

**The European Union's Tacis Programme
for the Russian Federation**

EuropeAid/126554/C/SER/RU

Delegation of the European Commission to Russia

**Promoting investments in energy
savings projects in Russian Federation
regions**

**Potential for increased
energy efficiency in the
Rostov, Sverdlovsk and
Tver regions**

October 2009



This project is funded by the
European Union



This project is implemented by
the ICF Consortium

Published October 2009

Copyright © 2009 by EuropeAid, European Commission

Enquiries concerning reproduction should be sent to
The Tacis Information Office,
European Commission, 170 Rue de la Loi, B-1049 Brussels

This report has been prepared by the ICF Consortium. The findings, conclusions and interpretations expressed in this document are those of the Consortium alone and should in no way be taken to reflect the policies or opinions of the European Commission.

Table of Contents

1. INTRODUCTION	5
2. MAIN CONCLUSIONS.....	6
3. GUIDANCE TO THE ASSESSMENT OF THE POTENTIAL FOR INCREASED ENERGY EFFICIENCY AT THE REGIONAL LEVEL.....	10
3.1. DETERMINING THE POTENTIAL FOR INCREASED ENERGY EFFICIENCY	10
3.2. MAJOR SOURCES OF INITIAL INFORMATION	12
3.3. LIST OF TECHNICAL ACTIONS	13
3.4. ENERGY SAVING COST CURVES	13
3.5. DETERMINING INDIRECT EFFECTS OF ENERGY SAVING.....	18
4. POTENTIAL FOR INCREASED ENERGY EFFICIENCY IN THE ROSTOV OBLAST.....	34
4.1. SUMMARY EVALUATION OF ENERGY EFFICIENCY POTENTIAL AND ENERGY SAVING COST CURVES	34
4.2. POTENTIAL IN ELECTRICITY SECTOR.....	37
4.3. POTENTIAL IN HEAT SUPPLY	39
4.4. POTENTIAL IN INDUSTRY	40
4.5. POTENTIAL IN AGRICULTURE	43
4.6. POTENTIAL IN TRANSPORT	44
4.6.1. Railway Transport.....	44
4.6.2. Urban Electric Transport	45
4.6.3. Pipeline Transport	45
4.6.4. Road Transport	45
4.6.5. Other Vehicles	46
4.7. POTENTIAL IN THE UTILITIES SECTOR.....	46
4.8. POTENTIAL IN THE SERVICE INDUSTRY	47
4.9. POTENTIAL IN THE HOUSING SECTOR	47
5. INCREASED ENERGY EFFICIENCY POTENTIAL IN THE SVERDLOVSK OBLAST	49
5.1. EVALUATION SUMMARY OF INCREASED ENERGY EFFICIENCY POTENTIAL AND CURVES OF ENERGY SAVING COST	49
5.2. POTENTIAL IN ELECTRICITY SECTOR.....	52
5.3. POTENTIAL IN HEAT SUPPLY	53
5.4. POTENTIAL IN INDUSTRY	54
5.5. POTENTIAL IN AGRICULTURE	56
5.6. POTENTIAL IN TRANSPORT	57
5.6.1. Railway Transport.....	57
5.6.2. Urban Electric Transport	58
5.6.3. Pipeline Transport	58
5.6.4. Road Transport	59
5.6.5. Other Vehicles	60
5.7. POTENTIAL IN THE UTILITIES SECTOR.....	60
5.8. POTENTIAL IN THE SERVICE INDUSTRY	60
5.9. POTENTIAL IN THE HOUSING SECTOR	61

6.	INCREASED ENERGY EFFICIENCY POTENTIAL IN THE TVER OBLAST	63
6.1.	EVALUATION SUMMARY OF INCREASED ENERGY EFFICIENCY POTENTIAL AND CURVES OF ENERGY SAVING COST	63
6.2.	POTENTIAL IN ELECTRICITY SECTOR	66
6.3.	POTENTIAL IN HEAT SUPPLY	67
6.4.	POTENTIAL IN INDUSTRY	68
6.5.	POTENTIAL IN AGRICULTURE	70
6.6.	POTENTIAL IN TRANSPORT	70
6.6.1.	Railway Transport	70
6.6.2.	Urban Electric Transport	72
6.6.3.	Pipeline Transport	72
6.6.4.	Road Transport	73
6.6.5.	Other Vehicles	73
6.7.	POTENTIAL IN THE UTILITIES SECTOR	73
6.8.	POTENTIAL IN THE SERVICE INDUSTRY	74
6.9.	POTENTIAL IN THE HOUSING SECTOR	74

1. Introduction

This report is prepared within the EU project *“Promotion of Investment in Energy Saving Projects in the Russian Regions”*. The target of this stage is to assess the potential of increased energy efficiency and to build curves of energy saving cost for three Russian regions: Rostov, Sverdlovsk and Tver oblasts.

The main target of this report is to assess the potential of increased energy efficiency in the principal economic sector of three Russian regions. The selected sectors correspond to the structure of integrated fuel and energy balances (IFEB) of these regions assessed for three regions over the period 2000-2008. IFEB data for 2008 already reflect the impact of the crisis therefore in some cases the base level of energy consumption was determined based on the 2007 IFEB data.

When determining the potential, information about specific energy consumption using the best world technologies were widely used. The calculations also applied the data used by CENEF when preparing the report to the State Council Presidium *“On Increased energy efficiency of the Russian Economy”* (July 2, 2009 in Arkhangelsk) and materials prepared by CENEF when developing the State Program *“Energy Saving and Increased energy efficiency in the Russian Federation over the Period until 2020”*.

Section 2 of this report provides a brief description of its main conclusions. Section 3 describes the guidance to determine the energy saving potential. Sections 4-6 present the results of assessment of potentials of increased energy efficiency and curves of energy saving cost for three Russian oblasts: Rostov, Sverdlovsk and Tver.

2. Main Conclusions

Three Russian regions – Rostov, Sverdlovsk and Tver oblasts – boast a considerable technical potential of energy saving (see Fig. 2.1.). In all three regions technical potential exceeded the growth of primary energy consumption in 2000-2007 when the regions' economy was developing in a fast pace. It means that in the future these regions' economy is technically possible without growth of primary energy consumption over minimum 8-12 years.

Market potential of saving in the Rostov and Tver oblasts is a little lower than primary energy growth that happened in 2000-2007 and in the Sverdlovsk oblast, on the other hand, this potential is much higher. That is development without growth of primary energy consumption or with minimum growth is not only technically possible but economically feasible.

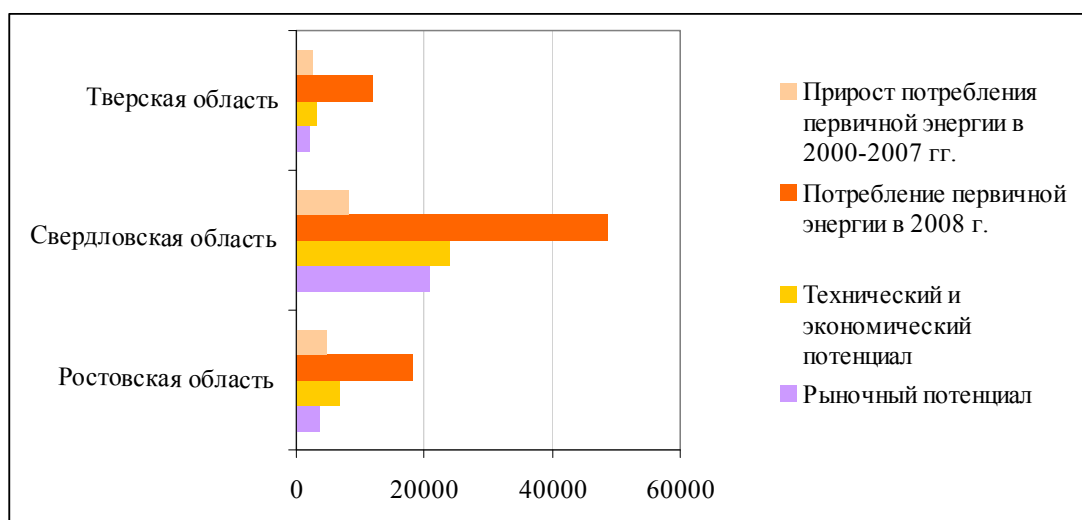


Figure 2.1. Distribution of Energy Saving Potential by Sectors for three oblasts in 2008

Technical potential of final energy saving:

- 1 in the Rostov oblast is 4844-5196 K toe or 39-42% of the level of final energy consumption in 2008;
- 2 in the Sverdlovsk oblast is 11579-11976 K toe or 33-34% of the level of final energy consumption in 2008;
- 3 in the Tver oblast is 1982-2182 K toe or 55-61% of the level of final energy consumption in 2008.

Technical potential of primary energy saving:

- 1 in the Rostov oblast is 6622-6874 K toe or 36-37% of the level of primary energy consumption in 2008;
- 2 in the Sverdlovsk oblast is 24070-24468 K toe or 49-50% of the level of primary energy consumption in 2008;
- 3 in the Tver oblast is 3236-3436 K toe or 27-29% of the level of primary energy consumption in 2008.

The lower share of primary energy saving potential in comparison with the share of final energy saving potential in the Rostov and Tver oblasts is related to the fact that calculations did not take into consideration efficiency enhancement of electricity output at NPPs; and in general the share of technical potential of saving of electric

and thermal energy output is lower than in other sectors.

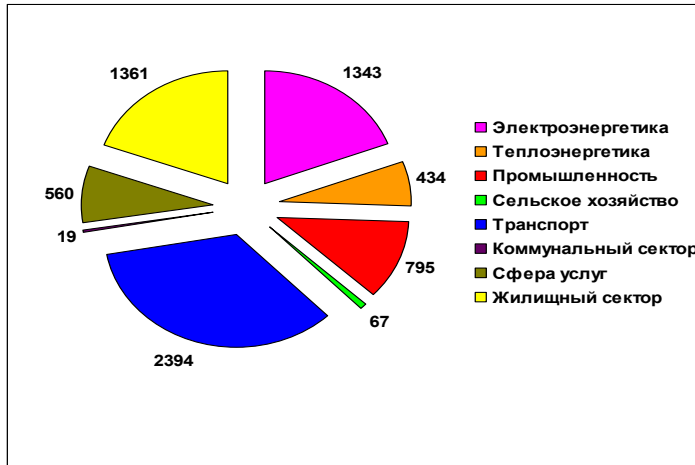
The structure of technical potential of energy saving is very different in three regions (see Fig. 2.2.):

- 1 in the Rostov oblast electricity sector accounts for 19% of primary energy saving potential, thermal energy sector – 8%; industry – 11%; agriculture – 1%; transport – 35%; utilities – less than 1%; service industry – 8% and housing sector – 20%.
- 2 in the Sverdlovsk oblast electricity sector accounts for 50% of energy saving potential, thermal energy sector – 2%; industry – 24%; agriculture – less than 1%; transport – 12%; utilities – less than 1%; service industry – 2% and housing sector – 10%.
- 3 in the Tver oblast electricity sector accounts for 31% of energy saving potential, thermal energy sector – 7%; industry – 7%; agriculture – 1%; transport – 24%; utilities – less than 1%; service industry – 5% and housing sector – 25%.

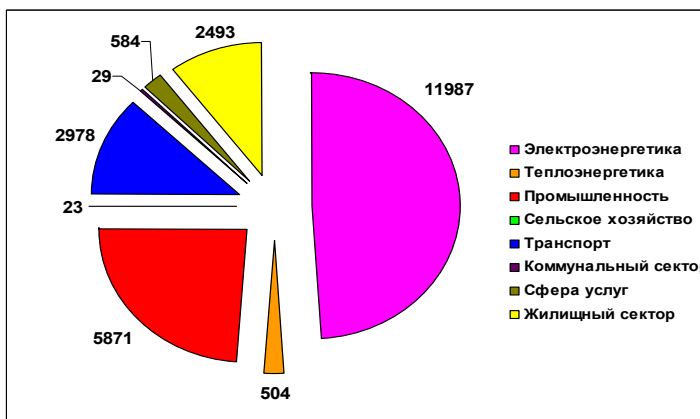
The Sverdlovsk oblast has three-fourths of the potential in the electricity sector and in the industry; the Rostov and Tver oblasts main potential lies in electricity sector, transport and buildings. In the latter two fields potential implementation will be comparatively expensive.

To implement regional programs with ambitious targets to enhance energy efficiency it is needed to determine the actions on potential use in all sectors without exception.

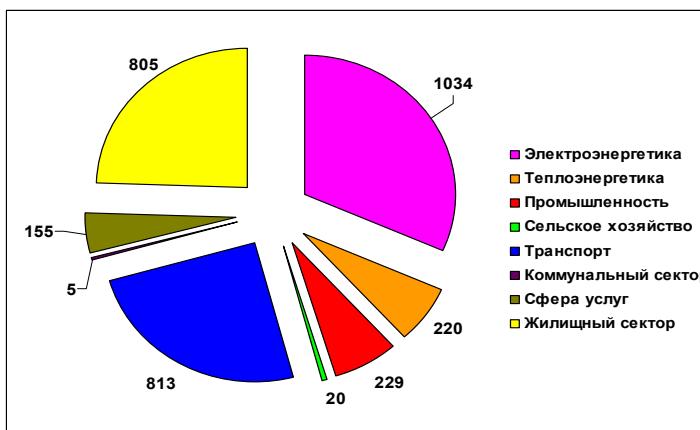
In all three oblasts economic potential of energy saving is equal to the technical potential. The curves of primary energy saving cost (see Fig. 2.3.) were built to determine the economic potential of energy saving. Economic potential was determined using the price for natural gas at USD 200/1000 m³ (export price for the natural gas less transportation cost and excise taxes) as a closing price. Accounting of additional effects and additional costs did not impact the conclusion that the economic potential of energy saving is equal to the technical one.



the Rostov oblast



the Sverdlovsk oblast



the Tver oblast



Figure 2.2. Distribution of Energy Saving Potential by Sectors for Three Oblasts in 2008

Market potential of energy saving:

- 1 in the Rostov oblast is 3488-3588 K toe or 19-20% of the level of primary energy consumption in 2008 and 51-54% of the level of technical and economic potentials;
- 2 in the Sverdlovsk oblast is 21195-20829 K toe or 43% of the level of primary energy consumption in 2008 and 85-88% of the level of technical and economic potentials;
- 3 in the Tver oblast is 2113-2268 K toe or 18% of the level of primary energy consumption in 2008 and 65-66% of the level of technical and economic potentials.

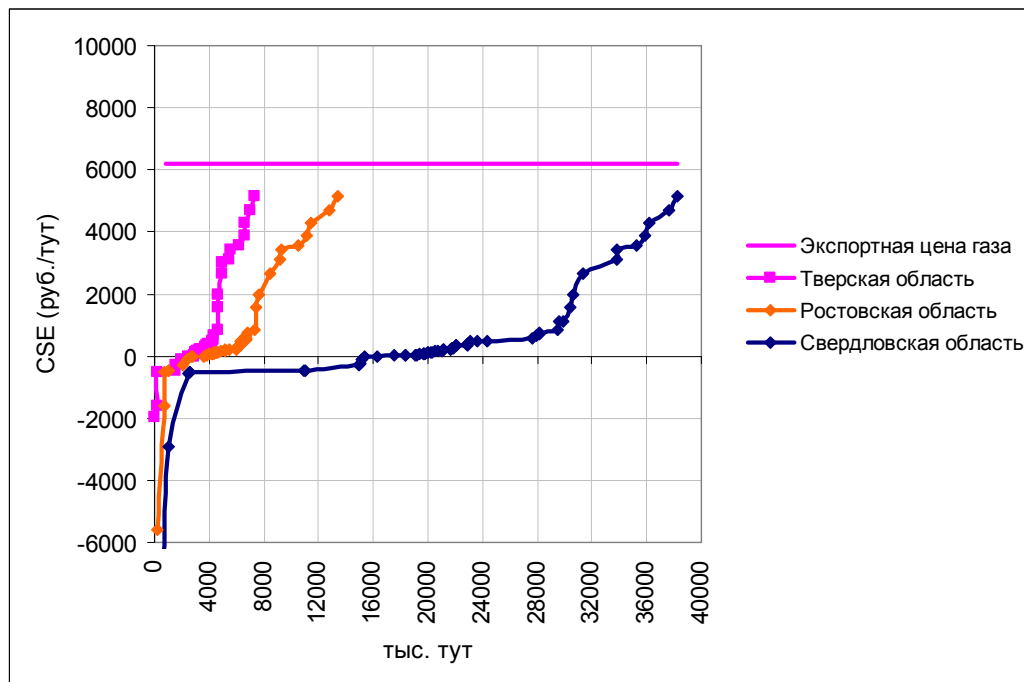


Figure 2.3. Cost of Saved Energy (CSE) curves for Three Oblasts

The market potential was determined using the average internal price for natural gas expected for the year 2010 as closing price for final consumers at 3500 rub./1000 m³ in each of three regions.

Increase of the average price for gas to 4500 rub./1000 m³ would enable expansion of the share of market potential in the technical and economic potentials.

- 1 in the Rostov oblast to 68-69%;
- 2 in the Sverdlovsk oblast to 86-89%;
- 3 in the Tver oblast to 68-69%.

To implement the larger potential that fell into the zone of financially unattractive actions at internal prices for gas in the range 3500-4500 rub./1000 m³ such as upgrading of public and residential buildings, transfer of cars to hybrid engines, state support and adequate price policy are required.

Similar conclusions were made by IEA according to its estimates the basic mass of additional capital investment (minimum two-thirds) to provide the “scenario 450” shall be used for upgrading of buildings and vehicles. Therefore IEA encourages expansion of mechanisms of financial support of investment in upgrading of buildings and transport. For Russia, as can be seen on Fig. 2.2., such support is paid back by saving of resources of natural gas for export.

3. Guidance to the assessment of the potential for increased energy efficiency at the regional level

3.1. Determining the potential for increased energy efficiency

According to the level of specific energy consumption for manufacture of a product, work or service unit, several categories of energy efficiency level can be selected.

“Theoretical minimum” – minimum possible specific energy consumption according to laws of thermodynamics required for performance of particular works or material conversion;

“Practical minimum” – best practically achieved in the world indicators of specific energy consumption using the technologies that proved their efficiency;

“Actual consumption abroad” – average or predominant indicators of specific energy consumption in other countries;

“Average consumption in Russia” – average indicators of specific energy consumption in Russia;

“Best regional indicators” – best practically achieved indicators of specific energy consumption in the regions;

“Average regional indicator” – average statistical value of specific energy consumption in the region. This indicator was used to assess the potential of increased energy efficiency;

“Worst regional indicator” – equipment with worst efficiency indicators in the region according to the statistical reporting data.

The potential of increased energy efficiency in each sector is determined as the product of the level of economic activity in this sector by the spread of actual (average for the region) specific consumption of energy for manufacture of a product, work or service unit and “practical minimum” – the value of specific consumption for most energy efficient technologies, technical aids or buildings used for manufacture of the similar products, works or services. To compare the indicators of energy intensity the data on “practical minimum” specific consumption achieved somewhere in the world at units in actual service and “average world” level was used. They were compared to the “best”, “average” and “worst” regional indicators.

Where possible all energy consuming units (or their representative sampling) were distributed by the level of energy efficiency. All units were divided into three groups: “green” (most efficient corresponding to the “practical minimum” specific consumption), “yellow” (with specific consumption above the “green” zone but below “average world” level) and “red” (all units with specific consumption above the “average world” level) (see Fig. 3.1.).

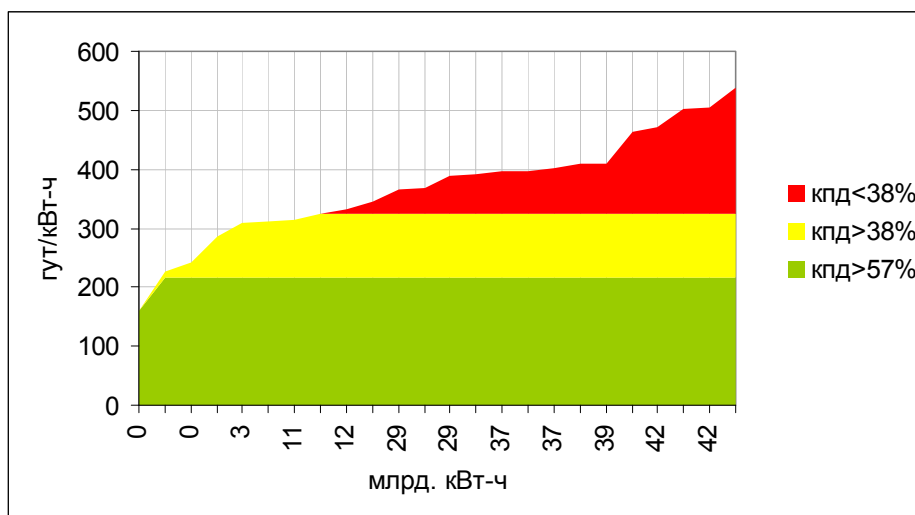


Figure 3.1. Distribution of Electricity Output at Electric Power Plants of the Sverdlovsk Oblast by Efficiency Level

Three principal definitions of increased energy efficiency were used in this report:

Technical (technological) potential is assessed on the assumption that all equipment is immediately replaced with the best samples corresponding to the “practical minimum” specific consumption. The technical potential shows only theoretic possibilities of energy saving without taking into account cost and other restrictions for its implementation. It can be assessed as the result of “removing” the red zone (lower value) or red and yellow zones (upper value). To assess the technical potential of increased energy efficiency the information only about already tried-and-true technologies was used.

