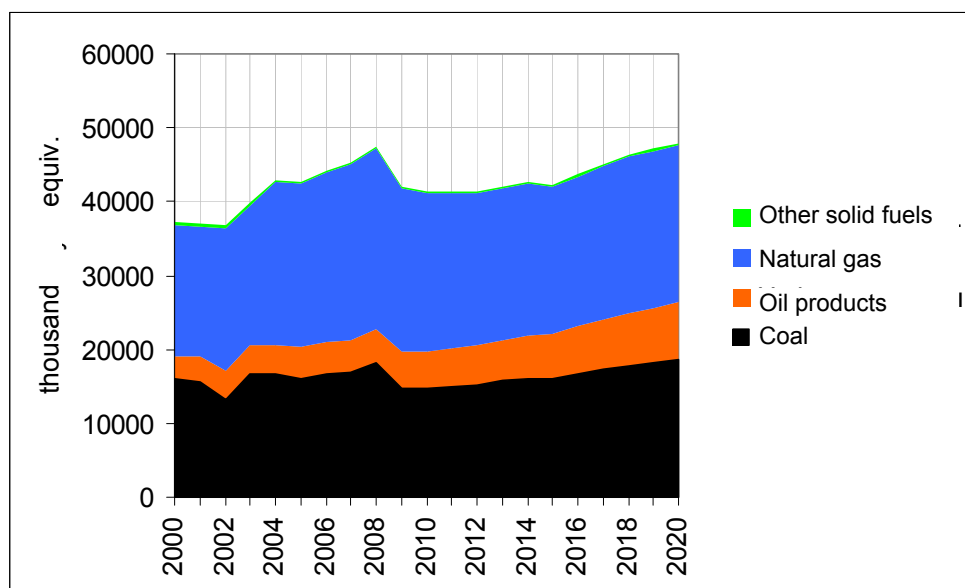


Fig. 4.3. Trend of electric energy final consumption in "Innovative" Scenario

4.4.3 TREND OF GHG EMISSION

Sverdlovsk region takes the first place among Russian regions in GHG emissions. The year of 1990⁹ was taken as the base year for the estimate of GHG emission trend (just like for Russia in general). According to CENEF estimate of 2000 (following IPCC methodology of 1996), GHG emissions in Sverdlovsk region in 1990 related to consumption, extraction and transportation of fuel accounted for 108,8 mln equiv. t CO₂.¹⁰

CENEF estimate of 2006 (95,1 mln t), made according to IPCC new methodology, exceeds the estimate by Urals Centre for Energy Efficiency and Ecology (UCEEE) which was based on the previous IPCC methodology (87,3 mln t).¹¹ (GHG emission trend in Sverdlovsk region is characterized mostly by CO₂ emissions. The portion of CH₄ and N₂O emissions in the total equaled only 0,3% in 2008).

Economy growth in the region in 2000-2008 was accompanied by a rapid growth of GHG emission and by 2008 the emission equaled 94% of the level in 1990. The increment of emission was due to transport (46% of the increment), industry (35%), power stations (20%). The crisis blocked the ascending trend. According to CENEF estimate, emission will drop by 13% in 2009 due to the crisis and the emission will be 18% lower than in 1990. In 2010 it will decrease a little bit more.

With the assumptions of this scenario, emissions stay at the new low level till 2015 and only after that start growing, as new heat power station are commissioned, and by 2020 reach 96% of the level of 1990 and 102% of the level of 2008.

⁹ Methodology of emission estimate in 1990 slightly differed from the methodology used by Bashmakov I.A., Dzedzich M.G., Lunin A. A., Lebedev O.V. "Anthropogenic GHG Emissions Inventory for Rostov, Tver and Sverdlovsk regions (Energy sector)". CENEF. «Promoting Investments in Energy Efficiency Projects in Russia's regions» project. M., 2009. But the discrepancies are not that big and the results are comparable.

¹⁰ CENEF. Multi-Regional Project to Develop Monitoring and Reporting Capacity for Multiple Greenhouse Gases in Russia. For the Battelle Memorial Institute, Pacific Northwest Division. Worldwide Fund for Nature, Russian Program Office. Moscow, March 2002.

¹¹ Concise information report on GHG emissions inventory by industry branches in Sverdlovsk region in 1990-2006. UCEEE LLC. The inventory was based on the previous IPCC methodology.

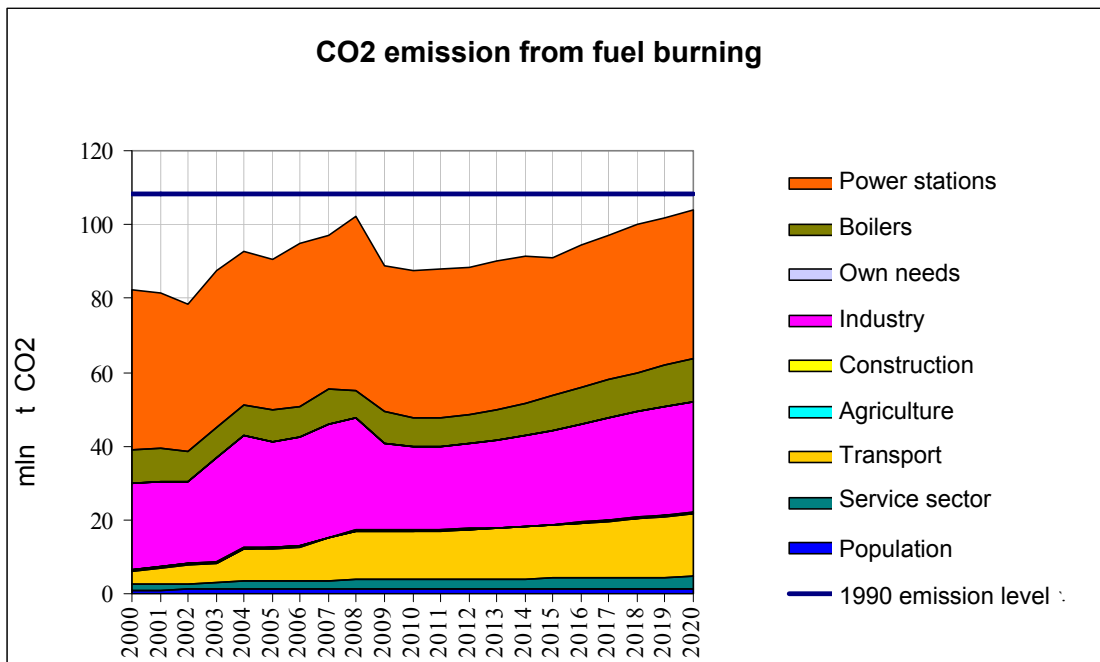


Fig. 4.4. CO₂ emission trend by industry sectors in “Innovative” Scenario

Over the period of 2008-2012, accumulated unsold quotas (balance between emission at the level of 1990 for five years and actual total GHG emission over the same period) will be equal to 87 mln equiv. t CO₂ in Sverdlovsk region.

According to this scenario, by 2020 GHG emission will be only 4% lower than the level of 1990, while accumulated unsold quotas in 2008-2020 will constitute 186 mln equiv. t CO₂, which is 1,8 more than annual emission in 2020 (see Fig. 4.5). After 2009 the main increment of emission will take place in industry (44%), transport (27%) and electric power industry (21%).

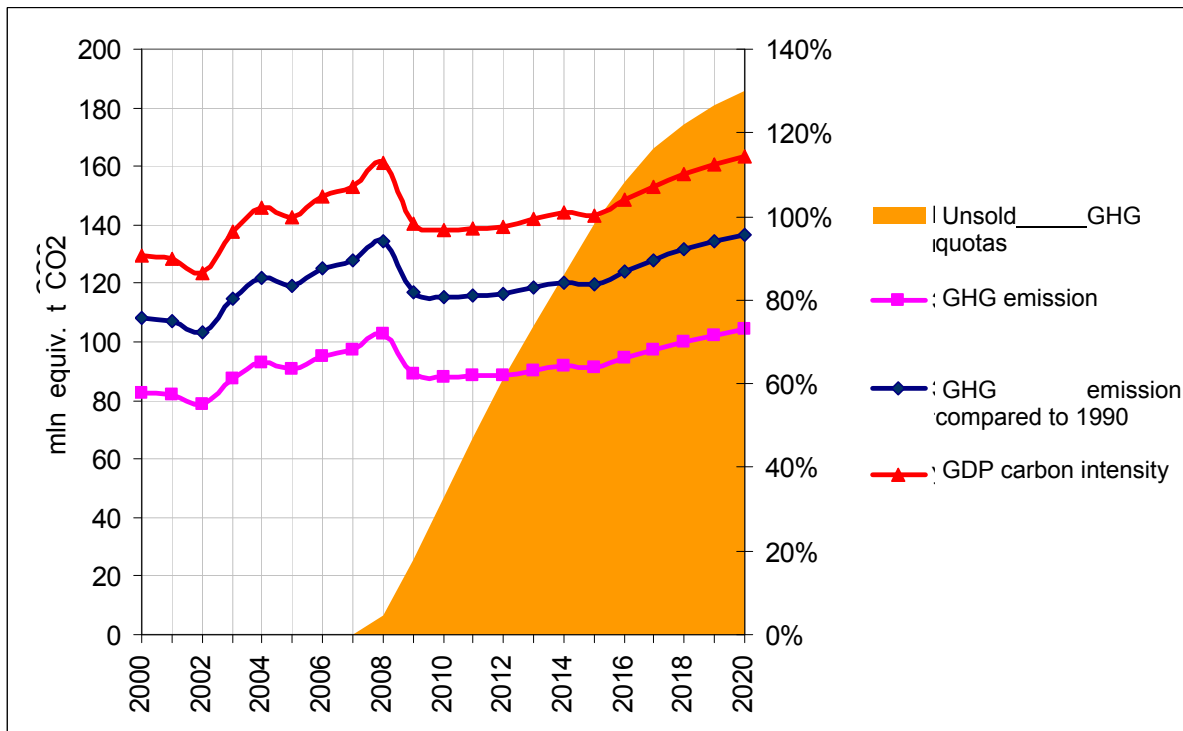


Fig. 4.5. Trend of GHG emission basic indicators in “Innovative” Scenario

Therefore, in this scenario:

- Crisis blocked emissions reaching the level of 1990, which was supposed to take place in 2011. Up to 2012 emissions will stay at the new relatively low level. However, later, when economic growth starts recuperating, emissions also start to grow. Annual GHG emissions in 2020 reach the level of 4% lower than the level in 1990;
- It is highly probable that Sverdlovsk region will keep its status among Russian regions as the region with the biggest volume of emissions;
- Average annual GHG emissions in 2008-2012 happen to be 16% lower than the level of 1990;
- Accumulated unsold quotas for GHG emissions in 2008-2012 are equal to 87 mln equiv. t CO₂;
- Average annual GHG emissions in 2013-2020 happen to be 11% lower than the level of 1990;
- Accumulated unsold quotas for GHG emissions in 2013-2020 are equal to 186 mln equiv. t CO₂.

According to this scenario, Sverdlovsk region can only take the following obligations:

- Keep average annual GHG emissions in 2013-2020 at 10% lower than the level of 1990.

If in the post-Kyoto period we take into consideration accumulated unsold quotas for GHG emission in 2008-2012 (on the average, 10,9 mln equiv. t CO₂ per year in 2013-2020), Sverdlovsk region could take the obligation to keep annual GHG emissions in 2013-2020 at 21% lower than the level of 1990. (This is just an assumption, since quotas for regions were not defined).

4.5 “Innovative” scenario with rapid increase of energy efficiency

4.5.1 CONCEPT

This modification of “Innovative” Scenario is based on the hypothesis of considerable acceleration of energy efficiency increase (see Tables 3.10 and 3.11). Energy intensity reduction rate in production of basic goods and services, considered in this scenario, in many ways are based on estimates of both current level of energy efficiency and on the estimate of energy efficiency increase by CENef.¹²

In this scenario electrical energy consumption grows slower and, therefore, the volume of commissioned new facilities in electric energy is also reduced. In this scenario BN-1800 unit at Beloyarskaya nuclear power plant is not supposed to be commissioned till 2020. Also there is no commissioning of PGU steam-gas unit in 2017 at Serovskaya state district power plant, coal unit of 115 MWt at Nizhneturinskaya state district power plant in 2015 and commissioning of one of PGU steam-gas units at Novo-Bogoslovskaya steam power plant in 2017.

This modification of “Innovative” Scenario keeps all other conditions of the previous scenario.

¹² See Bashmakov I.A., Dzedzichuk M.G., Lunin A. A., Lebedev O.V. Features and indicators of energy efficiency in Rostov, Tver and Sverdlovsk regions. CENef. « Promoting Investments in Energy Efficiency Projects in Russia’s regions» project. M., 2009; Bashmakov I.A., Dzedzichuk M.G., Lunin A. A., Lebedev O.V. Energy efficiency growth potential in Rostov, Tver and Sverdlovsk regions. CENef. « Promoting Investments in Energy Efficiency Projects in Russia’s regions» project. M., 2009.

4.5.2 PROJECTED ENERGY BALANCE

With the assumptions of this scenario the consumption of primary energy decreases till 2012 and only after that starts to grow. In 2020 it is 8% lower than the level of 2008 (see Fig. 3.6). The consumption of organic fuel in 2020 also does not reach the pre-crisis level and stays at 12% lower than the level of 2008 (see Fig. 3.7).

The increment of primary energy consumption 2012-2020 is formed up due to industrial production growth (49%), power consumption growth at transport (22%); electric energy production (13%); growth of consumption by population (9%).

GRP energy intensity by primary energy in 2007-2020 decreases by 31%, and by final energy by 31% as well.

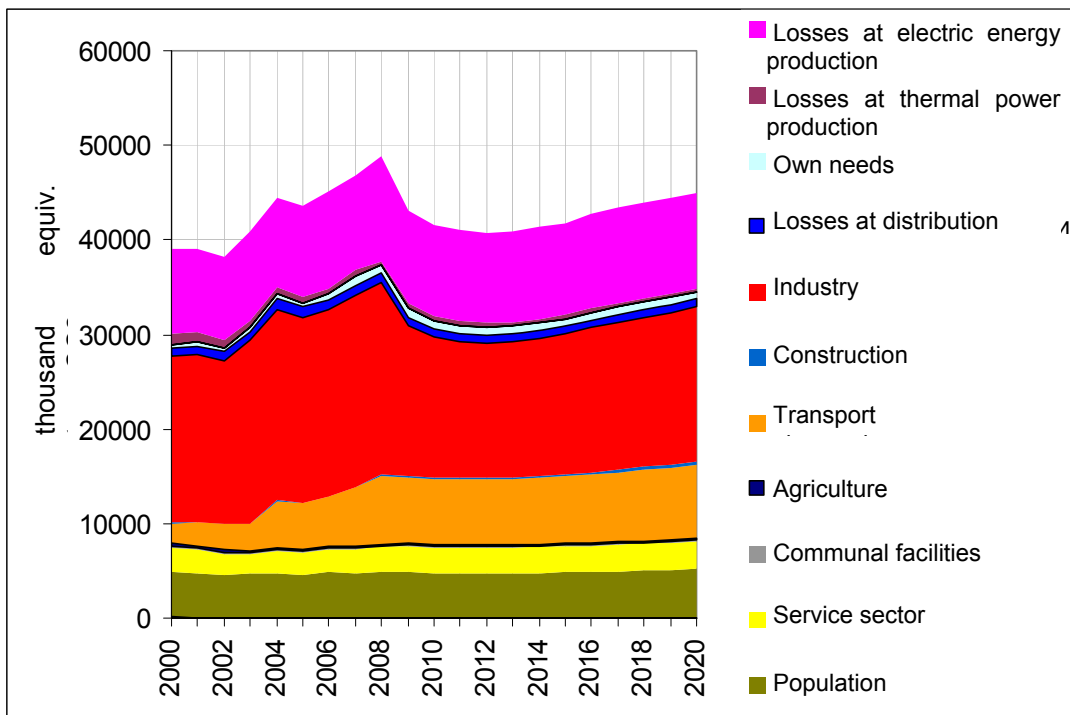


Fig. 4.6. Trend of energy consumption basic indicators in "Innovative" Scenario

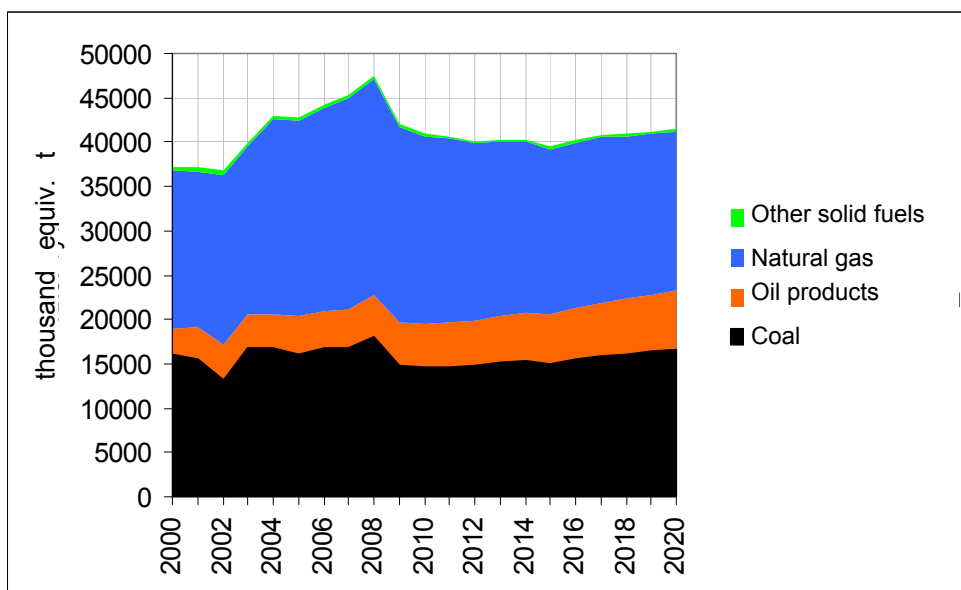


Fig. 4.7. Trend of electric energy final consumption in "Innovative" Scenario

4.5.3 TREND OF GREENHOUSE GASES EMISSIONS

In this case the trend of both GHG emissions and GHG emissions basic indicators changes considerably and looks different than in “Innovative” development Scenario. (see Fig. 3.8 and 3.9 and Table 3.12). GHG emissions in 2020 are 11% lower than the level of 2008 and 17% lower than the level of 1990.

