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**Energy Efficiency at Regional Level in
Arkhangelsk, Astrakhan and Kaliningrad
Regions**

**Astrakhan Fuel and Energy
Balance**

Draft Report

March 2007



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| Prepared by: | IBA | 25-02-2007 |
| Checked by: | NKU, AZW | 20-03-2007 |
| Approved by: | AZW | 25-03-07 |
| Approved by: | EBE | |

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LIST OF ABBREVIATIONS

| | |
|-------------------------|--|
| bos | basic oxygen steel |
| bbbl | barrel |
| bcm | billion cubic metres |
| b/d | barrels per day |
| Btu | British thermal unit |
| CCGT | combined-cycle gas turbine |
| CHP | combined heat and power (plant) |
| CNG | compressed natural gas |
| CO | carbon monoxide |
| CO₂ | carbon dioxide |
| COG | coke-oven gas |
| CV | calorific value |
| GCV | gross calorific value |
| GHG | greenhouse gas |
| GJ | gigajoule, or one joule x 10 ⁹ (see joule) |
| GJ/t | gigajoule per tonne |
| IFEB | Integrated Fuel and Energy Balance |
| J | joule |
| kWh | kilowatt/hour, or one watt x one hour x 10 ³ |
| LNG | liquefied natural gas |
| LPG | liquefied petroleum gas; refers to propane, butane and their isomers, which are gases at atmospheric pressure and normal temperature |
| MBtu | million British thermal units |
| MJ/m³ | megajoule/cubic metre |
| Mm³ | million cubic metres |
| MPP | main (public) power producer |
| MSW | municipal solid waste |
| Mtce | million tonnes of coal equivalent |
| Mtoe | million tonnes of oil equivalent |
| MW | megawatt, or one watt x 10 ⁶ |
| NCV | net calorific value |
| Nm³ | normal cubic metre |
| NO_x | nitrogen oxides |
| PV | Photovoltaic |
| Ttce | Thousand tonnes of coal equivalent |
| tce | tonne of coal equivalent; 1 tce = 0.7 toe |
| TFC | total final consumption ("end-use" or "useful" consumption) |
| TJ | Tera joule, or one joule x 10 ¹² |
| toe | tonne of oil equivalent |
| TPES | total primary energy supply |
| VOCs | volatile organic compounds |

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1. Development of an integrated energy balance

1.1 Introduction

One of the tasks under the current EuropeAid project on “Energy Efficiency at the regional level in Astrakhan, Arkhangelsk and Kaliningrad regions” is to attempt developing regional fuel energy balances in the three regions.

This report contains the first results of this task for the Kaliningrad region. The first chapter introduces the energy balance in international format and the available Russian information sources. Chapters 2, 3 and 4 deal with a detailed description of the elements of the fuel and energy balance and the final result, including an assessment of energy supply efficiency in Kaliningrad region..

Chapters 5, 6 and 7 discuss respectively the planned energy sector development in Kaliningrad region, the potential for renewable energy use and the implementation of the energy efficiency programme in the region. Chapter 8 concludes with remarks on several institutional issues that stand in the way of overall improvement of energy data.

Chapter 9 presents conclusions and recommendations.

1.2 Fuel and Energy Balance

Accurate and comprehensive energy sector data and statistics form the basis for sound energy and energy efficiency strategies and policies. Fuel and energy balances combine energy sector information in one overview and are used structurally in many countries. The need to develop a comprehensive national Integrated Fuel and Energy Balance has been discussed at length ever since the late 30'es. However, to date the concept has not been effectively used in Russia.¹, although during the period of the Soviet Union, a summary energy balance by regions and nation-wide was developed once every five years; but not anymore.

In this report a regional fuel and energy balance is developed based on a widespread and accepted international methodology, i.c. the format of the International Energy Agency (IEA). The energy situation in the region is described using the IEA model, but integrating the specific features of the Russian energy statistics. This is important to

- reflect the relations between energy supply- and end-use comprehensively;
- improve the reliability of analysis and projections of inter-fuel competition in many sectors;
- take into account the energy resource (natural gas in the first place) competition between sectors.

The Fuel and Energy Balance consists of three blocks:

1. Primary energy resources;
2. Energy resource transformation;
3. Energy end-use (final energy consumption, usually by sector).

The Resource Block includes primary energy production, export and import, and stock changes.

The second block describes transformation of energy resources. It includes fuel balances of the power and heat sectors showing the contribution of technical progress towards improved efficiency of heat- and power generation; fuel price competition parameters; and overall power- and heat generation and consumption.

¹See Veiz V.I., Probst A.E., and Rusakovskiy E.A. The National Unified Energy Balance in the 3rd five-years-period. Planned Economy. 1937, No. 9-10; Also see the contemporary discussion on Unified Energy Balance in “Tariff regulation and expertise”, No. 2. 2005.

The third block describes energy end-use by sectors (final energy consumption). Thus, power-, heat-, and fuel demand are continuously evaluated based on changing economic development parameters and energy balance dynamics. This provides a systematic picture of the energy sector situation and a sound basis for demand and supply forecasts. The structure of the balance changes, as determined by changing proportions of sub-sector economic development; technical progress; price fluctuations; and other factors that are incorporated into the analysis of energy balances.

1.3 Major sources of information

1.3.1 STATISTICAL DATA

Russian regional statistic departments provide statistical reports containing energy sector data (statistical yearbooks, bulletins, analytical papers etc.). This allows developing of an initial database for the energy balance. The statistical forms used are the following:

- ⇒ Three statistical forms to develop power balance parameters:
 - “E-1” (Power balance of the economy, production, trade, consumption);
 - “E-2” (Power consumption by major industries);
 - “E-3” (Power consumption by major industrial sectors);
 - and “Power sectors and power plants of Russia, the CIS countries and the Baltic states” Inventory published by Incotech;
- ⇒ Five more statistical forms to develop power-, heat-, and fuel balances:
 - “11 TER” (fuel, heat, and power use);
 - “6 TP” (power and heat generation and fuel use in the power sector);
 - “4-fuel” (data on fuel residues, supply and consumption, waste petroleum products collection and use);
 - “22 ZhKH” (data on utilities’ performance during the reform period, also containing partial information on heat-, natural gas-, and power consumption);
 - Forms on heat generated by boiler houses and heat distribution systems.

Not all institutions are required to submit the whole set of completed forms. For example, Form “11 TER” is only for companies whose annual fuel and energy consumption is above 10 tce. Therefore, some sources allow for a basic, rather than a comprehensive, picture of energy use, and additional data, as well as data verification, are required. For example, “11 TER” only reflects transportation heat losses, and continuously tends to underestimate them.

In spite of its incompleteness, “11 TER” is the basic data source for Fuel and Energy Balance development. It is the basis for fuel consumption statistics, and for the understanding of the region’s power sector development by the Oblast Government. This form integrates three data blocks:

- ⇒ Output by major industries and production stages;
- ⇒ Corresponding power-, heat-, and fuels consumption;
- ⇒ Specific power-, heat-, and fuel consumption to provide various types of work and services.

The latter group of indicators allows evaluating the efficiency of energy use. Comparison of specific indicators over a period of time and with other regions and countries provides an indication of the energy efficiency potential by industries and production stages.

“11 TER” provides data for 23 energy carriers, which are not really necessary for describing the general energy situation in the region. Further analysis considers only six major groups:

- power,

- heat,
- coal,
- crude oil and petroleum products,
- natural gas,
- other solid fuels.

This type of classification of energy carriers is the usual practice for the IEA and many countries, although more profound detalization is possible for some sectors.

“11 TER” does not allow automatic distribution of data by the above mentioned three blocks of the Fuel and Energy Balance. A special effort is required to do so, following the logics, rather than the letter, of the IEA energy balance development methods, because the source information does not fit this purpose completely.

Regional energy supply efficiency analysis uses a “bottom-up” approach. Evaluation starts from the 3rd block. Efficiency of energy use is assessed for each sector, industry, or product. Overall consumption of a particular energy carrier is the sum of this energy carrier consumption by sectors. The second block evaluates the efficiency of each sector with due consideration of energy loss coefficients, own needs consumption, and specific consumption of energy transformation. Data from the first block (with an account of the necessary fuel stock piling) are used to determine regional demand for local energy resource production, or import, of energy resources from other regions. And *vice versa*, having information on possible oil-, gas-, coal-, and power production, energy import-export balance can be developed. Coal, oil, gas, and power (hydro and renewable) outputs are evaluated through a critical estimation of available development projections for these sectors.

It should be noted, that data from different statistical forms may be contradictory (see Section 2). Therefore, any manipulation with these data requires a careful and weighted approach.

1.3.2 SECTORAL STATISTICS

Power- and utility sector reforms have caused a fragmentation of data for energy consumption and generation that are available for specific sectors. For example, in Astrakhan Oblast, there are three major power grid trading companies (Astrakhanskaya energy trading company AESK, Astrkommunenergo, and Rusenergosbyt (supplies power to all “Gasprom” facilities in the region)), and 14 local power distribution companies outside Astrakhan city. As a rule, they do not possess a comprehensive sector-wide picture even in the energy market sector they operate. The available sectoral data only deal with their own (sub-) sector or market niche and therefore a comprehensive picture even in its own energy market segment where they operate, is lacking. However, these data are still useful and important for understanding the energy situation in the region.

Most useful are the data presented to the Tariff Service to justify power-, heat-, and gas tariffs for the next regulation period. They are very important to improve reliability of estimates in the Fuel and Energy Balance. However, access to these data is very limited. If the regional Government would establish and implement monitoring of the local energy situation, data provided to the Tariff Service could become the core for such monitoring.

Unfortunately, the data and other information accumulated by the Tariff Services is only used to justify the tariffs, whereas its application potential could in practice be much wider.

1.3.3 DATA FROM ANALYTICAL STUDIES AND GOVERNMENT PROGRAMMES

In 2005, Astrakhan Oblast government approved of the “Energy strategy of Astrakhan Oblast until 2020 in coordination with the fuel and energy sector development, gas supply and gasification of the region”. The “Strategy” was developed by the local experts and OAO “Promgas” with some involvement of Siberian Institute of Energy Systems. The narrative part of this document contains useful data on energy production and energy use in Astrakhan Oblast. However, the retrospective

aspect of analysis ends in 2000-2001; but a complete multi-volume version of the “Strategy” includes a pretty detailed analysis of the regional energy situation until 2004 inclusive.

In 2002, Astrakhan Oblast Tariff Service developed a paper “Guidelines for loss reduction in the power sector of Astrakhan Oblast until 2005”, which includes very important data on actual power losses and recommendations for loss reduction in municipalities.

2 Analysis of the regional energy supply and demand

2.1 Power balance

2.1.1 POWER GENERATION

The power sector is in the focus of the Astrakhan Oblast project; therefore, special attention is given to the description of its state-of-the-art. "6-TP" is the major data source for this description; the tables of this form provide data on power and heat generation and fuel consumption by power plants; efficiency of power plants; etc. This form was the basis for the power sector section development of the IFEB (see Table 2.1).

The Oblast power demand is by 80% met through local power generation. The remaining 20% are provided from the Federal Wholesale Power Market (FOREM). The power capacity shortage amounts to nearly 30%. There are no federal-level power plants in Astrakhan Oblast. The Astrakhan energy utility includes: "Astrakhan Generation"; a branch of OAO "YuGK TGK-8"; OAO "Astrakhanenergo"; OAO "Astrakhan energy trading company"; OAO "Astrakhan power mains". Overall installed capacity of Astrakhan power system is 504 MW, or 521.7 MW if diesel power plants are included (see Table 2.1). The capacity of power plants of "Astrakhan Generation" branch is 480 MW. The main physical assets of this utility are 70% depreciated. Astrakhan Oblast power sector uses around 1.3 mln tce per annum, primarily natural gas.

Astrakhanskaya GRES (100 MW) was commissioned in 1960, and in 2007 the normative lifecycle of its equipment will expire. Long-lasting operation determines very high and continuously growing specific fuel consumption for electricity generation (the efficiency being below 30%) and high equipment repair costs (see Table 2.2). Natural gas is the main fuel for this GRES.

Table 2.1 Basic operation parameters of Astrakhan oblast power plants

| | Units | 2001 | 2002 | 2003 | 2004 | 2005 |
|--|-----------------|----------------|----------------|----------------|----------------|----------------|
| Installed capacity | thou. kW | 517.9 | 517.9 | 516.9 | 522.0 | 521.7 |
| Astrakhanskaya GRES | thou. kW | 100.0 | 10.00 | 100.0 | 100.0 | 100.0 |
| Astrakhanskaya CHP plant-2 | thou. kW | 380.0 | 380.0 | 380.0 | 380.0 | 380.0 |
| Co-generation plant of OAO "Severnaya" | thou. kW | 24.0 | 24.0 | 24.0 | 24.0 | 24.0 |
| Diesel power plants | thou. kW | 14.6 | 13.9 | 12.9 | 18.0 | 17.7 |
| Available capacity | thou. kW | 504.0 | 517.9 | 516.9 | 522.0 | 521.7 |
| Installed capacity load | Hours | 6,246.2 | 6,160.2 | 6,004.2 | 5,810.9 | 5,944.2 |
| Power generation | mln. kWh | 3,235.0 | 3,190.5 | 3,103.4 | 3,033.2 | 3,101.0 |
| Astrakhanskaya GRES | mln. kW | 723.4 | 669.3 | 624.3 | 698.7 | 704.2 |
| Astrakhanskaya CHP-2 | mln. kW | 2,408.7 | 2,431.6 | 2,378.3 | 2,234.3 | 2,306.7 |
| CHP of OAO "Severnaya" | mln. kW | 102.9 | 89.1 | 100.2 | 99.9 | 89.7 |
| Diesel power plants | mln. kW | 0.2 | 0.5 | 0.6 | 0.4 | 0.5 |
| Power supply to the grid | mln. kWh | 2,940.8 | 2,890.0 | 2,800.4 | 2,731.9 | 2,801.7 |
| Heat supply | thou. Gcal | 2,269.9 | 2,278.6 | 2,286.5 | 2,206.3 | 2,289.8 |
| CHP plants | thou. Gcal | 2,050.4 | 2,065.0 | 2,075.2 | 1,990.9 | 2,094.4 |
| peak boiler-houses | thou. Gcal | 219.5 | 213.6 | 211.3 | 215.4 | 195.5 |
| Own needs | mln. kWh | 294.2 | 300.5 | 303.0 | 301.3 | 299.3 |
| electricity generation | mln. kWh | 195.1 | 206.2 | 204.4 | 205.7 | 201.7 |
| heat supply | mln. kWh | 99.1 | 94.3 | 98.6 | 95.5 | 97.6 |
| Specific consumption for own needs | | | | | | |
| electricity generation | % | 6.6% | 6.5% | 6.6% | 6.8% | 6.5% |
| heat supply | kWh/Gcal | 43.7 | 41.4 | 43.1 | 43.3 | 42.6 |
| Fuel consumption | thou. tce | 1,415.2 | 1,352.9 | 1,317.2 | 1,274.3 | 1,337.4 |

| | Units | 2001 | 2002 | 2003 | 2004 | 2005 |
|--------------------------------|-----------|---------|---------|---------|---------|---------|
| electricity generation | thou. tce | 1,044.3 | 1,022.0 | 986.1 | 954.8 | 1,003.4 |
| heat supply | thou. tce | 370.8 | 331.0 | 331.2 | 319.5 | 334.3 |
| natural gas | thou. tce | 1,415.0 | 1,350.6 | 1,315.3 | 1,274.2 | 1,329.6 |
| petroleum products | thou. tce | 0.30 | 2.26 | 1.98 | 0.11 | 8.09 |
| fuel oil | thou. tce | 0.12 | 2.09 | 1.89 | 0.05 | 7.93 |
| diesel oil | thou. tce | 0.17 | 0.17 | 0.09 | 0.07 | 0.16 |
| Specific fuel consumption | | | | | | |
| electricity supply to the grid | g/kWh | 355.1 | 353.6 | 352.1 | 349.5 | 358.1 |
| heat supply | g/Gcal | 163.4 | 145.2 | 144.8 | 144.8 | 146.0 |

Source: "6-TP" for corresponding years.

Table 2.2 Basic operation parameters of Astrakhanskaya GRES

| | Units | 2001 | 2002 | 2003 | 2004 | 2005 |
|--------------------------------|------------|-------|-------|-------|-------|-------|
| Installed power capacity | Thou. kW | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |
| Installed power capacity load | hours | 7234 | 6693 | 6243 | 6987 | 7042 |
| Installed heat capacity | Gcal/hr | 244 | 244 | 244 | 244 | 244 |
| Electricity generation | Mln. kWh | 723.4 | 669.3 | 624.3 | 698.7 | 704.2 |
| Electricity supply to the grid | Mln. kWh | 657.9 | 606.2 | 563.6 | 636.9 | 643.8 |
| Heat supply | Thou. Gcal | 798.2 | 524.4 | 529.8 | 473.0 | 459.4 |
| Own use | Mln. kWh | 65.5 | 63.0 | 60.7 | 61.8 | 60.4 |
| electricity generation | Mln. kWh | 37.8 | 46.0 | 41.1 | 45.6 | 44.9 |
| heat supply | Mln. kWh | 27.8 | 17.0 | 19.5 | 16.2 | 15.5 |
| Specific own needs consumption | | | | | | |
| electricity generation | % | 5.2% | 6.9% | 6.6% | 6.5% | 6.4% |
| heat supply | kWh/Gcal | 34.8 | 32.5 | 36.9 | 34.2 | 33.7 |
| Fuel consumption | Thou. tce | 385.0 | 333.5 | 314.0 | 336.8 | 341.1 |
| electricity generation | Thou. tce | 262.6 | 253.4 | 232.8 | 265.5 | 270.8 |
| heat supply | Thou. tce | 122.4 | 80.1 | 81.3 | 71.3 | 70.4 |
| natural gas | Thou. tce | 384.9 | 331.4 | 312.1 | 336.7 | 339.9 |
| fuel oil | Thou. tce | 0.12 | 2.09 | 1.89 | 0.05 | 1.27 |
| Specific fuel consumption | | | | | | |
| electricity generation | g/kWh | 399.2 | 418.0 | 413.0 | 416.9 | 420.6 |
| heat supply | g/Gcal | 153.3 | 152.8 | 153.4 | 150.7 | 153.2 |

Source: "6-TP" for corresponding years.

Astrakhanskaya CHP-2 (380 MW) is in operation since 1985. The main fuel is natural gas. Electricity and heat generation has been stable over the recent years. Specific fuel consumption for power generation is quite high (see Table 2.3).

Table 2.3. Basic operation parameters of Astrakhanskaya CHP plant-2

| | Units | 2001 | 2002 | 2003 | 2004 | 2005 |
|--------------------------------|------------|--------|--------|--------|--------|--------|
| Installed power capacity | Thou. kW | 380.0 | 380.0 | 380.0 | 380.0 | 380.0 |
| Installed power capacity load | hours | 380.0 | 380.0 | 380.0 | 380.0 | 380.0 |
| Installed heat capacity | Gcal/hr | 910 | 910 | 910 | 910 | 910 |
| turbines | Gcal/hr | 710 | 710 | 710 | 710 | 710 |
| peak boiler-house | Gcal/hr | 200 | 200 | 200 | 200 | 200 |
| Electricity generation | Mln. kWh | 6339 | 6399 | 6259 | 5880 | 6070 |
| Electricity supply to the grid | Mln. kWh | 2408.7 | 2431.6 | 2378.3 | 2234.3 | 2306.7 |
| Heat supply | Thou. Gcal | 2195.3 | 2208.9 | 2151.8 | 2011.4 | 2083.6 |
| Own use | Mln. kWh | 213.4 | 222.7 | 226.5 | 222.8 | 223.1 |
| electricity generation | Mln. kWh | 150.2 | 154.0 | 156.6 | 153.6 | 151.3 |
| heat supply | Mln. kWh | 63.2 | 68.7 | 69.9 | 69.3 | 71.8 |
| Specific own needs consumption | | | | | | |
| electricity generation | % | 6.2% | 6.3% | 6.6% | 6.9% | 6.6% |
| heat supply | kWh/Gcal | 47.3 | 48.6 | 49.8 | 50.2 | 48.4 |
| Fuel consumption | Thou. tce | 947.6 | 950.1 | 931.0 | 866.3 | 928.5 |
| electricity generation | Thou. tce | 754.1 | 746.2 | 727.7 | 667.3 | 711.5 |
| heat supply | Thou. tce | 193.6 | 203.9 | 203.3 | 198.9 | 217.0 |

| | Units | 2001 | 2002 | 2003 | 2004 | 2005 |
|---------------------------|-----------|-------|-------|-------|-------|-------|
| natural gas | Thou. tce | 947.6 | 950.1 | 931.0 | 866.3 | 922.1 |
| fuel oil | Thou. tce | | | | | 6.39 |
| Specific fuel consumption | | | | | | |
| electricity generation | g/kWh | 343.5 | 337.8 | 338.2 | 331.8 | 341.5 |
| heat supply | g/Gcal | 144.8 | 144.2 | 144.9 | 144.2 | 146.2 |

Source: "6-TP" for corresponding years.

OAO "Severnaya CHP" is an industrial plant commissioned in 1962 and supplying electricity and heat to OAO "Astrakhanbumprom" enterprise and neighboring residential communities. Operation of the CHP is based on heat generation; electricity generation depends on the heat loads. Specific fuel consumption factors are the lowest (see Table 2.4). However, the CHP load is getting down determined by relatively high power tariffs. Energy trading companies prefer to buy cheaper electricity at FOREM. This explains declining installed power capacity load in recent years. Renovation plans include installation of a PT-39/35-3.4/1.0 turbine; this will allow for decommissioning of obsolete turbines and power generation in the condensation mode.

Table 2.4 Basic operation parameters of Severnaya co-generation plant

| | Units | 2001 | 2002 | 2003 | 2004 | 2005 |
|--------------------------------|------------|-------|-------|-------|-------|-------|
| Installed power capacity | Thou. kW | 24.0 | 24.0 | 24.0 | 24.0 | 24.0 |
| Installed power capacity load | hours | 4286 | 3711 | 4550 | 4163 | 3736 |
| Installed heat capacity | Gcal/hr | 194 | 194 | 194 | 194 | 194 |
| Electricity generation | Mln. kWh | 102.9 | 89.1 | 100.2 | 99.9 | 89.7 |
| Electricity supply to the grid | Mln. kWh | 87.6 | 74.4 | 84.5 | 83.4 | 73.9 |
| Heat supply | Thou. Gcal | 134.8 | 126.3 | 142.2 | 137.8 | 150.9 |
| Own use | Mln. kWh | 15.2 | 14.7 | 15.7 | 16.6 | 15.8 |
| electricity generation | Mln. kWh | 7.1 | 6.1 | 6.5 | 6.5 | 5.4 |
| heat supply | Mln. kWh | 8.1 | 8.5 | 9.2 | 10.1 | 10.3 |
| Specific own needs consumption | Mln. kWh | | | | | |
| electricity generation | Mln. kWh | 6.9% | 6.9% | 6.5% | 6.5% | 6.1% |
| heat supply | Thou. Gcal | 60.1 | 67.4 | 64.8 | 73.0 | 68.4 |
| Fuel consumption | Thou. tce | 48.2 | 35.9 | 40.1 | 37.7 | 36.8 |
| electricity generation | Thou. tce | 27.5 | 22.2 | 25.4 | 21.8 | 20.9 |
| heat supply | Thou. tce | 20.7 | 13.6 | 14.7 | 15.8 | 16.2 |
| natural gas | Thou. tce | 48.2 | 35.9 | 40.1 | 37.7 | 36.8 |
| fuel oil | Thou. tce | | | | | 0.27 |
| Specific fuel consumption | | | | | | |
| electricity generation | g/kWh | 314.1 | 298.7 | 300.7 | 262.1 | 283.3 |
| heat generation | g/Gcal | 153.4 | 107.9 | 103.3 | 114.8 | 107.3 |

Source: "6-TP" for corresponding years.

Total capacity of six diesel power plants (OAO "Bassol" in N.Baskunchak town; OAO RZhD; Astrakhanskaya diesel power plant in Baskunchak station; OOO "Astrakhangasprom" in Aksaraisk town; and OOO PKF "Tumaksky fish plant" in Tumak town) equals 17.7 MW. In 2005, they generated 476 thousand kWh (see Table 2.5). Specific fuel consumption by diesel power plants is quite high.

