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Delegation of the European Commission to Russia

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

Demonstration of Energy Demand Forecast in Astrakhan Region

Draft Report

September 2007

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LIST OF ABBREVIATIONS

bos	basic oxygen steel
bbl	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 calorifc value
GHG	greenhouse gas
GJ	gigajoule, or one joule x 109 (see joule)
GJ/t	gigajoule per tonne
J	joule
kWh	killowatt/hour, or one watt x one hour x 103
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 termal 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 106
NCV	net calorific value
Nm3	normal cubic metre
NOx	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 1012
toe	tonne of oil equivalent
TPES	total primary energy supply
VOCs	volatile organic compounds

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1. Executive Summary

For the development of projection scenarios the consultant used the data of the social and economic development projection of the Oblast until 2010 made in 2007 and the "Medium- and long-term social and economic development strategy of Astrakhan Oblast" published in 2006. The latter document is based on the analysis of economic development and potential of the Oblast and considers three scenarios until 2016: "Inertia", "Restoration of the resource portfolio" (investments inflow in the oil & gas sector), and "The new resource portfolio" (investments inflow in the new competitive technologies which need highly qualified manpower). Discussion of the energy sector development perspectives with representatives of the Astrakhan Oblast Ministry of fuel and energy complex and natural resources in 2007 allowed for the verification of energy policy priorities.

This report specifies the concepts of energy production growth in the Oblast; evaluates the energy efficiency potential in addressing problems related to energy supply for the economic growth; and estimates energy demand growth perspectives and evolution of the Integrated Fuel and Energy Balance of the Oblast. Three economic and energy development scenarios were considered:

1. **"Astrakhan Inertia"** (correlates with the Inertia scenario of the social and economic development);
2. **"Oil & gas breakthrough"** (generally, correlates with the "Restoration of the resource portfolio" scenario);
3. **"Sustainable development"** (close to the "New resource portfolio" scenario).

Implementation of these scenarios requires developing an inherently consistent system of assumptions reflecting qualitative characteristics of the scenarios in the system of parameters, which are used as inputs to the "ENERGYBAL" model (exogenous variables).

Scenario runs using the "ENERGYBAL" model allowed assessing corresponding energy development parameters; to reveal limitations/constraints to growth, and to identify possible ways to alleviate (some of) these constraints.

The *"Astrakhan inertia" scenario* is based on the following main assumptions:

- ❖ Population reduces to 954 thousand people in 2020;
- ❖ Oil extraction will be growing slowly, while gas extraction will stabilize at a level close to 12 bln. m3 annually;
- ❖ Until 2010, the GRP of Astrakhan Oblast will be growing relatively dynamically, and beyond 2010, the growth rates will be slowly declining. Real residential income growth is relatively slow, hampering the commercial sector and trade development;
- ❖ The list of potential facilities to increase electricity- and heat capacity and production includes energy units at Astrakhan CHP-2 (two gas turbines with 350 MW overall capacity), GRES (a 200 MW gas turbine), the Northern CHP (a 100 MW gas turbine), new Gasprom CHP (a 125 MW gas turbine), and commissioning of three mini-CHPs of 10 MW each (tentatively in Znamensk, Narimanov, and Olya port). All these sources will be using natural gas as the basic fuel. The new sources are assumed to make maximum use of district heating cogeneration opportunities;
- ❖ The commissioning schedule is determined by the desire to improve electricity self-sufficiency of the Oblast and will not pursue any specific energy efficiency policies.

Primary energy consumption under the "Astrakhan inertia" scenario will increase from 4,679 Ttce in 2005 to 6,481 Ttce in 2020, or by 35%. Electricity consumption will increase to 8,4 bln. kWh. Energy intensity of the GRP declines by 43% in 2005-2020, and electricity intensity by 16%.

Electricity self-sufficiency of the Oblast will be practically achieved by 2016 through the commissioning of the following capacities: in 2011, Gasprom CHP (200 MW), in 2014, a new block of cogeneration plant at GRES (125 MW), and in 2020, a new block of cogeneration plant at TETs-2 (100 MW). Besides, in 2011-2013, three mini-cogeneration plants will be commissioned annually (10 MW each). This will increase natural gas consumption. The growth of residential gas consumption is determined by ongoing gasification and new housing stock with decentralized heat supply;

The growth of heat generation by new cogeneration plants leads to reduced gas consumption by heat-only boiler-houses. District heat generation in this scenario will decrease due to the growing decentralization of heat supply and improved energy efficiency of new buildings.

However, the electricity self-sufficiency policy in the "Astrakhan inertia" scenario may face difficulties because of the considerable investment demand for the construction of new and capacity increase of existing cogeneration plants.

The Gasprom cogeneration plant and the mini-cogeneration plants will face problems related to the supply of excess electricity to the grid; these problems need to be addressed;

To make cogeneration plants economically attractive, it is important to ensure high heat loads; otherwise payback periods may exceed 15 years, and investors may lose interest. Residential heat load alone cannot address this problem;

Without electricity distribution network renovation programs it will be impossible to ensure uninterrupted electricity supply (especially high-voltage supply) and reduce the high distribution losses.

The main assumptions in the *"Oil & gas breakthrough" scenario* are:

- World oil and gas prices keep high enough, so the investment attractiveness of the scheduled oil & gas projects is not lost. By 2020, extraction of oil and gas condensate will increase to 14 mln. tons, and gas extraction to 20 bln. m3;
- Growing revenues (including budget revenues) from the oil & gas sector promote accelerated development of other sectors, and GRP growth rates increase. Industry, construction, ship building, agriculture, and transport continuously develop;
- Economic development of the Oblast until 2010 will be similar to that in the Astrakhan inertia scenario. After 2011, the GRP will increase by 10% on average annually;
- Growing residential incomes and improving living conditions in the Oblast will allow for an effective migration policy, provide manpower for the economic growth, and stabilize population at 990 thousand people after 2010;
- The Oblast succeeds in attracting investment in the electricity sector and commissioning of new electric capacities to improve electricity self-sufficiency, renovate and expand the electricity network.

Primary energy consumption under the "Oil & gas breakthrough" scenario in the Oblast will increase from 4,679 Ttce in 2005 to 8,084 Ttce in 2020, and electricity consumption increases to 11.3 bln. kWh, which is 3 times higher, than the 2005 level.

Energy intensity of the GRP in 2020 declines by 53%, and electricity intensity by 22%. Complete electricity self-sufficiency of the Oblast is achieved by 2016, but then, as electricity consumption grows, scheduled capacity commissioning is not sufficient, and it declines to 83%.

20 bln. m3 of gas will be extracted in this scenario, while local consumption in the oblast reaches 5.7 bln. m3.

Heat generation will increase by 24% in 2005-2020 due to heat recovery and heat generation by new cogeneration plants.

The main risks associated with the "Oil & gas breakthrough" scenario:

- Inability to leverage sufficient investment in the energy construction and electricity transmission/distribution network renovation and development;
- The risk of delays in new energy facilities construction;
- Significant growth of energy construction costs and natural gas prices may lead to:
  - Low affordability of electricity tariffs for many consumers; and
  - Electricity sector unattractiveness for private investors;
- Without energy efficiency efforts down the whole energy supply chain, these risks may become a factor considerably hampering economic development.

The *"Sustainable development" scenario* is based on all the conditions of the "Oil & gas breakthrough" scenario except that it is assumed that energy efficiency will become a critical component of the Oblast's energy policy, and the Oblast administration will implement the following programs:

- Energy efficiency in the industrial sector;
- Energy efficiency in the electricity- and heat supply systems;
- Energy intensity reduction in residential buildings;
- Electricity- and heat distribution losses reduction.

Primary energy consumption under the "Sustainable development" scenario in the Oblast increases from 4,679 Ttce in 2005 to 7,494 Ttce in 2020, and electricity consumption increases to 8.8 bln. kWh in 2020.

Aggressive energy efficiency policies result in 590 Ttce of energy savings. District heat generation in this scenario only increases by 7% in 2020.

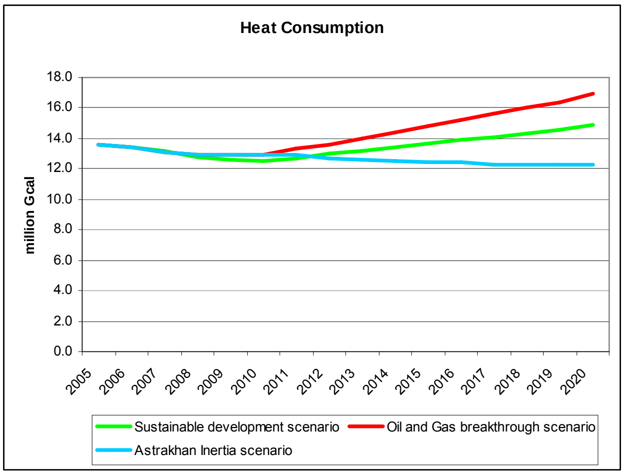
Commissioning of new electric capacities as scheduled in the "Astrakhan inertia" scenario will lead to complete electricity self-sufficiency of the Oblast with the same economic growth parameters as in the "Oil & gas breakthrough" scenario.

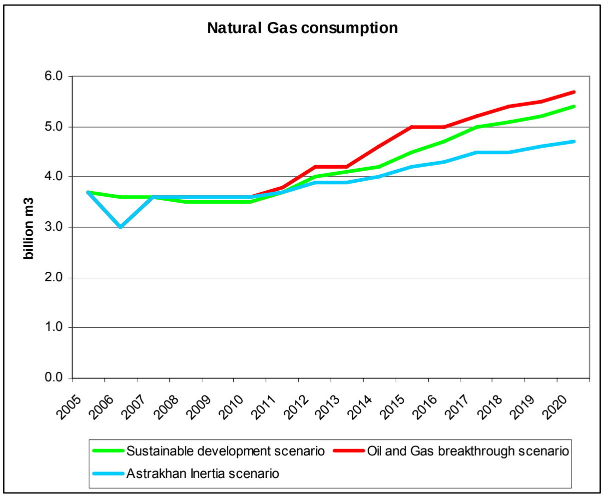
Gas consumption only increases to 5.4 bln. m3 due to the new power plants (CHP) and more efficient industrial and residential consumption.

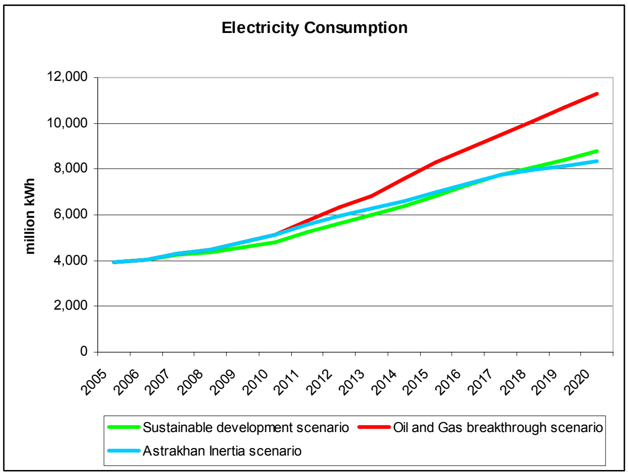
The major problem in this scenario is related to the considerable efforts needed to design and implement aggressive energy efficiency policies;

One of the positive effects of strong energy efficiency policies is that the commissioning of new plants is significantly delayed: before 2015, only 430 MW need to be commissioned (versus 780 MW in the "Oil & gas breakthrough scenario). New electricity capacity demand until 2020 goes decreases by 100 MW. This will bring the possibilities of attracting investments more in line with the investment demand.

The following charts show at a glance the development of heat, natural gas and electricity consumption in the three scenarios.







Conclusions

- Using a computerized model for energy demand forecasting is an effective “planning tool” to improve macro-economic and energy policy because it allows for a thorough check on internal consistency of economic and energy policy and good insight in the policy-related driving forces, constraints and risk factors.
- Introducing strong energy efficiency programs is a “no-regret” strategy. Under all circumstance it will contribute to alleviating possible limitations/constraints of an economic policy as well as mitigate risks due to uncertainty.

Recommendations

- It is recommended to assign specific responsibility in the regional administration for integrated economic and energy planning in terms of
  - Collecting and analyzing data and developing annually integrated fuel and energy balances and
  - Updating and testing of economic and energy policy scenarios.
- Further testing of existing economic and energy policies for inconsistencies using the computerized demand forecast model will improve the quality of decision making.
- It is necessary to build upon the current experience in building consistent and realistic regional development scenarios using a computerized model.

- The model that has been transferred to the regional administration's staff should be further developed, in particular the model's macro-economic and energy modules to fit the region's needs and its underlying assumptions.
- It is especially important to develop further the energy pricing module due to the wide-ranging consequences of changing energy prices for economic and energy policy decisions.
- There is a strong need from a strategic as well as economic point of view to develop and implement energy efficiency programs in the public sector (heat and electricity supply and distribution, schools, hospitals etc.) and to create conditions for the private sectors allowing for accelerated energy efficiency improvements.

1. Introduction

One of the tasks under the current EuropeAid project on “Energy Efficiency at the regional level in Astrakhan, Arkhangelsk and Kaliningrad regions” consisted of developing a regional integrated fuel and energy balances in the three regions. The results were presented in a project report on the Astrakhan regional energy balance. The consultant continued with the development of an energy demand forecast for the period 2007-2020 as a demonstration of this planning tool for policy makers. It was based on the notions of transferring knowledge through frequent discussions/workshops with oblast staff and training of several experts on the use of the computer model with the aim of making recommendations to increase the planning capability in the regional administration.

This report contains the results obtained for the Astrakhan region.

1.1 Approach

This paper considers economic and energy development scenarios for Astrakhan Oblast until 2020. Energy projecting in the Oblast already has some history behind. In 2000, the Oblast Administration adopted the “Electricity sector development concept for Astrakhan Oblast for 2001-2005 and until 2010”, and on July 23, 2004, the “Energy strategy of Astrakhan Oblast development until 2020 in connection with the fuel and energy sector development, gas supply system and gasification of the region”. The “Strategy” provides an energy consumption projection until 2020, evaluates energy efficiency opportunities, and identifies strategic energy policies and energy project priorities. However, the bottleneck of the “Strategy” is the energy demand projection. Both the “Concept” and the “Strategy” considerably overestimated electricity and heat demand for 2005. Discussion of the energy sector development perspectives with representatives of the Astrakhan Oblast Ministry of fuel and energy complex and natural resources in 2007 allowed for the verification of energy policy priorities.

For the development of projection scenarios the consultant used the data of the social and economic development projection of the Oblast until 2010 made in 2007 and the “Medium- and long-term social and economic development strategy of Astrakhan Oblast” published in 2006. The latter document is based on the analysis of economic development and potential of the Oblast and considers three scenarios until 2016: “Inertia”, “Restoration of the resource portfolio” (investments inflow in the oil & gas sector), and “The new resource portfolio” (investments inflow in the new competitive technologies which need highly qualified manpower).

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Scenario runs using the “ENERGYBAL” model allowed it to assess corresponding energy development parameters; to reveal limitations, or “limits of growth”, related to the mismatch of future economic and energy development; and to identify possible ways beyond the “limits of growth”.

1.2 Organisation of the report

The second chapter deals with general background information on the region's economy and energy supply sector. Electricity and heat supply in the region, including different supply options are briefly presented and it concludes with different options for energy efficiency. Chapter three introduces the region's economic development strategy, which is analysed and used for th development of the concepts and scenarios for the region as well as the results of the scenario runs.

Chapter 4 presents the conclusions and recommendations. Tables showing the main input data can be found in the annexes.

Disclaimer:

In no way, this report and its findings, conclusions and interpretations reflect the official oblast government policy or opinions of administration officials. They are solely the consultant's responsibility.

2 General economic and energy background

2.1 Regional economic situation

Astrakhan region is a part of the Southern Federal Okrug (territory). It is situated in the Caspian plain where the Volga flows to the Caspian sea at the interface of Europe and Asia. The Volga provides outlet to the basins of Azov, Black and Caspian seas. The region has a well developed transportation infrastructure and pipeline transportation. The central city of Astrakhanskaya oblast is Astrakhan, which is situated at a distance of 1534 км from Moscow. The area of oblast is 44,1 thousand km² or 0,3% of the total area of Russian Federation. The population is around 1 million inhabitants.