Economic potential is a part of technical potential that is economically feasible when using the social criteria of investment decision-making: rate of discounting 6%, imputed price for energy (export price of the natural gas), ecological and other additional costs (e.g., price for carbon). Time is needed to implement this potential, the implementation period is determined by the speed of replacement of primary energy consuming equipment.

Market potential is a part of economic potential that can be used feasibly when using private criteria of investment decision-making in real market conditions (actual prices for equipment and energy carriers, taxes and so on).

There are three basic differences when assessing the economic and market potential: the procedures of investment decision-making are different – centralized or decentralized (because of this differences under other similar conditions energy intensity is always twice and large in the state-planned economy than in the market economy); rates of discounting – the value of money and risk perception (12% for industry and 33-50% for households); and effects – actual not imputed prices, accounting of taxes and benefits, inclusion of additional ecological and other costs. A higher alternative cost of capital for households is conditioned by some reasons: usually households are not willing to take risks related to investment in energy saving actions, to make more or less considerable capital investment they have to take credits at rates for private borrowers; or when they have available funds they have more important (from their point of view) spheres for investment.

We can select two more grades for potential of increased energy efficiency:

Information resources are a part of market potential in the form of feasibility study and individual decisions prepared by the result of information collection and analysis.

Financial resources are a part of the information resources against which the decisions were made concerning provision of funds for implementation of actions.

3.2. Major sources of initial information

To assess the potential of increased energy efficiency, primarily the IFEB data for the respective regions for the years 2007 and 2008 were used. In conditions of the lack of the official statistical data about fuel and energy balance, the IFEB assessed by the CENEF experts are the only sources based on which integral indicators of energy efficiency can be calculated in particular economic sectors.

To assess the potential the data on characteristics of specific energy consumption for “practical minimum” and for “actual consumption abroad” are used. These data is taken from multiple foreign sources of information.

The list of base actions on increased energy efficiency considerably exceeds the number of economic sectors. In many cases additional structuring of data on energy consumption beyond the IFEB detalization is required: to assess the fleet and structure of energy consuming equipment, to build curves of objects distribution by energy efficiency levels. For these additional assessments several models by economic sectors for each region were built. Calculations for these models enabled assessing the effect from implementation of each base action for each region.

In some cases (housing sector, service industry, transport) energy consumption structure for some needs (heating, hot water supply, lighting, food preparation, domestic electric hot plates) was determined based on the use of models describing availability, age and specific characteristics of energy consumption by various equipment and buildings. Such models of different levels of complexity were used for all economic sectors and for all base actions on increased energy efficiency. While building these models large arrays of various auxiliary data characterizing the availability and state of some equipment was used. In case of absence of the data for some region similar data for other regions and average Russian data was used or the data was logically reconstructed using additional indirect information, approved calculation procedures, data of foreign countertypes and data from other sources.

To assess expenses for implementation of actions on increased energy efficiency the information about implemented projects, energy audits, actual feasibility studies as well as data from special sources were used. The 2009 prices and expected prices for energy carriers in 2015 were used. The calculations also used the price for carbon at 20 €/CO₂.

3.3. List of technical actions

To assess technical potential of energy saving 51 technical actions or groups of actions were selected. This selection will be corrected for application to each of the three regions taking into account specific features of their IFEBs and other peculiarities including climate. In each region the list includes but not limited by 25 actions recommended by IEA.

3.4. Energy saving cost curves

The important component of the procedure for assessment of the potential of increased energy efficiency and costs required for its implementation is the method of accounting of the latter.

Principal enhancement of energy efficiency of the Russian and regional economies is possible under upgrading and renovation of a considerable part of accrued fixed assets. But the main target of their upgrading and renovation is not only increased energy efficiency but also (to a greater degree) in maintaining efficiency and general capacity of the fixed assets, obtaining additional profits and reduction of costs and adverse environmental impacts. Increased energy efficiency and energy costs reduction are only one of the effects of upgrading and renovation. Therefore calculation of costs for projects uses the concept of incremental capital investment.

When providing grounds for many projects on increased energy efficiency not incremental but total capital investment was assessed since the cost of equipment is not divided into parts providing an opportunity to continue or increase manufacture of goods and services and providing the effect of energy consumption reduction. Therefore often cost of projects for increased energy efficiency is 2-4 times overvalued and the cost of energy saving is assessed as the effect only.

Incremental capital investment is calculated as spread between cost of equipment for the energy saving project, characteristics of which correspond to high classes of energy efficiency or better foreign technologies and capital investment for installation of new equipment with low or average level of energy efficiency compared with equipment efficiency that is operated now in Russia (e.g. difference of the cost of high-efficiency electric engines and medium-efficiency electric engines). In some cases when the only target of investment is increased energy efficiency, for example, when installing a variable electric drive or metering devices, the calculations used total capital investment. The data on capital investment in different processes were taken from various available sources.

To assess economic and market potentials average Russian data on specific incremental capital investment that were assessed during development of the State Program "Energy Saving and Increased energy efficiency in the Russian Federation over the period until 2020" was taken.

To determine the economic and market potentials the cost of energy saving (CSE) was assessed by the following formula:

$$CSE = \frac{CRF * Cc + Cop}{ASE} \quad (3.1),$$

where:

Cc – incremental capital investment for action implementation;

Cop – change of operational costs or additional effects (growth of output, quality increase and so on);

ASE – annual saving of final energy;

CRF – factor of reduction of capital investment (normative efficiency factor of capital investment), that is calculated by the formula:

$$CRF = \frac{dr}{1 - (1 + dr)^{-n}} \quad (3.2),$$

where dr – rate of discounting, and n – equipment lifetime.

When assessing the economic potential the rate of discounting 6% was used, and when assessing the market potential – 12% of all investment. For each type of equipment their own lifetimes are used.

Additional costs or benefits (Cop) can include annual change of operational costs, removal of the demand in capital investment or removal of external factors impact related to a particular energy saving project. Benefits (for example, growth of products output due to increase of their reliability and reduction of maintenance downtimes, reduction of repair and emergency recover works cost, reduction of the share of defective articles due to automation and improvement of working conditions and so on) are reflected in the form of negative costs in Cop .

To illustrate use of equation 3.1 we'll take a simple example of incandescent lamp replacement (60 W for 20 rubles) with a compact luminous tube (11 W for 67 rubles). Let's assume that the rate of discounting for a household is 50%, lighting is used 2000 hours annually, the operation life of an incandescent lamp is 1000 hours and compact luminous lamp – 10 000 hours. Then the cost of electricity saving is 7 kopecks with average cost of electricity in Moscow in 2008 - 2 rub./kW-h:

$$CSE = \frac{0.58 * (67 - 20) - 20}{0.049 * 2000} = 0.07 \text{ rub.};$$

When assessing by total but not incremental capital investment, the cost of saved electricity would be 19 kopecks/kW-h. When using the rate of discounting 6% CSE becomes negative (-7 kopecks/kW-h) since the given cost of an energy efficient lamp ($0.24 * 47$) is lower than the cost of an incandescent lamp.

For each action the saving amount of final energy was assessed. Rating of actions by cost enables building a curve of energy saving. Actually, two curves are built: for social and private rates of discounting. Crossing of the first curve with the imputed price for energy (price for natural gas) gives the value of the economic potential, and crossing of the second curve with the average price

for energy – market potential. It is evident that both potentials are growing as the prices for energy carriers grow.

Assessment of additional costs and benefits (Cop) is very important for assessment of the curve of energy saving cost (CESC) though it is quite difficult. Special report on assessment of additional effects from implementation of 81 energy saving projects in the US has made a conclusion that they are increasing the effect from implementation of projects by 44% on the average and reduce the payback period of such projects to 1 year. It is availability of such effects that can result in negative cost of energy saving.

Special attention shall be paid to validation of additional costs and benefits. Their assessment for energy efficient technologies in the industry (by the list of energy intensive products manufactured in three regions) as well as in other sectors is given in table 3.1.

Table 3.1. Assessment of additional effects and costs of implementing actions for increased energy efficiency

	Additional effect	Additional costs	
	rub./toe (in 2009 prices)	rub. (in 2009 prices)	
Electricity sector			
Electricity generation			Additional effect is determined by reduction of costs for overhaul and running repair of equipment and growth of electricity generation through reduction of emergency and repair downtimes of equipment and respective increase of its operating capacity
Transfer (transportation) of electricity	12127	79	Additional effect is determined by reduction of operational costs for running maintenance and repairs of electric grids, TSS and SS. Additional costs are determined by the need for maintenance of the Automated Information and Measuring System of Commercial Energy Metering, dispatch systems and operational control of power supply.
Thermal energy sector			
Thermal energy generation at boiler plants			Additional effect is determined by reduction of costs for overhaul and running repair of equipment and growth of thermal energy generation through reduction of emergency and repair downtimes of equipment.
Transfer of thermal energy			Additional effect is determined by reduction of costs for overhaul and running repairs of electric grids equipment and growth of thermal energy supplies through reduction of emergency and repair breaks in heat supply.
Industry			
Iron ore manufacture	496	-	Additional effect is determined by increase of iron ore manufacture (iron-ore concentrate) during upgrading and/or reconstruction of process plants.
Iron-ore pellets manufacture	299	-	Additional effect is determined by increase of iron-ore pellets manufacture during upgrading and/or reconstruction of process plants.
Iron-ore agglomerate manufacture (agglomerating plants)	2100	1084	Additional effect is determined by increase of agglomerate manufacture during upgrading and/or reconstruction of agglomerating plants. Additional costs are conditioned by the need to purchase iron-ore concentrate (ore) to provide additional amount of agglomerate manufacture.
Coke manufacture	1156	724	Additional effect is determined by increase of coke manufacture during upgrading and/or reconstruction of coke and by-product processes. Additional costs are conditioned by the need to purchase coal to provide additional amount of coke manufacture.

	Additional effect	Additional costs	
	rub./toe (in 2009 prices)	rub. (in 2009 prices)	
Industry			
Cast iron manufacture (blast-furnace process)	1333	-	Additional effect is determined by increase of cast iron manufacture during upgrading and/or reconstruction of blast-furnace plants. Reconstruction of blast-furnaces with installation of bevelless charging devices enables increased the process capacity of blast-furnace process by 10-25% on the average and does not require additional coke consumption for cast iron manufacture.
Basic oxygen steel manufacture	27695	16023	Additional effect is determined by increase of steel manufacture during upgrading and/or reconstruction of converter furnaces. Additional costs are conditioned by the need to purchase (manufacture) cast iron to provide additional amount of basic oxygen steel manufacture.
Electric furnace steel manufacture	35778	8178	Additional effect is determined by increase of steel manufacture during upgrading and/or reconstruction of electric furnaces. Additional costs are conditioned by the need to purchase scrap metal to provide additional amount of steel manufacture.
Rolled iron manufacture	257	-	Additional effect is determined by increase of rolled iron manufacture during upgrading and/or reconstruction of rolling mills.
Aluminum manufacture	1825	-	Additional effect is determined by the following factor: 1. increase of aluminum manufacture during upgrading and/or reconstruction of process plants; 2 Reduction of anode consumption during aluminum manufacture.
Cardboard manufacture	1884	-	Additional effect is determined by increase of cardboard manufacture during upgrading and/or reconstruction process plants (cardboard-making machines – CMM).
Paper manufacture	2569	-	Additional effect is determined by increase of paper manufacture during upgrading and/or reconstruction of process plants (paper-making machines – PMM).
Housing sector			
Upgrading of lighting systems	3160		Saving in lamps purchase due to replacement of incandescent lamps with compact luminous lamps having a much longer lifetime.

Source: CENEF assessment

3.5. Determining indirect effects of energy saving

Assessment of the potential of final energy saving does not provide full understanding of possibilities to reduce energy consumption. This assessment also makes the saving of energy carriers various in quality, energy potential and cost that is not very correct.

Saving of an energy unit by final consumers provides additional saving along the whole energy chain: losses in electric, thermal and gas grids, cost of energy resources transfer, saving for their treatment, processing and mining, cost of fuel for electric and thermal energy generation, electricity consumption for this fuel manufacture and so on are reducing. The amount of this indirect saving can be very considerable.

In 1993 presentation of the potential of increased energy efficiency was proposed in the form of a table of the energy balance and the method of indirect effects assessment similar to that used for intersectoral balance. Calculations are based on the following presentation of the dependence between consumption of final and primary energy: $PE = AE * PE + FE$, or $PE = (E - AE)^{-1} * FE$, where PE is the vector of consumption (generation) of primary energy by types of energy carriers, AE is a square matrix of factors of primary resource consumption i for manufacture and delivery of the energy carrier j to the consumer, FE is the vector of final energy consumption (including net export of energy carriers). Each factor a_{ij} shows how much coal, oil products, gas, electricity and heat is required to provide consumer with a coal unit, for example. Any changes in technologies result in changes in the AE matrix. Matrix assessment $(E - AE)^{-1}$ for Russia for 2008 is given in table 3.2.

If the final consumer saves 1 toe of oil products then total demand in energy in the fuel and energy complex will reduce by 0.12 toe and in case of their transfer accounting – by 0.2 toe. Electricity and heat have the highest indirect effects. They considerably exceed conventional factors used in calculation of indirect effects: 2.5-3 times for electricity on the assumption that generation is 40% efficient and losses during transfer 6-7% and 1.25 for thermal energy (with heat generation efficiency 85% and losses in grids 5%). Taking into account all indirect effects it turns out that with saving by the final Russian consumer of 1 toe of electricity along the whole energy chain, not 2.5-3 but 4.7 toe is saved (4.9 toe taking into account transfer). By the way, availability of these indirect effects is the basis for providing subsidies for actions on increased energy efficiency from the state and society who have this indirect effect free of charge. Its accounting is important when assessing the economic potential.

Table 3.2. Matrix of Total Factors of Energy Consumption in the Fuel and Energy Complex per Energy Unit Supplied to a Final Consumer (2005, toe/toe)

	Coal	Crude oil	Oil products	Natural gas	Other solid fuels	Electricity	Heat
Coal	1.01	0.01	0.01	0.00	0.00	1.01	0.27
Crude oil	0.00	1.01	0.00	0.00	0.00	0.00	0.01
Oil products	0.00	0.00	1.05	0.00	0.00	0.09	0.08
Natural gas	0.01	0.03	0.03	1.02	0.00	2.28	0.91
Other solid fuels	0.00	0.00	0.00	0.00	1.00	0.01	0.03
Electricity	0.01	0.01	0.01	0.00	0.00	1.34	0.01
Heat	0.00	0.00	0.02	0.00	0.00	0.01	1.18
Total	1.03	1.06	1.12	1.03	1.00	4.74	2.49
Total including pipeline, railway and road transfer of energy carriers	1.04	1.07	1.20	1.10	1.00	4.91	2.56

Source: CENEF assessment

Thus, technical potential of primary energy saving was determined as the sum of final energy saving and reduction of primary energy consumption in the energy sector both through efficiency enhancement of technologies for conversion of one types of energy into others and through reduction of demand in resource conversion:

$$TEEP = \Delta FE + (AE - AE_{nt}) * (PE - \Delta FE) \quad (3.3),$$

where AE_{nt} is AE matrix with new technological factors.

When assessing the potential the fact was taken into account that base values of the vector of primary energy (for the year 2008) shall be corrected to the amount of reduction of final energy consumption (ΔFE). That is the more, for example, electricity is saved by final consumers, the less electricity needs to be generated, that is why the effect from upgrading of power plants equipment will be a little less than that retaining the generation at the 2008 level. Thus, growth of final energy saving is reducing the amount of saving in the processes of generation and transfer of electric and thermal energy as compared with the baseline levels (see equation 3.3.).

Accounting of indirect energy saving makes the indicators of energy saving and specific cost for energy saving more comparable. For three regions when assessing the indirect parameters of energy saving Russian average factors from table 3.2. were used obtained based on the study of the table of the Russian energy balance for the year 2008.

When as a result of actions a particular energy carrier is saved, then respective values of the last line of table 3.2. were used as the multiplier of total effect of primary energy saving. When saving several primary energy carriers, the multipliers of total effect of primary energy saving against final energy saving for each sector were obtained as follows:

$$m_i = dPE_i = (E - AE)^{-1} * dFE_i \quad (3.4),$$

where:

dPE_i – reduction of primary energy consumption during reduction of final

energy consumption per unit in sector i;

dFE_i – vector of shares of particular energy carriers used in sector i.

In this case equation (3.1) is changed into equation (3.5), and a curve of final energy saving into the curve of primary energy saving. It is the latter curve assessed for each region that was used as the means for analysis of economic and market potentials of primary energy saving.

In this case the equation for the cost of primary energy saving will look as follows:

$$CSE = \frac{CRF * Cc + Cop}{ASE * m_i} \quad (3.5),$$

where:

Cc – incremental capital investment for action implementation;

Cop – change of operational costs or additional effects (production growth, quality increase and so on);

ASE – annual saving of final energy;

m_i – multiplier of total effect of primary energy saving;

CRF – factor of capital investment reduction (normative factor of capital investment efficiency).

To answer the question if technical actions are of interest from the point of view of economic or financial efficiency, the cost of primary energy saving (CSE) is compared with the imputed price of primary energy using the export price for Russian natural gas. Medium-term prove policy of the Russian government is aimed at bringing the internal process for gas to correspondence with the export price for gas. When determining the imputed price the cost of transit by pipelines and excise duties were subtracted from the export price for the natural gas.

The expected 2010 prices are used to be the basis to determine the share of economically feasible implementation of the technical potential. When assessing the economic potential the effect of saving from all actions that have passed a test for economic feasibility is subtracted from the amount of the technical potential. Respectively, when assessing the market potential the effect of saving from all actions that have not passed the test for market feasibility is subtracted from the amount of economic potential.

Difference of economic potential from the market one, among other things includes accounting of external factors. The most important external factor is reduction of greenhouse gases emission that is the result of projects on increased energy efficiency. It is assumed that an additional economic effect from energy saving and GHG emission reduction can be achieved through implementation of credits on the market for reduction of CO₂ emissions. The cost of these credits is included as an additional effect (negative Cop) to the cost of energy saving.

In the second half of 2009 the system of European emission trading had prices for units of emission reduction at 12-16 euro per 1 ton of CO₂. It is

supposed that as far as overcoming the crisis this price would grow a little. The calculations took the sale price at 20 euro per tone of CO₂.

3.6. Specifics of Determining the Potential of Increased energy efficiency in Particular Economic Sectors

3.6.1. Electricity Sector

To assess the potential of increased energy efficiency in the electricity sector for gas thermal power plants the “practical minimum” included specific fuel consumption while generating electricity at CCP with 60% efficiency. Minimum efficiency for thermal plants operating on solid fuel was assumed at 48%.

When determining the minimum level of losses in electric grids the structure of electricity consumption was taken into account at different levels of voltage as well as the amount of electricity transferred outside the region.

Reduction of electricity losses can be achieved through: the use of self-supporting insulating conductors (SSIC) and “Torsada”-type conductors for overhead lines of medium and low voltage 35-0.38 kV; use of XLPE cables in high, medium and low voltage cable lines; the use of new generation cables (Aero-Z); use of dry-type transformers with SF₆ insulation and/or dry-type transformers with cast insulation and guarded design; use of modular integrated transformer substations (MITS) and/or pillar package transformer substations (PPTS); use of power-factor correction units; replacement of distressed energy meters of class 2.5 and 2.0 with new modern electronic energy meters of class 1.0 and/or 0.5 (with the function of multi-tariff accounting of electricity, remote data transmission and possibility to work in the Automated information and measuring system of commercial energy metering (AIMSCEM); AIMSCEM units with dispatch system and remote energy supply control system.

3.6.2. Thermal Energy Sector

Determination of the technical potential of energy saving at boiler plants was based on the gas-operating boiler plants with 95% efficiency and operating on other fuels with 92% efficiency.

When assessing the opportunity to reduce losses in thermal grids not the statistical data on losses but CENEF assessments were used. Installation of metering devices results in reduction of energy consumption but in growth of the share of thermal energy referred to losses. This fact was taken into account during calculations. When assessing the energy saving potential it was supposed that losses in thermal grids will be reduced to 10%.

