MINISTRY OF NATURE PROTECTION OF TURKMENISTAN
NATIONAL INSTITUTE OF DESERT FLORA AND FAUNA
RESEARCH PRODUCTION CENTRE OF ECOLOGICAL MONITORING

INITIAL NATIONAL COMMUNICATION OF TURKMENISTAN UNDER UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE

PHASE 2. CAPACITY BUILDING IN PRIORITY AREAS OF THE ECONOMY OF TURKMENISTAN IN RESPONSE TO THE CLIMATE CHANGE

Ashgabat - 2006

To protect the nature, to use rationally and to augment the natural resources is the duty of every citizen of Turkmenistan

Saparmurat Turkmenbashi

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Introduction

On May 1, 1995 Turkmenistan signed the United Nations Framework Convention on Climate Change (UNFCCC). On June 5, 1995, Mejlis (Parliament) of Turkmenistan ratified this Convention.

Immediately, there was arranged the preparing of action plan to implement the respective commitments of Turkmenistan. The work over Initial National Communication on UNFCCC started in November 1997 and was completed in December 1998. As soon as it had been approved in the State Committee of Turkmenistan on fulfillment of Turkmenistan's commitments arising from the UN Environmental Conventions and Programs, the Initial National Communication was published in Russian and English languages. In November 2000, this report was presented at the 6th Conference of UNFCCC Parties.

The following job was done within the time frame of Initial National Communication preparing:

- Drawing up of National Cadastre for the year 1994 of anthropogenic GHG emissions and sinks not controlled by Montreal Protocol;
- Analysis of vulnerability of crucial economic sectors and ecosystems, as well as development of recommendations on adaptation of these sectors to the possible climate change;
- Assessment of measures on limitation of anthropogenic GHG emissions in various economic sectors and development of recommendations on adoption of national policy in this regard.
- Drawing up of National Action Plan on UNFCCC.

The research showed that in 1994 the GHG emissions in Turkmenistan amounted to 52304.766 thousand tons of CO_2 equivalent, of which CO_2 made 31859.07 thousand tons. The shares of GHG with the direct greenhouse effect in total emission represented carbon dioxide (CO_2) – 60.91%, methane (CH_4)– 38.86%, nitrogen monoxide (N_2O) – 0.23%.

Combustion of fuel in Turkmenistan resulted in 31019 thousand tons of carbon dioxide as the total emission. The energy sector was the main source of CO_2 emission that in absolute expression made 12157 thousand tons in 1994.

The GHG emissions will change in line with further development of the economy.

This project has been developed within the second phase framework, as the follow-up of Initial National Communication. The project was aimed at filling in the available gaps and developing further the Initial National Communication in such directions as:

- Identification of priority technological needs of the economy of Turkmenistan in abatement of GHG emissions and reduction of adverse impact of climate change.
- Conduction of additional studies to evaluate vulnerability and development of measures on adaptation to climate change.
- Strengthening of regional monitoring system and building up of capacity to participate in Global System of Climate Monitoring.

When analyzing the ecosystems vulnerability, it was taken into consideration that Turkmenistan is referred to the territories that may suffer to the largest extent from global climate warming. Further drying of climate may cause a number of unfavorable consequences, including the drying up of soil in main cotton and grain cultivating areas of the country. As the agriculture of the country adapted itself to the present climatic latitude zones, any shift in these zones may impact on agricultural plants yield and on productivity of pastures.

Perfection of public awareness in climate change and GHG emissions abatement issues was the important result of the project. The insufficiency of information on these issues may preclude the appearing of concern among the main groups of the population regarding the threat of global warming and connected with it possible decrease of crop yield, change in precipitations quantity and deterioration of life conditions.

The estimation of measures on reduction of anthropogenic GHG emissions in various sectors of the economy was of recommendation character.

All undertakings on GHG emissions abatement or on increase of the reduction potential are directly linked with such challenge as environment protection. Reduction of GHG emissions in energy and industry sectors may be a good contribution to the measures and policy directed on increase of energetic efficiency and development of alternative energy sources connected with the use of water, wind, sun, instead of such non-renewable resource as natural gas.

The policy and measures directed on reduction of technogenic emissions of carbon dioxide in energy sector of the economy of Turkmenistan arise from the conception of national energy strategic development aimed at increasing the efficiency of energy consumption and energy supply.

The measures developed within the framework of Initial National Communication have become the starting point for the fulfillment of the 2nd phase of the project.

The intention was to single out the following areas:

- Identification of technological needs

The technological needs of Turkmenistan cover a broad range of topics – from abatement of GHG emissions up to development and introduction of adaptation technologies. The technologies applied in power engineering, in extraction and distribution of hydrocarbon resources, the energy-efficient technologies in industrial and municipal sectors, as well as technologies on using of clean energy sources (sun, wind) are the priority ones in the matter of GHG emissions reduction.

- Identification of key technologies

The project will provide estimation of key technologies that would promote the decline of GHG emissions and mitigate largely the adverse impact of climate change, as well as identification of needs for these technologies in view of their economic and environmental efficiency.

- Working out of medium-term and long-term measures and projects to respond to particular requirements of energy consumption and energy conservation in various sectors of the economy

The appropriate attention was given to the current position and perspective development of the economy of Turkmenistan.

The current position of the economy is presented over the period of 1990-2000 with such characteristics as GDP structure, energy intensity of GDP, rates of development against the current year, investment conditions and the technologies market position.

The following sectors have been identified as the priority ones:

- oil and gas industry (extraction, refining, distribution of fuel and energy resources);
- power engineering industry (production dynamics, change of efficiency coefficient, structure of generating capacities);
- industry (chemical industry, building materials industry);
- housing and communal services sector;
- agriculture;
- water management;
- transport (automobile, railway, marine, air)

It is anticipated also to increase the potential of participation in systematic observations networks such as:

- meteorological, agro-meteorological, aerologic observations;
- observations over the atmosphere pollution, including GHG;
- hydrologic observations.

To overcome the existing statistical uncertainties and obstacles in receiving the needed information when studying the possible changes of climate and consequences of these changes, the additional research was undertaken to study:

- impact of climate change on desert pastures;

- impact of climate change on water resources;
- impact of climate change on agriculture.

Implementation of the second phase of the project will help Turkmenistan identify and assess its current technological requirements in respect of its commitments under UNFCCC and Kyoto Protocol.

General information about Turkmenistan

Turkmenistan lies in the southern part of Central Asia and borders with Kazakhstan and Uzbekistan in the north, Uzbekistan and Afghanistan in the east, Afghanistan and Iran in the south and has the Caspian Sea in the west. The total borderline of Turkmenistan equals to 5646 km. Turkmenistan is on the 50th place by territory size. The area is 491.2 thousand square km. It is 1100 km from west to east and 650 km – from south to north.

Turkmenistan is the multinational state. People of over 40 nationalities live in Turkmenistan where the number of Turkmen people is over 90%. The rural population for today accounts for 55.5%. Over the last 10 years, the population increased by 3.5% on average every year. As of 01.01.2005, the number of residents of the country was 6 million 550 thousand people, with the average annual growth as 4%. The density of the population is relatively low – 13.3 men per 1 square km. People of able-bodied age are over 50% of the population of the country. The mean age is 24. The population of the country has high educational level (literacy is 99.8%).

Ashgabat is the capital city of the country; it is situated not far from the southern border with Iran. The population of the capital city is 871.5 thousand.

The diverse natural conditions of Turkmenistan include three main types of landscape: deserts, oases and mountains. Turkmenistan is mainly a flat territory; the Karakum desert occupies approximately 80% of the whole area. The larger part of the territory of the country has no rivers and surface water flows. Amudarya, Murgab, Tedjen are the main rivers that run from the peaks of Pamirs and Parapamiz mountains. Amudarya is the largest river of Turkmenistan. The rivers of the country have big importance in irrigation. However, their uneven distribution over the territory of the country causes water shortage for irrigation, especially in the south and in the west.

The climate of Turkmenistan is sharply continental and absolutely dry. The small quantity of atmospheric precipitations and high evaporating capacity are typical for this climate.

1. Current position and development prospects of the economy of Turkmenistan

1.1. Current position of the economy of Turkmenistan

1.1.1. General characteristics of the economy over 1990-2001

Turkmenistan is the sovereign, independent, neutral state. The Constitution adopted on May 18, 1992 is the main law of the country. In December 1995, Turkmenistan got the status of neutral state under the Resolution of UN General Assembly.

Analysis of the economy position shows that structural reforms over the years of independence have provided progressive development of all main sectors of the economy.

Today, Turkmenistan has rather diverse production potential. The industry sector has enterprises of power engineering and hydrocarbons production, oil refining, chemical and petrochemical industries, machine engineering and metalworking, building materials, light and food industries. This sector of the economy produces over one third of GDP and provides the largest part of the income of the country (80%).

The reforms over the years of independence have mainly been directed on accelerated development of manufacturing branches of the economy, increase of their export potential, stimulation of production modernization and creation of new branches. Over the years under review, the majority of operating enterprises have been reconstructed, 698 objects have been constructed for the production purposes and equipped with modern technologies that promoted the growth of products competitiveness at domestic and external markets.

The gross domestic product (GDP) has been the most precise indicator of effectiveness of the economy development. In the first half of 1990s, the position of the economy of Turkmenistan and accordingly the volume of GDP considerably fluctuated. There was strong dependence on import of a big number of capital goods, foodstuffs and consumer goods.

The agrarian specialization of the economy of the country inherited from the soviet period provided in GDP structure the high share of agriculture (40%). Industry accounted for only 17%, where the mining branches made 80%. Many enterprises issuing finished products were not oriented on the domestic market and worked mainly for the requirements of other republics. The agricultural production was specialized for growing of technical crops (cotton-fiber). As a result, the decline in this crop production within the seasons of unfavorable climatic conditions affected the GDP indicator. Foodstuffs production was practically not available in Turkmenistan.

The high dependence of the economy on import of goods and services, as well as the prevalence of raw resources in export led to the difficulties which the country came across with within the first years of the independence. Due to dependence of the economy on gas extraction and gas export, the notable growth of GDP was marked at the time when production and export of gas showed the increase (Figure 1.1).

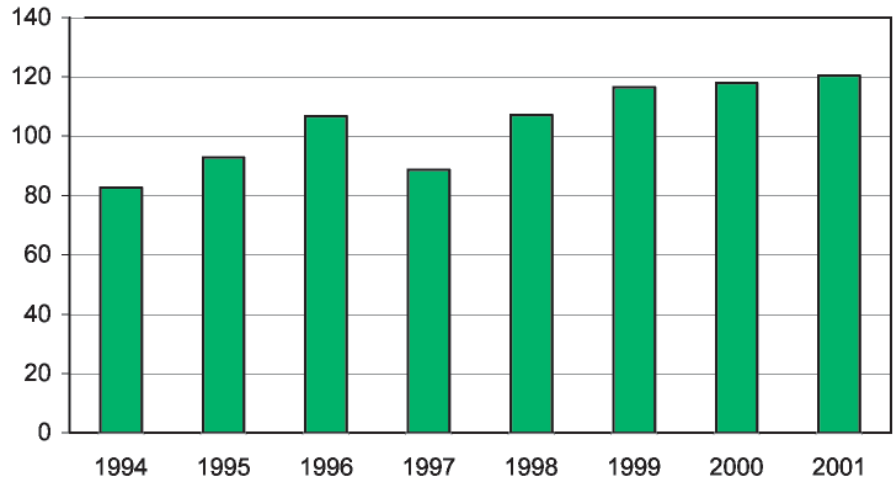

Figure 1.1. GDP over Turkmenistan, in % to the previous year

In 1999-2001, the share of industry in the GDP volume was 31-38%. In the structure of added value of the industry the percentage of downstream branches reduced nearly twice, making 36%, while the light and food industries percentage increased to 45%.

Over the period under review, the state carried out wide-range agrarian reforms. Together with retaining the cotton growing as the priority branch of the agriculture, the grain growing was developed and the basis for dynamic development of livestock-raising branch was created. It allowed to solve the problem of providing the population with the main foodstuffs produced domestically. Now, the agriculture in the structure of GDP of the country occupies 26%. The dynamics of industrial and agricultural production development over 1994-2001 is in Figure 1.2.

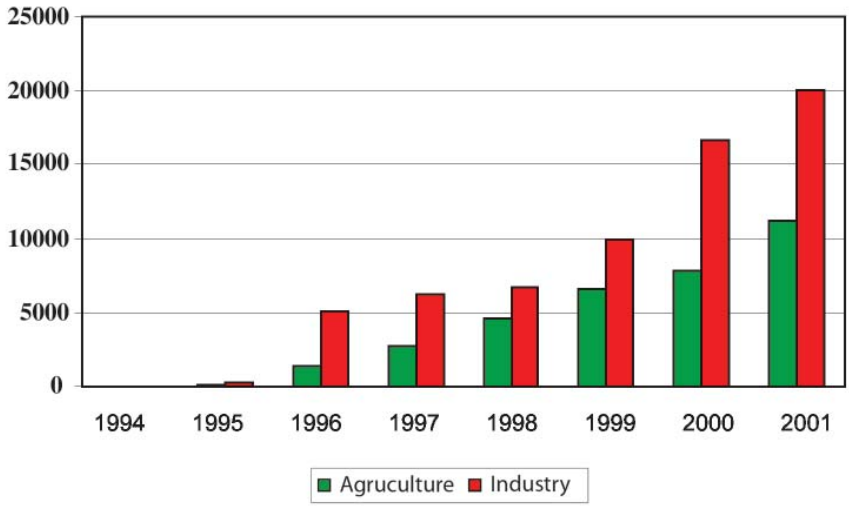

Figure 1. 2. Dynamics of industry and agriculture development over Turkmenistan, in national currency (billion manat)

The investment activity in all sectors of the economy provided high growth that promoted the forming of a notable share of construction in the volume of GDP. Over the years of reforms, its percentage stably remained at the level of 10-13%.

It was necessary to undertake radical changes practically in all sectors of the economy, and the own model of transition to market economy was worked out. Its main, strategic principles envisaged

the stepwise, evolutionary reforming, acknowledgement of leading role of the state in economic processes management at the initial stage, as well as the multi structure character of the economy and social orientation of the reforms.

These principles were taken into consideration during working out of the national program "10 years of stability" (1990-2000) and other strategies that later found their development in the Program of President of Turkmenistan Saparmurat Turkmenbashi "Strategy of socioeconomic reforms in Turkmenistan for the period to 2010".

Consistent implementation of the objectives set up in these programs allowed, irrespective of the difficulties of transition period, to prevent big decline of production, falling of the living standards of the population and to retain stability in the society.

The foreign and domestic policies of Turkmenistan, the positive neutrality status, the consistency of reforms promoted the achievement of appropriate outcome in socioeconomic development. The main macroeconomic indicators of the development of the country over 1994-2001 are in Annex 1.1.

These indicators have been provided through the profound reorganization of all production potential, implementation of active industrial and investment policies. First of all, these measures were directed on reorientation of industry from extractive to the manufacturing one, on manufacture of finished product and accelerated development of labor-intensive branches.

As a result, over the years of independence, the branch-wise structure of GDP has strongly changed and dependence of the economy of Turkmenistan on fuel and energy complex lowered.

It is necessary to note that the upward tendency of the economy development still remains. The GDP growth over the years under review proves it: in 1999 – 116%, 2000 – 118%, 2001 – 120.5% (Figure 1.1.). Practically, all sectors of the economy suggest the growth.

The non-state sector has a special role in GDP formation and this role in providing the accelerated rates of economy development increases. By 1999, privatization in trade, catering, consumer services was fully completed. Availability of adequate legal base, opening of credit lines, including the foreign ones, simplified the procedure of private enterprises opening and licensing, led to enlargement of the sphere of entrepreneurship. The private sector dominates in agriculture (60%), trade (70%) and transport (56%).

The optimal structure of economy for the country was the outcome of the comprehensive reforms. The structure of GDP in 2001 is shown in Figure 1.3.

The stable growth of GDP within the years of the period under review resulted in the increase of average income per capita. In 1996, the GDP per capita in Turkmenistan was US$2968 (by purchasing power parity), and in 2001 it was US$5350.

The share of GDP directed on consumption increased, thus promoting the rise of the living standard of the population. In early 1990s, 30% of GDP were allocated for consumption, in 2001 this indicator showed 51%, with attributing to over 70% of consumption to the domestic production.

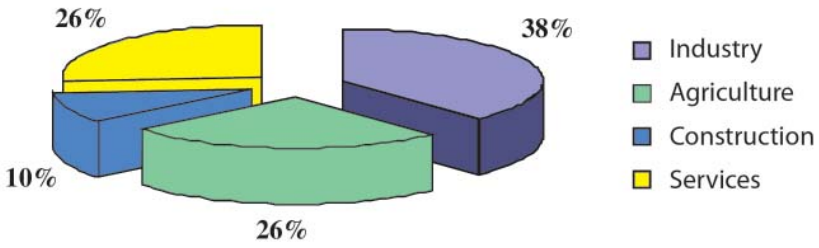

Figure 1.3. Structure of GDP of Turkmenistan in 2001, %

1.1.2. GDP changes and the use of primary fuel and energy resources over 1990-2001

Naturally, the changes in economic situation, in GDP structure influenced on consumption of fuel and energy resources (FER). The natural gas extraction prevailed in the balance of energy resources of the country. In 1990, the economy produced 87.8 billion cubic meters of gas and 5 million tons of oil. The energy resources were mainly exported. In 1990, 65 billion cubic meters of gas were exported through the trunk gas pipeline to the Western Europe. Over these years, Turkmenistan took the third place in oil extraction among the FSU countries. A part of extracted oil and gas was and is refined now at the oil refining enterprises of the country. The information on dynamics of production, use and export of oil and gas and electricity over 1995-2001 is shown in Annex 1.2.

Rapid development of industrial potential and transport system of the country, and also the growth of electricity consumption by households and agriculture led to the consistent increase of FER using. This, in turn, caused the growth of harmful substances volumes emitted to atmosphere. Pollution of air in the regions of the country where fuel, chemical, oil and gas industries, as well as industry of construction materials and municipal economy prevail was especially intensive.