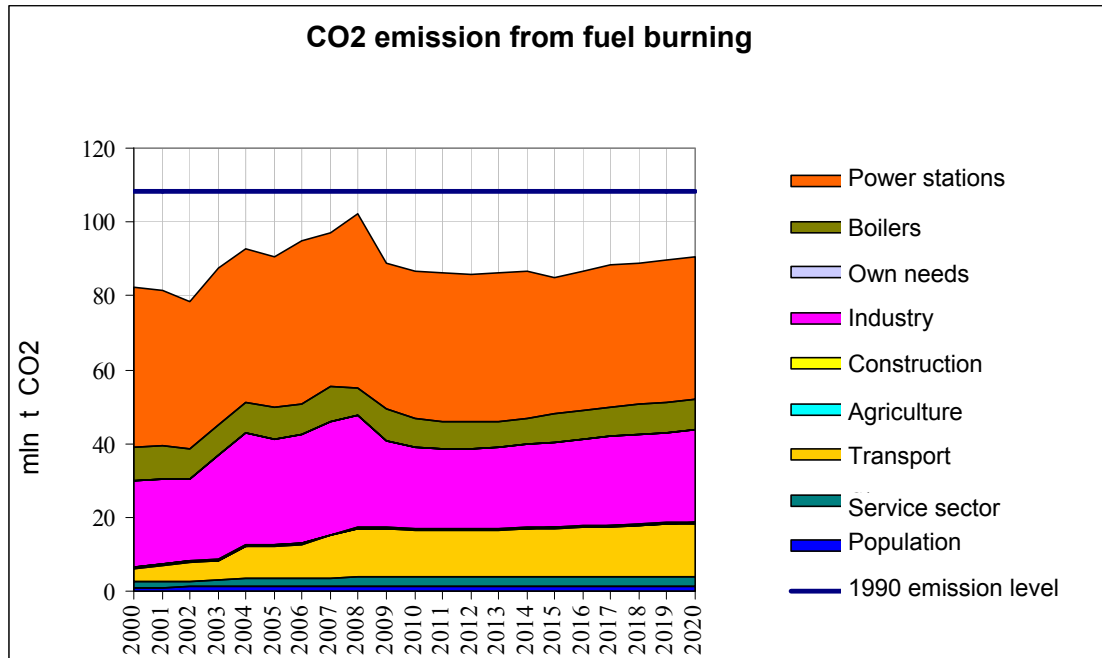


Fig. 4.8. CO₂ emissions trend by economy sectors in “Innovative” Scenario with rapid increase of energy efficiency

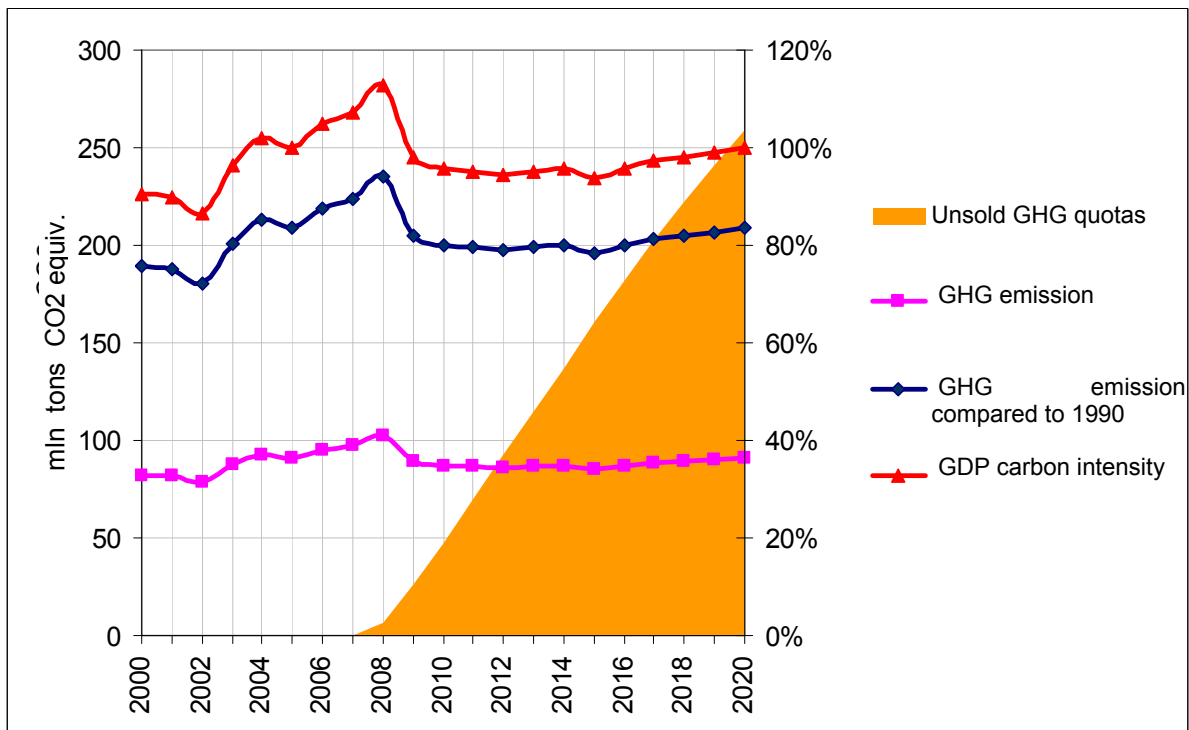


Fig. 4.9. GHG emissions basic indicators trend in “Innovative” Scenario with rapid increase of energy efficiency

In this scenario:

- Annual GHG emissions in 2020 reach the level 17% below the level of 1990;
- Average annual GHG emissions in 2008-2012 are 17% lower than the level of 1990;
- Accumulated unsold quotas for GHG emissions in 2008-2012 equal 93 mln equiv. t CO₂;
- Average annual GHG emissions in 2013-2020 are 19% lower than the level of 1990;
- Accumulated unsold quotas for GHG emissions in 2013-2020 equal 259 mln equiv. t CO₂.

According to this scenario, Sverdlovsk region can take the obligation to keep average annual GHG emissions in 2013-2020 at 15% lower than the level of 1990.

Table 4.10. Trend of energy intensity during equipment replacement process (without influence from price changes and machine loading) in “Innovative” Scenario + Energy Efficiency

Years	Reduction of energy intensity in iron ore production	Reduction of energy intensity in sintered iron ore production	Reduction of energy intensity in pellets production	Reduction of energy intensity in pig iron production	Reduction of energy intensity in coke production	Reduction of energy intensity in open-hearth steel production	Reduction of energy intensity in converter steel production	Reduction of energy intensity in electric furnace steel production	Reduction of energy intensity in steel pipes production	Reduction of energy intensity in rolled metals production	Reduction of energy intensity in electric ferroalloys production	Reduction of energy intensity in cement and clinker production	Reduction of energy intensity in other productions	Reduction of energy intensity in construction	Reduction of energy intensity in railway transport	Reduction of energy intensity in pipeline transport	Reduction of energy intensity in auto transport	Reduction of energy intensity in other transport	Reduction of energy intensity in agriculture	Reduction of energy intensity in community facilities	Reduction of energy intensity in services sector	Reduction of energy intensity in existing residential facilities	Specific energy consumption in new resid. facil. (in % to exist. resid. accomod.)
	% per year	% per year	% per year	% per year	% per year	% per year	% per year	% per year	% per year	% per year	% per year	% per year	% per year	% per year	% per year	% per year	% per year	% per year	% per year	% per year	% per year	% per year	% per year
2007	1,0%	-1,0%	1,0%	1,0%	0,0%	2,0%	0,0%	1,0%	0,0%	1,0%	0,0%	2,0%	-1,0%	0,0%	-2,0%	0,0%	-1,0%	-2,0%	3,0%	0,0%	1,0%	1,0%	90%
2008	1,0%	-1,0%	1,0%	1,0%	0,0%	2,0%	0,0%	1,0%	0,0%	1,0%	0,0%	2,0%	-1,0%	0,0%	-2,0%	0,0%	-1,0%	-2,0%	3,0%	0,0%	1,0%	1,0%	90%
2009	1,0%	0,0%	1,0%	1,0%	0,0%	2,0%	0,0%	1,0%	0,0%	1,0%	0,0%	1,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-1,0%	2,0%	0,0%	1,0%	1,0%	90%
2010	3,0%	0,5%	1,5%	2,0%	3,0%	2,0%	0,0%	1,0%	1,0%	3,0%	1,0%	3,0%	2,0%	0,0%	1,0%	1,0%	1,0%	1,0%	3,0%	1,0%	2,0%	2,0%	70%
2011	3,0%	0,5%	1,5%	2,0%	3,0%	2,0%	0,0%	1,0%	1,0%	3,0%	1,0%	3,0%	2,0%	0,0%	1,0%	1,0%	1,0%	1,0%	3,0%	1,0%	2,0%	2,0%	70%
2012	3,0%	0,5%	1,5%	2,0%	3,0%	2,0%	0,0%	1,0%	1,0%	3,0%	1,0%	3,0%	2,0%	0,0%	1,0%	1,0%	1,0%	1,0%	3,0%	1,0%	2,0%	2,0%	70%
2013	3,0%	0,5%	1,5%	2,0%	3,0%	2,0%	0,0%	1,0%	1,0%	3,0%	1,0%	3,0%	2,0%	0,0%	1,0%	1,0%	1,0%	1,0%	3,0%	1,0%	2,0%	2,0%	70%
2014	3,0%	0,5%	1,5%	2,0%	3,0%	2,0%	0,0%	1,0%	1,0%	3,0%	1,0%	3,0%	2,0%	0,0%	1,0%	1,0%	1,0%	1,0%	3,0%	1,0%	2,0%	2,0%	70%
2015	3,0%	0,5%	1,5%	2,0%	3,0%	2,0%	0,0%	1,0%	1,0%	3,0%	1,0%	3,0%	2,0%	0,0%	1,0%	1,0%	1,0%	1,0%	3,0%	1,0%	2,0%	2,0%	70%
2016	3,0%	0,5%	1,5%	2,0%	3,0%	2,0%	0,0%	1,0%	1,0%	3,0%	1,0%	3,0%	2,0%	0,0%	1,0%	1,0%	1,0%	1,0%	3,0%	1,0%	2,0%	2,0%	70%
2017	3,0%	0,5%	1,5%	2,0%	3,0%	2,0%	0,0%	1,0%	1,0%	3,0%	1,0%	3,0%	2,0%	0,0%	1,0%	1,0%	1,0%	1,0%	3,0%	1,0%	2,0%	2,0%	70%
2018	3,0%	0,5%	1,5%	2,0%	3,0%	2,0%	0,0%	1,0%	1,0%	3,0%	1,0%	3,0%	2,0%	0,0%	1,0%	1,0%	1,0%	1,0%	3,0%	1,0%	2,0%	2,0%	70%
2019	3,0%	0,5%	1,5%	2,0%	3,0%	2,0%	0,0%	1,0%	1,0%	3,0%	1,0%	3,0%	2,0%	0,0%	1,0%	1,0%	1,0%	1,0%	3,0%	1,0%	2,0%	2,0%	70%
2020	3,0%	0,5%	1,5%	2,0%	3,0%	2,0%	0,0%	1,0%	1,0%	3,0%	1,0%	3,0%	2,0%	0,0%	1,0%	1,0%	1,0%	1,0%	3,0%	1,0%	2,0%	2,0%	70%

Source: CENEf estimate

Table 4.11. Production structure and electric and heat power industry efficiency in “Innovative” Scenario + Energy Efficiency

Year	Electric energy production at existing heat stations	Electric energy production at new stations	Electric energy production at nuclear power stations	Electric energy production at hydro stations	Electric energy production at wind power station	Heat production at new stations	Heat production at nuclear power stations	Heat production at existing heat stations	Specific fuel consumption for electric energy production at new stations	Specific fuel consumption for electric energy production at existing stations	Specific fuel consumption for heat production at new stations	Specific fuel consumption for heat production at existing stations	Boiler efficiency factor	Portion of losses in electric mains	Portion of losses in heat network	Portion of heat consumption for power stations' own needs
	mln KWt-h	mln KWt-h	mln KWt-h	mln KWt-h	mln KWt-h	th. GCal	th. GCal	th. GCal	g equiv. fuel/ KWt-h	g equiv. fuel/ KWt-h	kg equiv. fuel/ GCal	kg equiv. fuel/ GCal	%	%	%	%
2007	42970	0	4 088	24,20	0	0	344	36775	216,0	332,4	143,0	154,3	81,0%	6,5%	6,5%	5,5%
2008	48453	0	4 084	21,12	0	0	333	36785	216,0	331,4	143,0	152,3	87,0%	8,1%	5,5%	4,5%
2009	41331	0	4 370	24,20	0	0	357	33000	216,0	331,4	143,0	152,3	87,1%	7,3%	6,0%	5,0%
2010	40856	819	4 181	24,68	0	700	341	32886	216,0	331,4	143,0	152,3	87,2%	7,2%	5,9%	4,9%
2011	40256	2341	4 212	25,18	0	700	344	32742	216,0	331,4	143,0	152,3	87,3%	7,1%	5,8%	4,9%
2012	39143	2899	4 254	25,68	0	1120	347	32470	219,4	331,4	143,0	152,3	87,4%	7,0%	5,7%	4,8%
2013	38629	4087	4 215	28,25	0	1540	344	32342	218,4	331,4	143,0	152,3	87,5%	6,9%	5,6%	4,8%
2014	37111	5518	5 575	31,07	0	1560	455	31961	217,8	331,4	143,0	152,3	87,6%	6,8%	5,5%	4,7%
2015	32578	7342	8 567	34,18	0	1597	700	30790	217,4	331,4	143,0	152,3	87,7%	6,7%	5,4%	4,7%
2016	32578	9114	9 655	37,60	0	1616	788	30790	217,1	331,4	143,0	152,3	87,8%	6,6%	5,3%	4,6%
2017	32378	10339	9 655	41,36	0	1653	788	30733	217,0	331,4	143,0	152,3	87,9%	6,5%	5,2%	4,6%
2018	32007	10339	9 655	45,50	0	1653	788	30627	217,0	331,4	143,0	152,3	88,0%	6,4%	5,1%	4,5%
2019	32007	10339	9 655	50,05	0	1653	788	30627	217,0	331,4	143,0	152,3	88,1%	6,3%	5,0%	4,5%
2020	32007	10339	9 655	55,05	0	1653	788	30627	217,0	331,4	143,0	152,3	88,2%	6,2%	4,9%	4,4%

Source:CENef estimate

Table 4.12. Structure of energy consumption by sectors in “Innovative” Scenario +Energy Efficiency (thousand equivalent tons)

Year	Losses in electric energy production	Losses in heat power production	Fuel conversion	Auxiliaries	Losses in distribution	Industry	Construction	Transport	Agriculture	Community facilities	Services sector	Population	Non-energy needs
2005	9661,4	692,0	0,0	387,0	1088,3	19594,6	81,3	4934,3	205,1	146,0	2337,1	4474,2	68,5
2006	10219,9	524,6	0,0	715,0	1026,2	19692,5	96,1	5085,6	195,4	140,6	2526,1	4767,0	57,7
2007	9844,6	683,2	0,0	1010,3	1051,6	20251,8	100,8	6252,2	184,2	141,5	2472,3	4715,5	64,2
2008	11117,0	357,4	0,0	887,0	1030,5	20203,9	184,1	7217,8	179,3	98,1	2714,9	4765,3	64,1
2009	9704,2	631,8	0,0	885,5	904,2	15841,3	138,6	7065,2	176,5	102,0	2761,2	4795,6	49,2
2010	9634,1	558,9	0,0	855,6	851,2	14867,0	132,2	6957,1	176,6	100,1	2721,1	4726,2	48,1
2011	9658,3	526,7	0,0	844,9	822,8	14437,5	138,4	6914,0	176,7	100,6	2735,5	4718,8	48,4
2012	9488,9	492,8	0,0	825,6	801,0	14282,4	150,4	6859,1	176,8	100,0	2746,1	4715,3	49,6
2013	9482,6	460,1	0,0	820,3	792,6	14382,4	164,9	6937,1	175,5	98,4	2744,4	4714,7	52,0
2014	9657,9	440,4	0,0	821,6	789,5	14597,1	184,0	7033,0	174,8	97,6	2754,9	4730,1	54,8
2015	9628,9	429,3	0,0	815,3	792,2	14898,2	206,5	7110,0	174,1	96,7	2776,2	4761,8	57,9
2016	10064,0	409,9	0,0	831,9	795,8	15245,7	230,8	7267,6	173,6	95,9	2806,8	4806,2	61,1
2017	10133,8	392,5	0,0	833,9	802,1	15587,5	255,7	7416,9	173,1	95,2	2847,5	4863,4	64,5
2018	10053,7	374,4	0,0	823,9	805,0	15850,8	281,7	7532,8	172,7	94,5	2894,2	4928,3	67,8
2019	10052,4	353,7	0,0	816,5	809,4	16106,1	310,4	7662,0	172,4	93,8	2947,3	5002,1	71,3
2020	10052,4	331,1	0,0	809,0	814,7	16355,0	339,7	7800,1	172,1	93,1	3006,1	5084,7	74,9

Source: CENEf estimate

4.6 “Inert” scenario

4.6.1 CONCEPT

This scenario covers the period till 2012. It uses low option parameters from Sverdlovsk region government prognosis till 2012. For later years the assumptions of Ministry of Economic Development are used. It is assumed that economy will be recovering very slowly due to stagnation of Russian and world economies.

The change rates of a greater part of macroeconomic indicators for this scenario in 2010-2012 are close to the rates considered in Ministry of Economic Development prognosis for conservative scenario.

This scenario assumes commissioning of BN-800 unit at Beloyarskaya nuclear power station in 2014, growth of Reftinskaya state regional power station capacity in 2012 by 25 MWt, commissioning of PGU-410 steam-power unit at Sredneuralskaya state regional power station in 2010, commissioning of two PGU units at Novo-Bogoslovskaya thermal station in 2012 and 2013.

On the basis of all these assumptions, CENEf formed up “Inert” Scenario of the trend for main control variables of the ENERGYBAL-SVERDLOVSK model for the period 2010-2020 (see Table 4.13-4.15).

4.6.2 PROJECTED ENERGY BALANCE

In this scenario GRP in 2008-2020 grows by 7% only, while primary energy consumption in 2020 is 13% lower than the level of 2008 (see Fig. 4.10 and Table 4.16). GRP power intensity in primary energy in 2007-2020 decreases by 17,5% and by 18% in final energy.

Energy consumption grows, basically, due to growth of consumption by population, services sector and transport. At that, energy consumption in industry and electric power industry will be considerably lower than the level of 2008.

Fuel consumption drops in 2009. The decrease continues till 2015. After that fuel consumption stabilizes at a low level (see Fig. 4.11). Economic slack and rapid growth of prices for natural gas in this scenario result in considerable decrease of natural gas consumption against certain stabilization of coal consumption after a drop followed by an increase due to a greater loading of existing coal power stations.