Table 2.5 Basic operation parameters of Astrakhan Oblast diesel power plants

| | Units | 2001 | 2002 | 2003 | 2004 | 2005 |
|--------------------------------|-----------|-------|-------|-------|-------|-------|
| Installed power capacity | thou. kW | 14.6 | 13.9 | 12.9 | 18.0 | 17.7 |
| Electricity generation | mln. kWh | 0.155 | 0.505 | 0.552 | 0.372 | 0.476 |
| Installed power capacity load | hours | 10.7 | 36.3 | 42.9 | 20.7 | 26.9 |
| Electricity supply to the grid | mln. kWh | 0.153 | 0.423 | 0.467 | 0.303 | 0.381 |
| Own needs | mln. kWh | | 0.1 | 0.1 | 0.1 | 0.1 |
| Specific fuel consumption | g/kWh | 477.1 | 394.8 | 471.1 | 528.1 | 414.7 |
| Diesel fuel consumption | thou. tce | 0.07 | 0.17 | 0.09 | 0.07 | 0.16 |

Source: "6-TP" for corresponding years.

2.1.2 POWER DISTRIBUTION

High voltage power grid of Astrakhan Oblast is part of the Central Power Grid. It is connected to Volgograd Oblast energy system through four single circuit 220 kV or higher voltage 1,494 km long transmission lines. One of these four transmission lines, Volgograd South Substation – Cherny Yar, is 500 kV. Apart from this, it is connected to the Southern Power Grid through a 220 kV 969.8 km power transmission line (see Table 2.6). Astrakhan Oblast energy system is also connected with Kalmykia and Kazakhstan Republics energy systems through 220 kV and 110 kV power transmission lines supplying power and capacity to these systems.

Table 2.6 Basic operation parameters of HV-power transmission lines in Astrakhan Oblast

| Astrakhan Oblast energy system | Parameters | 2001 | 2002 | 2003 | 2004 | 2005 |
|--------------------------------|--|-------|-------|-------|-------|-------|
| Central Power Grid | Total length of high-voltage 220 kV or more transmission lines, km, incl.: | 1,455 | 1,494 | 1,494 | 1,494 | |
| | 500 kV | 178 | 178 | 178 | 178 | 178 |
| | 200 kV | 1,277 | 1,316 | 1,316 | 1,316 | 1,316 |
| Southern Power Grid | 220 kV (single circuit) | | | | | 969.8 |

The stations are “Cherny Yar” and “Vladimirskaia” 220/110 kV, located in the north of Astrakhan Oblast. At the receive end of the Center – Astrakhan power transmission line there is a tie station “Astrakhan”, designed as a 500/220 kV substation, which includes a distribution device – 220 kV (see Table 2.7). In the future, autotransformers 500/220 kV will be installed at the substation.

Table 2.7 220 kV transformers capacity of the Central and Astrakhan Oblast energy systems in 2001-2005

| | 2001 | 2002 | 2003 | 2004 | 2005 |
|------------------------------------|-------|-------|-------|-------|-------|
| 220 kV transformers capacity, MV.A | 1,254 | 1,254 | 1,192 | 1,272 | 1,272 |

Power distribution in Astrakhan Oblast is performed through 0.4-220 kV power transmission lines of OAO “Astrakhanenergo”, MUP “Astrkommunenergo”, UMP “Kommunenergo” of Trusovsky region, and other small companies. OAO “Astrakhanenergo” operates 21,178 km of 0.4-220 kV power transmission and distribution lines (see Table 2.8).

MUP “Astrkommunenergo” operates 1,351 km of 0.4-10 kV power distribution lines (see Table 2.9). Lifetimes of 90.5% of overhead lines and of 25.7% of cable lines have completely expired. MUP “Kommunenergo” of Trusovsky region operates 709 km of 0.4-10 kV power distribution lines.

Table 2.8 Basic parameters of power transmission lines operated by OAO "Astrakhanenergo"

| Name | Time of commissioning | | | | | | | | Total |
|------------------------------|-----------------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|--------|
| | Before 1965 | 1965 1970 | 1970 1975 | 1975 1980 | 1980 1985 | 1985 1990 | 1990 1995 | 1995 2000 | |
| Overhead lines, total, km | 899 | 3,170 | 3,744 | 4,529 | 3,709 | 4,377 | 661 | 89 | 21,178 |
| 220 kV | - | 489 | - | - | 196 | 338 | 137 | - | 1,167 |
| 110 kV | 168 | 151 | 417 | 501 | 507 | 447 | 93 | 83 | 2,367 |
| 35 kV | 79 | 73 | 183 | 163 | 137 | 36 | 1 | - | 672 |
| 6-10 kV | 135 | 1,687 | 1,998 | 2,898 | 2,215 | 2,880 | 184 | 5 | 12,002 |
| 0.4 kV | 517 | 763 | 1,146 | 967 | 654 | 676 | 246 | 1 | 4,970 |
| Depreciation, % | 100 | 100 | 80 | 60 | 50 | 30 | 15 | - | - |
| Cable lines, total, km | 1.3 | 14.6 | 20.7 | 27.4 | 19 | 22 | 8 | - | 113 |
| 10 kV | - | 12 | 19 | 26 | 18 | 21 | 8 | - | 104 |
| 6 kV | 1 | 2 | 1 | - | - | - | - | - | 4 |
| 0.4 kV | 0.3 | 0.6 | 0.7 | 1.4 | 1 | 1 | - | - | 5 |
| Depreciation, % | 100 | 100 | 80 | 60 | 50 | 30 | 15 | - | - |
| Transformers 35-220 kV, pcs. | - | - | 88 | 40 | 42 | 50 | 21 | - | 241 |
| Depreciation, % | - | - | 100 | 100 | 80 | 60 | 40 | - | - |

Table 2.9 Basic parameters of power distribution lines operated by MUP "Astrkommunenergo"

| Name | Time of commissioning | | | | | | | | Total |
|---------------------------|-----------------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|--------|
| | Before 1965 | 1965 1970 | 1970 1975 | 1975 1980 | 1980 1985 | 1985 1990 | 1990 1995 | 1995 2000 | |
| Overhead lines, total, km | 22.43 | 628.38 | 2.46 | 13.9 | 10.28 | 19.8 | 8.14 | 13.87 | 719.26 |
| 6-10 kV | 10.54 | 128.11 | 0.73 | 12.2 | 9.6 | 2.61 | 4.93 | 13.34 | 182.06 |
| 0.4 kV | 11.89 | 500.27 | 1.73 | 1.7 | 0.68 | 17.19 | 3.21 | 0.53 | 537.2 |
| Depreciation, % | 100 | 100 | 80 | 60 | 50 | 30 | 15 | - | - |
| Cable lines, total, km | 93.33 | 68.76 | 35.18 | 82.89 | 43.62 | 227.1 | 45.17 | 35.46 | 631.51 |
| 6-10 kV | 84.28 | 47.85 | 1.03 | 49.96 | 33.99 | 172.73 | 32.24 | 23.7 | 445.78 |
| 0.4 kV | 9.05 | 20.91 | 34.15 | 32.93 | 9.63 | 54.37 | 12.93 | 11.76 | 185.73 |
| Depreciation, % | 100 | 100 | 80 | 60 | 50 | 30 | 15 | - | - |

Table 2.10 Basic parameters of power distribution lines operated by MUP "Kommunenergo" of Trusovsky region

| Name | Time of commissioning | | | | | | | | Total |
|---------------------------|-----------------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-------|
| | Before 1965 | 1965 1970 | 1970 1975 | 1975 1980 | 1980 1985 | 1985 1990 | 1990 1995 | 1995 2000 | |
| Overhead lines, total, km | 224.4 | 70.2 | 63.7 | 55.4 | 55.0 | 49.9 | 19.1 | 8.0 | 545.7 |
| 6-10 kV | 58.4 | 17.5 | 16.5 | 15.6 | 17.0 | 16.9 | 5.1 | 4.0 | 151.0 |
| 0.4 kV | 166.0 | 52.7 | 47.2 | 39.8 | 38.0 | 33.0 | 14.0 | 4.0 | 394.7 |
| Depreciation, % | 100 | 100 | 80 | 60 | 50 | 30 | 15 | - | - |
| Cable lines, total, km | 74.7 | 17.6 | 17.5 | 13.4 | 14.7 | 13.0 | 9.6 | 2.7 | 163.2 |
| 0.4 kV | 51.2 | 10.3 | 10.3 | 7.1 | 8.0 | 7.0 | 4.6 | 2.0 | 100.5 |

| Name | Time of commissioning | | | | | | | | Total |
|-----------------|-----------------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|-------|
| | Before 1965 | 1965 1970 | 1970 1975 | 1975 1980 | 1980 1985 | 1985 1990 | 1990 1995 | 1995 2000 | |
| 6-10 kV | 23.5 | 7.3 | 7.2 | 6.3 | 6.7 | 6.0 | 5.0 | 0.7 | 62.7 |
| 0.4 kV | 100 | 100 | 80 | 60 | 50 | 30 | 15 | | |
| Depreciation, % | | | | | | | | | |

According to the electricity balance (see Table 2.12), the share of transmission and distribution losses increased to 19.3% in 2005. The losses include power grid transmission losses, distribution losses of MUP “Astrkommunenergo”, which supplies power to Astrakhan city, and distribution losses of other local power suppliers. In 2006, power grid transmission losses were estimated at around 400 mln kWh, distribution losses of MUP “Astrkommunenergo” (as approved of in the tariff justification) – 93 mln kWh, and distribution losses of other suppliers – around 3 mln kWh; these total for 496 mln kWh. In 2005, total transmission and distribution losses accounted for nearly 650 mln kWh. Transmission losses of “Rusenergosbyt” are to be added to this value.

According to the 2006 power balance of the power grid (AESK), transmission losses amounted to nearly 15%. Growing share of technical losses is responsible for overall losses factor growth in the recent years. This is clearly illustrated in Fig. 2.1. Extremely low outdoor temperatures of January 2006 (in the upper right-hand corner of the graph) determined abrupt increase in residential and office electricity consumption for space heating. Power lines are not designed for such high loads. Therefore, power losses grew substantially (up to 23% in AESK-operated lines). If the outdoor temperatures in January 2006 had been normal, AESK power transmission losses would have been 2% lower (21% instead of 23%); and if they had been similar to those in January 2005, then 4% lower. With average monthly outdoor air temperature of 18°C AESK transmission power losses equal just 9-10%. The growing share of low voltage consumption is a significant loss increase factor (see Fig. 2.1). As soon as this share exceeds 37%, losses are exceeding 15%. This analysis shows, that the share of excessive transmission losses determined by inadequate power transmission development was above 29% of total losses in 2006. According to the data reported by MUP “Astrkommunenergo”, low voltage losses accounted to 87% of overall losses in 2005. The 2006 power tariff determines this share at 71%, and the 2007 tariff – at 75%.

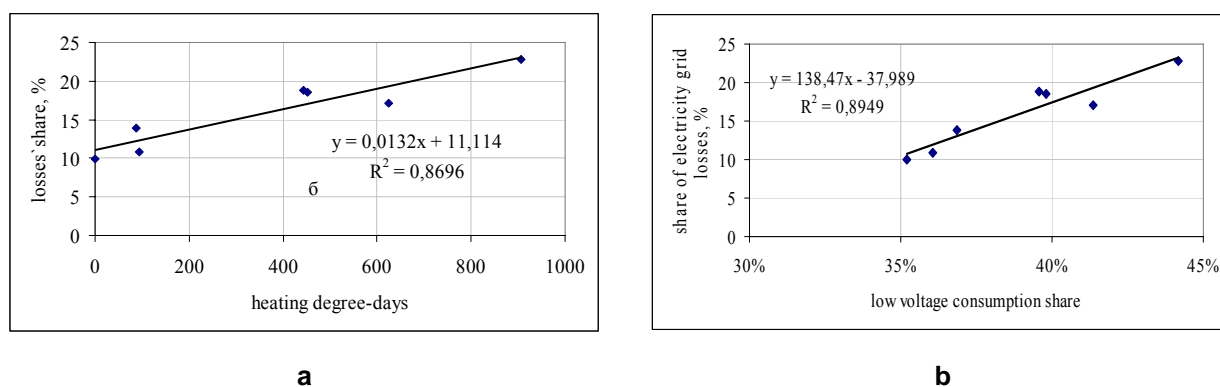


Fig. 2.1 Correlation of the electricity transmission and distribution losses (%) to the number of degree-days and to the share of low-voltage consumption (for 2006 monthly data)

In other words, lower outdoor temperatures and higher low-voltage loads result in significant growth of power losses. According to MUP “Astrkommunenergo”, aluminum wires in low-voltage lines are overtempered, and merely break when bended during repairs. Metering in MUP “Astrkommunenergo” maintenance zones in downtown Astrakhan city carried out by this company’s staff in winter 2006 with a complete set of metering equipment and maximum elimination of any possible power stealing revealed power discrepancies of around 20%. This means, that commercial losses, which are usually believed to be responsible for loss growth, are in fact not that huge, constituting just 3-4%, while the major factors determining losses increase include high wear and tear

of equipment and disbalance of transmission/distribution capacity and load in many substations (capacity deficit).

The paper "Guidelines for power losses reduction in Astrakhan Oblast power sector until 2005" developed by Astrakhan Oblast public utility commission in 2002 contains a quite comprehensive analysis of power losses as of 2001. This paper specifies standard and excessive power transmission and distribution losses (see Table 2.11). According to Astrakhan Oblast public utility commission, excessive power losses are 26% of overall losses. This estimate is pretty close to our estimate above (29%). In some locations, the share of losses reaches 30-50%; and about half of these are commercial losses. Distribution losses of MUP "Astrkommunenergo" grew up from 6.5% in 1992 to 21.5% in 2001; during the same period distribution losses of "Kommunenergo" of Trusovsky region grew up from 6.5% to 19.3%.

Table 2.11 Estimation of excessive transmission and distribution power losses in 2000 by Astrakhan Oblast public utility commission (mln kWh)

| | Total losses | Standard losses | Excessive losses (according to public utility commission) | Share of transmission / distribution losses | Share in total losses |
|--|---------------------|------------------------|--|--|------------------------------|
| AO "Astrakhanenergo" | 489.1 | 399.4 | 63.3 | | 73.9% |
| Power transmission lines within power plants | 26.4 | 0.0 | 0.0 | | 4.0% |
| General use lines | 462.7 | 399.4 | 63.3 | 13.90% | 69.9% |
| AO "Astrakhanenergo" | 459.4 | 399.0 | 60.4 | | 69.4% |
| High voltage | 30.0 | 0.0 | 0.0 | | 4.5% |
| Medium voltage | 139.4 | 0.0 | 0.0 | | 21.1% |
| Low voltage | 290.0 | 0.0 | 0.0 | | 43.8% |
| OAO "Severnaya co-generation plant" – medium voltage | 3.3 | 0.4 | 2.9 | 3.90% | 0.5% |
| "Astrkommunenergo" | 96.70 | 36.00 | 60.70 | 16.3% | 14.6% |
| "Kommunenergo" of Trusovsky region | 39.90 | 11.95 | 27.96 | 23.2% | 6.0% |
| Housing&utility in Ikryanskoye | 10.57 | 1.73 | 8.84 | 50.8% | 1.6% |
| Housing&utility in Kapustin Yar | 3.69 | 0.83 | 2.86 | 45.1% | 0.6% |
| Akhtubzhilkomkhoz | 15.40 | 6.18 | 9.22 | 30.0% | 2.3% |
| Housing&utility in Seitovka | 1.41 | 0.80 | 0.62 | 27.6% | 0.2% |
| Housing&utility in Krasnye barrikady | 1.59 | 0.82 | 0.77 | 16.7% | 0.2% |
| Chernoyarzhilkomkhoz | 3.77 | 3.77 | 0.00 | 14.5% | 0.6% |
| Total | 662.1 | 461.5 | 174.3 | 16.5% | 100.0% |

Source: "Guidelines for power losses reduction in Astrakhan Oblast power sector until 2005"

The public utility commission estimated overall commercial power losses in Astrakhan Oblast at 90 mln kWh, or 14% of the total losses, and identified three basic factors determining this high value: considerable wear and tear of the power lines; unbalanced structure of power consumption and power distribution development; and insufficient metering. In 2002, the public utility commission estimated distribution losses reduction potential at 144 mln kWh; this grew up even further by 2006. If losses could be reduced to the maximum accepted level in developed countries (8%), power savings of 450 mln kWh, or nearly 15% of overall power generation in Astrakhan Oblast, could be achieved, exceeding the power generation increase required by the "Energy Strategy of Astrakhan Oblast" in 2005-2010.

Against this background, lack of specific utility programs to reduce distribution power losses looks very strange. In its report, the public utility commission suggested the development of a

Comprehensive target program for power loss reduction; but this was never developed. Even more strangely, renovation of the power distribution system is not included in the priorities, or energy savings factors, or investment policies specified by the "Energy Strategy of Astrakhan Oblast".

2.1.3 POWER BALANCE STATISTICS

The regional power balance is based on the "E-1", "E-2", and "E-3" forms and is shown in Table 2.12. Working with these data involves certain problems. The three forms significantly differ in terms of industrial power consumption.

Table 2.12. Astrakhan Oblast power balance based on "E-1", "E-2", and "E-3" (mln kWh)

| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|--|----------------|----------------|----------------|----------------|----------------|----------------|
| Electricity generation | 3,435.9 | 3,241.4 | 3,191.6 | 3,105.1 | 3,034.7 | 3,102.4 |
| Electricity import | 694.8 | 742.4 | 728.3 | 901.9 | 957.6 | 2,781.2 |
| Electricity export | 505.9 | 366.4 | 208.6 | 316.1 | 210.50 | 1,917.1 |
| <i>Self-sufficiency (%)</i> | <i>90.2%</i> | <i>94.8%</i> | <i>89.6%</i> | <i>86.0%</i> | <i>84.1%</i> | <i>80.2%</i> |
| Electricity consumption | 3,624.8 | 3,617.4 | 3,711.3 | 3,690.9 | 3,781.8 | 3,966.5 |
| <i>Growth rate (%)</i> | <i>2.9%</i> | <i>-0.2%</i> | <i>2.6%</i> | <i>-0.5%</i> | <i>2.5%</i> | <i>4.9%</i> |
| Overall distribution losses | 597.9 | 581.6 | 687.3 | 672.5 | 627.9 | 766.3 |
| <i>Share in overall consumption (%)</i> | <i>16.5%</i> | <i>16.1%</i> | <i>18.5%</i> | <i>18.2%</i> | <i>16.6%</i> | <i>19.3%</i> |
| Power sector own needs | 306.2 | 306.4 | 317.0 | 317.6 | 317.9 | 338.4 |
| Final electricity consumption | 2,720.7 | 2,729.4 | 2,707.0 | 2,700.8 | 2,836.0 | 2,861.8 |
| <i>Growth rate (%)</i> | <i>4.8%</i> | <i>0.3%</i> | <i>-0.8%</i> | <i>-0.2%</i> | <i>5.0%</i> | <i>0.9%</i> |
| Industrial consumption, excl. of own needs | 1,007.9 | 1,011.8 | 1,038.1 | 1,085.7 | 1,117.2 | |
| Fuel sector | 724.9 | 753.4 | 788.2 | 802.3 | 820.6 | |
| Ferrous Metallurgy | 0.4 | 0.0 | 0.0 | 0.0 | 0.0 | |
| Chemical and Petrochemical | 25.1 | 26.0 | 23.7 | 23.8 | 23.6 | |
| Machine building and Metal working | 65.0 | 65.8 | 70.2 | 77.5 | 72.1 | |
| Timber, Wood, and Pulp&Paper | 5.3 | 3.6 | 3.9 | 2.9 | 2.2 | |
| Building Materials | 24.0 | 21.2 | 17.5 | 17.1 | 20.0 | |
| Glass and porcelain industry | 0.0 | 5.3 | 4.6 | 5.4 | 11.5 | |
| Light industry | 8.9 | 7.8 | 4.1 | 7.0 | 2.6 | |
| Food industry | 70.7 | 63.2 | 55.5 | 55.2 | 49.0 | |
| Other | 83.6 | 65.5 | 70.3 | 94.5 | 115.5 | |
| Construction, total | 50.2 | 67.8 | 58.8 | 93.0 | 91.9 | 76.6 |
| incl. drilling of oil- and gas-wells | 3.9 | 0.6 | 3.0 | 7.0 | 18.0 | |
| Utilities, total | 751.0 | 747.6 | 763.4 | 708.1 | 716.60 | |
| incl. lighting and household needs of urban population | 483.6 | 440.5 | 453.4 | 414.8 | 418.00 | 474.0 |
| street lighting in cities and towns | 28.8 | 27.3 | 21.2 | 24.4 | 29.80 | 9.8 |
| water supply and sewage | 90.8 | 88.2 | 89.9 | 84.7 | 83.70 | 8.0 |
| other utilities | 147.8 | 191.6 | 198.9 | 184.2 | 185.10 | |
| Agriculture, total | 582.3 | 584.1 | 516.4 | 494.8 | 500.70 | 359.0 |
| incl. for production needs | 206.0 | 207.7 | 179.3 | 159.8 | 137.70 | 137.8 |
| lighting and household needs of rural population | 203.1 | 240.2 | 213.4 | 228.6 | 223.30 | 221.2 |
| post offices and telecommunication agencies; storages | 173.2 | 136.2 | 123.7 | 106.4 | 139.70 | |

| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|--|--------------|--------------|--------------|--------------|---------------|--------------|
| Transport, total | 130.9 | 122.6 | 119.1 | 123.0 | 130.10 | 169.8 |
| railway, water, air, and automobile | 102.6 | 94.5 | 91.1 | 90.3 | 83.00 | 105.9 |
| railway | 51.0 | 39.6 | 54.7 | 54.5 | 51.90 | 85.7 |
| railway for electric traction | 3.1 | 1.8 | 2.3 | 2.8 | 2.80 | 3.4 |
| trams, trolleybuses | 13.5 | 12.3 | 11.2 | 10.0 | 10.00 | 9.6 |
| oil pipelines | 8.2 | 9.1 | 9.3 | 15.6 | 28.10 | 35.0 |
| natural gas pipelines | 6.6 | 6.7 | 7.5 | 7.1 | 9.00 | 2.4 |
| Communication | | | | | | 15.7 |
| Post offices and telecommunication agencies; culture agencies; health care institutions; trade | 218.5 | 222.9 | 242.4 | 226.6 | 312.80 | |

Sources: Forms "E-1", "E-2", and "E-3".

4.9% total electricity consumption increase in 2005 was determined by a sudden growth of electricity distribution losses. This data on losses growth originated from higher losses allowances in the process of power tariff setting for 2005, rather than from an actual physical growth in losses. According to the data reported by MUP "Astrkommunenergo", the share of losses in 2005 was 27.2%, so losses increased by 130 mln kWh. The 2006 tariff determines the share of losses only at 12.4%, and the 2007 tariff – at 14.9%. Therefore, a sudden growth of losses in 2005 was policy-determined, and did not result from the changes in the technical condition of the power supply system. Final electricity consumption only increased by 0.9%.

Table 2.1 is not structured in the most effective way. For example, residential power consumption in rural areas is represented in the Utilities and Agriculture. Agriculture also includes commercial consumption in the rural areas. The Other Utilities line seems to include power consumption by boiler-houses. Therefore, a considerable restructuring of Table 2.12 data is required to develop the power consumption concept for the Fuel and Energy Balance by (sub-) sector.

Changes in the statistical classification have become a serious problem.. The "All-Russian Classifier of Economic Activities" (OKVED) was adopted effectively since January 1, 2003, to replace the previous All-Russian Classifier of Sectors of Economy (OKONKh)². OKVED classifies types of economic activities. Basic classification parameters include area of activity, technology, raw materials. Unlike in OKONKh, types of economic activities are classified regardless of companies' type of ownership or departmental subordination. Therefore, the 2005 data are not specified by sectors in detail, they are only broken down by mining (28.8 mln. kWh in 2005), manufacturing (788.2 mln. kWh in 2005), and utilities (power, gas, and water production and distribution - 1119.4 mln. kWh in 2005). Apart from these, there are data on agricultural, transport, and communication consumption (see the 2005 column in Table 2.12).