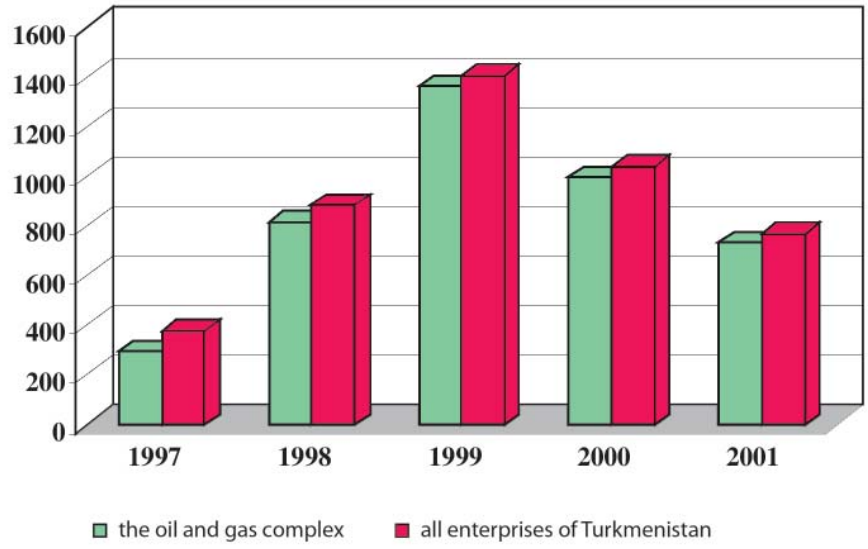

Figure 1.4. Harmful substances emissions to atmosphere from the stationary sources, (thousand tons)

According to the governmental statistics, the volumes of harmful substances emitted to atmosphere equaled between 521 thousand tons in 1995 and 768.5 thousand tons in 2001. Hydrocarbons, sulfur dioxide, carbon dioxide, oxides of nitrogen and solid substances were the main contaminants in addition to carbon dioxide. Emissions from the oil and gas complex accounted for 95% of their total volume over the country. In 2001, they fell down by 46% (Figure 1.4.) in comparison with 1999, owing to utilization of the casing-head gas at the fields of the western Turkmenistan that earlier had been flared or emitted to atmosphere. Now, this gas is sent to the trunk gas pipeline or injected to the oil beds to intensify extraction. In future, the consistent realization of environment protection measures in the country, such as construction of new treatment facilities, modernization of production, replacement of old equipment, perfection of technological processes and others, will boost the reduction of harmful substances emissions to atmosphere.

1.1.3. Investment conditions and the technological market position

Production efficiency, as well as economic and ecological security depend in many respects on the investment policy.

The laws "On investment activity", "On foreign investments", "On pledge", "On property", "On enterprises", "On joint-stocks companies", "On foreign concessions", "On hydrocarbon resources" specify the rights, responsibilities and liabilities of the participants of investment process, define their privileges, the aspects of activity, including those connected with the environment protection.

All this provided the dynamics and the high rates of investment process in Turkmenistan. Over 1991-2001, the total volume of investments had grown 12.9 fold.

Putting into operation of hundreds of factories, plants allowed to create additional job places, solve the problems of employment and increase of incomes of the population. The dynamics of investments to the economy of the country over 1994-2001 is shown in Figure 1.5.

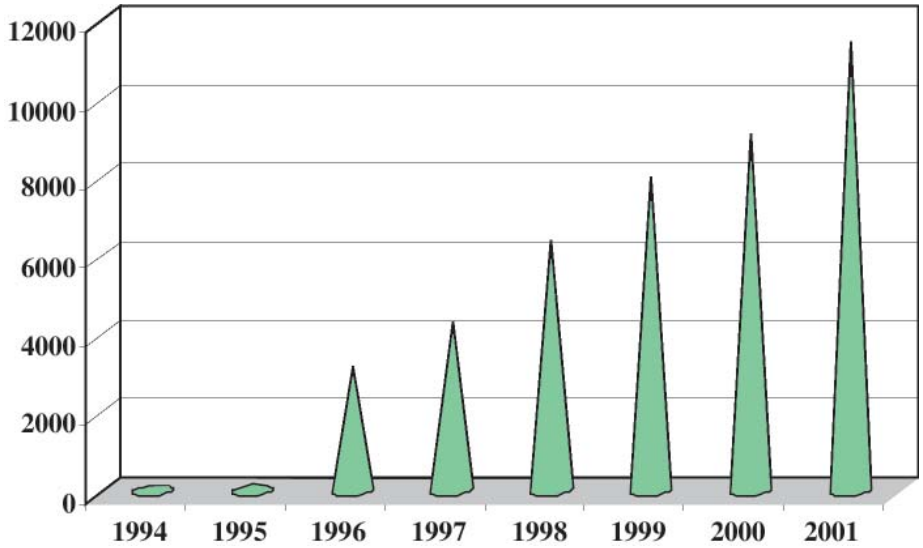

Figure 1. 5. Dynamics of capital investments growth in Turkmenistan, (billion manat)

Considerable part of investments was channeled to the social sphere. Over 1991-1995, the share of these investments increased from 23 to 40% of the total volume.

Since 1997, there appeared the tendency of priority investing of production sphere. The share of investments to industry development remained on the level of 50% of their total volume. Notable changes took place in agro-industrial complex of the country. The new irrigated lands have been put into operation, the new canals, collectors and local motor roads have been constructed. These measures boosted the solution of strategically important objective for the country, which is the provision of food security.

Large investments have been made to the implementation of environment protection measures, including the improvement of ecological situation in the Aral Sea zone. Water purification plant, trunk water pipes and collectors appeared in Dashoguz velayat. In other regions, new drainage networks were constructed and the existing ones were reconstructed. The capital repair of equipment at the oil refining and cotton-cleaning plants was performed to reduce the emission of harmful substances to atmosphere. The Abadan cement plant was relocated to reduce the level of air pollution nearby the capital city of the country. When constructing the new industrial objects, the new technologies were used in consideration of the environment protection measures.

Favorable economic situation, huge resources and appropriate legal base attracted the foreign

capital in a form of direct investments. Over the years under review, the share of foreign investments accounted for 10-12% of their total volume (Figure 1.6.). In 2001, over 140 foreign companies from 20 countries of the world participated in the investment activity.

The policy of attraction of foreign investments to the economy of the state stipulated implementation of the priority investment projects promoting the availability of Turkmen goods at external markets, the export increase and diversification, the new job places creation, the production and social infrastructure development, as well as the capital flow to the labor abundant regions with rich natural resources in order to speed up their development. To this end, the share of foreign direct investments increased through the creation of joint ventures with foreign participation in cities, free economic zones and border territories of the country, and also through attraction of foreign loans to highly effective productions with further repayment of these loans from return on investment.

Over the years of independence, hundreds of objects have been constructed and put into operation with the participation of foreign companies. These were the objects of oil and gas, power engineering, chemical, food, light, medical industries, transport and communication and socio-cultural objects.

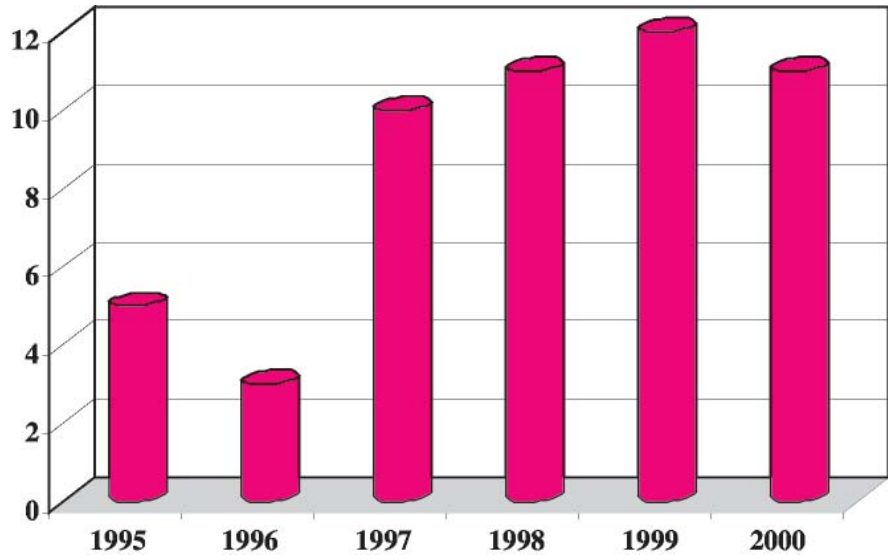

Figure 1. 6. Share of foreign investments in the fixed assets of the country, %

Active investment policy paved the way for the expansion of **technological market.** Over the years of independence, the import of capital goods has grown from 5% in 1991 to 50% in 2001, due to increase of the supply of equipment for gas, textile industries and agricultural sector.

Intensification of oil and gas extraction was directly connected with introduction of new technologies to the exploring and drilling work at onshore and offshore fields of the Turkmen sector of the Caspian Sea, supply of oil drilling platforms, vessels and pipe laying cranes. Construction of new facilities for gas preparation and processing, creation of petrochemical production and fertilizers production were of similar importance in this respect. Modern technologies came to power engineering that intends to begin to widely use gas for electricity generation.

In particular, large state investments were channeled to complete reconstruction and modernization of the Turkmenbashi Refinery, of which over US$1 billion has been already used. Large amounts were used for the purchase of drilling equipment, construction and reconstruction of compressor plants, developing of oil and gas fields and realization of projects on exploring and developing of perspective on-shore structures. Just in 2001, approximately US$800 million were invested to the oil and gas complex at the expense of own funds.

1.1.4. Role of private sector in the economy of Turkmenistan

Since the first years of independence gaining, the government approved the stepwise, gradual transition to market relations. The non-state sector of economy, with domination of private sector in it, was developed in parallel with the state sector of the economy.

Over the years of reforms in Turkmenistan, the legal framework and the institutional structure were established to render assistance to small and medium business development. In early 1990s, the legal base was established for the private sector. These were the laws of Turkmenistan "On entrepreneur activity", "On property", "On free economic zones", "On denationalization and privatization" and so on.

As a whole, the foundation for further development of market infrastructure was formed. The new bank, finance, tax and insurance systems were created. The commodity exchange, the audit, leasing companies and other market structures were formed. The system of centralized distribution of commodity resources was abolished in the country to provide conditions for a free wholesale trade. All economic entities of any form of ownership have got access to the commodity and raw resources of the country. The basis for securities market functioning was created. The market structures, the state support to private entrepreneurship development ensured favorable conditions for functioning and increasing of the effectiveness of this sector of the economy.

Availability of private enterprises by branches of the economy is shown in Figure 1.7.

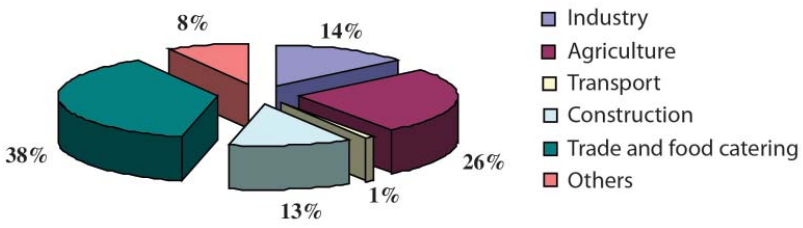

Figure 1. 7. Availability of small non-state enterprises by basic economic branches of Turkmenistan in 2001

There appeared the tendencies of reorientation of non-state sector in favor of the development of commodity producing branches. These structures notably increased tax payments to the central and local budgets. The privileged system of crediting promoted the development of private enterprises. The percentage of credits granted to non-state sectors increased every year. Such international financial organizations as the European Bank for Reconstruction and Development, the Central Asian-American Fund for Entrepreneurship Support, the Turkmen Joint-Stock Bank of Reconstruction, Development and Support of Entrepreneurship played a big role in these developments. Also, the volume of credits of the banks of Turkmenistan in national and in foreign currencies increased every year. The credits in foreign currency were extended mainly for the financing of private commodity producers, of export-oriented or import-substitution productions. According to the governmental statistics, the share of short-term credits issued by the banks of the country to enterprises and organizations of non-state sector accounted for 18% as at 01.05.02.

The non-state sector was developing by means of establishment of private enterprises and privatization of state enterprises, and also by reforming the property relations in the agrarian complex. Over the years of reforms in Turkmenistan, around 2000 state-owned objects were privatized, 33 state enterprises were restructured to the joint-stock companies. The overall government support to lease-

holders and private landowners, particularly the adoption of laws "On private property", "On farmers' associations" provided favorable conditions for the development of non-state sector in agriculture.

The private sector of the economy dominated in the consumer market of the country. In 2001, its share was 87% of commodity turnover. The private producers sold the main volumes of commodities (82%) at the market where people purchased over 90% of vegetables, fruits, melons and gourds, over 80% of meat and other foodstuffs. The market became the main source of commodity resources, owing to sensitive response to public demand and flexible price policy.

Since 1993, the joint ventures and the foreign companies came with their trade activity to the domestic market of Turkmenistan.

Thus, the economic reforms over the years under review boosted further development of market relations and creation of economic and legal conditions for the advanced development of non-state sector in various branches of the economy. As of 01.01.2002, this sector of the economy had 15 thousand registered enterprises, of which 12.5 thousand were the private ones making 66% of total quantity of registered legal entities of the country.

The share of private sector in industry made 23%, in agriculture – 76% and in trade – 89% of gross output. Over 50% of GDP was produced in private sector.

1.1.5. Securities market. Financial and credit market

Transition to market economy in Turkmenistan requires creation of financial market to accumulate free financial resources of economic entities and invest them to the priority economic branches.

The securities market is a component of the financial market. The legal base of this market is the law "On securities and stock exchanges in Turkmenistan". A number of joint-stock companies and joint-stock commercial banks were established in compliance with the deepening of economic reforms of the country and realization of the state program of privatization in Turkmenistan. The securities market has got its further development.

The investors show their trust to the stocks of joint-stock banks of the country as to a reliable, effective method of investment of financial resources.

The inter-bank currency exchange market is the basis of the money market development. In practice, all commercial banks participate in biddings.

The inter-bank market of credit resources plays important role in distribution of uncommitted resources to the priority branches of the economy. The inter-bank market of credit resources in national currency is very active. The positive sign of the credit market is that the interest rate decreases when the volume of credit transactions grows.

1.2. Current position of main economic sectors and prospects of their development.

The state independence of Turkmenistan has provided an opportunity to pursue independent industrial policy, which was the crucial element in establishment of national economy as a whole.

Availability of huge mineral resources and good prospects of the expansion of hydrocarbon resources extraction and refining made the basis of this policy.

Oil and gas are considered to be available on 80% of the territory and the projected resources are assessed as 21-23 trillion cubic meters of gas and 12 billion tons of oil. Natural gas, petroleum products, electric energy are the main items of industrial export. Turkmenistan has big reserves of mining-chemical and mining raw materials. These are sodium sulfate, magnesium, iodine, bromide, sodium chloride, potassium salt, carbonate raw materials for chemical industry, bentonite clays, kaolin, and raw materials for the production of mineral fibers, marble onyx, earth wax and others. The metal mineral resources include lead and zinc. There are numerous fields of mineral resources suitable for the industry of building materials in the territory of Turkmenistan.

Analysis of the structure of capital investments in Turkmenistan of 1990s showed that a considerable part of total investments was directed on expansion and perfection of industrial sector of the economy (Figure 1.1.).

Table 1.1.
Percentage of industry in the capital investments over Turkmenistan in 1994-2001

Years	Percentage of industry, %
1994	35
1995	40
1996	38
1997	53
1998	51
1999	59
2000	46
2001	44

The industrial policy of this period was of absolutely selective character. Two main directions had got the priority in industrial development – the fuel and energy complex (FEC) and the manufacturing industries of the agrarian complex – with the aim to involve to the industrial process the natural resources. Since 1993, the share of this sphere of industrial production in total volume of industrial investment made over 90%. Large structural transformations at the initial stage were implemented on the basis of extensive factors of growth. The reproduction structure of industrial investments showed that the share of new construction over 1994-2000 was 70-80%. Such active capital redistribution suggested the opportunity to realize some crucial goals over the relatively short term of independent development. In 2001, this structure looked as follows (Figure 1.8.).

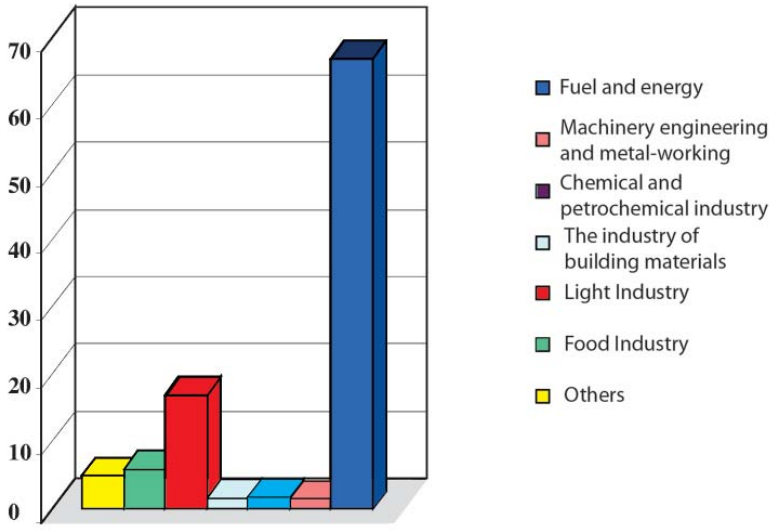

Figure 1.8. Branch-wise structure of industrial production of Turkmenistan in 2001, %

The fuel and energy complex (FEC) was traditionally the priority branch of the economy of Turkmenistan. Figure 1.12 shows the percentage of FEC products in total volume of the industrial production over 1995-1999. While occupying 60-65% (2000-2001) in industrial production, this complex played and still plays the determining economic and social role for the country. Over 68% of total returns in the industrial sector fell to its share in 2001. The branch-wise structure of FEC in 2001 is in Figure 1.9.

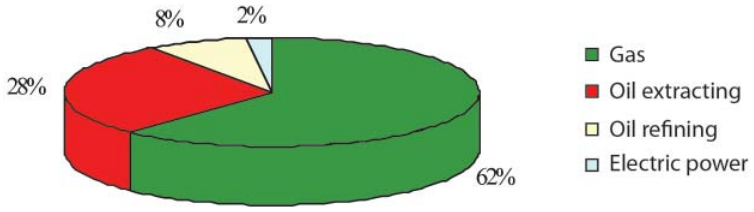

Figure 1.9. Branch-wise structure of FEC of Turkmenistan in 2001, %

1.2.1. Oil and gas industry

The oil and gas complex of Turkmenistan not only forms the structure of the economy, it plays the key role at all the stages of its development. Its role in creating the gross domestic product and export potential of the country is high.

The potential resources of hydrocarbon raw materials amount due to projections to 43 billion tons in oil equivalent. Now, the reserves of hydrocarbon resources in Turkmenistan are represented by 130 gas fields and 27 oil fields, of which accordingly 39 and 18 are under development.

In 1970-1980s, at the time of intensive extraction of hydrocarbons in Turkmenistan, the volume of oil production reached over 16 million tons and of gas – 85-90 billion m^3. The extensive method of hydrocarbons extraction led to premature exhaustion of the fields, watering and destruction of productive horizons, and at the same time the non-observance of ecological norms at the time of extraction brought intensive contamination to environment. The hydrocarbon resources extraction, their export, domestic use and refining sharply declined with the collapse of the Soviet Union and break of economic ties. Production growth in this industry started from the second half of 1990s (Figure 1.10, 1.11). The growth stemmed from modernization and reconstruction of enterprises, introduction of highly effective and environmentally safe technologies that could promote the reduction of wastes discharges to environment.

The Law of Turkmenistan "On hydrocarbon resources" has become the huge incentive for the industry development, as it permitted to realize transition of the national oil and gas complex to the market relations, to the standards of international cooperation.

This legal act specifies the rational and effective use of hydrocarbon resources and conservation of natural resources of Turkmenistan as the main aims and objectives. It assigns some compulsory environmental measures and measures on protection of the health of people.