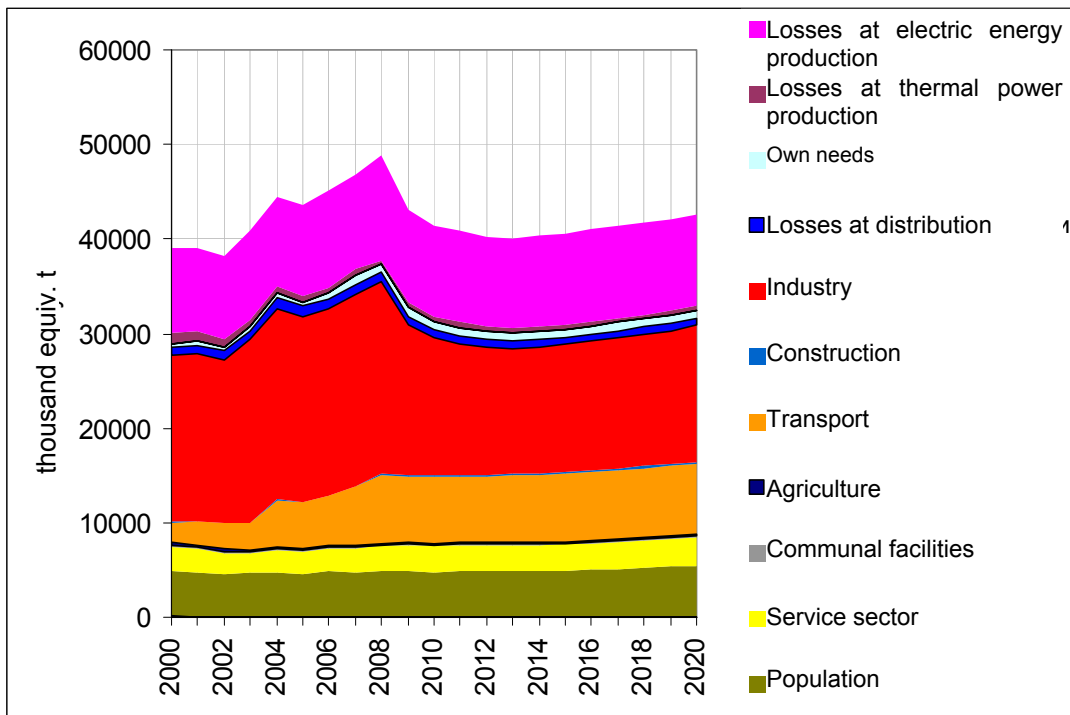


Fig. 4.10. Trend of energy consumption in different sectors, according to “Inert” Scenario

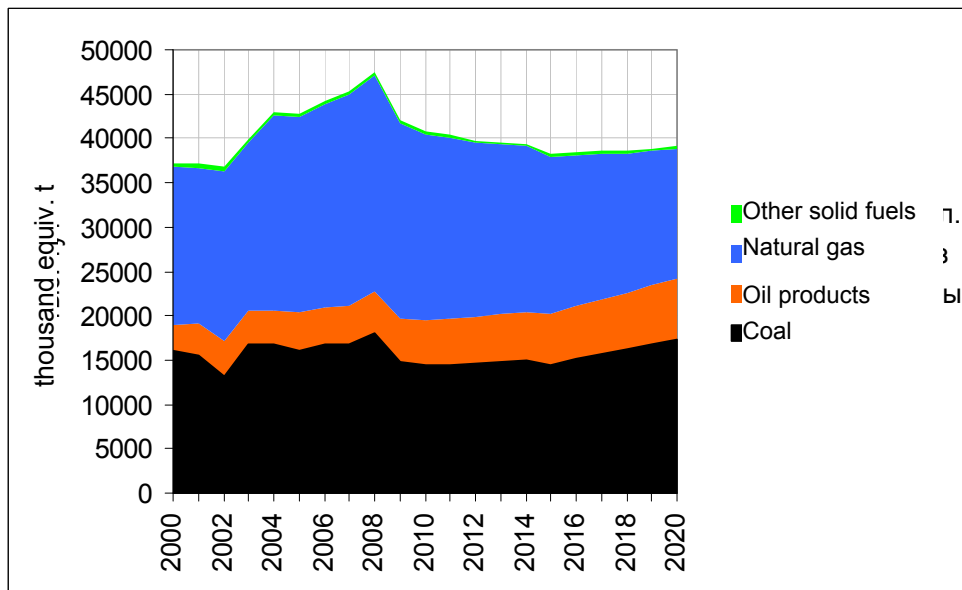


Fig. 4.11. Trend of fuel consumption according to “Inert” scenario

4.6.3 TREND OF GREENHOUSE GASES EMISSION

According to this scenario GHG emissions grow very slowly till 2020 after a drop during the crisis. In 2020 GHG emissions equal 88 mln equiv. t CO₂, which is 16% lower than the level of 2008 and 19% lower than the level of 1990 (see Fig. 4.12). Accumulated unsold quotas in 2008-2020 will be equal to 283 mln equiv. t CO₂, which is 3,2 times more than annual emission in 2020.

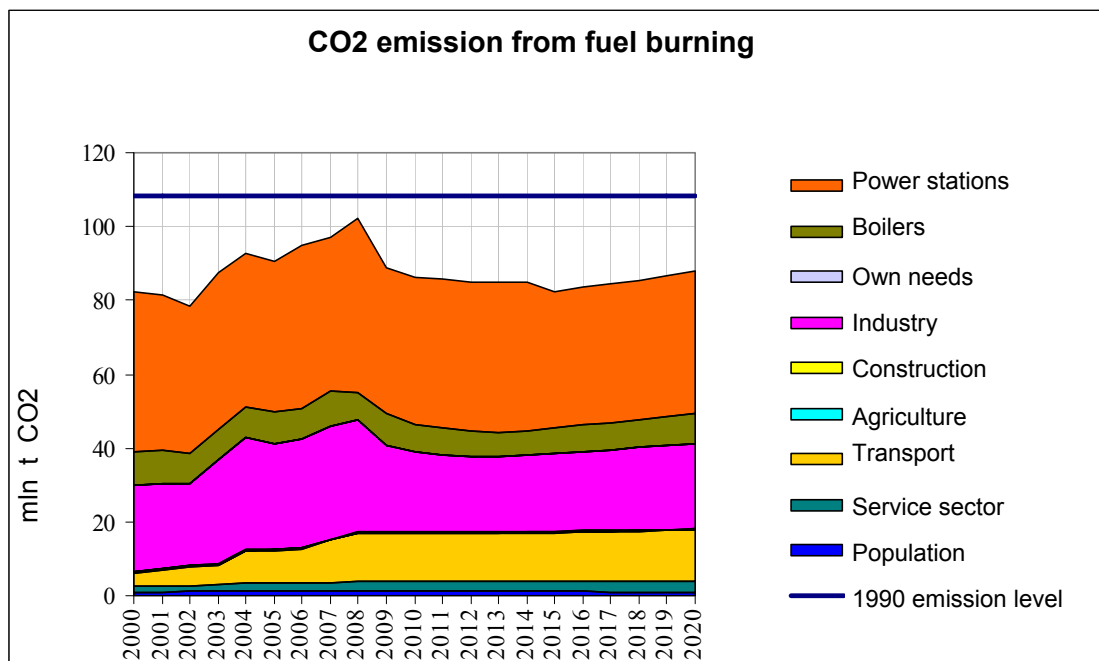


Fig. 4.12. CO₂ emissions trend by sectors of economy in “Inert” Scenario

Over the period of 2008-2012, accumulated unsold quotas (balance between emission at the level of 1990 for five years and actual total GHG emission over the period) will be equal to 95 mln equiv. t CO₂ (see Fig. 4.13). In 2020 only emissions in transport and service sector exceed the level of 2008.

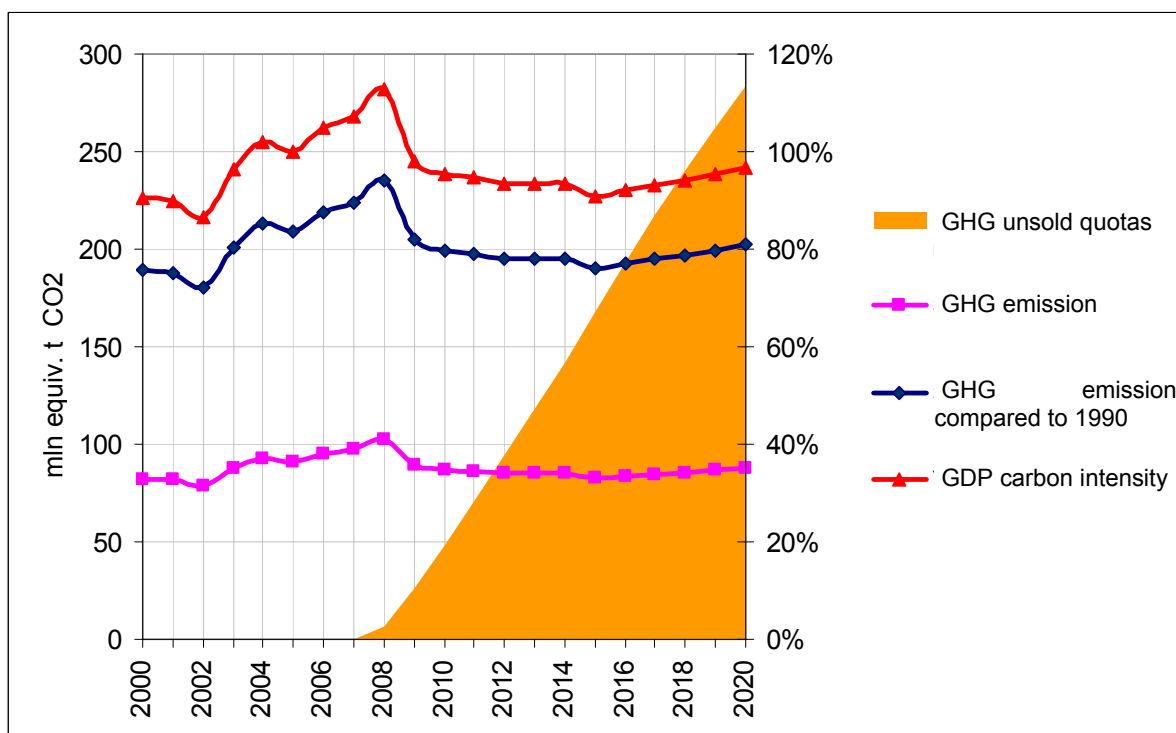


Fig. 4.13. GHG emissions main indicators trend in “Inert” Scenario

In this scenario:

- Annual GHG emissions after 2009 decrease and stay at the level below 2008 and 1990 up to 2020;

- Average annual GHG emissions in 2008-2012 are 18% lower than the level of 1990;
- Accumulated unsold quotas for GHG emissions in 2008-2012 are equal to 95 mln equiv. t CO₂;
- Average annual GHG emissions in 2013-2020 are 22% lower than the level of 1990;
- Accumulated unsold quotas for GHG emissions in 2013-2020 are equal to 283 mln equiv. t CO₂.

According to this scenario Sverdlovsk region can take the obligation to keep average annual GHG emissions in 2013-2020 at 20% lower than the level of 1990.

Table 4.13. Main macroeconomic assumptions in "Inert" Scenario

Year	GRP growth rate	Population	Production index in industry	Production index in processing industry	Index of volume of work in construction	Agricultural production index	Retail and gross sale turnover index	Index of volume of paid services to population	Index of real earnings of population	Commissioning of residential facilities	Commissioning of service sector facilities	Number of clinics and hospitals	Number of kindergartens and educational establishments	Railway transport cargo turnover	Pipeline transport turnover	Number of autos
	%	th. people	%	%	%	%	%	%	%	th. m ²	th. m ²	pieces	pieces	Mln t/km	Mln m ³ /km	pieces
2007	109,2%	4395,6	111,7%	113,9%	118,6%	95,8%	123,1%	104,6%	107,2%	1913,0	910,8	821	1344	2764	72503	1300000
2008	102,5%	4392,3	98,0%	96,6%	101,1%	97,9%	114,2%	104,7%	101,9%	1702,0	585,6	821	1320	2828	72576	1326000
2009	83,3%	4392,8	76,8%	73,5%	74,6%	99,5%	94,4%	94,5%	96,0%	1550,0	465,0	821	1303	2816	65565	1352520
2010	96,9%	4389,2	94,1%	97,5%	96,0%	100,5%	101,4%	101,9%	100,4%	1580,0	474,0	821	1303	2802	62696	1379570
2011	99,3%	4385,6	98,7%	100,2%	103,8%	100,5%	102,5%	102,4%	102,0%	1710,0	513,0	821	1303	2819	61177	1407162
2012	101,0%	4378,7	101,1%	102,4%	107,8%	100,5%	103,8%	102,5%	103,4%	1917,0	575,1	821	1303	2873	58726	1435305
2013	103,8%	4377,3	101,7%	102,7%	106,3%	103,0%	105,9%	104,5%	103,8%	2038,2	611,5	821	1303	2922	57196	1464011
2014	104,2%	4376,3	102,1%	103,1%	106,1%	103,0%	105,4%	104,3%	104,3%	2162,2	648,7	821	1303	2984	55682	1495487
2015	104,2%	4375,5	102,5%	103,5%	106,1%	103,0%	104,8%	103,8%	104,6%	2294,1	688,2	821	1303	3058	52743	1529884
2016	103,8%	4375,0	102,1%	103,1%	105,6%	103,0%	104,6%	103,6%	104,2%	2423,5	727,1	821	1303	3123	50791	1562011
2017	103,6%	4374,5	101,9%	102,9%	105,2%	103,0%	104,3%	103,5%	103,8%	2549,1	764,7	821	1303	3182	48842	1593251
2018	103,1%	4374,0	101,4%	102,4%	104,7%	103,0%	104,1%	103,3%	103,7%	2669,5	800,9	821	1303	3228	46927	1625116
2019	102,9%	4373,5	101,2%	102,2%	104,3%	103,0%	103,8%	103,2%	103,5%	2783,3	835,0	821	1303	3267	45225	1657619
2020	103,2%	4372,9	102,5%	103,5%	103,8%	103,0%	103,6%	103,0%	103,4%	2889,1	866,7	821	1303	3349	43716	1690771

Source: CENef estimate

Table 4.14. Volume of production of basic goods in "Inert" Scenario

Year	Electric power production	Merchantable iron ore	Sintered iron and manganese ore	Iron ore pellets	Pig iron	Coke	Open-hearth steel	Converter steel	Electric furnace steel	Steel pipes	Rolled metals	Electric ferroalloys	Cement
	Mln KWt/h	th.t			th. t		th.t		th. t	th. t	th.m ²	th.t	th.t
2007	47083	12436	6436	6029	5877	2909	2862	3817	2484	2309	7051	372	3417
2008	52558	11302	5836	5304	5292	2791	2577	3330	2857	2080	6720	311	3263
2009	45725	9607	5369	4880	4181	2204	1546	2331	2301	1664	5376	187	2447
2010	45880	8916	4983	4529	3850	2030	1424	2193	2197	1623	5242	183	2349
2011	46834	8687	4855	4413	3723	1963	1377	2165	2197	1626	5252	184	2439
2012	46322	8673	4847	4405	3690	1946	1365	2189	2248	1665	5378	190	2629
2013	46957	8728	4878	4434	3690	1946	1365	2226	2310	1710	5524	196	2795
2014	48231	8798	4917	4469	3690	1946	1365	2273	2388	1763	5696	203	2965
2015	47915	8881	4964	4511	3690	1946	1365	2330	2482	1825	5896	211	3146
2016	49003	8954	5004	4548	3690	1946	1365	2379	2563	1882	6079	219	3323
2017	48804	9021	5042	4582	3690	1946	1365	2425	2638	1937	6256	226	3496
2018	48434	9072	5070	4608	3690	1946	1365	2459	2695	1983	6407	233	3661
2019	48434	9116	5095	4630	3690	1946	1365	2489	2744	2028	6549	239	3817
2020	48435	9208	5146	4677	3690	1946	1365	2551	2847	2099	6779	249	3962

Source: CENef estimate

Table4.15. Production structure and energy intensity in electric and heat power industries in "Inert" Scenario

Year	Electric energy production at existing thermal stations	Electric energy production at new stations	Electric energy production at nuclear stations	Electric energy production at hydro stations	Electric energy production at windmill stations	Heat production at new stations	Heat production at nuclear stations	Heat production at existing thermal stations	Specific fuel consumption for electric production at new stations	Specific fuel consumption for electric production at existing stations	Specific fuel consumption for heat production at new stations	Specific fuel consumption for heat production at existing stations	Boiler efficiency factor	Portion of losses in electric mains	Portion of losses in heat network	Portion of heat consumption for electric power stations' own needs
	mln KWt-h	mln KWt-h	mln KWt-h	mln KWt-h	mln KWt-h	th. GCal	th. GCal	th. GCal	g equiv. fuel/ KWt-h	g equiv. fuel/ KWt-h	kg equiv. fuel / GCal	kg equiv. fuel / GCal	%	%	%	
2007	42970	0	4 088	24,20	0	0	344	36775	216,0	332,4	143,0	154,3	81,0%	6,5%	6,5%	5,5%
2008	48453	0	4 084	21,12	0	0	333	36785	216,0	331,4	143,0	152,3	87,0%	8,1%	5,5%	4,5%
2009	41331	0	4 370	24,20	0	0	357	33000	216,0	331,4	143,0	152,3	87,1%	7,3%	6,0%	5,0%
2010	40856	819	4 181	24,68	0	700	341	32886	216,0	331,4	143,0	152,3	87,2%	7,2%	5,9%	5,0%
2011	40256	2341	4 212	25,18	0	700	344	32742	216,0	331,4	143,0	152,3	87,3%	7,1%	5,8%	5,0%
2012	39143	2899	4 254	25,68	0	1120	347	32470	219,4	331,4	143,0	152,3	87,4%	7,0%	5,7%	5,0%
2013	38629	4087	4 215	26,19	0	1540	344	32342	218,4	331,4	143,0	152,3	87,5%	6,9%	5,6%	5,0%
2014	37111	5518	5 575	26,72	0	1560	455	31961	217,8	331,4	143,0	152,3	87,6%	6,8%	5,5%	5,0%
2015	32578	6742	8 567	27,25	0	1597	700	30790	217,5	331,4	143,0	152,3	87,7%	6,7%	5,4%	5,0%
2016	32578	6742	9 655	27,80	0	1597	788	30790	217,5	331,4	143,0	152,3	87,8%	6,6%	5,3%	5,0%
2017	32378	6742	9 655	28,35	0	1597	788	30733	217,5	331,4	143,0	152,3	87,9%	6,5%	5,2%	5,0%
2018	32007	6742	9 655	28,92	0	1597	788	30627	217,5	331,4	143,0	152,3	88,0%	6,4%	5,1%	5,0%
2019	32007	6742	9 655	29,50	0	1597	788	30627	217,5	331,4	143,0	152,3	88,1%	6,3%	5,0%	5,0%
2020	32007	6742	9 655	30,09	0	1597	788	30627	217,5	331,4	143,0	152,3	88,2%	6,2%	4,9%	5,0%

Source: CENEf estimate

Table 4.16. Structure of energy consumption by sectors in "Inert" Scenario (thousand equivalent ton)

Year	Losses in electric energy production	Losses in heat power production	Fuel conversion	Auxiliaries	Losses in distribution	Industry	Construction	Transport	Agriculture	Community facilities	Services sector	Population	Non-energy needs
2005	9661,4	692,0	0,0	387,0	1088,3	19594,6	81,3	4934,3	205,1	146,0	2337,1	4474,2	68,5
2006	10219,9	524,6	0,0	715,0	1026,2	19692,5	96,1	5085,6	195,4	140,6	2526,1	4767,0	57,7
2007	9844,6	683,2	0,0	1010,3	1051,6	20251,8	100,8	6252,2	184,2	141,5	2472,3	4715,5	64,2
2008	11117,0	357,4	0,0	887,0	1030,5	20203,9	184,1	7217,8	179,3	98,1	2714,9	4765,3	64,1
2009	9704,2	631,8	0,0	885,5	904,2	15843,8	138,6	7065,5	176,5	102,0	2761,2	4795,6	49,2
2010	9634,1	563,2	0,0	862,6	843,1	14537,8	132,0	7029,0	172,4	100,3	2741,6	4769,7	46,3
2011	9658,3	536,4	0,0	861,6	812,8	13923,8	136,3	7055,0	168,3	100,9	2765,5	4788,5	45,7
2012	9488,9	505,0	0,0	851,1	791,8	13525,6	146,4	7064,8	164,5	101,1	2765,8	4800,3	46,2
2013	9482,6	472,7	0,0	851,8	776,5	13302,6	154,8	7113,6	164,7	100,0	2754,9	4808,5	47,0
2014	9657,9	459,4	0,0	861,5	769,0	13311,0	163,8	7184,8	165,2	99,2	2771,4	4848,0	48,0
2015	9571,7	455,9	0,0	858,1	767,0	13431,0	173,5	7217,1	166,0	98,8	2795,4	4905,4	49,2
2016	9839,1	449,3	0,0	870,0	765,2	13597,3	183,0	7274,0	167,0	98,7	2828,6	4978,7	50,3
2017	9795,2	448,1	0,0	871,9	766,3	13788,5	192,4	7325,8	168,2	98,9	2870,5	5066,4	51,2
2018	9717,9	448,1	0,0	871,9	764,4	13949,4	201,5	7372,8	169,5	99,1	2916,7	5166,5	52,0
2019	9717,9	447,1	0,0	875,1	763,1	14101,1	210,1	7428,0	171,0	99,5	2966,4	5275,4	52,6
2020	9717,9	445,8	0,0	880,1	766,0	14379,9	218,1	7520,6	172,7	100,0	3018,3	5390,7	53,9

Source: CENef estimate

5. Tver region

5.1 Main conclusions

Economic crisis considerably updated all development estimates for Russian economy, and for economy of Tver region as well. Regional economy development prognosis for 2009-2011 was approved by decision of Tver region administration on December 18, 2009. The prognosis assumed industrial production decrease by 3% in 2009. However, the first 9 months of 2009 showed the actual decrease by 21%.