The new classification does not specify residential power consumption; it is included in power-, gas-, and water distribution. Such power consumption breakdown is extremely inadequate for analysis. All Russian analysts faced an inability prolonging power consumption data series by sectors for 2005. Other statistical forms are to be used to develop a comprehensive intense power balance.

2.1.4 "11-TER" DATA

"11-TER" allows a relatively easy prolongation of dynamic statistical series to analyze the energy situation in accordance with OKVED, because it has always presented data not only by sectors, but specifying "cross-cutting" types of economic activities for all sectors. For example, oil extraction shows cast iron and bread outputs, apart from basic activities. "11-TER" is

² For detail see "Re-estimation of Russia's GDP rows in compliance with transfer to new classifiers". Submitted by the Statistical Committee of the Russian Federation (Rosstat). UN. Economic and Social Council. European statistical commission. Conference of European Statistics. Group of experts in national accounts. Geneva, April 25-28, 2006.

basically structured according to the technology principle. Therefore the evolution of product and technology structure of production in demand analysis and forecasts can be taken into account, as well as developing a classification of the most energy intensive types of products and services. This is also convenient for analysis and forecasts purposes. "11-TER" does not provide data on non-ferrous metals (there is none in Astrakhan Oblast), while machine building is only represented by metal processing.

At the same time, a lot of industrial energy consumption is shared between a few universal energy carrier outputs (oxygen, compressed air, heat) and water output; operation of industrial railway transport, lifting and road construction equipment. In other words, "11-TER" has proved to be the most sustainable form to reflect the structure of power consumption, given the changes in economic statistics classifier for Russia (see Table 2.13).

This form reflects around two thirds of overall electricity consumption in the region (see the last row in Table 2.13) and about three quarters of final electricity use. Small consumers are not reporting data required in this form. This form indicates residential consumption in 2005 73 mln kWh higher, than the power balance statistics.

Table 2.13. Astrakhan Oblast power balance based on Form "11-TER" (mln kWh)

| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|--|----------------|----------------|----------------|----------------|----------------|----------------|
| Electricity supply | 3,147.4 | 2,857.4 | 2,817.5 | 2,817.3 | 2,770.3 | 2,844.5 |
| Power plants | 3,134.7 | 2,853.2 | 2,815.1 | 2,815.6 | 2,748.2 | 2,817.0 |
| Diesel power plants | 12.7 | 4.2 | 2.3 | 1.7 | 22.2 | 27.5 |
| Electricity and heat sectors' own needs | 37.1 | 37.0 | 39.1 | 35.7 | 34.6 | 43.4 |
| Electricity generation at power plants | 3.4 | 7.1 | 6.1 | 6.5 | 6.5 | 5.4 |
| Heat generation at power plants | 8.7 | 8.1 | 8.5 | 9.2 | 10.1 | 10.3 |
| Heat generation at industrial and regional boiler-houses | 24.5 | 21.3 | 24.3 | 20.0 | 18.0 | 27.5 |
| regional boiler-houses | 5.5 | 11.3 | 17.3 | 15.1 | 11.3 | 13.8 |
| Heat supply by agricultural boiler-houses | 0.6 | 0.5 | 0.1 | 0.0 | 0.1 | 0.1 |
| Transmission/distribution power losses | 459.4 | 457.8 | 475.3 | 483.5 | 486.8 | 533.2 |
| Industrial | 652.9 | 679.5 | 712.3 | 742.5 | 759.5 | 761.7 |
| Oil extraction, including gas condensate | 5.0 | 5.8 | 5.9 | 6.5 | 5.4 | 6.3 |
| Other needs in oil extraction | 1.8 | 2.1 | 1.9 | 2.4 | 2.4 | 2.5 |
| Oil and gas condensate refining | 54.8 | 74.0 | 72.9 | 78.8 | 77.2 | 70.9 |
| Own needs and gas extraction losses | 7.3 | 8.5 | 9.2 | 9.5 | 6.9 | 8.9 |
| Gas processing | 327.7 | 346.9 | 378.9 | 377.3 | 399.1 | 405.0 |
| Oxygen | 0.7 | 0.0 | 0.0 | 1.3 | 1.2 | 1.3 |
| Compressed air | 1.7 | 0.0 | 0.0 | 1.8 | 2.2 | 3.1 |
| Sulphur | 148.2 | 147.6 | 149.0 | 150.7 | 155.9 | 156.8 |
| Wood drying | 0.0 | 0.0 | 0.0 | 0.2 | 0.2 | 0.2 |
| Bread and bakery products | 5.5 | 5.2 | 5.3 | 4.8 | 4.1 | 3.8 |
| Water pumping and supply (excl. public utility needs) | 70.7 | 60.5 | 61.0 | 70.4 | 65.9 | 66.6 |
| Effluent treatment | 29.5 | 28.8 | 28.3 | 38.8 | 39.0 | 36.3 |
| Transport | 54.9 | 50.2 | 53.4 | 52.7 | 57.1 | 56.4 |
| Natural gas transmission | 1.5 | 1.7 | 2.0 | 2.4 | 2.6 | 2.6 |
| Electric traction of railway trains (Ministry of Transportation) | 2.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.6 |
| Operation of railways (Ministry of Transportation), excl. of electric traction | 37.8 | 36.1 | 40.1 | 40.4 | 44.7 | 44.4 |
| Electric traction of trams | 6.8 | 6.3 | 5.8 | 5.1 | 4.7 | 4.4 |
| Electric traction of trolleybuses | 6.7 | 6.0 | 5.5 | 4.8 | 5.0 | 4.3 |

| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|--|----------------|----------------|----------------|----------------|----------------|----------------|
| Agriculture | 67,1 | 68,3 | 86,7 | 37,9 | 58,1 | 49,8 |
| Space heating in greenhouses | 0.2 | 0.1 | 0.1 | 0.0 | 0.2 | 0.2 |
| Water pumping for melioration and water supply | 66.9 | 62.9 | 43.3 | 32.6 | 52.0 | 45.2 |
| Land irrigation and drainage | 0.0 | 5.3 | 43.3 | 5.3 | 5.9 | 4.4 |
| Construction | 0.1 | 33.6 | 18.9 | 16.6 | 35.4 | 35.6 |
| Exploration drilling of oil- and gas wells | 0.1 | 31.6 | 12.4 | 3.4 | 19.0 | 10.9 |
| Operation drilling of oil- and gas wells | 0.0 | 2.0 | 6.4 | 13.2 | 16.4 | 24.6 |
| Utility | 58.7 | 64.1 | 74.7 | 73.1 | 83.1 | 67.7 |
| Other industrial consumption | 103.5 | 122.1 | 67.4 | 159.5 | 143.0 | 129.8 |
| Residential | 771.9 | 778.7 | 704.0 | 828.6 | 773.9 | 714.4 |
| Overall consumption | 2,205.5 | 2,291.1 | 2,231.6 | 2,430.1 | 2,431.2 | 2,391.7 |
| <i>Of total consumption in Table 2.12 (%)</i> | <i>60.8%</i> | <i>63.2%</i> | <i>61.6%</i> | <i>67.0%</i> | <i>67.1%</i> | <i>66.0%</i> |

Source: Form "11 TER" for various years

2.1.5 "22-ZHKH" DATA

"22 ZhKH" gives only three figures: overall power sales (796 mln. kWh during the first six months of 2006), including to the residential sector (463 mln. kWh) and social facilities (111 mln. kWh). Total electricity consumption for 2006 may be estimated at 635 mln. kWh.

2.1.6 DATA FROM ASTRAKHAN OBLAST TARIFF SERVICE

Data of Astrakhan Oblast Tariff Service is another source of information on electricity consumption volume and structure, which specifies power consumption not only by sectors, but also by voltage levels (see Table 2.14). These data specify large industrial consumers and show the dynamics of so-called non-industrial consumption. Abrupt growth of power consumption by medium and small industrial, as well as non-industrial, consumers in 2005 just "catches the eye". These data also show, that low-voltage consumption was growing faster, than overall consumption. One can mention that none of the forms show considerable growth of residential power consumption in recent years.

Table 2.14 Electricity balance developed based on the data of Astrakhan Oblast Tariff Service (mln kWh)

| | 2001 | 2002 | 2003 | 2004 | 2005 | Average annual increase rate |
|---|--------------|---------------|--------------|---------------|---------------|------------------------------|
| Industrial and equated consumers with 750 kVA or higher capacity | 984.7 | 1016.3 | 953.8 | 1066.1 | 1057.7 | 1.8% |
| incl.: high-voltage | 749.8 | 788.2 | 683.2 | 791.1 | 798.7 | 1.6% |
| medium-voltage | 234.2 | 228.1 | 267.9 | 272.4 | 257.0 | 2.3% |
| low-voltage | 0.7 | 0.0 | 2.8 | 2.6 | 2.1 | 31.4% |
| Industrial and equated consumers with the capacity below 750 kVA | 257.9 | 254.8 | 254.8 | 255.9 | 317.1 | 5.3% |
| incl.: high-voltage | 0.0 | 0.0 | 6.5 | 4.7 | 4.7 | |
| medium-voltage | 158.6 | 159.2 | 165.6 | 181.1 | 227.7 | 9.5% |
| low-voltage | 99.3 | 95.6 | 82.8 | 70.1 | 84.7 | -3.9% |
| Electric railway transport (electric traction) | 1.6 | 2.2 | 2.4 | 2.5 | 2.9 | 16.2% |
| incl.: high-voltage | 1.6 | 2.2 | 2.4 | 2.5 | 2.9 | 16.2% |
| Electric urban transport (electric traction) | 12.2 | 11.0 | 10.0 | 9.6 | 9.1 | -7.0% |
| medium-voltage | 12.0 | 10.8 | 9.8 | 9.4 | 8.9 | -7.2% |
| low-voltage | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.0% |
| Non-industrial consumption | 462.3 | 450.7 | 453.5 | 499.3 | 548.5 | 4.4% |
| medium-voltage | 198.5 | 196.9 | 203.9 | 204.0 | 213.5 | 1.8% |

| | 2001 | 2002 | 2003 | 2004 | 2005 | Average annual increase rate |
|------------------------------------|----------------|----------------|----------------|----------------|----------------|------------------------------|
| low-voltage | 263.8 | 253.8 | 249.6 | 295.3 | 335.0 | 6.2% |
| Agricultural consumption | 198.8 | 175.5 | 156.9 | 137.3 | 140.2 | -8.4% |
| medium-voltage | 131.4 | 115.4 | 124.0 | 115.2 | 121.3 | -2.0% |
| low-voltage | 67.4 | 60.2 | 32.8 | 22.1 | 18.9 | -27.3% |
| Residential, total | 502.0 | 497.7 | 537.1 | 535.6 | 514.0 | 0.6% |
| incl.: urban | 321.6 | 305.5 | 330.8 | 331.3 | 303.3 | -1.5% |
| medium-voltage | 0.3 | 1.0 | 10.8 | 3.3 | 0.0 | -100.0% |
| low-voltage | 321.3 | 304.5 | 320.0 | 328.0 | 303.3 | -1.4% |
| agricultural | 180.4 | 192.2 | 206.3 | 204.3 | 210.7 | 4.0% |
| low-voltage | 180.4 | 192.2 | 206.3 | 204.3 | 210.7 | 4.0% |
| Cities and towns, total | 148.1 | 112.1 | 103.1 | 96.3 | 131.4 | -2.9% |
| incl.: cities | 120.0 | 88.0 | 71.3 | 60.5 | 105.6 | -3.1% |
| medium-voltage | 68.3 | 43.8 | 44.3 | 20.6 | 0.0 | -100.0% |
| low-voltage | 51.7 | 44.2 | 27.0 | 39.9 | 105.6 | 19.5% |
| Towns | 28.1 | 24.1 | 31.8 | 35.8 | 25.8 | -2.1% |
| medium-voltage | 1.0 | 1.2 | 1.8 | 0.0 | 0.0 | -100.0% |
| low-voltage | 1.0 | 1.2 | 1.8 | 0.0 | 0.0 | -100.0% |
| Operation needs | 19.0 | 17.1 | 13.8 | 11.2 | 7.9 | -19.6% |
| medium-voltage | 13.3 | 10.2 | 8.0 | 6.0 | 5.6 | -19.3% |
| low-voltage | 5.7 | 6.9 | 5.8 | 5.2 | 2.3 | -20.3% |
| Overall supply to consumers | 2,586.6 | 2,537.4 | 2,485.3 | 2,613.8 | 2,728.9 | 1.3% |
| incl.: high-voltage | 751.4 | 790.4 | 692.0 | 798.3 | 806.3 | 1.8% |
| medium-voltage | 817.6 | 766.5 | 836.1 | 812.0 | 834.1 | 0.5% |
| low-voltage | 1,017.5 | 980.5 | 957.2 | 1,003.5 | 1,088.6 | 1.7% |

Source: Data of Astrakhan Oblast Tariff Service

2.1.7 COMPARATIVE ANALYSIS OF POWER BALANCE DATA TAKEN FROM DIFFERENT SOURCES

Before developing the regional power balance for its further integration in the Fuel and Energy Balance, it is important to compare data from Tables 2.1-2.12/2.14 and decide on the reliability and accuracy of information provided by different sources. Unfortunately, there are discrepancies between all the sources related to all critical indicators, especially for 2005 data (see Table 2.15). They root in different approaches to the coverage and classification of consumers. Therefore it is necessary developing an integral electricity balance based on *the integration* of all available data.

Table.2.15. Comparison of major indicators of the regional power balance (mln kWh)

| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|----------------------------------|-------|-------|-------|-------|-------|-------|
| Power generation | | | | | | |
| Statistics – “6-TP” | | 3,235 | 3,190 | 3,103 | 3,033 | 3,101 |
| Statistics – electricity balance | 3,436 | 3,241 | 3,192 | 3,105 | 3,035 | 3,102 |
| Distribution losses | | | | | | |
| Statistics – electricity balance | 598 | 582 | 687 | 673 | 628 | 766 |
| Statistics – “11-TER” | 459 | 458 | 475 | 484 | 487 | 533 |
| Own needs | | | | | | |
| Statistics – “6-TP” | | 294 | 301 | 303 | 301 | 299 |
| Statistics – electricity balance | 284 | 306 | 306 | 317 | 318 | 318 |
| Statistics – “11-TER” | 37 | 37 | 39 | 36 | 35 | 43 |
| Electricity consumption | | | | | | |
| Statistics – electricity balance | 3,625 | 3,617 | 3,711 | 3,691 | 3,782 | 3,967 |
| Statistics – “11-TER” | 2,205 | 2,291 | 2,232 | 2,430 | 2,431 | 2,392 |

| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|--|-------|-------|-------|-------|-------|-------|
| Useful electricity consumption | | | | | | |
| Statistics – electricity balance | 2,721 | 2,729 | 2,707 | 2,701 | 2,836 | 2,862 |
| Statistics – “11-TER” | 2,168 | 2,254 | 2,193 | 2,394 | 2,397 | 2,348 |
| Tariff Service | | 2,587 | 2,537 | 2,485 | 2,614 | 2,729 |
| Residential electricity consumption | | | | | | |
| Statistics – electricity balance | 687 | 681 | 667 | 643 | 641 | 695 |
| Statistics – “11-TER” | 772 | 779 | 704 | 829 | 774 | 714 |
| Statistics – “22-ZhKH” | | | | | | 645 |
| Tariff Service | | 650 | 610 | 640 | 632 | 645 |

Source: Data from Tables 2.1-2.14

2.1.8 INTEGRATED POWER BALANCE OF ASTRAKHAN OBLAST

The integrated power balance has been developed based on the information on the three power sector blocks: power resources, transformation and transmission/distribution losses and useful consumption. It has sufficient degree of detail for further analysis. It also accounts for the recent changes in the power consumption statistics.

2.1.9 THE BLOCK OF POWER RESOURCES

The block of electricity resources includes electricity generation by Astrakhanskaya GRES, Astrakhan CHP-2, “Severnaya” CHP, and diesel power plants, and electricity trade balance. With maximum use of the “6-TP” data a section of the block of electricity resources was developed (see Table 2.16). As equipment depreciates, electricity generation tends to go down, while electricity consumption grows. This brought Astrakhan Oblast electricity self-sufficiency from 95% down to 78%. Three fourths of electricity is produced by CHP-2. In 2000-2005 alone, net electricity import grew 4.6-fold. This suggests stricter requirements to the carrying capacity of high-voltage power transmission lines.

Table 2.16 Electricity resources for Astrakhan Oblast (mln kWh)

| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|----------------------------------|---------|---------|---------|---------|---------|---------|
| Electricity generation | 3,433.3 | 3,241.4 | 3,191.6 | 3,105.1 | 3,034.7 | 3,102.4 |
| Astrakhanskaya GRES | 757.4 | 723.4 | 669.3 | 624.3 | 698.7 | 704.2 |
| Astrakhan CHP-2 | 2,591.7 | 2,408.7 | 2,431.6 | 2,378.3 | 2,234.3 | 2,306.7 |
| OAO “Severnaya CHP” | 83.8 | 102.9 | 89.1 | 100.2 | 99.9 | 89.7 |
| Diesel power plants | 0.5 | 0.2 | 0.5 | 0.6 | 0.4 | 0.5 |
| Electricity import | 694.8 | 742.4 | 728.3 | 901.9 | 957.6 | 2,781.2 |
| Electricity export | 505.9 | 366.4 | 208.6 | 316.1 | 210.50 | 1,917.1 |
| Electricity trade balance | 188.9 | 376.0 | 519.7 | 585.8 | 747.1 | 864.1 |
| Self-sufficiency (%) | 94.8% | 89.6% | 86.0% | 84.1% | 80.2% | 78.2% |
| Total consumption | 3,622.2 | 3,617.4 | 3,711.3 | 3,690.9 | 3,781.8 | 3,966.5 |
| <i>Growth rate (%)</i> | 2.9% | -0.1% | 2.6% | -0.5% | 2.5% | 4.9% |

Source: data from Tables 2.1-2.3

2.1.10 POWER CONSUMPTION DURING ENERGY TRANSFORMATION, TRANSMISSION, AND DISTRIBUTION

Power consumption during energy transformation, transmission, and distribution includes consumption for own and technology needs, distribution losses and power transformation (for example, for heat generation, see Table 2.17).

Table 2.17 Power consumption during energy transformation, transmission, and distribution (mln kWh)

| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|--|----------------|----------------|----------------|----------------|----------------|----------------|
| Overall resources for consumption | 3,622.2 | 3,617.4 | 3,711.3 | 3,690.9 | 3,781.8 | 3,966.5 |
| Own needs of power plants | 294.1 | 294.2 | 300.5 | 303.0 | 301.3 | 299.3 |
| electricity generation | 195.1 | 195.1 | 206.2 | 204.4 | 205.7 | 201.7 |
| heat supply | 99.0 | 99.1 | 94.3 | 98.6 | 95.5 | 97.6 |
| <i>Share in electricity generation (%)</i> | 8.6% | 9.1% | 9.4% | 9.8% | 9.9% | 9.6% |
| Supply to the grid | 3,328.1 | 3,323.2 | 3,410.8 | 3,387.9 | 3,480.5 | 3,667.2 |
| Transmission losses | 597.9 | 581.6 | 687.3 | 672.5 | 627.9 | 766.3 |
| <i>Share in electricity supply to the grid (%)</i> | 18.0% | 17.5% | 20.2% | 19.9% | 18.0% | 20.9% |
| Useful electricity supply | 2,730.2 | 2,741.6 | 2,723.5 | 2,715.4 | 2,852.6 | 2,900.9 |
| <i>Growth rate (%)</i> | 4.8% | 0.4% | -0.7% | -0.3% | 5.1% | 1.7% |
| Electricity consumption for heat generation in boiler-houses | 25.1 | 21.8 | 24.4 | 20.0 | 18.1 | 27.6 |
| End-use electricity consumption | 2,705.2 | 2,719.8 | 2,699.1 | 2,695.4 | 2,834.6 | 2,873.3 |
| <i>Share in resources for consumption (%)</i> | 74.7% | 75.2% | 72.7% | 73.0% | 75.0% | 72.4% |

Source: Consultant's estimates based on the data of Tables 2.1-2.4.

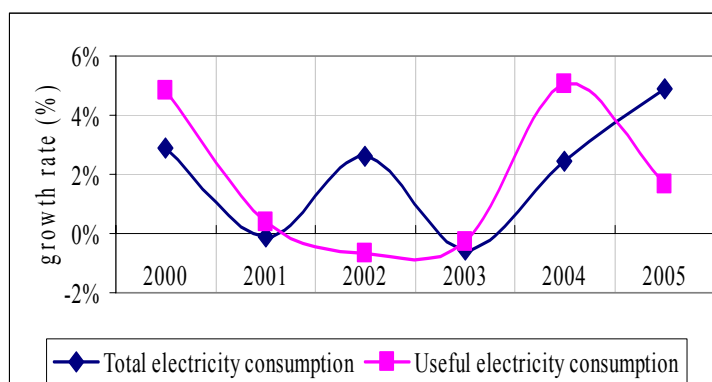


Fig. 0.1. Comparison of total and useful electricity consumption growth rates (%)

End-use equals three thirds of all power resources.

2.1.11 THE BLOCK OF POWER END-USE

The block of power end-use was developed with an account of the recent changes in the power consumption statistics (introduction of OKVED), and keeping in mind that "11-TER" was not affected by these changes. So the data were compiled from various sources (see Table 2.18).

Industry (41%), and primarily oil and gas, is the main electricity consumer. Residential and commercial sectors are responsible for 45% of electricity end-use. Residential consumption only grew up by 1% in 2000-2005. Against the background of growing commercial losses this means, that part of residential power consumption increase is not metered (or billed). Transport is the second largest consumption sector, followed by agriculture. Abrupt power consumption increase in transport and decline in construction result from the change in statistical system. Residential power consumption growth is the result of relatively cold weather. Local experts estimate power consumption for space heating in winter at 15% of overall residential consumption.

A combination of Tables 2.16-2.18 provides Astrakhan Oblast electricity balance. In 2006, electricity consumption grew up by 4%.