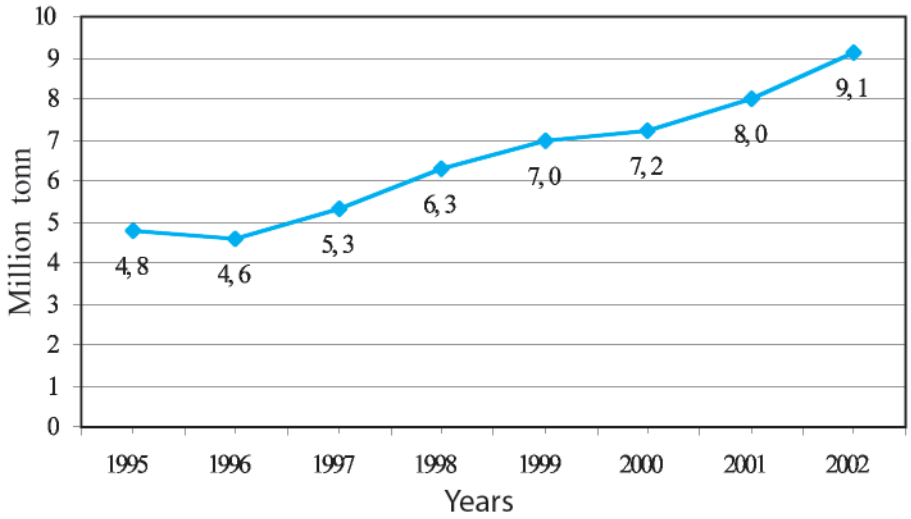

Figure 1.10. Oil extraction

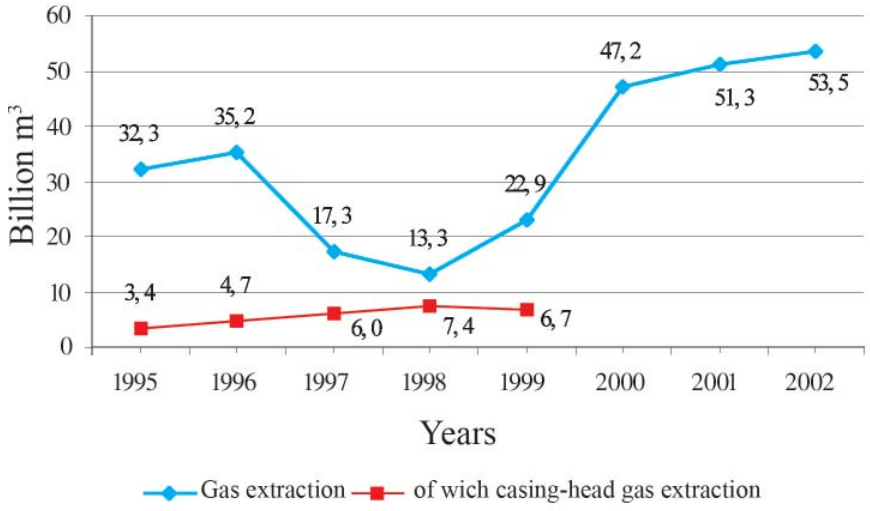

Figure 1.11. Gas extraction

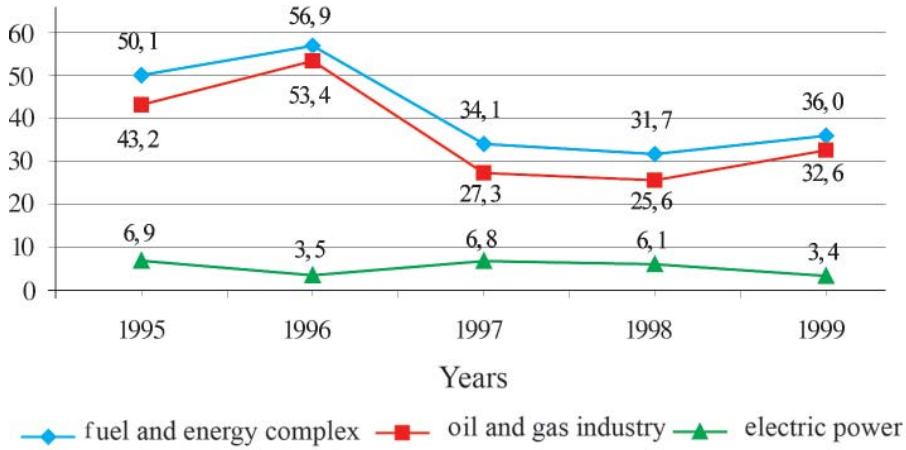

Figure 1.12. Percentage of fuel and energy complex products in total volume of industrial output of Turkmenistan over 1995-1999, %

However, the oil and gas industry at all stages of its functioning largely affects the environment, with unfavorable consequences for the life of a man and existence of biodiversity.

The impact of oil and gas complex objects implies emission to atmosphere of the products of natural gas combustion, emission of crude natural and casing-head gases, hydrogen sulfide, crude and petroleum products escape, effluents of highly-mineralized, toxic bedded and technological waters, various solid wastes and also mechanical, acoustical and thermal breaking of the landscape equilibrium.

The adequate legal framework created over the years of independence predetermined large interest of foreign investors to participation in developing the priority projects for the country. Production Sharing Agreement (PSA) is the most preferable form of attracting the foreign investments to the oil and gas projects in Turkmenistan. Today, a number of foreign companies work on conditions of production sharing.

Development of the Turkmen shelf of the Caspian Sea is one of the priority directions in the sphere of hydrocarbon resources prospecting and extraction.

Reconstruction of the existing oil refining plants and construction of the new ones are aimed at increasing the quality of petroleum products, enhancing the nomenclature of output, increasing of oil refining industry. It is connected with the necessity to expand the export potential of the country and also with the development of adjoining branches, and first of all, petrochemical branch.

The oil processing branch has in its structure two refineries: refinery in Turkmenbashi city (Turkmenbashi Refinery) and refinery in Seydi town (Seydi Refinery). From the first days of independence of Turkmenistan, President of Turkmenistan determined the modernization and reconstruction of the Turkmenbashi Refinery as the priority target in development of oil and gas complex of the country. Successful realization of the complex program of the Turkmenbashi Refinery resulted in production of considerable volumes of high octane unleaded gasoline. The volume of oil refining increased up to 6 million tons per year, and the depth of refining increased up to 90%.

Successful implementation of the comprehensive reconstruction of the Refinery resulted in notable improvement of the positions of Turkmenistan at the international market. While satisfying the domestic needs in broad mix of petroleum products, the country becomes one of the world exporters of these products. Some indicators of the oil and gas refining industry of Turkmenistan are in Annex 1.3.

The enterprises of the oil and gas industry are the main sources of the emissions of harmful substances to atmosphere, and mainly of hydrocarbons. The analysis of emissions dynamics showed the reduction of total volume of emissions from 1362.4 thousand tons in 1999 to 732.4 thousand tons in 2001.

In 1998, after the upswing of oil extraction, the assessment of gas combustion volumes was performed. It appeared that 2-2.5 billion cubic meters of casing head gas was emitted to atmosphere or burnt up every year. Today, 40% of this casing head is used for production of liquefied gas at the Turkmenbashi Refinery and also for using it in gas lift process.

In case of maximal production of oil, the volume of casing head gas will reach 8.1 billion m^3 per year by 2010. It is necessary to introduce the certain schemes of casing-head gas utilization in order to prevent the adverse impact on environment. There are some ways of utilization of casing-head gas:

1. Collection of casing head gas for compressing it and transporting through the gas pipelines for realization on a commercial basis or using in gas lift exploitation of oil beds. To this end, the small compressor stations should be constructed at every extraction object in consideration of the volumes.

2. Collection of casing head gas and its processing to liquefied gas, chemical fertilizers (ammonia, urea) and getting of liquid oil fuel (methanol and etc.). To this end, the construction of facilities to produce above named products at the objects of extraction should be envisaged.

3. Generation of electric power on the basis of casing-head gas and realization of this power at the domestic and external market.

Now, three units produce liquefied gas in Turkmenistan. The first one was put into operation in 1998 at the gas condensate field Naip. Its projected capacity is 15 thousand tons of liquefied gas and the same quantity of gas condensate per year. From 1998, the unit works steadily and issues products in projected volumes. In November 2002, the 2nd unit of liquefied gas production was put into operation at the Naip field with the projected capacity of 9 million m^3 per day of gas processing and of 65 thousand tons per year of liquefied gas production.

Turkmenbashi Refinery is the other large producer of liquefied gas. Upon modernization of the enterprise, the production of liquefied gas increased from 18 to 220 thousand tons per year.

In perspective, it is assumed to introduce some new units with the help of foreign investors. By 2010, the production of liquefied gas will reach 0.6 million tons and by 2020 it will increase up to 2 million tons per year.

1.2.2. Power engineering

Power engineering is one of the leading branches of the industry and its capacities are sufficient for satisfying the needs of the country and for export of electricity to the neighbor countries.

Over the years of independence, owing to re-equipment and installation of additional capacities, construction of new high-voltage power transmission lines the stable and reliable functioning of power engineering system of Turkmenistan considerably increased.

The thermal power stations make the basis of power engineering, where the natural gas is the initial energy carrier. Six power stations with total capacity of 2562.2 MW compose the structure of the electric power system of the country. They are Mary SRPS, Turkmenbashi TPS, Abadan SRPS, Balkanabat SRPS, Seydi TPS. These power stations have the status of the objects of general use. Within the last years, they produce over 10 billion kW/h per year. The annual consumption of natural gas at these stations is approximately 3.5 billion m^3.

The natural gas is the main fuel at the power stations, while the furnace fuel oil is the reserve one. The dynamics of ratio in using the natural gas and fuel oil at the power stations is shown in Figure 1.3.

The use of the reserve fuel – fuel oil is less than 1%.

The change of efficiency and of specific consumption of conditional fuel is shown in (Figure 1.4).

Table 1.2.
Structure of generating capacities of power stations in 2000, MW

Technology	Designed capacity	Available capacity
Thermal power stations, condensate	2255	1829
Thermal power stations, gas turbine	369	270
Hydropower stations	1.2	1.2
Total	**2652.2**	**2100.2**

Table 1.3
Dynamics of natural gas and fuel oil consumption at the power stations

Years	Fuel oil			Natural gas			Total thousand tons c. f.
	Thousand tons	Thousand tons c. f.	% of total	Million cubic m.	Thousand tons c. f.	% of total	
1994	29.7	40.9	1.0	3526.7	4028.6	99.0	4069.5
1995	28.1	38.8	1.0	3477.1	3819.6	99.0	3858.4
1996	52.7	72.7	1.9	3567.7	3827.5	98.1	3900.3
1997	35.5	49.0	1.3	3393.1	3623.6	98.7	3672.6
1998	8.3	11.4	0.3	3313.4	3593.9	99.7	3605.3
1999	6.9	9.6	0.3	3214.1	3472.6	99.7	3482.2
2000	13.5	18.6	0.5	3560.4	3809.5	99.5	3828.1
2001	28.0	38.6	1.0	3642.0	3864.4	99.0	3903.0

Table 1.4.
Efficiency and specific consumption of fuel at thermal power stations

Indicators	Measure unit	Years							
		1994	1995	1996	1997	1998	1999	2000	2001
Specific consumption	g/kilowatt-hours	365.4	370.3	369	377.6	383.5	379	370.9	385.5
Coefficient of efficiency	%	33.62	33.17	33.29	32.53	32.03	32.41	33.41	33.86

The availability and the use of a considerable quantity of old and obsolete capacities and equipment were the main reasons of such situation. Therefore, the wide-ranging measures on modernization of the existing power stations have been undertaken in Turkmenistan.

The USA Company "General Electric" implemented the construction of gas turbine plant (GTP) for 123 MW in 1997 at the Abadan SRPS. That was the first turbine in the region meeting the international technological standards and environmental requirements. The similar gas-turbine plant was commissioned in 2004. The total designed capacity of the power station is 369 MW. The replacement of steam turbine generators to the highly effective and environmentally safe gas turbine plants will contribute to the reduction of emissions of harmful substances from the power stations of the country.

Thus, from the point of view of energy resources saving and decrease of emissions of carbon dioxide the following version of modernization for the existing power stations is proposed:

- technological equipment of Turkmenbashi HPP, Balkan SRPS and Abadan SRPS will be replaced for the highly effective steam-and-gas plants;
- the measures will be taken for solution of the problems of Mary SRPS and Seydi HPP, i.e. the effective method of modernization of the present power units by additional building up of steam-and-gas plants. When modernizing the present power units with 210 MW and 80 MW capacities, the saving of fuel will be 9-9.7% (fuel oil combustion) and 8.3-8.9% (natural gas combustion).

Turkmenistan is the energy abundant state and it can potentially produce 17 billion kW/h of electric power and export 47% of this volume to the ECO countries. (Annex 1.4).

Turkmenistan exports electricity to Afghanistan, Iran, and Turkey. The volumes depend on the needs in these countries. The power transmission lines were constructed to the cities of Afghanistan: Mazari Sharif, Andhoi, Hodjadukki, Shibergan (110 kV). The construction of PTL-220 kV to Gerat city is envisaged. Two power transmission lines (110 kV and 220kV) connect the Turkmen and Iranian power systems. All this allows to considerably increase the export of electricity to the neighbor country.

Turkmenistan is the initiator of creation of a single electric power system of member countries of ECO on the basis of the existing systems. Such unification of electric power systems of a number of countries will provide some engineering and economic advantages, and increase reliability and quality of power supply.

The heat in Turkmenistan is supplied through the HPP, large and small heating boilers and also apartment heat generators.

The Ministry of Energy and Industry is the main supplier of heating. In 2000, the share of heat supplied by the Ministry accounted for over 60% of total volume. Therewith, the heat required for the production purposes is also supplied from boiler houses of separate ministries, agencies. These are:

SC "Turkmenneft", SC "Turkmengas", Association of Food Industry, "Turkmendokun", etc. The data of heat production in Turkmenistan are in Table 1.5.

Table 1.5.
Heat production in Turkmenistan, thousand Gcal

Name	Measure unit	Years							
		1994	1995	1996	1997	1998	1999	2000	2001
Heat production	Thousand Gcal	2379.7	2251.0	2029.7	1727.7	1430.0	1372.9	1571.5	1168.3

Today, the centralized heating is supplied to industrial enterprises in a volume of 50%, to state municipal sector in a volume of 15% of all heated surface in Turkmenistan.

In Ashgabat city, 52% of all heated surface gets heating from centralized system. It is about 60 boiler houses belonging to Ashgabat hyakimlik. Around 8% of users get the hot water from the centralized system of heating.

The total capacity of boiler houses, with taking into consideration of hot water supply, is 565 Gcal/h. With the norm 100 million m^3/year of natural gas consumption, the real consumption is 153 million m^3 per year.

The total length of heating nets of the centralized system as a whole in Ashgabat city is 465 km, of which 61% is laid under ground and 39% - over ground. The largest part of surface nets is not protected with heat insulation that causes heat losses in a volume of 55850 Gcal over the heating period. The surface net should be provided with insulation. It will be possible to save around 2 million 234 thousand cubic meters of gas and prevent the additional emission of GHG. The exploitation period of 30% of heating nets is over 20 years that leads to damages and heat losses rather often.

Large losses happen in intra-house systems of heating and hot water supply, at the heating units and in the transfer nets. Due to the small percentage of the provision of users with hot water from the centralized heating system, there are many cases of unauthorized using of hot water for the private needs in apartments from the centralized heating system. In a whole, all water leakages in the centralized heating system lead to big losses in heat-transfer and to the reduction of its efficiency.

For the replenishment of water in the centralized heating system, the water is spent in a volume of 55107 m^3/day (36348 m^3/day is the norm), i.e. by 18759 m^3/day above norm, and over the whole heating period the water losses make 2438670 m^3. To heat this water 14632 Gcal is required additionally, leading to fuel surcharge in a volume of 2700000 m^3 of natural gas.

Thus, for the reduction of heat losses and consequently for the decrease of useless consumption of energy resources a number of engineering and organizational measures are required.

1.2.3. Renewable energy sources

Due to its geographic and climatic conditions, Turkmenistan disposes of the certain reserves of energy of sun, wind and geothermal waters. The rivers of the country practically have no energetic potential. Amudarya is the largest river in the territory of Turkmenistan with its 1000 km length. It is mainly the flat part of the river where the banks are often washed out and channel changes. Large investments for the huge dikes construction will be required to turn hydrologic energy to electric energy. The other rivers (Murgab, Tedjen, Atrek) cannot be used for HPS construction because of small quantity of water in them.

Energy of Sun In Central Asia, the duration of daytime in June is 16 hours, in December – 8-10 hours. There are 300 sunny days in a year; the duration of sunlight is 2500-3100 hours in a year and 320-400 hours in a month in summer. The average daily density of solar radiation in the territory of Turkmenistan is 23760 J/m^2 per day. Each square meter of surface receives $8x10^6$ kJ of power per year and the whole territory – $4x10^{15}$ kJ.

The Scientific-Production Association "GYUN" has performed the certain research concerning the use of solar energy.

Due to estimations, the annual solar radiation inflow of not less of 1200kW h/m^2 will permit to

provide up to 25% of heat consumption of the heating systems, 50% in the system of hot water supply and 75% in the systems of air conditioning. The consumption of organic fuel and the emissions to atmosphere of nitrogen oxide and sulfur will decrease. The transition to the solar heat supply of 10% of rural users will save up to 1.7 million t. c. f. per year.

The analysis of users' load on heating, air conditioning and hot water supply shows that the use of solar energy would save 2364 thousand t. c. f. or 52.6%, of which 1110.6 thousand t. c. f. or 61.5% in the rural area.

The introduction of solar power units will save the fuel and reduce the emissions of GHG:

- solar dryer will save 270 million t. c. f. over 10 years and cut down the CO_2 emissions by 655Tg;
- solar boiler will save 0.15 t. c. f. per 1 sq. m. per year and cut down the CO_2 emissions by 0.364 Mg;
- autonomous solar complex will save over 10 years 1.8-2.0 t. c. f. and cut down the emissions of CO_2 by 4.37-4.85 Mg.

Energy of wind. The map of distribution of wind-energy resources over the territory of Turkmenistan permitted to calculate the energy resources of pasture regions making in total 38.2 million hectares. The annual economic effect from combination of solar-wind energy systems of heat and cold supply for countryside house of 150 m² area will be US$ 0.4 thousand per year, with saving 180-200 kg c. f. per capita. The wind energy device may satisfy 40%-85% of energy consumption. The autonomous solar energy complex has been designed. It includes solar desalting unit, solar-wind energy unit for water lifting and energy supply, stand by unit (diesel power station of low capacity), sheep yards, solar greenhouse with drip irrigation, shepherd's house with solar system of heat and cold supply and system of distributing reservoirs for salty, distilled and potable water, photo reactor of closed type for production of chlorella, and ferments for processing of animal husbandry wastes. The autonomous solar power complex will save 1.8-2.0 t. c. f. over ten years and decrease the CO_2 emissions by 4.37-4.85 Mg.