The territory is rich in the following resources: oil (at the depth of 6 thousand m), which is not smaller than the famous Tyumen field; the world largest gas-condensate field; sedimentary salt deposit of the lake Baskunchak; and limestone, marl, mortar sand.

The region is industrial and agrarian. Fuel industry is the leading industrial branch, which forms 43% of all industrial products, and food industry, the share of which is 22%. Basic branch of food industry is fishing and fish products. It is Russia's number one sturgeon farming area. The role of the complex of fish industries in the structure of commodity output is significant and amounts to almost 20%.

Another important economic branche is the salt industry, which comes first in Russia. The salt mines at the lake Baskunchak meet ¼ of total demand for high grade salt. Akhtubinsk is the largest salt port. Astrakhan is also a terminal for timber cargo, which determined the development of woodworking industry.

Agriculture plays an important role in the economy of the region. 64,2% of the land is suitable for farming. Plant cultivation is based on unique agro-climatic resources of the lower part of Volga. In the total yield of rice the region is second after Krasnodar Kray.

The petrochemical industry is very developed in Astrakhan. This is connected with the operation of gas-condensate field in the region of Aksaraysk. The reserves of industrial gas amount to about 95% of the reserves in near-Volga region. The reserves of Astrakhan gas-condensate field are estimated to be over 7,2 billion m3. Only 2% has been worked out by now. The resources of gas fields are condensate-and-ethanol-containing and are suitable for processing. Due to the presence of hydrogen sulfide gas should be treated prior to supplying to the transportation pipeline. Gas production has increased more than three times since the beginning of 90-s and is completely covering the demand of the region.

Oil reserves are estimated to be in the range of 56,3 million tons. The production of oil stock (mainly condensate) 65% of which is being processed at the Astrakhan gas-chemical complex has also increased three times for the last few years. The output of gas-chemical complex meets the demand for oil refining products in full. The surplus of oil stock (about 1,1 million tons), 2,3 billion m^3 of gas and 1165 thousand tons of petroleum products are exported to other regions of RF.

Basically, pollution of the environment in Astrakhan oblast is connected with emissions to atmosphere caused by gas industry. Besides, there are oil and gas pipelines laid along the territory of the oblast. And above all, there are oil tank farms in the port of Astrakhan (in the delta of Volga), which is used by oil tankers in their way from Middle Asia and Iran. Several areas of underground pollution have been identified in the oblast, the largest being in the territory of the Astrakhan gas-chemical complex.

Future developments of the fuel industry and energy sector of Astrakhan oblast are connected with:

- ❖ deeper processing of the produced hydrocarbon resources;

- improving efficiency of fuel and energy consumption;
- need for reconstructing and upgrading of existing Heat Power Plants by means of replacing the withdrawing capacities by combined Gas and Steam turbine units or Gas turbine units;
- reconstructing and improving the technical condition of power grids

2.2 Energy consumption patterns

The total primary energy consumption and final energy consumption are shown in the following two charts.

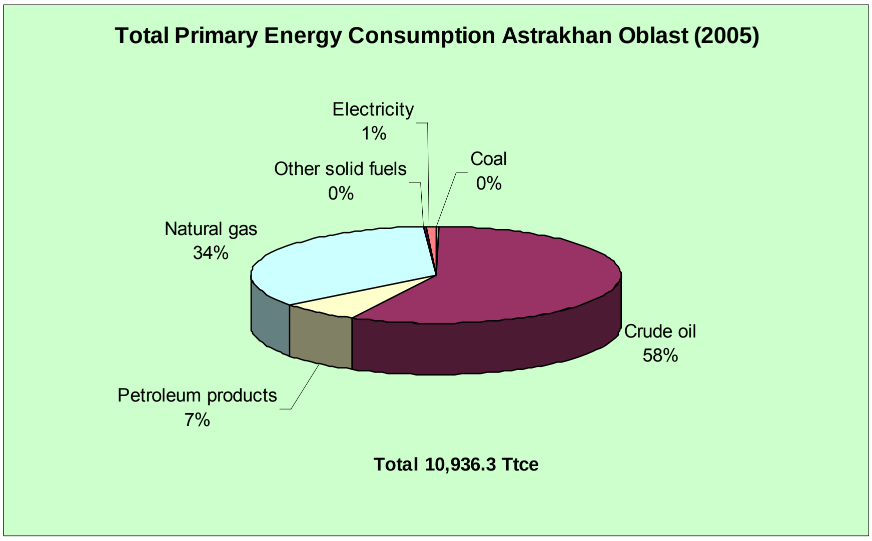


Fig. 2.1 Total Primary Energy Consumption Astrakhan Oblast, 2005 (Ttce)

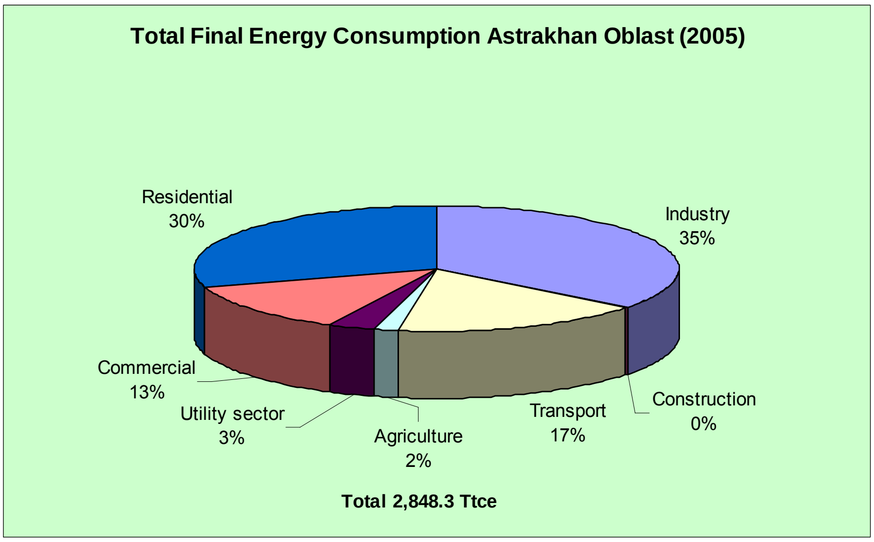


Fig. 2.2 Total Final Energy Consumption Astrakhan Oblast, 2005 (Ttce)

2.3 Energy sector in Astrakhan

Power Supply and Demand

The Astrakhan region purchases 30% of its power needs from the wholesale market FOREM due to its lack of generation capacity (around 30%). Because of aging generation assets this deficit is likely to increase.

The total installed capacity of the region is 504 MW, of which “Astrakhan Generation” (recently privatised and part of the territorial generation company (TGC) number 8) takes 480 MW and other stations 24 MW.

The table below give an overview of energy assets data:

Site	Number of turbines	Number of steam boilers	Number of heating boiler	Installed capacity MW	Installed heat capacity MW
Astrakhanskaya GRES	4	4	-	100	244
Astrakhanskaya TETS-2	4	4	2	380	910
Boilerhouse "Zentralnaya" (District heating)	-	5	3	-	375
Municipal Company «District heating», city Astrakhan (rented equipment and network)					681
Total	8	13	5	480	2210

Heat supply

The lagest heat producer is TGC-8 (Astrakhan generation). The share of Astrakhan generation on the local heat market amounts to 60%.

Heat generated by municipal district heating enterprise „Teplovye sety“ of Trusovsky district and JSC TETS „Severnay“ of city Astrakhan amounts to around 20%. The largest industry companies have their own heat production capacity, which, however, do not participate in the district heating.

2.4 Energy sector development

New power generation is mainly based on gas turbines in a combined cycle that could be operated for combined heat and power production or only for power production when the heat load is low (CHP, GTCC). These new plants can have an overall efficiency around 90% and with a power generation efficiency around 55-60%. District heating is an important part of this strategy and will also give an energy efficient and cost effective system. It is also assumed that the district heating will be developed and increased with the general heat demand.

The main strategy is based on an ensemble of power and heat demand in district heating networks that reduces the overall gas demand. The overall system efficiency will decrease if the district heat demand is low compared with the power demand.

Peak power demand

Power demand, due to electric heating must be avoided, to reduce both peak power generation and investments in power grid capacity and low voltage distribution systems.

In the long term increasing comfort cooling with electrical chillers can lead to the same situation especially in the low voltage distribution systems during summers as we now experience with electrical heaters during wintertime. With district cooling in the central parts of Astrakhan some of this can be avoided. Large scale production of cooling can be done with geothermal storage or with absorption cooler units, with only a small amount of electricity. The latter also increase the heat load during summer time (i.e. excess heat from power production is used instead of electricity).

Electricity losses in low voltage grid

The very high losses in the low voltage grid depend of lack of capacity during wintertime due to increased electric heating when it's cold. This can be met with a 100 % availability within the district heating systems and with a 100 % capacity. Increased maintenance to get a reliable district heating have therefore a higher priority than investments in low voltage grid capacity. Where the former also increases the overall efficiency (and profit) for the energy systems.

The remaining (real) losses in the low voltage grid are about 10 % which still is high and needs to be taken care of, but they're not critical for the overall system performance.

District heating

It is of utterly importance that the district heating can give a full comfort to all consumers all a year round and with the same reliability as a local gas or electrical distribution system. District heating is currently unreliable for the consumers due to lack of capacity, low availability and because it is shut off too early and put on to late during the heating season.

To reach this objective the operational strategy ought to be based on the following technical demands or guidelines:

- The system capacity should be large enough to secure heating even during the coldest winter day and the system should be able to deliver heat whenever needed so that the indoor temperature always can be kept at 21°C. The system should also be able to deliver hot water during the summertime
- New systems should be designed so it is possible to control the temperature individually within each apartment.
- When having efficient gas combined cycle plant for power production, they will be in operation during the whole year. It is therefore always interesting to deliver heat to increase the profitability even during colder days during late spring and early autumn. This means also that even a small load during the summertime for hot water production could be of interest since it is usually the best way of using the excess heat from the power plants.
- Using gas for heating instead of using the 'waste heat' from power production gives a loss of system efficiency. Using electricity for heating doubles that inefficiency, since production of one part electricity needs two to three parts of gas. Use of heat-pumps (or 'reversible' comfort coolers) levels out this relation one to one in the best cases. (That means that an expensive heat pump is just as "system efficient" as a common gas-heater/boiler)
- Energy conservation in district heating network, such as better insulation in piping, is of less importance in the short term since the primary problem is lack of availability. The heat can also be considered as "waste" from power production. In long term is efficient piping of course very important.

Demand side

Energy conservation is of high importance, especially for electricity in the short term.

Energy conservation should aim at high efficiency in all new projects (buildings as well as industrial plants). Energy requirements ought to be set up concerning all new buildings (envelope and technical installations) as well as household appliances, regarding use of heat, cooling and electricity.

Introduce "Energy label" with classification for white goods, light-bulbs, windows, etc. (see http://en.wikipedia.org/wiki/European_Union_energy_label) and public awareness campaigns (including schools) for electricity savings.

Best practice for enterprises concerning "low dangling fruits", i.e. technically easy and straight forward activities, with a good economic benefit. Typical activities concerns lighting, ventilation and pumping systems, electrical motors, stand-by-losses, time of operation (i.e. rebuild system so it will be possible to switch off equipments at end of day by hand or with timers).

Energy losses in distribution systems

The high energy losses within the heat and electrical distribution systems are a part of the energy demand. It is therefore necessary that all extensions and rehabilitation of existing systems will be performed with distribution lines of best quality that will result in low energy losses and a long life time for all new piping and cables.

Electricity and heat system expansion

Power supply options

New power generation should be combined heat and power plants based on natural gas fired combined cycle units, which have a power efficiency of 50 % or better and overall efficiency of 85 % or better.

Old units should not be retrofitted with less efficiency. Keep them as long as they are profitable and then either decommission or rebuild them completely to meet the requirements above.

If coal prices will be significant lower than gas prices it could be profitable to import coal on Volga. However, the investments in harbour terminals and new power plants (close to the terminal) will be vast and this is not likely within the timeframe of the scenarios

Transport on Volga also opens for import of bio-fuels from other regions. This could of course be interesting if the renewable fuel price is significant lower than the price for natural gas, oil or coal. As mentioned above, this is not likely in the short term, but should be considered in long term strategy.

As a complement for power production, consider installation of 'mini-CHPs',_based on gas turbines, where the heat demand is larger than 25-30 Gcal/year, which equals an electrical output of 4-5 MW or more.

Windmills (2-5 MW each) in good windy positions integrate well in power grids with a high share of fast controlled production units, such as gas turbines. Wind mills could therefore be a perfect renewable compliment in the Astrakhan Oblasts power system. The investment cost is in the same range as for a corresponding gas turbine.

Installation of one to three windmills for demonstration and learning purpose can be considered as soon as main power production is secured.

Larger wind farms or off-shore farms can be considered in the long term strategy.

Heat supply options

District heating is the key to an efficient energy system in Astrakhan Oblast. Larger district heating system should be supplied by gas fired CHP plants and medium sized systems should be supplied with heat by mini-CHPs.

Small systems can be supplied with gas fired boilers or whenever possible from bio waste incineration (see bio fuels below).

For individual heating, when district heating is not an option, gas fired boilers should be put in place. If there is no gas network either, oil is the second possible option. Heat pumps and electric heating should be avoided.

Bio-fuels from agriculture residues can be used in boiler-houses and in larger building level boilers. This could be a local solution for both heat and waste treatment.

Wood pellets and other standardized bio fuels can be an option in the long term strategy, but that will require new infrastructure (harbour terminals) as well as new boilers, fuel storage, etc.

Energy saving measures

The potential for energy savings is big and is possible in all part of the energy system. Possible measures mainly consist of the following actions:

- Investment in new high efficient energy production plants
- Installing of new distribution lines for heat and electricity with low energy losses
- Improved energy management within all areas to secure that the energy consumption correspond the actual true energy demand.
- Improved operation and control of the energy systems both on the distribution and demand side (households, commercial buildings and industries).
- Improved building envelopes for all new or refurbished buildings
- Installations of high energy efficient technical systems and appliances

Cooling supply options

Large scale production of cooling can be done with geothermal seasonal storage or by absorption cooling where only a small amount of electricity is needed. The latter increases the heat demand during summer time (i.e. excess heat from power production can be used for cooling instead of peak load electricity which will give a double effect since the excess heat is recovered at the same time as the power consumption is reduced).

Recommendations

There is a deficit in power production, therefore the main objective is to invest in new power plants. These power plants shall be based on best available technique, based on gas combined cycle plants with a power production efficiency above 50%. These plants can also produce heat which could be considered as excess or waste heat and that is why it is of extreme importance to use this heat in best possible manner.

The strategy should therefore in short term be based on the following considerations:

- Install large gas combined cycle plants for the base load for the power production and large industries as well as mini CHPs ($\geq$ 4-5 MW_e) within medium sized district heating systems when possible;
- Update existing district heating systems to obtain a 100 % availability and capacity (i.e. truly reliable for the consumers) is necessary, including
    - Produce hot tap water entirely with district heating whenever possible;
    - Introduce a new operation strategy for the district heating system all a year round;
    - Introduction of a strategy for reduction of both supply and return temperatures within the district heating network in order to increase the power production yield;
    - Avoid using natural gas and heat pumps within district heating areas;
    - Expand district heating systems wherever possible;

- Establish a continuous programme for energy conservation, especially for electricity;
- Establish a new energy strategy for new buildings including requirements concerning the design of all new buildings (envelope and technical installations) as well as household appliances, regarding use of heat, cooling and electricity.

In addition, for the medium and long term strategy, the introduction of new windmills can be considered as well as the introduction of district cooling systems based on geothermal seasonal energy storage or absorption cooling driven by excess heat. The installations could be a combination of small and large scale systems. This district cooling will replace electrical chillers why the electricity demand can be reduced substantially during the summertime. In the long term, introduction of solar energy when cost effective could be considered.