Table.2.18 Structure of useful power consumption in Astrakhan Oblast (mln. kWh)

| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | Share in 2005 |
|--|----------------|----------------|----------------|----------------|----------------|----------------|---------------|
| End-use electricity consumption | 2,705.2 | 2,719.8 | 2,699.1 | 2,695.4 | 2,834.6 | 2,873.3 | 100.0% |
| Industry | 1,120.9 | 1,112.5 | 1,147.7 | 1,147.2 | 1,248.7 | 1,175.1 | 40.9% |
| Oil and gas | 543.0 | 582.8 | 615.8 | 622.8 | 644.5 | 647.9 | 22.5% |
| Oil extraction, including gas condensate | 5.0 | 5.8 | 5.9 | 6.5 | 5.4 | 6.3 | 0.2% |
| Oil and gas condensate refining | 54.8 | 74.0 | 72.9 | 78.8 | 77.2 | 70.9 | 2.5% |
| Own needs in gas extraction | 7.3 | 8.5 | 9.2 | 9.5 | 6.9 | 8.9 | 0.3% |
| Gas processing | 327.7 | 346.9 | 378.9 | 377.3 | 399.1 | 405.0 | 14.1% |
| Sulphur | 148.2 | 147.6 | 149.0 | 150.7 | 155.9 | 156.8 | 5.5% |
| Bread and bakery products | 5.5 | 5.2 | 5.3 | 4.8 | 4.1 | 3.8 | 0.1% |
| Water raise and supply (excl. municipal utility needs) | 70.7 | 60.5 | 61.0 | 70.4 | 65.9 | 66.6 | 2.3% |
| Waste water treatment | 29.5 | 28.8 | 28.3 | 38.8 | 39.0 | 36.3 | 1.3% |
| Other industrial consumption | 472.2 | 435.2 | 437.4 | 410.5 | 495.4 | 420.6 | 14.6% |
| Construction | 50.2 | 67.8 | 58.8 | 93.0 | 91.9 | 76.6 | 2.7% |
| Oil and gas wells drilling | 0.1 | 33.6 | 18.9 | 16.6 | 35.4 | 35.6 | 1.2% |
| Agriculture | 206.0 | 207.7 | 179.3 | 159.8 | 137.7 | 137.8 | 4.8% |
| Water pumping for melioration and water supply purposes | 66.9 | 62.9 | 43.3 | 32.6 | 52.0 | 45.2 | 1.6% |
| Irrigation and drainage | 0.0 | 5.3 | 43.3 | 5.3 | 5.9 | 4.4 | 0.2% |
| Transport | 130.9 | 122.6 | 119.1 | 123.0 | 130.1 | 169.8 | 5.9% |
| Gas pipeline transportation | 1.5 | 1.7 | 2.0 | 2.4 | 2.6 | 2.6 | 0.1% |
| Electric traction of railway trains (Ministry of Transportation) | 2.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.6 | 0.0% |
| Operation of railways (Ministry of Transportation), excl. of electric traction | 37.8 | 36.1 | 40.1 | 40.4 | 44.7 | 44.4 | 1.5% |
| Electric traction of trams | 6.8 | 6.3 | 5.8 | 5.1 | 4.7 | 4.4 | 0.2% |
| Electric traction of trolleybuses | 6.7 | 6.0 | 5.5 | 4.8 | 5.0 | 4.3 | 0.1% |
| Other transport consumption | 76.0 | 72.4 | 65.7 | 70.3 | 73.0 | 113.4 | 3.9% |
| Utility, commercial and public sector | 508.7 | 526.4 | 525.4 | 526.6 | 582.4 | 616.2 | 21.4% |
| Utility | 58.7 | 64.1 | 74.7 | 73.1 | 83.1 | 67.7 | 2.4% |
| Commercial and public | 450.0 | 462.3 | 450.7 | 453.5 | 499.3 | 548.5 | 19.1% |
| Public consumers in the AESK service zone | | | | 283.4 | 285.9 | 287.3 | 10.0% |
| Residential | 686.7 | 680.7 | 666.8 | 643.4 | 641.3 | 695.2 | 24.2% |
| Urban | 483.6 | 440.5 | 453.4 | 414.8 | 418.0 | 474.0 | 16.5% |
| Rural | 203.1 | 240.2 | 213.4 | 228.6 | 223.3 | 221.2 | 7.7% |

Source: Consultant's estimates based on the data from Tables 2.1-2.5.

2.2 Heat balance

Conflicting and poor data on heat generation and consumption, taken from different information sources, considerably complicate development of a heat balance. Both the statistical yearbook "On the problems of fuel and energy consumption in Astrakhan Oblast" for 2005, and the Report by Astrakhan Oblast Government "Operation results of the Fuel and Energy Sector of Astrakhan Oblast in 2005" only devote 1 page each to the situation in heat supply.

"11-TER" is the basic source for heat balance development; also some use was made of the inventory "Astrakhan Oblast heating network operation" and data obtained based on "22 ZhKH".

2.2.1 THE BLOCK OF HEAT RESOURCES

It is important to point out that in terms of energy, heat supplied to heating networks from the installation (boiler house or CHP) rather than heat generated, is statistically reported. Heat sources own needs consumption is not adequately reflected in the statistics. The most complete information on heat generation by power plants and peak boiler-houses is provided in form "6-TP", and by all heat sources in form "11-TER". These two statistical forms were taken as the basis for heat resources evaluation (see Table 2.19). Heat generation and consumption data are not consistent even within "11-TER".

Table 2.19 Heat generation in Astrakhan Oblast (th Gcal)

| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | Share in 2005 |
|---|---------------|---------------|---------------|---------------|---------------|---------------|---------------|
| <i>Heat resources</i> | | | | | | | |
| Heat supply by power plants | 1,934 | 2,223 | 2,013 | 2,017 | 1,936 | 2,017 | 14.0% |
| Astrakhanskaya GRES | 561 | 798 | 524 | 530 | 473 | 459 | 3.2% |
| Astrakhanskaya co-generation plant-2 | 1,301 | 1,337 | 1,414 | 1,403 | 1,380 | 1,484 | 10.3% |
| "Severnaya" co-generation plant | 72 | 88 | 74 | 84 | 83 | 74 | 0.5% |
| Heat supply by boiler-houses | 4,666 | 4,289 | 4,572 | 4,150 | 4,194 | 4,224 | 29.3% |
| Industrial and regional | 4,579 | 4,232 | 4,560 | 4,142 | 4,181 | 4,241 | 29.4% |
| incl. regional | 1,106 | 830 | 1,130 | 1,081 | 1,156 | 1,338 | 9.3% |
| Agricultural companies | 31 | 30 | 28 | 42 | 25 | 11 | 0.1% |
| Electric boiler-houses | 1 | 1 | 12 | 0 | 0 | 1 | 0.0% |
| Heat supply by heat recovery units | 6,507 | 7,155 | 7,411 | 7,831 | 7,922 | 8,166 | 56.7% |
| Other units | 4 | 0 | 0 | 0 | 0 | 0 | 0.0% |
| Total | 13,111 | 13,667 | 13,996 | 13,999 | 14,052 | 14,407 | 100.0% |
| <i>Increase rate (%)</i> | | 4.2% | 2.4% | 0.0% | 0.4% | 2.5% | |
| <i>Source data</i> | | | | | | | |
| "6-TP" | | | | | | | |
| Heat supply by power plants | 1,934 | 2,223 | 2,013 | 2,017 | 1,936 | 2,017 | |
| "11-TER" | | | | | | | |
| Heat supply by power plants | 1,972 | 1,916 | 1,939 | 2,075 | 1,991 | 2,094 | |
| Heat generation by power-plants | 1,972 | 2,050 | 2,065 | 2,075 | 1,991 | 2,152 | |
| Heat generation by boiler-houses | 4,666 | 4,289 | 4,572 | 4,150 | 4,194 | 4,224 | |
| Industrial and regional | 4,579 | 4,232 | 4,560 | 4,142 | 4,181 | 4,241 | |
| Agricultural companies | 31 | 30 | 28 | 42 | 25 | 31 | |
| Electric boiler-houses | 1 | 1 | 12 | 0 | 0 | 1 | |
| Own needs | | | | | | | |

Source: "6-TP" and "11-TER"

Overall heat generation in 2005 declined by 0.6%. Heat supplied by heat recovery units plays an important role in the Astrakhan Oblast heat balance. Heat recovery units, which use recovered heat of natural gas processing and sulfur production as well as direct combustion, are a major heat source in Astrakhan Oblast. This heat is not supplied to the heat network, but used on-site. Heat generation by heat recovery units are directly determined by gas processing volumes. Heat supply by power plants is pretty stable, and its fluctuations are determined by the climate factor. Heat supply by boiler-houses is declining. Astrakhan Oblast has a considerable (almost 2-fold) excess in heat generation capacity of power plants and boiler-houses.

2.2.2 HEAT CONSUMPTION DURING ENERGY TRANSFORMATION, TRANSMISSION, AND DISTRIBUTION

Transmission and distribution heat losses are the major indicator of this heat balance section. Statistical data show, that the length of the heat network in Astrakhan Oblast declined from 1,352 km (two-pipe network) in 2000 to 868 km in 2005, or by 36%. This means that decentralization of residential heat supply is developing dynamically. More than a quarter of the heat network needs replacement. "11-TER" only provides data on heat transmission losses, whose share has been growing lately (see Table 2.20). The "Strategy" authors evaluate transmission heat losses in 2002 and 2005 at 10.7% of heat supply (excluding of recovered heat supply). They also state, that distribution heat losses amount to 20-25%. The estimates below are based on the assumption that distribution heat losses amount to 15%. Overall heat transmission and distribution losses estimates are based on this figure. Importantly, over the last five years specific heat losses per 1 km of the heat network have grown from 518 GCal to 927 GCal, or by 78%.

Table 2.20 Evaluation of heat transmission and distribution losses (thou. Gcal)

| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|-------|-------|-------|-------|-------|-------|
| Heat supply by power plants and boiler-houses | 6,600 | 6,511 | 6,585 | 6,168 | 6,130 | 6,241 |
| Transmission losses | 219 | 226 | 248 | 195 | 257 | 360 |
| <i>Share of losses (excl. of heat recovery units)</i> | 3.3% | 3.5% | 3.8% | 3.2% | 4.2% | 5.8% |
| Heat supplied to distribution networks | 3,663 | 3,178 | 2,887 | 3,096 | 3,102 | 2,965 |
| <i>Share of heat supply by power plants and boiler-houses</i> | 55% | 49% | 44% | 50% | 51% | 48% |
| <i>Share of distribution losses</i> | 15.0% | 15.0% | 15.0% | 15.0% | 15.0% | 15.0% |
| Distribution losses | 549 | 477 | 433 | 464 | 465 | 445 |
| Total transmission and distribution losses | 769 | 703 | 681 | 660 | 722 | 805 |

Sources: "11-TER" and Astrakhan Oblast Statistical Yearbook-2006

2.2.3 THE BLOCK OF HEAT END-USE

The block of heat end-use should reflect unaccounted heat losses. An assumption was made, that all accounted heat losses are related to Industrial and Other industrial consumption, while all unaccounted losses to the Utility Sector, Commercial, and Residential in proportion to their respective heat consumption. For these sectors, unaccounted heat losses are specified in a separate line (see Table 2.21). It turned out, that residential heat consumption is 20% below the accounted value. This is a normal difference between estimated and actually metered levels of heat consumption in Russian residential buildings. Values verified for unaccounted losses much more accurately reflect the real situation in heat consumption.

Industry is responsible for 81% of heat consumption – basically recovered heat from gas refining and sulphur production (65%). Residential and utility sectors are responsible for over 21.5% of useful heat consumption and for 94% of heat supplied to the distribution network. According to "22-ZhKH", residential heat consumption equaled 2,022 thou. Gcal. Heat consumption by residential, communal and services sectors is declining, and by industrial sector is growing. This results in the growth of useful heat consumption, although pretty slow in the recent years. On average, in 2000-2005 annual heat consumption grew by 2%.

Table 2.21 Heat consumption in Astrakhan Oblast (thou. Gcal)

| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | Share in 2005 |
|---|---------------|---------------|---------------|---------------|---------------|---------------|---------------|
| Industrial | 9,254 | 10,275 | 10,873 | 10,737 | 10,665 | 11,061 | 81,3% |
| Oil and gas extraction | 4 | 5 | 5 | 5 | 6 | 6 | 0.0% |
| Oil and gas condensate refining | 440 | 481 | 474 | 492 | 497 | 491 | 3.6% |
| Gas refining | 6,123 | 6,583 | 6,815 | 7,141 | 7,241 | 7,481 | 55.0% |
| Sulphur | 1,051 | 1,135 | 1,209 | 1,259 | 1,284 | 1,322 | 9.7% |
| Wood products drying | 0 | 0 | 0 | 6 | 6 | 6 | 0.0% |
| Bread and bakery products | 1 | 3 | 1 | 1 | 1 | 1 | 0.0% |
| Other industrial consumption* | 1,635 | 2,068 | 2,369 | 1,832 | 1,631 | 1,755 | 12.9% |
| Transport and communication | 113 | 162 | 188 | 196 | 183 | 198 | 1.5% |
| Railway operation needs | 113 | 162 | 188 | 196 | 183 | 198 | 1.5% |
| Agriculture | 13 | 6 | 6 | 6 | 6 | 6 | 0.0% |
| Greenhouse heating | 13 | 6 | | | 0 | 6 | 0.0% |
| Construction | 0 | 5 | 3 | 3 | 6 | 5 | 0.0% |
| Oil and gas wells drilling | 0 | 5 | 3 | 3 | 6 | 5 | 0.0% |
| Utility and services sector ("22-ZhKH) | 1,256 | 1,001 | 871 | 887 | 841 | 760 | 5.6% |
| Unaccounted losses | 196 | 159 | 141 | 144 | 133 | 121 | 0.9% |
| Consumption | 1,059 | 842 | 730 | 743 | 708 | 638 | 4.7% |
| Residential – "22-ZhKH" | 2,257 | 1,996 | 1,811 | 1,979 | 2,100 | 2,022 | 14.9% |
| Urban | | | | 1,818 | 1,956 | 2,022 | 14.9% |
| Rural | | | | 161 | 144 | 129 | 0.9% |
| Unaccounted losses | 353 | 317 | 292 | 321 | 332 | 323 | 2.4% |
| Consumption | 1,904 | 1,679 | 1,518 | 1,658 | 1,768 | 1,699 | 12.5% |
| Total useful consumption | 12,892 | 13,441 | 13,748 | 13,804 | 13,795 | 14,047 | 103.3% |
| Same, excl. unaccounted losses | 12,343 | 12,964 | 13,315 | 13,340 | 13,330 | 13,602 | 100.0% |
| <i>Increase rate (%)</i> | | 5.0% | 2.7% | 0.2% | -0.1% | 2.0% | |

* Lack of information did not allow it to completely reflect agricultural and construction heat consumption. Part of heat consumption by these sectors is shown in the line "Other industrial consumption".

Sources: "11-TER" and "22-ZhKH".

2.3 Natural gas balance

2.3.1 THE BLOCK OF NATURAL GAS RESOURCES

Astrakhan Oblast is a large natural gas producer: 12 bln m³ per annum, or around 2% of overall Russia's natural gas production. Natural gas is rich in condensate, so along with natural gas, gas condensate is extracted and accounted for in the line "oil and gas condensate extraction". Natural gas resources are constituted by extracted natural gas minus own needs consumption and gas extraction and transmission losses (see Table 2.22).

Table 2.22 Natural gas resources (mln. m³)

| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---------|---------|---------|---------|---------|---------|
| Production | 9,947 | 10,517 | 10,891 | 11,408 | 11,567 | 11,936 |
| Own needs consumption and gas extraction losses | 183.9 | 191.1 | 205.3 | 171.5 | 174.3 | 167.3 |
| Gas transmission losses | 42.5 | 50.4 | 35.9 | 42.7 | 39.4 | 14.7 |
| Gas export* | 6,537.9 | 7,268.3 | 7,663.4 | 8,232.8 | 8,439.9 | 8,644.1 |
| Resources available for consumption | 3,182.3 | 3,007.2 | 2,986.4 | 2,961.0 | 2,913.4 | 3,109.9 |

Sources: Astrakhan Oblast Statistical Yearbook-2006. "11-TER", "4-TP", and "22-ZhKH" forms..

2.3.2 NATURAL GAS CONSUMPTION DURING ENERGY TRANSFORMATION, TRANSMISSION, AND DISTRIBUTION

The data on natural gas industrial consumption were taken from "11-TER", while on residential consumption and consumption by social facilities from "22-ZhKH" and "4-T". (see Table 2.23). In fact, own needs consumption and gas transmission losses may be included into natural gas consumption in energy resources transformation, transmission, and distribution. Power plants and boiler-houses consume more than a half of available natural gas resources. In 2000-2006, gas consumption for these purposes was not growing, because there was no power or heat generation growth.

Table 2.23. Natural gas consumption in Astrakhan Oblast (mln. m3)

| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | Share in 2005 |
|--|----------------|----------------|----------------|----------------|----------------|----------------|---------------|
| Resources available for consumption | 3,182.3 | 3,007.2 | 2,986.4 | 2,961.0 | 2,913.4 | 3,109.9 | 100.0% |
| Transformation into power and heat | 1,696.7 | 1,670.2 | 1,703.8 | 1,665.2 | 1,599.6 | 1,639.3 | 52.7% |
| Power generation by power plants | 961.5 | 899.4 | 879.4 | 848.7 | 823.0 | 859.6 | 27.6% |
| Heat generation by power plants | 257.7 | 260.8 | 256.1 | 257.6 | 246.6 | 260.1 | 8.4% |
| Boiler-houses | 475.9 | 507.4 | 567.4 | 556.5 | 529.1 | 518.3 | 16.7% |
| incl. regional | 76.6 | 88.1 | 140.2 | 135.0 | 134.9 | 157.8 | 5.1% |
| Agricultural boiler-houses | 1.6 | 2.6 | 0.8 | 2.4 | 1.0 | 1.3 | 0.0% |
| Industry | 930.6 | 820.3 | 740.3 | 775.7 | 775.3 | 873.4 | 28.1% |
| Gas processing | 168.4 | 182.2 | 179.0 | 189.3 | 190.4 | 195.0 | 6.3% |
| Oil extraction (incl. gas condensate) | 3.7 | 3.9 | 3.5 | 5.8 | 4.3 | 4.3 | 0.1% |
| Oil refining (incl. gas condensate) | 272.6 | 297.5 | 284.5 | 297.5 | 295.5 | 292.5 | 9.4% |
| Sulphur | 242.4 | 263.8 | 241.9 | 255.4 | 250.4 | 249.7 | 8.0% |
| Bread and bakery products | 3.8 | 3.6 | 3.9 | 3.5 | 2.8 | 2.7 | 0.1% |
| Other industrial consumption | 239.8 | 69.4 | 27.5 | 24.2 | 32.0 | 129.1 | 4.2% |
| Agriculture | 0.0 | 0.0 | 1.3 | 1.3 | 0.7 | 0.8 | 0.0% |
| Greenhouses heating | 0.0 | 0.0 | 1.3 | 1.3 | 0.7 | 0.8 | 0.0% |
| Transport | 0.1 | 0.4 | 0.8 | 0.6 | 0.7 | 0.2 | 0.0% |
| Utility sector | 1.4 | 0.9 | 2.3 | 0.5 | 0.4 | 0.7 | 0.0% |
| Commercial | 75.5 | 82.2 | 89.0 | 91.0 | 96.9 | 124.1 | 4.0% |
| Residential | 251.6 | 273.9 | 296.8 | 303.4 | 323.0 | 413.6 | 13.3% |

* The figures in italics are the consultants estimates.

Sources: Astrakhan Oblast Statistical Yearbook-2006; "11-TER", "22-ZhKH", and "4-T" forms.

2.3.3 THE BLOCK OF NATURAL GAS END-USE

Nearly 16% of natural gas is consumed in gas and gas condensate extraction and refining. Besides, 8% of gas consumption relates to sulphur production during gas processing. For agriculture, there are only data on greenhouses heating, part of which shifted to autonomous gas-fired boiler-houses in 2002. Small amounts of gas are consumed in the form of compressed gas in the transportation sector. Residential consumption grows, as more and more towns and villages are supplied with natural gas. Commercial gas consumption was estimated by CENEf and needs verification. Statistical discrepancies are reflected in the line "Other industrial consumption". For this reason, the dynamics of this indicator is very unstable.

2.4 Coal balance

The role of coal in the IFEB of Astrakhan Oblast is negligible. There is no coal mining in Astrakhan Oblast; all the coal is delivered from other locations (primarily from Donetsk and

Kuznetsky coalfields and Khakassia Republic). Information on coal consumption was taken from "11-TER" and "4-T" (see Table 2.24). Coal consumption considerably declined in 2003 through reduced heat generation by coal-fired power plants. Then it somewhat stabilized. Coal is consumed by 23 coal-fired boiler-houses, for space heating of individual housing and other facilities in towns with no access to gas supply. Overall coal consumption is not growing, while residential consumption for individual space heating is going down.

Table.2.24. Coal consumption in Kaliningrad Oblast (Ttce)

| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | Share in 2005 |
|---------------------------------------|------|------|------|------|------|------|---------------|
| Import | 53.7 | 44.2 | 54.8 | 37.9 | 44.3 | 45.9 | |
| Industrial and regional boiler-houses | 7.4 | 5.8 | 4.6 | 5.3 | 6.2 | 5.0 | 11.5% |
| incl. regional boiler-houses | 3.1 | | | | 0.8 | 0.3 | 0.7% |
| Agricultural boiler-houses | 0.2 | 0.1 | 0.2 | 0.4 | 0.5 | 0.4 | 0.9% |
| Other consumption | 18.1 | 15.7 | 18.6 | 15.5 | 17.1 | 16.0 | 36.9% |
| Utility sector | 2.4 | 1.4 | 0.5 | 0.5 | 0.4 | 0.3 | 0.6% |
| Commercial | 11.1 | 7.6 | 6.4 | 5.4 | 5.0 | 5.6 | 13.0% |
| Residential | 21.0 | 15.8 | 14.9 | 17.0 | 17.1 | 16.0 | 37.0% |
| Total consumption | 60.3 | 46.4 | 45.3 | 44.0 | 46.3 | 43.3 | 100.0% |
| Stock changes | -6.6 | -2.2 | 9.6 | -6.1 | -2.0 | 2.6 | |

Source: "11-TER" and "4-T"

2.5 Petroleum products balance

Data on liquid fuel consumption were taken from "11-TER" and "4-T". Transport is the major petroleum products consumer (56%), followed by boiler-houses, commercial sector, and other consumers. Liquid fuel consumption is somewhat declining, basically through reducing consumption by the transport sector. Consumption by transport sector includes private vehicles. Reliability of data on liquid fuel consumption (especially gasoline and diesel fuel) leaves much to be desired. Overall data for 2000 and 2001 were corrected. Communal and commercial sectors consumption were estimated by the consultant.

Table 2.25 Petroleum products consumption in Astrakhan Oblast (thou. tce)

| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | Share in 2005 |
|---|--------------|--------------|--------------|--------------|--------------|--------------|---------------|
| Heat and power generation | 145.4 | 121.9 | 79.7 | 82.9 | 81.5 | 108.9 | 14.5% |
| Power generation by power plants | 0.2 | 0.1 | 1.6 | 1.4 | 0.0 | 6.1 | 0.8% |
| Heat generation by power plants | 0.1 | 0.0 | 0.5 | 0.5 | 0.0 | 1.8 | 0.2% |
| Boiler-houses | 143.1 | 119.2 | 76.7 | 79.9 | 81.0 | 100.4 | 13.4% |
| incl. regional | 28.3 | 42.4 | 35.6 | 34.5 | 43.8 | 47.2 | 6.3% |
| Rural boiler-houses | 2.0 | 2.6 | 0.9 | 1.1 | 0.4 | 0.6 | 0.1% |
| Industry | 28.9 | 31.0 | 25.7 | 25.4 | 17.0 | 19.8 | 2.6% |
| Bread and bakery products | 0.9 | 0.2 | 1.8 | 2.5 | 0.0 | 0.0 | 0.0% |
| Diesel locomotives of industrial railway transport | 0.4 | 0.1 | 0.5 | 0.0 | 0.4 | 0.3 | 0.0% |
| As raw materials | 0.7 | 0.5 | 0.5 | 0.4 | 0.1 | 0.1 | 0.0% |
| Other | 26.8 | 30.3 | 22.9 | 22.5 | 16.4 | 19.4 | 2.6% |
| Transport | 482.4 | 426.3 | 456.2 | 401.9 | 429.1 | 421.6 | 56.3% |
| Aviation | 35.5 | 36.1 | 29.9 | 25.5 | 23.2 | 12.5 | 1.7% |
| Automobile | 308.7 | 257.6 | 263.5 | 251.2 | 267.4 | 285.4 | 38.1% |
| Water transport | 10.3 | 12.7 | 14.7 | 14.9 | 14.3 | 5.0 | 0.7% |
| Railway operation needs | 127.8 | 119.9 | 148.0 | 110.3 | 124.2 | 118.7 | 15.8% |
| Agriculture | 28.5 | 26.0 | 26.7 | 27.9 | 15.7 | 23.4 | 3.1% |
| Fishery | 13.0 | 12.0 | 15.5 | 17.7 | 6.4 | 15.7 | 2.1% |
| Tractors | 14.3 | 12.8 | 10.3 | 9.7 | 8.8 | 7.3 | 1.0% |
| Greenhouse heating | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.0% |
| Water pumping for land reclamation and water supply | 0.5 | 0.3 | 0.3 | 0.1 | 0.1 | 0.1 | 0.0% |
| Irrigation and drainage | 0.6 | 0.9 | 0.5 | 0.4 | 0.4 | 0.4 | 0.0% |
| Construction | 16.2 | 20.5 | 17.0 | 11.6 | 7.7 | 11.8 | 1.6% |
| Operation of lifting and road | 15.1 | 12.3 | 11.9 | 8.1 | 6.4 | 11.8 | 1.6% |

| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | Share in 2005 |
|--|--------------|--------------|--------------|--------------|--------------|--------------|---------------|
| construction machinery | | | | | | | |
| Oil and gas wells drilling (exploration) | 1.1 | 8.0 | 3.3 | 0.9 | 0.0 | 0.0 | 0.0% |
| Oil and gas wells drilling (operation) | | 0.2 | 1.8 | 2.5 | 1.3 | 0.0 | 0.0% |
| Utility sector | 57.9 | 51.8 | 49.9 | 41.0 | 66.5 | 45.6 | 6.1% |
| Commercial | 117.5 | 105.1 | 101.3 | 83.2 | 135.0 | 92.7 | 12.4% |
| Residential | 17.79 | 17.47 | 14.49 | 23.61 | 26.93 | 25.49 | 3.4% |
| Total consumption | 894.6 | 800.2 | 770.8 | 697.5 | 779.4 | 749.4 | 100.0% |

* Italicized figures are the consultant's estimates.