Geothermal energy Turkmenistan has a big potential of geothermal waters (GTW). In perspective, the broader use of GTW in medical and sanatorium institutions of Turkmenistan and also in heating the premises, the greenhouses will be possible. For instance, the combined use of solar energy and energy of geothermal waters in various regimes of the work of greenhouse will cover the heat losses: solar radiation – 15.1%, air heating – 29.6%, subsoil heating – 24.5%, combined heating – 69.2%.

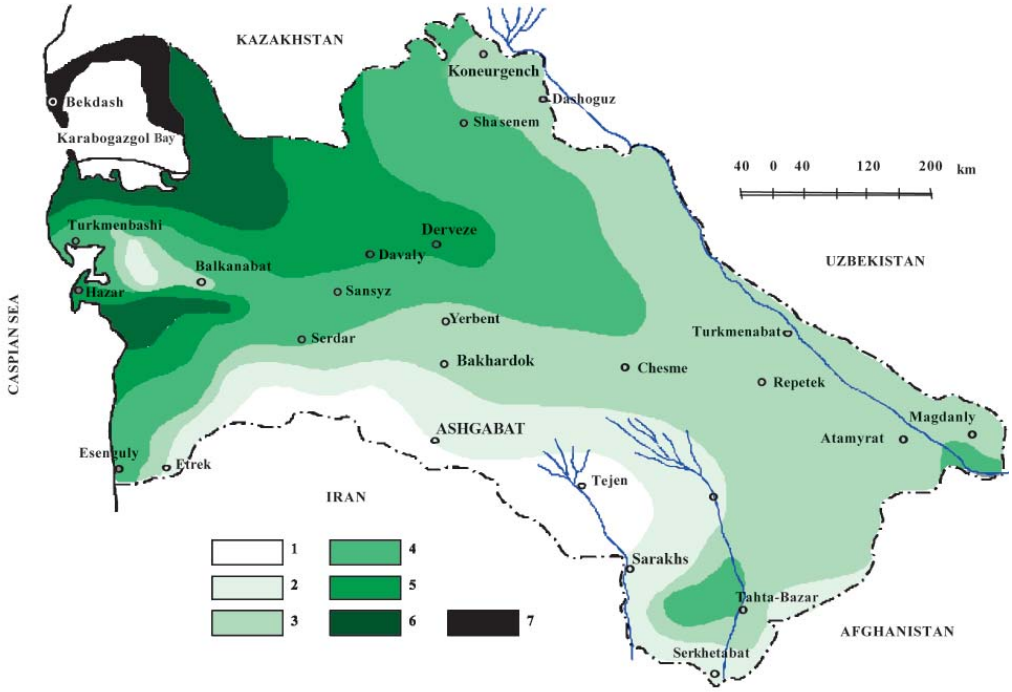

Figure 1.13. Wind - energy resources of Turkmenistan

1 – the districts where energy of air flow with 90% provision will be less than 100 kWh/m² per year; **2** – between 100 and 200; **3** – between 200 and 400; **4** – between 400 and 600; **5** – between 600 and 800; **6** – between 800 and 1000; **7** – over 1000

1.2.4. Chemical industry

The chemical industry of Turkmenistan is represented by the JSC "Turkmendokun" reporting to the Ministry of Energy and Industry of Turkmenistan.

Eight industrial enterprises producing over 50 kinds of products compose the structure of the JSC "Turkmendokun".

The main part of technological plants, workshops and facilities of this industry was constructed at the time of the Soviet Union, and production capacities were designed for the whole market of the USSR.

After the USSR break-up, the chemical industry of Turkmenistan, despite the availability of raw materials, labor force, energy, lost its largest consumers because of closing or reduction of their production powers.

In connection with above and other subjective and objective reasons, the volumes of chemical production and the sale of these products notably reduced in early 1990s. The production breakdown continued in 1995-1996, and then it began to grow gradually (Figure 1.14.).

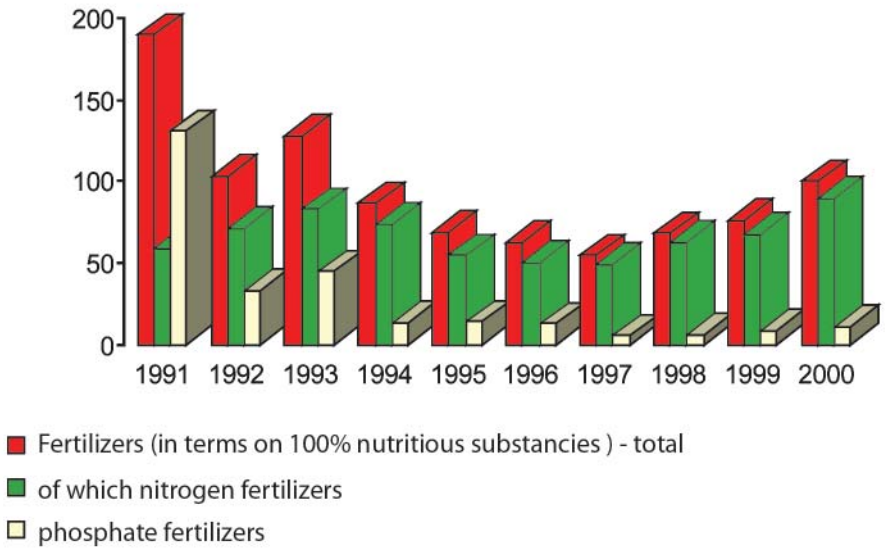

Figure 1.14. Production of fertilizers, thousand tons

All chemical enterprises of Turkmenistan operate on the basis of local raw materials (brines of Garabogazgol, iodide-bromine waters, salts, ore minerals, non-ore minerals, natural gas, casing head gas of oil fields and others), except some enterprises such as production of phosphate fertilizers, household items.

The coverage of the needs of agriculture in mineral fertilizers and consequently the provision of food security of Turkmenistan is the main aim of the chemical industry of the country.

The significant growth of the volume of output of operating enterprises is envisaged due to reconstruction and modernization of their capacities. It is planned to organize largest production of new kinds of fertilizers (carbamide, sulfate potassium) and others.

The growth of chemical products will be the outcome of these transformations.

Notwithstanding big differences in the problems at the chemical enterprises, the measures directed on development of each particular enterprise have much in common. The following general for all enterprises measures may boost the achievement of adequate production indicators:

- restoring and expanding the own raw materials base;

- bringing the products quality and design to ISO-9001 standards;
- ensuring the environmentally safe production and introducing gradually the standards of ecological management system ISO 14000;
- improving the work of the existing colleges, study centers at the enterprises and training and retraining of the staff in higher educational institutions of Turkmenistan and abroad with the purpose of provision of chemical enterprises with highly qualified engineers and workers.

The chemical industry of Turkmenistan has enormous perspective of development owing to the large diversity and reserves of available mineral resources. It is referred to the basic branches of the economy of the country as the development of agriculture, textile industry, foodstuffs production, energy sector directly depends on the position of this branch.

According to the data of National Institute of State Statistics and Information of Turkmenistan, the share of the chemical industry in gross industrial output in 1996-1999 was 2-3%, and in profit – 0.1-0.6%. These indicators were much lower of the potential of the chemical branch.

Equally with natural gas, cotton and cotton goods, the products of the chemical branch constitute the important export item of the country. The export specialization of the chemical branch should remain in respect of iodine, sodium sulfate, technical carbon, bishofite and epsomite. The iodine and clean grades of sodium sulfate are especially perspective among them. Turkmenistan is endowed with the reserves of raw materials for production of these items and consequently the increase of iodine, sodium sulfate production and further the potassium sulfate should be the priority direction in further development of the chemical industry.

The measures on chemical industry development stipulate:

- bringing of the volume of mineral fertilizers output to 1 million tons in 2005 and 2.35 million tons in 2010;
- reconstruction and modernization of existing production, increase of designed capacities using, improvement of economic indicators of production;
- organization of production of such new goods as carbamide, sodium sulfate, calcinations and caustic soda, cement;
- increase of commodity output volume threefold in 2005 in comparison with 1999, and twofold in 2010 in comparison with 2005.

The carbon dioxide emissions stemming from the chemical production at enterprises of JSC "Turkmendokun" can be subdivided into three main parts:

- emission from natural gas combustion
- emission from using of natural gas in production of ammonia
- emission from production of cement.

The dynamics forecast of carbon dioxide emissions occurring from natural gas combustion at the enterprises of JSC "Turkmendokun" for the period to 2010 is shown in Table 1.6.

Table 1.6.
Dynamics forecast for carbon dioxide emissions at the JSC "Turkmendokun" enterprises for the period to 2010

Name	Estimation over 2002	Forecast to 2005	Forecast to 2010
Emissions (Gg CO_2) from natural gas combustion	665.948	1660.619	2871.246
Emissions (Gg CO_2) from consumption of natural gas for ammonia production	195.6	615	1275
Emissions (Gg CO_2) from cement production	-	-	124.625
TOTAL:	**861.548**	**2275.619**	**4270.871**

The natural gas is used for production of ammonia as a component of such mineral fertilizers as ammonium nitrate and carbamide. In production of ammonia the hydrogen is separated chemically and combined with the nitrogen, while the remaining carbon finally goes out as CO_2.

To calculate the carbon dioxide emissions from ammonium nitrate and carbamide production the needed natural gas volume was determined and the coefficient of emission accepted in Europe (1.5 tons of carbon dioxide per one ton of ammonia) was applied.

The National Program "Strategy of economic, political and cultural reforms in Turkmenistan for the period to 2020" stipulates the increase of cement production up to 4 million tons by 2020 owing to construction of new and reconstruction of the existing production objects. Three cement plants with total capacity of 255 thousand tons per year will be constructed in Magdanly, Karlyuk district of Lebap velayat and in Balkan velayat.

The growth of CO_2 emissions over the forecast period will stem from increase of production volumes at chemical enterprises of JSC "Turkmendokun". It will be production of ammonium nitrate up to 400 thousand tons per year owing to upgrading of the capacities in PA "Maryazot" in Mary city, as well as construction of new production of carbamide with the capacity of 400 thousand tons per year in the structure of PA "Maryazot" Mary city, construction of new plant of carbamide production with the capacity of 350 thousand tons per year at the Joint-Stock Company "Turkmencarbamide" in Tedjen town, construction of new carbamide production with the capacity of 350 thousand tons per year in the structure of chemical enterprise in Turkmenabat city.

1.2.5. Housing and communal services sector

Safe shelter is one of the basic human needs, and it influences essentially on the life activity of a man. In early 2002, the available housing in Turkmenistan equaled totally to 89.7 million sq. m. (31.9 million sq. m. (36%) in cities and 57.8 million sq. m. (64%) in rural settlements). Over the first 10 years of independence, 120 thousand new comfortable apartments with total area of 11.6 million sq. m. have appeared. On average, 15.1 sq. m. fell per person in city, 20.8 sq. m. – per rural resident.

The private residential space made 22% of total area in cities and 78% - in rural settlements. On average, this indicator was 79% over Turkmenistan.

Now, the indicators of provision of the population with electricity and gas are high. Over the years of independence, the important task of the social policy has been resolved – complete gasification of cities and rural settlements - that in addition to the social aspect was greatly significant for improvement of the environment. The length of one line gas network in the streets was 19.8 thousand km as of the end of 2000, (2.6 thousand km in 1991), of which 492.3 km (2.5% of total length) was the newly constructed section. The natural gas and the liquefied gas enter 99% of apartments.

According to the survey performed by the World Bank and the national statistics agencies of Turkmenistan, over 50% of households have access to the centralized water supply system. People in rural area have in some places the centralized pipe water, in other places they use water wells or the water is delivered by transport. The houses in Ashgabat city, in Balkan and Akhal velayats have much better access to the centralized pipe water system. The well as the source of water supply has wide spread in Dashoguz and Lebap velayats. Separate apartments, houses are more comfortable from the point of view of availability in them of centralized pipe water and in rural areas some houses have sufficient provision with centralized pipe water and individual pumps.

According to the survey, the provision of households with the source of hot water varies depending on type of a house and its location. As a whole, the most part (85%) of households have the gas boiler or the stove to get hot water, 4% have the centralized supply of hot water, 3% use electric heaters. All these ratios are typical for urban and rural areas, as well as for all velayats.

The gas stoves have equal availability in urban and rural houses – in 25% of households. The Government of Turkmenistan made a decision to give preference to autonomous heat supply in perspective.

The project of Government of Turkmenistan and UNDP "Development of communal services in cities of Turkmenistan" stipulates the perfection of the activity of municipal agencies in nine cities of the country – Ashgabat, Turkmenabat, Dashoguz, Keneurgench, Mary, Bairam-Ali, Balkanabat, Turkmenbashi and Hazar. Performance of the project will be very meaningful in realization of the social programs of the country.

1.2.6. Agriculture

Agriculture is traditionally the key sector of the economy of Turkmenistan, over one fourth of gross domestic product falls to its share and approximately 48% of employed people work in agriculture. Provision of food security of the country is the main objective of the agricultural sector of the economy.

Agro-climatic conditions and availability of adequate for agricultural production land areas serve a good basis for growing of cotton, grain, vegetables and melons and gourds, fruits and grapes, and for cattle-breeding. The area of agricultural lands is more than 40 million hectares. The available land for irrigated farming equals to 17 million hectares, of which agricultural crops occupy 2 million hectares. Cotton occupies around half area of the irrigated land. The country is the largest producer and exporter of cotton-fiber. Over the last years, the grain growing as the new branch of agriculture has got its intensive development. The wheat cultivation is an important element of grain growing. The natural desert pastures occupy a considerable part of the territory of Turkmenistan. The livestock-raising is the traditional branch of the agriculture of Turkmenistan, and especially the breeding of sheep and goats. The breeding of cattle, camels, horses and poultry are also available on an adequate level.

Commencing from the first years of independence, the agriculture was declared to be one of the most important sectors of the economy. The Programs of President of Turkmenistan Saparmurat Turkmenbashi "10 years of stability", "Grain", New village" defined the stages and the rates of agriculture development in 1991-2000, while the National Program of President of Turkmenistan Saparmurat Turkmenbashi "The strategy of socioeconomic reforms in Turkmenistan for the period to 2010" set up the aims and objectives for the years 2000-2010.

Over the past years the appropriate legal framework has been formed to specify the successive reforming of land relations for the period of transition to market economy. The Land Code of Turkmenistan is the basic law of this legal base that also includes the laws "On farms", "On farmers' associations", "On land lease to foreign states", "On allotment of land to private ownership for the agricultural purposes" and others.

The Decree of President of Turkmenistan "On land ownership and land use right in Turkmenistan" (1993) appeared to be the significant step in acceleration of transformation processes in the aspect of legal norms for land allotment to private ownership and long-term use.

Simultaneously, the Government has undertaken the unprecedented measures to enlarge the agricultural production volumes and to create favorable economic conditions for the farmers. The system of taxation and crediting is highly privileged for cotton and wheat producers working on contractual basis, 50% discount on payment for seeds, techniques and machinery services, chemical and mineral fertilizers.

Now, two forms of ownership function in the structure of agriculture: the state form (farmers' associations, subsidiary plots of enterprises and organizations) and non-state form (farmers, private producers and owners of personal land plots).

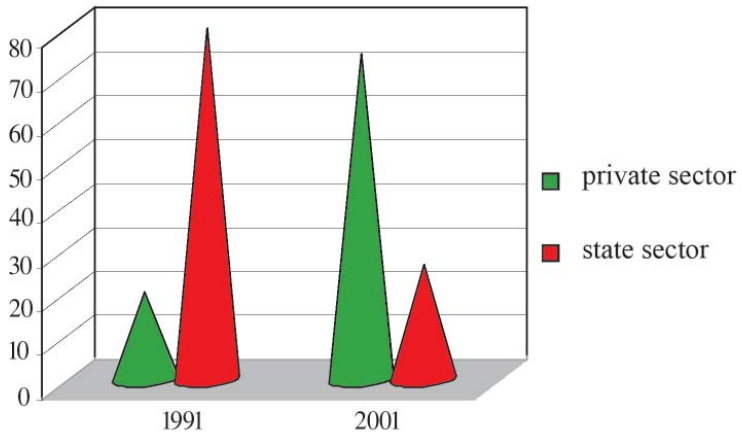

Figure 1.15. Share of private sector in total agricultural output of Turkmenistan, %

As of 01.01.2002, 582 farmers' associations, 1.8 thousand farms, 0.7 thousand subsidiary plots of enterprises and organizations, over 5.2 thousand private producers of goods and 667.1 thousand families at their personal land lots and suburban gardening farms were engaged in producing the agricultural products.

The number of private producers continued to increase. The progressive forms of lease relations became more popular in the village. In 2000, 74% of all agricultural output fell to the share of private sector. It supplied 98% of potatoes, 74% - vegetables, 78% - fruits, 89% - meat, 95% - milk, 94% – eggs, 79% – wool.

The measures undertaken over the years of independence promoted accelerated development of agriculture and allowed to increase the volumes of practically all kinds of agricultural products (Annex 1.10).

Turkmenistan remains to be one of the largest producers and exporters of cotton-fiber. Cotton occupies about half of the irrigated land area. Cotton gathered in 2001 exceeded the level of 2000 by 13%. This branch of agriculture is strategically important, as the development dynamics of the whole agriculture and also the position of cotton cleaning, vegetable oil and textile industries depend on its growth.

Grain growing - the new branch of agricultural production - has got its intensive development, and mainly the growing of wheat. In 2000, 1705 thousand tons of wheat were gathered, in 2001 – over 2 million tons and in 2002 – 2.311 thousand tons. These successful crops resulted in creation of the sufficient state reserve and achievement of 420 kg as the mean grain production per capita over the country.

Rice production is traditional agricultural branch for Turkmen people. The Dashoguz and Lebap velayats do it, but the rice areas equal to only 1.5% of total area of grain crops and grain legumes crops.

Renewal and increase of the level of equipping the agro-industrial complex with agricultural machinery is one of the factors promoting the growth of agricultural production. The enormous attention is paid to the improvement of culture of farming, increase of crop yield, rational and effective use of resources.

With the purpose of rational use of resources in Turkmenistan, President of Turkmenistan Saparmurat Turkmenbashi signs annually the special decrees establishing the particular, science-based norms of water and mineral fertilizers per hectare for future crops. It undoubtedly promotes the effective use of these inputs, the farming culture and the increase of output per hectare (Figure 1.16).

Favorable conditions for livestock-raising, long-term leasing of livestock, exemption from taxes promote the stable development of animal husbandry. The sheep breeding is the largest branch in livestock-raising. The matter of food security provision requires also the increase of cattle breeding and fodder base creation. The breeding of camels, horses and poultry develops adequately as well. Over 1991-2001, the cattle number increased 2 fold, sheep and goats – more than 2 fold, camels – by 28%, and horses – by 45%.