When studying the opportunities of boiler plants conversion to combined heat and power plants, the following typical technologies were studied:

- 1 conversion of gas-operating water boiler plants (municipal and manufacturing enterprises) of high capacity (more than 400 Gcal/hour) and their complete reconstruction to GTP of waste type or

CCP bringing the water boilers to peaking operation;

- 2 conversion of gas-operating steam boiler plants of industrial enterprises (or small number of public boiler plants) to GTP or CCGT;
- 3 improvement of boiler flow diagrams of steam boiler plants using high-potential steam heat for electricity generation in the flow of previously throttled stream to cover own demand of boiler plants;
- 4 GPU use in the gas-operating boiler plant diagram for electricity generation for own needs.

To implement possibilities of these technologies it is required to follow a special policy promoting development of geographically-distributed generation of electricity based on external heat consumption for heating. The existing limitations shall be taken into account:

- 1 for sites of regional heat supplying plants located near urban lands or inside these areas, construction of binary combined cycles is essentially bounded by strict requirements for arrangement of sanitary protection zones. Therefore conversion of boiler plants to combined heat and power plants can be installed mainly in the urban industrial areas;
- 2 payback of these projects of 12 MW capacity and higher is prolonged for a longer period since the turbines are operating mainly for own needs and supply of energy excesses to grids is difficult for different reasons.

Conversion of large boiler plants (RTS) located in the urban lands to combined heat and power plants with various equipment is essentially bounded. But conversion of boiler plants of industrial enterprises with expanded sanitary protection zones is very prospective.

3.6.3. Industry

When determining the potential in the industry the potential during manufacture of energy intensive products and potential achieved through implementation of typical actions for non-energy intensive industry were determined.

In the first case the potential was determined by comparison of specific energy consumption when manufacturing the products. There are several troubles here, for example, practical inconsistency of the list of products that have the data on the “practical minimum” – best world technologies and the list products for that form “11-TER” provides specific consumption for manufacture of industrial products in that sphere. Therefore some products were compared with the average or best Russian indicators.

The possibility of energy saving through implementation of typical actions (introduction of efficient electric motors, variable electric drive, efficient compressed air systems, efficient systems of industrial lighting, efficient steam supply systems) was assessed by the special model for each region.

In Russia the share of high-efficiency motors does not exceed 2-3%. Russia does not have the state policy of promotion of efficient motors, no special motivation for their use. On the contrary, the share of motors that are

more than 20 years in operation is quite high. Such motors had repairs minimum 3-5 times, every time losing 0.5% and more efficiency. As a result, over their lifetime motors' efficiency is reduced by 5-25%. Therefore their replacement with more efficient motors gives a considerable energy saving effect and saving for running maintenance of approximately 2-7% of the cost of electricity consumed by them.

Average load of an electric motor (load consumed by the machine operating device against the nominal load) in the Russian industry is 0.3-0.4 and in the European industry – 0.6. It means that motor efficiency is much lower than the nominal one. Overestimated "just in case" motor capacity often results in excessive pressure in hydraulic lines, growth of losses, reduction of reliability and so on (in 75% of cases pump capacity is overestimated by more than 20%).

Capacity saving when using efficient electric motors costs USD 670/kW on the average. Indirect effects of this project can also include growth of motor operation resource due to reduction of its winding temperature, more resistance to fluctuations, operation with less overheating, reduced noise level; longer warranty life.

Variable electric drive can be efficiently used approximately for 40-50% of all electric motors. Most effect from its use can be achieved in continuous drives with variable load and motor capacity more than 3 kW. By experts estimates, Russia is only 5% equipped with electric motors with variable drives from the potential market saturation. Electric drive use provides saving in the amount of 10-34% and even more. The calculations used the average saving estimate equal 22%.

Compressed air is the most expensive energy carrier at an industrial enterprise partly because systems of compressed air production are least efficient: 80% of consumed energy is lost in the form of low-temperature heat while compressing and about a half of the remaining energy is lost in particular parts of the system, including escape in the systems of compressed air distribution (20-30% of losses) bringing total efficiency of the whole system to 10-15%. Compressed air systems are often designed with excessive capacity that results in instability of pressure and accelerated wear of equipment.

Saving potential in the compressor motor and drive control is already taken into account. Primary part of additional saving is provided through such actions as implementation of the program of leak detection and elimination, decentralization of compressed air systems, zoning and reconfiguration of air pipelines, creating systems for compressed air storage, installation of control systems for system operation, replacement or repair of filters, installation of ball valves in the distributions systems, heat recovery and so on.

There are low-cost actions on energy saving when operating the compressed air systems: reduction of consumption and leaks, disconnection of tools and equipment not used in operation, automatic regulation of compressed air supply into the system; compartmentation of the system of air distribution to consumers, arrangement of ring-type air

lines, disconnection of not-used branches; division of the system when it has consumers with very different pressure; avoidance of operating pressure range increase in the system above 0.5 MPa, use of heat of the compressor cooling system, use of automatic control with help of through-conduit valves for the order of compressor start depending on changes of the time constant of pressure drop in the system (depending on the flow in the system and compressor capacity), replacement of distressed compressors (modern compressor when idle consume up to 30% of nominal power, old ones – up to 90%), replacement, where possible, of compressed air at the consumers with other energy carriers, use of standalone compressors interconnected with the unit consuming compressed air.

The systems of industrial lighting consume minimum 5-6% of all electricity consumed in the industry less technological needs of energy-intensive sectors or about 172 M kW-h. Main ways to enhance energy efficiency of lighting systems: reduction of the rated capacity of lighting fixtures and reduction of the number of hours of their operation, replacement of light sources with new energy efficient lighting fixtures (replacement of mercury lamps with metal-and-halogen lamps, replacement of standard luminous lamps of T12 and T8 type with T5 type, use of light emitting diodes) in case of retaining the entitled wattage of lighting, use of electronic control equipment (ECE); efficiency enhancement through maximum use of natural light in the daytime and lighting control; use of modern lighting fixtures (use of membrane baffles on luminous lamps enables reducing the number of lamps and their capacity); use of automatic switches for emergency lighting systems in the zones of personnel temporary stay. Lighting can be controlled from infrared sensors or other sensors; surfaces of production premises can be painted in light colors to increase the factors of daylight and artificial light use; keeping the light transmissive structures and lighting fixtures clean; installation of protection from exceeding the nominal levels of voltage. Replacement of old lighting fixtures with new efficient ones with electronic control equipment, introduction of control systems for lighting when activating the use of daylight enables saving of about 35%.

Primary actions on steam efficiency enhancement are typical for various industry sectors: steam accounting, heat insulation of steam pipelines and removable lagging points for shutoff valves, installation of a condensate catcher and condensate return, use of plate heat exchangers and their timely maintenance, use of secondary heat (saving 5–30%), vapor recompression, use of the vapor produced from condensate at abrupt pressure drop and so on. At a typical Russian enterprise low-cost actions provide not more than 30% of vapor saving with 1 year payback period. The calculations of upgraded steam supply systems used the average saving of 30%.

3.6.4. Agriculture

For agriculture Russian statistics provide several indicators of energy efficiency: specific consumption for heating of glasshouses, for heating of static greenhouses, for water pumping for melioration and water supply; for irrigation and drainage of lands; and specific fuel consumption for

tractor operation per 1 ha. According to form “11-TER” only large and medium agricultural enterprises report, whose share in agricultural products has reduced in the recent years. Thus, completeness of accounting of energy consumption in agriculture leaves much to be desired.

Comparison of specific consumption in Russian and world agriculture showed that Russia spends 250-280 kgoe per 1 ha of cropland while the US spends only 140 kgoe. Total energy consumption for production of 1 conditional grain unit in Russia is more than 5 times higher than in the US that reduces competitive ability of Russian products. Energy intensity of livestock products in Russia 2.0-2.5 times exceeds the leading western countries.

Low energy efficiency of agriculture is related to surplus and high wear of facilities: annual capacity factor of power substations, boiler plants, rated capacity of internal combustion engines does not reach 20%; about 90% of equipment and distribution lines are operating beyond the depreciation life.

Tractors often have excessive capacity in comparison with the required one for work performance due to lack of tractors by capacity parameters as well as due to their low reliability that results in the share of operable equipment of only 81-84%. The situation is improving gradually. The number of tractors and other agricultural machinery is reducing per 1000 ha of croplands, generating capacities are reducing in absolute terms. But in 2006 the Russian agriculture had a share of tractors with more than 10 years operating life of 72%, combined and forage harvesters – 62%.

Low energy efficiency of Russian agriculture is reducing its competitive ability considerably. Proportion of energy consumption in the cost of Russian agricultural products is “over-the-top” of 20%, while in the developed countries it does not exceed 10%.

Equipment fleet renovation was an important action on potential implementation. The spread in energy efficiency is determined not only by insufficient level of energy efficiency of agricultural machinery but also by imperfection of technologies themselves. Implementation of animals’ genetic potential is below 60%. Lack of use of resource saving and soil-protective technologies results in almost double shortfall in crop production (insufficient fertilization and crop protecting agents, inobservance of optimal agroterms, ungraded sowing and so on). Therefore improvement of agricultural technologies can provide a very convincing effect in addition to renovation and optimization of machinery and equipment fleet.

The potential can be implemented through actions on accounting of energy consumption, optimization and minimization of soil treatment (beardless plowing, shallow work), optimization of machinery and equipment fleet in capacity and energy efficiency, use of more efficient methods of fertilization, improving the quality of seeds, increasing the share of areas for perennial grasses, increase of food balance for cattle breeding, procuring of packaged haylage, technical upgrading of agroindustry,

developing generating services in agriculture.

Agriculture has great opportunities of using renewable energy sources: biomass, biogas, biofuel, solar, wind energy and other types of RES. Actions on their use shall be integrated into programs of increased energy efficiency.

“State Program of Agriculture Development and Regulation of Markets of Agricultural Products, Raw materials and Food over the period of 2008-2012” adopted in 2007 aims at accelerated transfer of the Russian agriculture to the use of new highly efficient and resource-saving technologies. Technical and technological upgrading according to the Program is based on renovation of the agricultural machinery fleet. “State Program of Agriculture Development and Regulation of Markets of Agricultural Products, Raw materials and Food over the period of 2008-2012” aims at bringing the factor of tractors renovation to 10.3% by 2012.

The potential of energy saving in agriculture was assessed in two directions: efficiency enhancement of tractor fleet and efficiency enhancement of energy consumption for glasshouse heating. Potential assessment for other directions is complicated due to lack of information required for such assessments.

Modern diesel tractor engines are 10-15% more efficient as compared with that in operation now. If in the process of tractor fleet renovation it will be optimized along the capacity line and part of old energy intensive equipment will be withdrawn from service, then saving per one new tractor is assessed at 20%.

The share of energy consumption in the cost price of glasshouse products reaches 40-60% over the year and in winter – 70-80%. Specific energy consumption can be reduced by 50-65% through actions on improvement of insulation of glasshouses (including double-layer plastic greenhouses); more efficient methods of greenhouse utilities control and automation of control systems of heat sources and microclimate instead of supplying heat per temperature charts; introduction of efficient systems of water heating for irrigation, department premises, service and administrative zones, heat accumulators; use of waste heat; use of variable frequency drives in circulation pumps; introduction of new technologies – drip feed, photoculture and so on.

3.6.5. Transport

This section assesses the potential for railway, pipeline, electric urban and road transport.

For railway transport possible savings of electricity and liquid fuel are assessed. Price growth for electricity and diesel fuel is a motivation for OJSC “Russian Railways” to enhance energy efficiency. By 2010 they are planning to reduce specific energy consumption by 3.5-4% per gross-t/km in electricity and by 6% in fuel. By 2020 their targets are even more ambitious: respective reduction for electric traction – 10-12%, for diesel operation – 13-18% and own needs – 20-25%. These target are expected to be achieved through:

- 1 replacement of worn-out equipment fleet with electric locomotives of new generation with reduced air resistance, reduced weight of trains, regeneration braking and more efficient traction (increased energy efficiency by 10-15%);
- 2 increase of electric locomotive loading, use of more efficient technologies of control and dispatching (5%) and information technologies (up to 10%);
- 3 replacement of bimetallic suspension wires with copper ones (reduction of losses by 10-15%), use of parallel sectionalization (reduction of losses by 10-20%);
- 4 additional railway substation (almost four times reduction of losses);
- 5 repair of railways and construction of high speed mains.

Most actions required for increased energy efficiency in the railway transport can be implemented without additional capital investment. Replacement and upgrading of the rolling stock and other equipment are required to continue operation of railway system. All modern rail vehicles are more efficient than those in operation now, therefore to enhance energy efficiency no new investment as such are required. Increased energy efficiency will result from this replacement without additional capital investment.

Other actions that finally will serve for energy efficiency and productivity enhancement include: installation of information and technology control systems, replacement of diesel engines for locomotives, replacement of fuel systems for engines and installation of fuel meters.

Energy consumption and energy intensity dynamics of road transport in the Russian regions is quite difficult to determine, since statistical authorities do not collect the required data and do not carry out special research. Methods of resolving the problems of finding the amounts of fuel consumption by road transport are determined in the previous report prepared within this project. These values were used while determining the energy saving potential in road transport in this report.

When determining the fuel consumption by road transport, assumptions of vehicle fleet, specific fuel consumption by buses, passenger cars and trucks are used by types (gasoline, diesel fuel, liquefied and compressed gas) at their average run. This minimal set of data that will be required to assess fuel consumption by road transport. It is possible to increase assessment accuracy through use of additional data on the structure of vehicle fleet: for example, division of buses fleet into minibuses, high and medium capacity buses and, say, division of trucks by load-carrying capacity, but this data is not collected in many regions.

Two approaches may be used to assess fuel consumption by transport: based on the data of sold fuel or distance passed by vehicles. In the first case, the analysis showed instability of statistical data that cannot be considered reliable. In the second case, large array of data has to be examined (average run of vehicles, technically sound vehicle fleet of a

certain group and so on) that also reduces reliability of calculations. Comparison of the results of using these two methods enables assessing the measure of uncertainty of fuel consumption in transport.

This report used the second approach to assess fuel consumption by road transport. This approach is based partly on statistically measured values (number of vehicles), on normative parameters (operating standards of fuel consumption) and expert estimation of values (average run of cars, share of Russian cars, distribution of road vehicles by types of fuel consumed and so on). For sure, use of values assessed by experts decreases the calculation accuracy but, nevertheless, provides more reliable assessment just because the statistical data on fuel use has very low quality and is characterized by considerable and inexplicable gaps in years.

Fulfillment of technical opportunities of economic performance enhancement of gasoline engines enables reducing specific consumption by 14-27% at additional cost of USD 1500-1800 per car, and most advanced models without hybrid systems enable reducing specific consumption by 28-45% at additional cost of USD 2800-3400 per car. Difference in the cost of a “conventional” passenger car and a hybrid one is assessed at USD 4000-5600. In case of buses and trucks adjusting factors were introduced for an “ordinary” difference in the cost of buses and trucks with passenger cars.

Dependence of fuel efficiency of a car on additional costs is almost directly proportional (see Fig. 3.2.). Car fuel efficiency enhancement costs 50 K rub./toe on the average, and for most efficient technologies – about 55 K rub./toe.

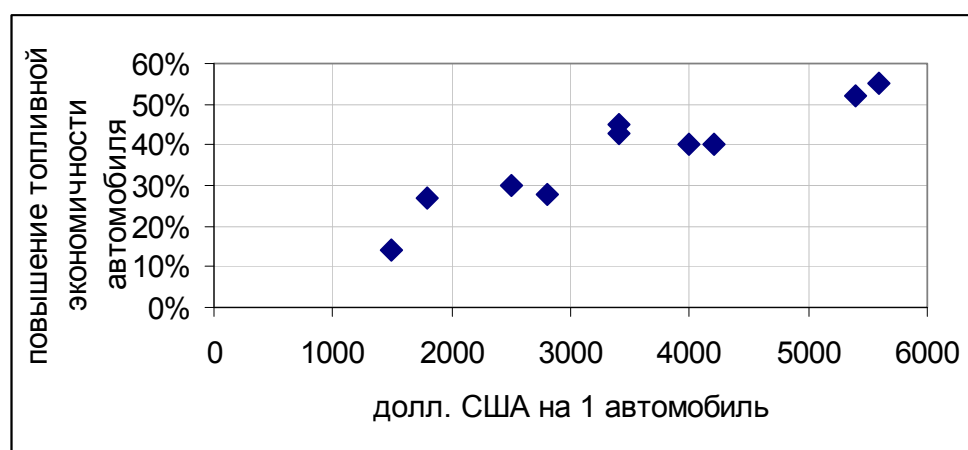


Figure 3.2. Dependence of Fuel Efficiency Enhancement of a Passenger Car on Additional Costs

Use of hybrid buses, passenger cars and trucks (internal combustion engine + electric motor) is the most energy efficient technology. Its potential is assessed on the assumption that all fleet of technically sound vehicles is transferred to this technology. This method was not applied for other road transport since this category includes motor transport (motorcycles, mopeds and so on), with missing data on their fleet, and specialty cars whose structure is also not determined. In addition, fuel consumption by this category of road transport is insignificant and can be disregarded.

Hybrid vehicles possess a technological potential that, nevertheless, still can be “added up” since fuel consumption by a hybrid car depends on a driving style and traffic conditions. When taking the technological factor into account it is supposed that its part is added up from developing energy efficient driving skills and developed traffic planning and logistics. According to the Finland’s National Energy Efficiency Plan, energy efficient driving enables saving 8-12% of fuel for passenger car drivers and about 4% for truck and bus drivers. This report has assumed a conditional value of 5%. Assessment of effects from rational organization of traffic planning and logistics seems to be the most difficult one. It was also assumed at 5% of fuel saving.

3.6.6. Utilities

The potential of increased energy efficiency of water supply and removal systems is aimed at implementation of two typical groups of technical projects:

- 1 introduction of efficient electric motor and optimization of systems of electric motor operation;
- 2 introduction of variable frequency drives.

In addition, possibilities of energy saving in street lighting were assessed in this sector.

3.6.7. Service Industry

Calculation of the technological potential for the service industry was made by each consumed energy carrier.

To assess the potential for buildings with centralized heating the assumption was made that all existing buildings were upgraded per thermal protection requirements under SNiP 23-02-2003 “Thermal Protection of Buildings”. Technological potential of thermal energy for hot water supply was assessed based on norms of hot water consumption for various consumers in accordance with Appendices 2 and 3 of “Sanitary Norms and Regulations” No. 2.04.01-85 “Internal Water Pipeline and Sewage Systems of Buildings”.

Potential of electricity saving was calculated as follows. Electricity consumption was divided for consumption of:

- 1 computer equipment (workstations (system unit+monitor), servers, exchange stations, switches and switch-boards, scanners photocopiers and so on);
- 2 lighting systems;
- 3 electric heating systems, hot water supply systems and consumption by other electric appliances.

For educational institutions among other electric appliances, electric hot plates, electric water heaters, electric water boilers, cabinet ovens, refrigerators, TV-sets and audio/video equipment, air conditioners, laboratory benches and other devices were taken into account.

For health care institutions among other electric appliances both domestic electric appliances (electric hot plates, electric water heaters, electric water boilers, TV-sets and audio/video equipment, refrigerators, electric ovens, washing machines) and special medical equipment (steam autoclaves, sedimentators, X-ray apparatuses, sterilization equipment, disinfection plants and so on) were taken into account. Potential of electricity saving for the above equipment was calculated on the basis of replacement of all existing equipment fleet with most energy efficient models being sold in Russia.

Potential of electricity consumed for lighting was calculated on the assumption that all inefficient lamps are replaced with energy efficient fixtures with electronic ballasts and luminous lamps of new generation (type T5 with light efficiency more than 90 lm/W), luminous lamps of T12 standard (with light efficiency more than 70 lm/W) and incandescent lamps are replaced with compact energy saving luminous lamps. In addition, upgrading includes systems of lighting control and optimization of light distribution and growth of the use of daylight.

Potential of electricity consumed for food preparation is calculated on the assumption that all electric hot plates and ovens are replaced with modern energy efficient ones. Potential of electricity consumed for hot water supply is calculated on the assumption that all electric water boilers are replaced with energy efficient ones and electric hot plates are used for water heating only in the period of hot water outage for 21 days.

Natural gas is used for heating, hot water supply and food preparation. When calculating the technological potential of the natural gas for heating the assumption was made that all buildings are constructed in accordance with modern requirements for thermal protection per Regional Construction Norms and SNIIP. Potential of natural gas for food preparation was calculated based on the fact that modern gas ovens are about 20% more efficient than the existing ones.

Oil products (liquefied gas) are also used for heating, hot water supply and food preparation. Due to insignificant consumed amount of oil products and, therefore, potential, their consumption for hot water supply and food preparation were fixed at the 2008 level.

3.6.8. Housing Sector

Technological potential for the housing sector was also calculated by each consumed energy and energy carrier broken down to buildings with centralized and independent heating.

Technological potential was assessed by two scenarios. Difference between them is that in the first case technological potential was assessed on the assumption that all buildings with independent heating are replaced with “passive” ones, and in the second case – that buildings with independent heating are upgraded in accordance with the requirement for thermal protection per SNIIP 23-02-2003 “Thermal Protection of Buildings”.

Technological potential of thermal energy for hot water supply was assessed on the assumption that hot water is consumed at the rate of 50

l/person/daily.