Source: "11-TER" and "4-T".

3 Integrated Fuel and Energy Balance

IFEB of Astrakhan Oblast for 2005 is the result of integrating electricity, heat, natural gas, coal, petroleum products and other solid fuels (wood, peat, etc.) balances. The IFEB provides an opportunity to comprehensively present the energy situation in the region in one table (see Table 3.1). Three points should be specifically mentioned here. Lack of data prevents from building an effective natural gas balance. So natural gas transition to other regions was estimated. Practically all produced gas condensate is locally processed at refinery; therefore, the "crude oil" column should be rather titled "gas condensate" and reflect condensate processing data. Some refinery products are consumed locally, but mostly products of condensate refinery are delivered to other regions. However, no sufficiently detailed statistics on total refinery output could be found. Data are available only on gasoline, diesel oil, and mazut (heavy fuel oil) production and trade, leaving all other petroleum products production and delivery to other regions not reported. The arbitrary assumption was made that other refinery products equal to 40% of diesel fuel production. The third issue is considerable amounts of recovered heat of natural gas and gas condensate processing at local refinery and gas-chemical plants. Part of natural gas reported here as delivered to other regions in reality may be flared in gas processing and in sulphur production processes. Data for agricultural boiler were corrected to escape exceeding 100% efficiency of those installations.

Total primary energy consumption equals 10,936 thou. tce with large uncertainty left on material balance of oil refining. A considerable part of energy (8088 thou. tce) is used in energy transformation, transmission, and distribution. This is partly made up for by large-scale heat recovery (1,168 thou. tce). Industrial sector (not accounting for oil and gas refineries) is responsible for 35.6% of total energy end-use. The share of transport is 16.7%, agriculture – 1.6%, utility sector – 3.2%, commercial – 13.0%, and residential – 29.9%. The share of residential end-use consumption has grown by 2.7% compared to 2000.

The proportions of Astrakhan Oblast IFEB for 2005 (see Table 3.2) give grounds to some conclusions in terms of possible balance evolution and the effectiveness of energy supply in the region. Natural gas, gas condensate, and crude oil are the major local primary energy resources. Contributions of hydro and renewable energy are practically negligible.

Oil dominates in the structure of primary energy consumption (57.2%), followed by natural gas (34.3%), petroleum products (6.8%) and imported power (1%). The share of natural gas in the fuel balance of power plants is 99.4%, and in the fuel balance of boiler-houses 85%.

Natural gas dominates in energy end-use (37.7%), followed by heat, liquid fuel, and electricity. The share of heat in the energy end-use is large in the industrial (44%) and residential (28%) sectors.

Generally, there is no clear trend for electricity consumption growth in the energy end-use consumption by sectors. In the residential energy consumption the share of natural gas is clearly growing, as more towns are gasified, and in 2005 it reached 56.3%.

Figure 3.1 below shows a summary in schematic form how the fuel and energy balance was developed from different information sources as discussed in detail in the previous chapters.

Table.3.1. Integrated Fuel and Energy Balance of Astrakhan Oblast for 2005 (Ttce)

| | Coal | Crude oil | Petroleum products | Natural gas | Hydro and renewables | Other solid fuels | Electricity | Heat | Total |
|-------------------------------------|------|-----------|--------------------|-------------|----------------------|-------------------|-------------|---------|---------|
| Production | | 6295,5 | | 13845,8 | | 28,1 | | | 20169,4 |
| Import | 45,9 | | | | | | 342,1 | | 387,9 |
| Export | | -36,7 | -3026 | - | | | -235,8 | | -13393 |
| Stock changes | 2,6 | | -25,0 | 10094,3 | | | | | -22 |
| Primary energy consumption | 43,3 | 6258,8 | 748,4 | 3751,5 | 0,0 | 28,1 | 106,3 | | 10936,3 |
| Statistical discrepancies | 0,4 | | 0,0 | 0,0 | | | 0,3 | 0,7 | 1,4 |
| Power plants | 0,0 | | -7,9 | -1298,8 | 0,0 | | 381,6 | 288,5 | -636,7 |
| Electricity generation | 0,0 | | -6,1 | -997,1 | | | 381,6 | | -621,6 |
| Heat generation | -5,0 | | -102,8 | -904,5 | | -0,2 | | 892,5 | -120,0 |
| Co-generation plants | 0,00 | | -1,8 | -301,7 | | | | 288,5 | -15,0 |
| Boiler-houses | -5,0 | | -101,0 | -602,8 | | -0,2 | -3,4 | 604,0 | -108 |
| Industrial | -4,7 | | -53,2 | -418,2 | | -0,2 | | 411,2 | -65 |
| Municipal | -0,3 | | -47,2 | -183,0 | | 0,0 | | 191,3 | -39,2 |
| Agricultural | -0,4 | | -0,6 | -1,6 | | | | 1,5 | -1,0 |
| Heat recovery units | | | | | | | | 1167,7 | 1167,7 |
| Oil refining | | -6258,8 | 3749 | -339,3 | | | -8,7 | -70,2 | -2927,9 |
| Gas refining | | | | -226,2 | | | -49,8 | -1069,8 | -1345,8 |
| Own needs | | | | -194,0 | | | -36,8 | | -230,8 |
| Distribution losses | | | | -17,1 | | | -94,3 | -115,1 | -226,4 |
| Final energy consumption | 37,9 | | 639,5 | 1073,3 | | 8,8 | 294,6 | 805,9 | 2848,3 |
| Industry | 16,0 | | 22,1 | 447,6 | | 1,2 | 86,0 | 441,7 | 1014,7 |
| Oil and gas extraction | | | | 5,0 | | | 1,9 | 0,8 | 7,7 |
| Sulphur | | | | 289,6 | | | 19,3 | 189,0 | 498,0 |
| Water raise and supply for industry | | | | | | | 12,7 | | 12,7 |
| Bread and bakery products | | | 0,0 | 3,2 | | | 0,5 | 0,1 | 3,7 |
| Other | 16,0 | | 22,1 | 149,8 | | 1,2 | 51,7 | 251,8 | 492,6 |
| Construction | | | 1,5 | | | | 9,4 | 0,7 | 11,6 |
| Transport | 0,0 | 0,0 | 426,3 | 0,2 | 0,0 | 0,0 | 20,9 | 28,3 | 475,7 |
| Aviation | | | 12,5 | | | | | | 12,5 |
| Automobile | | | 285,4 | 0,2 | | | | | 285,6 |
| Railway | | | 118,7 | | | | 5,5 | 28,3 | 152,6 |
| Water | | | 5,0 | | | | | | 5,0 |
| Urban electric | | | | | | | 1,1 | | 1,1 |
| Other transport | | | 4,7 | | | | 14,3 | | 18,9 |
| Agriculture | | | 25,8 | 0,9 | | | 16,9 | 0,9 | 44,6 |
| Utility sector | 0,3 | | 45,6 | 0,8 | | 5,2 | 8,3 | 30,1 | 90,3 |
| Commercial | 5,6 | | 92,7 | 143,9 | | | 67,5 | 61,1 | 370,8 |
| Residential | 16,0 | | 25,5 | 479,8 | | 2,4 | 85,5 | 242,9 | 852,1 |

Source: Developed by the consultant

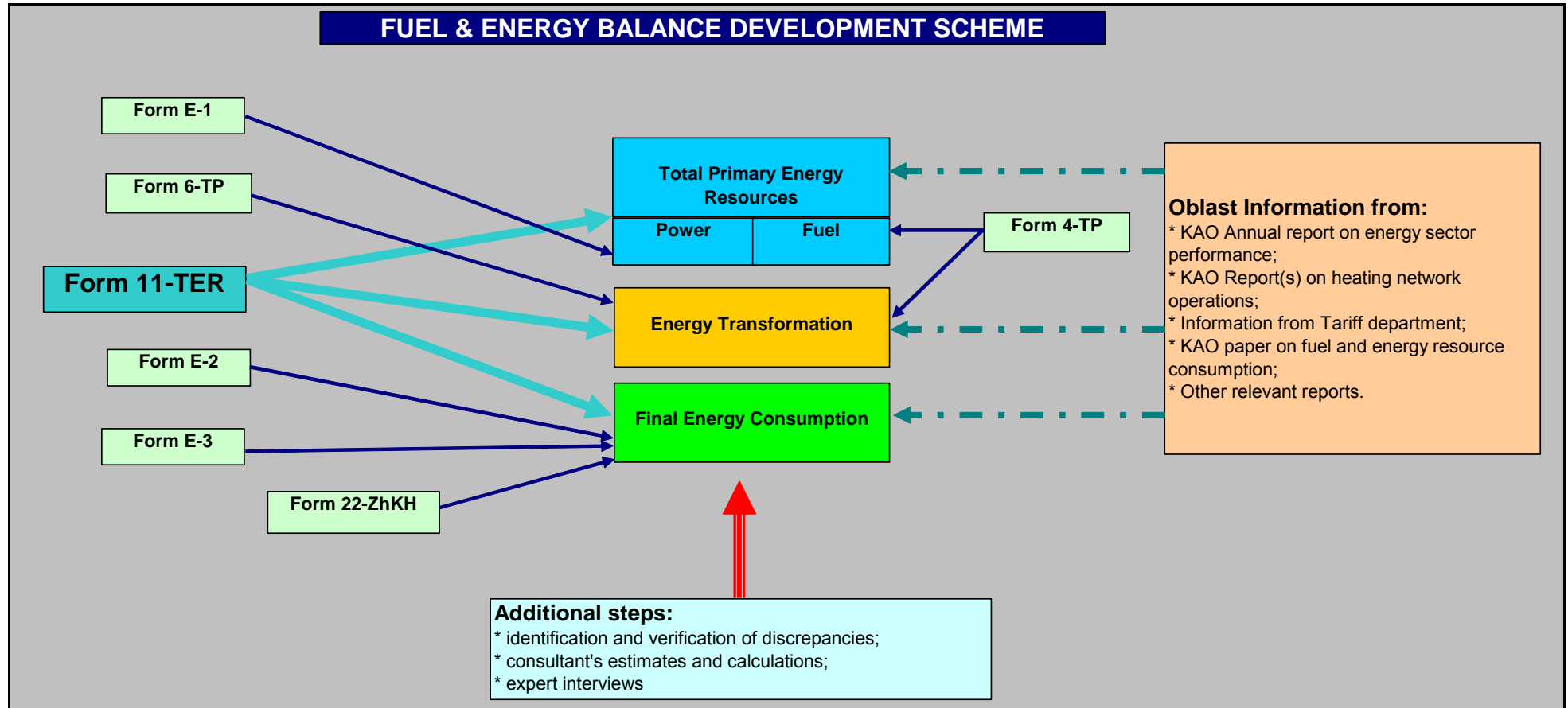
Table 3.2 Major proportions of Integrated Fuel and Energy Balance of Astrakhan Oblast for 2005 (%)

| | Coal | Crude oil | Petro-leum products | Natural gas | Hydro and renewables | Other solid fuels | Electricity | Heat | Total |
|-------------------------------------|-------------|--------------|---------------------|--------------|----------------------|-------------------|--------------|--------------|---------------|
| Production | 0,0% | 31,2% | 0,0% | 68,6% | 0,0% | 0,1% | 0,0% | 0,0% | 100,0% |
| Import | 11,8% | 0,0% | 0,0% | 0,0% | 0,0% | 0,0% | 88,2% | 0,0% | 100,0% |
| Export | 0,0% | 0,3% | 22,6% | 75,4% | 0,0% | 0,0% | 1,8% | 0,0% | 100,0% |
| Primary energy consumption | 0,4% | 57,2% | 6,8% | 34,3% | 0,0% | 0,3% | 1,0% | 0,0% | 100,0% |
| Power plants | 0,0% | 0,0% | 0,6% | 99,4% | 0,0% | 0,0% | 29,2% | 22,1% | 51,3%* |
| Electricity generation | 0,0% | 0,0% | 0,6% | 99,4% | 0,0% | 0,0% | 38,0% | 0,0% | 38,0%* |
| Heat generation | 0,5% | 0,0% | 10,2% | 89,3% | 0,0% | 0,0% | 0,0% | 88,2% | 88,2%* |
| Co-generation plants | 0,0% | 0,0% | 0,6% | 99,4% | 0,0% | 0,0% | 0,0% | 95,0% | 95,0%* |
| Boiler-houses | 0,7% | 0,0% | 14,2% | 85,0% | 0,0% | 0,0% | -0,5% | 85,2% | 84,7%* |
| Industrial | 1,0% | 0,0% | 11,2% | 87,8% | 0,0% | 0,0% | 0,0% | 86,3% | 86,3%* |
| Municipal | 0,1% | 0,0% | 20,5% | 79,4% | 0,0% | 0,0% | 0,0% | 83,0% | 83,0%* |
| Agricultural | 16,1% | 0,0% | 22,8% | 61,0% | 0,0% | 0,0% | 0,0% | 59,8% | 59,8%* |
| Heat recovery units | | | | | | | | 100,0% | |
| Oil refining | 0,0% | 213,8% | -128,0% | 11,6% | 0,0% | 0,0% | 0,3% | 2,4% | 100,0% |
| Gas processing | 0,0% | 0,0% | 0,0% | 16,8% | 0,0% | 0,0% | 3,7% | 79,5% | 100,0% |
| Own needs | | | | -5,2% | | | -34,6% | | |
| Distribution losses | | | | 1,9% | | | -20,9% | -12,9% | |
| Final energy consumption | 1,3% | 0,0% | 22,5% | 37,7% | 0,0% | 0,3% | 10,3% | 28,3% | 100,0% |
| Industrial | 1,6% | 0,0% | 2,2% | 44,1% | 0,0% | 0,1% | 8,5% | 43,5% | 100,0% |
| Oil&gas extraction | 0,0% | 0,0% | 0,0% | 64,8% | 0,0% | 0,0% | 24,4% | 10,8% | 100,0% |
| Sulphur | 0,0% | 0,0% | 0,0% | 58,2% | 0,0% | 0,0% | 3,9% | 38,0% | 100,0% |
| Water raise and supply for industry | 0,0% | 0,0% | 0,0% | 0,0% | 0,0% | 0,0% | 100,0% | 0,0% | 100,0% |
| Bread and bakery products | 0,0% | 0,0% | 0,0% | 85,1% | 0,0% | 0,0% | 12,4% | 2,5% | 100,0% |
| Other | 3,2% | 0,0% | 4,5% | 30,4% | 0,0% | 0,2% | 10,5% | 51,1% | 100,0% |
| Construction | 0,0% | 0,0% | 12,6% | 0,0% | 0,0% | 0,0% | 81,3% | 6,1% | 100,0% |
| Transport | 0,0% | 0,0% | 89,6% | 0,1% | 0,0% | 0,0% | 4,4% | 6,0% | 100,0% |
| Aviation | 0,0% | 0,0% | 100,0% | 0,0% | 0,0% | 0,0% | 0,0% | 0,0% | 100,0% |
| Automobile | 0,0% | 0,0% | 99,9% | 0,1% | 0,0% | 0,0% | 0,0% | 0,0% | 100,0% |
| Railway | 0,0% | 0,0% | 77,8% | 0,0% | 0,0% | 0,0% | 3,6% | 18,6% | 100,0% |
| Water | 0,0% | 0,0% | 100,0% | 0,0% | 0,0% | 0,0% | 0,0% | 0,0% | 100,0% |
| Urban electric | 0,0% | 0,0% | 0,0% | 0,0% | 0,0% | 0,0% | 100,0% | 0,0% | 100,0% |
| Other | 0,0% | 0,0% | 24,7% | 0,0% | 0,0% | 0,0% | 75,3% | 0,0% | 100,0% |
| Agriculture | 0,0% | 0,0% | 57,9% | 2,0% | 0,0% | 0,0% | 38,0% | 2,1% | 100,0% |
| Utility sector | 0,3% | 0,0% | 50,5% | 0,9% | 0,0% | 5,7% | 9,2% | 33,3% | 100,0% |
| Commercial | 1,5% | 0,0% | 25,0% | 38,8% | 0,0% | 0,0% | 18,2% | 16,5% | 100,0% |
| Residential | 1,9% | 0,0% | 3,0% | 56,3% | 0,0% | 0,3% | 10,0% | 28,5% | 100,0% |

* efficiency of electricity and heat generation installations

Source: Consultant's estimates based on Table 2.14 data.

Figure 3.1 Fuel and Energy Balance development chart



4 Assessment of the energy supply efficiency in Astrakhan Oblast

4.1 Assessment of the efficiency of energy supply

According to Table 3.2, the gross fuel efficiency factor at power plants equals 51%. Specific fuel consumption for power generation is stable (see Table 3.2). Specific fuel consumption for heat generation at power plants is only estimated. To keep co-generation plants competitive, it needs to be reduced, at least to the level of specific fuel consumption of industrial boiler-houses. The efficiency of heat generation by all boiler-houses is 85.6%, and by industrial boiler-houses – 86.3%. Statistics report the efficiency of agricultural boiler-houses above 100% for some years (see Table 4.1), but the data for 2005 seem more realistic, showing it at 60%.

Heat transmission and distribution losses are estimated at 15% (see above). There are higher assessments, but they only refer to distribution pipelines. The share of dilapidated heat network is 12% of overall heat network length. Power distribution losses are 20%. Nearly 70% of power losses occur in low-voltage (0.4 kV) lines. Local experts' estimates of commercial losses equal 3-4%. Technical losses equal 12-14%, or twice the value of many foreign countries.

Table 4.1 Specific fuel consumption for electricity and heat generation and power distribution losses

| | Units | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|--|-----------|-------|-------|-------|-------|-------|-------|
| Electricity generation | gce/kWh | 356.2 | 366.0 | 363.0 | 350.1 | 347.4 | 356.1 |
| Heat supplied by power plants | kgce/Gcal | 151.7 | 158.1 | 153.5 | 144.2 | 143.7 | 144.9 |
| Industrial and municipal boiler-houses | kgce/Gcal | 153.5 | 168.7 | 162.3 | 176.4 | 168.0 | 167.0 |
| Municipal boiler-houses | kgce/Gcal | 108.7 | 174.1 | 175.8 | 176.8 | 173.9 | 172.3 |
| Agricultural boiler-houses | kgce/Gcal | 134.6 | 192 | 71.3 | 102.3 | 83.1 | 239.2 |
| Electricity distribution losses | % | 16.5 | 16.1 | 18.5 | 18.2 | 16.6 | 19.3 |
| Heat losses (excl. recovered heat) | % | 15 | 15 | 15 | 15 | 15 | 15 |

Source: "11-TER" and data from Table 2.12.

4.2 Assessment of industrial and agricultural energy end-use efficiency

In 2000-2005, the efficiency of energy end-use was growing in some sectors and declining in other (see Table 4.2). To a certain extent, such dynamics is determined by the changes in the production scale. This can be illustrated by the dependence of energy intensity of industrial output (see Fig. 4.1). Growing oil and gas condensate refining volumes determine the level of specific consumption (see Fig. 4.2).

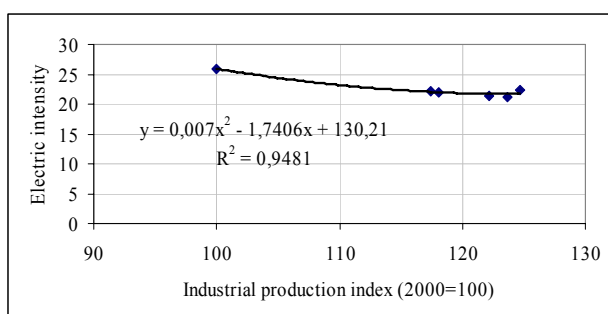


Fig 4.1 Dependence of industrial energy intensity on industrial output

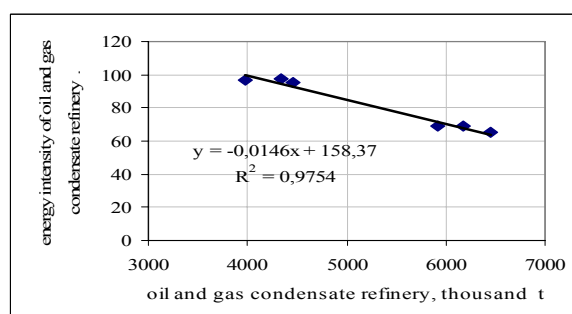


Fig 4.2 Dependence of oil and gas condensate refining energy intensity on the refined volumes

The dynamics of indicators in Table 4.2 are partially determined by statistical inaccuracies (for example, the drop in specific consumption for greenhouses heating in 2002), and partially by the introduction of new technologies.

As was mentioned above, statistical data on specific fuel consumption by agricultural boiler-houses are very unreliable. The last figure for 2005 seems more reliable and therefore was used for the IFEB calculations.

Table 4.2 Energy intensities for some goods and services production

| | Units | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---------------|-------|-------|-------|-------|-------|-------|
| Oil and gas extraction | kgce/t | 2.0 | 1.9 | 1.2 | 1.9 | 2.0 | 1.4 |
| Oil and gas condensate refining | kgce/t | 153.6 | 154.0 | 107.0 | 106.8 | 149.1 | 153.6 |
| Own needs consumption and gas extraction losses | kgce/t | 15.0 | 21.3 | 22.0 | 17.6 | 17.6 | 16.4 |
| Gas refining | kgce/thou. m3 | 93.9 | 108.8 | 108.2 | 108.1 | 108.1 | 108.0 |
| Sulphur production | kgce/t | 117.8 | 115.0 | 107.3 | 107.3 | 105.6 | 103.6 |
| Bread and bakery products | kgce/t | 135.5 | 108.4 | 168.4 | 175.3 | 163.4 | 177.2 |
| Water raise and supply (excl. municipal utility sector) | kgce/thou. m3 | 59.7 | 66.5 | 85.1 | 78.9 | 80.5 | 77.3 |
| Effluent treatment | kgce/thou. m3 | 55.0 | 52.9 | 53.1 | 52.4 | 55.3 | 56.0 |
| Water pumping for melioration and water supply | kgce/thou. m3 | 11.0 | 14.4 | 9.5 | 14.4 | 10.9 | 9.7 |
| Irrigation and drainage | kgce/hectar | 78.5 | 122.5 | 106.5 | 115.4 | 123.0 | 94.5 |
| Heating of winter greenhouses | kgce/m2 | 52.8 | 53.7 | 24.5 | 25.9 | 29.4 | 25.0 |
| Heat supply by agricultural boiler-houses | kgce/Gcal | 137.0 | 194.1 | 71.7 | 102.4 | 83.6 | 240.4 |

Source: "11-TER".

5 Analysis of energy sector forecasts in the region

5.1 Economic and energy development projections

Astrakhan Oblast energy sector development projections already have a certain history. In 2000, the Oblast government adopted “Astrakhan Oblast power sector development concept for 2001-2005 and until 2010”. On July 23, 2004, it approved “The Energy Strategy of Astrakhan Oblast until 2020 in compliance with the fuel and energy complex development and gas supply”. The “Strategy” was developed by local experts in cooperation with the Siberian Institute for energy systems. It is published as a brochure³.

The “Strategy” provides the Oblast energy consumption projections until 2020, estimates of energy efficiency potential, and identifies some energy policy strategies and priorities.

The bottleneck of the “Strategy” is energy demand projections. Two scenarios of economic growth assume, that the GRP will grow 3-3.6-fold, or by 7.6-8.9% per year in 2005-2020⁴. Against the background of 4.4% GRP average annual growth rates in the latest 5 years, and 2-3% during the last two years, the source of such economic optimism is not quite clear.