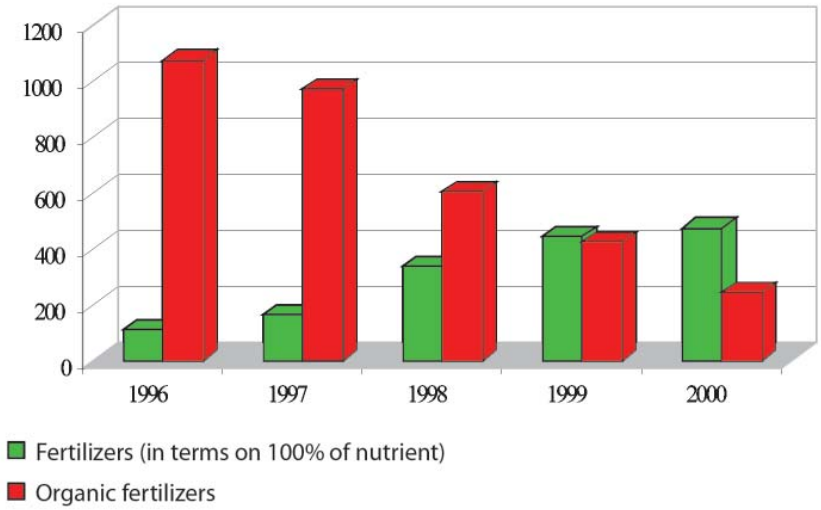

Figure 1.16. Input of mineral and organic fertilizers to the sown areas, thousand tons

Successful development of private sector in livestock-raising led to the rise of effectiveness of the branch and the increase on this basis of animal husbandry production. Over 1991-2001, the volume of meat production has grown by 82%, milk – 2.7 fold, eggs – by 44% and wool – by 72%.

The animal husbandry production growth improved largely the supply of food market, provided the industrial enterprises of the country with raw materials and expanded the export of products.

The government support to private producers of livestock-raising branch suggests the broad system of privileges. These are the exemptions from taxes and other payments to the budget, the right to keep livestock without quantity limitation, as well as the allocation of land plot for forage production and so on. These favorable conditions make a good basis for the increase of livestock and poultry and their productivity.

The law "On food security" issued in 2000 defines main strategies of implementation of the state policy in this direction.

This law stipulates also the strengthening of state control over food market in respect of meeting the ecological and sanitary-epidemiological norms that in turn will promote the increase of ecologically pure foodstuffs production and also their export.

The agro-technical arrangements are in no small measure important in the production of ecologically pure products. Over the last years, the use of non-organic (chemical) fertilizers, herbicides significantly reduced, while the defoliants are not used more. Elaborations in the field of bioengineering are not conducted in the country. All these factors in a whole positively influence on the ecology and health of people.

The construction of Turkmen Lake is of enormous significance for the development of agriculture. The solution of many social and ecology – economic problems today and in future is connected with the realization of this grandiose project.

1.2.7. Transport

Turkmenistan has all kinds of modern transport and has extensive network of railway, air and motor transport lines. The length of railway line is 2.5 thousand km, motor transport – 13.6 thousand km. The main trunk-railway lines Turkmenbashi – Turkmenabat – Kungrad, Mary – Gushgy, Buhara – Kerkechi – Termex, Tedjen – Serakhs – Meshkhed join human settlements of the country and also the neighbor countries. The main motor roads Turkmenbashi – Ashgabat – Turkmenabat, Ashgabat – Dashoguz link the east and the west, the north and the south of the country. The air terminal in Ashgabat is the center of international air transportations with a capacity of 1600 passengers

per hour. The seaport in Turkmenbashi city is the central point in the transport corridor TRACECA. The completion of its reconstruction, which is performed now with participation of foreign investors (European Bank for Reconstruction and Development), will lead to the increase of cargo handling up to 10 million tons. It will become the largest crossing point of Turkmenistan in the international transit corridor Europe – Caucasus – Asia and one of the modern ports of the region with the developed infrastructure.

From the moment of independence gaining, the total volume of cargo transportation by all kinds of transport increased 1.8 times and passenger turnover - 2 times. It happened due to the development of the existing roads and construction of the new ones (Figure 1.17).

Over the period of independence, the motor transport sector was fully renovated. Huge amounts of money were unvested to the renewal of motor vehicles fleet, modernization of repair base, reconstruction of old and construction of new motor roads, bus terminals in various regions of Turkmenistan. In 2000, the construction of new road Ashgabat-Karakum desert-Dashoguz (530 km) started. This road will largely accelerate the development of productive forces in the adjacent human settlements. The construction of road Ashgabat-Turkmenbashi of 585 km length is underway. Recently, the reconstruction of road Ashgabat-Mary-Turkmenabat (600 km) began. All these roads meet the parameters of first technical category – the six-line road with the dividing strip and 12.5 meter carriage-road on each side.

According to the survey performed by the World Bank and agencies of the state statistics (1998), the indicators are enough high concerning the types of roads available in the country: 81% of human settlements have all or the main roads with the strong cover, 15% have mainly the earth roads and 4% - the earth roads only. At the same time, the quality of 83% of roads was marked as satisfactory and only of 13% as bad. The perfect and good mark was not given to any road.

The enormous attention is paid to the increase of quality of roads being under construction or reconstruction. Today, the perfect smooth of modern motor roads is one of the symbols of the new life of Turkmenistan.

According to the statistics of the road police of Turkmenistan, in 2000, the automobile fleet of the country included over 644 thousand vehicles. Here, not the quantity of transport vehicles, but their abundance in the cities of the country where many people live poses the problem.

Transport vehicles become the global factor adverse for environment mainly due to the high toxicity of exhaust gas. Over 50% of all harmful emissions in the world are referred to the share of transport. Especially, large cities feel this burden. For instance, the emissions from transport make 80% of total quantity of harmful emissions in Ashgabat.

In Turkmenistan, the problem of air pollution by exhaust gas is mainly connected with the depreciation of automobile fleet, poorly developed maintenance services and infrastructure in Turkmenistan. To mitigate the pollution, there were introduced the strict quantified limits of harmful substances content in the exhaust gas of automobiles. It is necessary to note that the emissions of highly toxic lead into atmosphere stopped after switching of motor transport to the unleaded gasoline.

Within realization of the Programs of President of Turkmenistan Saparmurat Turkmenbashi on development of railway transport there have been constructed over the last 10 years the railway Tedjen-Serakhs-Meshhed of 300 km length by which more and more cargo is transported through the border to the ports of the Gulf, and also the railway Turkmenabat-Atamurat (215 km) connecting the velayat center with 5 etraps of Lebap velayart on the left bank of Amudariya. The construction of a new railway bridge through the Tedjen River increased the capacity of transport corridor Central Asia – Caucasus – Europe. The new trunk railway Ashgabat-Karakum-Dashoguz (530 km) across the Central Karakum desert will reduce the way between two largest velayats of the country – Akhal and Dashoguz velayats.

The constructed railway lines joined Europe and Asia, revived the Great Silk Road. Over the years of independence there has been created railway network that turned Turkmenistan to the large transit country. Today, the citizens of Turkey, Iran, Russia, Uzbekistan, Tajikistan, UAE and many

other countries of Asia and Europe use the Turkmen transit.

The air transport intensively develops. The newly constructed airports and the modernized airports serve international and internal air flights. They have rather adequate material and technical base of modern civil aviation. The aircrafts of Turkmenistan Airlines implement regular flights to many countries of Europe and Asia and charter flights to any country of the world.

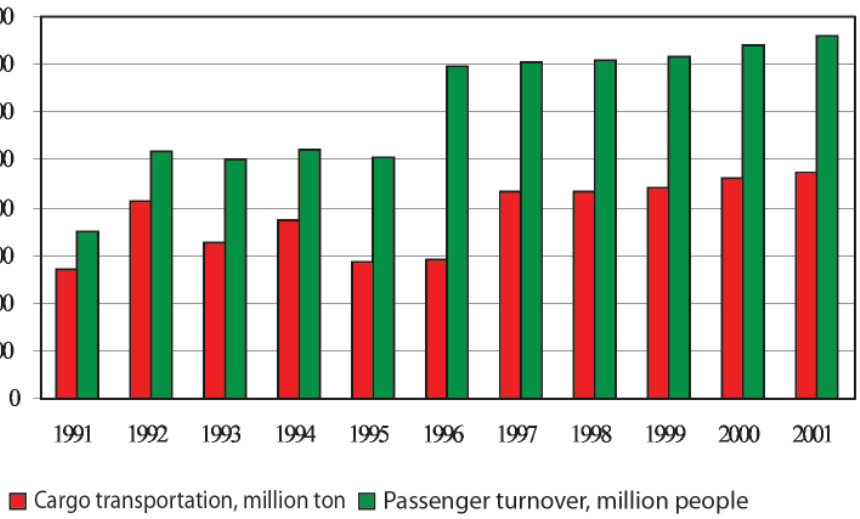

Figure 1.17. Cargo and passenger transportation by all kinds of transport over Turkmenistan

1.2.8. Water management sector

The total volume of water resources of Turkmenistan consumed by the sectors of the economy come from surface flows of Amudarya, Murgab, Tedjen, Artek rivers, small water flows of north-eastern slopes of the Kopetdag mountains and to a smaller extent from ground and collector-drainage waters. The surface water resources make approximately 87.5 - 98.2% of their total volume in the water sector balance

The Amudarya River plays a crucial role in the economy of Turkmenistan; its mean long-term flow is 63 km^3 of which 22 km^3 is the share of Turkmenistan, of which some part belongs to the Karakum River (12-13 km). The irrigation system of Lebap velayat takes between 3 and 5 km^3, while the irrigation system of Dashoguz velayat takes between 4.5-7.5 km^3.

The Murgab River is the second river by size of flow. The mean long-term and mean annual consumption of water in the river is 55.1 m^3/s, and the flow – 1751 million m^3 per year. Kashan and Kushka tributaries enter the Murgab River but they do not play the significant role in forming of total flow of this river.

The Tejen River flows westwards against the Murgab River. Over 69 years permanent observations at the post Pulihatun show the mean long-term flow as 1066 million m^3 and the mean long-term consumption as 33.8 m^3/s.

The Atrek River, similarly to all other rivers, is not only the near border river, but also the border river with 150 km length. Fifteen water currents enter the river in the territory of Iran and the river Sumbar with Chandyr tributary - in Turkmenistan. Over 35 years observations show the mean long-term consumption as 8.37 m^3/s and flow – 292.8 million m^3.

The Karakum River has the particular significance among the surface water resources. Currently, its length is 1300 km. More than 1 million hectares is irrigated from this river. The average annual water intake of the Karakum River depending on the waterway year is 12-13 km^3. With maximal consumption of the complex of main facilities the consumption of the Karakum River may be 600-650 m^3/s. Three internal water reservoirs of 2.4 km^3 capacity in total have been constructed and operate for the seasonal regulation of liquid and solid flow of the Karakum River.

Thus, the flow of surface water sources used for the needs of the economy is the following:

- Amudarya River – 22000 million m^3
- Murgab River – 1050 million m^3
- Tedjen River – 230 million m^3
- Atrek River – 70 million m^3
- Small sources – 70 million m^3

TOTAL 23420 million m^3

In Turkmenistan, the proved stock of ground water makes 3.4 million m^3/day, while the explored stock is 6 million m^3/day and the projected ones - 9 million m^3/day.

The Ministry of Water Management of Turkmenistan is the government agency coordinating the activity of water complex of the country.

The investment program over the period until 2020 covers all the branches of the economy of Turkmenistan, including the Ministry of Water Management.

Total investments to the development of water complex of Turkmenistan are shown in Table 1.7.

Table 1.7.
Investments to the development of water economy sector, US$ million

Years	Dashoguz velayat	Lebap velayat	Mary velayat	Akhal velayat	Balkan velayat	Karakum River	Potential development	Turkmenistan
2001-2005	168	109	324	302	63	40	2626	3632
2006-2010	542	330	463	400	139	13	1073	2960
2011-2015	44	98	12	30	14	0	584	782
2016-2020	80	66	30	30	14	0	584	804
2021-2025	122	60	22	30	12	0	584	830

For the purpose of economic sustainability provision, the work on increase of the Karakum River capacity, the construction at this river of hydro-technical facilities and pump stations, the reconstruction of intra-system reservoirs and also regulation of flow at the other waterways of the state will continue.

With the purpose of improvement of ecological situation, ameliorative condition of the irrigated lands and increase of the use of CDW, President of Turkmenistan Saparmurat Turkmenbashi signed on 31.08.2000 the Decree № 3172 "On creation of Karakum Lake" that later was named as Turkmen Lake of golden century. There was also defined the construction of the complex of water canals and respective facilities for the diversion of collector-drainage waters to the lowland Karashor and reuse of this water for the needs of the economy of the country (pasture watering, water cleaning at the bioplateau and using it again for irrigation).

2. Macroeconomic forecast

2.1. Long-run development conditions, including the environmental programs

Development of Turkmenistan in conditions of state independence, positive neutrality, political stability and growing authority of the country on the world arena opened broad perspectives for economic and social progress, cultural and spiritual renewal of the society. The situation was a good base for defining the long-term goals, the strategy of further stable development of the state.

The strategic goal was to turn Turkmenistan into a dynamically developing state with the effectively working and socially oriented market economy providing high living standards for the population. This goal was defined in the National Program of President of Turkmenistan Saparmurat Turkmenbashi the Great "Strategy of socioeconomic reforms in Turkmenistan for the period to 2010". The program suggests rather ambitious but achievable aims and objectives of the development of Turkmenistan and defines four priorities: provision of economic, food, social and ecologic security, where:

- economic security includes the high level of economic growth and efficient use of resources and production potential of the country, continuation of economic reforms, privatization and support of entrepreneurship with guaranteed ownership right and fair competition, further integration into world economy and encouragement of foreign investments, conduction of moderately tough monetary policy and balanced fiscal policy to provide macroeconomic stability;
- food security is the increase of production for full satisfaction of the needs of population in main kinds of domestically produced goods, support and protection of the interests of domestic producers, strict control over quality of exported agricultural products and imported foodstuffs;
- social security is the provision of right for labor, increase of real income, strengthening of the social security network to protect the most vulnerable groups of the population;
- ecologic security is the implementation of a complex of measures directed on combination of industrial development of the country with environment protection, combating the effects of ecologic catastrophe in the Aral Sea zone, provision of high quality potable water, safe use of chemicals in the agriculture and prevention of soil erosions and salinity, reduction of harmful emissions to the atmosphere, etc.

Achievement of the defined goals and realization of the undertaken measures will pave the way for the formation of a principally new, highly effective structure of the economy of the country with developed market institutes guaranteeing the economic and political independence with simultaneous keeping of ecologic balance and achieving of adequate living standard.

The Presidential Program has got its reflection in the special national programs "Education", "Healthcare", "New village", "Grain", "Manufacturing", "National Environmental Action Plan of Saparmurat Turkmenbashi, President of Turkmenistan" (NEAP), "Concept for development of oil and gas sector of Turkmenistan until 2020" and other long-term special programs for the economy sectors.

2.2. Forecast for GDP throughout 2010

Successful implementation of the economic reforms made it possible to establish a firm basis for further acceleration of socioeconomic development of Turkmenistan, provide the appropriate living conditions for the population. Maintenance of stable economic growth and, first of all, of gross domestic product growth, is of critical importance in this regard. The average annual growth rates are envisaged to be not less than 20%.

The petrochemical, light and food branches of the industry are the priority ones where new productions and modern technologies are established and domestic raw materials are used.

It was envisaged to accelerate significantly the agricultural development over the period until 2005. Compared to the year 2000, the added value of the agriculture increased more than twofold, thus making good contribution to achievement of food self-sufficiency and strengthening of raw material base for the manufacturing branches.

The gross domestic product volume was planned to increase 2.5fold in 2005 and 6.2fold in 2010, compared to 2000.

Implementation of the outlined reforms will lead to growth of GDP per capita up to US$ 16.5 thousand (by purchasing power parity) in 2010 (Figure 2.1).

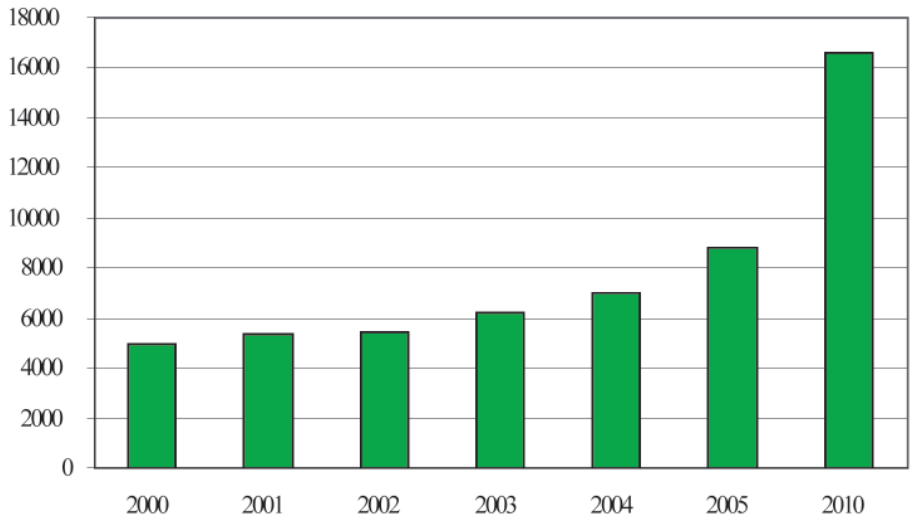

Figure 2.1. Gross domestic product of Turkmenistan per capita (by purchasing power parity), USD

2.3. Expected investments into economy. Forecast for the economy sectors development

These are the essential factors for implementation of the long-run plans:

- state support to the sectors of the economy by providing credits, including attraction of foreign loans. The budget financing will remain for the investment projects of social complex;
- increase of own investment resources, including those to be provided from accumulation fund and depreciation deductions;
- improvement of entrepreneurship financing through the development of financial institutes of long-term lending.

The policy of foreign investments attraction will focus on implementation of investment projects promoting the movement of Turkmen goods and technologies to the foreign market, the increase and diversification of the export potential, the flow of capital to the labor abundant regions with rich natural resources to speed up their development.

It is envisaged to establish over the period until 2010 in Turkmenistan the production potential sufficient on the one hand for the rational use of natural, material and labor resources and on the other hand for the proportional development of various branches of national economy and regions of the country. To realize this program the investment volume per year will increase nearly fivefold by the year 2010 compared to 2000. With the development of market relations the significance of own resources of the enterprises will increase in the structure of financing sources. Their share in total volume of investments in 2010 will make 60%. Implementation of a number of transnational projects will provide a possibility to attract finance from international organizations, large companies and banks of the world to the economy of the country through raising the share of direct and portfolio investments.

The program of socioeconomic reforms suggests intensification of investment activity of the population by means of increasing of their trust to the financial and banking institutes. The volume of these resources will show the nearly fivefold increment by 2010.

Ratio of the investments to production and social spheres will change. In 2010, the investments to production sphere will grow 4.3 fold, while to the social sphere – 5.5 fold, compared to 2000 (Figure 2.2).