In 2008 GHG emissions in Tver region constituted only 73% of 1990 level. In 2009-2010, according to CENef estimate, emissions will be equal to 68% of the level of 1990.

To estimate the trajectory of GHG emissions in Tver region within ENERGYBAL-Tver model, three scenarios were developed and implemented (see Fig. 4.1):

- “Innovative” development – an option of macroeconomic indicators trend, which are close to “Innovative” development estimate by Ministry of Economic Development;
- “Innovative” development with rapid increase of energy efficiency;
- “Inert” development – an option of macroeconomic indicators trend, which are close to “Inert” development estimate by Ministry of Economic Development .

Implementation of these scenarios in ENERGYBAL-Tver model made it possible to evaluate the prospects of GHG emissions trend from energy sector, following IPCC classification (see Fig. 4.1 and Table 4.1).

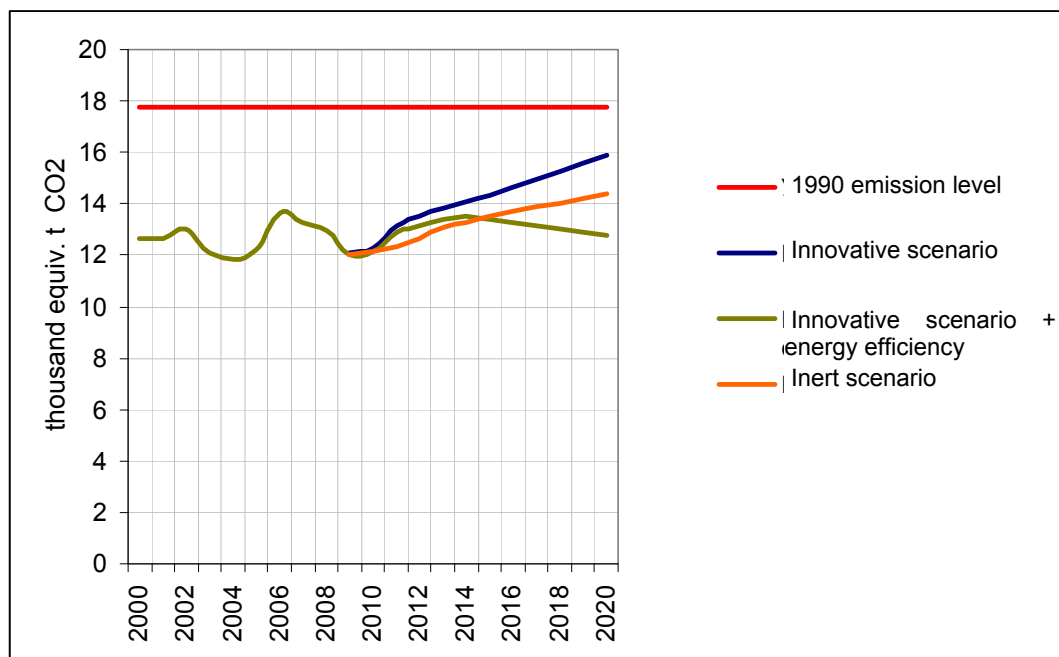


Fig. 5.1. Comparison of scenarios of GHG emission trends from fuel combustion, extraction and transportation (energy sector) in Tver region

Analysis of prognostic data made it possible to draw the following conclusions:

- GHG emission in Tver region, most probably, will be in the following ranges:
 - 12,1-12,3 mln equiv. t CO₂ in 2010;
 - 13,4-14,3 mln equiv. t CO₂ in 2015;
 - 12,8-15,9 mln equiv. t CO₂ in 2020;
- Besides characteristics of regional macroeconomic development, the uncertainty of emission trend is determined by uncertainty of projects implementation in the regional main branch of industry, which is electric power industry, including the development of nuclear power stations. Against such an uncertainty, various options of renewed energy sources development do not considerably influence emission trend;
- Neither “Innovative” Development Scenario nor “Inert” Development Scenario manage to stop the growth of GHG emission after recovery of economy;
- “Innovative” Development Scenario formed the upper limit of prognosis;
- “Inert” Development Scenario defines the lower limit of prognosis till 2015. After that the development follows “Innovative” Scenario with rapid increase of energy efficiency;
- In “Innovative” Scenario with rapid increase of energy efficiency only considerable efforts for the increase of energy efficiency in Tver region (including equipment upgrade at Konakovskaya state regional power station) make it possible to steadily decrease GHG emission after the emission peaks in 2015;
- During the Kyoto Protocol period (2008-2012) Tver region can:
 - Maintain average annual GHG emission at 28-30% lower than the level of 1990;
 - Accumulate unsold quotas for GHG emission in the volume of 24,9-26,7 mln equiv. t CO₂;
- For the post-Kyoto period, Tver region can take the obligations which are just a trace less ambitious than those by European Union:
 - Keep annual GHG emission at a level 11-19% lower than the level of 1990;
 - Keep average annual GHG emission in 2013-2020 at 17-23% lower than 1990 level;
 - Keep average annual GHG emission in 2013-2020 at 37% lower than the level of 1990 with consideration in the post-Kyoto period of accumulated emission quotas unsold in 2008-2012, (since regional quotas were not distributed actually).

In the course of active policy for energy efficiency increase, Tver region can take the obligation to keep average annual GHG emission in 2013-2020 at 20% lower than the level of 1990.

Table 5.1. GHG emission estimate for different scenarios of Tver region development (mln equiv. t CO₂)

Year	Level of 1990	"Inert"	"Innovative"	"Innovative" +prices
2000	17,77	12,64	12,64	12,64
2001	17,77	12,65	12,65	12,65
2002	17,77	13,00	13,00	13,00
2003	17,77	12,11	12,11	12,11
2004	17,77	11,81	11,81	11,81
2000	17,77	12,64	12,64	12,64
2005	17,77	12,23	12,23	12,23
2006	17,77	13,62	13,62	13,62
2007	17,77	13,28	13,28	13,28
2008	17,77	12,96	12,96	12,96
2009	17,77	12,09	12,03	12,04
2010	17,77	12,27	12,12	12,18
2011	17,77	13,12	12,88	12,35
2012	17,77	13,50	13,17	12,66
2013	17,77	13,82	13,39	13,06
2014	17,77	14,05	13,51	13,26
2015	17,77	14,32	13,38	13,55
2016	17,77	14,61	13,25	13,70
2017	17,77	14,93	13,15	13,87
2018	17,77	15,23	13,01	14,03
2019	17,77	15,55	12,90	14,19
2020	17,77	15,88	12,80	14,39

Source: CENef estimate

5.1 Projection model

The energy forecast model and GHG emissions generated by the energy sector in the Tver region – ENERGYBAL-TVER – was developed based on the following reports that were prepared by CENef and other experts, within the project on “Promoting Investments in Energy Efficiency Projects in Russia’s Regions” project:

- Integrated fuel and energy balance and energy efficiency indicators of Rostov, Tver and Sverdlovsk regions;
- Inventory of anthropogenic greenhouse gas emission for Rostov, Sverdlovsk and Tver regions;
- Energy efficiency increase potential in Rostov, Tver and Sverdlovsk regions.

The reports and forecasts in the model are based on the integrated fuel and energy balance concept. For Tver region in the model there are 29 sectors of energy consumption, including 7

types of industrial products. The Integrated fuel-energy balances for 2000-2008 were evaluated on the basis of collected statistics (see Table 5.2).

Table 5.2. *Integrated fuel-energy balance of Tver region in 2008 z. (thousand equiv. t)*

	Coal	Crude oil	Oil products	Natural gas	Hydro and non-trad. ren. en.	Nuclear power stations	Other solid fuels	Electric energy	Heat	Total	
	1	2	3	4	5	6	7	8	9	10	11
Production						1,2	8729,6	137,2			8867,9
Import (from outside the region)	178,8	0,0	1580,7	5235,3		0,0	0,0	-7151,9			-157,1
Export (outside the region)		0,0	0,0	0,0				-3932,5			-3932,5
Changes of reserves	14,4	0,0	0,0	0,0			-14,1				0,4
Primary energy consumption	164,4	0,0	1580,7	5235,3	1,2	8729,6	151,2	-3219,5	0,0		12642,9
Imbalance										-71,7	-71,7
Power stations: total	-53,3	0,0	-35,0	-3340,9	-1,2	-8729,6	-39,3	3996,9	552,9		-7649,5
Electric energy	-30,8	0,0	-29,7	-2911,2	-1,2	-8526,3	-7,8	3996,9			-7510,1
Existing power stations	-30,8	0,0	-29,7	-2911,2	-1,2	-8526,3	-7,8	3996,9			-7510,1
New stations	0,0	0,0	0,0	0,0		0,0	0,0	0,0	0,0	0,0	0,0
Heat energy	-111,4	0,0	-129,7	-1333,7		-203,3	-83,6	-24,7	1614,4		-271,9
Existing power stations: heat	-22,5	0,0	-5,3	-429,7			-31,4		485,8		-3,1
New stations: heat	0,0	0,0	0,0	0,0		0,0	0,0	0,0	0,0	0,0	0,0
Boilers	-88,9	0,0	-124,4	-904,0	0,0	0,0	-52,2	-24,7	1058,4		-135,7
Nuclear stations and non-trad. ren. en. sour.						-203,3			67,1		-136,2
Waste-heat utilization	0,0	0,0	0,0	0,0		0,0	0,0	0,0	3,1		3,1

	Coal	Crude oil	Oil products	Natural gas	Hydro and non-trad. ren. en.	Nuclear power stations	Other solid fuels	Electric energy	Heat	Total
plants										
Fuel conversion										0,0
Own needs		0,0	0,0	0,0			0,0	-158,1	-2,8	-160,9
Losses during distribution		0,0	0,0	0,0			0,0	-108,1	-206,6	-314,7
Final consumption	22,2	0,0	1421,3	990,4			59,8	389,3	1333,3	4216,3
Industry	21,0	0,0	37,5	178,7			54,3	111,5	460,7	863,6
Fiber and chemical threads	2,9	0,0	0,0	0,1			0,0	4,0	1,4	8,5
Paper and cardboard	0,0	0,0	0,0	0,0			0,0	6,0	17,2	23,2
Textile	0,0	0,0	0,0	0,0			0,0	2,3	8,9	11,1
Meat	0,0	0,0	0,0	8,2			0,0	3,0	11,2	22,3
Other	18,1	0,0	37,5	170,4		0,0	54,2	96,3	422,0	798,5
Construction	0,0	0,0	11,2	0,0			0,0	7,4	0,1	18,8
Transport	0,0	0,0	1334,9	271,6		0,0	0,0	35,0	4,7	1646,1
Railway transport			88,1	0,0			0,0	20,5	3,6	112,1
Pipeline transport			0,0	263,9			0,0	9,5	1,1	274,5
Auto transport			1199,3	7,7			0,0	0,0	0,0	1207,0
Other transport			47,5	0,0			0,0	5,0	0,0	52,5
Agriculture	0,0		16,8	0,0			0,0	10,5	17,6	44,9
Community facilities	0,0		0,0	0,0			0,0	16,3	0,9	17,3
Service sector	0,0		1,5	40,3			0,0	89,3	179,1	310,2
Population	1,2		18,5	494,9			5,6	119,3	670,1	1309,6
Non-energy needs	0,0	0,0	0,9	4,9			0,0			5,8

Source: CENEf estimate

Reporting economic statistics from the following basic sources were collected to evaluate ENERGYBAL-TVER model parameter evaluation:

- «Tver region in numbers in 2007» Statistics collected book. Tver. 2008;

- «Electric energy, gas and water production and distribution; fuel fossil extraction in Tver region in 2003–2007 and January–September of 2008» Statistics collected book. Tver. 2009;
- «Transport in Tver region in 2007» Statistics collected book. Tver. 2008;
- «On residential facilities as of the end of 2007». Statistics bulletin. Tver. 2008;
- «Major overhaul of residential facilities in 2007». Statistics bulletin. Tver. 2008;
- «Industrial production in Tver region in 2000–2007». Statistics collected book. Tver. 2008;
- «Socioeconomic status of Tver region in 2008». Information and analytical bulletin. Tver. 2009;
- «Socioeconomic status of Tver region in January–August of 2009». Information and analytical bulletin. Tver. 2009;
- «Housing conditions and level of prosperity of Tver region households in 2007 (based on the results of household sample inquiries)». Statistics bulletin. Tver. 2008.

Sequences of data for 2000–2008 were formed on the basis of these statistics to evaluate model parameters. Also evaluation of all parameters of dependencies was performed and thus ENERGYBAL-TVER projected model was formed up. Besides, statistics were collected on parameters of crisis development in economy in Tver region in 2009. The data for 2009 used in the model fully reflect crisis development.

Based on the GHG anthropogenic emission inventory data for Tver region, a block of GHG emission was created in ENERGYBAL-TVER model. GHG emission breakdown by sectors of economy is a bit different from the inventory breakdown, which was done in accordance with “Guiding principles for GHG national inventories” (IPCC, 2006).¹³

5.2 Forecast information collection and analysis

Data about possible prospective trend of main control variables of the model for the period 2010–2020 were collected to create prognostic scenarios:

- «Prognosis of Russian Federation socio-economic development in 2010 and in the planned period of 2011 and 2012 (Ministry of Economic Development, September 2009);
- «Main indicators of Tver region socio-economic development in 2009 and in the period up to 2011». Tver region government. December 2008. («Strategy of Tver region long-term socio-economic development» is in work);
- Demographic prognosis for Tver region up to 2025. (developed by RosStat). «Estimated number of inhabitants in the Russian Federation up to 2025.». Statistics bulletin. Federal Agency for State Statistics. 2007;

¹³ Bashmakov I.A., Dzedzichuk M.G., Lunin A. A., Lebedev O.V. “Anthropogenic GHG Emissions Inventory for Rostov, Tver and Sverdlovsk regions (Energy sector)”. «Promoting Investments in Energy Efficiency Projects in Russia’s regions» project M., 2009.

- Information on plans to upgrade and build power stations (including nuclear station) of main power generation companies in Tver region;
- Data about investment projects which are supposed to be implemented in power intensive industry of Tver region in 2010-2015.

The crisis hit Tver region industry seriously. According to data from information and analytical bulletin «Tver region socio-economic status in January-August of 2009», production of meat products decreased in January-August of 2009 by 9%; bakery products – by 5%; cotton cloths – by 88%; cardboard – by 3%; fibers and chemical threads – by 63%; excavators – by 94%; passenger carriages – by 40%; electric energy production – by 8%. That is why main indicators of Tver region socio-economic development prognosis for 2009 and for the period up to 2011 were considerably updated during prognostic scenario development. According to CENEF estimate, GRP reduction in the region in 2009 can reach 10%.

Estimates by Ministry of Economic Development became the basis for such a correction. Two recovery scenarios by Ministry of Economic Development were analyzed to define general economic situation in Russia. The scenarios were presented in «Scenario conditions for performance of Russian Federation economy and main parameters of Russian Federation socio-economic development in 2010 and in the planned period of 2011 and 2012» and in «Russian Federation socio-economic development in 2010 and in the planned period of 2011 and 2012» (Ministry of Economic Development, September 2009). The first scenario (conservative) is that of economic growth till 2012, which later reaches the rates of “Inert” scenario development «Concept of long-term socio-economic development of the Russian Federation». The second scenario (moderately optimistic) assumes economic growth till 2012, which later reaches the rates of “Innovative” scenario «Concept of long-term socio-economic development of the Russian Federation».

Sets of scenario variables of the model were formed up on the basis of these sources of information. All estimates of Tver region administration prognostic and strategic documents were updated with consideration of crisis development parameters.

Results obtained within the framework of this project were used for development of the scenario with acceleration of energy efficiency increase and development of renewable energy sources.¹⁴

5.3 Investment projects analysis

Investment projects analysis was performed on the basis of data collection about prospective investment projects, presented in the Tver region government site, and on the results of the analysis of investment programs of several dozens of industrial enterprises of the region.

Electric energy production is the main branch of industry in the region. Plans of electric energy generation development in Tver region are formed by several companies: RosEnergoAtom federal state unitary enterprise, (Kalininskaya nuclear power station and planned Tverskaya nuclear power station), Integrated Power Generation Company OGC-5 (Konakovskaya state district power plant), TGC-2 (three thermal power plants in Tver) and independent companies, including isolated generation plants of industrial enterprises.

In accordance with Federal target program «Nuclear energy industrial complex development in Russia for the period 2007-2010 and the outlook up to 2015» it is planned to extend by 15 years

¹⁴ Bashmakov I.A., Dzedzichuk M.G., Lunin A. A., Lebedev O.V. Energy efficiency growth potential in Rostov, Tver and Sverdlovsk regions. CENEF. «Promoting Investments in Energy Efficiency Projects in Russia’s regions» project. M., 2009;

the service life of power generating unit #1 commissioned in 1984 at Kalininskaya nuclear power station (decision to be taken by the end of 2016); terminate the construction of power generating unit #4 and commission it in 2011. Besides, the plan is to start construction of Tver nuclear power station with VVER-1200 type reactors and the start-up of the first unit in 2011-2015. Such a lax term of nuclear power station first generating unit start-up is defined by the fact that in 2008 the construction site was not selected yet. The choice has to be either Rzhev or Udomel districts of the region, where Kalininskaya nuclear power station is located. That means that the first generating unit cannot be constructed and commissioned earlier than 2018, even though the plan was to construct all four generating units of the station before 2020 (planned design capacity of the station is 4600 MWt). This particular research assumes that the start-up of the first unit will be after 2020. This assumption does not affect in any way the trend of emissions because all electric energy from Tverskaya nuclear power station will be exported out of the region and, therefore, will not replace electric energy from Konakovskaya state district power station, which also exports energy out of the region, mostly, or energy from thermal power plants, which produce heat power, and transformation of which into boilers is unpractical.