Both the “Concept” and the “Strategy” have considerably overestimated power and heat demand for 2005. Power demand projection is evaluated using an extremely simple scheme: based on too high GRP growth expectations and too high GRP electricity intensity reduction expectations (by 5.6% per year, given its actual reduction only by 3% per annum in the last 5 years). Heat demand projection was developed using a so-called “direct counting method”, i.e. heat demand is estimated based on the dynamics of major products output. This method does not allow it to couple products/services output levels and the dynamics of GRP and other indicators. While this dependence does exist (see Fig. 5.1). If it persists, given gas extraction growth projections by the “Strategy” authors of 20-24 mln m³, average annual GRP growth rates will only equal 2.6-3.9% instead of 7.6-8.9%.

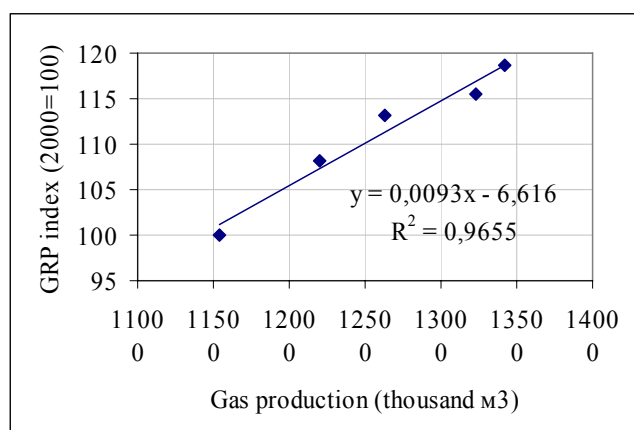


Fig 5.1. The ratio of GRP and gas extraction in 2000-2004

The following fact illustrates low potential of the selected approach: the program adopted in 2004 projects power consumption in Astrakhan Oblast in 2005 at 4,300-4,400 mln kWh, and in fact it was 3,970 mln kWh, or 8-11% lower (see Table 5.1). In other words, even a one year projection error was nearly 10%. This error was determined by too high GRP projection for 2005 and inadequate

³ “The Energy Strategy of Astrakhan Oblast until 2020 in compliance with the fuel and energy complex development and gas supply”. Moscow, 2005.

⁴ Different pages of the brochure “The Energy Strategy of Astrakhan Oblast until 2020 in compliance with the fuel and energy complex development and gas supply” (see pp. 42 and 52) provide different estimates of GRP growth rates. On p. 52, the growth rates range is 5-10% per annum.

methods used for energy demand projections. The “Concept” is better than the “Strategy” in projecting heat demand for 2005: it is only 9% inaccurate.

Table 5.1 Fuel and energy consumption projection for Astrakhan Oblast in 2010-2020

| | Units | 2000* | 2005* | 2005 | 2010 | 2020 | Growth in 2020 compared to 2005 | |
|---|------------|--------|--------|--------|-------------|--------|---------------------------------|--------|
| | | | | | | | times | %/year |
| “Astrakhan Oblast power sector development concept for 2001-2005 and until 2010” | | | | | | | | |
| Electricity | mIn kWh | 3,622 | 3,967 | 4,670 | 5,220-5,555 | | | |
| Heat | thou. Gcal | 13,111 | 14,407 | 14,560 | 17,700 | | | |
| “The Energy Strategy of Astrakhan Oblast until 2020 in compliance with the fuel and energy complex development and gas supply” | | | | | | | | |
| Electricity | mIn kWh | 3,622 | 3,967 | 4,410 | 5,550 | 7,250 | 1.64 | 3.4% |
| | | | | 4,300 | 5,020 | 6,850 | 1.59 | 3.2% |
| Heat | mIn kWh | 13,111 | 14,407 | 15,662 | 17,788 | 19,268 | 1.23 | 1.4% |
| Natural gas | thou. tce | 3,692 | 3,610 | 2,744 | 3,653 | 4,369 | 1.59 | 3.1% |
| Coal | thou. t | 60 | 43 | 35 | 45 | 50 | 1.43 | 2.4% |
| Fuel oil | thou. t | 139 | 195 | 156 | 161 | 101 | 0.65 | -2.9% |

Source: for 2000 and 2005 (marked with *) – Consultant’s estimates; for 2005-2020 - the “Strategy”.

The optimistic and pessimistic scenarios vary in power demand estimates for 2020 only in the range from 6,900 to 7,300 mIn kWh; thus leaving uncertainty range equal to 400 mIn kWh, or only 5-6% of estimated 2020 consumption level, which is within the projection inaccuracy range for 2005. In other words, the projection practically lacks demand estimate uncertainty. This is unacceptable, because natural gas extraction and processing is the largest energy consumer in the Oblast, and this sector can hardly be projected with such determinism. For heat, there is no demand growth uncertainty range whatsoever, but it is important to remember, that gas processing and gas chemistry are responsible for a large part of heat consumption, and for these sectors tough determinism can hardly be justified. There are other serious mistakes: distribution losses in 2005 equaled 512 mIn kWh versus projected 766 mIn kWh. Natural gas and fuel oil consumptions in 2005 are misestimated.

AESK experts in their own projections estimate annual power demand growth in 2007-2009 at 1.5-2%, and annual power demand growth of Astrakhan Gas Refinery at around 4%, whereas for other consumers only at 0.5-1.0%. In the “Strategy”, power demand growth rate until 2010 equals 4.5%.

The following aspects should be noted:

- ⇒ Poor methodological basis of proposed energy and power demand projections for Astrakhan Oblast;
- ⇒ Lack of clear accounting of energy efficiency efforts in energy demand dynamics evaluation;
- ⇒ Excessive determinism and practical neglect of considerable uncertainties in the energy future (mirrored in very narrow range between what the “Strategy” authors call optimistic and pessimistic scenarios) of the Astrakhan Oblast, whose prosperity is based on unclear perspectives of the oil and gas sector development.

The “Strategy” authors focus on the evaluation of options to meet energy demand. The projection includes 12 such options. In the power sector, there are plans to renovate Astrakhanskaya GRES, Severnaya CHP, build up Astrakhanskaya CHP-3 and a CHP at Astrakhan Gas Refinery, build up several mini-CHPs and heat network from CHP-2 to the downtown Astrakhan city to switch the central boiler-house to a standby operation mode. All these efforts will require 15.6 bln rubles in investment, of which 10 bln rubles in 2006-2010, or 2

bln rubles annually, which is 10% of all yearly investments in the Oblast. In order to judge if these investments are viable, it is important to verify energy demand projections.

5.2 Potential energy supply development barriers

Astrakhan Oblast may face significant energy difficulties:

- ⇒ The major energy problem of the region is insufficient utilization of natural gas extraction potential, which is determined by insufficient gas pipeline carrying capacity (Makat – North Caucasus gas pipeline is filled with Turkmenian gas; this limits the possibility to supply gas to Integrated gas transport system); limited production capacity of Astrakhansky Gas Refinery and regional gas market;
- ⇒ Expanding natural gas extraction and processing will require additional power supply and power capacity;
- ⇒ This may lead to further growth of dependence on power import, which has already increased from 5% in 2000 to 22% in 2005;
- ⇒ Growing electricity generation requires replacement of outdated equipment of major power plants;
- ⇒ To improve the efficiency of natural gas use by power plants it is important to develop further co-generation;
- ⇒ However, as access to natural gas supply is improving in more settlements in Astrakhan Oblast, distributed heat supply grows and centralized heat demand relatively declines (heat generation by power plants and boiler-houses has been going down in the recent years). This makes it difficult to achieve full heat generation loads of existing and planned co-generation units and limits the construction potential of mini-cogeneration capacities to 40-60 MW;
- ⇒ The existence of fuel oil- and coal-fired boiler-houses in a natural gas excessive region adds to consumers' burden in covering considerable additional costs of inefficient heat supply services. However, while considering a fuel switch, it is important to take into account that with present gas pricing policy the costs of natural gas for local consumers will be significantly growing;
- ⇒ Declining reliability of energy supply and growing power and heat distribution losses as a result of their underdevelopment and old age.

5.3 Potential improvement of energy projections

Astrakhan Oblast energy projections have shortcomings that are typical for Russia. Simulation of "energy / economic" development is still under developed in Russia. Existing energy and power demand projection models are often based on outdated methodologies and not transparent, and they do not allow for checking estimations or reproducing them with a different set of assumptions. They practically do not take into account market factors, such as producer or consumer reactions to price fluctuations, or tax incentives, etc.

As a basis for improvement of the energy and energy efficiency strategy/policy of the oblast, energy supply and demand projection models need to be structured to perform certain tasks. These tasks include among others:

- ⇒ Better integration of power sector development projections with macroeconomic projections, as well as with projected changes in the fuel and energy balance;
- ⇒ To improve reliability of the power sector development projections, improvement of projections of power (capacity), heat, and fuel demand by consumer groups and by sectors of the economy, sufficient to account for the impacts of the following groups of factors:
 - Economic structure development and other structural changes;
 - Technology shifts;
 - Consumer reactions to changing energy prices;

- Interfuel price and non-price competition;
- ⇒ Identifying key management parameters in the models ensuring a realistic development of different scenarios that are consistent and can be compared, and analysed. The scenarios include procedures for sensitivity analysis and elimination of contradictory scenario elements;
- ⇒ Ensuring the possibility for simulating the efficiency of the energy policy, including price growth scenarios and meeting the energy demand both through construction of new energy sources and energy efficiency improvements;
- ⇒ A possibility to assess the effects of tariff growth on consumers' affordability, energy producers' competitiveness, and energy utilities' revenues;
- ⇒ Providing decision-makers with effective tools to evaluate integrated consequences of technical, pricing, tax, environmental, and investment policies;
- ⇒ Coordination of procedures for short-term, medium-term (5 years), and long-term (15 to 30 years) energy development projections and development of a technology for systemic verification of projected power and capacity balances as the basis for investment programs implementation;
- ⇒ Ensuring a transparent technology for source data collection and processing for model development and calibrating;
- ⇒ Ensuring effective formats for projections presentation.

All these tasks are yet to be accomplished in the Oblast. As to the development and comparison of options to meet energy demand, "The Energy Strategy of Astrakhan Oblast until 2020 in compliance with the fuel and energy complex development and gas supply" suggests quite good quality solutions, except that possibilities for integrating renewables in the Astrakhan Oblast energy balance are not used.

6. Potential of secondary and renewable energy use

Astrakhan Oblast experts estimated the renewable energy technical potential at 57 mln tce (see Table 6.1), which is 12 times higher than primary energy consumption in 2005. Solar energy constitutes the major part of renewable energy resources (82.3%), followed by wind energy (17.4%), while hydro and biogas are only responsible for 0.26% of renewable energy resources potential.

Table 6.1 Estimation of technical potential of renewable energy resources in Astrakhan Oblast (mln tce/year)

| | Solar | Wind | Hydro | Biogas | Total |
|----------------------|--------------|-------------|--------------|---------------|--------------|
| Astrakhan Oblast | 46.9 | 9.9 | 0.024 | 0.12 | 56.9 |
| incl. Astrakhan city | 0.5 | 0.07 | | 0.07 | 0.67 |

Hydro and biogas resources are focused in certain, pretty limited, localities. Local experts estimate the economic potential of renewable energy resources at just 50 thou. tce / year, or approximately 1% of total energy consumption.

7 Energy efficiency policy implementation

“Energy Efficiency Program of Astrakhan Oblast for 1999-2005” was implemented. Because of extremely scarce financing, many intended program measures were not realized. The authors of “The Energy Strategy of Astrakhan Oblast until 2020 in compliance with the fuel and energy complex development and gas supply” have estimated the energy efficiency potential in Astrakhan Oblast, as of 2004, at 370-430 thou. tce of fuel (7-8% of consumption), 1895-2085 thou. Gcal of heat (13-15% of consumption), and 677-821 mln kWh of power (17-21% of consumption). Obviously, energy efficiency potential is higher than that. However, the experience of a large-scale implementation of energy efficiency policies and measures is pretty limited.

There is not much information on the economic effectiveness of energy efficiency improvements. For example, the form “Data on heat supply in Astrakhan Oblast in 2005” points out, that required 36 mln rubles were invested in measures to improve heat efficiency in the whole Oblast (2.5 rubles per Gcal of supplied heat), while only 0.5 mln rubles savings were generated by such investments.

The proposal of the Oblast-level public utility commission regarding the implementation of “Comprehensive target program of reducing power losses in Astrakhan Oblast” developed in 2002 was not adopted, while the losses kept growing.

It seems important to develop and launch Astrakhan Oblast Energy Efficiency Program for 2007-2015. In the framework of this program, energy efficiency activities are to be pushed in the industrial and municipal utility sectors and in the fuel & energy complex.

8 Institutional issues for developing energy policies

8.1 Major institutional holders of energy information

Development of energy balances requires a considerable amount of data on separate energy resources production, supply and consumption, including descriptions of their transformation processes. Major sources of these data include:

- ⇒ Federal statistics authorities. Previously, power balances and fuel consumption data belonged to “closed” sources of information. In recent years, these data are publicly available;
- ⇒ Regional structures of sectoral energy holdings (RAO “EES Rossii”, RAO “Gasprom”, etc.). Power sector reform and anti-monopoly measures have made information that is available to these holdings more fragmentary. The number of power sales companies in one oblast may be large, so obtaining data from them is a time consuming and costly effort;
- ⇒ Departments of the Oblast Government (fuel and energy; municipal utility sector, Tariff Service, etc.). This information is often a compilation of data from various sources; it is not complete and poorly structured. However, in some Russian regions (for example, in KhMAO – Yugra) there is a monitoring of heat supply companies, and these data provide a more reliable picture;
- ⇒ Consulting companies, including energy efficiency centers and agencies. These sources have data on energy losses; energy efficiency potential based on implemented energy audits. They provide more reliable information on actual energy consumption by some organizations and on energy losses, than other sources.

The result of the evolution of the information base for energy balance development is a shift from using primarily sectoral statistics to a larger use of federal statistics. However, this certainly does not mean, that a single source of information may be ignored while collecting data.

8.2 Information support to energy policy implementation

The quality of federal energy statistics is not yet optimal. There is sometimes an internal inconsistency, as well as a lack of special knowledge by statistical personnel and this requires additional institutional and other data sources. In order to obtain a comprehensive picture of energy supply in Kaliningrad Oblast it is necessary to systematize data collection from all information holders. However, currently data collection from all sources, except statistical authorities, has been extremely complicated over the recent years. Access to information is often denied on the grounds of commercial classified data, lack of personnel, or other excuses. In some instances, letters of inquiry from the above authorities are needed to provide the required data. However, the effectiveness of such data collection method is limited, and only part of required information is provided for through such letters. There is no monitoring of the utility systems state-of-the-art, or understanding of the need for such monitoring.

Communication with the local experts also revealed the lack of sufficient institutional resources and qualified personnel capable of energy use data collection and analysis. The data used by the Oblast government are often not complete or reliable (see also section 2). The Oblast government mainly focuses on the collection and procession of current information. This puts a barrier to both the development of effective energy policies and monitoring of their implementation.

Annex I to this report contains more detailed information on the institutional background of the Astrakhan Oblast and its energy policies.

9 Conclusions and Recommendations

A. Conclusions

- It is possible to develop an integrated fuel and energy balance for the **Astrakhan** region. However, all available sources of information need to be collected, verified for consistency and analyzed, including some expert's assessments in order to achieve a comprehensive and consistent vision of the past and present energy situation. The energy data reliability could be greatly improved if relevant energy data were reported and collected in a structural way.
- The existing energy data are mostly in the format of sectoral reports and fragmented formats of regional statistics and are not integrated and compatible.
- Having a comprehensive and reliable fuel and energy balance allows making an analysis of major energy proportions and trends along with an assessment of the efficiency of energy supply and consumption limitations and problems. This forms a good basis for developing regional energy projections as well as for developing regional energy and energy efficiency policies to mitigate potential energy supply shortages in future.
- Energy forecasting methods, including scenario development needs to be made more consistent and realistic.

B. Recommendations

1. It is recommended to strengthen the oblast organization, perhaps formalized by governor's decree or resolution, by:
 - Establishing an energy planning group in the organization with the responsibility of developing and maintaining a comprehensive energy data base and other relevant data in order to produce annually updated energy balances as a basis for annual regional energy situation analysis and reporting.
 - Establishing new formats for processing energy statistics data to form a region wide integrated energy balance.
 - Establishing structural procedures for collection additional or missing information for energy balance development.
2. Develop a modern methodological basis for comprehensive projections of the regional energy future and energy sector development scenarios including:
 - Integrating macroeconomic projections with the development of integrated energy balances and all energy supply systems and demand sectors in order to identify the most effective and least cost solutions for safeguarding the reliable energy basis for future economic development.
 - Training staff in the use of computerized models for supply and demand forecasting.
3. Assign clear responsibilities within the organization for energy and energy efficiency policy.
 - Consider energy efficiency improvements as an important least cost resource in meeting expected additional energy demand;
 - Develop a comprehensive oblast energy efficiency improvement program, which may include subprograms for power sector; housing and communal sector; industrial sector; transportation, public buildings sector etc;

- Allocate sufficient administrative and financial resources for program implementation;
4. Establish a practice of demand-side management for electricity, heat and gas supply;
 5. Establish minimal energy efficiency performance requirements for energy facilities (energy sources and networks) operating at regulated tariffs, which progress over time.

ANNEXES

Annex I Institutional aspects of energy sector development and energy saving in Astrakhan oblast

Institutional Issues of Energy and Energy Efficiency Sector

Astrakhan oblast

1. General Structure of the Sector

Astrakhan oblast (hereafter as oblast) is noted for its level of social and economic development among the southern territories of the Russian Federation. Over the past several years, the Astrakhan oblast has demonstrated a steady rate of economic growth as measured by regional gross domestic product (GDP) and other important indicators of the social and economic development. For example, the region enjoys the highest average wage levels in the Southern Federal Area (okrug) of the Russian Federation; available cash revenue per household member and capital investment rate per capita. Furthermore, the region takes third place in the league of industrial production per capita.

| Indicators | Unit | 2001 | 2002 | 2003 | 2004 | 2005 |
|------------------------------|-------------|-------|-------|---------|--------|-------|
| Regional gross product | Billion RUB | 36,4 | 45,2 | 54,1 | 63,4 | 78,7 |
| Rate in to the previous year | % | 108,4 | 104,6 | 102,1 | 103,2 | 106,0 |
| Monthly average wage rate | RUB | 2 661 | 3 530 | 4 431,6 | 5495,4 | 6830 |
| Rate in to the previous year | % | 140,1 | 132,7 | 125,5 | 124,0 | 124,3 |

At the same time however, analysis shows that the economic growth in the oblast is closely linked to the overall macroeconomic conditions of the Russian economy as a whole. Such a growth was based on the use of the natural resources indigenous to the region. Primarily this is the production capacity of the Volga River potential; its hydrocarbon deposits, the unique recreative potential of Volga river delta and Volga-Akhtubinsk subsoil (?) as well as the rich fisheries of the river and the Caspian Sea.

Currently the resources that have been providing the economic growth of the region over the last decade are under considerable decrease. A chain of unfavourable circumstances created barriers to the production of hydrocarbon even though the hydrocarbon deposits are large and its production level increased at 1990s. Primarily, such unfavorable circumstances are: special nature of the hydrocarbon composition that comes from the Caspian syncline (tectonic depression) and technological complication with its processing; LLC (limited liability company) "Astrakhangasprom" and TPE (territorial production enterprise) "Astrakhanmorneftegas", branch of LLC "LUKOIL-Nizhnevolzhskneft", produce oil and gas in the oblast. It means the investment plans and an access to the "pipeline" influence the sector development. It is well known that "Gazprom" as well as "LUKoil" give priority to the development of the oil and gas and oil chemical sub-sector in the region. Moreover the corporate policy of these companies (primarily within the sphere of the transport infrastructure) does not stimulate the attraction of new investors.

The following projects have been implemented within the framework of the fuel and energy sector: construction of the GPP (gas processing plant) at the Astrakhan right-shore gas-condensate field, exploration of the Camel and Northern-Camel deposits, gasification of communities in the Astrakhan oblast. At the end of 2005 the Russian Federation and

Kazakhstan ratified the agreement in pursuant to which the issues related to the exploration of Imashevsk field are to be regulated by the separate agreement.

The oblast is energy deficient. Electricity deficit is covered mainly by the supplies from the Federal Energy Wholesale Market (FOREM). Lack of generating capacities (the deficit of which is up to 30%), whereas the local electricity demand is satisfied by own generating capacities up to 80%), and wear and tear of the fixed assets over 70% (the wear and tear of the production facilities at Astrakhanskaya GRES power plant is more than 90%) are the main problems of the regional energy sector.

The JSC "Astrakhanenergo" used to be the main energy supplying entity in the territory of the Astrakhan oblast. In the course of the reforms within the power sub-sector and in accordance with the legislation of the Russian Federation the entity was divided into following type of business:

- JSC "SGC-TGC-8" branch of "Astrakhan generation" - generation;
- JSC "Astrakhanskaya sbytovaya company" - sales;
- JSC "Astrakhanenergo" - network.

Volgograd generation, Rostov generation, Rostov city generation, Dagestan generation, Stavropol generation and Kuban generation are the part of the JSC "SGC TGC-8", the headquarter of which is in Rostov-on-Don.

Two TPPs contributes to the generating capacities of the "Astrakhanskaya generation" branch of the JSC "SGC TGC-8". They are: "Astrakhanskaya GRES power plant" and "Astrakhanskaya TPP – 2" as well as the central boiler-house plant.

| Source | The installed electricity power, MW | The installed thermal power, Gcal/h |
|---------------------------------|-------------------------------------|-------------------------------------|
| Astrakhanskaya GRES power plant | 100 | 244 |
| Astrakhanskaya TPP-2 | 380 | 910 |
| Central boiler-house plant | - | 375 |

Isolating generating plant, JSC "TPP-Severnaya" (TPP JSC "Astrakhanboomprom") with the electricity power of 24 MW and thermal power of 194 Gcal/h is also located in Astrakhan.

Besides there are more than 400 small energy supplying sources all over the territory of the oblast. The main part of those sources is the diesel power plants, which are at the balance of the large municipal and industrial organisations. They are the reserve to ensure the secure power supply to consumers. In spite of the large enough total installed capacity of these sources (more than 40 MW), the power generation rate is too small.

Main production indicators of the branch "Astrakhanskaya generation":

| Astrakhanskaya generation | 2003 | 2004 | 2005 | 2006 (Plan approved by the Federal Tariffs Service) |
|--|----------|---------|----------|---|
| Power production, mln kWh | 3002,64 | 2932,93 | 3010,85 | 2750,0 |
| Thermal power supply, thousand Gcal | 2144,3 | 2068 | 2138,9 | 2519,2 |
| Productive thermal power supply, thousand Gcal | 1955,874 | 1887,69 | 1879,695 | |

In 2005 the total power consumption rate for the Astrakhan oblast was 3795 thousand^o kWh, i.e. deficit of the own power generation is about 20%.

The forecasting balance for generation and supplies of the power (thermal energy) and capacity for 2007 makes provision for the volume increase in power generation and supplies up to accordingly by 5.2% and 1.6%. The Tariffs Service of the Astrakhan oblast developed the forecasting balance.

Currently branches of the JSC "SGC TGC-8" face an urgent need for replacement the physically and morally outdated equipment. It is explained by the following factors: date for putting the equipment into operation; technical decisions taken at the stage of its design; materials used for its production; duration and quality of operation; maintenance and repair works.

Peak of putting the generating capacities into operation at "Astrakhanskaya generation" was at 1980–1990-ies (56% of the capacities were introduced during this period). In accordance with the forecast up to 2015 100 MW (215) is to be withdrawn. The generating equipment planned to replace the obsolete one is selected on the basis of the requirements stated in "Technical Policy Concept of the RAO "UES of Russia" and local operation conditions (fuel supplies, supplies' market of heat and electricity, etc.). Due to the envisaged decommissioning and with the purpose to expand the capacities it is suggested to implement the following investment projects:

- Expansion of Astrakhanskaya GRES power plant through the construction of steamgas installation of 110 MW (investment costs are estimated at 1 952,7 mln RUB at 2005 values);
- Construction of the steamgas installation of 340 MW at Astrakhanskaya TPP-3.