3 Development scenarios for Astrakhan Oblast

This chapter contains three different scenarios for a possible future development of Astrakhan region. The following sections will set out the scenario concepts and assumptions and the basic input data into the model (ENERGYBAL) used to generate the energy demand over the forecasting period.

3.1 The "Astrakhan Inertia" scenario

3.1.1 SCENARIO CONDITIONS

This scenario is based on the social and economic projection made by Astrakhan Oblast administration (Form 2p "Basic parameters to be provided for the development of the RF social and economic development projection until 2010") and on the qualitative description of the Inertia scenario of the Oblast's development presented in the "Medium- and long-term social and economic development strategy of Astrakhan Oblast".

This scenario builds on the following Oblast's development assumptions:

- ❖ Population reduces to 954 thousand people in 2020;
- ❖ The oil & gas sector will keep being the basis of the Oblast's economy, but oil extraction will be growing slowly, while gas extraction will stabilize at a level close to 12 bln. m3 annually;
- ❖ Until 2010, the GRP of Astrakhan Oblast will be growing relatively dynamically[1], and beyond 2010, the growth rates will be slowly declining, because, according to the Inertia scenario of the "Social and economic development strategy of Astrakhan Oblast", no new "points of growth" capable of pushing the economic growth will emerge;
- ❖ Real residential incomes increase is relatively slow, hampering the commercial sector and trade development;
- ❖ Electricity- and heat generation by new and expanded old sources may start in 2009 (according to the Oblast administration) or in 2011 (according to the projection by the consultant). The list of potential facilities to increase electricity- and heat capacity and production includes energy blocks at cogeneration plant-2 (two gas turbines with 350 MW overall capacity), GRES (a 200 MW gas turbine), the Northern cogeneration plant (a 100 MW gas turbine), cogeneration plant of Gasprom (a 125 MW gas turbine), and three mini-cogeneration plants of 10 MW each (tentatively in Znamensk, Narimanov, and Olya port). All these sources will be using natural gas as the basic fuel;
- ❖ The new sources will make maximum use of district heating cogeneration opportunities;
- ❖ The commissioning schedule is determined by the desire to improve electricity self-sufficiency of the Oblast; there is no goal of launching electricity export to other oblasts;

[1] According to the projection by Astrakhan Oblast Ministry of economic development, the GRP of the Oblast will grow by 7.2% in 2007 and by 7.7% in 2008. Then the growth rates will increase to 17.9% in 2009 and 17% in 2010. However, this is a projection mistake determined by the overestimation of added value dynamics in natural resources extraction (1.3-fold in 2009 and by 43% in 2010 respectively) with the same oil and gas extraction levels. This just cannot be. In accordance with the "Social and economic development strategy of Astrakhan Oblast", after 2011 GDP annual growth rates can be 0.2% maximum. They must be lower in the inertial scenario, so an assumption was made that annual GDP growth rate will keep at 7% in 2009-2010 and gradually reduce thereafter by 0.2% per year until 2020.

- ❖ The situation with energy efficiency improvements and energy conservation measures is only determined by consumers' reaction to growing energy prices and by autonomous energy efficiency technical progress, as obsolete equipment is replaced. This scenario does not assume active renovation of fixed assets[2] or large-scale application of new equipment and technologies.

Therefore, energy efficiency improvements and energy conservation are determined by: (a) consumers' reaction to growing energy, primarily natural gas, prices, and (b) autonomous technical progress, i.e. renovation of production facilities and equipment and residential appliances. It is assumed, that in all end-use consumption sectors autonomous technical progress will lead to 1% annual energy intensity reduction, and new residential buildings will be 30% more energy efficient per 1 m2, than existing housing stock.

Projections of electricity tariff and price indexes for various sectors (construction, trade, transport, etc.) until 2010 were taken from the projection made by the Oblast administration, and after 2010 these were assessed by the authors with an account of national inflation rate reduction projections for this period. Electricity price for the industrial and other sectors in 2006-2010 will increase by 59% to approximately 1.94 rubles/kWh, or 7.5 cents/kWh, and for the residential sector by 74% to 2.35 rubles/kWh, or 9 cents/kWh.

Until 2010, natural gas price growth projection correlates to the projected by the RF Ministry of economic development and trade domestic price growth[3]. Therefore, the price of natural gas for the industrial consumers (including transportation and trade markups) in 2010 will 2.3-fold exceed the 2006 level and with the current ruble/USD exchange rate will equal 130 USD/thou.m3. After 2010, the gas price will show 7% annual growth. Natural gas price hikes will lead to 57% heat tariffs growth for industrial consumers and 90% growth for residential consumers. Price growth for residual oil, gasoline, and diesel fuel, which are the types of fuel potentially capable of replacing natural gas, will be quite high. This growth is taken at 7% per year.

Gas extraction will increase to 12 bln. m3 and then stabilize, same as sulphur production, which will keep at around 4.8 mln. t until 2020. Oil and gas condensate extraction will increase to 5.3 mln. t in 2010 and to 7.1 mln. t in 2020. Production of petroleum products will increase to 2.7 mln. t in 2010 and to 4.2 mln. t in 2020.

Housing commissioning will increase to 1,000 thou. m2 in 2010, and then will show 5% annual growth. The number of health care and educational institutions and kindergartens will keep at the 2006 level (old, dilapidated facilities will be replaced with new ones, and as the population drops, saturation with these institutions grows). Passenger turnover will be annually growing by 4% on average, and cargo turnover will be growing at the same rate as GDP with the increase of transport corridors load.

In more detail quantitative assumptions of the "Astrakhan Inertia" scenario are shown in Tables A.3-A.6 in Annex 2.

3.1.2 ENERGY SECTOR DEVELOPMENT UNDER THE "ASTRAKHAN INERTIA" SCENARIO

Integrated Fuel and Energy Balance

Under the assumptions of this scenario, primary energy consumption in the Oblast will increase from 4,679 Ttce in 2005 to 6,481 Ttce in 2020, or by 38.5% (see Fig. 3.1 and Table 3.1). Natural gas and petroleum products (primarily in transport) dominate in the energy balance, and this situation is preserved until 2020. Net electricity import is gradually going down to zero, as own generation sources are being built.

[2] Fixed assets depreciation is 55%.
[3] It is very likely that the federal Government will stick to the price growth plans, because it is a binding condition for Russia to join the WTO.

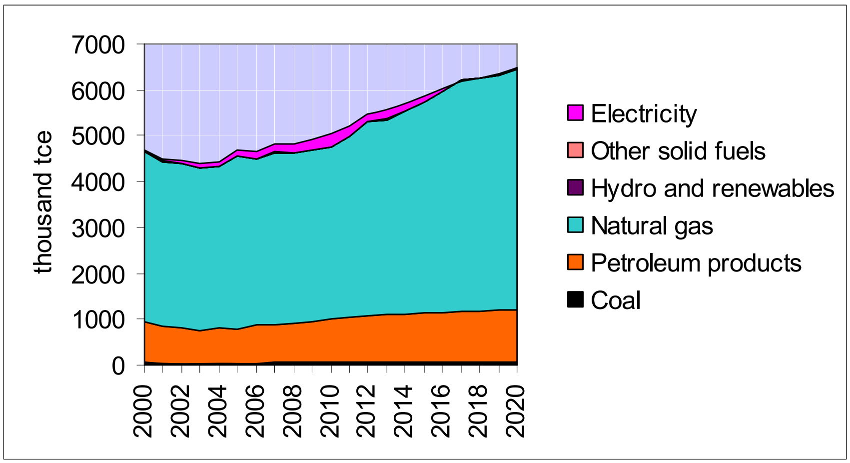


Fig. 3.1 Primary energy consumption in the «Astrakhan Inertia» scenario

Table 3.1 Integrated Fuel and Energy Balance in 2020 under the « Astrakhan Inertia » scenario (Ttce)

	Coal	Crude oil	Petroleum products	Natural gas	Hydro/Renewables	Other solid fuels	Power	Heat	Total
Production		**1,0179.4**		**14051.4**	**0.0**	**28.1**			**24,258.9**
Import	60.0		0.0	0.0			17.8		77.8
Export		0	3,072	-8,794			0		-5,721
Stock changes									0
Primary energy consumption	**60**	**0**	**1,140**	**5,258**	**0.1**	**4**	**18**	**0**	**6,479**
Statistical discrepancies									
Power plants	0.0	0.0	-13.7	-2,535.5	-0.1	0.0	1,010.8	512.7	-1,025.7
Electricity generation	0.0	0.0	-12.5	-1,907.8	-0.1	0.0	1,010.8		-909.5
Existing plants	0.0	0.0	-12.5	-742.7	-0.1	0.0	278.9		-476.3
New plants	0.0	0.0	0.0	-1,165.1	0.0	0.0	731.9	0.0	-433.2
Heat generation	-0.6	0.0	-48.2	-759.0	0.0	0.0	0.0	1,857.5	1,049.7
Existing plants	0.0	0.0	-1.2	-354.8	0.0	0.0	0.0	260.9	-44.9
New plants	0.0	0.0	0.0	-272.9	0.0	0.0	0.0	251.7	-21.1
Boiler-houses	-0.6	0.0	-47.0	-131.3	0.0	0.0	0.0	159.8	-19.1
Industrial	-0.5	0.0	-32.5	-87.9	0.0	0.0	0.0	108.8	-12.1
Municipal	-0.1	0.0	-14.6	-43.4	0.0	0.0	0.0	51.0	-7.1
Agricultural								1,185.0	1,185.0
Own needs				-196.9			-96.8		-293.8
Distribution losses				-17.3			-200.6	-103.7	-321.6
Final Energy Consumption	**59.5**	**0.0**	**1,079.3**	**2,376.8**	**0.0**	**3.5**	**731.2**	**1,753.8**	**6,004.1**

Table 3.2 Integrated Fuel and Energy Balance – Final Energy Consumption by sector (Ttce)

	Coal	Crude oil	Petroleum products	Natural gas	Hydro/Renewables	Other solid fuels	Power	Heat	Total
Final Energy Consumption	**59.5**	**0.0**	**1,079.3**	**2,376.8**	**0.0**	**3.5**	**731.2**	**1,753.8**	**6,004.1**
Industry	23.9	0.0	10.4	1,248.5	0.0	0.2	318.1	1,176.9	2,778.1
Oil and gas extraction	0.0		0.0	6.8		0.0	3.2	0.4	10.4
Oil refining	0.0	0.0	0.0	556.3	0.0	0.0	38.7	92.5	687.6
Gas refining	0.0		0.0	368.8		0.0	97.9	624.5	1,091.2
Sulphur	0.0		0.0	141.1		0.0	57.1	166.2	364.5
Water abstraction and industry supply	0.0		0.0	2.7		0.0	1.0	0.1	3.8
Bread and bakery products	0.0	0.0	0.0	0.0	0.0	0.0	12.3	0.0	12.3
Other	23.9		10.4	172.9		0.2	107.9	293.2	608.5
Construction	0.0		48.4	0.0		0.0	30.6	0.8	79.9
Transport	0.0	0.0	852.1	0.3	0.0	0.0	50.4	51.9	954.7
Aviation	0.0		23.1	0.0		0.0	0.0	0.0	23.1
Automobile	0.0		356.3	0.3		0.0	0.0	0.0	356.6
Railway	0.0		442.3	0.0		0.0	6.6	51.9	500.8
Water	0.0		30.4	0.0		0.0	0.0	0.0	30.4
Urban electric	0.0		0.0	0.0		0.0	1.0	0.0	1.0
Other transport	0.0		0.0	0.0		0.0	42.8	0.0	42.8
Agriculture	0.0		26.4	0.7		0.0	37.0	1.0	65.1
Municipal services sector	0.3		15.8	0.7		2.0	9.6	40.8	69.2
Commercial	9.9		106.4	194.4		0.0	115.5	120.9	547.1
Residential	25.3		19.9	932.1		1.3	170.0	361.4	1,510.0

Source: Consultant's estimates

Electricity balance

As shown in Fig. 3.2, electricity self-sufficiency of the Oblast is practically achieved by 2016 due to the commissioning of the following capacities: in 2011, cogeneration plant of Gasprom (200 MW); in 2014, a new block of cogeneration plant at GRES (125 MW); and in 2020, a new block of cogeneration plant at TETs-2 (100 MW). Besides, in 2011-2013, a mini-cogeneration plant will be commissioned annually (10 MW each). There will be no need for a new block at the Northern cogeneration plant (100 MW) until 2020.

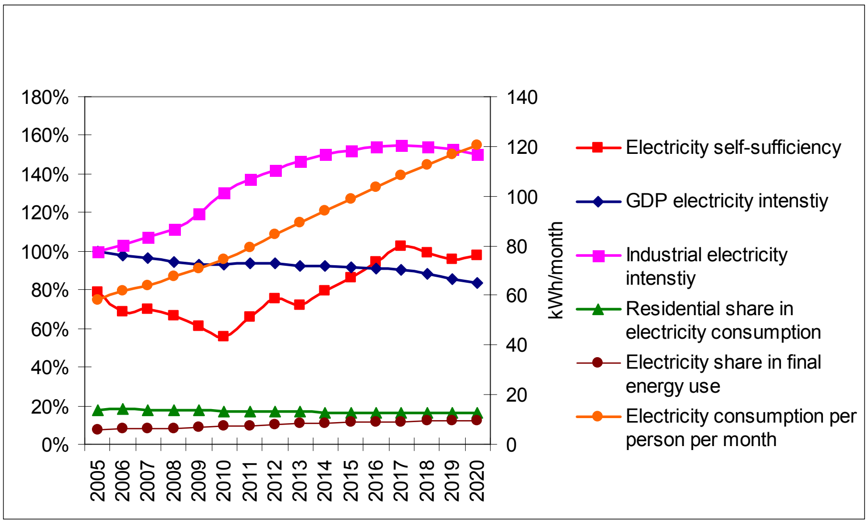


Fig. 3.2 Electricity indicators in the «Astrakhan Inertia» scenario

Electricity intensity of the GRP in 2005-2020 will go down by 16%, while industrial electricity intensity will be growing due to faster growth of electricity intense sectors. Residential electricity consumption will be growing dynamically, requiring renovation and development of low-voltage transmission lines. Nevertheless, the share of the residential sector in the overall electricity consumption will somewhat decline (see Fig. 3.3).

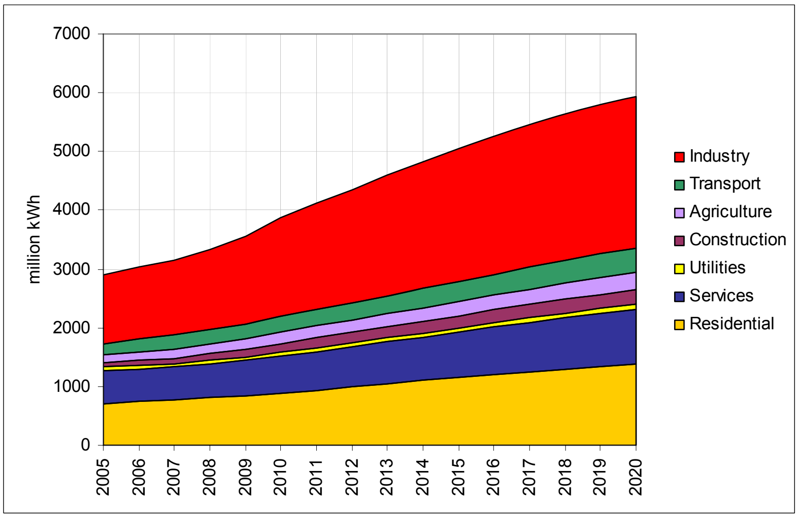


Fig. 3.3 Electricity end-use in the «Astrakhan Inertia» scenario

Table 3.3. Electricity balance by the «Astrakhan Inertia» scenario (mln. kWh)

Year	Production	New plants	Existing plants	Net Import	Consumption	Growth rates	Own needs	Supply to the grid	Transmission losses	Useful supply
2005	3,101	0	3,101	836	3,936	3.2%	299	3,637	766	2,871
2006	2,777	0	2,777	1,283	4,060	3.1%	281	3,778	736	3,043
2007	3,012	0	3,012	1,273	4,285	5.6%	291	3,995	836	3,159
2008	2,995	0	2,995	1,501	4,496	4.9%	289	4,207	877	3,330
2009	2,920	0	2,920	1,856	4,776	6.2%	282	4,494	931	3,563
2010	2,847	0	2,847	2,293	5,141	7.6%	275	4,866	1,002	3,863
2011	3,674	898	2,776	1,889	5,563	8.2%	354	5,208	1,085	4,124
2012	4,502	1,795	2,707	1,452	5,954	7.0%	434	5,519	1,161	4,358
2013	4,517	1,878	2,639	1,731	6,248	4.9%	436	5,812	1,218	4,593
2014	5,266	2,693	2,573	1,357	6,623	6.0%	508	6,115	1,291	4,823
2015	6,016	3,507	2,509	976	6,992	5.6%	580	6,411	1,363	5,048
2016	6,971	4,525	2,446	399	7,370	5.4%	673	6,697	1,437	5,260
2017	7,928	5,543	2,385	-198	7,730	4.9%	765	6,965	1,507	5,457
2018	7,868	5,543	2,325	80	7,949	2.8%	759	7,189	1,550	5,639
2019	7,810	5,543	2,267	335	8,145	2.5%	754	7,391	1,588	5,803
2020	8,161	5,951	2,210	202	8,363	2.7%	787	7,575	1,631	5,945

Source: Consultant's estimates

Heat balance

District heat generation in this scenario will be declining due to the growth of distributed heat supply and improved energy efficiency of new buildings. Heat produced by boiler-houses will be gradually substituted by heat produced by new cogeneration plants. Heat generation by heat recovery units will keep about constant, which can be explained by gas extraction stabilization (see Fig. 3.4). The GRP heat intensity in 2005-2020 will drop nearly 3-fold. Residential district heat consumption will increase by 49% by 2020, and industrial heat consumption will be declining due to the substitution of heat with gas and electricity.