According to data from «General pattern of electric energy industry installations development and location» for 2011-2020, upgrade of 8 units at Konakovskaya state district power plant, built in 1965-1969, was planned. This equipment was supposed to be replaced by six PGU-400 installation with efficiency factor of 58%. Five installations were supposed to be commissioned by 2015 and one more – by 2020. This way the station capacity will stay at the same level but all equipment can be replaced with a new and more energy efficient equipment. The work on implementation of this project at Konakovskaya state district power station has not started, but similar projects are being implemented at other state district power stations which make part of OGK-5. There are no data from OGK-5 about specific parameters of this project on Konakovskaya state district power station upgrade. But data is available on a similar project of PGU-410 construction (generating unit #12) at Sredneuralskaya state district power station. A gas turbine with General Electric generator of 270 MWt capacity is being installed there and a steam turbine with Skoda Power a.s. generator of 140 MWt capacity plus 200 GCal/h of heat power, as well as exhaust-heat boiler (Nooter/Eriksen, Inc.). The cost of the project is about 350 mln euro. Konakovskaya state district power plant upgrade is analyzed in “Innovative” scenario with rapid energy efficiency increase..

In 2008 construction of PGU-210 started at Tverskaya thermal power plant-3, which makes part of TGK-2. Gas turbine of 160 MWt capacity, exhaust-heat boiler will be installed at the station while existing PT-60 turbine will be upgraded and conversed to reduced steam parameters. PGU efficiency factor will constitute 51%. Initially the strategic plan of TGK-2 (September 2007) provided the commissioning of the installation in September 2009, but later it was moved to the first quarter of 2010. However, crisis development can postpone this term even more. In “Innovative” scenario the commissioning of this unit is moved to 2011. The second investment project at Tverskaya thermal power plant-3 is the installation of a turbine-generator with capacity of 115 MWt. The turbine-generator will burn coal and produce electric energy with efficiency factor of 45%. Initially (in 2007) the commissioning of this unit was planned for May 2010. Implementation of this investment project has not started yet and will be delayed, most probably. In “Innovative” scenario the commissioning of this unit is moved to 2015.

In 2005 a turbine-generator of 4 MWt capacity was installed and commissioned at Tverskaya thermal power plant-4. A project of further enlargement of Tverskaya thermal power plant-4 was analyzed at the cost of construction of additional facilities of 70 MWt capacity in 2013. But the details of this project as well as prospects of its implementation are not clear.

Various combinations of above mentioned projects in the territory of Tver region were analyzed when developing scenarios of GHG emissions. It should be noted that 30% of goods and services of the region were produced by electric energy and heat energy industries. That is why the trend of electric energy production in the region is stronger than in other regions and it defines the trend of industrial production.

5.4 “Innovative” scenario

5.4.1 CONCEPT

Long-term development strategy is not developed in Tver region yet. That is why assumptions of “Innovative” scenario by Ministry of Economic Development after 2012 are used as the regional long-term development strategy. Assumptions of moderately optimistic scenario by Ministry of Economic Development are used for the same purpose for the period before 2012.

It is assumed that the economy will be recovering due to the growth of real credit supply and, therefore, recovery of consumer demand, activation of enterprises’ upgrade, increase of business efficiency and competitive power.

Rates of changes of a greater part of macroeconomic indicators in this scenario for 2010-2012 are close to the rates in moderately optimistic scenario by Ministry of Economic Development. After 2012 it is assumed that industry will be developing dynamically due to electric energy industry, transport engineering, chemical industry, light industry and wood processing industry.

It is supposed that all industrial investment projects planned for implementation before 2009 will be fully implemented with a certain time lag. Estimates of the prognosis for 2009 were taken on the basis of data about regional economy development in the three quarters of 2009.

This scenario plans commissioning of generating unit #4 at Kalininskaya nuclear station in 2011 and commissioning of PGU-210 at Tverskaya thermal power plant -3 in 2011 as well.

Having considered all these assumptions, CENef prepared a scenario of the trend of main control variables in ENERGYBAL-TVER model for the period 2010-2020 (see Table 5.3-5.8).

Table 5.3. Main macroeconomic assumptions in "Innovative" Scenario

Year	GRP growth rate	Population	Production index in industry	Production index in processing industry	Index of volume of work in construction	Agricultural production index	Retail and gross sale turnover index	Index of volume of paid services to population	Index of real earnings of population	Commissioning of residential facilities	Commissioning of service sector facilities	Number of clinics and hospitals	Number of kindergartens and educational establishments	Railway transport cargo turnover	Pipeline transport turnover	Number of autos
	%	th. people	%	%	%	%	%	%	%	th. m2	th. m2	pieces	pieces	mln t/km	Mln m3/km	pieces
2007	107,7%	1379,5	108,1%	112,4%	97,7%	100,7%	106,5%	106,0%	107,2%	418,7	125,6	313	1413	10154	72503	333363
2008	107,8%	1370,4	101,6%	103,2%	139,0%	102,5%	113,0%	110,0%	110,5%	343,8	103,1	310	1403	10316	78137	351032
2009	90,1%	1357,9	80,0%	70,0%	94,0%	99,1%	101,5%	98,0%	99,3%	418,0	146,3	307	1390	8253	78919	372382
2010	103,4%	1348,5	102,7%	103,5%	108,1%	102,4%	102,3%	105,0%	100,4%	438,9	153,6	304	1380	8475	79708	381344
2011	105,4%	1340,7	104,6%	104,5%	106,2%	102,7%	103,9%	109,0%	102,8%	466,1	163,1	302	1372	8866	80505	395824
2012	105,8%	1333,8	107,0%	105,7%	108,0%	102,5%	104,9%	104,8%	104,0%	503,4	176,2	300	1364	9487	81310	412008
2013	108,2%	1325,8	110,2%	105,9%	110,0%	103,0%	107,6%	106,0%	106,6%	553,7	193,8	298	1355	10451	82123	435717
2014	105,5%	1317,9	104,4%	106,3%	111,6%	103,2%	106,9%	106,0%	106,8%	618,0	216,3	296	1346	10912	82945	452600
2015	105,7%	1318,2	104,6%	106,6%	112,2%	103,4%	106,8%	106,0%	106,9%	693,3	242,7	296	1346	11417	83774	470552
2016	105,6%	1313,7	104,6%	106,6%	111,8%	103,4%	106,6%	105,9%	106,8%	775,1	271,3	294	1341	11945	84612	489000
2017	105,5%	1309,3	104,6%	106,5%	110,8%	103,3%	106,5%	105,9%	106,7%	858,8	300,6	293	1336	12489	85458	507703
2018	105,3%	1304,8	104,3%	106,2%	110,2%	103,2%	106,3%	105,8%	106,5%	946,3	331,2	292	1331	13031	86312	526464
2019	105,2%	1300,4	104,3%	106,1%	110,2%	103,1%	106,2%	105,8%	106,4%	1042,8	365,0	291	1326	13589	87176	545632
2020	105,1%	1296,3	104,3%	106,1%	109,5%	103,1%	106,0%	105,7%	106,3%	1141,8	399,6	290	1321	14169	88047	565177

Source: CENef estimate

Table 5.4. Volumes of main goods production in “Innovative” scenario

Year	Electric energy production	Fibers and chemical threads	Paper and cardboard	Cloths	Meat (including 1 st category sub products)
	mln KWt-h	th.t	th.t	th. m2	th.t
2007	32660	6,4	53	118542	24
2008	32495	6,0	56	72927	28
2009	30220	6,2	54	14585	26
2010	30462	7,3	64	72927	27
2011	31951	11,5	65	74386	28
2012	35151	11,5	70	75873	29
2013	42228	11,5	77	77391	30
2014	42232	11,5	80	78939	31
2015	42236	11,5	84	80517	32
2016	42240	11,5	88	82128	33
2017	42244	12,2	92	83770	34
2018	42248	13,0	96	85446	35
2019	42252	13,7	100	87155	36
2020	42256	14,6	105	88898	37

Source: CENef estimate

Table 5.5. Production structure and energy intensity in electric and heat power industries in “Innovative” Scenario

Year	Electric energy production at existing thermal stations	Electric energy production at new stations	Electric energy production at nuclear stations	Electric energy production at hydro stations	Electric energy production at windmill stations	Heat production at new stations	Heat production at nuclear stations	Heat production at existing thermal stations	Specific fuel consumption for electric energy production at new stations	Specific fuel consumption for electric energy production at existing stations	Specific fuel consumption for heat production at new stations	Specific fuel consumption for heat production at existing stations	Boiler efficiency factor	Portion of losses in electric mains	Portion of losses in network	Portion of heat consumption for electric power stations' own needs
	mln KWt-h	mln KWt-h	mln KWt-h	mln KWt-h	mln KWt-h	th. GCal	th. GCal	th. GCal	g equiv. fuel/ KWt-h	g equiv. fuel/ KWt-h	kg equiv. fuel / GCal	kg equiv. fuel / GCal	%	%	%	%
2007	10006	0	22 648	6,73	0	0	539	3495	251,0	327,7	134,0	141,6	85,9%	15,5%	11,1%	0,3%
2008	9608	0	22 877	9,55	0	0	469	3397	251,0	327,0	134,0	141,6	90,5%	13,9%	13,4%	0,2%
2009	8069	0	22 142	9,55	0	0	454	3601	240,0	327,0	134,0	141,6	85,5%	16,4%	11,8%	0,2%
2010	8311	0	22 142	9,55	0	0	454	3601	240,0	327,0	134,0	141,6	85,5%	16,3%	11,7%	0,2%
2011	9608	189	22 142	11,55	0	0	454	3601	240,0	327,0	134,0	141,6	85,5%	16,2%	11,6%	0,2%
2012	10006	540	24 592	13,55	0	0	504	3601	240,0	327,0	134,0	141,6	85,5%	16,1%	11,5%	0,2%
2013	10081	540	31 592	15,55	0	0	648	3601	240,0	327,0	134,0	141,6	85,5%	16,0%	11,4%	0,2%
2014	10081	540	31 592	17,55	2	0	648	3601	240,0	327,0	134,0	141,6	85,5%	15,9%	11,3%	0,2%
2015	10081	540	31 592	19,55	4	0	648	3601	240,0	327,0	134,0	141,6	85,5%	15,8%	11,2%	0,2%
2016	10081	540	31 592	21,55	6	0	648	3601	240,0	327,0	134,0	141,6	85,5%	15,7%	11,1%	0,2%
2017	10081	540	31 592	23,55	8	0	648	3601	240,0	327,0	134,0	141,6	85,5%	15,6%	11,0%	0,2%
2018	10081	540	31 592	25,55	10	0	648	3601	240,0	327,0	134,0	141,6	85,5%	15,5%	10,9%	0,2%
2019	10081	540	31 592	27,55	12	0	648	3601	240,0	327,0	134,0	141,6	85,5%	15,4%	10,8%	0,2%
2020	10081	540	31 592	29,55	14	0	648	3601	240,0	327,0	134,0	141,6	85,5%	15,3%	10,7%	0,2%

Source: CENEf estimate

Table 5.6. Trend of energy intensity during equipment replacement process (without influence from price changes and machine loading) in “Innovative” Scenario

Year	Energy intensity reduction in fiber and threads production	Energy intensity reduction in paper and cardboard production	Energy intensity reduction in cloths production	Energy intensity reduction in meat production	Energy intensity reduction in other goods production	Energy intensity reduction in construction	Energy intensity reduction in railway transport	Energy intensity reduction in pipeline transport	Energy intensity reduction in other transport	Energy intensity reduction in agriculture	Energy intensity reduction in communal facilities	Energy intensity reduction in service sector	Energy intensity reduction in existing residential facilities	Specific energy consumption in new resid. facil. (in % to exist. housing stock)
	% per year	% per year	% per year	% per year	% per year	% per year	% per year	% per year	% per year	% per year	% per year	% per year	% per year	% per year
2007	-2,0%	-1,0%	2,0%	-1,0%	4,0%	-1,0%	2,0%	0,0%	1,0%	-10,0%	4,0%	0,0%	0,0%	-1,0%
2008	-2,0%	-1,0%	2,0%	-1,0%	4,0%	-1,0%	2,0%	0,0%	1,0%	-10,0%	4,0%	0,0%	0,0%	-1,0%
2009	-1,0%	-1,0%	1,0%	-1,0%	2,0%	0,0%	2,0%	0,0%	0,0%	-1,0%	2,0%	0,0%	0,0%	-1,0%
2010	-1,0%	-1,0%	1,0%	-1,0%	2,0%	0,0%	2,0%	0,0%	0,0%	-1,0%	2,0%	0,0%	0,0%	-1,0%
2011	-1,0%	-1,0%	1,0%	-1,0%	2,0%	0,0%	2,0%	0,0%	0,0%	-1,0%	2,0%	0,0%	0,0%	-1,0%
2012	-1,0%	-1,0%	1,0%	-1,0%	2,0%	0,0%	2,0%	0,0%	0,0%	-1,0%	2,0%	0,0%	0,0%	-1,0%
2013	-1,0%	-1,0%	1,0%	-1,0%	2,0%	0,0%	2,0%	0,0%	0,0%	-1,0%	2,0%	0,0%	0,0%	-1,0%
2014	-1,0%	-1,0%	1,0%	-1,0%	2,0%	0,0%	2,0%	0,0%	0,0%	-1,0%	2,0%	0,0%	0,0%	-1,0%
2015	-1,0%	-1,0%	1,0%	-1,0%	2,0%	0,0%	2,0%	0,0%	0,0%	-1,0%	2,0%	0,0%	0,0%	-1,0%
2016	-1,0%	-1,0%	1,0%	-1,0%	2,0%	0,0%	2,0%	0,0%	0,0%	-1,0%	2,0%	0,0%	0,0%	-1,0%
2017	-1,0%	-1,0%	1,0%	-1,0%	2,0%	0,0%	2,0%	0,0%	0,0%	-1,0%	2,0%	0,0%	0,0%	-1,0%
2018	-1,0%	-1,0%	1,0%	-1,0%	2,0%	0,0%	2,0%	0,0%	0,0%	-1,0%	2,0%	0,0%	0,0%	-1,0%
2019	-1,0%	-1,0%	1,0%	-1,0%	2,0%	0,0%	2,0%	0,0%	0,0%	-1,0%	2,0%	0,0%	0,0%	-1,0%
2020	-1,0%	-1,0%	1,0%	-1,0%	2,0%	0,0%	2,0%	0,0%	0,0%	-1,0%	2,0%	0,0%	0,0%	-1,0%

Source: CENef estimate

Table 5.7. Prices for power carriers in “Innovative” scenario

Year	Electric energy					Gas		Heat		Gasoline	Diesel oil	Fuel oil	Coal	Firewood
	Industry	Transport	Agriculture	Other	Population	Industry	Population	Industry	Population					
	Rub KWt/h	Rub KWt/h	Rub KWt/h	Rub KWt/h	Rub KWt/h	Rub/th.m ³	Rub/t	Rub/m ³	Rub/GCal					
2007	2,22	2,22	2,22	2,66	1,88	2356	2620	1016	1124	29689	26449	9717	1679	325
2008	2,70	2,70	2,70	3,24	2,35	2728	3346	1199	1326	29570	26343	9678	1811	324
2009	3,05	3,05	3,05	3,66	2,59	3454	4042	1319	1459	31344	27924	10259	2052	343
2010	3,54	3,54	3,54	4,25	2,84	3996	4882	1490	1649	34103	30381	11162	2213	373
2011	4,04	4,04	4,04	4,85	3,13	4600	5615	1639	1813	36899	32872	12077	2380	404
2012	4,37	4,37	4,37	5,25	3,72	5520	7018	1883	2084	39966	35604	13080	2618	437
2013	4,65	4,65	4,65	5,58	4,54	6099	8773	2074	2294	43247	38528	14155	2756	473
2014	4,93	4,93	4,93	5,92	5,06	6526	10545	2217	2452	46325	41270	15162	2852	507
2015	5,20	5,20	5,20	6,24	5,60	6702	10830	2334	2582	49385	43996	16163	2891	540
2016	5,46	5,46	5,46	6,55	6,14	6890	11133	2444	2704	53142	47342	17393	2931	582
2017	5,72	5,72	5,72	6,86	6,43	7055	11400	2554	2825	57306	51052	18756	2966	627
2018	5,97	5,97	5,97	7,17	6,72	7267	11742	2666	2950	61717	54982	20200	3011	675
2019	6,23	6,23	6,23	7,47	7,00	7565	12224	2781	3077	66424	59175	21740	3072	727
2020	2,22	2,22	2,22	2,66	1,88	2356	2620	1016	1124	29689	26449	9717	1679	325

Source: CENEf estimate

Table 5.8. Inflation parameters in “Innovative” scenario

Year	Price index (industrial goods production)	Price index (processing industry)	Price index (extraction industry)	Tariffs index (freight traffic)	Price index (construction production)	Price index (agriculture production)	Consumption prices index	Paid services price index
	%	%	%	%	%	%	%	%
2007	115,9%	117,7%	119,7%	103,8%	116,4%	131,6%	112,7%	112,2%
2008	110,7%	110,3%	123,7%	123,4%	122,9%	102,5%	113,2%	111,9%
2009	99,6%	102,0%	120,7%	122,4%	100,0%	100,0%	111,6%	113,4%
2010	106,0%	111,7%	111,7%	121,4%	118,4%	112,7%	110,0%	111,6%
2011	108,8%	111,4%	115,2%	120,4%	108,9%	107,7%	108,0%	110,6%
2012	108,2%	111,3%	112,5%	119,4%	113,3%	108,4%	107,0%	109,8%
2013	108,3%	111,0%	112,8%	118,4%	110,8%	110,9%	106,6%	109,9%
2014	108,2%	110,8%	111,6%	117,4%	111,8%	110,5%	106,2%	109,6%
2015	107,1%	110,6%	111,2%	116,4%	111,0%	107,5%	105,8%	109,4%
2016	106,6%	110,4%	110,4%	115,4%	111,1%	108,3%	105,4%	109,2%
2017	107,6%	110,2%	109,8%	114,4%	110,7%	109,4%	105,0%	109,0%
2018	107,8%	110,0%	109,1%	113,4%	110,6%	109,0%	104,6%	108,8%
2019	107,7%	109,8%	108,5%	112,4%	110,4%	109,2%	104,2%	108,6%
2020	107,6%	109,6%	107,8%	111,4%	110,2%	109,3%	103,8%	108,4%

Source: CENef estimate

5.4.2 PROJECTED ENERGY BALANCE

With the assumptions of “Innovative” scenario, GRP grows by 63% in 2008-2020, while primary energy consumption increases by 31% (see Fig. 4.2 and Table 4.9). GRP energy intensity in 2007-2020 decreases by 28%. This is lower than the target value for Russia. Partially, slow reduction of energy intensity depends on the increase of energy production at nuclear power stations, which is required to meet the needs of other regions. Electricity intensity of GRP in 2007-2020 decreases by 37%.