Potential for electricity was calculated as follows. Electricity consumption was divided for consumption by refrigerators and freezers, washing machines, TV-sets, for lighting, electric heating, hot water supply and consumption by other domestic electrical appliances.

Potential of electricity consumption by refrigerators was determined on the assumption that the existing refrigerator fleet is replaced with energy efficient one consuming 0.5 kW-h/day (most energy efficient model of all sold in Russia).

Potential of electricity consumption by washing machines was determined on the assumption that the existing washing machine fleet is replaced with models consuming 0.57 kW-h/cycle (most energy efficient model of all sold in Russia).

Potential of electricity consumption by TV-sets was determined on the assumption that the existing TV-set fleet is replaced with models consuming 94.2 kW-h/year (most energy efficient model of LCD sold in Russia).

Potential of electricity consumption for lighting was determined on the assumption that the existing non-energy efficient lamps are replaced with compact luminous ones or similar by efficiency (for example, light emitting diodes).

Potential of electricity consumption for food preparation was determined on the assumption that all electric ovens and hot plates are replaced with modern energy efficient models.

Assessment of the technological potential of electricity for heating is different in two scenarios because of differences in the procedures of potential assessment for buildings with individual heating. In the first case correction for use of electric heating by “passive” houses was made. The calculation was made on the assumption that heat loads for electric heaters are 15 kW-h/m²/year. In the second case, there was no need to heat up the houses with help of electric heaters since all houses were upgraded in accordance with the requirements for thermal protection per SNiP 23-02-200 “Thermal Protection of Buildings”. Therefore there is no additional consumption in this case.

Potential of reduction of electricity consumption for hot water supply was calculated on the assumption that all electric water boilers are replaced with energy efficient ones and electric hot plates are used for water heating only in the period of hot water outage for 21 days.

For other domestic electrical appliances consumption was fixed at 2008 level since their structure is very different and cannot be calculated and assessed with the acceptable accuracy and electricity consumption is insignificant in general.

Natural gas is used for heating in buildings with decentralized heating, hot water supply and food preparation both in residential buildings and detached houses. Assessment of the technological potential of natural gas for heating is different in two scenarios because of differences in the

procedures of potential assessment for buildings with individual heating. In the first case the assumption of using the technologies applied when constructing “passive” houses. Thus, natural gas consumption was brought to zero. In the second case, consumption was calculated on the assumption that buildings with individual heating correspond to the requirements for thermal protection per SNiP 23-02-2003 “Thermal Protection of Buildings”.

Potential of natural gas consumed for food preparation is calculated on the assumption that modern gas ovens are 20% more efficient than the existing ones. Potential of natural gas consumed for hot water supply is calculated on the assumption that capacity of modern energy efficient gas boilers is 17 kW and hot water consumption rate is 120 l/day/person.

Coal is used by population mainly for heating of buildings with individual heating. Technological potential for coal was calculated by two scenarios due to differences in the procedures of potential assessment for a housing stock with individual heating.

In the first case, concerning the buildings with individual heating the assumption was made about using the technologies applied when constructing “passive” houses. Thus, coal consumption was brought to zero. In the second case, consumption was calculated on the assumption that buildings with individual heating correspond to the requirements for thermal protection per SNiP 23-02-2003 “Thermal Protection of Buildings”.

Oil products are used by population in buildings with individual heating for heating, hot water supply and food preparation. Assessment of the technological potential for thermal energy does not depend on any scenario since oil products were not used for housing stock heating. Due to insignificant consumed amount of oil products and, therefore, potential, their consumption for hot water supply and food preparation were fixed at the 2008 level.

Other solid fuels the same as coal are used mainly for heating in the buildings with individual heating. Technological potential for other solid fuels was calculated by two scenarios due to differences in the procedures of potential assessment for a housing stock with individual heating.

In the first case, concerning the buildings with individual heating the assumption was made about using the technologies applied when constructing “passive” houses. Thus, thermal energy consumption was brought to zero. In the second case, consumption was calculated on the assumption that buildings with individual heating correspond to the requirements for thermal protection per SNiP 23-02-2003 “Thermal Protection of Buildings”.

Assessment of incremental cost of technological potential implementation seems quite difficult due to lack of special research and calculations in this field. Nevertheless, CENEF has made some assessments. Upgrading cost of buildings with centralized heating is assessed in accordance with SNiP 23-02-2003 “Thermal Protection of Buildings” based on the cost of primary actions on fulfillment of SNiP requirements, namely: installation of insulation, plastic windows and individual heat supply stations.

CENEF research of 86 models of refrigerators, 67 washing machines and 64

TV-sets (primary domestic electrical appliances) sold in Russia at the moment did not discover any significant dependence between the device cost and level of its energy efficiency. Therefore in this case incremental capital investments were set to zero.

Cost of incandescent lamps replacement with compact luminous lamps was assessed based on the difference of costs between these lamps.

4. Potential for increased energy efficiency in the Rostov Oblast

4.1. Summary evaluation of energy efficiency potential and Energy Saving Cost Curves

Technical potential of final energy saving in the Rostov oblast is 4844-5196 K toe or 39-42% of the level of final energy consumption in the year 2008.

Technical potential of primary energy saving in the Rostov oblast is 6622-6874 K toe or 36-37% of the level of primary energy consumption in the year 2008.

Electricity sector accounts for 19% of primary energy saving potential, thermal energy sector accounts for 8%; industry – 11%; agriculture – 1%; transport – 35%; utilities sector – less than 1%, service sphere – 8% and housing sector – 20% (see Fig. 4.1.). Thus, main potential lies in transport and in buildings – two spheres where its implementation is quite expensive.

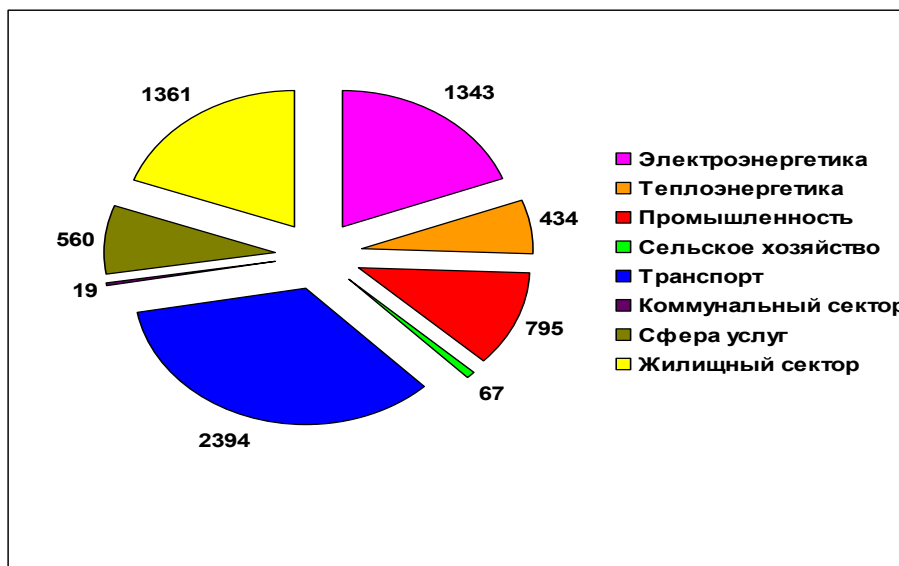


Figure 4.1. Distribution of Energy Saving Potential in the Rostov Oblast in 2008

Ranges in evaluation of the energy saving potential are determined by differences in the individual residential buildings upgrade. Lower share of primary energy saving potential is related to the fact that the calculations did not take into consideration increase of energy generation efficiency by NPPs, and generally the share of the technical potential of saving in electric and thermal energy generation is lower than in other sectors.

Distribution of the technical potential of primary and final energy saving in the Rostov oblast by major actions is shown in table 4.1

Table 4.1. Energy Saving Potential in the Rostov Oblast

Action	Final energy saving	Primary energy saving ¹	Technical potential of energy saving ²
Gas power plants upgrading	268.0	294.8	294.8
Coal power plants upgrading	960.0	998.4	613.1
Electricity transfer	113.3	556.2	435.3
Thermal energy generation at boiler plants	113.1	289.4	36.84
Thermal energy transfer	112.4	287.7	100.12
Cogeneration at boiler plants	270.0	297.0	297.00
Coal mining	22.1	96.2	22.1
Coal conversion	0.7	3.0	0.7
Electric furnace steel manufacture	37.2	182.4	37.2
Martin steel manufacture	122.0	145.2	122.0
Steel pipes manufacture	124.7	225.7	124.7
Chemical fibers and threads manufacture	12.5	38.4	12.5
Cardboard manufacture	0.9	2.7	0.9
Cotton fabrics manufacture	21.0	54.7	21.0
Meat and meat products manufacture	11.6	46.2	11.6
Bread and cereal products manufacture	10.9	20.2	10.9
Efficient electric motors	10.2	50.1	10.2
Variable frequency drive	16.7	82.1	16.7
Efficient compressed air systems	5.9	29.0	5.9
Efficient industrial lighting systems	7.4	36.2	7.4
Efficient steam supply systems	197	504.3	197
Fuel saving in other industrial manufactures	194	424.9	194
Fuel saving increase of tractor fleet	66.4	79.6	66.4
Increased energy efficiency of glasshouse cropping	1.1	1.6	1.1
Increased energy efficiency of electric traction of railway transport	42.3	207.8	42.3
Increased energy efficiency of locomotives and diesel trains	29.9	35.9	29.9
Increased energy efficiency of electric traction of trams	1.5	7.2	1.5
Increased energy efficiency of electric traction of trolleybuses	1.3	6.2	1.3
Increased energy efficiency of gas pipeline transport	1.7	6.7	1.7
Transfer of passenger cars to hybrid analogs	1121.9	1346.3	1121.9
Transfer of buses to hybrid analogs	284.2	341.1	284.2
Transfer of trucks to hybrid analogs	532.0	638.4	532.0
Energy efficient driving	189.76	227.7	189.76
Efficient transport planning and logistics	189.76	227.7	189.76
Variable frequency drive and efficient engines in water supply and removal	14.7	72.1	14.7
Street lighting	4.3	21.1	4.3
Upgrading of service industry buildings with centralized heating	332.7	851.8	332.7
Upgrading of hot water supply systems (service industry)	5.2	13.2	5.2
Increased energy efficiency of food preparation systems (service industry)	0.9	1.4	0.9
Efficient gas boilers (service industry)	124.6	137.0	124.6
Efficient lighting systems (service industry)	28.5	139.8	28.5
Procurement of energy efficient equipment (service industry)	68.5	336.3	68.5
Upgrading of residential buildings with centralized heating	273.24	699.5	273.24
Upgrading of residential buildings with individual heating (option 1)	650.5	1247.5	650.5
Upgrading of residential buildings with individual heating	298.6	572.5	298.6

Action	Final energy saving	Primary energy saving ¹	Technical potential of energy saving ²
(option 2) ³			
Upgrading of hot water supply systems	187.1	479.0	187.1
Replacement of domestic electric hot plates with energy efficient ones	160.9	790.0	160.9
Upgrading of lighting systems of residential buildings	35.1	172.1	35.1
Increased energy efficiency of domestic food preparation systems	53.7	59.0	53.7
Total			6622-6874

¹ Without correction to energy saving by final consumers.

² With account to reduction of the demand in generation and transfer of electricity due to complete implementation of the technical potential of energy saving by final consumers.

³ Is considered as an alternative to the previous line.

Source: CENEF assessment.

When determining the technical potential, simple summation of all components of the two first columns of table 4.1. is not allowed, since potential in electric and thermal energy sector in them is determined taking into consideration the volumes of electric and thermal energy generation in the year 2008. In case of complete implementation of the saving technical potential at final consumers, the volumes of the required generation of these energy carriers will considerably decrease. That is why the saving amounts will reduce considerably in these sectors. Correction to take this factor into consideration is made in the last column of table 4.1. And this has become the basis for assessment of the integral saving of primary energy.

To determine the economic and market potentials of saving, the curves of primary energy saving cost were built up (see Fig. 4.2.). In the first case the cost of primary energy saving was determined using the data on incremental capital investment using the social discount rate (6%). In the second case the additional effects and additional costs were taken into consideration. And finally, in the third case, the cost of primary energy saving was determined for the private rate of return (12%) using the data on additional effects and additional costs from implementation of energy saving actions.

Economic potential of energy saving in the Rostov oblast is equal to the technical potential. Accounting of additional effects and additional costs does not change this result. For some actions additional effects are not determined therefore violet and blue curves on Fig. 4.2. in some zones run into one. Economic potential was determined using the natural gas as the closing price at USD 200/1000 m³ (export price for the natural gas less transport costs and excise taxes).

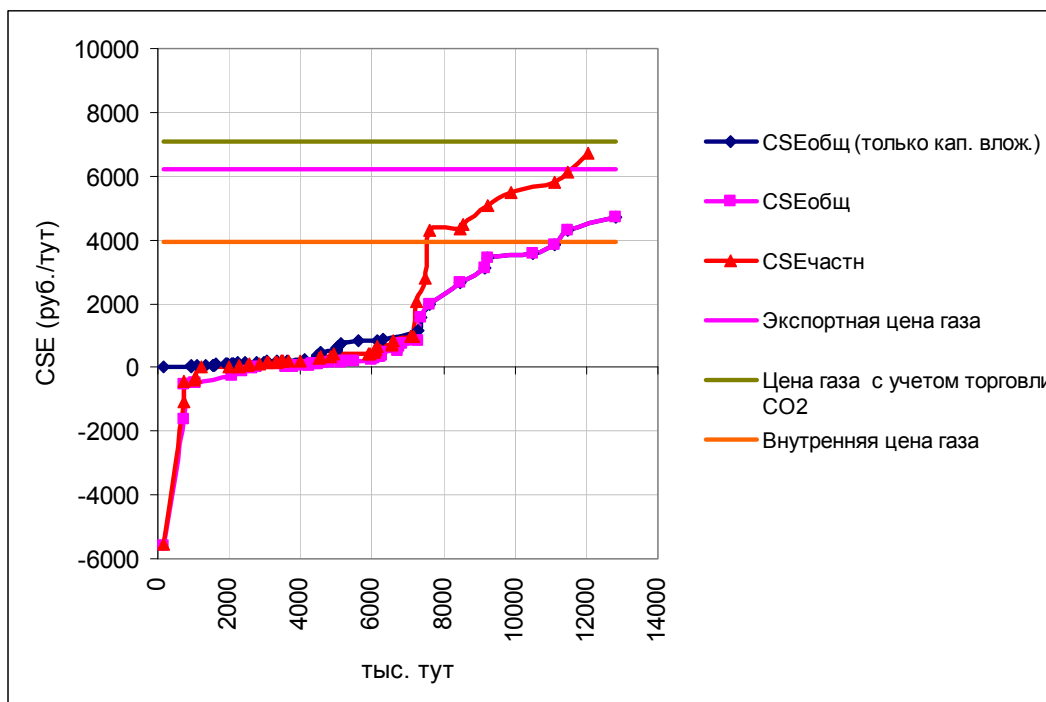


Figure 4.2. Curves of Primary Energy Saving for the Rostov Oblast

Market potential of energy saving in the Rostov oblast is 3488-3588 K toe or 19-20% of the level of primary energy consumption in the year 2008 and 51-54% of the level of technical and economic potentials. The market potential was determined using the average internal price for natural gas expected for the year 2010 as closing price for final consumers at 3940 rub./1000 m³.

Increase of the initial price for gas to 4500 rub./1000 m³ in 2010 would enable expansion of the market potential by 1068 K toes or to 68-69% of the level of technical and economic potentials. To implement the larger potential that fell into the zone of financially unattractive actions (upgrading of service industry and residential buildings with centralized heating, transfer of cars to hybrid engines) state support and adequate price policy are required.

Thus, with some financial support from the federal authorities and adequate price policy in 2010-2012 implementation of the energy saving potential can be commercially attractive if it is minimum 25% of the total primary energy consumption in the sphere and nearly 70% of the level of technical and economic potential of energy saving.

4.2. Potential in Electricity Sector

According to form "6-TP" in 2008 the thermal plants of the Rostov oblast have generated 13.3 MM kW-h including gas plants – 2.4 MM kW-h with average efficiency 38.9%, solid fuel plants – 10.9 MM kW-h with average efficiency 32.9% and gas piston plants – 0.02 MM kW-h with average efficiency 48.6%. These low efficiency indicators at thermal plants of the Rostov oblast are the result of operation of distressed equipment.

Technical potential of increased energy efficiency during electricity

generation in the Rostov oblast and bringing existing plants parameters to the modern technical level is assessed at 1202 K toe with electricity generation at the 2008 level. Coal plants account for 960 K toe and gas plants – 242 K toe.

In 2008 losses in electric grids of the Rostov oblast were 2546 M kW-h or 15.7% of all electricity consumed. Technical losses of electricity in the mains and distribution grids were 2248 M kW-h and commercial losses and losses due to low accuracy of metering devices were 298 M kW-h.

Relatively high level of losses is partly related to the high share of energy consumption by such distributed consumers who obtain MV and LV energy as population, service industry, transport, agriculture (45% of all energy consumption). Some losses are also related to electricity transfer from the Volgodonskaya NPP to other Russian regions.

But the main reason for high losses is depreciation of electric grids facilities that is 60% on the average, and depreciation of substations equipment reaches the level of 80%. According to grid companies (OJSC “FSK EES – MES Yuga” and OJSC “MRSK Yuga”) the Rostov oblast has the following electric grid facilities:

- 1 more than 10 K km of HV lines with 110-220-330-500 kV voltage.
- 2 528 main substations (substation – SS) with 35-110-220-330-500 kV voltage and rated capacity more than 14 GVA;
- 3 more than 67 K km of overhead and cable lines (OHL and CL) of low and medium voltage 35-0.38 kV;
- 4 13748 transformer substations (TSS) with rated capacity 1959 MVA.

If the share of electricity losses is reduced to 10%, its saving potential will be 942 M kW-h. By 2020 some of this potential can be implemented in the amount of 279 M kW-h through:

- 1 Reconstruction and/or upgrading of 10.1 K transformer substations of 1.44 GVA total rated capacity.
- 2 Reconstruction of 53.32 K km of overhead and cable lines of MV and LV distribution grids (35-0.38 kV).
- 3 Reconstruction of 9.83 K km of mains and HV distribution grids (110 kV and more).
- 4 Reconstruction, upgrading and/or expansion of 335 substations (SS) of 10.4 GVA total rated capacity.
- 5 Construction of 1.63 K km of new MV and LV distribution grids (35-0.38 kV).
- 6 Construction of 9.67 K of new transformer substations of 1.18 GVA total rated capacity.
- 7 Construction of 1.88 K km of new mains and HV distribution grids (110 kV and more).
- 8 Construction of about 13 new SS by OJSC “FSK EES – MES Yuga”

and OJSC “MRKS Yuga” of 3.73 GVA total rated capacity.

- 9 Improvement of the system of commercial and technical metering of electricity in grids and consumers (installation of the Automated Information and Measuring System of Commercial Energy Metering at 577.5 K of points for energy supply to consumers).

4.3. Potential in Heat Supply

According to form “1-TEP” the Rostov oblast has about 3379 municipal and departmental boiler plants, that in 2008 have generated 11.4 M Gcal. More than a half of these boiler plants are operating on gas, about one-third – on solid fuel and the rest – on oil products.

According to statistical average efficiency of boiler plants of the Rostov oblast is 87%. But actually it seems much lower. According to the statistical data only 20% of all boiler plants in the Rostov oblast have 95% efficiency (see Fig. 4.3.). But their actual amount seems much lower. Bringing the average efficiency of all gas-operating boiler plants to 95% and others – to 85-90% will enable “removing” the red zone of specific fuel consumption ascent and have saving in the amount of 95.6 K toe.

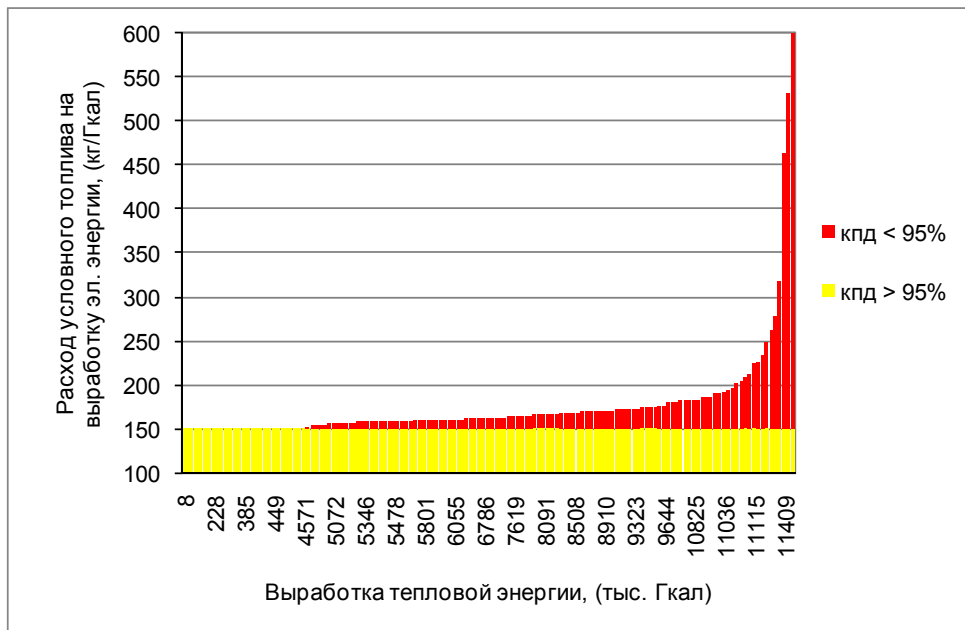


Figure 4.3. Distribution of Rostov Oblast Boiler Plants by Energy Efficiency Level in 2008

Depreciation of boiler plants equipment and low quality of its operation result in excessive consumption of electricity for heat generation and transfer. Upgrading of pumping equipment at the boiler plants will enable saving of 93.5 M kW-h.