Table 3.4 Heat balance in the «Astrakhan Inertia» scenario (thou. Gcal)

Years	Genera-tion	New plants	Exis-ting plants	Boiler-houses	Industrial boilers	Rural boilers	Heat recove-ry units	Distribu-tion losses	Useful supply
2005	14,407	0	2,289	4,224	2,875	1,349	8,166	805	13,607
2006	14,211	0	2,536	3,542	2,411	1,131	8,132	793	13,417
2007	13,917	0	2,536	3,241	2,206	1,035	8,140	777	13,140
2008	13,682	0	2,473	3,072	2,091	981	8,137	764	12,918
2009	13,654	0	2,411	3,038	2,068	970	8,205	762	12,892
2010	13,668	0	2,351	3,112	2,119	994	8,205	763	12,905
2011	13,627	232	2,292	2,816	1,917	899	8,287	761	12,867
2012	13,488	464	2,234	2,502	1,703	799	8,287	753	12,735
2013	13,371	503	2,179	2,402	1,635	767	8,287	746	12,625
2014	13,264	697	2,124	2,156	1,468	688	8,287	741	12,524
2015	13,175	890	2,071	1,927	1,311	615	8,287	736	12,439
2016	13,097	1,132	2,019	1,659	1,129	530	8,287	731	12,366
2017	13,038	1,373	1,969	1,409	959	450	8,287	728	12,310
2018	12,999	1,373	1,920	1,419	966	453	8,287	726	12,274
2019	12,983	1,373	1,872	1,451	988	463	8,287	725	12,258
2020	12,989	1,470	1,825	1,408	958	449	8,287	725	12,264

Source: Consultant's estimates

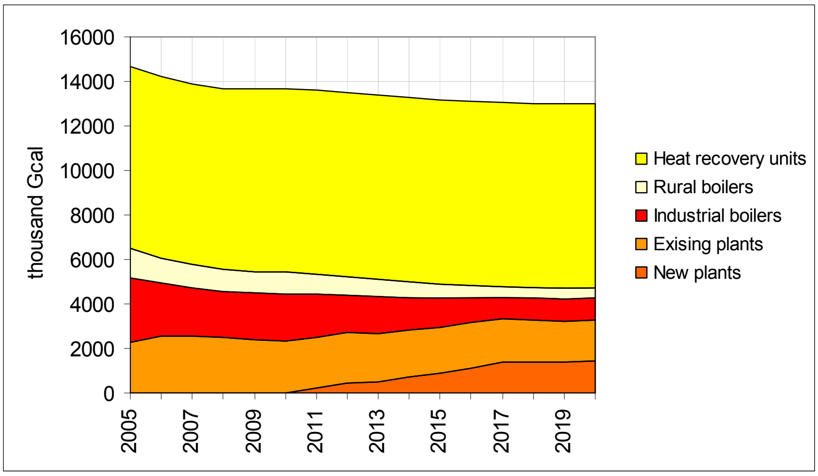


Fig. 3.4 Heat generation structure in the «Astrakhan Inertia» scenario

Natural Gas balance

Natural gas consumption will grow basically due to the commissioning of new power plants (see Fig. 3.5 and Table 3.5). Besides, gas consumption growth may be determined by gas utilization as raw materials at new gas/chemical plants, but no information on this option is available. Residential consumption grows due to ongoing gasification and growing individual housing stock with decentralized heat supply. Heat generation growth by new cogeneration plants leads to the reduction of gas consumption by boiler-houses.

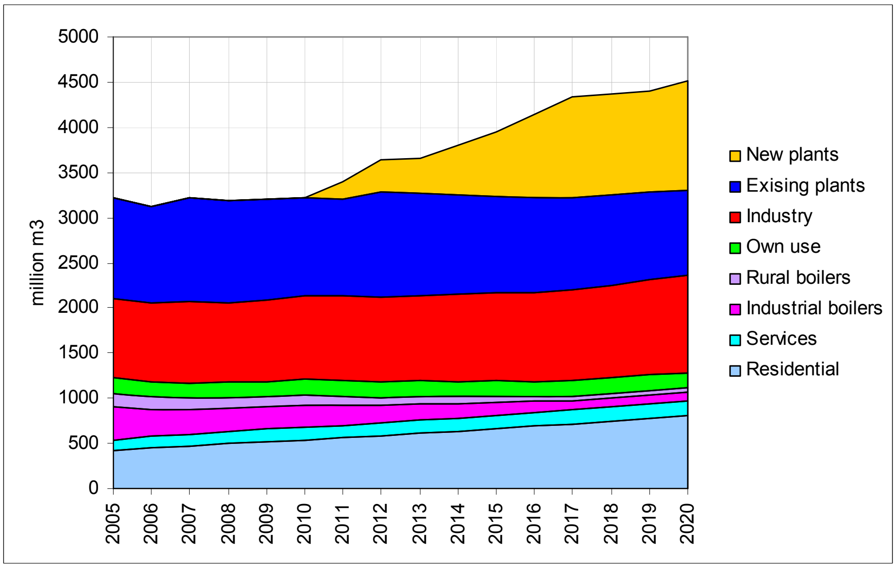


Fig. 3.5 Natural gas consumption in the «Astrakhan Inertia» scenario

Table 3.5 Natural gas balance in the « Astrakhan Inertia » scenario (mln. m3)

Years	Consumption	Existing plants	Boilers	Ind. boilers	Rural boilers	Own needs	Industry	Con-struction	Agriculture	Transp[ort	Municipal services	Commer-cial	Residen-tial
2005	3,742	0	1,121	520	361	159	167	874	0	1	0	1	124
2006	3,554	0	1,069	434	300	134	167	869	0	1	0	1	127
2007	3,615	0	1,142	394	272	122	167	912	0	1	0	1	129
2008	3,551	0	1,132	369	255	114	167	873	0	1	0	1	131
2009	3,560	0	1,111	361	249	111	168	899	0	1	0	1	133
2010	3,586	0	1,078	364	251	112	168	935	0	1	0	1	136
2011	3,716	183	1,072	324	224	100	170	941	0	1	0	1	137
2012	3,929	365	1,155	283	195	88	170	944	0	1	0	1	138
2013	3,929	385	1,135	268	184	83	170	949	0	1	0	1	140
2014	4,038	548	1,106	237	163	74	170	957	0	1	0	1	143
2015	4,160	712	1,078	209	143	66	170	970	0	1	0	1	146
2016	4,321	916	1,051	178	121	56	170	986	0	1	0	1	150
2017	4,490	1,120	1,024	149	101	48	170	1,005	0	1	0	1	154
2018	4,516	1,120	997	148	100	48	170	1,026	0	1	0	1	158
2019	4,550	1,120	972	149	101	49	170	1,050	0	1	0	1	163
2020	4,655	1,202	947	143	96	47	170	1,077	0	1	0	1	168

Source: Consultant's estimates

Liquid fuel balance

Liquid fuel consumption will be growing quite dynamically, basically due to the transport sector consumption (see Fig. 3.6). Consumption growth by automobile transport determined by the increasing number of cars will be partially balanced by the population reduction and ageing, which will hamper the automobile stock growth. The Oblast is able to completely provide itself with petroleum products.

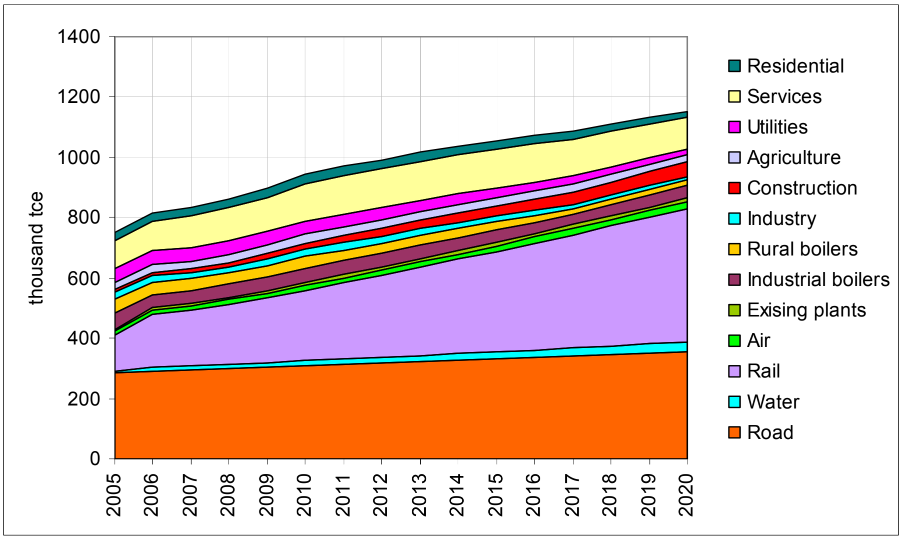


Fig. 3.6 Liquid fuel consumption in the «Astrakhan Inertia» scenario

3.1.3 RISKS ASSOCIATED WITH THE "ASTRAKHAN INERTIA" SCENARIO

The probability of this Inertia scenario implementation is pretty high, because it does not require any significant reforms or changing the Oblast's social and economic development policies, and is in line with the development trends of recent years seen in the whole country. However, with oil and gas prices decline in the external markets, the revenues of the oil & gas sector may drop, and so the attractiveness of oil and gas extraction development in the Oblast may decline; in this case GRP growth may become significantly slower, than specified in the scenario conditions.

In the energy aspect, the following risks may be highlighted:

- The electricity self-sufficiency policy may face difficulties determined by the need to leverage considerable investment for the construction of new, and capacity increase of existing, cogeneration plants. However, this risk is mitigated by the fact, that the new capacities will be needed only starting from 2011, and construction period of gas-fired cogeneration plants is relatively short. Still there is time. But importantly, because of the fast growing domestic and international demand for gas-turbine equipment and inadequate supply, this equipment must be ordered in 2008 at the latest, if the new capacities are to be commissioned in 2011;
- The Gasprom cogeneration plant and the mini-cogeneration plants will face problems related to the supply of excess electricity to the grid; these problems need to be addressed;
- To make cogeneration plants economically attractive, it is important to ensure their high heat loads; otherwise payback periods may exceed 15 years, and investors may lose interest. Residential heat load alone cannot address this problem;
- Without electricity distribution network renovation programs it will be impossible to ensure uninterrupted electricity supply (especially high-voltage supply) and reduce the extremely high distribution losses;

- If commissioning of the new capacities is delayed, it will be necessary to develop and renovate high-voltage electricity transmission lines.

3.2 The “Oil & Gas breakthrough” scenario

3.2.1 THE SCENARIO CONDITIONS

The “Social and economic development strategy for Astrakhan Oblast” includes a “Restoration of the resource portfolio” scenario[4], i.e.:

- Investment inflow in the oil & gas sector (at least USD 1.5-2 bln in oil and specific gas deposits, including Caspian sea shelf deposits) and its accelerated development;
- Development of transport infrastructure, including hydrocarbons transportation;
- Implementation of effective migration programs to mitigate the population reduction and ageing trend.

In other words, this scenario is based on the accelerated development of the oil&gas sector as a trigger for the Oblast’s development in the 21st century. Unfortunately, the “Social and economic development strategy for Astrakhan Oblast” focuses on the description of qualitative parameters of this scenario, providing very few quantitative development parameters. Only two of these are important for this paper: a possibility to increase gas extraction to 22 bln. m3 in 2008 and to 50 bln. m3 in 2015, and a possibility to ensure annual GRP growth rate at only 1.8% in 2008-2011 and at 10% in 2012-2015. Both these parameters until 2008 contradict with the projection made by the Astrakhan Oblast Ministry of economic development until 2010. Therefore, based on qualitative parameters of the “Strategy” and the Ministry’s projection, the consultant had to develop their own scenario, which they titled “Oil & gas breakthrough”.

In 2008, the LUKoil company expects to get the “first” oil in Caspian sea shelf and is planning to keep developing large oil deposits ashore. OAO “Astrakhangasprom” is commissioning a polyethylene products plant and launching a number of projects related to more profound gas processing. Oil and gas pipelines are being built to connect the Oblast with the central pipeline network and will allow for production increase and, correspondingly, oil and gas exports.

The “Oil & gas breakthrough” scenario is based on the following development concept:

- World oil and gas prices keep high enough, so the investment attractiveness of the scheduled projects is not lost, and major oil and gas extraction companies of the Oblast (OAO “Astrakhangasprom” and OAO “LUKoil”) can implement their plans as scheduled;
- Growing revenues (including budget revenues) from the oil&gas sector promote accelerated development of other sectors and GRP growth rates increase. Industry, construction, ship building, agriculture, and transport sustainably develop;
- Growing residential incomes and improving living conditions in the Oblast will allow for an effective migration policy and providing manpower for the economic growth. Besides, it will provide motivation for accelerated development of the commercial sector and trade, as well as of housing construction;
- The Oblast succeeds in attracting investment in the electricity sector and construction of new electric capacities to improve electricity self-sufficiency, renovate and expand electricity network.

These qualitative parameters correlate with the following basic managing quantitative variables dynamics scenario:

- Economic development of the Oblast until 2010 will be similar to that in the Inertia scenario;

[4] “Social and economic development strategy of Astrakhan Oblast”.

- By 2020, extraction of oil and gas condensate will increase to 14 mln. t, and gas extraction to 20 bln. m3;
- After 2011, the GRP will be growing by 10% on average annually. After 2010, the development of all sectors will accelerate compared to the "Astrakhan Inertia" scenario;
- Due to an effective migration policy, population will stabilize at 990 thousand people after 2010;
- Regarding energy prices and inflation parameters, the assumptions of the "Astrakhan Inertia" scenario are preserved;
- Similarly, all assumptions of this scenario are preserved in terms of energy efficiency parameters both in energy production and transport and energy end-use.

In more detail quantitative assumptions of the "Oil & gas breakthrough" scenario are shown in Tables A7-A9 in Annex 3.

3.2.2 ENERGY DEVELOPMENT UNDER THE "OIL & GAS BREAKTHROUGH" SCENARIO

Integrated Fuel and Energy Balance

Under the assumptions of this scenario, primary energy consumption in the Oblast increases from 4,679 Ttce in 2005 to 8,084 Ttce in 2020, or by 73% (see Fig.3.6 and Table 3.7). This happens despite the fact that due to growing energy prices and autonomous technical progress, energy intensity of the GRP in 2020 drops by 53% compared to the 2005 level. The share of natural gas in the energy balance keeps at the 2005 level (80%). Another 16% is the share of liquid fuel.