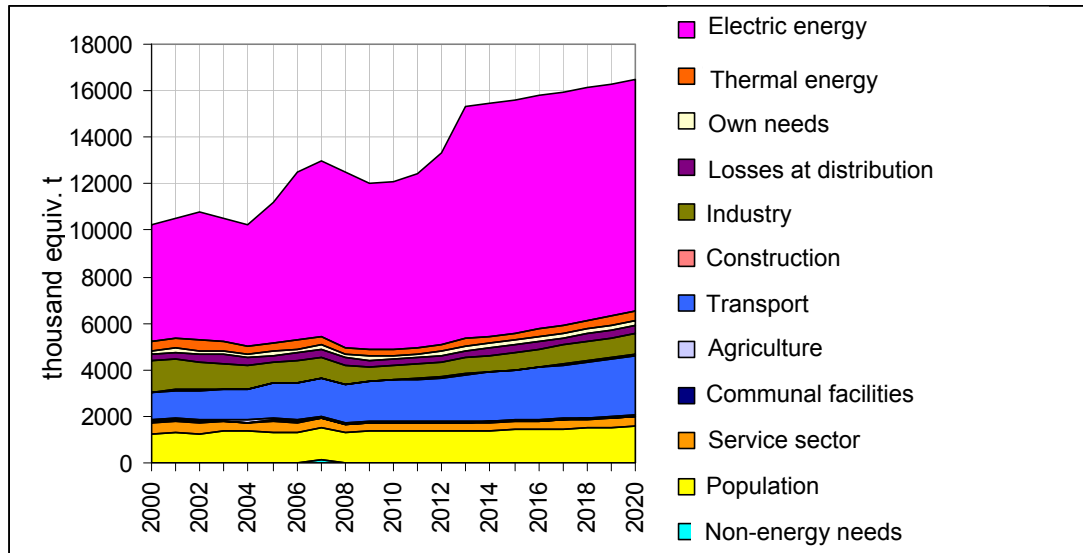


Fig. 5.2. Electric energy consumption main indicators trend in “Innovative” scenario

The usage of primary energy for production of electric energy is the main factor of energy demand increment. Transport follows the way. Tver region continues to be power excessive region till 2020. According to this scenario, electric energy export out of the region grows from 27 bln KWT-h in 2008 up to 34 bln KWT-h in 2020.

Since the lion share of electric energy production increase takes place due to production at nuclear power station, organic fuel consumption grows slower than primary energy consumption, i.e., by 18,6% in 2008 -2020 (see Fig. 4.3). Fuel consumption at transport grows by 879 thousand equivalent tons, with the total of fuel consumption growth by 1295 thousand equivalent tons. That means the portion of transport takes two thirds of fuel consumption increase.

Table 5.9. Structure of energy consumption by sectors in "Innovative" scenario (thousand equiv. tons)

Year	Losses in electric energy production	Losses in heat production	Auxiliaries	Losses in distribution	Industry	Construction	Transport	Agriculture	Communal facilities	Service sector	Population	Non-energy needs
2005	6036,9	356,5	193,5	285,6	905,5	13,4	1517,8	70,9	30,1	512,1	1291,6	8,9
2006	7155,4	436,5	176,6	329,5	955,3	14,1	1570,8	85,2	27,3	401,3	1316,2	8,6
2007	7533,3	346,2	204,0	322,8	913,3	13,4	1624,6	58,5	21,8	433,2	1347,3	142,6
2008	7510,1	271,9	160,9	314,7	863,6	18,8	1646,1	44,9	17,3	310,2	1309,6	5,8
2009	7174,9	268,4	149,3	277,0	624,7	18,6	1738,9	44,3	17,7	324,3	1380,6	4,1
2010	7224,3	266,2	150,5	274,4	612,0	18,5	1776,6	43,9	17,4	325,1	1377,3	4,2
2011	7511,1	267,4	157,7	277,0	628,1	18,5	1837,2	44,0	17,1	327,1	1374,9	4,4
2012	8245,0	282,5	173,3	280,8	645,8	18,5	1906,2	43,8	16,8	328,6	1372,9	4,7
2013	10008,1	326,6	207,8	293,8	677,3	19,3	2009,2	44,4	16,8	335,9	1392,7	4,9
2014	10008,1	330,9	207,9	300,1	704,9	21,6	2080,1	44,9	16,7	342,8	1397,5	5,3
2015	10008,1	336,8	207,9	305,6	737,2	24,3	2155,5	45,5	16,8	352,0	1408,9	5,6
2016	10008,1	343,7	208,0	313,6	772,5	27,2	2233,4	46,1	16,9	362,8	1429,4	6,0
2017	10008,1	351,4	208,1	321,3	811,3	30,3	2312,7	46,8	17,0	375,4	1457,1	6,4
2018	10008,1	358,7	208,2	329,7	848,3	33,5	2391,7	47,3	17,0	388,7	1485,4	6,8
2019	10008,1	366,2	208,3	338,8	886,4	37,0	2472,5	47,9	17,1	403,3	1517,2	7,2
2020	10008,1	373,9	208,4	348,7	926,3	40,7	2555,0	48,5	17,2	419,3	1551,8	7,6

Source: CENEf estimate

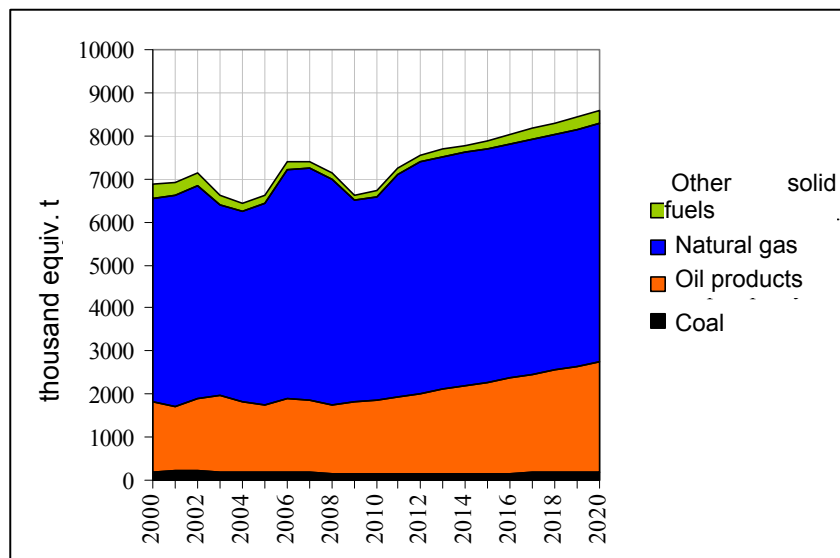


Fig. 5.3. Electric energy final consumption trend in "Innovative" scenario

5.4.3 GHG EMISSIONS TREND

GHG emissions trend in Tver region is defined, mostly, by CO₂ emissions. The portion of CH₄ and N₂O in the total emission is relatively small. The CH₄ share increases by 927 thousand equiv. t. CO₂, if emissions from cross-country gas pipelines passing through the territory of Tver region are incorporated into the total of the region. This volume was not accounted for in current research.

According to Kyoto protocol, the year of 1990 is taken as the reference year for Russia in general for GHG emissions trend estimate.¹⁵ According to CENef estimate dated 2000, in 1990 CO₂ emissions in Tver region related to fuel consumption, extraction and transportation accounted for 17,77 mln t. In 1997 the emissions reduced to 14,1 mln t.¹⁶ In 2000 the emissions were equal to 12,64 mln t, in 2007 – 13,27 mln t, in 2008 – 12,95 mln t, which is 27% lower than the level of 1990 (see Fig. 4.4).

Reduction of electric energy production at thermal power stations in 2008 resulted in the decrease of total emissions by 2%. According to CENef estimate, in 2009 emissions will be 9% lower than the level of 2007 and 31% lower than the level of 1990.

For the period of 2008-2012, accumulated unsold quotas (balance between the level of emissions in 1990 for five years and actual total GHG emissions over the period) in Tver region will be equal to 24,9 mln equiv. t CO₂.

¹⁵ Methodology of emission estimate for 1990 was slightly different from the methodology used by Bashmakov I.A., Dzedzich M.G., Lunin A. A., Lebedev O.V. Anthropogenic GHG emissions inventory for Rostov, Sverdlovsk and Tver regions (Energy sector). CENef. «Promoting Investments in Energy Efficiency Projects in Russia's regions» project. M., 2009. However, the differences are not great and the results are comparable.

¹⁶ CENef. Multi-regional project to develop monitoring and reporting capacity for multiple greenhouse gases in Russia. Implemented under the contract with PNNL. 2000.

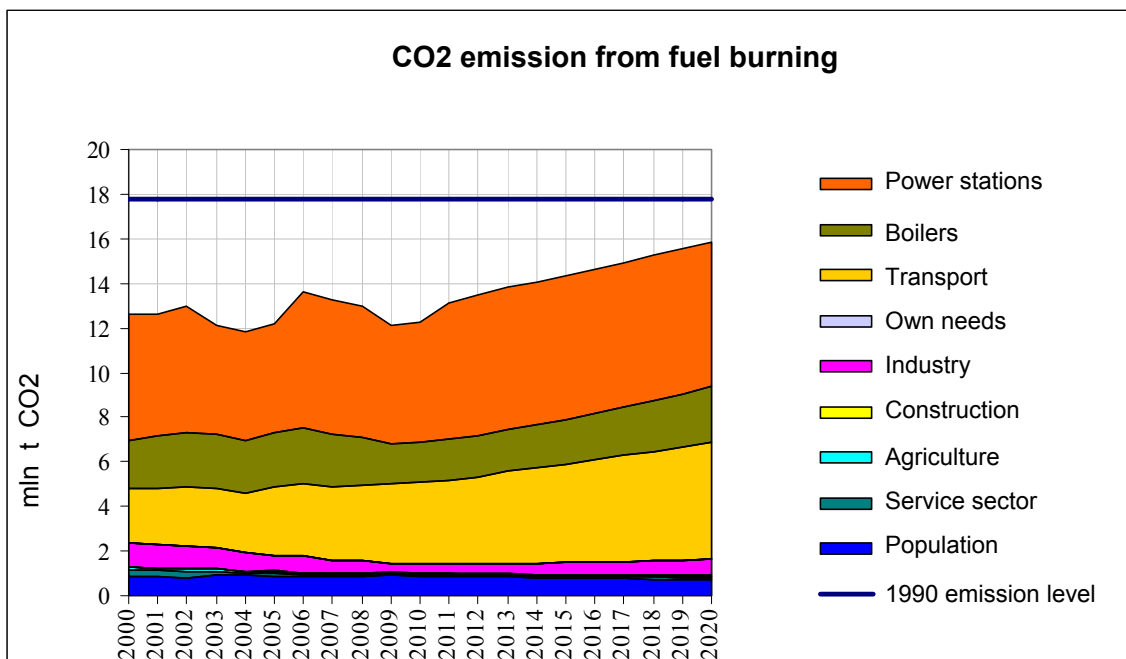


Fig. 5.4. CO₂ emission trend by sectors of economy in “Innovative” scenario

According to this scenario, GHG emissions by 2020 will still be 13% lower than the level of 1990, while accumulated unsold quotas in 2008-2020 will constitute 48,6 mln equiv. t CO₂, which is 3 times as much as annual emission in 2020 (see Fig. 5.5).

The main increment of emissions is produced by transport, i. e., 74% of the total increase in 2007-2020. Emission control in this sector is particularly difficult. Electric energy production is the second biggest contributor to emissions increase.

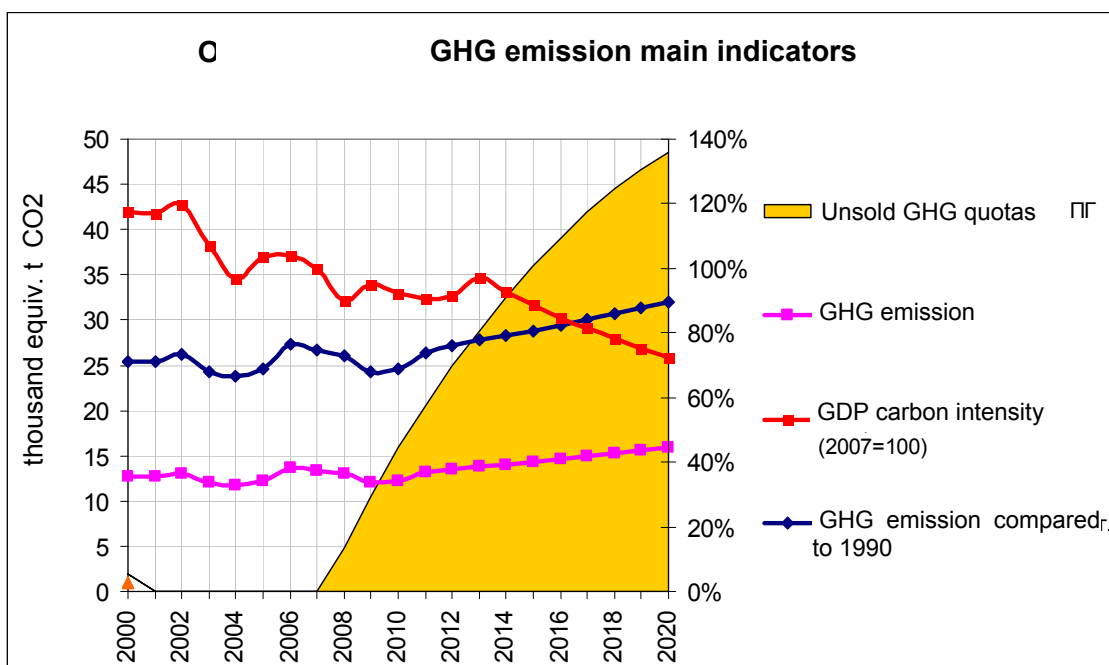


Fig. 5.5. GHG emission main indicators trend in “Innovative” scenario

Therefore, in this scenario:

- It will not be possible to stop GHG emission growth by 2020. Annual GHG emissions keep growing after 2009, but in 2020 they maintain at the level 11% lower than the level of 1990;
- Average annual GHG emissions in 2008-2012 are 28% lower than the level of 1990;
- Accumulated unsold quotas for GHG emissions in 2008-2012 are equal to 24,9 mln equiv. t CO₂;
- Average annual GHG emissions in 2013-2020 are 17% lower than the level of 1990;
- Accumulated unsold quotas for GHG emissions in 2013-2020 are equal to 23,7 mln equiv. t CO₂.

According to this scenario, Tver region can take obligations which are just a bit less ambitious than those by European Union:

- Maintain annual GHG emissions in 2013-2020 at the level 17% lower than the level of 1990.

If in the post-Kyoto period we take into consideration accumulated unsold quotas for GHG emission in 2008-2012 (on the average, 3,35 mln equiv. t CO₂ per year in 2013-2020), Tver region could take the obligation to keep annual GHG emissions in 2013-2020 at 37% lower than the level of 1990. (This is just an assumption, since quotas for regions were not defined).

5.5 “Innovative” scenario with rapid energy efficiency growth

5.5.1 CONCEPT

This modification of “Innovative” scenario keeps all the conditions of the previous scenario but assumes the hypothesis about rapid energy efficiency increase (see Tables 4.10 and 4.11). This hypothesis in many aspects is based on the estimates of both current energy efficiency level and on CENef estimates of energy efficiency growth potential.¹⁷

This scenario also assumes that in 2015-2020 equipment at 8 power supply units of Konakovskaya state district power station will be replaced by six PGU-400 with efficiency factor of 58%. One PGU will be commissioned each year in the period 2015-2020.

5.5.2 PROJECTED ENERGY BALANCE

With the assumptions of this scenario, GRP in 2008-2020 grows by 63%, while primary energy consumption grows by 16% only (see Fig. 4.6). GRP energy intensity in 2007-2020 decreases by 36%, which is just a bit lower than the target value for Russia. Like in the previous scenario, slow reduction of energy intensity depends on the growth of electric energy production at nuclear power plant. And this energy is used to cover the needs of other regions, mostly.

¹⁷ See Bashmakov I.A., Dzedzichuk M.G., Lunin A. A., Lebedev O.V. Features and indicators of energy efficiency in Rostov, Tver and Sverdlovsk regions. CENef. «Promoting Investments in Energy Efficiency Projects in Russia’s regions» project. M., 2009.; Bashmakov I.A., Dzedzichuk M.G., Lunin A. A., Lebedev O.V. Energy efficiency growth potential in Rostov, Sverdlovsk and Tver regions. CENef. «Promoting Investments in Energy Efficiency Projects in Russia’s regions» project. M., 2009.

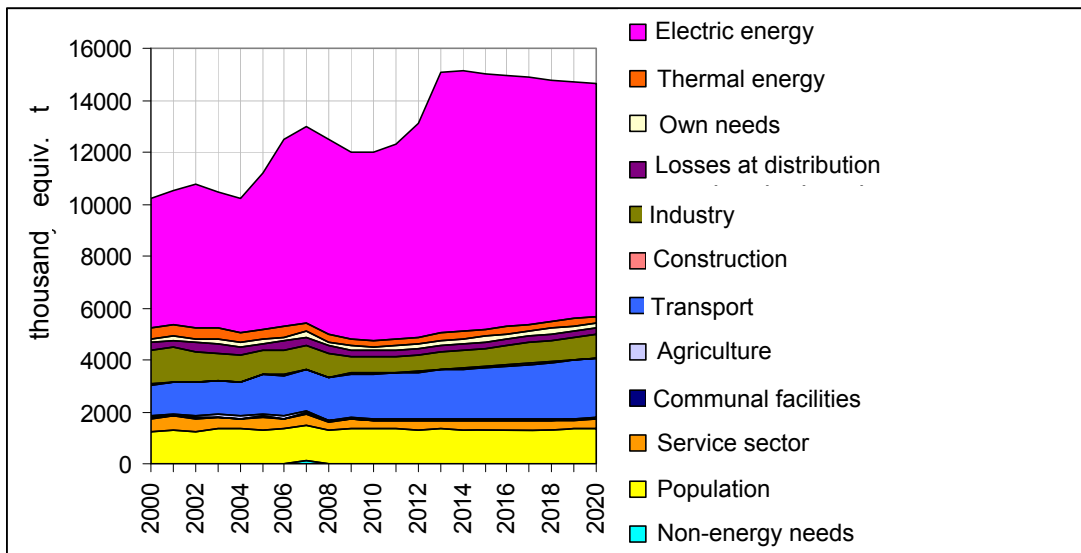


Fig. 5.6. Electric energy consumption main indicators trend in “Innovative” scenario

Organic fuel consumption grows slowly as the economy recovers, but later after energy efficiency increase effect is achieved in all sectors of economy and at Konakovskaya state district power station in particular, it starts decreasing in absolute numbers starting 2015. (see Fig. 5.7).