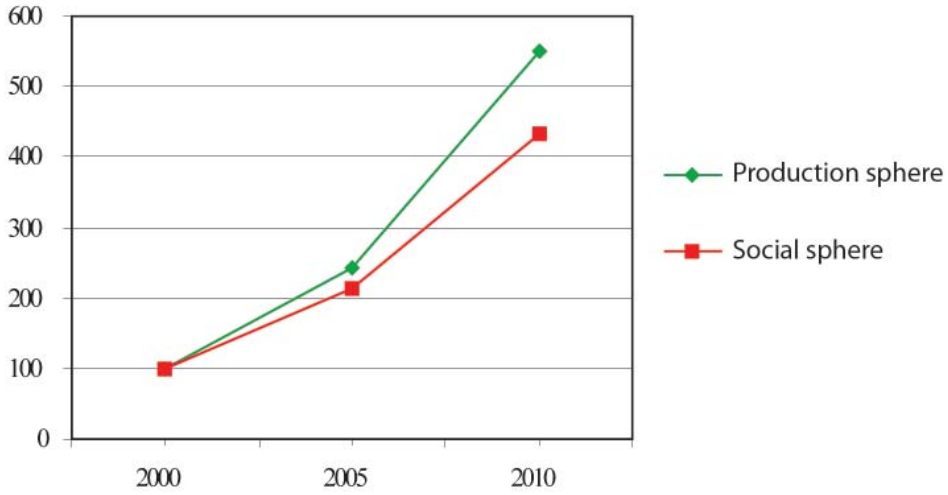

Figure 2.2. Dynamics of investments to production and social spheres of the economy of Turkmenistan, %

Focus of the economy of the country on development of branches producing finished goods, as well as the all-embracing use of natural resources predetermine the high level of investments to industrial sector. In perspective, the share of industry will remain to be large in the structure of investments, making 52% in 2010. The volume of investments into this sector will grow 4.4 fold, in comparison with 2000 (Figure 2.3).

The agriculture, being the raw material base for many industrial enterprises, will receive the new impulse for the further development by 2010. The volume of investments to this branch will increase almost tenfold in 2010, in comparison with 2000 (Figure 2.3). Its share in total volume of investments will account for 15%.

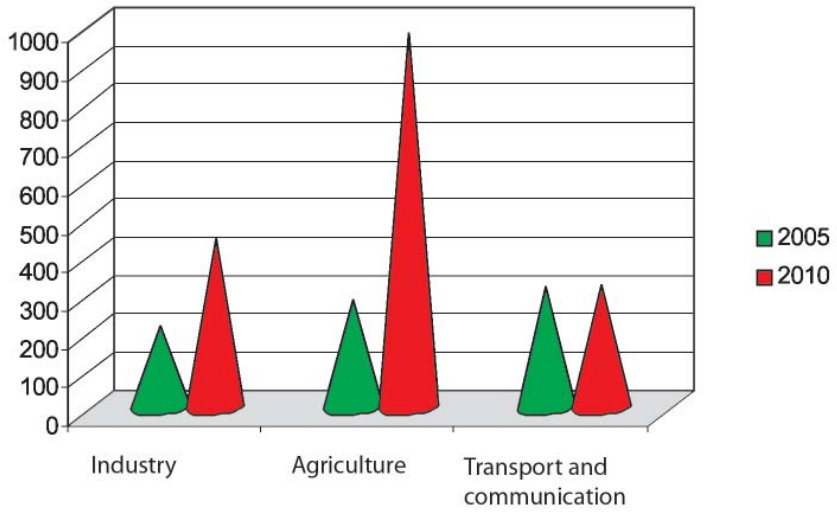

Figure 2.3. Dynamics of investments by industry (year 2000 – 100 %)

The build up of economic potential of the country is connected with further development of transport and communication. The geographical position of Turkmenistan provides advantages for creation of international transport corridors and construction of communication. In 2010, the investments for these purposes will increase 3.2 fold, compared to 2000 (Figure 2.3).

2.4. Oil and gas and oil-refining industry

The fuel and energy complex will continue to play the leading role in the structure of industry. It will remain to be the main complex of the country, as well as the main source of hard currency revenues.

The strategy of fuel and energy sector development was prepared in consideration of the huge oil and gas potential of Turkmenistan. It suggests such perspective directions as capital base development for geological prospecting work, introduction of new methods of oil and gas mining, development of the Caspian Sea shelf, modernization of refining capacities, pipeline infrastructure development. The special attention is drawn to creation of conditions for attraction of foreign investments and use of advanced technologies in these branches.

Turkmenistan is endowed with big potential reserves of hydrocarbons that according to the data of national and international experts amount to 45.44 billion tons of conditional fuel. The National Program stipulates the development of these reserves by reaching 100 million tons per year of oil extraction and 240 billion cubic meters per year of gas extraction in 2020. For the year 2005, the plans for crude oil and gas condensate equaled 28 million tons and natural gas - 85 billion cubic meters, while for 2010 – 48 million tons and 120 billion cubic meters accordingly. The volume of investments into the oil and gas complex will surge 6.5 fold by 2010, making US$10.5 billion. The share of foreign direct investments in this volume will account for over 75%.

Until 2010, it is intended to develop export to 85% of total volume of the mined hydrocarbon resources. The export of natural gas would reach 100 billion cubic meters by 2010. To this end, reconstruction of the existing gas transportation system is stipulated and optional projects of new gas pipelines construction are considered.

Further considerable growth of hydrocarbon resources extraction predetermines the main development directions for the enterprises of oil-refining branch. It is planned to create the capacities for production and transportation of liquefied natural gas, for wider use of this environmentally safe fuel in automobile transport.

The environmental clause is important in investment projects concerning oil and gas mining and oil refining branches development. For these purposes, the certain measures will focus on reduction of gas and oil losses during transportation and consumption. These measures will include the introduction of energy-conservation technologies and techniques, the broader use of natural gas for production purposes till complete exclusion of fuel oil using, the reduction of specific consumption of fuel and lubricants per unit of capacity or per unit of product, and this reduction is supposed to be brought to the level of the developed countries.

2.5. Power engineering

The power engineering sector development for the period to 2010 will envisage complete satisfaction of the growing needs of the economy of the country in electricity and increase of the export of electricity to neighboring countries. The available potential of the power engineering industry of the country suggests possibility to increase this export.

In view of the perspective construction of new power-intensive productions, enterprises and objects, as well as in view of the needs of neighboring countries it is planned to produce electric power in a volume of 16.4 billion kWh by 2005, and 25.5 billion kWh – by 2010. Over 40% of total produced electric power will be exported in 2010. Supply of thermal electric energy by 2010, in comparison with 2000, will increase around 2.3 fold.

Table 2.1.
Forecast for the growth of designed capacities and consumption of electric energy

Indicators	Years			
	1995	2000	2005	2010
Designed capacities, MW	2529.2	2652.2	3101.2	4193.2
Energy consumption, billion kWh	8.347	8.955	11.511	14.513

Table 2.2.
Structure of fuel consumption by power engineering for the period to 2010

Indicators	Years			
	1995	2000	2005	2010
Natural gas, million cubic meters	3477	3176.7	4460.95	8927
Million tons of conditional fuel	3.82	3.36	4.72	9.574
% of total consumption	99	99.5	99.6	99.8
Fuel oil, million tons	0.028	0.012	0.023	0.013
Million tons of conditional fuel	0.038	0.016	0.018	0.018
% of total consumption	1	0.5	0.4	0.2
Total, million tons of conditional fuel	3.86	3.376	4.738	9.592

The perspective needs in heat will be covered through build up of the capacities of centralized heat supply. The generating of heat will make 2.5 million Gcal/g by 2010.

Based on augmentation of generating capacities, electric energy and heat production, the Ministry of Energy and Industry of Turkmenistan prepared estimations of fuel consumption for the period until 2010 (Table 2.2.)

2.6. Chemical industry

The chemical industry development in perspective will focus on maximal use of domestic raw materials, satisfaction of essential needs of other sectors of the economy, increase of its export potential.

The resource availability makes it possible to produce all kinds of mineral fertilizers in volumes completely satisfying the domestic needs.

The projected volumes of production will allow to reduce notably public expenditures for the purchase of these fertilizers and stop their import completely by 2005, and also to begin to export this chemical product (Figure 2.4).

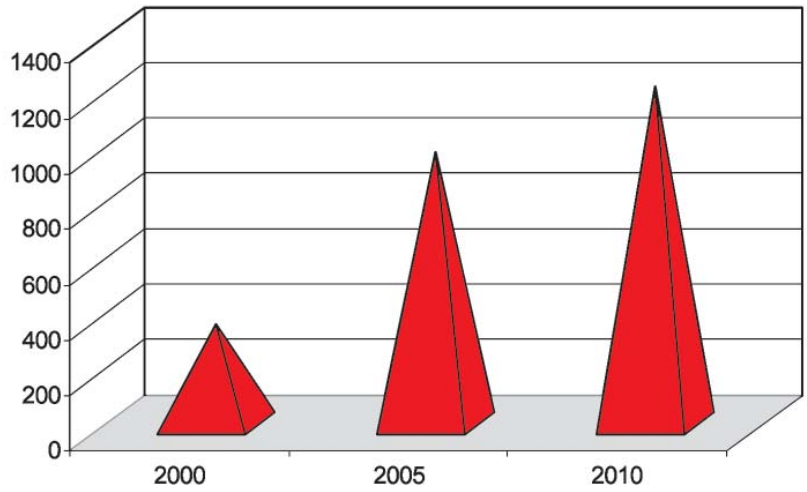

Figure 2.4. Dynamics of mineral fertilizers output, thousand tons

Production of other kinds of chemical products will increase through all-embracing and efficient use of rich resources of raw materials.

By 2010, the production and export of iodine will grow due to the increase and more effective use of the capacities of operating Khazar and Boyadag factories.

2.7. Machine engineering and metalworking

The growing needs of the economy of Turkmenistan in various techniques, the developing domestic raw material base, the production experience achieved over the last years at the enterprises of machine engineering branch are the powerful incentives for its accelerated development. For these purposes, the existing machine engineering enterprises will be re-equipped and reconstructed. Resultantly, the volume of output in machine building complex will grow fivefold in 2010, compared to 2000. The progressive changes will take place within the branch structure and the share of machine building branch in 2010 will make 67% against 30% in 2000. The agricultural and irrigation techniques, the pumps and home appliances will be the priority kinds of products in manufacturing process.

The enterprises of power engineering will develop intensively. It is planned in the nearest future to begin the production of high –voltage cables isolated with plastic. Thus, the needs of the country in cable products will be satisfied completely, and the conditions for the timely reconstruction of existing and construction of new urban electric networks will notably improve.

Organization of domestic ferrous and non-ferrous metallurgy, production of polypropylene as raw material for production of hard plastic to substitute many technical parts and junctions will help increase the material base of machine building and metal working branch, its nomenclature and its efficiency.

2.8. Building materials industry

The main task of construction industry development for the period until 2010 is a complete provision of the construction complex of the country with required building materials by means of developing the new productions, reconstructing the existing enterprises, modernizing their fixed assets, introducing modern technologies for development and transition to effective environmentally safe materials and production methods meeting the world standards.

Big attention is drawn to the production of cement as the main product of the construction industry. In consideration of availability of raw material reserves for this branch, it is planned to construct two cement plants in different regions of the country. The output of cement will reach 2 750 thousand tons by 2010. The output volumes of construction glass, wall and non-metallic materials and kaolin will also rise.

2.9. Textile industry

For the period until 2010 it is planned to continue work on increase of production base for the textile branch, reorientation of the industry of the country for more intensive processing of local raw materials that will provide possibility to develop further the cotton-processing productions and significantly increase the issue of high quality textile goods.

In view of the expected volumes of cotton crop, the production of cotton fiber will amount to 900 thousand tons by 2010, while over half of this volume is planned to be processed domestically (Figure 2.5).

To realize this program it is planned to construct the integrated textile complexes, new cotton-spinning factories, as well as to expand and reequip the existing plants of textile industry constructed in early 1990s. It is contemplated to construct by 2010 in all cotton-growing territories of the country the textile complexes involving cotton cleaning, spinning, weaving, clothes factories and dye-houses. Consequently, the output of many cotton items will increase considerably that will allow to raise the domestic market satiation and the export of a large portion of these products. In 2020, the textile complex of Turkmenistan will process up to 500 thousand tons of cotton fiber to manufacture the finished goods.

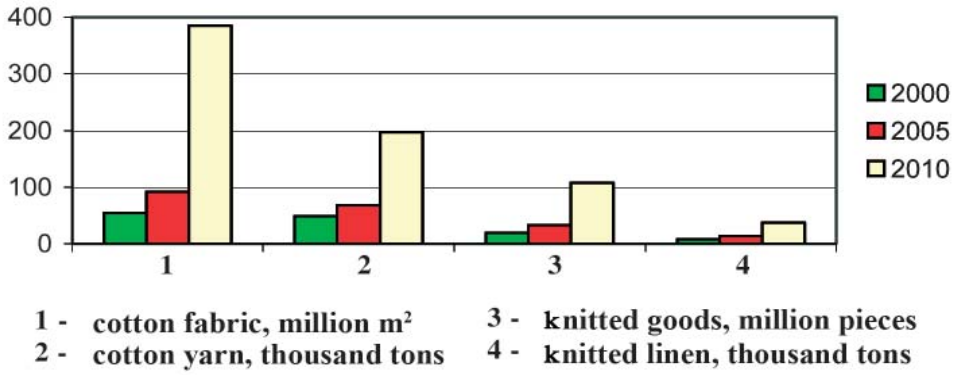

Figure 2.5. Dynamics of the textile industry output

2.10. Food industry

Very important tasks have been defined for the food industry for the forthcoming period, as the goal of food security and market satiation requires the establishment of highly technological food industry able to provide the population with high quality ecologically pure foodstuffs. Realization of the mentioned directions means maximal using of production potential of the existing enterprises, their modernization and reconstruction, construction of small and medium enterprises equipped with advanced technologies.

The population of the country will have vitally important foodstuffs of domestic production – meat and meat products, milk and dairy products, flour and flour items. Turkmenistan solves not

only the problem of food self-sufficiency, it will be able also to export the certain kinds of foodstuffs such as vegetable oil, canned fruits and vegetables, confectionery and macaroni goods by the end of the period in question.

2.11. Housing sector and communal services sector

Improvement of residential conditions, increase of housing construction and improvement of its quality are actual aims in this sector. It is planned to reach 22.6 square meters per person of residential space provision by 2010 (Figure 2.6).

Achievement of a high level of residential space provision requires considerable growth of housing construction, radical reforms in housing and communal services. The main priorities in this sphere include development of private housing resources in view of the constructed high-rise apartment houses of improved design in the capital city of the country and velayat centers, creation of free housing market, further construction of municipal housing for socially vulnerable groups of the population. It is planned to increase the share of private housing to 90% by 2010.

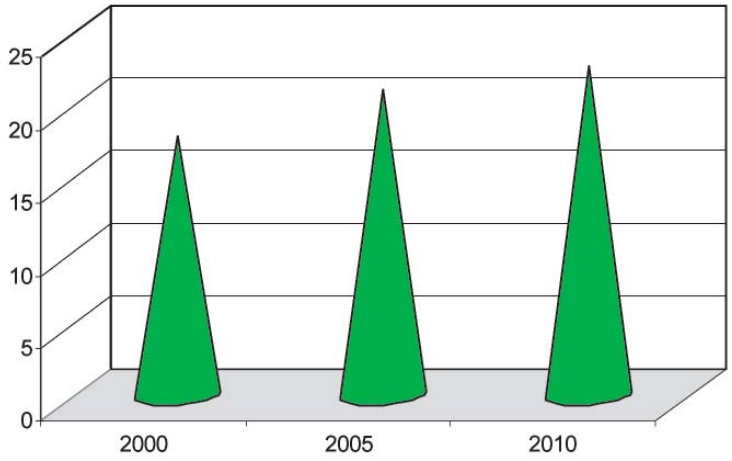

Figure 2.6. Dynamics of average housing provision per person in Turkmenistan until 2010, square meters

Considerable amounts of money will be allocated for the public utilities construction, particularly the objects providing heat and gas, drinking water, electric energy and sewerage objects. It is envisaged to develop public utilities through reconstruction and increase of water management and sewerage systems, development of collection, transportation and utilization systems for solid domestic wastes, as well as the greenery planting in human settlements of the country. Over the forecasted period the following objects will be put into operation: domestic wastes processing plant in Ashgabat; effluents treatment enterprises and plants in various regions of the country; communication tunnel with engineering network in Ashgabat, etc.

2.12. Agriculture

President of Turkmenistan Saparmurat Turkmenbashi defined the achievement of stable high growth of agricultural production and satiation of domestic market with foodstuffs and consumer goods as one of the main tasks of economic strategy for the period to 2010. It is planned to continue reforms and provide food self-sufficiency of the country. Fulfillment of this key direction will have to rest on such average annual growth of gross agricultural output as 19% in 2001-2005 and 13% in

2005-2010.

Maximal increase of the production of strategically important kinds of products – cotton and wheat remains the priority task of the agricultural producers. Achievement of the targets will stem from the increase in 2010 of wheat yield to 42.5 centners per hectare and cotton yield – to 45 centners per hectare. In 2020, the wheat and raw cotton production will increase accordingly 2.9 fold and 4.9 fold, compared to 2000. Vegetable output by 2010 would reach 1137 thousand tons. The firm base has already been laid for vine-growing development and increase of vine production by 2010 to 644.8 thousand tons.

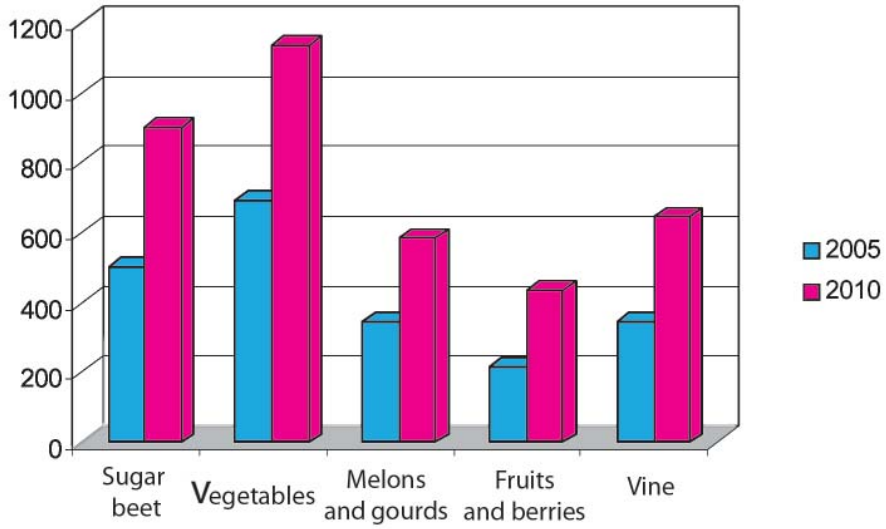

Figure 2.7. Dynamics of plant growing output, thousand tons

Livestock-raising branch is the guarantor in provision of food self-sufficiency. With the purpose of satiation of food market of the country by animal husbandry products it was planned to bring the cattle number to 2120 thousands by 2005 and to 2600 thousands by 2010; sheep and goats – to 16000 by 2005 and 18525 thousands by 2010. Traditional for Turkmenistan the camel and horse breeding will develop further (Figure 2.8).