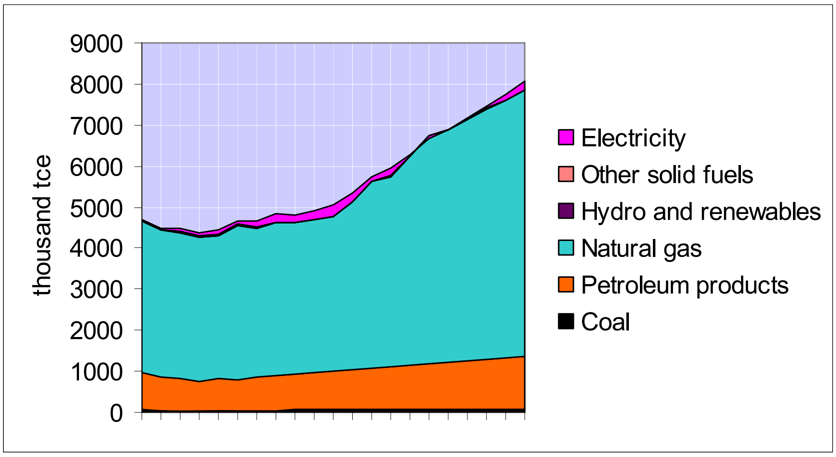


Fig. 3.7 Primary energy consumption in the «Oil & gas breakthrough» scenario

Table 3.6 Integrated Fuel and Energy Balance in 2020 under the « Oil & gas breakthrough » scenario (Ttce)

	Coal	Crude oil	Petroleum products	Natural gas	Hydro/ renewables	Other solid fuels	Power	Heat	Total
Production		**20,020.0**		**23,180.0**	**0.0**	**28.1**			**43,228.1**
Import	58.2		0.0	0.0			225.9		284.1
Export		0	2,906	-15,093			0		-12,186
Stock changes									0
Primary energy consumption	58	0	1,306	6,490	0.1	4	226	0	8,084
Statistical discrepancies									
Power plants	0.0	0.0	-13.3	-2,730.2	-0.1	0.0	1,161.2	471.2	-1,111.2
Electricity generation	0.0	0.0	-12.5	-2,147.2	-0.1	0.0	1,161.2		-998.5
Existing plants	0.0	0.0	-12.5	-742.7	-0.1	0.0	278.9		-476.3
New plants	0.0	0.0	0.0	-1,404.5	0.0	0.0	882.3	0.0	-522.2
Heat generation	-0.3	0.0	-39.9	-697.5	0.0	0.0	0.0	2,563.5	1,825.7
Existing plants	0.0	0.0	-0.9	-355.1	0.0	0.0	0.0	260.9	-44.9
New plants	0.0	0.0	0.0	-227.9	0.0	0.0	0.0	210.2	-17.6
Boiler-houses	-0.3	0.0	-39.0	-114.5	0.0	0.0	0.0	137.4	-16.5
Industrial	-0.3	0.0	-28.0	-75.7	0.0	0.0	0.0	93.5	-10.4
Municipal	-0.1	0.0	-11.1	-38.8	0.0	0.0	0.0	43.9	-6.1
Agricultural								1,954.9	1,954.9
Own needs				-324.8			-111.4		-436.2
Distribution losses				-28.5			-270.5	-143.1	-442.1
Final Energy Consumption	**57.9**	**0.0**	**1,253.7**	**3,291.8**	**0.0**	**3.7**	**1,005.2**	**2,420.4**	**8,032.6**

Source: Consultant's estimates

Table 3.7 Integrated Fuel and Energy Balance – Final Energy Consumption (Ttce)

	Coal	Crude oil	Petroleum products	Natural gas	Hydro/ renewables	Other solid fuels	Power	Heat	Total
Final Energy Consumption	**57.9**	**0.0**	**1,253.7**	**3,291.8**	**0.0**	**3.7**	**1,005.2**	**2,420.4**	**8,032.6**
Industry	25.6	0.0	11.1	1,859.2	0.0	0.3	482.5	1,692.7	4,071.5
Oil and gas extraction	0.0		0.0	14.0		0.0	5.8	0.6	20.4
Oil refining	0.0	0.0	0.0	570.4	0.0	0.0	36.6	80.6	687.6
Gas refining	0.0		0.0	740.5		0.0	154.1	905.5	1,800.1
Sulphur	0.0		0.0	229.8		0.0	100.9	270.5	601.2
Water raise and supply for industry	0.0		0.0	2.7		0.0	1.0	0.1	3.8
Bread and bakery products	0.0	0.0	0.0	0.0	0.0	0.0	24.1	0.0	24.1
Other	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Transport	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Aviation	25.6		11.1	302.0		0.3	160.1	435.3	934.4
Automobile	0.0		67.7	0.0		0.0	42.8	1.0	111.5
Railway	0.0	0.0	1,028.0	0.4	0.0	0.0	68.7	71.3	1,168.4
Water	0.0		23.1	0.0		0.0	0.0	0.0	23.1
Urban electric	0.0		356.2	0.4		0.0	0.0	0.0	356.6
Other transport	0.0		606.9	0.0		0.0	9.0	71.3	687.2
Agriculture	0.0		41.8	0.0		0.0	0.0	0.0	41.8
Municipal utility sector	0.0		0.0	0.0		0.0	1.0	0.0	1.0
Commercial	0.0		0.0	0.0		0.0	58.7	0.0	58.7
Residential	0.0		28.1	0.9		0.0	46.4	1.2	76.6

Source: Consultant's estimates

Electricity balance

As shown in Fig. 3.8, complete electricity self-sufficiency of the Oblast is achieved by 2016, but then, as electricity consumption grows, scheduled electric capacity commissioning is too low, and electricity self-sufficiency drops to 83%. New capacity commissioning schedule in this scenario is as follows: in 2011, cogeneration plant of Gasprom (200 MW), a new block in Northern cogeneration plant (100 MW) and the first mini-cogeneration plant; in 2012, the second mini-cogeneration plant; in 2013, the third mini-cogeneration plant; in 2014, a new block of cogeneration plant at GRES (200 MW) and a new block of cogeneration plant at TETs-2 (250 MW); in 2017, one more block of cogeneration plant at TETs-2 (100 MW).

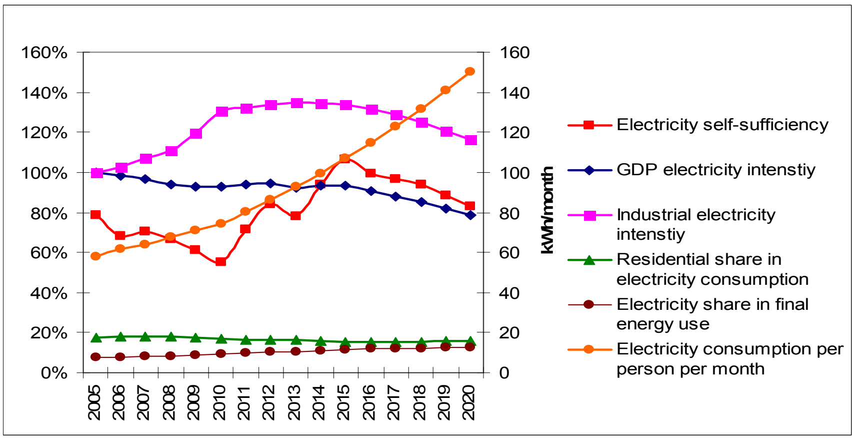


Fig. 3.8 Electricity consumption indicators in the «Oil & gas breakthrough» scenario

Electricity intensity of the GRP drops by 22% by 2020. Electricity consumption in this scenario increases to 11.3 bln. kWh, which is almost three times higher, than in 2005. Industrial sector is responsible for major consumption increase (see Fig. 3.9). Industrial electricity intensity first grows, then declines.

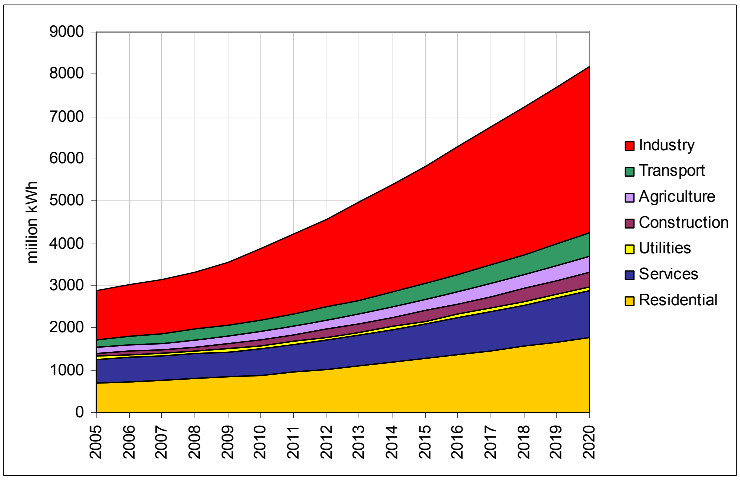


Fig. 3.9 Electricity end-use consumption in the «Oil & gas breakthrough» scenario

Table 3.8 Electricity balance in the « Oil & gas breakthrough » scenario (mln. kWh)

Year	Production	New plants	Existing plants	Net Import	Consumption	Growth rates	Own needs	Supply to the grid	Transmission losses	Useful supply
2005	3,101	0	3,101	836	3,936	3.2%	299	3,637	766	2,871
2006	2,777	0	2,777	1,283	4,060	3.1%	281	3,778	736	3,043
2007	3,012	0	3,012	1,273	4,285	5.6%	291	3,995	836	3,159
2008	2,995	0	2,995	1,501	4,496	4.9%	289	4,207	877	3,330
2009	2,920	0	2,920	1,856	4,776	6.2%	282	4,494	931	3,563
2010	2,847	0	2,847	2,293	5,141	7.6%	275	4,866	1,002	3,863
2011	4,081	1,305	2,776	1,638	5,719	11.3%	394	5,325	1,115	4,210
2012	5,317	2,610	2,707	1,014	6,330	10.7%	513	5,817	1,234	4,583
2013	5,332	2,693	2,639	1,491	6,824	7.8%	514	6,309	1,331	4,978
2014	7,099	4,526	2,573	456	7,555	10.7%	685	6,870	1,473	5,397
2015	8,867	6,358	2,509	-553	8,314	10.0%	855	7,458	1,621	5,837
2016	8,804	6,358	2,446	68	8,872	6.7%	849	8,022	1,730	6,292
2017	9,150	6,766	2,385	336	9,487	6.9%	883	8,604	1,850	6,754
2018	9,498	7,173	2,325	607	10,106	6.5%	916	9,189	1,971	7,219
2019	9,440	7,173	2,267	1,230	10,670	5.6%	911	9,759	2,081	7,679
2020	9,383	7,173	2,210	1,893	11,277	5.7%	905	10,372	2,199	8,173

Source: Consultant's estimates

Natural gas balance

Of 20 bln. m3 of natural gas to be extracted in this scenario local consumption in the Oblast will reach 5.7 bln. m3. Natural gas balance fluctuations will depend on the implementation of own generation plans (see Fig. 3.10 and Table 3.9). Due to the construction of cogeneration plants the burden on boiler-houses will reduce, and so will gas consumption by boilers. Gas consumption in the industrial sector grows dynamically, but most significant growth is seen in the residential sector.

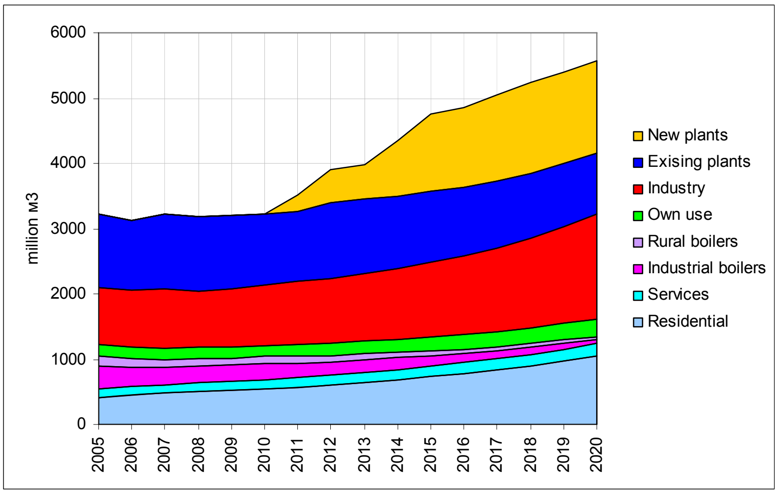


Fig. 3.10 Natural gas consumption in the «Oil & gas breakthrough» scenario

Table 3.9 Natural gas balance in the «Oil & gas breakthrough» scenario (mln. m3)

Years	Consumption	Existing plants	Boilers	Ind. boilers	Rural boilers	Own needs	Industry	Con-struction	Agricul-ture	Transport	Municipal services	Commer-cial	Residen-tial
2005	3,742	0	1,121	520	361	159	167	874	1	0	1	124	414
2006	3,554	0	1,069	434	300	134	167	869	1	0	1	127	452
2007	3,615	0	1,142	394	272	122	167	912	1	0	1	129	476
2008	3,551	0	1,132	369	255	114	167	873	1	0	1	131	508
2009	3,560	0	1,111	361	249	111	168	899	1	0	1	133	525
2010	3,586	0	1,078	364	251	112	168	935	1	0	1	136	540
2011	3,844	252	1,072	334	230	103	177	964	1	0	1	138	573
2012	4,200	503	1,155	304	209	94	185	999	1	0	1	141	608
2013	4,271	522	1,135	295	203	92	195	1,038	1	0	1	145	645
2014	4,626	858	1,106	268	184	84	204	1,084	1	0	1	150	687
2015	4,999	1,193	1,078	241	165	76	215	1,141	1	0	1	156	733
2016	5,070	1,225	1,051	207	141	66	225	1,207	1	0	1	162	783
2017	5,222	1,327	1,024	171	116	55	237	1,282	1	0	1	170	839
2018	5,406	1,395	998	158	106	52	249	1,370	1	0	1	177	900
2019	5,535	1,395	972	141	94	47	261	1,470	1	0	1	186	967
2020	5,674	1,408	947	99	65	34	280	1,604	1	0	1	195	1,040

Source: Consultant's estimates

Heat balance

Heat generation in the Oblast increases by 24% in 2020 compared to the 2005 level (see Table 3.10). The major growth is determined by heat recovery due to more profound gas condensate processing (see Fig. 3.10) and by new cogeneration plants.

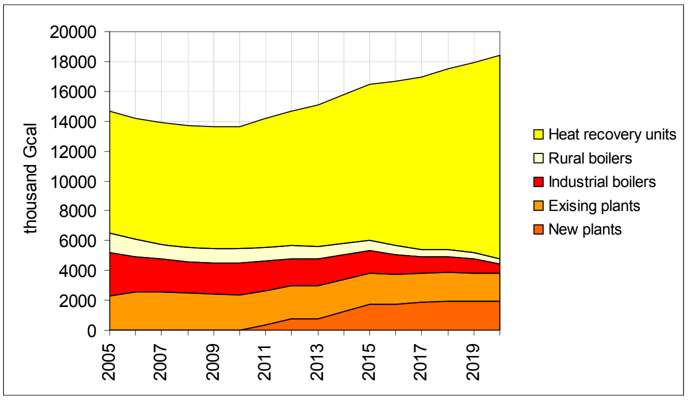


Fig. 3.11 Heat generation structure in the «Oil & gas breakthrough» scenario

Heat consumption growth is seen primarily in the residential and industrial sectors (see Fig. 3.11).