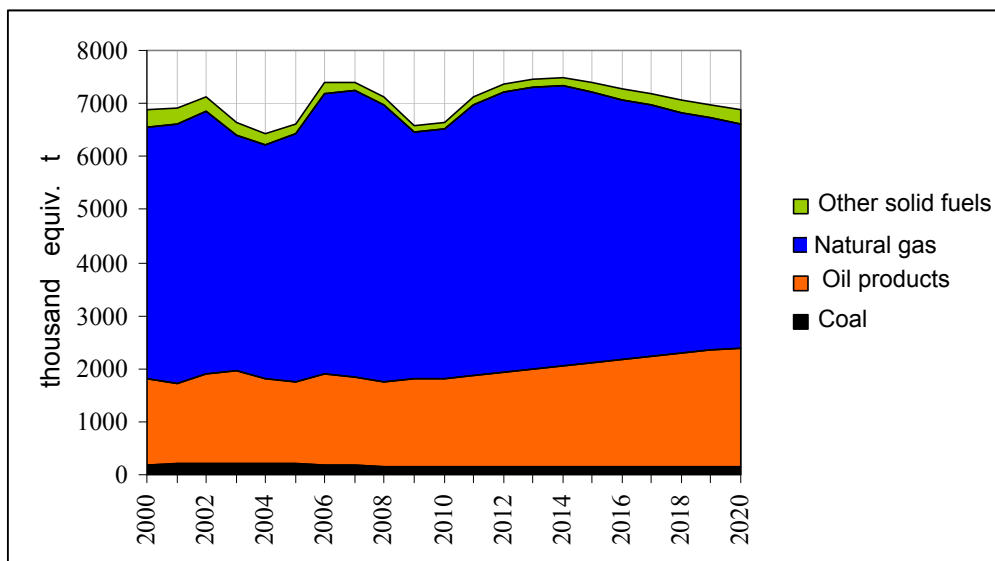


Fig.5.7. Electric energy final consumption trend in “Innovative” scenario

5.5.3 GHG EMISSION TREND

In this case GHG emission trend and GHG emission main indicators trend change considerably and looks different than in “Innovative” development scenario (see Fig. 5.8 and 5.9 and Table 5.12). GHG emissions reach the peak in 2014 (13,51 mln equiv. t CO₂) and then start steadily decreasing down to the level of 12,80 mln equiv. t CO₂ in 2020.

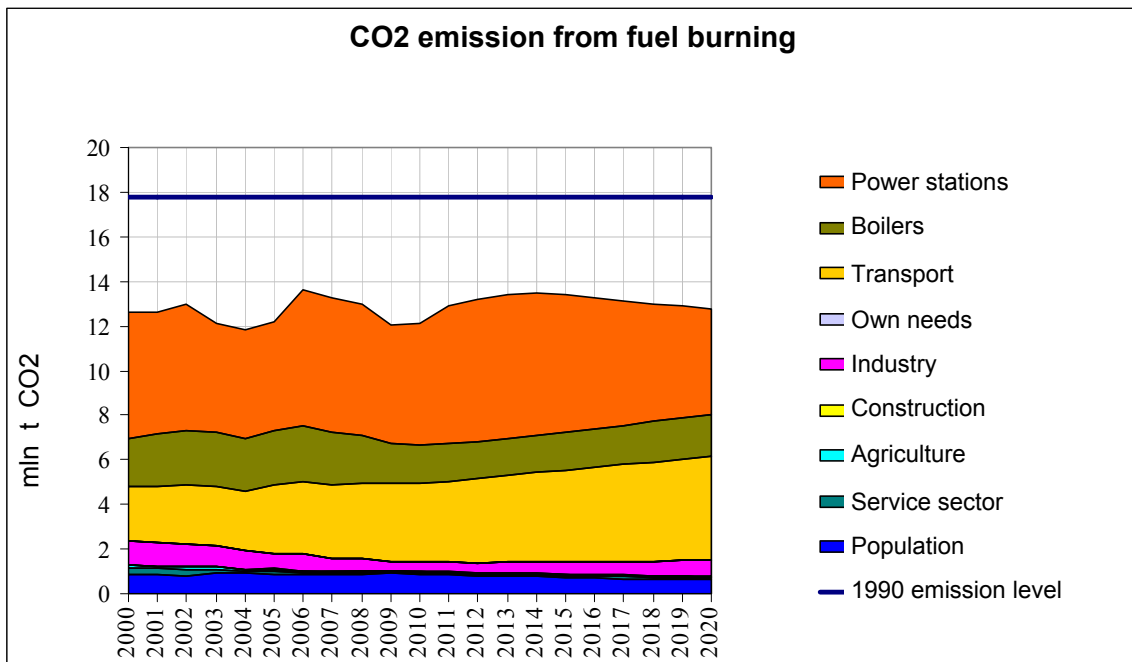


Fig. 5.8. CO₂ emission trend by sectors of economy in “Innovative” scenario + rapid energy efficiency increase

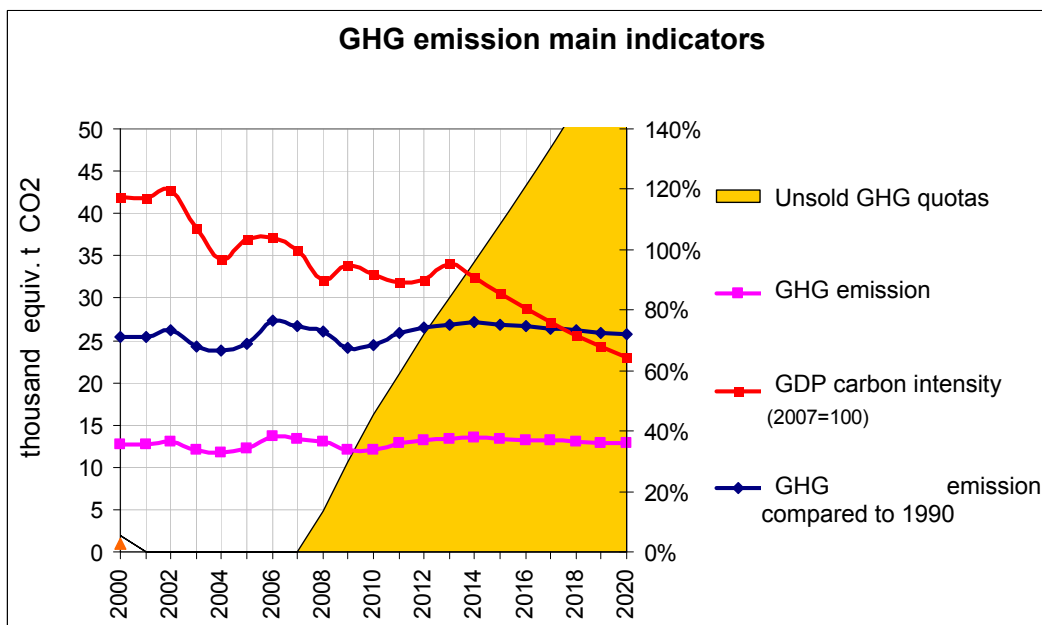


Fig. 5.9. GHG emission main indicators trend in “Innovative” scenario + rapid energy efficiency increase

In this scenario:

- Annual GHG emissions grow after 2009 (till 2014), and then decrease by 2020 and stay at the level 28% lower than the level of 1990;
- Average annual GHG emissions in 2008-2012 are 29% lower than the level of 1990;
- Accumulated unsold quotas for GHG emissions in 2008-2012 equal 25,7 mln equiv. t CO₂;
- Average annual GHG emissions in 2013-2020 are 26% lower than the level of 1990;

- Accumulated unsold quotas for GHG emissions in 2013-2020 equal 36,7 mln equiv. t CO₂.

According to this scenario, Tver region can take the obligation to keep average annual GHG emissions in 2013-2020 at 26% lower than the level of 1990.

Table 5.10. Trend of energy intensity during equipment replacement process (without influence from price changes and machine loading) in “Innovative” Scenario + Energy Efficiency

Year	Energy intensity reduction in fiber and threads production	Energy intensity reduction in paper and cardboard production	Energy intensity reduction in cloths production	Energy intensity reduction in meat production	Energy intensity reduction in other goods production	Energy intensity reduction in construction	Energy intensity reduction in railway transport	Energy intensity reduction in pipeline transport	Energy intensity reduction in auto transport	Energy intensity reduction in other transport	Energy intensity reduction in agriculture	Energy intensity reduction in communal facilities	Energy intensity reduction in service sector	Energy intensity reduction in existing residential facilities	Specific energy consumption in new resid. facil. (in % to exist. housing stock)
	% per year	% per year	% per year	% per year	% per year	% per year	% per year	% per year	% per year	% per year	% per year	% per year	% per year	% per year	%
2007	-2,0%	-1,0%	2,0%	-1,0%	4,0%	-1,0%	2,0%	0,0%	1,0%	-10,0%	4,0%	0,0%	0,0%	-1,0%	80%
2008	-2,0%	-1,0%	2,0%	-1,0%	4,0%	-1,0%	2,0%	0,0%	1,0%	-10,0%	4,0%	0,0%	0,0%	-1,0%	80%
2009	2,0%	2,0%	2,0%	2,0%	2,0%	0,0%	2,0%	1,0%	1,0%	1,0%	2,0%	1,0%	1,0%	1,0%	80%
2010	2,0%	2,0%	2,0%	2,0%	2,0%	0,0%	2,0%	1,0%	1,0%	1,0%	2,0%	1,0%	1,0%	1,0%	80%
2011	2,0%	2,0%	2,0%	2,0%	2,0%	0,0%	2,0%	1,0%	1,0%	1,0%	2,0%	1,0%	1,0%	1,0%	68%
2012	2,0%	2,0%	2,0%	2,0%	2,0%	0,0%	2,0%	1,0%	1,0%	1,0%	2,0%	1,0%	1,0%	1,0%	68%
2013	2,0%	2,0%	2,0%	2,0%	2,0%	0,0%	2,0%	1,0%	1,0%	1,0%	2,0%	1,0%	1,0%	1,0%	68%
2014	2,0%	2,0%	2,0%	2,0%	2,0%	0,0%	2,0%	1,0%	1,0%	1,0%	2,0%	1,0%	1,0%	1,0%	68%
2015	2,0%	2,0%	2,0%	2,0%	2,0%	0,0%	2,0%	1,0%	1,0%	1,0%	2,0%	1,0%	1,0%	1,0%	58%
2016	2,0%	2,0%	2,0%	2,0%	2,0%	0,0%	2,0%	1,0%	1,0%	1,0%	2,0%	1,0%	1,0%	1,0%	58%
2017	2,0%	2,0%	2,0%	2,0%	2,0%	0,0%	2,0%	1,0%	1,0%	1,0%	2,0%	1,0%	1,0%	1,0%	58%
2018	2,0%	2,0%	2,0%	2,0%	2,0%	0,0%	2,0%	1,0%	1,0%	1,0%	2,0%	1,0%	1,0%	1,0%	58%
2019	2,0%	2,0%	2,0%	2,0%	2,0%	0,0%	2,0%	1,0%	1,0%	1,0%	2,0%	1,0%	1,0%	1,0%	58%
2020	2,0%	2,0%	2,0%	2,0%	2,0%	0,0%	2,0%	1,0%	1,0%	1,0%	2,0%	1,0%	1,0%	1,0%	52%

Source: CENEf estimate

Table 5.11. Production structure and energy intensity in electric and heat power industries in “Innovative” scenario + energy efficiency

Year	Electric energy production at existing thermal stations	Electric energy production at new stations	Electric energy production at nuclear stations	Electric energy production at hydro stations	Electric energy production at windmills	Heat production at new stations	Heat production at nuclear stations	Heat production at existing thermal stations	Specific fuel consumption for electric production at new stations	Specific fuel consumption for electric production at existing stations	Specific fuel consumption for heat production at new stations	Specific fuel consumption for heat production at existing stations	Boiler efficiency factor	Portion of losses in electric mains	Portion of losses in heat network	Portion of heat consumption for electric power stations' own needs
	mln KWt-h	mln KWt-h	mln KWt-h	mln KWt-h	mln KWt-h	th. GCal	th. GCal	th. GCal	g equiv. fuel/ KWt-h	g equiv. fuel/ KWt-h	kg equiv. fuel / GCal	kg equiv. fuel / GCal	%	%	%	
2007	10006	0	22 648	6,73	0	0	539	3495	251,0	327,7	134,0	141,6	85,9%	15,5%	11,1%	0,3%
2008	9608	0	22 877	9,55	0	0	469	3397	251,0	327,0	134,0	141,6	90,5%	13,9%	13,4%	0,2%
2009	8069	0	22 142	9,55	0	0	454	3601	240,0	327,0	134,0	141,6	85,5%	15,5%	11,8%	0,2%
2010	8311	0	22 142	9,55	0	0	454	3601	240,0	327,0	134,0	141,6	86,0%	14,7%	11,5%	0,2%
2011	9608	189	22 142	11,55	0	0	454	3601	240,0	327,0	134,0	141,6	86,5%	13,9%	11,2%	0,2%
2012	10006	540	24 592	13,55	0	0	504	3601	240,0	327,0	134,0	141,6	87,0%	13,5%	10,9%	0,2%
2013	10081	540	31 592	15,55	0	0	648	3601	240,0	327,0	134,0	141,6	87,5%	13,4%	10,6%	0,2%
2014	10081	540	31 592	17,55	2	0	648	3601	240,0	327,0	134,0	141,6	88,0%	12,9%	10,3%	0,2%
2015	10081	540	31 592	19,55	4	0	648	3601	240,0	310,7	134,0	141,6	88,5%	12,4%	10,0%	0,2%
2016	10081	540	31 592	21,55	6	0	648	3601	240,0	292,3	134,0	141,6	89,0%	12,0%	9,7%	0,2%
2017	10081	540	31 592	23,55	8	0	648	3601	240,0	276,0	134,0	141,6	89,5%	11,7%	9,4%	0,2%
2018	10081	540	31 592	25,55	10	0	648	3601	240,0	257,6	134,0	141,6	90,0%	11,3%	9,1%	0,2%
2019	10081	540	31 592	27,55	12	0	648	3601	240,0	241,3	134,0	141,6	90,5%	10,9%	8,8%	0,2%
2020	10081	540	31 592	29,55	14	0	648	3601	240,0	225,0	134,0	141,6	90,5%	10,5%	8,5%	0,2%

Source: CENef estimate

Table 5.12. Energy consumption structure by sectors in “Innovative” scenario + energy efficiency (thousand equiv. tons)

Year	Losses in electric energy production	Losses in heat production	Auxiliaries	Losses in distribution	Industry	Construction	Transport	Agriculture	Communal facilities	Service sector	Population	Non-energy needs
2005	6036,9	356,5	193,5	285,6	905,5	13,4	1517,8	70,9	30,1	512,1	1291,6	8,9
2006	7155,4	436,5	176,6	329,5	955,3	14,1	1570,8	85,2	27,3	401,3	1316,2	8,6
2007	7533,3	346,2	204,0	322,8	913,3	13,4	1624,6	58,5	21,8	433,2	1347,3	142,6
2008	7510,1	271,9	160,9	314,7	863,6	18,8	1646,1	44,9	17,3	310,2	1309,6	5,8
2009	7174,9	266,6	149,3	268,1	623,2	18,6	1722,0	44,3	17,5	321,1	1367,6	4,1
2010	7224,3	256,4	150,4	255,0	608,6	18,5	1742,1	43,9	17,1	318,7	1350,7	4,2
2011	7511,1	249,6	157,7	246,5	622,6	18,5	1783,8	44,0	16,6	317,4	1332,8	4,4
2012	8245,0	256,9	173,2	242,3	638,6	18,5	1832,8	43,8	16,2	315,7	1315,5	4,7
2013	10008,1	292,9	207,7	247,9	667,9	19,3	1913,0	44,4	16,0	319,6	1319,2	4,9
2014	10008,1	288,8	207,7	243,9	693,5	21,6	1961,1	44,9	15,8	322,8	1308,0	5,3
2015	9843,6	285,5	207,8	239,6	723,6	24,3	2012,3	45,5	15,7	328,2	1300,6	5,6
2016	9658,5	282,6	207,8	237,6	756,5	27,2	2064,4	46,1	15,6	335,0	1300,9	6,0
2017	9494,0	279,9	207,9	235,1	792,6	30,3	2116,6	46,8	15,5	343,2	1307,0	6,4
2018	9309,0	276,5	207,9	232,0	826,7	33,5	2167,3	47,3	15,4	351,8	1312,7	6,8
2019	9144,4	272,9	208,0	229,1	861,6	37,0	2218,2	47,9	15,3	361,5	1320,5	7,2
2020	8979,9	274,4	208,0	226,3	898,1	40,7	2269,4	48,5	15,2	372,0	1327,7	7,6

Source: CENEf estimate

5.6 “Inert” scenario

5.6.1 CONCEPT

In this scenario growth rates of macroeconomic indicators from “Inert” scenario by Ministry of Economic Development were used for the period after 2012, while data from conservative scenario by Ministry of Economic Development were used before 2012. The scenario assumes stagnation of Russian and Tver region economies due to compression of state demand as state anti-crisis programs terminate, stagnation of bank crediting and low level of investment into infrastructure branches.

Change rates of the greater part of macroeconomic indicators of this scenario for 2010-2012 are close to the rates factored in Ministry of Economic Development estimate for conservative scenario.

It is supposed that the main part of industrial investment project planned for implementation will be implemented but with an even bigger delay than in “Innovative” scenario.

As for the leading regional branch of industry, which is electric energy generation, it is supposed that a slow demand for electric energy in Russia will lead to delay and curtailing of investment programs implementation.¹⁸ The “Inert” scenario assumes that in 2012 PGU-210 will be commissioned at Tver thermal power station-3 and power generation unit #4 at Kalininskaya nuclear power station in 2012. In this case the net balance of electric energy transmission out of the region will grow from 27 bln KWh in 2008 to 34 bln KWh in 2020. All other generation development projects will be implemented only after 2020.

CENEF created an “Inert” scenario of ENERGYBAL-TVER model main control variables trend for 2010 -2020 on the basis of all these assumptions (see Tables 4.13-4.15).

5.6.2 PROJECTED ENERGY BALANCE

With the GRP growth by 29% in 2008-2020, primary energy consumption increases by 23% (see Fig. 5.10 and Table 5.16) due to electric energy production (81% of the growth in 2008-2020) and transport (18% of the growth in 2008-2020). The growth in electric energy production is the result of commissioning of power generation unit #4 at Kalininskaya nuclear power station. The main part electric energy produced at this unit will be exported out of the region.

¹⁸ According to CENEF estimate, electric energy consumption in Russia will reach the level of 2008 not earlier than 2014-2016. In the estimate by Ministry of Economic Development electric energy consumption does not reach the level of 2008 till 2012.