Thermal grids of the Rostov oblast are 2780 km long, 7.5% of them need urgent replacement. Average age of thermal grids exceeds 13 years and depreciation is 65%. In many countries of the Western Europe with extensive heat supply systems, losses in thermal grids are 2-10%. In the Rostov oblast average normative losses in thermal grids, according to form “1-TEP” are 10.8%. Average losses in thermal grids, according to CENEF estimates, are 14.8%. Assessment of the energy saving potential supposed

that these losses will be reduced to 10%. The potential of thermal energy saving through reduction of excessive losses in thermal grids will be 112 K toe.

According to CENEF assessment, the oblast may construct 47 CCGT (turbine average power is 4 MW) and 22 CCP (turbine average power is 6 MW). Implementation of this program will result in fuel saving of 270 K toe.

4.4. Potential in Industry

Energy intensity dynamics in the industrial products of the Rostov oblast is difficult to trace because statistics authorities (Rostovstat) provide fixed factors of energy and fuel specific consumption per product unit (form “11-TER”) for many types of products in two recent years (and for some products – in 2006-2008). It is evident that the statistical data are fabricated. This result was obtained by industrial products separated in the oblast’s IFEBs: Martin steel and electric furnace steel, steel pipes, chemical fibers and threads, cotton fabrics, meat and meat products, bread and cereal products. Coal specific consumption are unchanged in 2007-2008 that makes determination of the industry energy saving potential more complicated.

Another difficulty is practical inconsistency of the products list, for that there is information about “practical minimum” – best foreign technologies and products list for that form “11-TER” provides specific consumption for industrial products manufacture in the Rostov oblast. But actual comparison with the “practical minimum” is possible only for electric furnace steel and cardboard. The indicator for the Rostov oblast exceeded those minimums 2.1 and 1.4 times respectively.

For the rest product types comparison can be made only with average or best Russian indicators (see Fig. 4.4.). The Rostov oblast boasts higher Russian average specific consumption of energy for coal manufacture (because of mining domination), martin steel and electric furnace steel, cotton fabrics. On the contrary, energy efficiency of chemical fibers and threads, meat and meat products manufacture is lower than the Russian average indicator.

Specific energy consumption during coal mining are very dependent on mining and geological conditions, formation characteristics, depth and mode of occurrence, maturity, recovery methods and so on. Therefore comparing specific consumption of different countries or regions is quite difficult. Expansion of advanced mining technologies (“ejecting mine” for underground mining) will enable final energy saving.

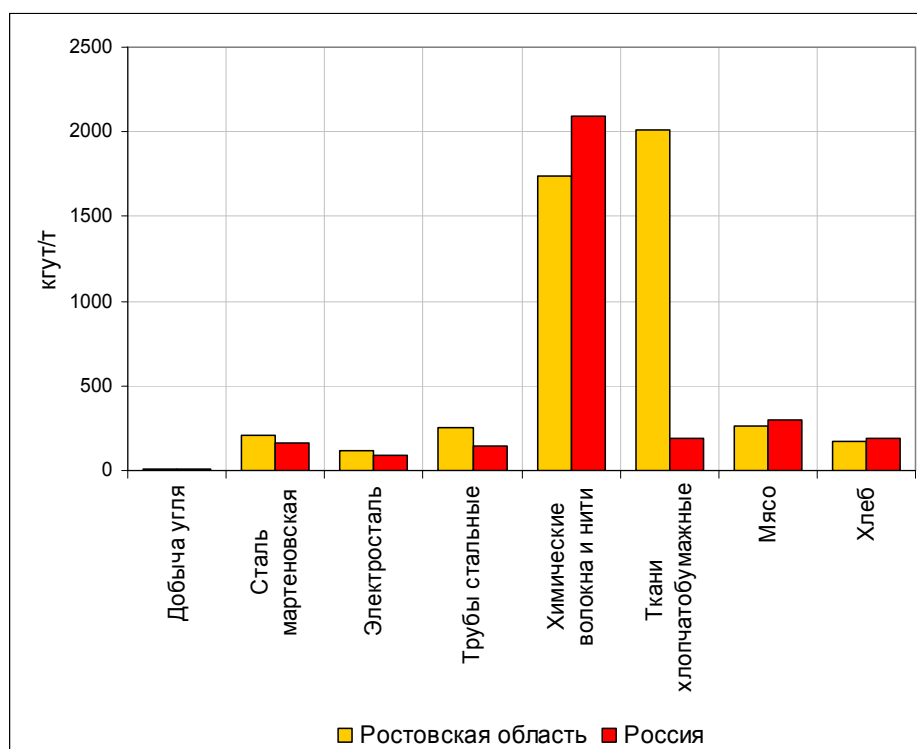


Figure 4.4. Comparison of Specific Energy Consumption for Industrial Products Manufacture in the Rostov Oblast and in Russia

In the years 2007 and 2008 the Rostov oblast industry, less technological needs of energy intensive sectors, consumed 2870 and 2660 MM kW-h of electricity respectively. Minimum half of them, that is about 1330-1440 MM kW-h was consumed by electric motors. Their rated capacity is about 1 GW and fleet – about 144 K units. Approximately 25% of motors are installed in the process equipment, 25% - to pumping equipment, 18% - to compressors for compressed air, 5% - to industrial refrigerators, 13% to ventilation and air conditioning systems, 6% - to conveyors and the rest to other equipment.

Table 4.2. Assessment of the Energy Saving Potential in the Rostov Oblast Industry

	Manufac- ture in 2008.	Specific energy consum- ption in the Rostov oblast	“Practic- al minimu- m”»		Final energy saving potenti- al	Multi- plier of total effect	Primary energy saving potenti- al
	K t	kgoe/t	kgoe/t		K toe	K toe	
Coal mining	7080.7	7.9	4.8	Kemerovo oblast	22.1	4.36	96.2
Coal conversion	3858.2	0.9	0.7	Sakhalin oblast	0.7	4.21	3.0
Electric furnace steel manufacture	608.8	116	55	World practice	37.2	4.91	182.4
Martin steel manufacture	588	207	0	Furnace shutdown in 2009	122.0	1.19	145.2
Steel pipes manufacture	614.2	253	50	Central federal district	124.7	1.81	225.7
Chemical threads and	14.6	1743	887	Moscow oblast	12.5	3.08	38.4

	Manufac- ture in 2008.	Specific energy consum- ption in the Rostov oblast	“Practic- al minimu- m”»		Final energy saving potenti- al	Multi- plier of total effect	Primary energy saving potenti- al
	K t	kgoe/t	kgoe/t		K toe		K toe
fibers manufacture							
Cardboard manufacture	5.6	391	239	World practice	0.9	3.03	2.7
Cotton fabrics manufacture (M m ²)	11.2	2007	138	Volgograd oblast	21.0	2.61	54.7
Meat and meat products manufacture	72.0	210	50	Chelyabinsk oblast	11.6	3.99	46.2
Bread and cereal products manufacture	134.9	170	89	Tambov oblast	10.9	1.85	20.2
Efficient electric motors				Calculation by model	10.2	4.91	50.1
Variable frequency drive				Calculation by model	16.7	4.91	82.1
Efficient compressed air systems				Calculation by model	5.9	4.91	29.0
Efficient industrial lighting systems				Calculation by model	7.4	4.91	36.2
Efficient steam supply systems				Calculation by model	197	2.56	504.3
Fuel saving in other industrial productions				Value	194	2.19	424.9
Total					794.6		1941.4

*The estimate should be adjusted since during commissioning of a new electric arc furnace in 2008 at OJSC “Tagmet” (Taganrog Metallurgical Combine) the data of the average specific consumption for electric furnace steel manufacture were at the 2007 level.

Source: CENEF assessment

Replacement of motors with more efficient ones usually provide about 25% of all saving in the electric motor systems. Other 32% account for optimization and control of pump operation, 15% - in the compressed air systems, 8% - in ventilation systems and 9% of saving account for introduction of electric motor control systems.

Implementation of the program for using the efficient electric motors in the Rostov oblast will enable electricity saving in the amount of 47.2 M kW-h. Saving of other 36 M kW-h can be reached through excessive power take-off of electric motors. Total – 10.2 K toe (see table 4.1).

Promotion of variable electric drives will enable electricity saving in the amount of 136 M kW-h in non-energy intensive industry alone (table 4.1.). indirect effects of this project will include improvement of control over the production processes and motors operational lifetime. Average cost of a variable frequency drive for ordinary industrial motors and drives with fans will be about USD 150 kW of motor capacity. Normally payback period of such projects is 0.5-2 years.

In 2008 in the Rostov oblast large and medium enterprises produced 1.46 MM m³ of compressed air and consumed more than 146 M kW-h for these

purposes.

Saving potential in the compressed air systems is assessed at 20-50%. The calculations assumed saving potential as 33% or 48 M kW-h (see table 4.1.) Possible saving in industrial lighting systems is assessed at 60 K kW-h.

In 2007 the industry consumed 6.6 M Gcal of heat including non-energy intensive industry – 6.1 M Gcal. Steam is the heat transfer medium for the most part of thermal energy – 70-80%, hot water used for heating and ventilation accounts for the rest 20-30%. Thus, steam consumption in non-energy intensive sectors can be assessed at 4.6 M Gcal.

Steam saving potential is equal 1.4 M Gcal or 197 K toe (see table 4.1.).

In 2007 Rostov oblast non-energy intensive industry consumed 919 K toe of fuel including 122 K toe of fuel for martin steel manufacture at OJSC “Tagmet” (Taganrog Metallurgical Combine). In 2008 this enterprise commissioned a new electric arc furnace of capacity 950-1000 K t of steel annually. Following this, OJSC “TAGMET” was planning to shutdown the Siemens-Martin plant (production capacity 600 K t of steel) in 2009. Thus, fuel saving of 122 K toe will be achieved.

Other 129 K t of fuel was consumed during steel pipes manufacture, 6 K toe during cotton fabric manufacture and 17 K toe during bread and cereal products manufacture. 645 K toe accounted for other industrial productions. Fuel saving potential in these productions can be assessed at 30%, or 194 K toe.

Total potential of final energy saving in the industry of the Rostov oblast is assessed at 795 K toe or 33% of total energy consumption in the industry (less electric and thermal energy sector) in 2008.

Total potential of primary energy saving in the industry is assessed at 1941 K toe or 10.6% of total primary energy consumption in the Rostov oblast in 2008.

4.5. Potential in Agriculture

In the Rostov oblast specific energy and fuel consumption by tractors per 1 ha in 2000-2008 reduced by 9%; for water transfer for melioration – by 2% and for irrigation and drainage of lands was stable. In 2000-2007 specific consumption for glasshouse heating reduced by 6%, in 2002-2007 for static greenhouse heating – by 7%.

Total potential of energy saving in the agriculture due to two above actions was 79 K toe (see table 4.3.). Energy saving potential at rural boiler plants, thermal and electric grids, diesel power plants was taken into account in the respective sections.

Table 4.3. Assessment of Energy Saving Potential in Agriculture of the Rostov Oblast

	Scope of work, products or transport fleet in 2008	Specific energy consumption in the Rostov oblast	“Practical minimum”»		Final energy saving potential	Multiplier of total effect	Primary energy saving potential
		kgoe	kgoe		K toe		K toe
Tractor operation (per 1000 ha)	14815	11	7	Target value for the RF as of 2020	66.4	1.20	79.6
Static greenhouse heating (1000 m ²)	98.0	22	11	World practice	1.1	1.50	1.6

Source: CENEF assessment

4.6. Potential in Transport

4.6.1. Railway Transport

Statistical data for the Rostov oblast enable assessing the energy saving potential in the following types of transport: for electric locomotives (specific consumption in 2000-2008 reduced by 9%); diesel locomotives and trains (specific consumption reduced by 6%); trams (specific consumption reduced by 1%); trolleybuses (specific consumption reduced by 1%); and for transportation of natural gas by pipelines (specific consumption reduced by 57%).

Energy efficiency indicators of the railway transport of the Rostov oblast are considerably lower than current Russian average indicators and even lower than target values for Russian as of 2020. Energy saving potential for railways is assessed on the assumption that specific consumption for railway transport can be reduced:

- 1 for electric traction of trains from 18 kgoe/10 K ton-km gross in 2008 (average value for Russia is 12 kgoe/10 K ton-km gross) to 10.0 kgoe/10 K ton-km gross in 2020 (target value for Russia as of 2020);
- 2 for diesel locomotives and trains from 67 kgoe/10 K ton-km gross in 2008 (average value for Russia is 62 kgoe/10 K ton-km gross) to 40.0 kgoe/10 K ton-km gross in 2020.

As a result, the potential of primary energy saving for railway transport is assessed at 345 K toe (see table 4.4.). There are opportunities to reduce operation and production costs at railroads but they are difficult to determine based on the comparative analysis.

Some success in reduction of specific energy consumption in 2000-2008 due to optimization of railroad loads and management was partly neutralized by the growing depreciation of equipment: 60% of power equipment were operated and 65-73% of the rolling stock with expired service life. This provides a large potential of energy saving in the railway sector.

Table 4.4. Assessment of the Potential of Energy Saving in Transport of the Rostov Oblast

	Scope of work, products or transport fleet in 2008	Specific energy consumption in the Rostov oblast	“Practical minimum”		Final energy saving potential	Multiplier of total effect	Primary energy saving potential
		kgoe/t	kgoe/t		K toe		K toe
Electric traction of trains (per 10 M t-km gross)	5295	18.0	10.0	Tyumen and Kurgan oblasts	42.3	4.91	207.8
Diesel locomotives and trains operation of the Ministry of Railways (per 10 M t-km gross)	1103	67.1	40.0	Target value for the RF as of 2020	29.9	1.20	35.9
Electric traction of trams (per 1 M t-km gross)	138	15.6	5.0	Russian average	1.5	4.91	7.2
Electric traction of trolleybuses (per 1 M t-km gross)	112	18.6	7.3	Russian average	1.3	4.91	6.2
Transfer of natural gas by gas pipelines (MM m ³ -km)	27.93	87.4	25.0	Target value for the RF as of 2020	1.7	3.83	6.7

Source: CENEF assessment

4.6.2. Urban Electric Transport

Statistical data for the Rostov oblast enable assessing the energy saving potential in urban electric transport alone: trams and trolleybuses. In 2000-2008 specific consumption by these transports stayed almost the same. The potential is assessed at 13.5 K toe when using the Russian average indicators as “minimum practical level”.

4.6.3. Pipeline Transport

Statistical data for the Rostov oblast enable assessing the energy saving potential in natural gas transfer by main pipelines alone. According to form “11-TER” specific consumption dropped in 2003-2004 due to abrupt reduction of the thermal energy use but the same figure is given for 2005-2008. Such dynamics erode credibility of the specific consumption indicator. In 2008 it was still three times as much the Russian average indicator. But the limited scale of transportation of natural gas provide quite a conservative estimate of the saving potential (see table 6.3.).

4.6.4. Road Transport

Fuel consumption by road transport of the Rostov oblast and energy saving potential were assessed by model MET-Rostov oblast by four transport types: buses, passenger cars and trucks, other vehicles.

In 2008 road transport of the Rostov oblast consumed 3795.1 K toe (mainly gasoline and diesel fuel), including 2157.5 K toe accounted for passenger car in the amount of 900.2 K pieces; 546.6 K toe accounted for buses in the

amount of 24.2 K pieces; 1023.1 K toe accounted for trucks in the amount of 166.1 K pieces; 67.9 K toe accounted for other vehicles.

Technological potential is 2317 K toe or 60% of total fuel consumption by road transport (see table 4.5.). This assessment falls in the range determined by IEA.

Table 4.5. Assessment of Fuel Saving Potential at the Road Transport of the Rostov Oblast

	Vehicles fleet in 2008.	Specific energy consumption in the Rostov oblast	“Practical minimum”		Final energy saving potential	Multiplier of total effect	Primary energy saving potential
	K	toe/year/car	toe/year/car		K toe	K toe	
Transfer of passenger cars to hybrid analogs	764.0	2.1	1.11	World practice	1121.9	1.20	1346.3
Transfer of buses to hybrid analogs	20.2	10.3	5.57	World practice	284.2	1.20	341.1
Transfer of trucks to hybrid analogs	86.9	21.5	11.59	World practice	532.0	1.20	638.4
Energy efficient driving				World practice	189.76	1.20	227.7
Efficient transport planning and logistics				World practice	189.76	1.20	227.7

Source: CENEF assessment

4.6.5. Other Vehicles

Missing data on fuel efficiency and fleet of other vehicles – air and water transport – does not enable assessing the energy saving potential.

Total potential of primary energy saving in the transportation sector is assessed at 2134 K toe or 55% of energy consumption by transport in the Rostov oblast in 2008. Potential of primary energy saving is 2638 K toe.

4.7. Potential in the Utilities Sector

The Rostov oblast consumed 0.75 MM kW-h of electricity for lifting and distribution of potable water and pumping and treatment of sewage waters in 2008. Practically all electricity consumption in the water supply and water removal sector account for electric motors of water intake facilities, pumping and sewage stations. Most electric motors have low efficiency in comparison with modern models, operating life 20 years and more and excessive rated capacity. Variable frequency drives are also not widely used in the water supply and removal systems.

Implementation of the potential of using the efficient electric motor will enable electricity saving of 17.7 K kW-h. Promotion of variable electric drives will enable electricity saving of 119 M kW-h.

Upgrading of the street lighting systems will enable saving of 35 M kW-h.

4.8. Potential in the Service Industry

Technological potential of energy saving in the service facilities of the Rostov oblast was assessed by model ERV-Rostov oblast by the following types of energy and energy carriers: thermal energy, electricity, natural gas, coal, oil products and other solid fuels according to the procedure from section 3. As seen from table 4.6. the technological potential is 560 K toe or 51% of total final energy consumption by the service industry.

Table 4.6. Assessment of the Fuel Saving Potential in the Service Industry of the Rostov Oblast

	Area of buildings or equipment fleet	Specific energy consumption in the Rostov oblast	“Practical minimum”		Final energy saving potential	Multiplier of total effect	Primary energy saving potential
					K toe		K toe
Upgrading of service industry buildings with centralized heating	17371	0.261	0.127	Per SNiP of the year 2003	332.7	2.56	851.8
Upgrading of hot water supply systems (service industry)	2291	0.0054	0.0031	World practice	5.2	2.56	13.2
Increased energy efficiency of food preparation systems (service industry)	2291	0.0031	0.0027	World practice	0.9	1.5	1.4
Efficient gas boilers (service industry)	2580	0.261	0.213	World practice	124.6	1.10	137.0
Efficient lighting systems (service industry)	26763	26.236	18.796	World practice	28.5	4.91	139.8
Procurement of energy efficient equipment (service industry)	26763	69.375	51.479	World practice	68.5	4.91	336.3

Source: CENEF assessment

4.9. Potential in the Housing Sector

Energy consumption by the housing sector of the Rostov oblast and energy saving potential were assessed by model MAN-Rostov oblast by the following types of energy and energy carriers: thermal energy, electricity, natural gas, coal, oil products and other solid fuels. The result is given in table 4.7.

Technological potential of energy saving in the housing sector depending on the upgrading of individual buildings is 1009-1360 K toe or 22-31% of total energy consumption by the housing sector. But when recalculating final energy saving to the primary energy, the capacities of the housing sector in reduction of energy consumption increase considerably.