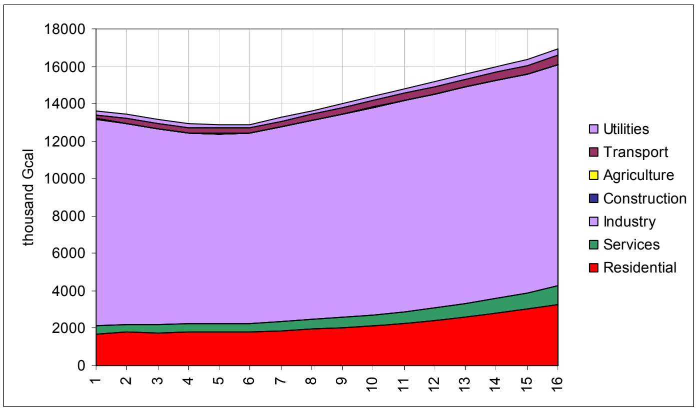


Fig. 3.12 Heat consumption structure in the «Oil & gas breakthrough» scenario

Table 3.10 Heat balance in the «Oil & gas breakthrough» scenario (thou. Gcal)

Years	Genera-tion	New plants	Existing plants	Boiler-houses	Industrial boilers	Rural boilers	Heat recovery units	Distri-bution losses	Useful supply
2005	14,407	0	2,289	4,224	2,875	1,349	8,166	805	13,607
2006	14,211	0	2,536	3,542	2,411	1,131	8,132	793	13,417
2007	13,917	0	2,536	3,241	2,206	1,035	8,140	777	13,140
2008	13,682	0	2,473	3,072	2,091	981	8,137	764	12,918
2009	13,654	0	2,411	3,038	2,068	970	8,205	762	12,892
2010	13,668	0	2,351	3,112	2,119	994	8,205	763	12,905
2011	14,040	366	2,292	2,901	1,975	926	8,615	784	13,256
2012	14,428	731	2,234	2,683	1,826	857	9,046	805	13,622
2013	14,823	774	2,179	2,643	1,799	844	9,498	828	13,995
2014	15,228	1,258	2,124	2,435	1,657	777	9,973	850	14,378
2015	15,648	1,741	2,071	2,215	1,508	707	10,472	874	14,775
2016	16,073	1,741	2,019	1,927	1,312	615	10,995	897	15,176
2017	16,497	1,849	1,969	1,609	1,095	514	11,545	921	15,576
2018	16,917	1,956	1,920	1,501	1,022	479	12,122	944	15,972
2019	17,329	1,956	1,872	1,356	923	433	12,729	967	16,362
2020	17,927	1,956	1,825	961	654	307	13,671	1,001	16,926

Source: Consultant's estimates

3.2.3 PRACTICAL FEASIBILITY OF THE "OIL & GAS BREAKTHROUGH" SCENARIO

From the economic point of view, there are several risks associated with the "Oil & gas breakthrough" scenario:

- Reduction of the investment attractiveness of complex oil & gas deposits development, if oil and gas prices drop. This risk is mitigated by the growth of domestic price for natural gas;
- Inability to provide qualified manpower for the economic growth (migration policy being one of the reasons), and competition for qualified staff between the oil&gas sector and other sectors;
- Inadequate institutional capacity to transform oil & gas revenues in the development of other sectors;
- From the environmental point of view, the "Oil & gas breakthrough" scenario puts very strict limitations for oil & gas companies potentially able of damaging tourism and fishery development in the Oblast.

Regarding the energy aspect of this scenario, the following basic risks need to be highlighted:

- Inability to leverage sufficient investment in the energy construction and electricity transmission/distribution network renovation and development;
- In 2006-2020, electricity generation will increase 3.4-fold. The Oblast has not seen such large-scale energy construction programs in the last 14 years, and so it lacks the infrastructure for rapid and large-scale energy construction. Therefore, there is a risk of new energy facilities construction delays;
- Significant growth of energy construction costs and natural gas prices may lead to unaffordable electricity tariffs for many consumers and electricity sector unattractiveness for private investors, given inability (or limited ability) to finance energy projects from the budget or switch power plants to other fuels, for example, coal;
- Certain increase of electricity imports dependence after 2017, despite considerable electric capacity commissioning. However, transmission capacity of electric transmission lines is adequate to the needed electricity delivery until 2020.

Without energy efficiency efforts down the whole energy supply chain and energy conservation policies, these risks may become a factor considerably hampering the Oblast's economic development.

3.3 The "Sustainable development" scenario

3.3.1 SCENARIO CONDITIONS

The "Social and economic development strategy of Astrakhan Oblast" includes one more development scenario ("New resource portfolio"), oriented at costly, highly qualified and mobile manpower and application of new technologies to considerably improve the productivity of capital.

This scenario is based on the resources of developing oil & gas sector. It preserves all the conditions of the "Oil & gas breakthrough", but assumes, that energy efficiency will become a critical factor to improve the productivity of capital. For this reason, the Oblast administration will implement a number of energy efficiency programs, including:

1. Energy efficiency in the industrial sector;
2. Energy efficiency in the electricity- and heat supply systems;
3. Energy intensity reduction in residential buildings;
4. Electricity- and heat distribution losses reduction.

This scenario suggests intense renovation of fixed assets and a large-scale application of new equipment and technologies. An assumption is made, that in all energy end-use sectors autonomous technical progress will be promoting energy efficiency improvements.

The assumptions of this scenario include annual energy efficiency improvement (autonomous technical progress) in the production of all goods and services from 1% in the "Oil & gas breakthrough" to 2%; electricity transmission and distribution losses reduction to 12%, and 1.4-fold heat distribution losses reduction. All the other scenario conditions are preserved. New cogeneration capacities are commissioned as scheduled in the Inertia scenario: in 2011, cogeneration plant of Gasprom (200 MW), in 2014, a new block of cogeneration plant at GRES (125 MW), and in 2020, a new block of cogeneration plant at TETs-2 (100 MW). Besides, in 2011-2013, a mini-cogeneration plant will be commissioned annually (10 MW each).

3.3.2 ENERGY DEVELOPMENT BY THE «SUSTAINABLE DEVELOPMENT» SCENARIO

Integrated Fuel and Energy Balance

Under the assumptions of this scenario, primary energy consumption in the Oblast increases from 4,679 Ttce in 2005 to 7,494 Ttce in 2020, or by 60% (see Fig. 3.12 and Table 3.11-3.12). In other words, aggressive energy efficiency policies result in 590 Ttce in savings. As previously, a considerable part of primary energy consumption increase is related to natural gas consumption.

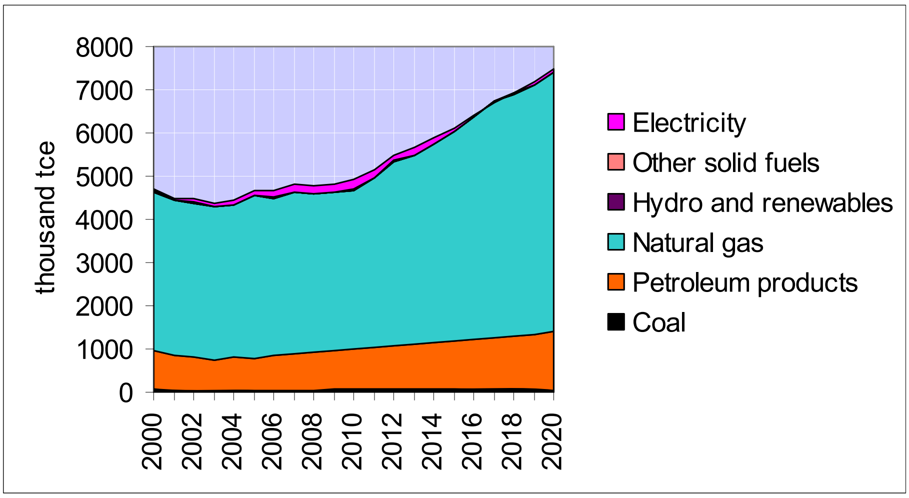


Fig. 3.13 Primary energy consumption in the «Sustainable development» scenario

Table 3.11 Integrated Fuel and Energy Balance in 2020 under the «Sustainable development» scenario (Ttce)

	Coal	Crude oil	Petroleum products	Natural gas	Hydro/ renewables	Other solid fuels	Power	Heat	Total
Production		**20020.0**		**23180.0**	**0.0**	**28.1**			**43,228.1**
Import	51.7		0.0	0.0			70.9		122.6
Export		0	2,874	-15,554			0		-12,680
Stock changes									0
Primary energy consumption	**52**	**0**	**1,339**	**6,029**	**0.1**	**3**	**71**	**0**	**7,494**
Statistical discrepancies									
Power plants	0.0	0.0	-13.3	-2,490.8	-0.1	0.0	1,010.8	471.2	-1,022.2
Electricity generation	0.0	0.0	-12.5	-1,907.8	-0.1	0.0	1,010.8		-909.5
Existing plants	0.0	0.0	-12.5	-742.7	-0.1	0.0	278.9		-476.3
New plants	0.0	0.0	0.0	-1,165.1	0.0	0.0	731.9	0.0	-433.2
Heat generation	-0.9	0.0	-100.5	-875.4	0.0	0.0	0.0	2,220.7	1,243.8
Existing plants	0.0	0.0	-0.9	-355.1	0.0	0.0	0.0	260.9	-44.9
New plants	0.0	0.0	0.0	-227.9	0.0	0.0	0.0	210.2	-17.6
Boiler-houses	-0.9	0.0	-99.7	-292.4	0.0	0.0	0.0	351.0	-42.1
Industrial	-0.7	0.0	-71.4	-193.3	0.0	0.0	0.0	238.9	-26.5
Municipal	-0.1	0.0	-28.3	-99.2	0.0	0.0	0.0	112.1	-15.5
Agricultural								1,398.6	1,398.6
Own needs				-324.8			-61.5		-386.3
Distribution losses				-28.5			-129.8	-88.8	-247.2
Final Energy Consumption	**50.8**	**0.0**	**1,225.8**	**2,892.3**	**0.0**	**3.2**	**890.5**	**2,131.9**	**7,194.5**

Source: Consultant's estimates

Table 3.12 Integrated Fuel and Energy Balance – Final Energy Consumption (Ttce)

	Coal	Crude oil	Petroleum products	Natural gas	Hydro/ renewables	Other solid fuels	Power	Heat	Total
Final Energy Consumption	**50.8**	**0.0**	**1,225.8**	**2,892.3**	**0.0**	**3.2**	**890.5**	**2,131.9**	**7,194.5**
Industry	22.4	0.0	9.7	1,627.3	0.0	0.3	422.3	1,481.8	3,563.8
Oil and gas extraction	0.0		0.0	12.2		0.0	5.0	0.6	17.8
Oil refining	0.0	0.0	0.0	499.0	0.0	0.0	32.0	70.5	601.5
Gas refining	0.0		0.0	648.5		0.0	134.9	793.1	1,576.5
Sulphur	0.0		0.0	201.1		0.0	88.3	236.8	526.2
Water raise and supply for industry	0.0		0.0	2.3		0.0	0.9	0.1	3.3
Bread and bakery products	0.0	0.0	0.0	0.0	0.0	0.0	21.1	0.0	21.1
Other	22.4		9.7	264.1		0.3	140.1	380.7	817.4
Construction	0.0		59.3	0.0		0.0	37.5	0.9	97.7
Transport	0.0	0.0	1,028.0	0.4	0.0	0.0	68.7	71.3	1,168.4
Aviation	0.0		23.1	0.0		0.0	0.0	0.0	23.1
Automobile	0.0		356.2	0.4		0.0	0.0	0.0	356.6
Railway	0.0		606.9	0.0		0.0	9.0	71.3	687.2
Water	0.0		41.8	0.0		0.0	0.0	0.0	41.8
Urban electric	0.0		0.0	0.0		0.0	1.0	0.0	1.0
Other transport	0.0		0.0	0.0		0.0	58.7	0.0	58.7
Agriculture	0.0		24.6	0.8		0.0	40.6	1.1	67.1
Municipal utility sector	0.2		9.7	0.7		1.7	9.7	40.9	62.9
Commercial	7.3		78.0	197.4		0.0	117.3	122.8	522.8
Residential	20.9		16.4	1,065.6		1.3	194.3	413.2	1,711.8

Source: Consultant's estimates

Electricity balance

In this scenario, electricity consumption increases to 8.8 bln. kWh in 2020 (versus 11.3 bln. kWh in the “Oil & gas breakthrough”) due to aggressive energy efficiency policies. Therefore, even with the commissioning of new capacities as scheduled in the Inertia scenario, it is possible to achieve nearly complete (93-103% in 2016-2020) electricity self-sufficiency of the Oblast. This happens with the same economic growth parameters, as in the “Oil & gas breakthrough” scenario (see Fig. 3.13).

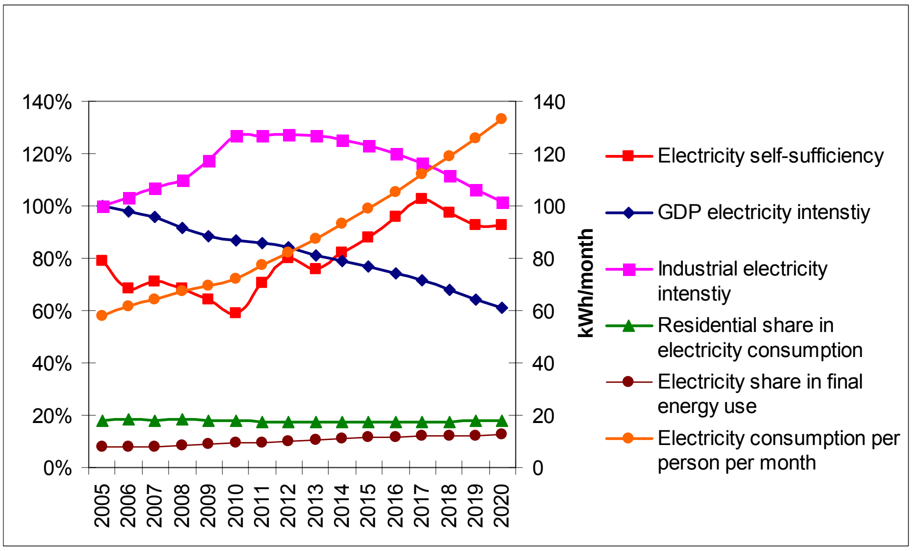


Fig. 3.14 Electricity consumption indicators in the «Sustainable development» scenario

Electricity intensity of the GRP drops by 2020 by 40%, and industrial energy intensity, after showing some initial growth, also declines. The share of the residential sector in electricity consumption keeps at 18% throughout the whole period.

Table 3.13 Electricity balance in the «Sustainable development» scenario, mln. kWh

	Generation	New plants	Existing plants	Import	Consumption	Growth rates	Own needs	Supply to the grid	Transmission losses	Useful supply
2005	3,101	0	3,101	836	3,936	3.2%	299	3,637	766	2,871
2006	2,777	0	2,777	1,283	4,060	3.1%	281	3,778	736	3,043
2007	3,012	0	3,012	1,228	4,240	4.4%	281	3,959	800	3,159
2008	2,995	0	2,995	1,372	4,367	3.0%	271	4,096	796	3,300
2009	2,920	0	2,920	1,636	4,556	4.3%	256	4,301	804	3,497
2010	2,847	0	2,847	1,973	4,820	5.8%	241	4,579	822	3,756
2011	3,674	898	2,776	1,543	5,217	8.2%	301	4,916	861	4,055
2012	4,502	1,795	2,707	1,127	5,628	7.9%	357	5,271	898	4,373
2013	4,517	1,878	2,639	1,458	5,975	6.2%	347	5,628	922	4,706
2014	5,266	2,693	2,573	1,135	6,401	7.1%	392	6,009	955	5,054
2015	6,016	3,507	2,509	819	6,835	6.8%	433	6,401	986	5,415
2016	6,971	4,525	2,446	315	7,286	6.6%	486	6,800	1,017	5,783
2017	7,928	5,543	2,385	-199	7,728	6.1%	535	7,193	1,043	6,150
2018	7,868	5,543	2,325	214	8,082	4.6%	514	7,568	1,055	6,513
2019	7,810	5,543	2,267	612	8,422	4.2%	494	7,928	1,063	6,864
2020	8,161	5,951	2,210	634	8,795	4.4%	500	8,295	1,055	7,240

Source: Consultant's estimates

Natural gas balance

Natural gas consumption increases to 5.4 bln. m3 due to the new plants, industrial and residential sectors (see Fig. 3.14). Residential gas consumption in 2006-2020 doubles. The share of natural gas in the end-use consumption grows from 35% in 2006 to 40% in 2020, primarily due to district heating, whose share in this period drops from 40% to 30%.