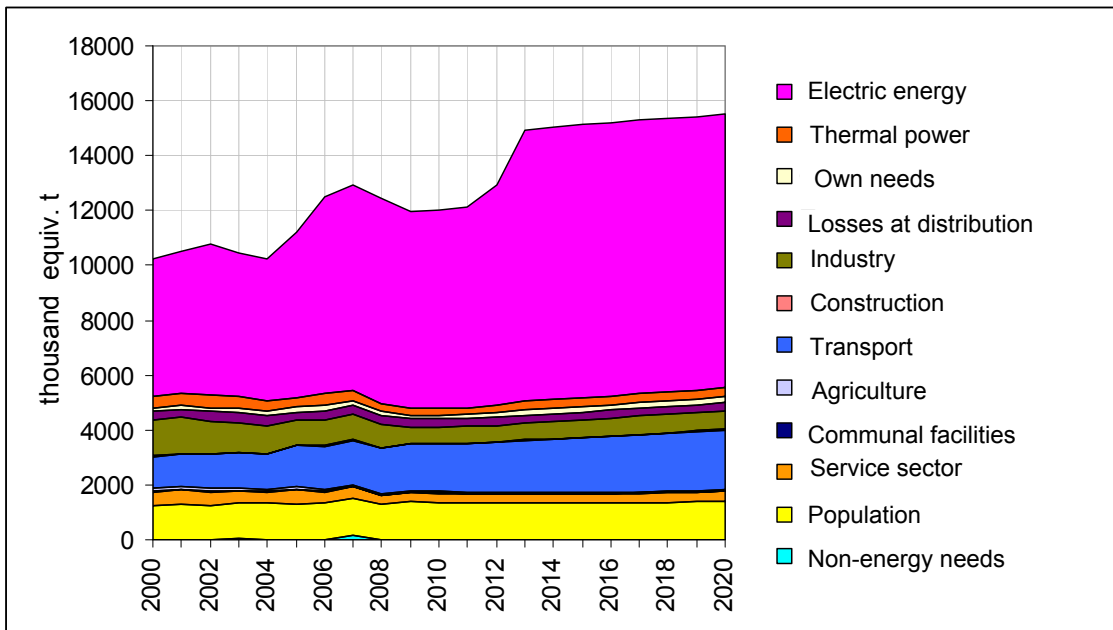


Fig. 5.10. Energy consumption trend in various sectors of economy in “Innovative” scenario

Fuel consumption increases by 8%, and organic fuel consumption grows by 6% (see Fig. 5.11).

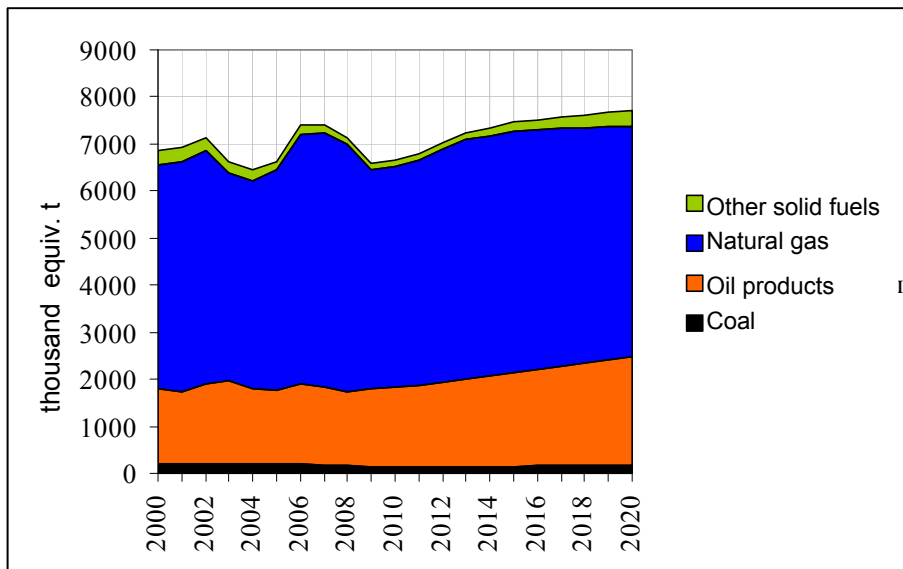


Fig. 5.11. Fuel consumption trend in “Inert” scenario

5.6.3 GHG EMISSION TREND

According to this scenario GHG emissions grow up to 14,39 mln equiv. t CO₂ by 2020, which is 11% more than the level of 2008, but still 19% lower than the level of 1990 (see Fig. 4.12).

Accumulated unsold quotas in 2008-2020 will constitute 58,73 mln equiv. t. CO₂, which is 3 times as much as annual emission in 2020.

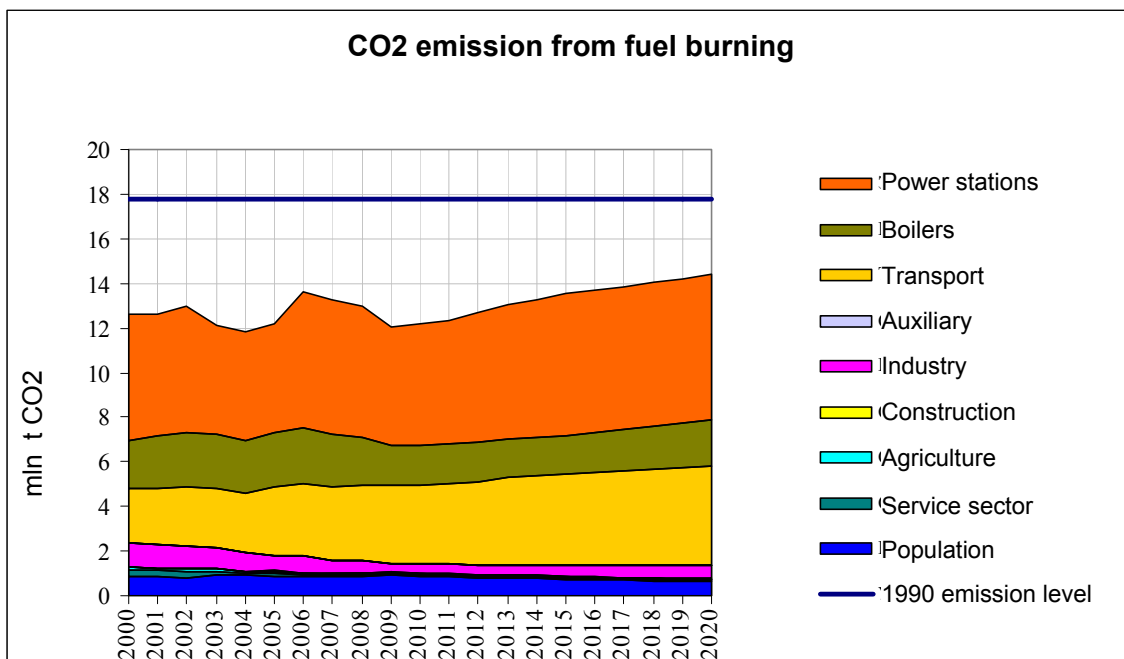


Fig. 5.12. CO₂ emission trend by sectors of economy in “Innovative” scenario

Accumulated unsold quotas in 2008-2012 (balance between emissions at 1990 level for 5 years and actual total GHG emissions for the indicated period) in Tver region will equal 26,7 mln equiv. t CO₂ (see Fig. 4.13). The main portion of emission increase takes place at transport and electric energy production.

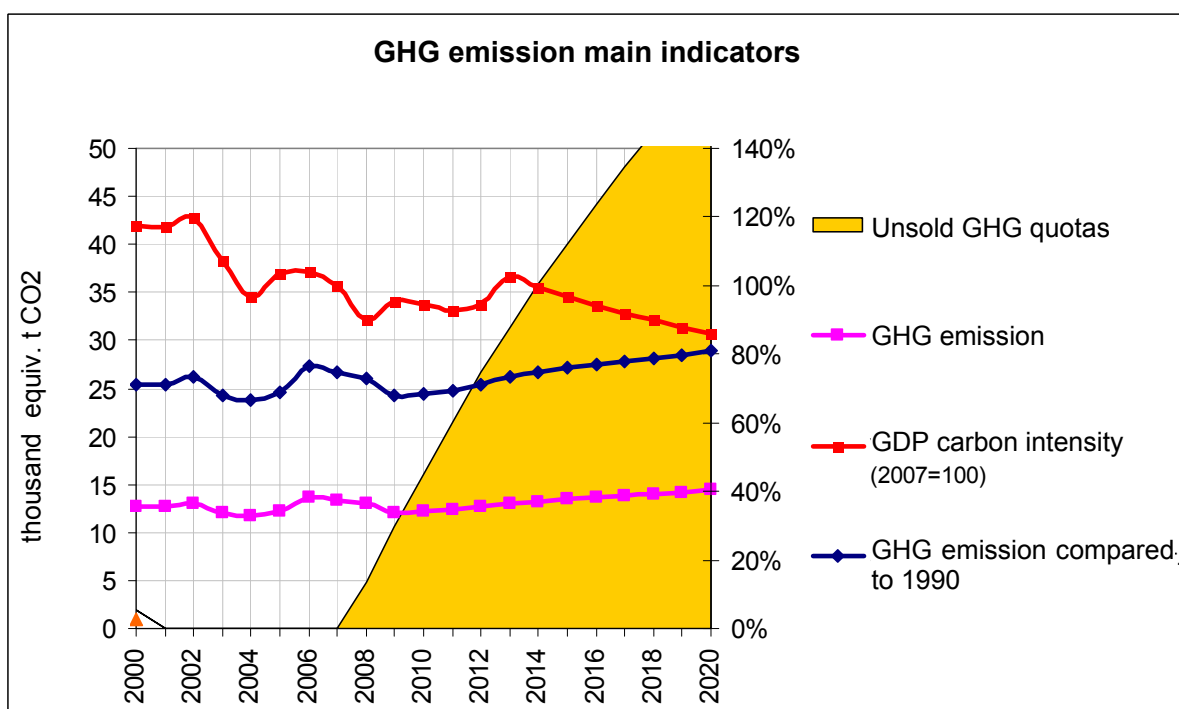


Fig. 5.13. GHG emission main indicators trend in “Innovative” scenario

In this scenario:

- Annual GHG emissions grow after 2009, but in 2020 they stay at the level 19% lower than the level of 1990;

- Average annual GHG emissions in 2008-2012 are 30% lower than the level of 1990;
- Accumulated unsold quotas for GHG emissions in 2008-2012 equal 26,7 mln equiv. t CO₂;
- Average annual GHG emissions in 2013-2020 are 22,6% lower than the level of 1990;
- Accumulated unsold quotas for GHG emissions in 2013-2020 equal 32,1 mln equiv. t CO₂.

According to this scenario Tver region can take the obligation to keep average annual GHG emissions in 2013-2020 at 20% lower than the level of 1990.

Table 5.13. Main macroeconomic assumptions in "Inert" scenario

Year	GRP growth rate	Population	Production index in industry	Production index in processing industry	Index of volume of work in construction	Agricultural production index	Retail and gross sale turnover index	Index of volume of paid services to population	Index of real earnings of population	Commissioning of residential facilities	Commissioning of service sector facilities	Number of clinics and hospitals	Number of kindergartens and educational establishments	Railway transport cargo turnover	Pipeline transport turnover	Number of autos
	%	th. people	%	%	%	%	%	%	%	th. m2	th. m2	pieces	pieces	mln t/km	Mln m3/km	pieces
2007	107,7%	1379,5	108,1%	112,4%	97,7%	100,7%	106,5%	106,0%	107,2%	125,6	313	1413	10154	72503	333363	125,6
2008	107,8%	1370,4	101,6%	103,2%	139,0%	102,5%	113,0%	110,0%	110,5%	103,1	310	1403	10316	78137	351032	103,1
2009	89,5%	1357,9	80,0%	70,0%	94,0%	99,1%	98,0%	98,0%	99,3%	140,0	307	1390	8253	70324	372382	140,0
2010	101,3%	1348,5	101,6%	101,9%	100,0%	100,4%	100,4%	102,0%	100,4%	147,0	304	1380	8383	72433	375717	147,0
2011	102,6%	1340,7	102,2%	102,5%	103,6%	102,0%	101,6%	104,0%	102,8%	152,3	302	1372	8566	74606	382447	152,3
2012	105,0%	1333,8	105,9%	104,0%	108,6%	101,6%	103,0%	104,8%	104,0%	165,4	300	1364	9074	76845	395786	165,4
2013	106,6%	1325,8	108,5%	102,7%	106,3%	103,0%	105,9%	104,5%	103,8%	175,8	298	1355	9841	79150	414004	175,8
2014	103,6%	1317,9	102,3%	103,1%	106,1%	103,2%	105,4%	104,3%	104,3%	186,5	296	1346	10068	79941	424358	186,5
2015	103,5%	1318,2	102,7%	103,5%	106,1%	103,4%	104,8%	103,8%	104,6%	197,9	296	1346	10336	80741	434899	197,9
2016	103,2%	1313,7	102,2%	103,1%	105,6%	103,4%	104,6%	103,6%	104,2%	209,1	294	1341	10561	81548	444700	209,1
2017	103,0%	1309,3	102,0%	102,9%	105,2%	103,3%	104,3%	103,5%	103,8%	219,9	293	1336	10777	82364	454183	219,9
2018	102,8%	1304,8	101,7%	102,4%	104,7%	103,2%	104,1%	103,3%	103,7%	230,3	292	1331	10959	83187	462988	230,3
2019	102,6%	1300,4	101,6%	102,2%	104,3%	103,1%	103,8%	103,2%	103,5%	240,1	291	1326	11130	84019	471404	240,1
2020	102,9%	1296,3	102,5%	103,5%	103,8%	103,1%	103,6%	103,0%	103,4%	249,3	290	1321	11403	84860	480995	249,3

Source: CENef estimate

Table 5.14. Volumes of main goods production in "Inert" scenario

Year	Electric energy production	Fibers and chemical threads	Paper and cardboard	Cloths	Meat (including 1 st category sub products)
	mln KWt-h	th.t	th.t	th. m2	th.t
2007	32660	6,4	53	118542	24
2008	32495	6,0	56	72927	28
2009	30220	6,2	54	14585	26
2010	30462	6,2	64	30000	27
2011	30903	7,3	65	50000	28
2012	34134	9,0	69	70000	29
2013	41585	10,0	75	72927	30
2014	41760	11,5	77	74386	31
2015	42052	11,5	79	75873	32
2016	42056	11,5	81	77391	33
2017	42060	11,8	82	78939	34
2018	42064	12,1	84	80517	35
2019	42068	12,3	85	82128	36
2020	42072	12,8	87	83770	37

Source: CENEf estimate

Table 5.15. Production structure and energy intensity in electric and heat power industries in “Inert” scenario

Year	Electric energy production at existing thermal stations	Electric energy production at new stations	Electric energy production at nuclear stations	Electric energy production at hydro stations	Electric energy production at windmills	Heat production at new stations	Heat production at nuclear stations	Heat production at existing thermal stations	Specific fuel consumption for electric production at new stations	Specific fuel consumption for electric production at existing stations	Specific fuel consumption for heat production at new stations	Specific fuel consumption for heat production at existing stations	Boiler efficiency factor	Portion of losses in electric mains	Portion of losses in heat network	Portion of heat consumption for electric power stations' own needs
	mln KWt-h	mln KWt-h	mln KWt-h	mln KWt-h	mln KWt-h	th. GCal	th. GCal	th. GCal	g equiv. fuel/ KWt-h	g equiv. fuel/ KWt-h	kg equiv. fuel / GCal	kg equiv. fuel / GCal	%	%	%	
2007	10006	0	22 648	6,73	0	0	539	3495	251,0	327,7	134,0	141,6	85,9%	15,5%	11,1%	0,3%
2008	9608	0	22 877	9,55	0	0	469	3397	251,0	327,0	134,0	141,6	90,5%	13,9%	13,4%	0,2%
2009	8069	0	22 142	9,55	0	0	454	3601	240,0	327,0	134,0	141,6	85,5%	16,4%	11,8%	0,2%
2010	8311	0	22 142	9,55	0	0	454	3601	240,0	327,0	134,0	141,6	85,5%	16,3%	11,7%	0,2%
2011	8560	189	22 142	11,55	0	0	454	3601	240,0	327,0	134,0	141,6	85,5%	16,2%	11,6%	0,2%
2012	8988	540	24 592	13,55	0	0	504	3601	240,0	327,0	134,0	141,6	85,5%	16,1%	11,5%	0,2%
2013	9438	540	31 592	15,55	0	0	648	3601	240,0	327,0	134,0	141,6	85,5%	16,0%	11,4%	0,2%
2014	9608	540	31 592	17,55	2	0	648	3601	240,0	327,0	134,0	141,6	85,5%	15,9%	11,3%	0,2%
2015	9897	540	31 592	19,55	4	0	648	3601	240,0	327,0	134,0	141,6	85,5%	15,8%	11,2%	0,2%
2016	9897	540	31 592	21,55	6	0	648	3601	240,0	327,0	134,0	141,6	85,5%	15,7%	11,1%	0,2%
2017	9897	540	31 592	23,55	8	0	648	3601	240,0	327,0	134,0	141,6	85,5%	15,6%	11,0%	0,2%
2018	9897	540	31 592	25,55	10	0	648	3601	240,0	327,0	134,0	141,6	85,5%	15,5%	10,9%	0,2%
2019	9897	540	31 592	27,55	12	0	648	3601	240,0	327,0	134,0	141,6	85,5%	15,4%	10,8%	0,2%
2020	9897	540	31 592	29,55	14	0	648	3601	240,0	327,0	134,0	141,6	85,5%	15,3%	10,7%	0,2%

Source: CENef estimate

Table 5.16. Energy consumption structure by sectors in "Innovative" scenario (thousand equiv. tons)

Year	Losses in electric energy production	Losses in heat production	Auxiliaries	Losses in distribution	Industry	Construction	Transport	Agriculture	Communal facilities	Service sector	Population	Non-energy needs
2005	6036,9	356,5	193,5	285,6	905,5	13,4	1517,8	70,9	30,1	512,1	1291,6	8,9
2006	7155,4	436,5	176,6	329,5	955,3	14,1	1570,8	85,2	27,3	401,3	1316,2	8,6
2007	7533,3	346,2	204,0	322,8	913,3	13,4	1624,6	58,5	21,8	433,2	1347,3	142,6
2008	7510,1	271,9	160,9	314,7	863,6	18,8	1646,1	44,9	17,3	310,2	1309,6	5,8
2009	7174,9	268,2	149,3	276,5	624,7	18,6	1708,4	44,3	17,7	322,8	1380,1	4,1
2010	7224,3	266,0	150,5	274,0	618,4	18,4	1728,6	43,0	17,3	319,9	1370,0	4,2
2011	7297,3	264,1	152,6	271,5	615,9	18,4	1762,5	42,6	16,8	316,4	1354,0	4,3
2012	8037,4	275,5	168,3	272,2	621,3	18,4	1824,7	41,9	16,5	312,9	1334,2	4,4
2013	9877,0	314,7	204,6	280,8	630,5	18,5	1909,8	42,2	16,4	314,8	1335,1	4,6
2014	9911,8	314,5	205,4	282,7	637,0	18,5	1953,2	42,3	16,2	316,7	1327,1	4,7
2015	9970,6	315,7	206,8	283,6	644,9	19,0	1997,4	42,5	16,2	320,4	1326,2	4,9
2016	9970,6	318,6	206,9	287,0	652,5	20,1	2038,5	43,0	16,1	325,8	1332,7	5,0
2017	9970,6	322,4	206,9	289,7	660,8	21,1	2078,3	43,4	16,1	332,4	1345,1	5,2
2018	9970,6	325,9	207,0	292,8	665,0	22,1	2115,1	43,8	16,1	339,2	1359,7	5,3
2019	9970,6	329,5	207,1	296,0	667,9	23,1	2150,5	44,2	16,1	346,3	1377,1	5,4
2020	9970,6	333,5	207,1	299,8	678,4	23,9	2191,5	44,7	16,2	353,7	1395,4	5,6

Source: CENEf estimate