Table 4.7. Assessment of the Potential of Energy Saving and Energy Carriers in the Housing Sector of the Rostov Oblast

	Area of buildings or equipment fleet	Specific energy consumption in the Rostov oblast	“Practical minimum”		Final energy saving potential	Multiplier of total effect	Primary energy saving potential
					K toe		K toe
Upgrading of residential buildings with centralized heating	47168	10.89	5.09	Per SNIIP of the year 2003	273.24	2.56	699.5
Upgrading of residential buildings with individual heating (option 1)	41932	16.33	0.817	“Passive” buildings	650.5	1.92	1247.5
Upgrading of residential buildings with individual heating (option 2)	41932	16.33	9.21	Individual buildings per SNIIP 2003	298.6	1.92	572.5
Upgrading of hot water supply systems	89100	5.20	3.10	World practice	187.1	2.56	479.0
Replacement of domestic electric hot plates with energy efficient ones	4246	58.74	20.84	World practice	160.9	4.91	790.0
Upgrading of lighting systems of residential buildings	15254	53.85	20.00	World practice	35.1	4.91	172.1
Increased energy efficiency of domestic food preparation systems	89463	3.40	2.80	World practice	53.7	1.10	59.0

Sources: CENEF assessment

5. Increased energy efficiency Potential in the Sverdlovsk Oblast

5.1. Evaluation Summary of Increased energy efficiency Potential and Curves of Energy Saving Cost

Technical potential of final energy saving in the Sverdlovsk oblast is 11579-11976 K toe or 33-34% of the level of final energy consumption in the year 2008.

Technical potential of primary energy saving in the Sverdlovsk oblast is 24070-24468 K toe or 49-50% of the level of primary energy consumption in the year 2008.

Electricity sector accounts for 50% of primary energy saving potential, thermal energy sector accounts for 2%; industry – 24%; agriculture – less than 1%; transport – 12%; utilities sector – less than 1%, service sphere – 2% and housing sector – 10% (see Fig. 5.1.). Thus, three thirds of the potential for the Sverdlovsk oblast lies in electricity sector and industry.

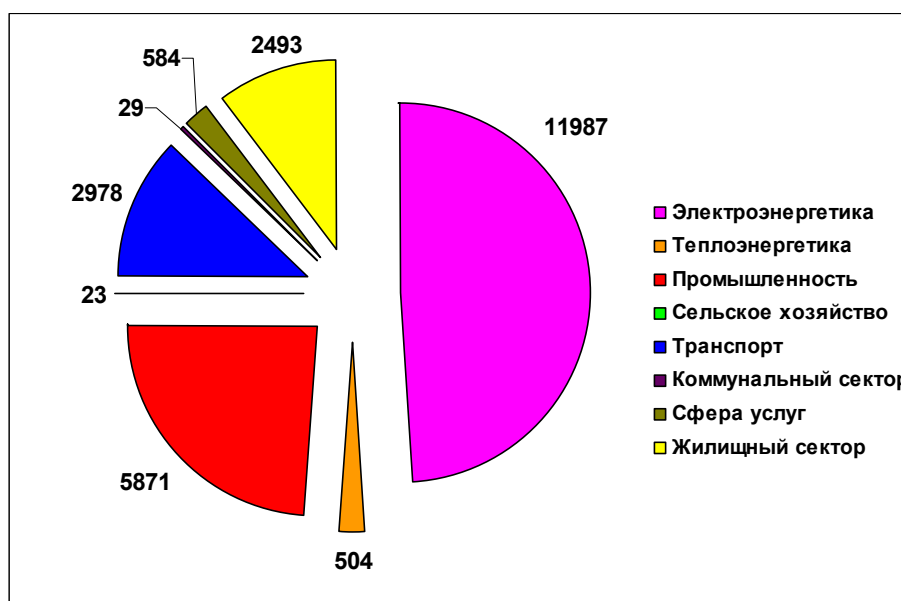


Figure 5.1. Distribution of Energy Saving Potential in the Sverdlovsk Oblast in 2008

Ranges in evaluation of the energy saving potential are determined by differences in the individual residential buildings upgrade.

Distribution of the technical potential of primary and final energy saving in the Sverdlovsk oblast by major actions is shown in table 5.1

Table 5.1. Energy Saving Potential in the Sverdlovsk Oblast

Action	Final energy saving	Primary energy saving ¹	Technical potential of energy saving ²
Gas power plants upgrading	7638	8402.2	8402.2
Coal power plants upgrading	3828	3981.2	3391.7

Action	Final energy saving	Primary energy saving ¹	Technical potential of energy saving ²
Electricity transfer	46.3	227.3	193.3
Thermal energy generation at boiler plants	405.6	431.6	188.53
Thermal energy transfer	104.4	267.3	209.26
Cogeneration at boiler plants	100.0	106.4	106.40
Coal mining	4.5	19.0	4.5
Iron ore manufacture	42.4	191.0	42.4
Iron-ore agglomerate manufacture	34.8	53.6	34.8
Iron-ore pellets manufacture	56.4	108.9	56.4
Coke manufacture	436.4	742.3	436.4
Cast iron manufacture	1323.9	1438.8	1323.9
Martin steel manufacture	122.0	152.0	122.0
Basic oxygen steel manufacture	122.0	478.4	122.0
Electric furnace steel manufacture	37.7	150.5	37.7
Rolled iron manufacture	678.2	1266.1	678.2
Steel pipes manufacture	405.1	790.0	405.1
Electric ferrous alloys manufacture	24.3	85.1	24.3
Aluminum manufacture	117.8	578.3	117.8
Alumina manufacture	278.8	713.8	278.8
Cellulose manufacture	9.8	26.5	9.8
Paper manufacture	10.2	32.4	10.2
Cardboard manufacture	4.3	12.8	4.3
Cement manufacture	50.1	73.7	50.1
Clinkers manufacture	207.5	305.0	207.5
Wool fabrics manufacture	2.0	5.9	2.0
Meat and meat products manufacture	30.2	94.5	30.2
Bread and cereal products manufacture	26.4	51.3	26.4
Efficient electric motors	86.1	167.5	86.1
Variable frequency drive	103.9	510.3	103.9
Efficient compressed air systems	37.4	183.6	37.4
Efficient industrial lighting systems	64.6	317.1	64.6
Efficient steam supply systems	197	504.3	197
Fuel saving in other industrial manufactures	1357	3256.8	1357
Fuel saving increase of tractor fleet	13.0	15.6	13.0
Increased energy efficiency of glasshouse cropping	9.7	25.3	9.7
Increased energy efficiency of electric traction of railway transport	64.0	314.3	64.0
Increased energy efficiency of locomotives and diesel trains	10.6	12.3	10.6
Increased energy efficiency of electric traction of trams	6.9	34.0	6.9
Increased energy efficiency of electric traction of trolleybuses	3.4	16.7	3.4
Increased energy efficiency of electric traction of underground trains	0.2	0.8	0.2
Increased energy efficiency of gas pipeline transport	660.6	779.6	660.6
Transfer of passenger cars to hybrid analogs	1121.9	1346.3	1121.9
Transfer of buses to hybrid analogs	284.2	341.1	284.2
Transfer of trucks to hybrid analogs	532.0	638.4	532.0
Energy efficient driving	147.0	176.4	147.0
Efficient transport planning and logistics	147.0	176.4	147.0
Variable frequency drive and efficient engines in water supply and removal	19.1	93.8	19.1
Street lighting	9.6	47.3	9.6
Upgrading of buildings with centralized heating (per SNiP of the year 2003) (service industry)	296.3	758.6	296.3
Upgrading of hot water supply systems (service industry)	4.6	11.9	4.6
Increased energy efficiency of food preparation systems (service industry)	1.1	1.6	1.1

Action	Final energy saving	Primary energy saving ¹	Technical potential of energy saving ²
Efficient gas boilers (service industry)	167.8	184.5	167.8
Efficient lighting systems (service industry)	42.9	210.8	42.9
Procurement of energy efficient equipment (service industry)	71.3	350.2	71.3
Upgrading of residential buildings with centralized heating	965.7	2472.2	965.7
Upgrading of residential buildings with individual heating (option 1)	736.0	1411.4	736.0
Upgrading of residential buildings with individual heating (option 2)	337.8	647.7	337.8
Upgrading of hot water supply systems	523.1	1339.1	523.1
Replacement of domestic electric hot plates with energy efficient ones	172.2	845.5	172.2
Upgrading of lighting systems of residential buildings	37.9	185.9	37.9
Increased energy efficiency of domestic food preparation systems	57.8	63.6	57.8
Total			24070-24468

¹ Without correction to energy saving at final consumers.

² With account to reduction of the demand in generation and transfer of electricity due to complete implementation of the technical potential of energy saving at final consumers.

³ Is considered as an alternative to the previous line.

Source: CENEF assessment.

When determining the technical potential, simple summation of all components of the two first columns of table 5.1. is not allowed, since potential in electric and thermal energy sector in them is determined taking into consideration the volumes of electric and thermal energy generation in the year 2008. In case of complete implementation of the saving technical potential at final consumers, the volumes of the required generation of these energy carriers will considerably decrease. That is why the saving amounts will reduce considerably in these sectors. Correction to take this factor into consideration is made in the last column of table 5.1. And this has become the basis for assessment of the integral saving of primary energy.

To determine the economic and market potentials of energy saving, the curves of primary energy saving cost were built up (see Fig. 5.2.). In the first case the cost of primary energy saving was determined using the data on incremental capital investment using the social discount rate (6%). In the second case the additional effects and additional costs were taken into consideration. And finally, in the third case, the cost of primary energy saving was determined for the private rate of return (12%) using the data on additional effects and additional costs from implementation of energy saving actions.

Economic potential of energy saving in the Sverdlovsk oblast is equal to the technical potential. Accounting of additional effects and additional costs does not change this result. For some actions additional effects are not determined therefore violet and blue curves on Fig. 5.2. in some zones run into one. Economic potential is determined using the natural gas as the closing price at USD 200/1000 m³ (export price of the natural gas less

transport costs and excise taxes).

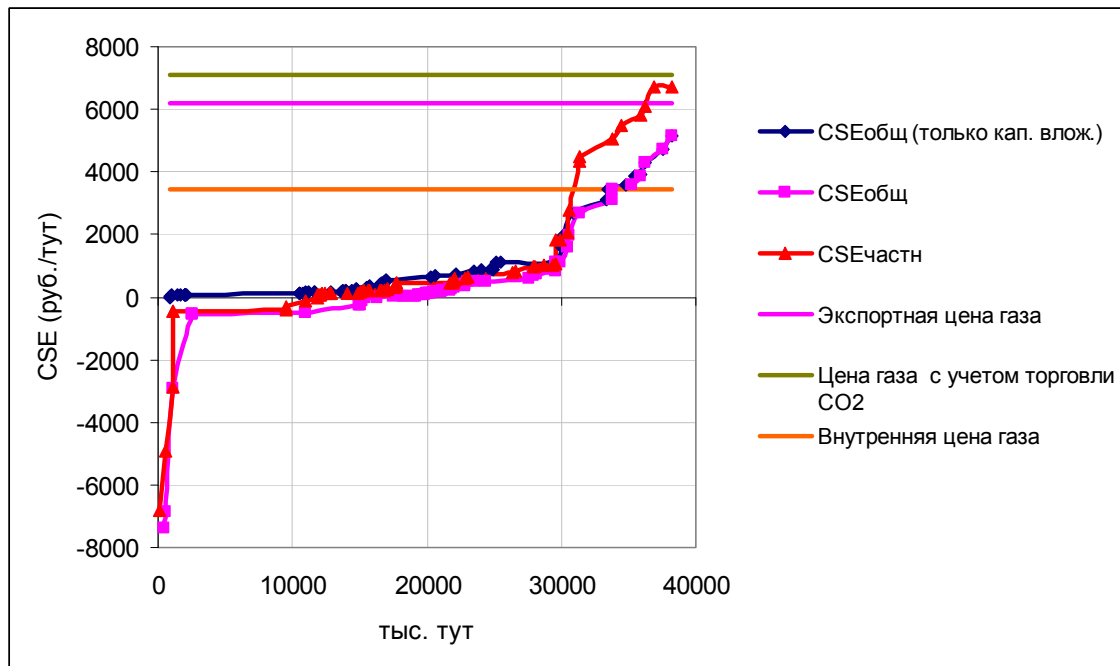


Figure 5.2. Curves of Primary Energy Saving for the Sverdlovsk Oblast

Market potential of energy saving in the Sverdlovsk oblast is 21195-20829 K toe or 43% of the level of primary energy consumption in the year 2008 and 85-88% of the level of technical and economic potentials.

The market potential was determined using the average internal price for natural gas expected for the year 2010 as closing price for final consumers at 3545 rub./1000 m³.

Increase of the initial price for gas to 4500 rub./1000 m³ in 2010 would enable expansion of the market potential by 309 K toe or to 86-89% of the level of technical and economic potentials. To implement the larger potential that fell into the zone of financially unattractive actions (upgrading of service industry and residential buildings with centralized heating, transfer of cars to hybrid engines) state support and adequate price policy are required.

5.2. Potential in Electricity Sector

According to form "6-TP" in 2008 the thermal plants of the Sverdlovsk oblast have generated 48.2 MM kW-h including gas plants – 49.6 MM kW-h with average efficiency 34.0%, solid fuel plants – 50.4 MM kW-h with average efficiency 34.0% and gas piston plants – 0.5 M kW-h with average efficiency 6.2%. These low efficiency indicators at thermal plants of the Sverdlovsk blast are the result of operation of distressed equipment.

Potential of increased energy efficiency in the energy sector of the Sverdlovsk oblast was assessed for gas thermal plants on the assumption of efficiency enhancement to 60% and for gas plants – to 48%. Technical potential of increased energy efficiency during electricity generation in the Sverdlovsk oblast and bringing existing plants parameters to the modern

technical level is 11466 K toe with electricity generation at the 2008 level. Coal plants account for 3828 K toe and gas plants – 7638 K toe.

In 2008 losses in electric grids of the Sverdlovsk oblast 3991 M kW-h (8.1% of all energy consumption). High share of energy consumption by the industry that obtains HV electricity is one of the main factors of a relatively low level of losses.

According to grid companies (OJSC “FSK EES – MES Urala” and OJSC “MRSK Urala”) the Sverdlovsk oblast has more than 12.73 K km of HV lines with 110-220-500 kV voltage; 400 main substations (substation – SS) with 35-110-220-500 kV voltage and rated capacity more than 11 GVA; more than 27 K km of overhead and cable lines (OHL and CL) of low and medium voltage 35-0.38 kV; 7301 transformer substations (TSS) with rated capacity 1825 MVA. And most these facilities (60-70%) are very depreciated.

The study showed that electricity losses during transfer by electric grids of the Sverdlovsk oblast can be reduced by the year 2020 by 375 M kW-h (46 K toe) through: reconstruction and/or upgrading of 5.4 K transformer substations of 1.4 GVA total rated capacity; reconstruction of 24.9 K km of overhead and cable lines of MV and LV distribution grids (35-0.38 kV); reconstruction of 12.4 K km of mains and HV distribution grids (110 kV and more); reconstruction, upgrading and/or expansion of 215 substations (SS) of 11.2 GVA total rated capacity; construction of 5.43 K km of new MV and LV distribution grids (35-0.38 kV); construction of 15.7 K of new transformer substations of 3.93 GVA total rated capacity; construction of 1.23 K km of new mains and HV distribution grids (110 kV and more); construction of 16 new SS of 4.53 GVA total rated capacity; improvement of the system of commercial and technical metering of electricity in grids and consumers (installation of the Automated Information and Measuring System of Commercial Energy Metering at 346.6 K of points for energy supply to consumers).

5.3. Potential in Heat Supply

According to form “1-TEP” the Sverdlovsk oblast has about 1330 municipal and departmental boiler plants, that in 2007 have generated 30.7 M Gcal. 40% of these boiler plants are operating on gas, 60% – on solid fuel and the rest – on oil and oil products.

Average efficiency of boiler plants of the Sverdlovsk oblast is 86% and 92-95% in the West European countries. Bringing the average efficiency of all gas-operating boiler plants to 95% (the level achieved at many new boiler plants constructed recently) and others – to 85-90% will enable fuel saving of 406 K toe. Upgrading of pumping equipment at the boiler plants will enable saving of 227.4 M kW-h.

Thermal grids of the Sverdlovsk oblast are 7837 km long, 25% of them need urgent replacement. Average age of thermal grids exceeds 18 years and depreciation is 75%. In the Sverdlovsk oblast average losses in thermal grids (according to form “1-TEP”) are 5.4%. Relatively low losses is the result of high share of thermal energy consumption not only in the industry (52% of the final thermal energy consumption). The industry does not

provide information about losses of thermal energy in industrial grids. According to CENEF estimates, making corrections to unaccounted losses when supplying heat to residential and public buildings brings the losses share to 6.4%. The potential of thermal energy saving through reduction of excessive losses in thermal grids of the Sverdlovsk oblast is 104 K toe.

Fuel saving can be 100 K toe more following implementation of actions on joint generation of thermal and electricity at boiler plants.

5.4. Potential in Industry

To assess the energy efficiency level during manufacture of the energy-intensive industrial products, average indicators for the Sverdlovsk oblast are compared with the average indicators for Russia and best indicators for the world (see Fig, 5.3.). Unlike others, the Sverdlovsk oblast has an opportunity to compare its indicators with the best world practice by a long list of industrial products. It was the basis to determine the potential of increased energy efficiency for energy-intensive industries (see table 5.2.).

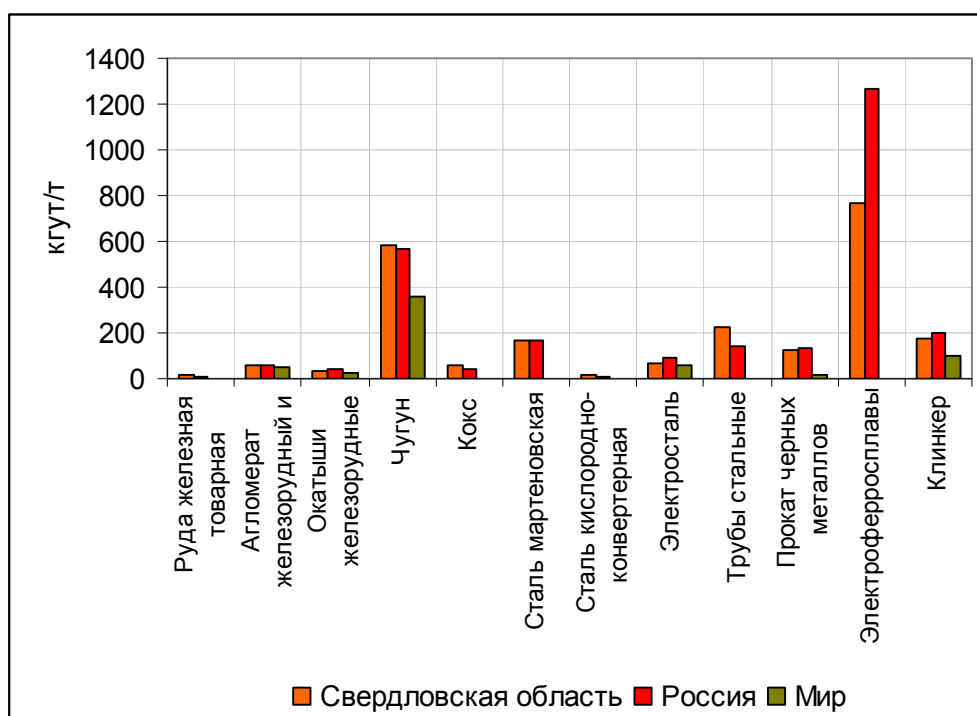


Figure 5.3. Comparison of Specific Energy Consumption for Industrial Products Manufacture in the Sverdlovsk Oblast and in Russia

In the Sverdlovsk oblast specific consumption for manufacture of all energy-intensive products is much higher than the best world practices and in some case higher than the Russian average indicators (see table 5.2.). The potential of increased energy efficiency in the energy-intensive industry of the Sverdlovsk oblast was assessed mainly as a result of comparing with the best world practice.