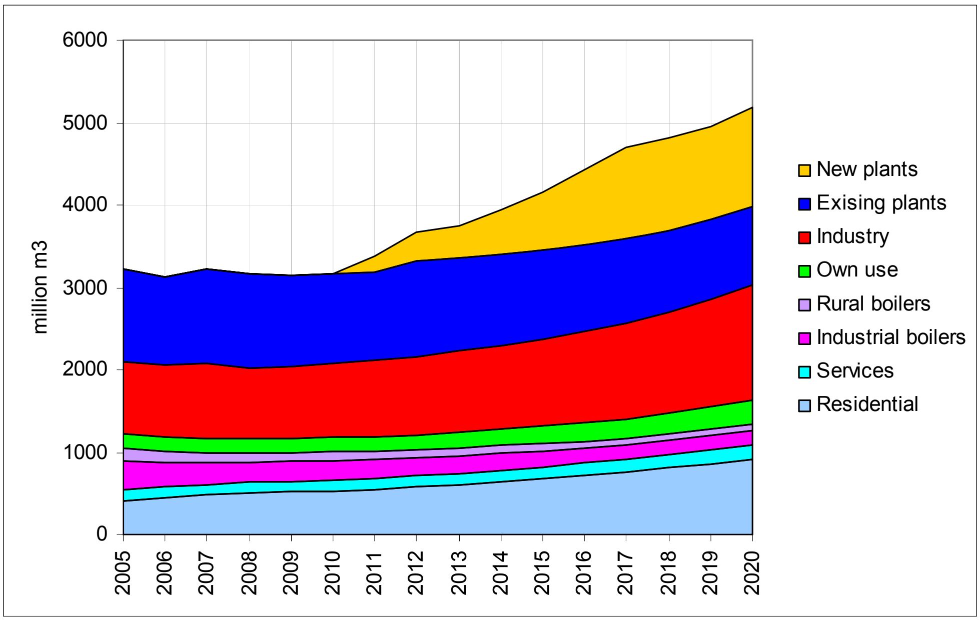


Fig. 3.15 Natural gas consumption in the «Sustainable development» scenario

Table 3.14 Natural gas balance in the «Sustainable Development» scenario (mln. m3)

Years	Consump-tion	Existing plants	Boilers	Ind. boilers	Rural boilers	Own needs	Indus-try	Con-struction	Agricul-ture	Transport	Mun. services	Commer-cial	Residen-tial
2005	3,742	0	1,121	520	361	159	167	874	1	0	1	124	414
2006	3,554	0	1,069	434	300	134	167	869	1	0	1	127	452
2007	3,610	0	1,142	392	271	121	167	912	1	0	1	129	476
2008	3,518	0	1,132	361	249	111	167	864	1	0	1	130	503
2009	3,500	0	1,111	346	239	107	168	881	1	0	1	130	516
2010	3,520	0	1,078	354	245	110	168	906	1	0	1	132	524
2011	3,705	183	1,072	332	229	103	177	925	1	0	1	133	551
2012	3,990	365	1,155	311	214	97	185	948	1	0	1	134	579
2013	4,061	385	1,135	312	214	98	195	976	1	0	1	136	609
2014	4,245	548	1,106	297	204	93	204	1,009	1	0	1	139	642
2015	4,448	712	1,078	284	194	90	215	1,051	1	0	1	143	679
2016	4,694	916	1,051	266	181	85	225	1,100	1	0	1	148	719
2017	4,953	1,120	1,024	249	168	80	237	1,157	1	0	1	153	763
2018	5,073	1,120	998	256	172	84	249	1,224	1	0	1	159	811
2019	5,208	1,120	972	263	175	88	261	1,300	1	0	1	164	863
2020	5,430	1,202	947	252	167	86	280	1,404	1	0	1	170	919

Source: Consultant's estimates

Heat balance

Heat generation in this scenario only increases by 7% by 2020. The growth will take place primarily at new plants and heat recovery units, while industrial and rural boilers will show generation decline (see Fig. 3.15).

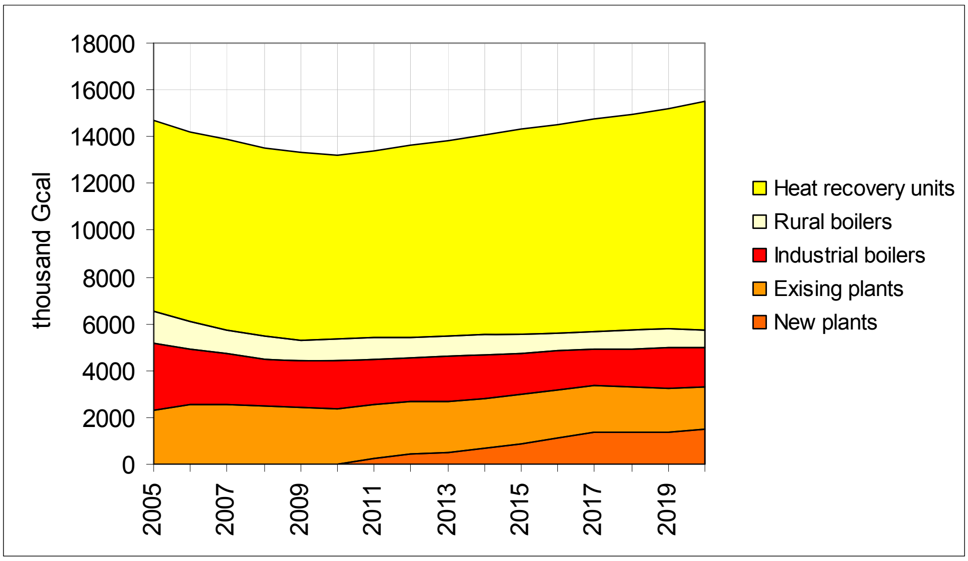


Fig. 3.16 Heat generation structure in the «Sustainable development» scenario

Heat intensity of the GRP will drop nearly 3-fold both due to heat efficiency improvements and to the switch to natural gas. This also determines reducing share of heat in the energy end-use. Heat consumption grows primarily in the commercial and residential sectors due to their dynamic development.

Table 3.15 Heat balance in the «Sustainable development» scenario, thou. Gcal

	Generation	New plants	Existing plants	Boiler-houses	Industrial boilers	Rural boilers	Heat recovery units	Distribution losses	Useful supply
2005	14,407	0	2,289	4,224	2,875	1,349	8,166	805	13,607
2006	14,211	0	2,536	3,542	2,411	1,131	8,132	793	13,417
2007	13,898	0	2,536	3,222	2,193	1,029	8,140	758	13,140
2008	13,512	0	2,473	2,999	2,041	958	8,040	721	12,791
2009	13,334	0	2,411	2,913	1,983	930	8,010	695	12,639
2010	13,200	0	2,351	3,033	2,065	969	7,816	673	12,527
2011	13,410	232	2,292	2,884	1,963	921	8,002	668	12,742
2012	13,629	464	2,234	2,742	1,867	876	8,188	664	12,965
2013	13,849	503	2,179	2,796	1,903	893	8,372	659	13,190
2014	14,074	697	2,124	2,699	1,837	862	8,554	655	13,419
2015	14,306	890	2,071	2,611	1,777	834	8,733	651	13,655
2016	14,536	1,132	2,019	2,476	1,685	791	8,909	646	13,890
2017	14,760	1,373	1,969	2,337	1,591	746	9,081	642	14,118
2018	14,976	1,373	1,920	2,435	1,658	778	9,248	636	14,339
2019	15,180	1,373	1,872	2,527	1,720	807	9,408	631	14,550
2020	15,530	1,470	1,825	2,454	1,671	784	9,780	621	14,908

Source: Consultant’s estimates

3.3.3 PRACTICAL FEASIBILITY OF THE «SUSTAINABLE DEVELOPMENT» SCENARIO

The major problem in this scenario is related to the considerable efforts needed to pursue aggressive energy efficiency policies. However, in the energy aspect, all basic risks are mitigated. The main thing is that building new cogeneration plants as scheduled in the inertia scenario, the Oblast is able to ensure the economic growth of the "Oil & gas breakthrough" scenario. Electric capacity demand until 2020 goes down by 100 MW, and commissioning of new plants is considerably delayed.

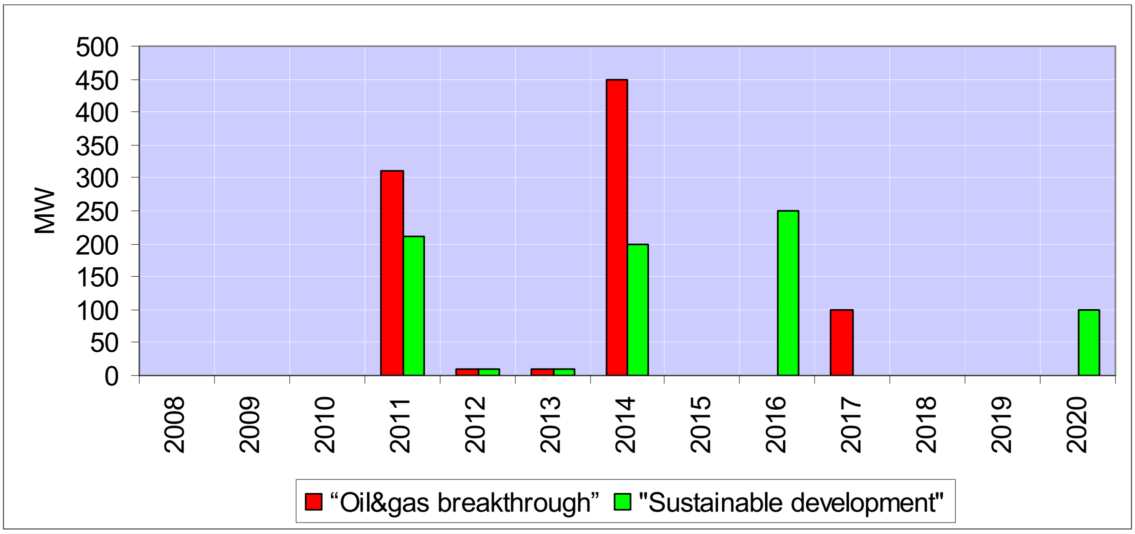


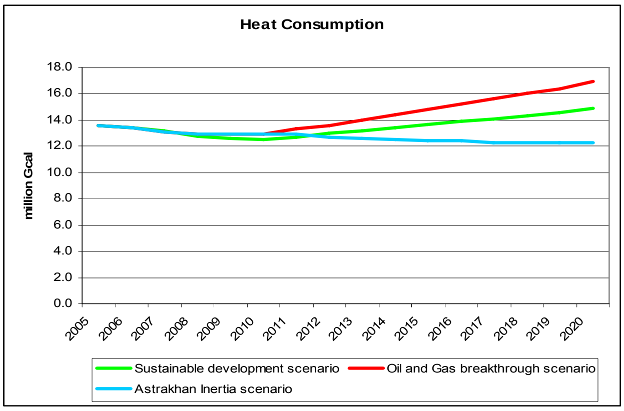
Fig. 3.17 Electric capacity commissioning in Astrakhan Oblast

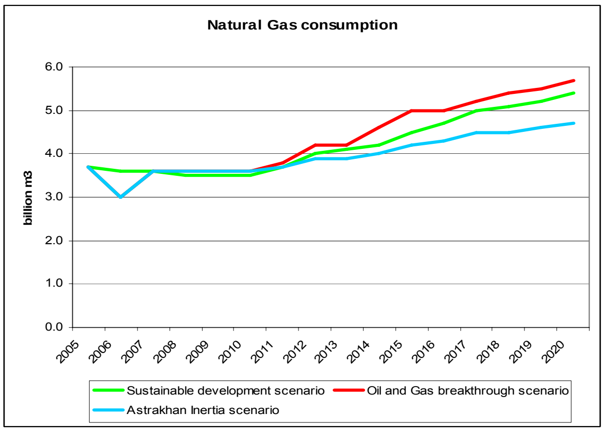
4 Conclusions and Recommendations

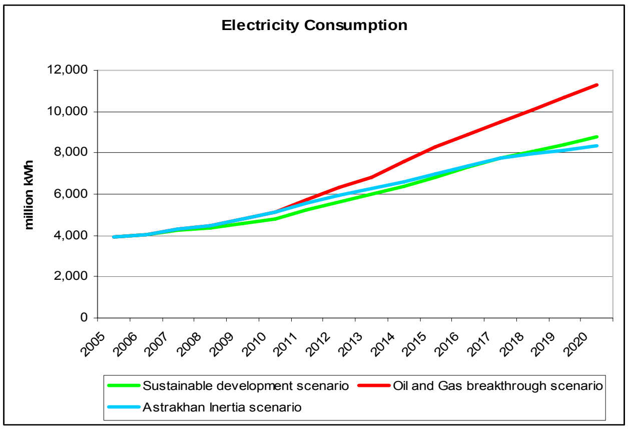
4.1 Conclusions

- Using a computerized model for energy demand forecasting is an effective "planning tool" to improve macro-economic and energy policy because it allows for a thorough check on internal consistency of economic and energy policy and good insight in the policy-related driving forces, constraints and risk factors.
- Introducing strong energy efficiency programs is a "no-regret" strategy. Under all circumstance it will contribute to alleviating possible limitations/constraints of an economic policy as well as mitigate risks due to uncertainty.

The following charts show at a glance the development of heat, natural gas and electricity consumption in the three scenarios.







4.2 Recommendations

- It is recommended to assign specific responsibility in the regional administration for integrated economic and energy planning in terms of
  - Collecting and analyzing data and developing annually integrated fuel and energy balances and
  - Updating and testing of economic and energy policy scenarios.
- Further testing of existing economic and energy policies for inconsistencies using the computerized demand forecast model will improve the quality of decision making.
- It is necessary to build upon the current experience in building consistent and realistic regional development scenarios using a computerized model.
- The model that has been transferred to the regional administration's staff should be further developed, in particular the model's macro-economic and energy modules to fit the region's needs and its underlying assumptions.
- It is especially important to develop further the energy pricing module due to the wide-ranging consequences of changing energy prices for economic and energy policy decisions.
- There is a strong need from a strategic as well as economic point of view to develop and implement energy efficiency programs in the public sector (heat and electricity supply and distribution, schools, hospitals etc.) and to create conditions for the private sectors allowing for accelerated energy efficiency improvements.

Annexes

Annex 1 Integrated Fuel and Energy Balance for 2005

Table A.1 Integrated Fuel and Energy Balance for 2005, Astrakhan region (Ttce)

	Coal	Crude oil	Petroleum products	Natural gas	Hydro and renew.	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	-10094,3			-235,8		-13393
Stock changes	2,6		-25,0						-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**

Source: Developed by the consultant (see report on Astrakhan Integrated Fuel and Energy Balance)

Table A.2 Integrated Fuel and Energy Balance for 2005, Astrakhan region, Ttce (continued)

	Coal	Crude oil	Petroleum products	Natural gas	Hydro and renew.	Other solid fuels	Electricity	Heat	Total
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 abstraction and industry supply							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. For more detailed information on energy balances, see the project report " Astrakhan Fuel and Energy Balance" (April, 2007).