Besides it is planned to re-equip thermal networks of "Astrakhanskaya Generation" during the period of 2006-2010 at the total cost of 516,7 mln RUB.

"Astrakhanskaya Generation" is the largest thermal power producer. Its share is about 60%. The other large heat producers and suppliers in Astrakhan are the municipal unitary enterprise (hereinafter MUP) "Teplovye Seti" (Heat Network), with its total installed capacity of 681 Gcal/h, and JSC "TPP-Severnaya".

The energy sector of the Astrakhan oblast faces the following main problems:

Oil and gas sub-sector:

- Delay with gasification due to the financing difficulties;

- Recent difficulties with the gas supplies, the solution of which requires the expansion of the trunk gas pipeline networks;
- Low level of the productive fuel consumption, mainly within the heat power supply sub-sector;
- More or less mono resource balance for the boiler and furnace fuel, which requires the higher level of reliability for the functioning of the system.

Electricity:

- Power and capacity deficit in the oblast, which influences its energy independence
- Obsolete equipment in operation at the main power sources, primarily at Astrakhanskaya TPP and TPP Severnaya
- High level of the wear-and-tear for the electricity network equipment

Thermal power supply:

- Lack of the system to develop the projects aimed to the expansion of thermal power supply to the populated areas
- Low efficiency of fuel consumption due to the insufficient use of the combined production technologies and outdated equipment at the major number of the boiler-house plants
- Inconsistency of the installed thermal power capacity with the connected load
- Hydraulic misalignment of the systems
- Intense corrosion process due to the low water quality at the network
- Insufficient thermal isolation
- Inadequate metering system for the heat produced and consumed

2. Management and Co-ordination Structure

Charter of the oblast and Law № 2/2005-O3 as of 02.02.2005 set up public authorities in the Astrakhan oblast.

Currently there are no public or administrative authorities or structures dealing with the energy efficiency issues.

Organisation and co-ordination within the sphere of energy efficiency and energy saving used to be mainly under authority of the territorial department of Gosenergonadzor (State Energy Inspection Entity) before the re-organisation of the public authorities took place.

At the Government level of the Astrakhan oblast the Ministry of the Fuel and Energy Sector and Natural Resources runs the issues of energy and energy supply. The Resolution of the Astrakhan oblast Government as of 13 June 2006 N 189-П approves the Statute of the Ministry.

The Ministry of the Fuel and Energy Sector and Natural Resources of the Astrakhan oblast is a body of an executive power of the public authorities that pursues the State policy and provides the legal regulation in the sphere of the fuel and energy and natural resources of the Astrakhan oblast.

In accordance with the Charter the Ministry has the following authority in the sphere of the fuel and energy sector:

- Pursuant of the State policy in the sphere of the supply with the fuel and energy resources to enterprises and budget organisations;
- Development and implementation of the integrated and branch targeted programmes in the sphere of the development of the fuel and energy sector;
- Elaboration of the State order for the fuel resources to ensure budget enterprises and organisations meet the heating season;
- Development of proposals within the sphere of the efficient production and use of the fuel and energy resources;
- Metering and control over the fuel and energy use by the enterprises within the fuel and energy sector;
- Drafting and signing of the agreements regarding supplies of liquid, solid and fluid fuel to the budget enterprises and organisations;
- Participation in regulatory bodies of the joint-stock companies and organisations of the fuel and energy sector in accordance with the procedure set up by the Federal legislation;
- Setting up the types of fuel and issuing permissions for use of such a fuel by the local enterprises under construction or reconstruction, economic entities and fuel-operated installations irrespectively of their affiliation and form of ownership;
- Participation in satisfaction the demand of economy and population for fuel and power and their rational and safe use;
- Control over supplies and sales of the liquefied hydrocarbon gas, wood fuel and coal to the population;

- Participation in elaboration of the consolidated balance of the power (capacity) generation and supplies to the regional energy system in interaction with the Unified Energy System of Russia;
- Participation in coordination of the decision-making process regarding establishment, re-organisation and liquidation of enterprises of the fuel and energy sector and extractive industries under Federal and Regional ownership in accordance with the established procedure;
- Coordination of use limits for the fuel and energy resources by the organisations under the financing from the regional budget;
- Approving the siting of the electricity units in the territory of the Astrakhan oblast;
- Government support within the respective competence to the development of gas supply;
- Development and implementation of the integrated and branch targeted programmes in the sphere of gasification of housing and communal entities, industrial and other organisations located in the Astrakhan oblast; control over implementation of these programmes;
- Analysis of the State policy pursuant within the defined sphere of activities of the Ministry itself;
- Approving of the Charters for the local State enterprises and agencies, that are under authorisation of the Ministry, in accordance with the established procedure.

The Ministry also deals with the issues related to the soil and water use.

LLC “Astrakhanskaya Toplivnaya (Fuel) Company” was founded in 2005 with the participation of the Ministry to satisfy the local market demand of the Astrakhan oblast for oil products.

Energy efficiency issues are not included into the sphere of activities of the Ministry. The Government of the Astrakhan oblast does not find it appropriate to add these issues to the responsibility of the Ministry.

The energy saving division used to be the part of the Regional Energy Commission. However in the course of its re-organisation such a division was abolished. Currently the division of balances and technical assessment of the engineering systems at the Tariffs Service of the Astrakhan oblast deals with these issues but limitedly.

Multiagency Council of the Development Strategy of the Fuel and Energy Sector of the Astrakhan oblast was founded in 2004 in accordance with the Resolution of the Governor № 438 as of 09.09.2004. Its main objective was the implementation of actions in the Astrakhan oblast envisaged by the Energy Strategy of Russia for the period till 2020 and the Concept of the Power Sub-sector Development in the Astrakhan oblast for the period of 2001-2005 and till 2010, which was approved by the resolution of the Administration Head № 423 as of 31.10.2000.

The Council was founded as an advisory body to coordinate the activity of the bodies of executive power, local authorities and organisations. The Council turned out to be ineffective to solve the entrusted issues, as it does not have the real tools to influence on the development of the Fuel and Energy Sector.

The majority of the activities that are traditionally related to the energy saving do not exist in the oblast or poorly developed and not properly organised.

As a rule, the structural divisions of senior organisations deal with such issues at the large enterprises of the Fuel and Energy Sector.

There was an attempt in the region to arrange the energy auditing of the budget organisations to optimise the energy resources use by them and, correspondingly, reduce the budget load. However such an action resulted in inspections with the obscure consequences and thus was failed.

There are ongoing talks about the need to establish the Regional energy efficiency centre. The Government of the Astrakhan oblast used to take a decision and issue the respective documents on its establishment in 2006 and later in 2007. It agreed on the Charter for such a centre as for the public enterprise. To establish such a centre there was the specific request to the budget. However the special financing item for centre was not added to the budget. Thus the financing of the statutory fund of the centre (500 000 RUB) has not been settled yet. There is an impression that at the level of the regional authorities the establishment and functioning of such a centre is not the priority.

Different patterns of ownership to establish the energy efficiency centre have been studied, including the non-profit partnership, autonomous non-profit organisation, etc. In 2005 the resolution of the Government of the Astrakhan oblast was adopted about the establishment of the Centre as the public unitary enterprise.

The draft of the new “Law on the Energy Efficiency” provides the availability of the public unitary enterprise in the Astrakhan oblast “Astrakhansky Regional Energy Efficiency Centre” as one of the main body to manage the energy saving issues.

The Charter of “Astrakhansky Regional Energy Efficiency Centre” states that from one side it is non-profit organisation whereas from the other side it is under authorisation of the Ministry of the Fuel and Energy Sector and Natural Resources of the Astrakhan oblast. The objectives of the establishment of the Centre were declared as the following:

- Pursuant of the State energy efficiency policy in the Astrakhan oblast;
- Development of the Regional integrated system to manage energy efficiency with the purpose to increase the energy potential for the region and provide the sustainable energy supplies to the most important social and economy development programmes in the Astrakhan oblast;
- Ensuring the organisational, economic, regulatory, informational and other conditions for interaction between the government authorities, producers, suppliers and users of energy resources and fuel;
- Profitability.

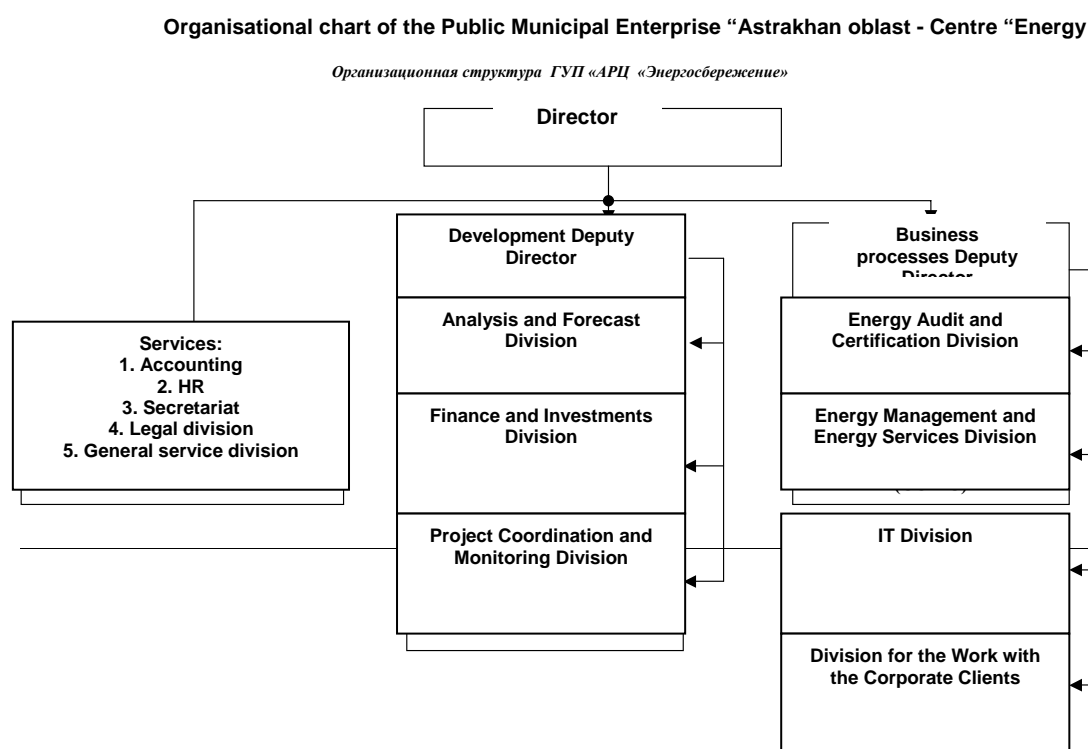
The types of activity of the enterprise are the following:

- To establish the social and corporate institutions and financial mechanisms in assistance to the activities of actors of the regional energy and fuel sector to effect legal and other regulatory acts, resolutions and decisions of the bodies of executive power;
- To follow organisational and coordinating measures with the purpose to initiate, develop, invest and implement innovation projects and programmes in the sphere of the fuel and energy and housing and communal sectors (including regional energy programme), assimilate the advanced techniques and new technologies to ensure the efficiency improvement in the sphere of the fuel and energy and housing and communal sectors;
- To integrate and rationally use tangible, information and technological and labour resources, consolidate efforts to implement large regional fuel and energy projects, ensure the financing of such projects, their expertise and control over their implementation;

- To develop the unified strategy and methodology for the regional energy supplies and saving on the basis of the latest achievement of the best practices in Russia and foreign countries;
- To analyse the most important problems in the sphere of the efficiency improvement of use the energy and fuel with due respect to the economic, environment and social consequences;
- To analyse the legal and regulatory basis and its improvement in accordance with the main objectives of the resources saving in the oblast;
- To develop and expertise regional and branch programmes and projects aimed to improve the use of fuel and energy. To provide an access to the different financial resources, including international grants and funds, as well as their consolidation to implement large regional energy saving projects.
- To development and expertise the projects about replacement of the non-renewable energy resources by the non-traditional ones for the regional fuel and energy balance.
- To carry out technical and economic analysis of the energy saving projects, develop business plans and investment proposals. Economic analysis of the tariffs and self-production cost of the power (heat) energy.
- To take actions directed to the establishment of the demonstration areas of the high-energy efficiency, branch and regional clusters, technical parks, business-incubators, transfer centers for the innovation technologies.
- To conduct energy inspections (auditing) of the energy using and energy producing enterprises, assess the energy saving potential at introduction of new technologies and energy efficient equipment, analyse energy supply security. Development of fuel and energy balances of the enterprises, municipal entities, region and their technical and economic analysis.
- To carry out diagnostics and assessment of the condition, tests and measuring of parameters of the energy supplying systems, restructuring and re-engineering of the energy entities at the industrial enterprises.
- To organise exhibitions, scientific and applicative conferences, symposiums, workshops and presentations of the Russian and foreign companies, search for partners and investors abroad.
- To provide scientific and methodological, educational, informative, expert and marketing support to the energy saving programmes and projects.
- To provide consulting and engineering services for organisational, regulatory, technical and financial aspects of the energy saving programmes and projects.
- To publish periodic and special literature with the purpose to develop energy efficiency and environment protection ideas, promote the energy saving best practices at the production sphere, housing and communal sector and households.
- To organise trainings and retraining of the qualified specialists regarding the issues of management and auditing in the energy sector.
- To ensure the supplies of the energy efficient equipment and technologies to the region. Equipment and real estate leasing in the energy sector.

- To expertise the energy consumers' activities together with the Ministry of the Economic Development of the Astrakhan oblast to define the reserves of economy of the fuel and energy resources.
- To participate in organising of the production of the energy saving equipment and introduction of the energy and resources saving technologies at organisations and industrial enterprises of the Astrakhan oblast together with the Astrakhan Ministry of Fuel and Energy Sector and Natural Resources.
- To develop together with the Astrakhan Ministry of Fuel and Energy Sector and Natural Resources of the Astrakhan oblast the database on the main energy users, projects on the improvement of the energy efficiency, Russian and foreign energy saving technique and technologies, financial sources for the innovation projects.
- To provide the quality control over the electricity, fuel and gas in their conformity to the State standards and other regulatory documents.
- To carry out foreign economic activity.

The management of the Centre suggested the following organisational chart:



It is obvious that based on the stated types of activity and proposed organisational chart the Centre intends to play the key role in the structure to manage the energy efficiency issues in the region, though some of the activity types seem to be excessive and unjustified (e.g. quality control over power and fuel, etc).

There is a controversial opinion in the region about the need to have such a Centre. In particular, in accordance with the future director, the energy supplying organisations and housing and communal enterprises are against it as they see the specific threat to their own interests.

As soon as the Centre is legally established there are plans for its financing from the budget funds. However the Director of the Centre is quite optimistic with his assessment of the perspectives for the development, achievements and ensuring of the financial stability. Along

with the objectives stipulated by the Charter there are some other tasks, often exotic ones, which are considered to be also implemented, e.g. trade with the quotas for the energy saving by the budget organisations, setting up the cooperative society of the energy users, and so on.

However, as far as it was understood the main and most stable financial flow will be provided from the expertises (e.g. expertise of tariffs of the energy supplying organisations, expertise of the standards for technological losses and specific fuel use rate), which will be ordered or initiated by the Regional Administration.

Such a work for the regional branches of the large enterprises is provided by the large expertise organisations – non-residents of the oblast. The rest enterprises and organisations have not been covered yet. The Centre may become a monopolist in the sphere of expertises at least for some period of time due to the lack of the reputable expert and consulting companies in the region operating in this sector.

3. Legal Basis

In 1999 the Astrakhan oblast adopted the regional Law № 33/99-03 "About Energy Efficiency and Improvement of Efficiency for Fuel and Energy Use". The Law was developed on the basis of the Federal Law " About Energy Efficiency", therefore it is similar to this Law and it is declaratory to much extent. Due to the nonserviceability of this regional Law it was abrogated and currently is not valid.

Currently there is the draft of the new Law "About Energy Saving in the Astrakhan oblast" under the reviewing by the public authorities.

The Law is aimed "to regulate relations in the sphere of the energy efficiency which appear in the process of the energy production, transfer and use with the purpose to provide regulatory, economic and organisational conditions for the effective use of the energy resources" and "to ensure the pursuant of the regional State policy in the sphere of the energy efficiency in the Astrakhan oblast oriented to the combination of the public regulation and market mechanisms".

One of the objectives of the public regulation is "overcoming the energy resources deficit, reducing the tension of the energy balance through the efficiency improvement for the energy resources use and changing the structure of their use".

It is assumed that the Law will assign the management of the energy saving in the region to the authorised bodies, namely:

- Ministry of Fuel and Energy Sector and Natural Resources – (coordination of energy efficiency measures in the Astrakhan oblast as well as the monitoring and submission of proposals to change the legal basis for the energy efficiency in the Astrakhan oblast);
- Public unitary enterprise of the Astrakhan oblast "Astrakhansky Energy Efficiency Centre";
- Branch ministries and agencies – within the limits of their authorisation by subordinate organisations in the Astrakhan oblast;
- Administrations of the municipal entities in the Astrakhan oblast – within the limits of their authorisation in the territories of responsibility.

Thus if the Law is adopted the energy efficiency centre will become the officially authorised body. However it should be noted that the former version of the Law also assumed such a centre with the respective responsibilities, but no improvement took place. Therefore it can be surely stated that the only availability of such a Law is not enough.

Among the others the following provisions of the draft law "About Energy Efficiency in the Astrakhan oblast" can be noted:

1. **"The regional budget annually allocates the funds to implement the regional energy efficiency programme. The volume of the mandatory funds (due to annual allocation) to implement the regional energy efficiency programme is presented at the expenditure side of budget as a separate item. It is provided on the basis of the request introduced by the regional Government. Expenditure item for the energy efficiency at the regional budget is protected and is due to the total-volume distribution".**

The attempt to legally provide the mandatory funds allocation for the implementation of the approved energy efficiency programmes has been taken to, most likely, avoid the past negative experience. However the probability such a provision passes the parliament is too much doubtful.

2. **“Tax relief for the payments to the budget of the Astrakhan oblast within the competence defined by the legislation of the Russian Federation” – is one of the State support types in the sphere of the energy efficiency.**

Possibly it will require further specification at the level of subordinate legislation.

3. **“Targeted off-budget energy efficiency fund, which is formed out of voluntary contributions by legal entities and private persons as well as allocations of the legal entities up to the volume of the introduced tax relief provided by the decision of the Astrakhan Government” is named as one of the financing sources for energy efficiency measures.**

This provision means that it is planned to organise the energy efficiency fund. It is doubtful that the fund will be replenished by the “voluntary donations” whereas the allocation of the legal entities has to be further specified.

4. **“Reduced tariffs (tariffs of economic development) for specific energy resources users” is one of the tools for energy saving incentive.**

Such a financing scheme of the energy efficiency projects has been already applied in the country (e.g. in Moscow). High-level coordination and interest expression of all authorised bodies, including Tariffs Service and energy supplying enterprises have to be provided.

5. **The basic level of the natural limits (standards) of energy supply for the period longer the payback period for the energy saving measures by one year is maintained for the budget agencies and unitary enterprises which reduced energy resources use due to the taken energy saving measures. The procedure for use of the saved budget funds due to the energy saving measures is set up in accordance with the Federal legislation and legislation of the Astrakhan oblast.**

In general, it can be stated that to provide the serviceability and efficiency of this Law it will be necessary to expend much effort in order to specify its provisions in the proper legal form.

4. Energy Policy and Development Programmes

Several different programmes, strategies and concepts for the development of the energy sector have been implemented and under implementation stage in the oblast. All of them are based on the condition that the oblast is energy deficient. The main of those programmes are briefly described below.

“Energy Strategy of the Astrakhan Oblast for the period till 2020 in relation to the Development of the Fuel and Energy Sector, Gas Supplies and Gasification of the Region”

It was developed by the JSC “Promgaz” and Astrakhan Administration and approved by the resolution of the Astrakhan Administration № 10/123 as of 23 July 2004.

The Strategy contains the following:

- Energy priorities and directions for their implementation;
- Scenarios for economy development and energy use by the housing branches;
- Development of the fuel and energy sector and energy balances;
- Development of the fuel producing and fuel processing branches;
- Energy supplies to the isolated areas;
- Improvement of energy use and directions for energy saving measures;
- Mechanisms to stabilise the energy sector functioning and principles for the strategy implementation.

The following is stated as the legal and regulatory conditions for implementation of the energy strategy:

- Amendments to the law “About Energy Efficiency”
- Draft law “About Rational Use of the Natural Gas in the territory of the Astrakhan Oblast”
- Draft law “About Energy Safety of the Astrakhan Oblast”
- Draft law “About Thermal Power Supply”
- Draft law “About the Gas Use as the Motor Fuel”

It is also required to adopt some subordinate acts, in particular:

- Provisions for the energy auditing
- Rules for the project expertise, feasibility studies and financial calculations of the efficiency
- Procedures for approval and regulation of power and heat tariffs
- Documents package about energy monitoring

Energy Saving Programme in the Astrakhan Oblast for 2000-2005

It was developed by the Astrakhan State Technical University and adopted by the resolution of the Government of the Administration of the Astrakhan oblast № 215 as of 20 June 2000.

The expected final results of the Programme – development of energy saving potential, which is assessed as of 12 % from the total volume of the energy resources use, i.e. value of the saved energy resources is 250 mln RUB.

The planned costs for the Programme implementation - 78 mln RUB, including

| | Mln RUB | % |
|-------------------------------------|----------------|----------|
| Federal budget | - | - |
| Regional budget | 2,4 | 3 |
| Energy efficiency fund | 23 | 30 |
| Own resources of enterprises | 20 | 25 |
| Bank loans | 25 | 32 |
| Resources from market mechanism use | 6 | 8 |
| Financing through leasing | 1,6 | 2 |

Objective of the Programme – justify and recommend energy saving measures and technologies providing efficient energy resources use and improving the profitability of the goods production, improving the social conditions and environment protection for business activities.

The following energy saving measures were recommended for the period of 2000-2005 in the Astrakhan oblast:

- Adoption of legal and regulatory energy efficiency acts;
- Establishment of the regional energy efficiency centre;
- Consolidation of funds from the energy efficiency measures;
- Establishment of the scientific and technical information centre as the basis for the use of the energy saving technologies;
- Coordination of functions and activities of the Regional Energy Commission, Astrakhan oblast Gosnadzor department, regional energy efficiency centre, scientific and technical information centre, scientific energy council under authorisation of the regional Administration and regional energy committee with the purpose to establish the united energy efficiency management system;
- Development of the specific programme to finance energy saving activities through introduction of the regulating acts, tax relief conditions, economic incentives at the level of enterprises and organisations, producers and suppliers of the energy resources, local and regional authorities;
- Introduction of the energy expertise for all the sites under construction, modernisation and reconstruction;

- Introduction of the mandatory energy inspection of all active enterprises and organisations of all legal forms of ownership;
- Introduction of mandatory energy passports for the enterprises and organisations with the annual energy resources' use rate more than 2000 tones of standard fuel as well as the energy efficiency programmes (per year and for the period till 2005);
- Acceleration of the process to install the quality controlling and metering devices for all types of the energy resources;
- Organisational and technical measures at the enterprises of the fuel and energy, agricultural, housing and communal, food sectors to eliminate the direct losses of the steam, cold and hot water, compressed air, electricity, fuel, gas and so on at all economic areas, including those ones on the basis of the data from energy inspections and passports of the sites;
- Current repairs of the energy equipment, adjustment of regimes, optimisation its operation with the purpose to improve its efficiency and environmental security;
- Introduction of the capacity regulating systems or parameters for energy equipment with the purpose to reduce non production losses of the energy resources;
- Replacement of the life-expired energy equipment with the modern one of the high energy efficiency and environmental security;
- Application of new energy saving technologies and equipment on condition of their short payback period;
- Establishment of the energy efficient demonstration areas at the enterprises and sites of the region which are successful at the taken energy saving measures on the basis of the new technologies;
- Study and rationalisation of the possibility to use non-traditional and renewable energy resources, defining areas and sites for their use (solar and wind installations, heat pump units);
- Development of the modern ways to assess the economic efficiency of new energy saving technologies, development of the technical proposal and feasibility studies for the average cost energy saving measures, projects and programmes which in case of the favourable economic condition in the country and region could be followed up by the end of this Programme;
- Organisation of the annual regional exhibition of the energy efficiency projects (finalised and under implementation), which are to be added to the regional plan of action for the next year and under the financial support.