Table 5.2. Assessment of the Energy Saving Potential in the Sverdlovsk Oblast Industry

	Manufacture in 2007	Specific energy consumption in the Sverdlovsk oblast	“Practical minimum”»		Final energy saving potential	Multiplier of total effect	Primary energy saving potential
1	K t	kgoe/t	kgoe/	5	K toe	7	K toe
	2	3	4		6		8
Coal mining	1322.0	6.0	2.6	Khakassia Republic	4.5	4.21	19.0
Iron ore manufacture	4987.5	17.0	8.5	World practice	42.4	4.51	191.0
Iron-ore agglomerate manufacture	6436.2	56.3	50.9	World practice	34.8	1.54	53.6
Iron-ore pellets manufacture	6028.8	33.4	24.0	World practice	56.4	1.93	108.9
Coke manufacture	2909.2	269.0	119.0	World practice	436.4	1.70	742.3
Cast iron manufacture	5876.8	580.3	355.0	World practice	1323.9	1.09	1438.8
Martin steel manufacture	3154.9	165	106.5	Volgograd oblast	122.0	1.25	152.0
Basic oxygen steel manufacture	3817.1	13.1	-15.0	World practice	122.0	3.92	478.4
Electric furnace steel manufacture	2483.6	70	55	World practice	37.7	3.99	150.5
Rolled iron manufacture	7051.0	127	31	World practice	678.2	1.87	1266.1
Steel pipes manufacture	2309.5	226	50	World practice	405.1	1.95	790.0
Electric ferrous alloys manufacture	372.0	765	765	Sverdlovsk oblast	24.3	3.51	85.1
Aluminum manufacture	319.2	1968	1599	World practice	117.8	4.91	578.3
Alumina manufacture	1814.3	478	324	World practice	278.8	2.56	713.8
Cellulose manufacture	39.1	610	358	World practice	9.8	2.69	26.5
Paper manufacture	39.0	569	307	World practice	10.2	3.17	32.4
Cardboard manufacture	7.2	835	239	World practice	4.3	2.98	12.8
Cement manufacture	3417.4	18	3	World practice	50.1	1.47	73.7
Clinkers manufacture	3003.1	174	105	World practice	207.5	1.47	305.0
Wool fabrics manufacture	3.0	1452	799	Bashkortostan Republic	2.0	3.01	5.9
Meat and meat products manufacture	82.9	415	50	Chelyabinsk oblast	30.2	3.12	94.5
Bread and cereal products manufacture	170.2	244	89	Tambov oblast	26.4	1.94	51.3
Efficient electric motors				Calculation by model	86.1	1.95	167.5
Variable frequency drive				Calculation by model	103.9	4.91	510.3
Efficient compressed air systems				Calculation by model	37.4	4.91	183.6
Efficient industrial lighting systems				Calculation by model	64.6	4.91	317.1
Efficient steam supply systems				Calculation by model	197	2.56	504.3
Fuel saving in other industrial productions				Calculation by model	1357	2.40	3256.8
Total					5870.8		12309.1

In the year 2007 the Sverdlovsk oblast industrial electric motors consumed 12.75 MM kW-h. Electric motors rated capacity is about 8.5 GW and fleet – about 1280 K units. Implementation of the program for using the efficient electric motors in the Sverdlovsk oblast will enable electricity saving in the amount of 450 M kW-h. Saving of other 250 M kW-h can be reached through excessive power take-off of electric motors. Total – 86.1 K toe. Use of variable electric drives will enable electricity saving in the amount of 845 M kW-h (table 5.2.).

Implementation of the program for increasing electric motors efficiency in addition to electricity saving can provide electricity saving in the amount of minimum 580 MW. Construction of these facilities at USD 1500-3000/kW would cost USD 870-1740 M that considerably exceeds the cost for implementation of the program for increase of electric motors efficiency.

In 2008 in the Sverdlovsk oblast large and medium enterprises produced 8.8 MM m³ of compressed air and consumed 922 M kW-h for these purposes. Saving in the compressed air systems can be 304 M kW-h (see table 5.2.).

Industrial lighting systems consume about 1500 M kW-h. Replacement of old lighting fixtures with new efficient ones with electronic control equipment, introduction of control systems for lighting when using the daylight will enable saving about 35% or 525 M kW-h (see table 5.2.).

In 2007 the Sverdlovsk oblast industry consumed 34.5 M Gcal of heat including non-energy intensive industry – 26 M Gcal.

Steam is the heat transfer medium for the most part of thermal energy – 70-80%, hot water used for heating and ventilation accounts for the rest 20-30%. Thus, steam consumption in non-energy intensive sectors can be assessed at 19.5 M Gcal. The calculations for upgraded steam supply systems used the assessment of the average saving at 30%. Steam saving potential is equal 5.9 M Gcal or 836 K toe (see table 5.2.).

In 2007 non-energy intensive industry consumed 4523 K toe. Fuel saving potential in these industries can be assessed at 30% or 1357 K toe.

Total potential of final energy saving in the industry of the Sverdlovsk oblast is assessed at 5870 K toe or 30% of total final energy consumption in the industry (less electric and thermal energy sector) in 2007.

Total potential of primary energy saving in the industry is assessed at 12.3 M toe or 25% of total primary energy consumption in the Sverdlovsk oblast in 2007.

5.5. Potential in Agriculture

In the Sverdlovsk oblast specific energy and fuel consumption by tractors per 1 ha in 2000-2008 reduced by 9%; for water transfer for melioration – by 2% and for irrigation and drainage of lands was stable. In 2000-2007 specific consumption for glasshouse heating reduced by 6%, in 2002-2007 for static greenhouse heating – by 7%.

Assessment of the energy saving potential in agriculture was made in two directions: efficiency enhancement of tractor fleet and increased energy efficiency for glasshouse heating (see table 5.3.). Assessment of the potential for other directions is complicated for lack of information required for such assessments.

Table 5.3. Assessment of Energy Saving Potential in Agriculture of the Sverdlovsk Oblast

	Scope of work, products or transport fleet in 2008	Specific energy consumption in the Sverdlovsk oblast	“Practical minimum”		Final energy saving potential	Multiplier of total effect	Primary energy saving potential
		kgoe	kgoe		K toe		K toe
Tractor operation (per 1000 ha)	4326	10	7	Target value for the RF as of 2020	13.0	1.20	15.6
Static greenhouse heating (1000 m ²)	138	141	71	World practice	9.7	2.61	25.3

Source: CENEF assessment

Total potential of energy saving in the agriculture due to two above actions was 41 M toe. Energy saving potential at rural boiler plants, thermal and electric grids was taken into account in the respective sections.

5.6. Potential In Transport

5.6.1. Railway Transport

Statistical data for the Sverdlovsk oblast enable assessing the energy saving potential in the following types of transport: for electric locomotives (specific consumption in 2000-2008 reduced by 8.4%); diesel locomotives and trains (specific consumption reduced by 55%); trams (specific consumption reduced by 2%); trolleybuses (specific consumption reduced by 3%); underground trains (specific consumption increased by 39%); and for transportation of natural gas by pipelines (specific consumption increased 3.4 times).

Energy efficiency indicators of the railway transport of the Sverdlovsk oblast are considerably lower than current Russian average indicators and even lower than target values for Russian as of 2020. Energy saving potential for railways is assessed on the assumption that specific consumption for railway transport can be reduced:

- 1 for electric traction of trains from 14.4 kgoe/10 K ton-km gross in 2008 (average value for Russia is 12 kgoe/10 K ton-km gross) to 10.0 kgoe/10 K ton-km gross in 2020 (target value for Russia as of 2020);
- 2 for diesel locomotives and trains from 44.9 kgoe/10 K ton-km gross in 2008 (average value for Russia is 62 kgoe/10 K ton-km gross) to 40.0 kgoe/10 K ton-km gross in 2020.

As a result, the potential of primary energy saving for railway transport is assessed at 329 K toe (see table 5.4.). There are opportunities to reduce operation and production costs at railroads but they are difficult to determine based on the comparative analysis.

Table 5.4. Assessment of the Potential of Energy Saving in Transport of the Sverdlovsk Oblast

	Scope of work, products or transport fleet in 2008	Specific energy consumption in the Sverdlovsk oblast	“Practical minimum”		Final energy saving potential	Multiplier of total effect	Primary energy saving potential
		kgoe/t	kgoe/t		K toe		K toe
Electric traction of trains (per 10 M t-km gross)	14418	14.4	10.0	Tyumen and Kurgan oblasts	64.0	4.91	314.3
Diesel locomotives and trains operation of the Ministry of Railways (per 10 M t-km gross)	2163	44.9	40.0	Target value for the RF as of 2020	10.6	1.16	12.3
Electric traction of trams (per 1 M t-km gross)	460	20.1	5.0	Russian average	6.9	4.91	34.0
Electric traction of trolleybuses (per 1 M t-km gross)	182	26.0	7.3	Russian average	3.4	4.91	16.7
Electric traction of underground trains (per 1 M t-km gross)	166	7.6	6.7	Moscow	0.2	4.91	0.8
Transfer of natural gas by gas pipelines (MM m ³ -km)	81421	33.1	25.0	Target value for the RF as of 2020	660.6	1.18	779.6

Source: CENEF assessment

5.6.2. Urban Electric Transport

Statistical data for the Sverdlovsk oblast enable assessing the energy saving potential in urban electric transport alone: trams and trolleybuses and underground. In 2000-2008 specific consumption for electric traction of trams and trolleybuses have reduced a little; for electric traction of underground trains – increased by 39%.

The potential of primary energy saving at these three types of urban electric transport was assessed at 51.8 K toe when using the Russian average indicators for trams and trolleybuses and specific consumption for electric traction of underground trains in Moscow as “minimum practical level”. Since there are opportunities to reduce the indicators chosen as “minimum practical level” of indicators, the saving potential in the urban electric transport can be considered a little underestimated.

5.6.3. Pipeline Transport

Statistical data for the Sverdlovsk oblast enable assessing the energy saving

potential in natural gas transfer by main pipelines alone.

According to form “11-TER” specific consumption spiked in 2004 due to abrupt growth of transferred gas amounts. Then in 2005-2008 it was gradually reducing but in 2008 it was still above the Russian average level (see table 5.4.). Target specific consumption for gas transfer by pipelines shall be reduced to 25.0 kgoe/M m³-km an average of Russia in 2020. This figure was used as an indicator of “practical minimum”. The potential of primary energy saving in the pipeline transport is was assessed at 780 K toe (see table 5.4).

5.6.4. Road Transport

Fuel consumption and technological potential of the Sverdlovsk oblast were assessed according to the same procedure as in the Rostov oblast by model MET-Sverdlovsk oblast by four transport types: buses, passenger cars and trucks, other vehicles.

In 2008 road transport of the Sverdlovsk oblast consumed 2939.3 K toe (mainly gasoline and diesel fuel). Technological potential is 1839 K toe or 63% of total fuel consumption by road transport (see table 5.5.).

Table 5.5. Assessment of the Fuel Saving Potential at the Road Transport of the Sverdlovsk Oblast

	Vehicles fleet in 2008.	Specific energy consumption in the Rostov oblast	“Practical minimum”		Final energy saving potential	Multiplier of total effect	Primary energy saving potential
	K	kgoe/100 km	kgoe/100 km		K toe	K toe	
Transfer of passenger cars to hybrid analogs	893.2	2.4	1.16	World practice	1121.9	1.20	1346.3
Transfer of buses to hybrid analogs	18.9	29.0	13.92	World practice	284.2	1.20	341.1
Transfer of trucks to hybrid analogs	71.5	14.3	6.87	World practice	532.0	1.20	638.4
Energy efficient driving				World practice	147.0	1.20	176.4
Efficient transport planning and logistics				World practice	147.0	1.20	176.4

Source: CENEF assessment

5.6.5. Other Vehicles

Missing data on fuel efficiency and fleet of other vehicles – air and water transport – does not enable assessing the energy saving potential.

Total potential of primary energy saving in the transportation sector of the Sverdlovsk oblast is assessed at 3836 K toe.

5.7. Potential in the Utilities Sector

The Sverdlovsk oblast consumed 0.62 MM kW-h of electricity for lifting and distribution of potable water and pumping and treatment of sewage waters in 2008. Practically all electricity consumption in the water supply and water removal sector accounts for electric motors of water intake facilities, pumping and sewage stations. Potential of increased energy efficiency of water supply and removal systems is aimed at implementation of two typical groups of technical projects: introduction of efficient electric motors and optimization of electric motors operation; introduction of the variable frequency drives. Implementation of the potential of using the efficient electric motor and variable electric drives will enable electricity saving of 155 M kW-h.

Upgrading of the street lighting systems will enable saving of 78 M kW-h.

5.8. Potential in the Service Industry

There are no complete statistical data on energy consumption by the state-financed facilities. Energy consumption by the state-financed organizations of the Sverdlovsk oblast and potential of energy saving was assessed based on the developed model ERV-Sverdlovsk oblast. As seen from table 5.6. the

technological potential of energy saving is 584 K toe.

Table 5.6. Assessment of the Fuel Saving Potential in the Service Industry of the Sverdlovsk Oblast

	Area of building s or equipm ent fleet	Specific energy consumpt ion in the Sverdlovs k oblast	“Practic al minimu m”		Final energy saving potenti al	Multipli er of total effect	Primary energy saving potential
					K toe		K toe
1	2	3	4	5	6	7	8
Upgrading of service industry buildings with centralized heating	16028	0.262	0.133	Per SNiP of the year 2003	296.3	2.56	758.6
Upgrading of hot water supply systems (service industry)	1695	0.0074	0.0047	World practice	4.6	2.56	11.9
Increased energy efficiency of food preparation systems (service industry)	1695	0.0042	0.0036	World practice	1.1	1.5	1.6
Efficient gas boilers (service industry)	3462	0.262	0.214	World practice	167.8	1.10	184.5
Efficient lighting systems (service industry)	28533	32.298	20.065	World practice	42.9	4.91	210.8
Procurement of energy efficient equipment (service industry)	28533	72.939	52.614	World practice	71.3	4.91	350.2

Source: CENEF assessment

5.9. Potential in the Housing Sector

Energy consumption by the housing sector of the Sverdlovsk oblast and energy saving potential (see table 5.7.) were assessed by model MAN-Sverdlovsk oblast by the following types of energy and energy carriers: thermal energy, electricity, natural gas, coal, oil products and other solid fuels.

Technological potential of energy saving in the housing sector depending on the upgrading of individual buildings is 2094-2493 K toe (see table 5.7.).

Table 5.7. Assessment of the Potential of Energy Saving and Energy Carriers in the Housing Sector of the Sverdlovsk Oblast

	Area of buildings or equipment fleet	Specific energy consumption in the Sverdlovsk oblast	“Practical minimum”		Final energy saving potential	Multiplier of total effect	Primary energy saving potential
					K toe		K toe
1	2	3	4	5	6	7	8
Upgrading of residential buildings with centralized heating	78935	29.55	17.32	Per SNiP of the year 2003	965.7	2.56	2472.2
Upgrading of residential buildings with individual heating (option 1)	17478	44.33	2.216	“Passive” buildings	736.0	1.92	1411.4
Upgrading of residential buildings with individual heating (option 2)	17478	44.33	25.00	Individual buildings per SNiP 2003	337.8	1.92	647.7
Upgrading of hot water supply systems	4390	0.28	0.16	World practice	523.1	2.56	1339.1
Replacement of domestic electric hot plates with energy efficient ones	4390	0.06	0.02	World practice	172.2	4.91	845.5
Upgrading of lighting systems of residential buildings	16474	53.85	20.00	World practice	37.9	4.91	185.9
Increased energy efficiency of domestic food preparation systems	96413	3.40	2.80	World practice	57.8	1.10	63.6

Sources: CENEF assessment

When recalculating final energy saving to the primary energy, the capacities of the housing sector in reduction of energy consumption increase considerably.

6. Increased energy efficiency Potential in the Tver Oblast

6.1. Evaluation Summary of Increased energy efficiency Potential and Curves of Energy Saving Cost

Technical potential of final energy saving in the Tver oblast is 1982-2182 K toe or 55-61% of the level of final energy consumption in the year 2008.

Technical potential of primary energy saving in the Tver oblast is 3236-3436 K toe or 27-29% of the level of primary energy consumption in the year 2008.

Electricity sector accounts for 31% of energy saving potential, thermal energy sector accounts for 7%; industry – 7%; agriculture – 1%; transport – 24%; utilities sector – less than 1%, service sphere – 5% and housing sector – 25% (see Fig. 6.1.).

Thus, more than a half of the potential for the Tver oblast lies in transport and in buildings –spheres where its implementation is quite expensive.

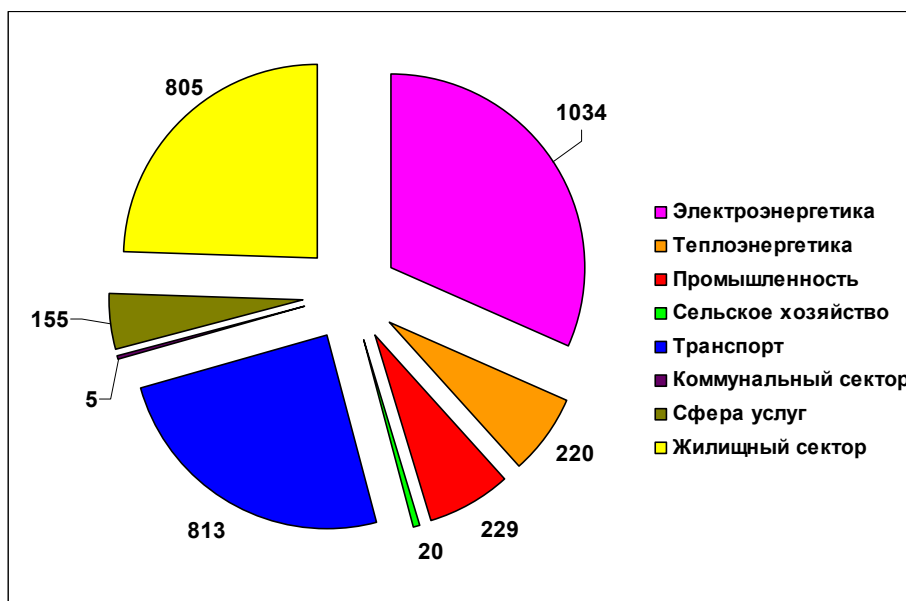


Figure 6.1. Distribution of Energy Saving Potential in the Tver Oblast in 2008

Ranges in evaluation of the energy saving potential are determined by differences in the individual residential buildings upgrade. Lower share of primary energy saving potential is related to the fact that the calculations did not take into consideration increase of energy generation efficiency at Kalininskaya NPP, and generally the share of the technical potential of saving in electric and thermal energy generation is lower than in other sectors.

Distribution of the technical potential of energy saving in the Tver oblast by major actions is shown in table 6.1

Table 6.1. Energy Saving Potential in the Tver Oblast

Action	Final energy saving	Primary energy saving ¹	Technical potential of energy saving ²
Gas power plants upgrading	1219.8	1341.7	938.7
Coal power plants upgrading	0.0	0.0	
Electricity transfer	40.0	196.6	95.8
Thermal energy generation at boiler plants	217.1	555.7	5.6
Thermal energy transfer	138.8	355.4	148.2
Cogeneration at boiler plants	60.0	66.0	66.0
Chemical fibers and threads manufacture	4.7	14.5	4.7
Cardboard manufacture	11.4	36.6	11.4
Cotton fabrics manufacture	2.4	8.1	2.4
Meat and meat products manufacture	20.0	46.7	20.0
Bread and cereal products manufacture	20.0	46.4	20.0
Efficient electric motors	3.3	16.3	3.3
Variable frequency drive	3.8	18.7	3.8
Efficient compressed air systems	1.1	5.4	1.1
Efficient industrial lighting systems	3.1	15.1	3.1
Efficient steam supply systems	107.3	274.6	107.3
Fuel saving in other industrial manufactures	52	131.0	52.0
Fuel saving increase of tractor fleet	3.9	4.7	3.9
Increased energy efficiency of glasshouse cropping	15.8	40.4	15.8
Increased energy efficiency of electric traction of railway transport	3.6	17.8	3.6
Increased energy efficiency of locomotives and diesel trains	61.9	74.3	61.9
Increased energy efficiency of electric traction of trams	1.1	5.4	1.1
Increased energy efficiency of electric traction of trolleybuses	0.8	3.7	0.8
Increased energy efficiency of gas pipeline transport	0.0	0.0	0.0
Transfer of passenger cars to hybrid analogs	272.3	326.8	272.3
Transfer of buses to hybrid analogs	52.4	62.9	52.4
Transfer of trucks to hybrid analogs	300.5	360.6	300.5
Energy efficient driving	60.4	72.4	60.4
Efficient transport planning and logistics	60.4	72.4	60.4
Variable frequency drive and efficient engines in water supply and removal	1.7	2.0	1.7
Street lighting	2.9	3.5	2.9
Upgrading of buildings with centralized heating (per SNiP of the year 2003((service industry)	92.8	237.7	92.8
Upgrading of hot water supply systems (service industry)	1.9	4.8	1.9
Increased energy efficiency of food preparation systems (service industry)	0.2	0.4	0.2
Efficient gas boilers (service industry)	14.9	16.4	14.9
Efficient lighting systems (service industry)	15.0	73.5	15.0
Procurement of energy efficient equipment (service industry)	30.2	148.1	30.2
Equipping with metering devices for heat and gas (residential buildings)	155.0	306.9	155.0
Upgrading of residential buildings with centralized heating	230.0	588.9	230.0
Upgrading of residential buildings with individual heating (option 1)	369.6	708.8	369.6
Upgrading of residential buildings with individual heating (option 2) ³	169.6	325.3	169.6

Action	Final energy saving	Primary energy saving ¹	Technical potential of energy saving ²
Upgrading of hot water supply systems	97.4	249.3	97.4
Replacement of domestic electric hot plates with energy efficient ones	81.7	401.1	81.7
Upgrading of lighting systems of residential buildings	9.3	45.6	9.3
Increased energy efficiency of domestic food preparation systems	17.2	18.9	17.2
Total			3236-3435

¹ Without correction to energy saving at final consumers.

² With account to reduction of the demand in generation and transfer of electricity due to complete implementation of the technical potential of energy saving at final consumers.

³ Is considered as an alternative to the previous line.

Source: CENEF assessment.

When determining the technical potential, simple summation of all components of the two first columns of table 6.1. is not allowed, since potential in electric and thermal energy sector in them is determined taking into consideration the volumes of electric and thermal energy generation in the year 2008. In case of complete implementation of the saving technical potential at final consumers, the volumes of the required generation of these energy carriers will considerably decrease. That is why the saving amounts will reduce considerably in these sectors. Correction to take this factor into consideration is made in the last column of table 6.1. And this has become the basis for assessment of the integral saving of primary energy.