Annex 2 Input data tables for “Astrakhan Inertia” scenario

Table A.3 Basic macroeconomic assumptions in the "Astrakhan Inertia" scenario

Year	GRP growth rate	Population	Industrial output index	Manufacturing output index	Construc-tion SOW index	Agricultural output index	Retail trade turnover index	Services	Real residential income index	Commissioning of residential buildings	Railway cargo turnover	Cargo shipment by water transport	Number of cars
	%	x000	%	%	%	%	%	%	%	x000 m2	mln. t-km	kton	pcs.
2007	104.4%	996	100.8%	100.0%	108.2%	110.1%	113.7%	105.8%	107.9%	648	12,818	2,100	244,233
2008	105.1%	994	101.2%	101.2%	107.9%	106.5%	116.0%	105.2%	111.7%	669	18,755	2,142	249,118
2009	107.2%	993	101.3%	102.6%	114.0%	107.0%	111.7%	105.2%	107.6%	720	19,712	2,251	254,100
2010	107.7%	992	101.7%	102.7%	116.0%	107.0%	110.5%	106.6%	108.4%	880	21,131	2,413	259,182
2011	107.7%	991	102.0%	108.3%	117.0%	107.5%	109.4%	112.0%	107.5%	950	22,758	2,599	264,366
2012	107.7%	990	102.4%	111.3%	119.1%	106.0%	108.9%	120.0%	107.5%	1,000	24,511	2,799	269,653
2013	107.0%	986	103.0%	104.4%	113.7%	105.0%	107.5%	109.1%	107.5%	1,050	26,398	3,015	275,046
2014	106.8%	983	103.0%	103.1%	108.9%	104.0%	107.3%	109.7%	107.3%	1,103	28,246	3,226	280,547
2015	106.6%	979	103.0%	103.9%	108.7%	103.0%	107.1%	110.4%	107.1%	1,158	30,166	3,445	286,158
2016	106.4%	976	103.0%	103.6%	108.5%	103.0%	106.9%	111.3%	106.9%	1,216	32,157	3,673	291,881
2017	106.2%	972	103.0%	103.4%	108.3%	103.0%	106.7%	112.1%	106.7%	1,276	34,216	3,908	297,719
2018	106.0%	968	103.0%	103.1%	108.1%	103.0%	106.5%	112.1%	106.5%	1,340	36,337	4,150	303,673
2019	105.8%	965	103.0%	103.2%	107.9%	103.0%	106.3%	110.8%	106.3%	1,407	38,517	4,399	309,746
2020	105.6%	961	103.0%	103.3%	107.7%	103.0%	106.1%	111.1%	106.1%	1,477	40,751	4,654	315,941

Sources: «Basic indicators submitted for the RF social and economic development projection until 2010», «Medium- and long-term social and economic development strategy of Astrakhan Oblast» and Consultant's estimates using a simplified macroeconomic model.

Table A.4 Basic products output under the « Astrakhan Inertia » scenario

Year	Electricity generation	Oil extraction	Gas extraction	Petroleum products	Sulphur production	Bread prod.
	mln. kWh	kton	mln. m3	kton		kton
2007	3,101	4,197	11,936	2,185	4,850	78
2008	2,773	4,173	11,897	2,187	4,827	79
2009	3,012	4,171	11,909	2,200	4,785	80
2010	2,995	4,183	11,904	2,201	4,712	85
2011	2,920	4,795	12,004	2,394	4,752	93
2012	2,847	5,297	12,004	2,687	4,752	98
2013	3,674	5,456	12,124	2,794	4,800	98
2014	4,502	5,619	12,124	2,906	4,800	98
2015	4,517	5,788	12,124	3,023	4,800	98
2016	5,266	5,962	12,124	3,143	4,800	98
2017	6,016	6,140	12,124	3,301	4,800	98
2018	6,971	6,325	12,124	3,466	4,800	98
2019	7,928	6,514	12,124	3,639	4,800	98
2020	7,868	6,710	12,124	3,821	4,800	98

Sources: «Basic indicators submitted for the RF social and economic development projection until 2010», «Medium- and long-term social and economic development strategy of Astrakhan Oblast» and Consultant's estimates using a simplified macroeconomic model.

Table A.5 Electric- and heat sector generation structure and efficiency under the « Astrakhan Inertia » scenario

Year	Electricity generation			Heat generation			Specific fuel consumption				Efficiency		Losses				
	New plant	hydro	wind	New plant	Existing CHP	Share ind. boilers	New plant	Existing CHP	New plant (heat)	Existing plant (heat)	Ind. boilers	HOB	Electricity transmission	Heat distr.	Own needs	Gas transmission	Own needs gas extraction
	mln. kWh	mln kWh	mln kWh	thou. Gcal	thou. Gcal	%	Gce /kWh	Gce /kWh	Kgce /Gcal	Kgce /Gcal	%	%	%	%	%	%	%
2007	0	0	0	0	2 289	68.1%	1 95.8	360.2	155.0	162.1	86.3%	82.7%	20.9%	5.6%	9.6%	0.12%	1.4%
2008	0	0	0	0	2 536	68.1%	1 95.8	341.7	155.0	167.6	86.8%	81.9%	19.5%	5.6%	9.6%	0.12%	1.4%
2009	0	0	0	0	2 536	68.1%	1 95.8	341.7	155.0	167.6	87.2%	82.3%	19.5%	5.6%	9.6%	0.12%	1.4%
2010	0	0	0	0	2 473	68.1%	1 95.8	341.7	155.0	167.6	87.6%	82.7%	19.5%	5.6%	9.6%	0.12%	1.4%
2011	0	0	0	0	2 411	68.1%	1 95.8	341.7	155.0	167.6	88.1%	83.2%	19.5%	5.6%	9.6%	0.12%	1.4%
2012	0	0	0	0	2 351	68.1%	1 95.8	341.7	155.0	167.6	88.5%	83.6%	19.5%	5.6%	9.6%	0.12%	1.4%
2013	898	0	0	232	2 292	68.1%	1 95.8	341.7	155.0	167.6	89.0%	84.0%	19.5%	5.6%	9.6%	0.12%	1.4%
2014	1 795	0	0	464	2 234	68.1%	1 95.8	341.7	155.0	167.6	89.4%	84.4%	19.5%	5.6%	9.6%	0.12%	1.4%
2015	1 878	0	0	503	2 179	68.1%	1 95.8	341.7	155.0	167.6	89.8%	84.8%	19.5%	5.6%	9.6%	0.12%	1.4%
2016	2 693	0	0	697	2 124	68.1%	1 95.8	341.7	155.0	167.6	90.0%	85.3%	19.5%	5.6%	9.6%	0.12%	1.4%
2017	3 507	0	0	890	2 071	68.1%	1 95.8	341.7	155.0	167.6	90.0%	85.7%	19.5%	5.6%	9.6%	0.12%	1.4%
2018	4 525	0	0	1 132	2 019	68.1%	1 95.8	341.7	155.0	167.6	90.0%	86.1%	19.5%	5.6%	9.6%	0.12%	1.4%
2019	5 543	0	0	1 373	1 969	68.1%	1 95.8	341.7	155.0	167.6	90.0%	86.5%	19.5%	5.6%	9.6%	0.12%	1.4%
2020	5 543	0	0	1 373	1 920	68.1%	1 95.8	341.7	155.0	167.6	90.0%	87.0%	19.5%	5.6%	9.6%	0.12%	1.4%

Table A.6 Energy prices under the « Astrakhan Inertia » scenario

Year	Electricity					Gas		Heat		Gasoline	Diesel fuel	Residual oil	Coal	Wood
	Indus-try	Transport	Agriculture	Other	Residen-tial	Industry	Residen-tial	Industry	Residen-tial					
	rubles /kWh	Rubles /kWh	rubles/kWh	rubles /kWh	Rubles /kWh	Rubles /thou. m3	Rubles /thou. m3	Rubles /Gcal	Rubles /Gcal	rubles/t	rubles/t	rubles/t	rubles/t	rubles/t
2007	1.21	1.23	1.21	1.21	1.10	1,209	1,300	275	404	15,797	14,587	4,459	2,293.1	453
2008	1.22	1.42	1.22	1.22	1.35	1,422	1,300	513	424	16,693	15,702	5,573	2,841	453
2009	1.39	1.63	1.39	1.39	1.52	1,635	1,495	552	552	18,300	16,600	6,500	2,955	591
2010	1.56	1.82	1.56	1.56	1.73	2,044	1,869	621	621	19,581	17,762	6,955	3,162	632
2011	1.74	2.03	1.74	1.74	1.99	2,611	2,386	707	707	20,952	19,005	7,442	3,383	677
2012	1.94	2.27	1.94	1.94	2.35	3,334	3,047	805	805	22,418	20,336	7,963	3,620	724
2013	2.13	2.49	2.13	2.13	2.58	3,567	3,261	833	833	23,988	21,759	8,520	3,873	775
2014	2.35	2.74	2.35	2.35	2.84	3,817	3,489	862	862	25,667	23,282	9,117	4,145	829
2015	2.58	3.02	2.58	2.58	3.12	4,084	3,733	892	892	27,463	24,912	9,755	4,435	887
2016	2.84	3.32	2.84	2.84	3.44	4,370	3,995	924	924	29,386	26,656	10,438	4,745	949
2017	3.12	3.65	3.12	3.12	3.78	4,676	4,274	956	956	31,443	28,522	11,168	5,077	1,015
2018	3.44	4.01	3.44	3.44	4.16	5,003	4,573	989	989	33,644	30,518	11,950	5,433	1,087
2019	3.78	4.42	3.78	3.78	4.57	5,353	4,893	1,024	1,024	35,999	32,655	12,786	5,813	1,163
2020	4.16	4.86	4.16	4.16	5.03	5,728	5,236	1,060	1,060	38,519	34,941	13,682	6,220	1,244

Annex 3 Input data tables for “Oil & Gas breakthrough” scenario

Table A.7 Basic macroeconomic assumptions in the "Oil & Gas breakthrough" scenario

Year	GRP growth rate	Popula-tion	Industrial output index	Manufac-turing output index	Construc-tion SOW index	Agricultu-ral output index	Retail trade turnover index	Services	Real residen-tial income index	Commis-sioning of residen-tial buildings	Railway cargo turnover	Cargo shipment by water transport	Number of cars
	%	x000	%	%	%	%	%	%	%	x000 m2	mln. t-km	kton	pcs.
2007	104.4%	996	100.8%	100.0%	108.2%	110.1%	113.7%	105.8%	107.9%	648	12,818	2,100	244,233
2008	105.1%	994	101.2%	101.2%	107.9%	106.5%	116.0%	105.2%	111.7%	669	18,755	2,142	249,118
2009	107.2%	993	101.3%	102.6%	114.0%	107.0%	111.7%	105.2%	107.6%	720	19,712	2,251	254,100
2010	107.7%	992	101.7%	102.7%	116.0%	107.0%	110.5%	106.6%	108.4%	880	21,131	2,413	259,182
2011	107.7%	991	102.0%	108.3%	117.0%	107.5%	109.4%	112.0%	107.5%	950	22,758	2,599	264,366
2012	107.7%	990	102.4%	111.3%	119.1%	106.0%	108.9%	120.0%	107.5%	1,000	24,511	2,799	269,653
2013	110.0%	990	110.9%	108.0%	113.7%	105.0%	110.6%	109.1%	110.6%	1,100	26,398	3,015	275,046
2014	110.0%	990	110.1%	108.0%	112.2%	105.0%	110.6%	109.7%	110.6%	1,210	29,038	3,316	280,547
2015	110.0%	990	110.1%	108.0%	112.2%	105.0%	110.6%	110.4%	110.6%	1,331	31,941	3,648	286,158
2016	110.0%	990	110.1%	108.0%	112.2%	105.0%	110.6%	111.3%	110.6%	1,464	35,136	4,013	291,881
2017	110.0%	990	110.1%	108.0%	112.2%	105.0%	110.6%	112.1%	110.6%	1,611	38,649	4,414	297,719
2018	110.0%	990	110.1%	108.0%	112.2%	105.0%	110.6%	112.1%	110.6%	1,772	42,514	4,855	303,673
2019	110.0%	990	110.1%	108.0%	112.2%	105.0%	110.6%	110.8%	110.6%	1,949	46,766	5,341	309,746
2020	110.0%	990	110.1%	108.0%	112.2%	105.0%	110.6%	111.1%	110.6%	2,144	51,442	5,875	315,941

Sources: «Basic indicators submitted for the RF social and economic development projection until 2010», «Medium- and long-term social and economic development strategy of Astrakhan Oblast» and Consultant's estimates using a simplified macroeconomic model.

Table A.8 Basic products output under the « Oil & Gas breakthrough » scenario

Year	Electricity generation	Oil extraction	Gas extraction	Petroleum products	Sulphur production	Bread production
	mln. kWh	kton	mln. m3	kton	kton	kton
2007	3,101	4,197	11,936	2,185	4,850	78
2008	2,773	4,173	11,897	2,187	4,827	79
2009	3,012	4,171	11,909	2,200	4,785	80
2010	2,995	4,183	11,904	2,201	4,712	85
2011	2,920	4,795	12,004	2,394	4,752	93
2012	2,847	5,297	12,004	2,687	4,752	98
2013	4,081	5,826	12,604	2,794	4,990	98
2014	5,317	6,409	13,234	2,906	5,239	98
2015	5,332	7,050	13,896	3,023	5,501	98
2016	7,099	7,755	14,591	3,143	5,776	98
2017	8,867	8,531	15,320	3,301	6,065	98
2018	8,804	9,384	16,086	3,466	6,368	98
2019	9,150	10,322	16,890	3,639	6,687	98
2020	9,498	11,354	17,735	3,821	7,021	98

Sources: «Basic indicators submitted for the RF social and economic development projection until 2010», «Medium- and long-term social and economic development strategy of Astrakhan Oblast» and Consultant's estimates using a simplified macroeconomic model.

Table A.9 Electric- and heat sector generation structure and efficiency under the « Oil & Gas breakthrough » scenario

Year	Electricity generation			Heat generation			Specific fuel consumption				Efficiency		Losses				
	New plant	hydro	wind	New plant	Existing CHP	Share ind. boilers	New plant	Existing CHP	New plant (heat)	Existing plant (heat)	Ind. boilers	HOB	Electricity transmission	Heat distr.	Own needs	Gas transmission	Own needs gas extraction
	mln. kWh	mln kWh	mln kWh	thou. Gcal	thou. Gcal	%	Gce /kWh	Gce /kWh	Kgce /Gcal	Kgce /Gcal	%	%	%	%	%	%	%
2007	0	0	0	0	2 289	68.1%	195.8	360.2	155.0	162.1	86.3%	82.7%	20.9%	5.6%	9.6%	0.12%	1.4%
2008	0	0	0	0	2 536	68.1%	195.8	341.7	155.0	167.6	86.8%	81.9%	19.5%	5.6%	9.6%	0.12%	1.4%
2009	0	0	0	0	2 536	68.1%	195.8	341.7	155.0	167.6	87.2%	82.3%	19.5%	5.6%	9.6%	0.12%	1.4%
2010	0	0	0	0	2 473	68.1%	195.8	341.7	155.0	167.6	87.6%	82.7%	19.5%	5.6%	9.6%	0.12%	1.4%
2011	0	0	0	0	2 411	68.1%	195.8	341.7	155.0	167.6	88.1%	83.2%	19.5%	5.6%	9.6%	0.12%	1.4%
2012	0	0	0	0	2 351	68.1%	195.8	341.7	155.0	167.6	88.5%	83.6%	19.5%	5.6%	9.6%	0.12%	1.4%
2013	1 305	0	0	232	2 292	68.1%	195.8	341.7	155.0	167.6	89.0%	84.0%	19.5%	5.6%	9.6%	0.12%	1.4%
2014	2 610	0	0	464	2 234	68.1%	195.8	341.7	155.0	167.6	89.4%	84.4%	19.5%	5.6%	9.6%	0.12%	1.4%
2015	2 693	0	0	503	2 179	68.1%	195.8	341.7	155.0	167.6	89.8%	84.8%	19.5%	5.6%	9.6%	0.12%	1.4%
2016	4 526	0	0	697	2 124	68.1%	195.8	341.7	155.0	167.6	90.0%	85.3%	19.5%	5.6%	9.6%	0.12%	1.4%
2017	6 358	0	0	890	2 071	68.1%	195.8	341.7	155.0	167.6	90.0%	85.7%	19.5%	5.6%	9.6%	0.12%	1.4%
2018	6 358	0	0	1 132	2 019	68.1%	195.8	341.7	155.0	167.6	90.0%	86.1%	19.5%	5.6%	9.6%	0.12%	1.4%
2019	6 766	0	0	1 373	1 969	68.1%	195.8	341.7	155.0	167.6	90.0%	86.5%	19.5%	5.6%	9.6%	0.12%	1.4%
2020	7 173	0	0	1 373	1 920	68.1%	195.8	341.7	155.0	167.6	90.0%	87.0%	19.5%	5.6%	9.6%	0.12%	1.4%