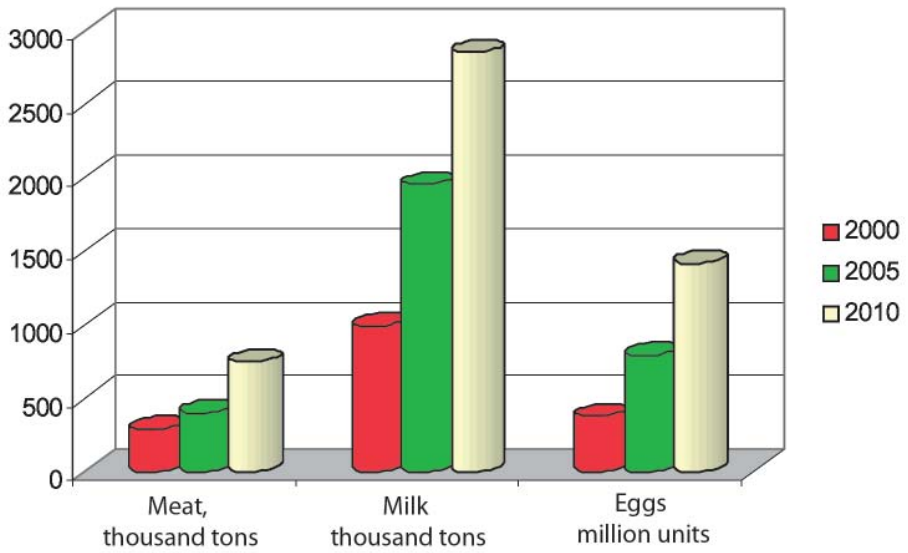

Figure 2.8. Dynamics of animal husbandry output

One of the important tasks in achievement of food security is to increase the efficiency of water resources use, including by means of construction of hydro-engineering facilities and pump stations.

The area of irrigated lands will make 2240.7 thousand hectares by 2010. At the same time, the amelioration work will continue on the irrigated lands.

Construction of Turkmen Lake will be very important for the development of water management branch. Implementation of this grandiose project of President of Turkmenistan Saparmurat Turkmebashi will make the basis for the increase of agricultural production. Diverting of drainage water (up to 10 cubic kilometers per year) will improve the irrigated lands.

For the stable supply of water resources to the economy of Turkmenistan it is planned to continue to increase the carrying capacity of the Karakum River, construct hydro-engineering facilities and pump stations on it.

2.13. Transport

Realization of "Strategy of socioeconomic reforms in Turkmenistan for the period to 2010" implies also further development of transport infrastructure of the country. By 2010, the freight by all kinds of transport will grow twofold, freight turnover – 3.4 fold.

This dynamics will appear due to the realization of large-scale investment projects on development of road and railway networks of Turkmenistan. The measures on improvement of the state of vehicles fleet and its renewal should raise the level and quality of transport services. It is planned to replenish the automobile fleet with new heavy trucks, increase the share of alternative environmentally safe motor fuel and continue the work on switching the cars to the natural gas fuel.

Construction of new main railway line along the North-South transport corridor Yeralievo – Turkmenbashi – Bereket – Etrek – state border with exit to the railway network of Iran will accelerate the integration of Turkmenistan to the system of international transportation.

Construction of railway Ashgabat-Karakum-Dashoguz (530 kilometers) is finished. After putting into operation the 2 kilometer bridge Atamurat-Kerkichi over the Amudarya River the establishment of common railway network of Turkmenistan will be completed.

It is planned to modernize the existing railways. Initially, the sectors Ashgabat-Bami (165 km), Ashgabat-Tejen (218 km) will be supplied with electric power and locomotive depots in Ashgabat, Dashoguz cities and in Amudarya settlement will be reconstructed.

The civil aviation will get its further development. Purchasing of aircrafts with superior technical and economic characteristics (economy in fuel consumption, reliability, ecological safety, comfort), particularly the new aircrafts of "Boeing" will permit to provide comfort for passengers and secure flights and open the new routes.

Within framework of the project on creation of transport corridor North-South the reconstruction of the seaport of Turkmenbashi city will continue. It will open the way to the increase of transportation volumes 3.8 fold and freight turnover - 5.7 fold by 2010.

Completion of the reconstruction of ferry crossing, cargo berths and infrastructure of Bekdash (Garabogaz) port by 2005 will open new perspectives for transporting the chemical products by sea abroad.

3. Forecast of greenhouse gases emissions in main branches of the economy of Turkmenistan, the estimation of emissions reduction potential

3.1. Forecast of GHG emissions in main branches of the economy of Turkmenistan

Intensive development of fuel and energy complex, including power engineering and oil and gas complexes is one of the priority objectives of the economy of Turkmenistan for the near future.

In accordance with the concept of President of Turkmenistan Saparmurat Turkmenbashi and main development directions of oil and gas complex of Turkmenistan for the period until 2010, the hydrocarbon resources mining will considerably increase. Mining of oil and gas condensate will surge to 28 million tons and natural gas – to 85 billion cubic meters by 2005, to 48 million tons and 120 billion cubic meters respectively by 2010. (Figure 3.1, Table 3.1).

Table 3.1.
Dynamics of development of oil and gas sector of Turkmenistan for the period to 2010

Item	Measure unit	Year					
		2000	2002	2003	2004	2005	2010
Primary fuel							
Natural gas							
Output	billion cubic meters	47.2	61.8	67.1	75.4	85.0	120.0
Import	billion cubic meters	-	-	-	-	-	-
Export	billion cubic meters	33.6	47.5	52.2	60.4	70	100
Domestic consumption	billion cubic meters	13.6	14.3	14.9	15	15	20
Oil *(including gas condensate)*							
Output	million tons	7.2	13.0	19.0	22.2	28	48
Import	million tons	-	-	-	-	-	-
Export	million tons	1.7	5.3	11	14	16	33
Primary refining	million tons	5.5	7.7	8	8.2	12	15

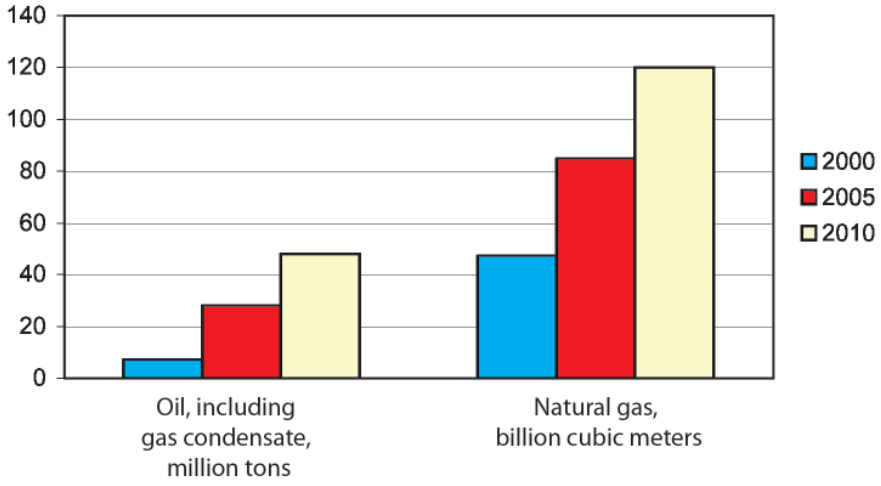

Figure 3.1. Dynamics of oil and gas mining

As far as the energy sector has the largest share in greenhouse gases emissions (according to IPCC), the perspective plans of oil and gas extraction and refining will permit to estimate projections for GHG emissions (Table 3.2).

Table 3.2.

Projected volumes of GHG emissions in energy sector, including oil and gas sector, Gg (thousand tons)

Year	CO_2	CH_4	Amount of CO_2 – equivalent
2002	41331	1022	62793
2005	67443	1493	98796
2010	86693	2027	129260

In addition, there were estimated the emissions of carbon dioxide occurring from the activity of chemical and cement production enterprises (Table 3.3):

- emission when using natural gas in ammonia production
- emission from production of cement

Table 3.3.

Projected volumes of GHG emissions in industrial sector, Gg (thousand tons)

Name	Estimation for 2002	Forecast for 2005	Forecast for 2010
Emission from natural gas combustion	666	1661	2871
Emission from use of natural gas for ammonia production	196	615	1275
Emission from production of cement	598	997	1371
Total:	**1460**	**3273**	**5517**

Growth of CO_2 emissions over the forecasted period will be connected with increase of production volume at chemical enterprises and with construction of new cement plants.

As it was estimated in Initial National Communication on UN Framework Convention on Climate Change, the greenhouse gases emissions in 2000 exceeded the level of 1994, in 2002 the excess of the level of 1994 made 17713 Gg (thousand tons) of CO_2 equivalent (Table 3.4, Figure 3.2).

Table 3.4.

Growth dynamics and forecast of GHG emissions, Tg (million tons)

Year	CO_2	CH_4	CO_2equivalent
1994 (inventory data)	31.859	0.968	52.187
2000	35.648	1.012	56.900
2002	45.023	1.186	69.900
2005	74.072	1.681	109.400
2010 (forecast)	97.810	2.258	145.200

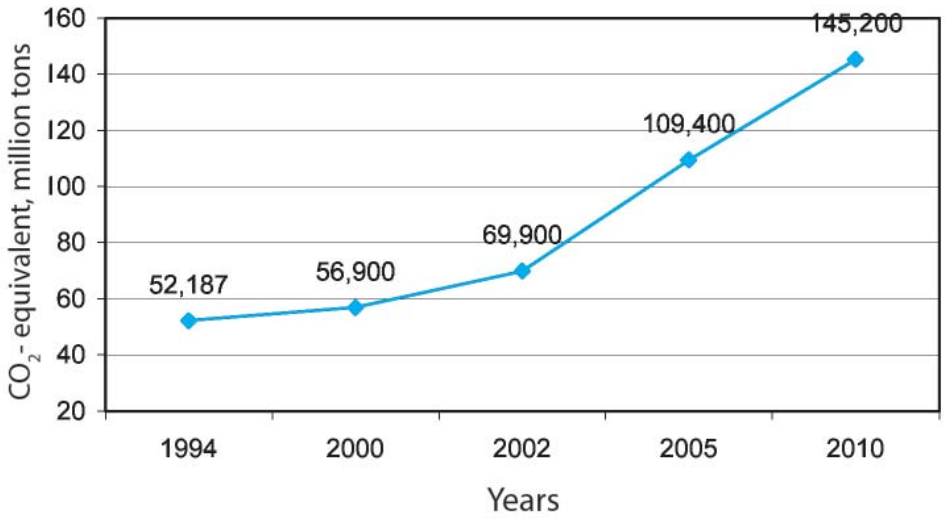

Figure 3.2. Growth dynamics and forecast of GHG emission in CO_2 equivalent, million tons

3.2. Potential for reduction of GHG emissions

All measures leading to the reduction of GHG emission or focused on increase of reduction potential are directly connected with such matter as environment protection. The reduction of GHG emission from energy and industrial enterprises may become the by-product of measures and policy directed on augmentation of energy efficiency and energy conservation.

The policy and measures envisaging the restriction of technogenic emissions of carbon dioxide in the energy sector respond to the concept of strategic development of the energy sector of the country aimed at increasing the efficiency of energy consumption and energy supply.

Now, the draft law of Turkmenistan on energy conservation is being prepared. This law will include all aspects of energy conservation in the spheres of energy production and energy consumption. It will define the inter-branch scheme of energy conservation management on the government level. One of the first priority measures on reduction of emissions in energy production and consumption is to work up the mechanism of realization of the energy conservation policy.

The example of realization of this policy is putting into operation in 1997 at the Abadan SRPS of new gas turbine plant with the 123 MW capacity consuming 39.75 thousand cubic meters of natural gas per hour. The existing 5 old steam-turbine plants generate 125 MW per hour with burning 56 thousand cubic meters of gas per hour. The second similar gas-turbine plant was constructed by the end of 2003. The general capacity of the power station made 371 Megawatt. It is planned to assemble two utilizing boilers and steam turbine to bring efficiency to 60-65%, i.e. receive full steam-gas cycle. Replacement of steam-turbine generators for highly effective and environmentally safe gas-turbine plants will reduce the emissions of harmful substances, increase the capacity of the Abadan power station and provide possibility to save a fuel (Tables 3.5. and 3.6., Figure 3.3).

Table 3.5.
Electric power output and fuel saving upon upgrading of the Abadan SRPS

Indicators	2004	2005	2006	2007	2008	2009	2010
Designed capacity before upgrading, megawatt	371	371	371	371	451	451	451
Designed capacity after upgrading, megawatt	371	371	371	371	451	451	451
Electric power output, billion kilowatt / hour	1.276	1.387	2.6	2.6	3.0	3.0	3.0
Fuel saving TJ	1473	1473	1473	1473	8435	8435	8435

Table 3.6.
Reduction of CO_2 emission due to upgrading of the Abadan SRPS, Gg(thousand tons)

Indicators	2003	2004	2005	2006	2007	2008	2009	2010
CO_2 emission before upgrading	1127.36	1686.49	1686.49	1686.49	1686.49	1686.49	1686.49	1686.49
CO_2 emission after upgrading	1127.36	1603.78	1603.78	1603.78	1603.78	653.80	653.80	653.80
CO_2 emission reduction	0	82.71	82.71	82.71	82.71	473.56	473.56	473.56

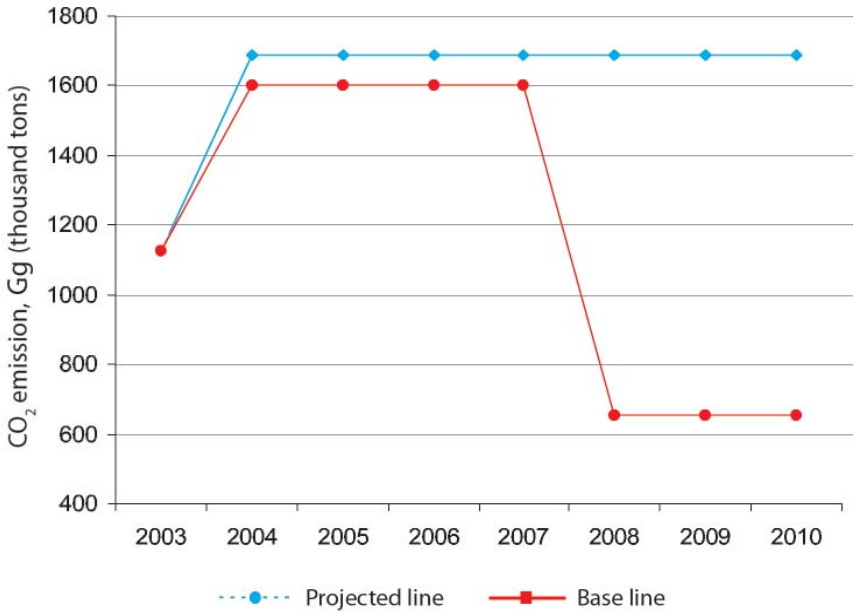

Figure 3.3. Dynamics of reduction of CO_2 emission due to upgrading of Abadan SRPS, thousand tons

Fuel saving over 2004-2010 will make 31197TJ (Table 3.5). It is seen from Table 3.6. that the potential of emissions reduction over 7 years (2004-2010) will make 1752 Gg (thousand tons).

Modernization of the Turkmenbashi Heat and Power Plant implies the mounting of two power-generating units to be commissioned on a phased basis. The designed total capacity will make 550 megawatt. The indicators of modernization effect are shown in Table 3.7. and Figure 3.4. Figure3.4. shows that emission reduction over 6 years (2005-2010) will come to 2380 Gg (thousand tons). Fuel saving over this period will be 42411TJ.

Table 3.7.
Reduction of CO_2 emissions due to upgrading of Turkmenbashi HPP, Gg (thousand tons)

Indicators	2003	2004	2005	2006	2007	2008	2009	2010
CO_2 emission before upgrading	1852.79	1852.79	1852.79	1852.79	1852.79	1852.79	1852.79	1852.79
CO_2 emission after upgrading		1852.79	1454.81	1454.81	1454.81	1454.81	1454.81	1461.75
CO_2 reduction			397.98	397.98	397.98	397.98	397.98	391.04

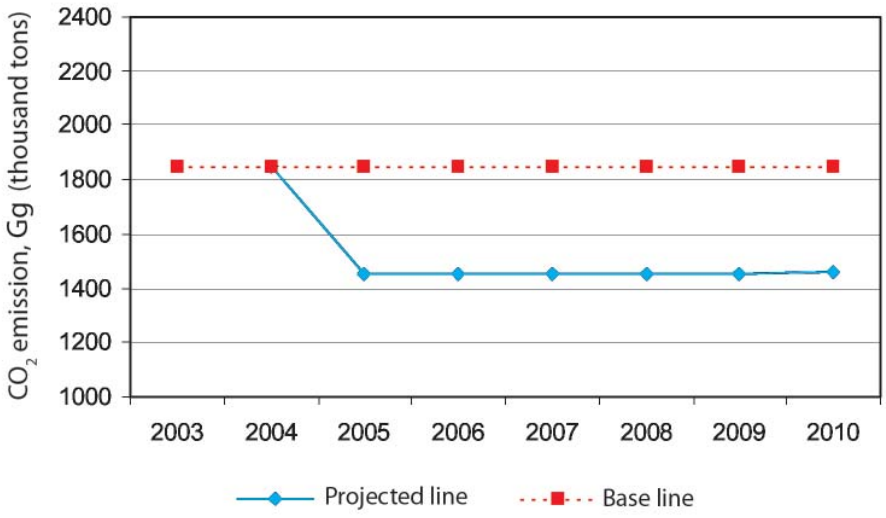

Figure. 3.4. Dynamics of CO_2 emissions reduction due to upgrading of Turkmenbashi HPP, thousand tons

Balkanabat SRPS has been upgraded by putting into operation of three gas turbines 3x42MW and one steam turbine of 50 MW of combined cycle. The general designed capacity of SRPS after upgrading makes 176 megawatt. Table3.8 and Figure 3.5 show the indicators of upgrading. Potential of GHG emissions reduction due to upgrading over the next 5 years (2006-2010) will make around 529Gg, and the total decline in fuel consumption over this period will reach 9428TJ.