To determine the economic and market potentials of saving, the curves of primary energy saving cost were built up (see Fig. 6.2.). In the first case the cost of primary energy saving was determined using the data on incremental capital investment using the social discount rate (6%). In the second case the additional effects and additional costs were taken into consideration. And finally, in the third case, the cost of primary energy saving was determined for the private rate of return (12%) using the data on additional effects and additional costs from implementation of energy saving actions.

Economic potential of energy saving in the Tver oblast is equal to the technical potential. Accounting of additional effects and additional costs does not change this result. For some actions additional effects are not determined therefore violet and blue curves on Fig. 6.2. in some zones run into one. Economic potential was determined using the natural gas as the closing price at USD 200/1000 m³ (export price of the natural gas less transport costs and excise taxes).

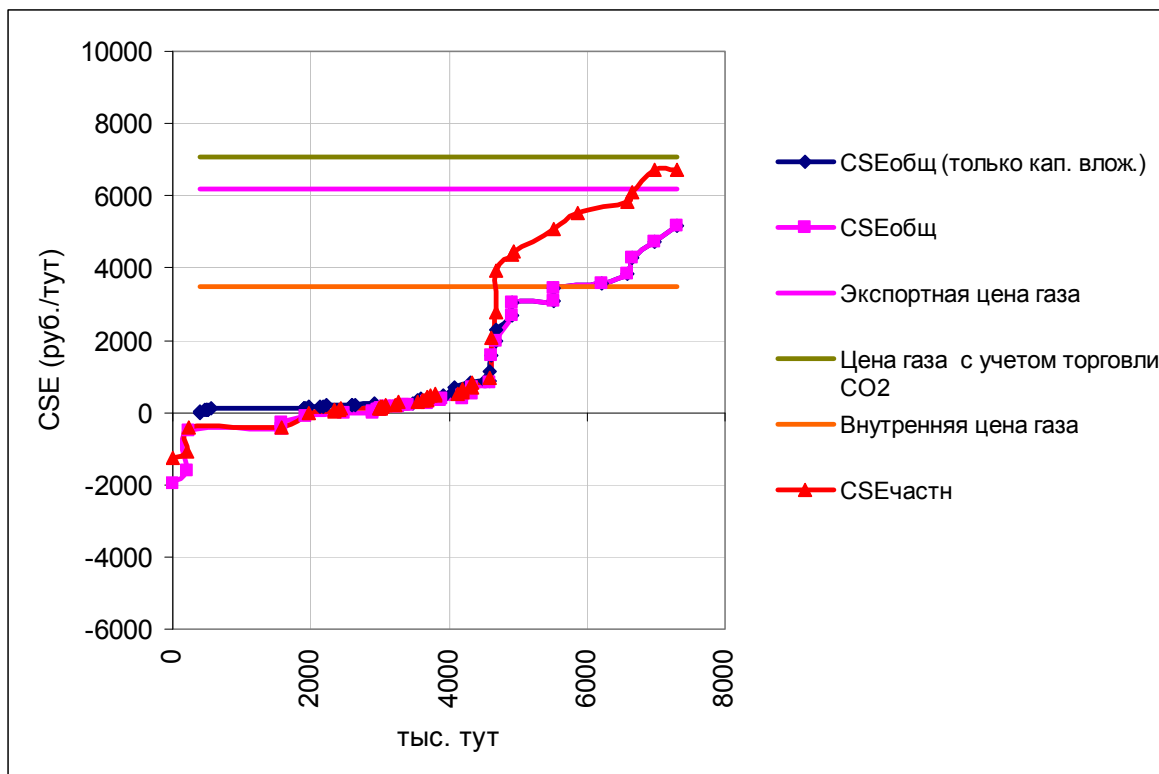


Figure 6.2. Curves of Primary Energy Saving for the Tver Oblast

Market potential of energy saving in the Tver oblast is 2113-2268 K toe or 18% of the level of primary energy consumption in the year 2008 and 65-66% of the level of technical and economic potentials.

The market potential was determined using the average internal price for natural gas expected for the year 2010 as closing price for final consumers at 3500 rub./1000 m³.

Increase of the initial price for gas to 4500 rub./1000 m³ in 2010 would enable expansion of the market potential by 98 K toes or to 68-69% of the level of technical and economic potentials.

To implement the larger potential that fell into the zone of financially unattractive actions (upgrading of service industry and residential buildings with centralized heating, transfer of cars to hybrid engines) state support and adequate price policy are required.

6.2. Potential in Electricity Sector

According to form "6-TP" in 2008 the thermal plants of the Tver oblast have generated 9.7 MM kW-h including gas plants – 9.6 MM kW-h with average efficiency 37.6%, solid fuel plants – 0.1 MM kW-h with average efficiency 43.6%. These low efficiency indicators at thermal plants of the Tver oblast are the result of a large shares of distressed equipment.

Technical potential of increased energy efficiency during electricity generation in the Tver oblast and bringing existing plants parameters to the modern technical level is assessed at 1220 K toe with electricity generation at the 2008 level. All potential is implemented at the gas thermal plants.

In 2008 losses in electric grids of the Tver oblast were 879 M kW-h or 15.9% of all electricity consumed. Technical losses of electricity in the mains and distribution grids were 717 M kW-h and commercial losses and losses due to low accuracy of metering devices were 162 M kW-h.

The same as in the Rostov oblast, relatively high level of losses is related to the high share of energy consumption by distributed consumers who obtain MV and LV energy. Some losses are also related to electricity transfer from the Kalininskaya NPP and Konakovskaya GRES power plant to neighboring regions.

The Tver oblast has more than 5.1 K km of HV lines with 110-220-330-500-750 kV voltage; 308 main substations (substation – SS) with 110-220-330-500-700 kV voltage and 7.6 GVA rated capacity; more than 44 K km of overhead and cable lines (OHL and CL) of low and medium voltage 35-0.38 kV; 10959 transformer substations (TSS) with rated capacity 1510 MVA. Depreciation of electric grids, SS and TSS is 70-80% on the average.

If the share of losses is reduced to 10%, the potential of electricity saving will be 325 M kW-h.

6.3. Potential in Heat Supply

According to form “1-TEP” the Tver oblast has about 797 municipal and departmental boiler plants, that in 2008 have generated 7.4 M Gcal. 40% of these boiler plants are operating on gas, 50% – on solid fuel and the rest – on oil and oil products.

Average efficiency of boiler plants of the Tver oblast is 75% and 92-95% in the West European countries. Only 5% of all boiler plants have 90% efficiency (see Fig. 6.3.). Bringing the average efficiency of all gas-operating boiler plants to 95% (the level achieved at many new boiler plants constructed recently) and others – to 85-90% will enable “removing” the red zone of specific fuel consumption ascent and have saving in the amount of 217 K toe. Upgrading of pumping equipment at the boiler plants will enable saving of 111.6 M kW-h.



Figure 6.3. Distribution of Tver Oblast Boiler Plants by Energy Efficiency Level in 2008

Thermal grids of the Tver oblast are 1787 km long, 28% of them need urgent replacement. Average age of thermal grids exceeds 15 years and depreciation is 70%. In many countries of the Western Europe with extensive heat supply systems, losses in thermal grids are 2-10%. In the Tver oblast average normative losses in thermal grids, according to form "1-TEP" are 12.3%. Average losses in thermal grids, according to CENEF estimates, are 19%. The potential of thermal energy saving through reduction of excessive losses in thermal grids of the Tver oblast is 139 K toe.

Fuel saving can be 60 K toe more following implementation of actions on joint generation of thermal and electricity at boiler plants.

6.4. Potential in Industry

The Tver oblast does not have energy-intensive industrial production (except for electricity sector). Final energy consumption in the industry is only 4.6% of the same indicator in the Sverdlovsk oblast. Therefore potential assessment of the increased energy efficiency is made mainly by comparison of average indicators for the Tver oblast with the best indicators for Russian and with a very limited product mix.

In the Tver oblast specific consumption for manufacture of all types of energy-intensive products is considerably higher than the levels of the best Russian practice (table 6.2.). The potential of increased energy efficiency in the energy-intensive industry of the Tver oblast was assessed for the years 2007-2008.

Table 6.2. Assessment of the Energy Saving Potential in the Tver Oblast Industry

	Manufacture in 2008.	Specific energy consumption in the Tver oblast	“Practical minimum”»		Final energy saving potential	Multipplier of total effect	Primary energy saving potential
	K t	kgoe/t	kgoe/t		K toe		K toe
Chemical threads and fibers manufacture	6.0	968	887	Moscow oblast	0.5	3.12	14.5
Cardboard manufacture	54.6	439	239	World practice	10.9	3.17	36.6
Cotton fabrics manufacture (M m ²)	117.6	215	138	Volgograd oblast	9.0	3.39	8.1
Meat and meat products manufacture	28.3	789	50	Chelyabinsk oblast	21.0	2.34	46.7
Bread and cereal products manufacture	119.8	204	89	Tambov oblast	13.8	2.32	46.4
Efficient electric motors				Calculation by model	3.3	4.91	16.3
Variable frequency drive				Calculation by model	3.8	4.91	18.7
Efficient compressed air systems				Calculation by model	1.1	4.91	5.4
Efficient industrial lighting systems				Calculation by model	3.1	4.91	15.1
Efficient steam supply systems				Calculation by model	107.3	2.56	274.6
Fuel saving in other industrial productions				Value	52	2.52	131.0
Total					225.7		613.5

Source: CENEF assessment

In the year 2007 the Tver oblast industrial electric motors consumed 505 M kW-h. Electric motors rated capacity is about 340 MW and fleet – about 50 K units. Implementation of the program for using the efficient electric motors in the Tver oblast will enable electricity saving in the amount of 17 M kW-h. Saving of other 10 M kW-h can be reached through excessive power take-off of electric motors. Total – 3.4 K toe. Promotion of variable electric drives will enable electricity saving in the amount of 31 M kW-h.

In 2007 the Tver oblast produced 0.4 MM m³ of compressed air and consumed 30 M kW-h for these purposes. Saving in the compressed air systems can be 9 M kW-h.

Industrial lighting systems consume about 70 M kW-h. Replacement of old lighting fixtures with new efficient ones with electronic control equipment, introduction of control systems for lighting when using the daylight will enable saving about 35% or 25 M kW-h.

In 2007 the Tver oblast industry consumed 3.7 M Gcal of heat including non-energy intensive industry – 3.3 M Gcal. Steam is the heat transfer medium for the most part of thermal energy – 70-80%, hot water used for heating and ventilation accounts for the rest 20-30%. Thus, steam

consumption in non-energy intensive sectors can be assessed at 2.5 M Gcal. The calculations for upgraded steam supply systems used the assessment of the average saving at 30%. Steam saving potential is equal 0.75 M Gcal.

In 2007 non-energy intensive industry consumed 173 K toe of fuel. Fuel saving potential in these industries can be assessed at 30% or 52 K toe.

Total potential of final energy saving in the industry of the Tver oblast is assessed at 226 K toe or 25% of total final energy consumption in the industry (less electric and thermal energy sector) in 2007.

Total potential of primary energy saving in the industry is assessed at 614 K toe or 5% of total primary energy consumption in the oblast in 2007.

6.5. Potential in Agriculture

In the Tver oblast specific energy and fuel consumption by tractors per 1 ha in 2000-2008 reduced by 16%; for water transfer for melioration – by 60%. In 2002-2006 specific consumption for static greenhouse heating reduced by 2%.

Assessment of the energy saving potential in agriculture was made in two directions: efficiency enhancement of tractor fleet and increased energy efficiency for glasshouse heating. Assessment of the potential for other directions is complicated for lack of information required for such assessments.

Table 6.3. Assessment of Energy Saving Potential in Agriculture of the Tver Oblast

	Scope of work, products or transport fleet in 2008	Specific energy consumption in the Tver oblast	“Practical minimum”		Final energy saving potential	Multiplier of total effect	Primary energy saving potential
		kgoe	kgoe		K toe		K toe
Tractor operation (per 1000 ha)	2712	9	7	Target value for the RF as of 2020	5.1	1.20	4.7
Static greenhouse heating (1000 m ²)	120	263	131	World practice	15.8	2.56	40.4

Source: CENEF assessment

Total potential of energy saving in the agriculture due to two above actions was 45 M toe (see table 6.3.). Energy saving potential at rural boiler plants, thermal and electric grids was taken into account in the respective sections.

6.6. Potential in Transport

6.6.1. Railway Transport

Statistical data for the Tver oblast enable assessing the energy saving

potential in the following types of transport: for electric locomotives (specific consumption in 2000-2008 increased by 6.9%, data for the year 2008 are not reliable); diesel locomotives and trains (specific consumption increased by 69% in 2000-2008); trams (specific consumption increased by 15% in 2000-2008); trolleybuses (specific consumption increased by 18% in 2000-2008); and for transportation of natural gas by pipelines (specific consumption reduced by 5.7% in 2005-2008).according to this data energy efficiency of transport in the Tver oblast in 2000-2008 was reducing.

Energy efficiency indicators of the railway transport of the Tver oblast are considerably lower than current Russian average indicators and even lower than target values for Russian as of 2020. Energy saving potential for railways is assessed on the assumption that specific consumption for railway transport can be reduced:

- 1 for electric traction of trains from 19.7 kgoe/10 K ton-km gross in 2008 (average value for Russia is 12 kgoe/10 K ton-km gross) to 10.0 kgoe/10 K ton-km gross in 2020 (target value for Russia as of 2020);
- 2 for diesel locomotives and trains from 81.2 kgoe/10 K ton-km gross in 2008 (average value for Russia is 62 kgoe/10 K ton-km gross) to 40.0 kgoe/10 K ton-km gross in 2020.

As a result, the potential of primary energy saving for railway transport is assessed at 92 K toe (see table 6.4.). There are opportunities to reduce operation and production costs at railroads but they are difficult to determine based on the comparative analysis.

Table 6.4. Assessment of the Potential of Energy Saving in Transport of the Tver Oblast

	Scope of work, products or transport fleet in 2008	Specific energy consumption in the Rostov oblast	“Practical minimum”		Final energy saving potential	Multiplier of total effect	Primary energy saving potential
		kgoe/t	kgoe/t		K toe		K toe
Electric traction of trains (per 10 M t-km gross)	372	19.7	10.0	Tyumen and Kurgan oblasts	3.6	4.91	17.8
Diesel locomotives and trains operation of the Ministry of Railways (per 10 M t-km gross)	1085	81.2	40.0	Target value for the RF as of 2020	61.9	1.20	74.3
Electric traction of trams (per 1 M t-km gross)	93	16.7	5.0	Russian average	1.1	4.91	5.4
Electric traction of trolleybuses (per 1 M t-km gross)	48	23.1	7.3	Russian average	0.8	4.91	3.7
Transfer of natural gas by gas pipelines (MM m ³ -km)	74	3589.7	25.0	Target value for the RF as of 2020			

Source: CENEF assessment

6.6.2. Urban Electric Transport

Statistical data for the Tver oblast enable assessing the energy saving potential in two types of urban electric transport alone: trams and trolleybuses. In 2000-2008 specific consumption by these transports were growing. Possible reason for that was reduction of loads on these transports and population switch to automobiles.

The potential of energy saving at urban electric transport is assessed at 9 K toe when using the Russian average indicators as “minimum practical level”.

6.6.3. Pipeline Transport

Statistical data for the Tver oblast enable assessing the energy saving potential in natural gas transfer by main pipelines alone. The data is available from the year 2005. According to form “11-TER” specific consumption for natural gas transfer in the Tver oblast is one of the highest in Russia and exceeds the Russian average 128 times. It is evident that the reason for this cannot be technical state of gas pipelines but imperfection of the statistical reporting system. Large transit gas pipelines go in the oblast territory. The amount of the transferred gas does not correspond to the data on energy consumption for pumping. For this reason energy saving potential at the pipeline transport was not assessed to the Tver oblast.

6.6.4. Road Transport

Fuel consumption and technological potential of the Tver oblast were assessed according to the same procedure as in the Rostov oblast by model MET-Tver oblast by four transport types: buses, passenger cars and trucks, other vehicles.

In 2008 road transport of the Tver oblast consumed 1207.0 K toe (mainly gasoline and diesel fuel).

Technological potential of final energy saving is 746 K toe or 62% of total fuel consumption by road transport (see table 6.5.).

Table 6.5. Assessment of the Fuel Saving Potential at the Road Transport of the Tver Oblast

	Vehicles fleet in 2008.	Specific energy consumption in the Rostov oblast	"Practical minimum"		Final energy saving potential	Multiplier of total effect	Primary energy saving potential
	K	kgoe/100 km	kgoe/100 km		K toe	K toe	
Transfer of passenger cars to hybrid analogs	290.8	11.1	3.8	World practice	272.3	1.20	326.8
Transfer of buses to hybrid analogs	6.8	32.6	17.1	World practice	52.4	1.20	62.9
Transfer of trucks to hybrid analogs	56.5	25.9	16.6	World practice	300.5	1.20	360.6
Energy efficient driving				World practice	60.4	1.20	72.4
Efficient transport planning and logistics				World practice	60.4	1.20	72.4
				Calculation by model	745.9		895.0

Source: CENEF assessment

6.6.5. Other Vehicles

Missing data on fuel efficiency and fleet of other vehicles – air and water transport – does not enable assessing the energy saving potential.

Total potential of primary energy saving in the transportation sector is assessed at 996 K toe or 8% of total primary energy consumption in the Tver oblast.

6.7. Potential in the Utilities Sector

The Tver oblast consumed 86 M kW-h of electricity for lifting and distribution of potable water and pumping and treatment of sewage waters in 2008.

Implementation of the potential of using the efficient electric motors and promotion of variable electric drives will enable electricity saving of 13.8 K kW-h.

Annually street lighting consumes 47 M kW-h. Use of efficient systems of street lighting will enable saving of minimum 23.6 M kW-h.

6.8. Potential in the Service Industry

There are no complete statistical data on energy consumption by the service industry. Energy consumption by the service industry of the Tver oblast and potential of energy saving was assessed based on the developed model ERV-Tver oblast.

As seen from table 6.6. the technological potential of final energy saving is 155 K toe or 36% of the year 2007 consumption.

Table 6.6. Assessment of the Fuel Saving Potential in the Service Industry of the Tver Oblast

	Area of buildings or equipment fleet	Specific energy consumption in the Tver oblast	“Practical minimum”		Final energy saving potential	Multiplier of total effect	Primary energy saving potential
					K toe		K toe
Upgrading of service industry buildings with centralized heating	5551	0.227	0.110	Per SNiP of the year 2003	92.8	2.56	237.7
Upgrading of hot water supply systems (service industry)	1187	0.0038	0.0023	World practice	1.9	2.56	4.8
Increased energy efficiency of food preparation systems (service industry)	1187	0.0021	0.0019	World practice	0.2	1.5	0.4
Efficient gas boilers (service industry)	355	0.227	0.185	World practice	14.9	1.10	16.4
Efficient lighting systems (service industry)	12836	26.267	16.781	World practice	15.0	4.91	73.5
Procurement of energy efficient equipment (service industry)	12836	71.580	52.470	World practice	30.2	4.91	148.1

Source: CENEF assessment

6.9. Potential in the Housing Sector

Energy consumption by the housing sector of the Tver oblast and energy saving potential (see table 6.7.) were assessed by model MAN-Tver oblast by the following types of energy and energy carriers: thermal energy, electricity, natural gas, coal, oil products and other solid fuels.

Technological potential of energy saving in the housing sector depending on the upgrading type of individual buildings is 2094-2493 K toe (see table 6.7.).

Table 6.7. Assessment of the Potential of Energy Saving and Energy Carriers in the

Housing Sector of the Tver Oblast

	Area of buildings or equipment fleet	Specific energy consumption in the Tver oblast	“Practical minimum”		Final energy saving potential	Multiplier of total effect	Primary energy saving potential
					K toe		K toe
Upgrading of residential buildings with centralized heating	78935	29.55	17.32	Per SNiP of the year 2003	965.7	2.56	2472.2
Upgrading of residential buildings with individual heating (option 1)	17478	44.33	2.216	“Passive” buildings	736.0	1.92	1411.4
Upgrading of residential buildings with individual heating (option 2)	17478	44.33	25.00	Individual buildings per SNiP 2003	337.8	1.92	647.7
Upgrading of hot water supply systems	4390	0.28	0.16	World practice	523.1	2.56	1339.1
Replacement of domestic electric hot plates with energy efficient ones	4390	0.06	0.02	World practice	172.2	4.91	845.5
Upgrading of lighting systems of residential buildings	16474	53.85	20.00	World practice	37.9	4.91	185.9
Increased energy efficiency of domestic food preparation systems	96413	3.40	2.80	World practice	57.8	1.10	63.6

Sources: CENEF assessment

When recalculating final energy saving to the primary energy, the capacities of the housing sector in reduction of energy consumption increase considerably.