In general the Programme was mainly the collection of some energy saving technologies with the assessment of the possible consolidated result from their introduction in the Astrakhan oblast.

Most of the directions and measures of the Programme both organisational as well as the technical ones have not been implemented. The Programme itself did not play any important role for organisation of the systematic approach to the energy efficiency in the region. However it should be noted that this Programme had some positive aspects, in particular:

- Understanding of necessity to develop legal and regulatory basis and institutional structure of the energy efficiency

- Understanding of the fact that at the beginning of the energy efficiency measures the priority should be given to those ones to sort out the mess with the use of the energy resources as well as to the short-term and low-cost energy saving measures and technologies with the short payback period
- Understanding of the modesty and insecurity with the budget financing of the Programme measures.

Regional Energy Strategy till 2010

It was developed by the JSC "Promgaz" in 2006. Officially was not approved because its Originator has not been paid.

Its objective – development of the set of the economic, technological and organisational measures, directed to the following:

- Efficiency improvement of the natural gas use at the sites of the fuel and energy sector
- Improvement of security and safety of the power and heat sites at the current conditions
- Development of the implementation mechanism for the Astrakhan oblast Energy Strategy with the perspective till 2020

It contains 10 volumes:

1. Monitoring over the implementation of the Astrakhan oblast Energy Strategy with the perspective till 2020;
2. Analysis of the directions for the social and economic development of the Astrakhan oblast;
3. Analysis and assessment of the current condition of the fuel and energy sector in the region.
4. Marketing study of the energy resources.
5. Assessment of technical and economic proposals about efficient use of power and heat energy resources within the systems of power and heat supplies in the Astrakhan oblast.
6. Efficiency of gas use in the Astrakhan oblast
7. Development of the supply-demand balance in the region till 2010 with the respect to the improvement of security, sustainability and safety of the energy supplies to users.
8. Financial proposals for the programme of multistage construction of energy supplying and gas sites.
9. Proposals of mechanisms to implement the energy strategy for short-term and long-term perspective.
10. Main provisions.

Concept for Development of the Power Sub-sector in the Astrakhan oblast for 2001 – 2005 and the period till 2010

It was approved by the resolution of the Governor of the Administration of the region № 423 as of 31 October 2000. Below are listed the participants of the concept development process:

- Administration of Astrakhan
- State institution “Department of Housing and Utilities of the Administration of the Oblast”
- Department of Agriculture and Food of the Administration of the Astrakhan oblast
- Committee of Economy and Investment Policy of the Administration of the Astrakhan oblast
- Small production-operating enterprise МП ПЭО “Astrcommunenergo”
- JSC “Astrakhanenergo”
- JSC “TPP-Severnaya”
- Regional energy commission of the Astrakhan oblast
- MUP “Communenergo” of the Trusovsk district
- Department of the Fuel and Energy Sector of the Administration of the Astrakhan oblast

The concept was developed to define the main objectives, directions, priorities, scales and mechanisms for the power sub-sector development in the region. The main objective of the Concept is defining the ways to develop and modernise the power sub-sector with the purpose to reach the targeted rate of social and economic development and improve the living standards for the local population.

The generating capacities located in the territory of the region increased the power production up to the maximum technically possible level and cannot satisfy the growing energy use level. There are two options to compensate the expected power deficit: an increase of the power purchase volume from the FOREM or increase the installed capacity of the power plants located in the territory of the region.

The current situation at the FOREM and experience of the power supplies to the region allows assuming that it will be impossible to cover the power deficit in the region by the only supplies from the FOREM.

The expected maximum load of consumers in the Astrakhan oblast in 2005 will be 710 MW. Starting from 2001 with the purpose to provide the secure power supplies to the Astrakhan oblast it is required to increase the total installed capacity of the power plants, located in the territory of the region, till the level higher of the expected maximum load of consumers at the simultaneous compensation of the retired capacities.

The availability of the own fuel reserves (Aksarai gas field) and geographical location of the Astrakhan oblast (there is the energy transit via the region to Kalmuckia and Kazakhstan. Possibly the energy transit volume will be increased due to the energy transit to Transcaucasia and other southern and eastern regions) contributes to the development of the own power capacities.

The following conditions define the choice of the power sub-sector development strategy of the Astrakhan oblast for 2000 – 2005 and for the period till 2010:

- Available 60% reserve of the thermal capacities at power plants, located in the territory of the region;
- Possibility to use the passive fixed assets of the power plants (buildings and constructions) in case the active part is retired. It allows an increase of the power capacity of the generating sources at the capital costs for construction of only active fixed assets;
- Available reserves to improve the efficiency of the use of the current generating capacities.

Taking into consideration the above listed conditions it is advisable to increase the installed capacities, located in the territory of the region, for the period till 2005 through reconstruction and modernisation of the available power plants, construction of new generating capacities with the simultaneous development of small non traditional energy sub-sector and energy efficiency.

The following measures are proposed to increase the installed power capacity in the region and improve the security level of the power supplies to consumers:

- Reconstruction of the Astrakhanskaya GRES power plant with the increase of the installed power capacity up to 140 MW.
- Reconstruction of the Astrakhanskaya TPP-2 with the increase of the installed power capacity up to 450 MW.
- Modernisation of the TPP-Severnaya with the increase of the installed power capacity up to 59 MW.
- Reconstruction of the power networks and additional construction of the networks.
- Construction of the steamgas TPP at Astrakhan gas processing plant of the total power capacity of 300 MW.
- Development of the small power sub-sector at the territory of the region through reconstruction of the boiler power plants of industrial and municipal enterprises of the Main Area office TPP (ГТУ ТЭЦ) of the total power capacity more than 40 MW.
- Energy saving measures.

It can be concluded that the Concept in general is aimed to the introduction of new generating capacities, whereas the issues related to the energy efficiency and reduction of the current big losses of the power have not been studied at all.

5. Tariffs Regulation

The standing regional energy commission (further as – REC) of the Administration of the Astrakhan Oblast under authorisation of the Governor of the Administration was founded on 10 February 1992 by the resolution of the Administration of the Astrakhan Oblast № 145-p “About Formation of the Regional Energy Commission (REC)”.

The REC used to be the standing collegial body, the members of which were: representatives of: the regulatory bodies, energy supplying organisations – JSC “Astrakhanenergo”, MUP “Astrcommunenergo”, Gorzhilcommunkhoz, - and users of energy and gas in the sphere of industry and communal services.

In 1997 the legal status of the REC changed, the Commission got a status of the legal entity. The resolution of the Governor of the Administration of the Astrakhan Oblast № 211 as of 28.05.1997 approved the structure, organisation chart, costs estimate, membership of interagency experts’ board under the authorisation of the REC of the Astrakhan Oblast Administration. On 03.06.1997 the Head of the Astrakhan Oblast Administration approved the statute of the REC of the Astrakhan Oblast Administration, which was registered by the decision of the Board of the Federal Energy Commission of the Russian Federation № 86 as of 10.06.1997.

In 2005 the resolution of the Astrakhan Oblast Governor № 34 as of 04.02.2005 “About Re-organisation of Bodies of Executive Power” amends the Charter of the Astrakhan Oblast. In accordance with this resolution the REC was re-organised and transformed to the Tariffs Service of the Astrakhan Oblast (further as – Service) with the transfer of a function of the Department of the Economic Development of the Astrakhan Oblast to set up tariffs and control exercise of the prices (tariffs), regulated by the State.

In accordance with the approved statute the Service is the Body of State Executive Power of the Astrakhan oblast. It ensures the regulation of the state prices (tariffs) within the competence of the actors of the Russian Federation; controls secure energy supplies to the population by the guaranteeing suppliers and application of the prices (tariffs) under the regulation of the REC itself and the Government of the Astrakhan oblast. The resolution of the Government of the Astrakhan oblast № 49-П as of 06.04.2005 defines functions of the Service.

The Service sets up the tariffs for the following goods and services:

- Liquefied gas in sale to the population for domestic needs (except the gas to fuel vehicles)
- Natural gas in sale to the population and households
- Solid fuel in sale to the population
- Domestic furnace fuel in sale to the population
- Kerosene in sale to the population
- Power transmission services through the distribution network within the limits of the marginal tariff rate (minimum and (or) maximum), which is set up by the Federal body of executive power for the power transmission services through the distribution network
- Sales mark-ups of the guaranteeing power suppliers
- Thermal power transmission services

- Thermal power except the one, which is produced by the power plants operating in the regime of the power and heat combined production
- Thermal power produced by the power plants operating in the regime of the power and heat combined production within the limits of the marginal tariff rate (minimum and (or) maximum), which is set up by the Federal body of executive power for the thermal power produced in the above mentioned way
- Electricity, supplied by the energy supplying organisations to consumers within the limits of the marginal tariff rate (minimum and (or) maximum), which is set up by the Federal body of executive power
- Other production, goods and services which are under state regulation in the territory of the Astrakhan oblast

Besides the Service carries out some other functions, namely:

- Analyses the influence if the set up prices (tariffs) to the financial and economic condition of the organisations, which carry out the regulated type of activity, production and goods users and standards of living in the Astrakhan oblast
- Submits the proposal for setting up the marginal tariffs for power and heat energy to the Federal body of executive power
- Approves the location of the power sites within the territory of the Astrakhan oblast
- Participates in development process of the regional energy programmes and energy efficiency programmes
- Participates in the development process and controls the implementation of programmes and forecasts social and economic development of the oblast

Tariffs of 2007

An order of the Federal Tariffs Service № 166-э/1 as of 01.08.2006 “About Marginal Tariffs for Power and Heat in 2007” sets up and enacts the following:

1. Marginal minimum and maximum tariffs for the electricity, supplied to the consumers, in average in the Astrakhan oblast, without differentiation by the consumers’ groups, voltage levels, annual number of hours for use of the installed capacity, time daily zones (hours) and calendar schedule for 2007:
 - Marginal minimum tariff level - 120,85 kopecks/kW without VAT;
 - Marginal maximum tariff level - 121,51 kopecks/kW without VAT.
2. Marginal minimum and maximum tariff levels for the thermal power, produced by the power plants operating in the regime of the power and heat combined production, in average in the Astrakhan oblast, without differentiation by the consumers’ group, type of heat agents, steam parameters, systems of the centralised heat supply and calendar schedule for 2007:
 - Marginal minimum tariff level - 221,3 RUB/Gcal;
 - Marginal maximum tariff level - 222,9 RUB/Gcal.
3. Marginal minimum and maximum tariff levels for the electricity supplied to the consumers from the areas of centralised and decentralised energy supplies in the Astrakhan oblast for 2007:

- Marginal minimum tariff level - 149 kopecks/kW with the VAT;
- Marginal maximum tariff level - 152 kopecks/kW with the VAT.

An order of the Federal Tariffs Service № 179-э/1 as of 11.08.2006 “About Amendments to the Order of the Federal Tariffs Service № 168-э/3 as of 1 August 2006” sets up the maximum level for heat tariffs increase of 109%, except for the heat produced by the power plants operating in the combined regime of electricity and heat production, in average in the Astrakhan oblast.

The named tariff levels are set up in average for the Astrakhan oblast. That is why tariff levels (rate of increase) for specific energy supplying (selling) organisations can be lower or higher. The same is related to the tariffs based on the type and category of the consumers.

The energy-supplying (energy selling) organisation proposed to increase the average tariff for electricity in the Astrakhan oblast up to 28 % starting from 01.01.2007.

Tariff increase for electricity in 2007 in comparison with the current tariffs for all electricity consumers (including budget consumers and population) did not surpass 13 % based on the results of the expertise conducted by the Service of the Astrakhan oblast in accordance with the method of economically justified costs.

Mainly the tariffs increase is caused by the “Federal factors”, including price increase for electricity at the wholesale market, tariff increase for services of the electricity transmission through the united National electricity network, provided by the JSC “Federal Network Company of the United Energy System”, and so on.

The mentioned increase level corresponds to the one, which was accepted while developing the budget of the Astrakhan oblast for 2007 and forecasting social and economy development of the Astrakhan oblast for 2007. Tariffs for electricity do not exceed the marginal electricity tariffs approved by the order of the Federal Tariffs Service № 166-э/1 as of 01.08.2006.

The speciality of the state power tariff regulation in 2007 was the set up of tariffs for electricity followed by the guaranteeing suppliers: JSC “Astrakhan Energy Selling Company” and LLC “Rusenergosbyt” – within the limits of their activities. It is caused by the amendments to the current legislation, including the introduction of the Rules for retail electricity markets’ functioning during the period of power sub-sector reforming, and establishment of the new market at the retail electricity market – guaranteeing supplier. The Rules were approved by the resolution of the Government of the Russian Federation № 530 as of 31.08.2006.

In 2007 for the population of the Astrakhan oblast the same tariffs for the electricity were set up as for the consumers equivalent to the population regardless the supplier of the power. In accordance to the current legislation the consumers equivalent to the population are: cities that are billed to on the basis of the general water meter; housing entities which consume power for the technical needs; horticultural entities, construction societies of holiday resorts (dachas) and garages, parking sites, communities, military housing units, residential areas at penitentiaries, cellars, shedders that are billed on the basis of the general water meter, entities that are maintained by the congregation.

Power tariff for the population and the population equivalent increased in 2007 by 12.6% in comparison with 2006 and is equal to 152 kopecks/kWh with the VAT (or 128,8 kopecks/kWh without the VAT), i.e. its is at the marginal maximum level.

In accordance with the resolution of the Government of the Russian Federation № 1444 as of 07.12.1998 “About Basis for the Price Setting for Power Consumed by the Population” the reduction ratio of 0.7 is applied to the rural population and the urban one that lives in houses with the installed electrical cooking appliances and heating devices.

Power tariffs for the population are set up without differentiation by the social quota for consumption.

For the other consumers the tariff for 2007 is (for comparison, LV single-rate tariff) 143,8 kopecks/kWh without the VAT, whereas for the budget consumers – 133,4 kopecks/kWh.

Thus, in the region there is still the tariff cross-subsidies within the power sub-sector.

Tariffs for the heat in 2007 for main suppliers is (RUB/Gcal, single rate for hot water):

- | | |
|--------------------------------|-------------------------|
| - JSC "TPP – Severnaya" | 373,59 (increase 13,7%) |
| - JSC "SGC TGC – 8" | 392,26 (increase 12,5%) |
| - Astrakhan MUP "Communenergo" | 677,64 (increase 13,3%) |

The tariffs are set the same for all users' groups without the cross-subsidies. There is lack of the combined production of heat and power that is why there is much higher tariff for the small unitary enterprise "Communenergo" and for the other heat supplying enterprises.

The Tariffs Service follows the practice of including the investment component to the sales tariff to implement the projects proposed by the energy supplying organisations. In such a case the additional funds can be envisaged as:

- Direct funds to implement the proposed project
- Funds to satisfy the loan borrowed by the enterprise to implement the project

Currently such a practice is applied only for large power (generating and network) companies. In 2007 such companies are: TGC-8 and Astrakhanenergo. The Tariffs Service considers that smaller regulating actors do not show sufficient initiative or there is no information about it.

One of the main criteria applied by the Service at the stage of approving the investment component is the tough restriction for the possible tariffs' increase.

The Service is virtually the expert organisation for the investment projects that are to be financed from the tariffs.

Currently the Service received only one programme from one of the water supplying organisations within the range of the investment programmes of the communal utilities, which are developed in accordance with the Federal law № 210. It means that such a mechanism has not been triggered yet in the region.

6. Investment policy

There is big attention is drawn to the investment activities and investments attraction in the region. The Ministry of the Economic Development and the Investment Council under the authorisation of the Governor of the Astrakhan Oblast provide the general management of the investment process and the budget for development. The Investment Council was founded in accordance with the resolution of the Governor of the Astrakhan oblast № 550 as of 21/11/2003 "About Investment Council under the Authorisation of the Governor of the Astrakhan Oblast" (with the amendment as of 20.03.2005; 21.04.2005; 21.02.2006).

The Law of the Astrakhan oblast № 30 as of 29.07.1998 "About the Investment Activities in the Astrakhan Oblast" (as in force on 07.06.2004 № 29/2004-O3) is the main legal and regulatory act of the Astrakhan oblast that regulates the investment activity. It defines the procedure and

conditions for the forming of the investment process in the territory of the Astrakhan oblast, including:

- Forming the market of investment projects
- Establishment of engineering and consulting firms to provide economic, management and information assistance to the projects development and implementation
- Providing information coverage for the investment process
- Attraction of the financial resource to implement projects

The Law defines the status of different investment projects, which can be as follows:

- Investment project approved by the Administration of the oblast (which is added to the regional projects' register after the Administration of the Astrakhan oblast develops and expertise the business-plan)
- Investment project of especial importance (the one to be implemented at the enterprises with the ownership ratio of the Astrakhan oblast and the investment volume of more than 30 000 of minimum monthly wage or if its is initiated by the Administration of Astrakhan oblast)
- Other project (initiated by the project's originators)

In dependence from the status of the project and its urgency for the regional development it can be decided to provide the state assistance to the project. Such a decision is taken on the basis of the expertise of the business-plan by the Administration of the Astrakhan oblast and if needed by the independent experts.

The following possible ways of the state assistance are regulated:

- Reduced tax rates, temporary exemption of taxes to the regional budget
- Easy loans through debenture loans of the Astrakhan oblast
- Restructuring or conversion of the debt to (or from) the budget
- Other financial favourable conditions: public contracts, plot of land and real estate to lease or to own
- Development and expertise of projects at the expense of the Government
- Assistance in getting the Customs relief
- Government guarantees issued by the oblast
- During the payback period to cease the validity of the legal tax acts, that impact the investment conditions
- Compensation to investors the missed profit or losses that are caused by illegal action or inaction of the authorised person

The Law of the Astrakhan oblast №23/2001-O3 as of 07.05.2001 "About Budget of the Balance of the Astrakhan Oblast" (as in force on 02.10.2003 № 36/2003-O3) defines the main rules and principles of investment projects financing out of the regional budget of the Astrakhan oblast.

Development budget is formed out of funds from the regional budget. Its funds can be allocated to the financing of the investment projects (if specific requirements are met) as follows:

- Financing of the share of the Administration with Charter Fund
- Financing of “investment projects of especial importance”
- Financing of the projects within the framework of the regional targeted programmes at the condition of their recoverability of not more than 50% from the total financing volume
- Financing at the condition of the projects recoverability, that are implemented through leasing arrangement
- Financing to decrease the interest rate for the attracted loans on the basis of the recoverability of not more than 0.5% refinancing rate of the Central Bank

Total volume of the allocated funds from the development budget for 2002-2004 was about 56 mln RUB with the total number of projects equal to 28. The development budget of 30 mln RUB approved for 2006.

It should be noted that the budget possibilities of the region are considerably limited and mainly depend on the gratuitous contributions (in 2006 almost up to 29% by income), whereas the budget is formed with deficit.

| Budget items, mln RUB | 2005 | | 2006 |
|--|---------------|---------------|----------------|
| | approved | implemented | |
| Tax and non-tax revenues | 5253,1 | 5412,3 | 6888,9 |
| Gratuitous contributions | 2492,5 | 2492,5 | 2872,2 |
| Revenues from commercial and other profitable type of activity | 243,0 | 348,1 | 213,0 |
| TOTAL REVENUES | 7988,6 | 8252,9 | 9974,1 |
| TOTAL COSTS | 8817,9 | 8907,4 | 11176,8 |
| Deficit (%) | 14,1 | 11,4 | 15,0 |

In 2006 the Government of the Astrakhan oblast approved the resolution № 205-П as of 22.06.2006 “About Procedure for Approval of Investment Programmes (Projects) of Development of the Organisations that Provide Regulation of Activities within the Competence of Bodies of Executive Power of Public authorities in Astrakhan Oblast”.

Such a procedure developed with the aim to put an order to the process of the approval of investment programmes (projects). Such an approval is provided within the framework of regulation (approval) of prices (tariffs) that is based on the methods of economic justification of costs economic grounds for return on investment capital and indexation of tariffs.

The resolution defines the procedure for approval of investment programmes (projects), which can be briefly described as following:

1. The organisations submit to the Tariffs Service of the Astrakhan oblast the following documents (with consideration of proposals from the local authorities about possibility to implement investment programme through the regulated tariffs):
 - Explanatory note;
 - Business-plan of the investment project;
 - List of investment projects that are part of the investment programme (project);
 - Data on the financial source of the investment programme (project);
 - Documents to confirm the demand for the asked financing (construction contracts, etc);
 - Feasibility study for the mentioned investment projects, duration of their implementation and volume of the required financing;
 - Forecast when production capacities are put into operation;
 - Financial plan of an actor for 3 year by type of activity;
 - Analytical data on the planned and real indicators of the investment programme (project) implementation during the previous and current year;
 - Accounting reports for the previous and current year signed by the management of the enterprise and marked by the tax body;
 - Other documents required confirming the data presented in the investment programme (project).
2. The Tariffs Service of the Astrakhan oblast provides the expertise of investment programmes (projects) by the following directions:
 - Impact of the investment project to the regulated prices and tariffs;
 - Conformity the change with the regulated prices and tariffs due to the investment project implementation with the marginal levels, that are set up by the Government of the Russian Federation;
 - Final conclusion whether it is possible to add implementation costs of the investment programme (project) to the regulated tariffs (prices).

And submits its conclusion to the Ministry of the Economic Development of the Astrakhan oblast with the purpose to conduct the further expertise of the investment programme (project).

3. The Ministry of the Economic Development of the Astrakhan oblast defines the list of bodies of executive power of the public authorities of the Astrakhan oblast to run the technical and economic expertise of the submitted programmes (projects).
4. The Ministry of the Economic Development of the Astrakhan oblast issues the consolidated conclusion on the basis of the results from the conducted expertise and submits it to the session of the Government of the Astrakhan oblast to approve the respective investment programme (project).

Some conclusions

1. Currently there is no state or administrative bodies or structures in the oblast that officially deal with the problems of the energy efficiency. The respective divisions used to be earlier under Gosenergonadzor and REC, however in the course of their re-organisation they were abolished.

There are ongoing talks about the need to organise the Regional Energy Efficiency Centre. The Government of the Astrakhan oblast used to take a decision and issue the respective documents in 2006 and later in 2007 agreed upon the Charter of such a centre as for the state enterprise. However currently the issue of even the initial financing (contribution to the Charter capital) has not been decided yet. There is an impression that at the level of the regional authorities the establishment and functioning of such a centre is not the priority.

2. It should be admitted that there is no any sufficient basis and potential for serious and fast changes to improve the energy efficiency and provide the systematic approach. It is needed to develop them. All a few initiatives are the enthusiasm and understanding by some of individuals only.
3. There are no legal incentives for investment to the energy efficiency. The same conditions are valid and for other investment projects. There is a possibility to finance investment projects within the energy sector (including those ones of the energy efficiency) through the tariff component. The procedure for submission such projects and their approval is defined, however in general such a possibility is very much limited.
4. The region adopted the Law "About Energy Efficiency", developed and approved the Energy Saving Programme for 2000-2005. In reality they did not show any results and there was no the systematic approach to the energy saving and energy efficiency. Even there was lack of any specific activity related to the energy saving (programmes for energy auditing, etc).

Currently there is a draft of a new law "About Energy Efficiency in the Astrakhan Oblast" at the review by the public authorities of the Astrakhan oblast. To make this law efficient it will be needed to specify its provisions and make them effective in the proper regulatory way.

5. In the region there are a few different programmes, strategies and concepts of the energy sector development that were finalised or under development. All of them are based on the fact that the region is energy deficient and there is a need to introduce new generating capacities (except of the programme "Main Directions to Reduce Losses in the Energy Sector of the Astrakhan oblast", developed by the REC). Issues related to the energy efficiency are mentioned as of the least priority.
6. On 18 May 2006 the Government of the Russian Federation reviewed the issues of the social and economic development of the Astrakhan oblast. As the result of this session some of the Federal Ministries together with the Government of the Astrakhan oblast were authorised to study the issues related to the development of the region including development of the power sub-sector and deeper conversion of hydrocarbon.

Most likely it can be considered that at the Federal level there is the understanding that the problems in the mentioned sectors exist and have to be settled. What will be the role of the Federal Ministries and the result of their involvement is not clear yet.