Table 3.8.
Reduction of CO_2 emissions due to upgrading of Balkanabat SRPS, Gg(thousand tons)

Indicators	2006	2007	2008	2009	2010
CO_2 emission before upgrading	612.85	612.85	696.42	696.42	696.42
CO_2 emission after upgrading	557.13.	557.13	557.13	557.13	557.13
CO_2 emissions reduction	55.72	55.72	139.29	139.29	139.29

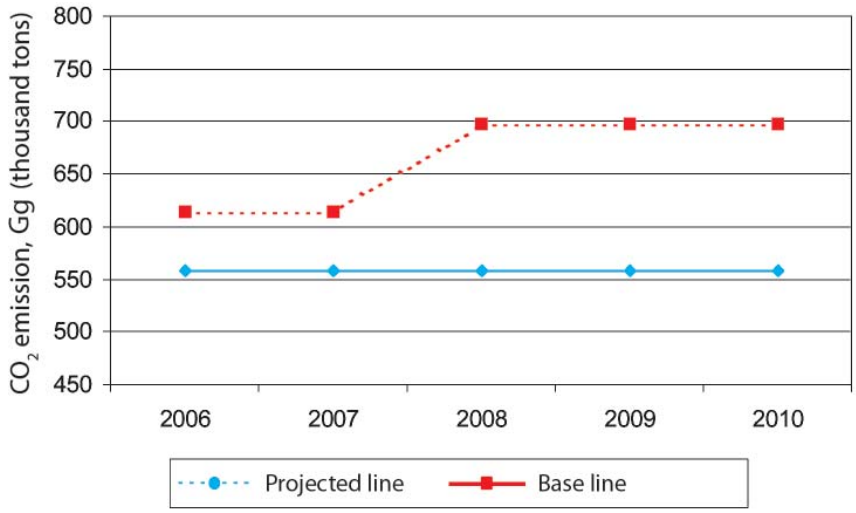

Figure 3.5. Dynamics of CO_2 emissions reduction due to upgrading of Balkanabat SRPS, thousand tons

Solution of the problem of State Regional Power Station in Mary envisages the efficient way of modernization of the existing power-generating units by adding the gas-turbine plants. The upgrading may start in 2006 and will be completed in 2009. The designed capacity will be 2165 megawatt. Table 3.9 and Figure 3.6 show the indicators of upgrading. The fuel saving over 5 years (2006-2010) will make 93975TJ, and the potential for CO_2 emissions reduction will reach nearly 5275Gg.

Table 3.9.
Reduction of CO_2 emissions due to upgrading of Mary SRPS, Gg (thousand tons)

Indicators	2005	2006	2007	2008	2009	2010
CO_2 emission before upgrading	6861.42	6861.42	6861.42	6861.42	6861.42	6861.42
CO_2 emission after upgrading	6861.42	6614.41	6367.40	5747.13	5395.82	4906.60
CO_2 emissions reduction		247.01	494.02	1114.29	1465.60	1954.82

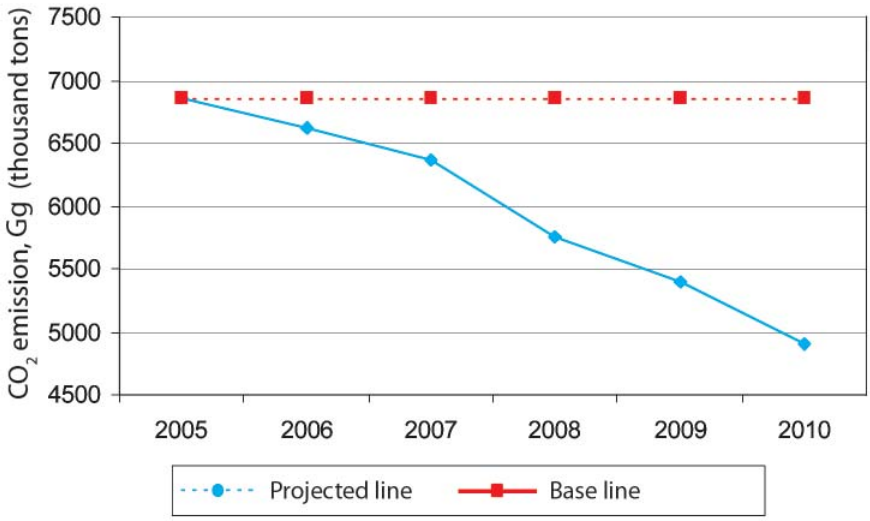

Figure 3.6. Dynamics of CO_2 emissions reduction due to upgrading of Mary SRPS, thousand tons

It is suggested to upgrade the Seydi Heat and Power Plant by adding to the existing power-generating units the gas-turbine generator. The designed capacity of this heat and power plant will make 210 megawatt. The total reduction of fuel consumption over 4 years (2007-2010) will make 12698 TJ.

Table 3.10 and Figure 3.7 highlight the dynamics of reduction of CO_2 emissions. It is seen from the indicators that the potential of reduction of GHG emissions over 4 years will make about 713 Gg.

Table 3.10.

Reduction of CO_2 emissions due to upgrading of Seydi HPP, Gg (thousand tons)

Indicators	2006	2007	2008	2009	2010
CO_2 emission before upgrading	760.12	760.12	760.12	760.12	760.12
CO_2 emission after upgrading	760.12	641.31	641.31	522.51	522.51
CO_2 emission reduction		118.81	118.81	237.61	237.61

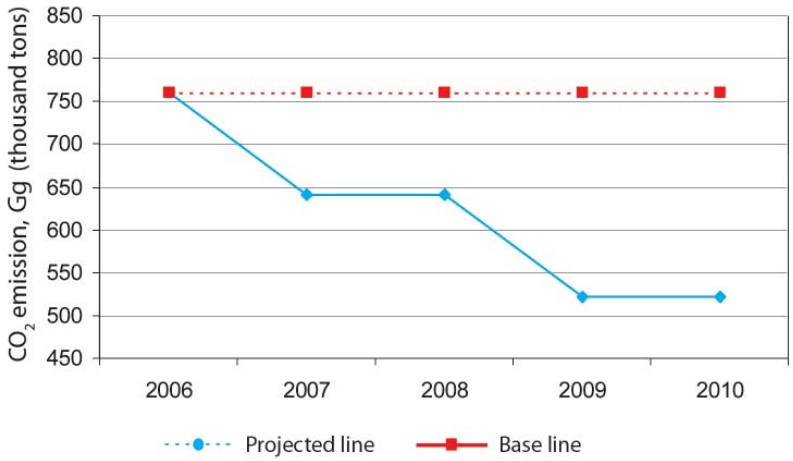

Figure 3.7. Dynamics of reduction of CO_2 emissions due to upgrading of Seydi HPP, thousand tons

In perspective, the upgrading of Heat and Power Plants and State Regional Power Stations will provide a possibility to reduce fuel consumption (Figure 3.8.) and reduce carbon dioxide emissions by 30% without decreasing the total capacity. The projections for every particular power station in view of the time required for upgrading, type of proposed upgrading, expected volume of electric and thermal power output, degree of reduction of fuel consumption made a basis for estimation of total reduction of CO_2 emissions by years over the whole power supply system of Turkmenistan (Figure 3.9, Table 3.11).

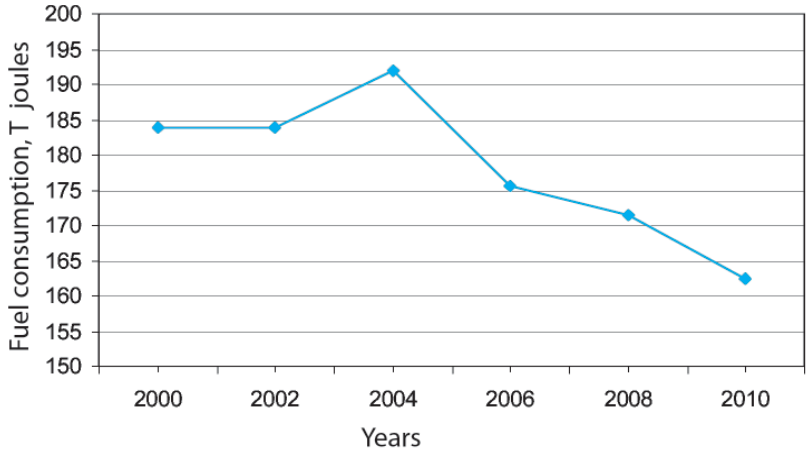

Figure 3.8. Reduction of fuel consumption over the whole power supply system due to phased upgrading of SRPS and HPP

The dynamics of emissions reduction and potential of CO_2 emission reduction in energy sector of Turkmenistan is seen in Table 3.11 and Figures 3.9 and 3.9a.

Table 3.11.
CO_2 emission and potential of its reduction over the power supply system of Turkmenistan

Years	Indicators		
	CO_2 emission before upgrading (base line), Gg (thousand tons)	**CO_2 emission after upgrading (projected line), Gg (thousand tons)**	**Reduction of CO_2 emission Gg (thousand tons)**
2003	11400	11400	0
2004	12386,4	11794,3	592,1
2005	12386,4	11794,3	592,1
2006	12386,4	11794,3	592,1
2007	12386,4	11181,5	1204,9
2008	12553,6	10009,2	2544,4
2009	12553,6	9141,1	3412,5
2010	12553,6	8651,9	3901,7

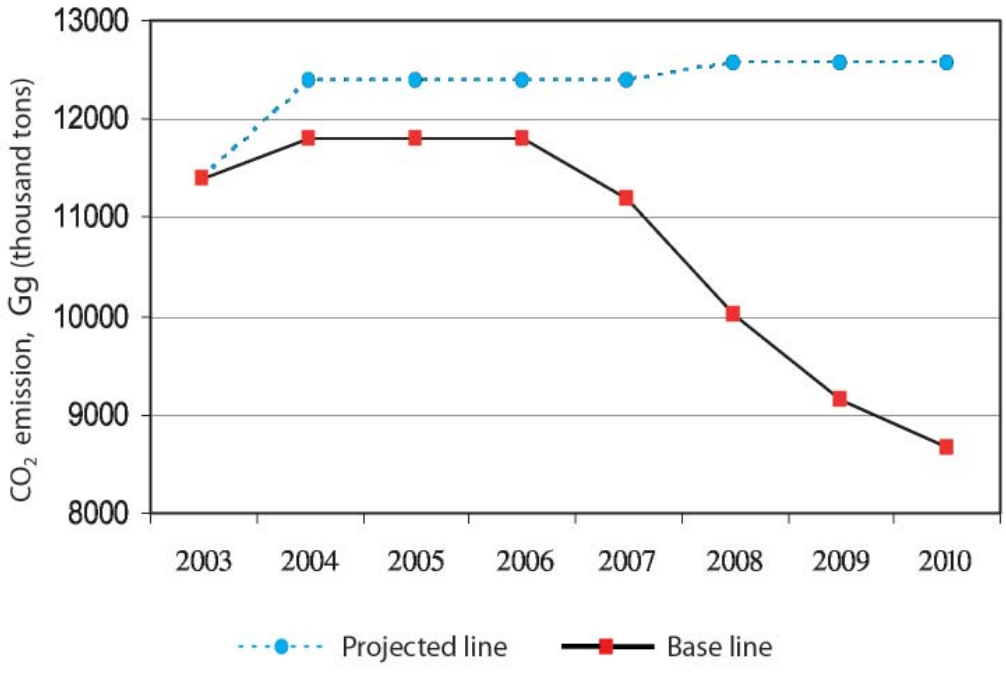

Figure 3.9. Dynamics of reduction of CO_2 emissions in power supply system of Turkmenistan, Gg(thousand tons)

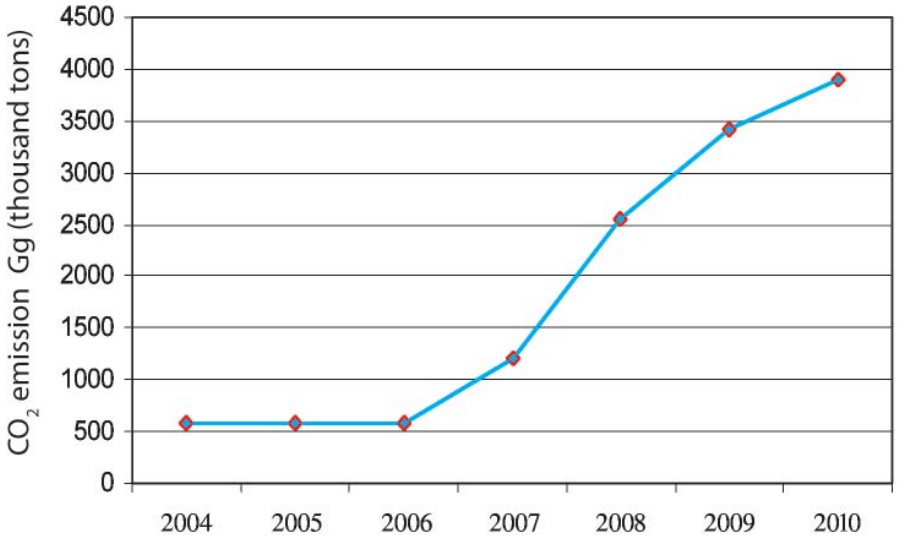

Figure 3.9 a. Potential for reduction of CO_2 emissions in the power engineering system of Turkmenistan

The potential of CO_2 emission reduction over the whole power system of Turkmenistan will be 12840 Gg (Table 3.11, Figure 3.9a). Two gas turbine plants each of 125MW capacity have been commissioned recently in the outskirts of Ashgabat city, and similar gas turbine power station is constructed in Dashoguz city.

In the chemical industry the significant reduction of CO_2 emissions is expected in 2005 - 2010 after putting into operation of carbamide producing plant. Carbon dioxide blown out into atmosphere during ammonia production will be used as the raw material for carbamide production. Potential of emissions reduction in 2005 will make 256.6Gg/year, in 2010 – 549.8 Gg/year (Figure 3.10).

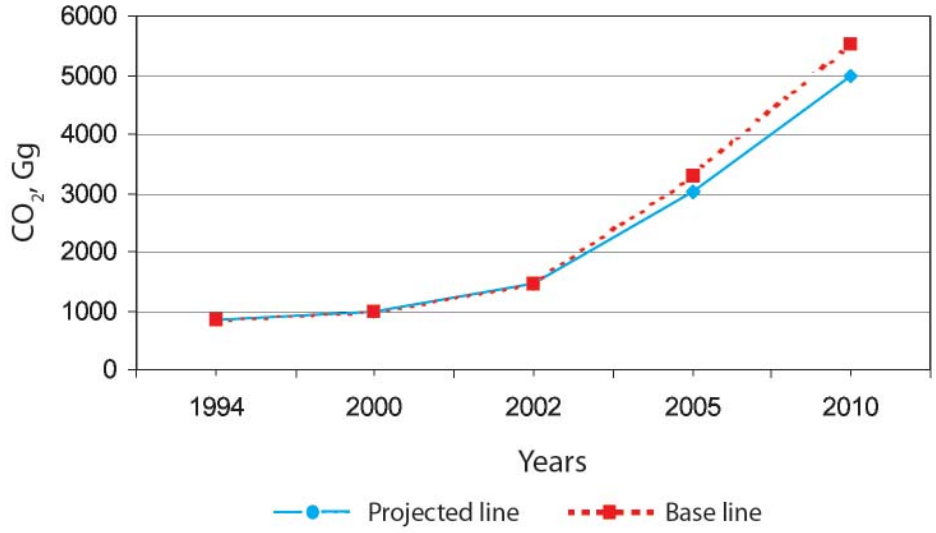

Figure 3.10. Potential for reduction of CO_2 emissions upon the carbamide plant commissioning

Presently, there are three plants of liquefied-gas production in Turkmenistan. The first one was put into operation in 1998 at the gas condensate field Naip. This natural gas refining plant produces 15 thousand tons of liquefied gas per year. In November 2002, construction of the second liquefied gas production plant was completed also at the field Naip with the designed capacity of 9 million cubic

meters of gas refining per day and production of 65 thousand tons of liquefied gas per year. The other plant works at the Turkmenbashi Refinery. After its modernization the liquefied gas producing capacity increased from 18 to 220 thousand tons per year.

Now, the new liquefied gas production plant is constructed at the Naip field under the contract with the Canadian Company "Thermo Design Engineering". The capacity will be 50 thousand tons a year. It is in plans of Turkmenistan for near future to produce up to 500 thousand tons per year of liquefied gas.

In 1998, after the sharp increase of oil mining there was undertaken the assessment of gas combustion volumes. The assessment showed that each year the casing-head gas was emitted or burnt up in a volume between 2 and 2.5 billion cubic meters. At present, 40% of casing-head gas is used in production of liquefied gas at the Turkmenbashi Refinery, as well as is used in gas-lift process. Given the share of methane in casing-head gas makes 87%, it means that about 0.87 billion cubic meters of methane or 584 thousand tons is not emitted into atmosphere per year. In terms of CO_2-equivalent it will make 12264 Gg/year with further increase of this amount (Figure 3.11).

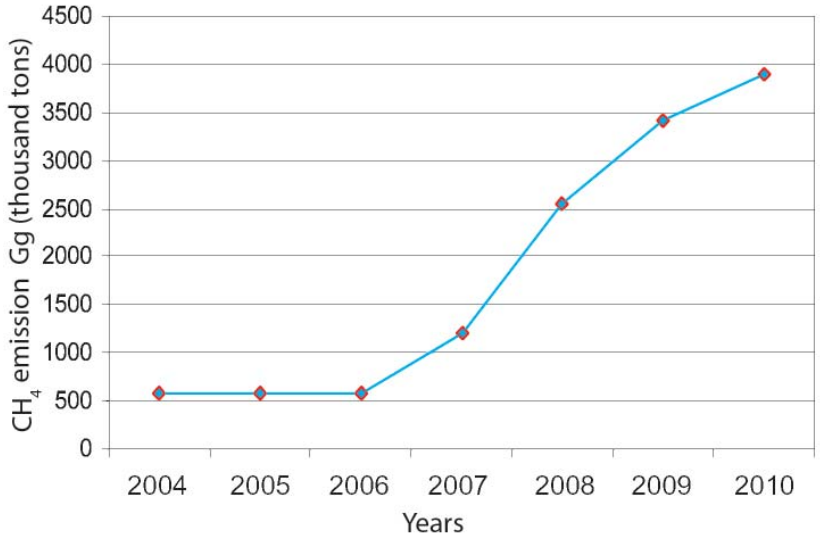

Figure 3.11. Increase of utilizing casing head gases

The potential of GHG emissions reduction may significantly rise when:

- using natural gas, casing-head gas, including the gas burnt up in oil mining and refining processes;
- using new technologies, when mining, refining and transporting oil and gas;
- increasing completeness of fuel using at combined generation of heat and electric power;
- increasing energy-efficiency of the existing systems of centralized heat supply by means of applying the pipes with adequate polyurethane isolation ;
- using fuel-free renewable energy sources.

4. Identification and presentation of technological needs

Identification of technological needs in order to prevent to a maximum extent the negative impact of possible climate change on economy of any country, including Turkmenistan, is the actual objective.

4.1. Principles of technological needs identification

As Intergovernmental Panel on Climate Change defined, the environmentally safe technology is the technology of mitigation of adverse effects and adaptation to the climate change and it should support development sustainability.

When determining the technological needs of the country, the traditional structure of its economy, the economic growth in near future and in long-term perspective, vulnerability of each economic sector to climate change, negative or positive effects of climate change, priority of protection of the economic branches from negative effects of climate change were taken in consideration.

Introduction of environmentally safe technologies should promote the achievement of progress in national priorities of the economic development of Turkmenistan. The main objective of the economic policy of Turkmenistan as of the state with transition economy is the stable socioeconomic growth. To achieve this main goal, the environmental standards and the interests of world community should be taken into consideration.

The climatic technologies selection implied the following criteria:

- economy sectors of priority character from point of view of GHG reduction;
- share of the selected sector in GDP structure;
- assessment of the existing technologies;
- interrelation with other technologies;
- quantitative reduction of GHG emissions after technologies replacement;
- ecological, social, economic and political implications of technology;
- possibility of further improvement of these technologies.

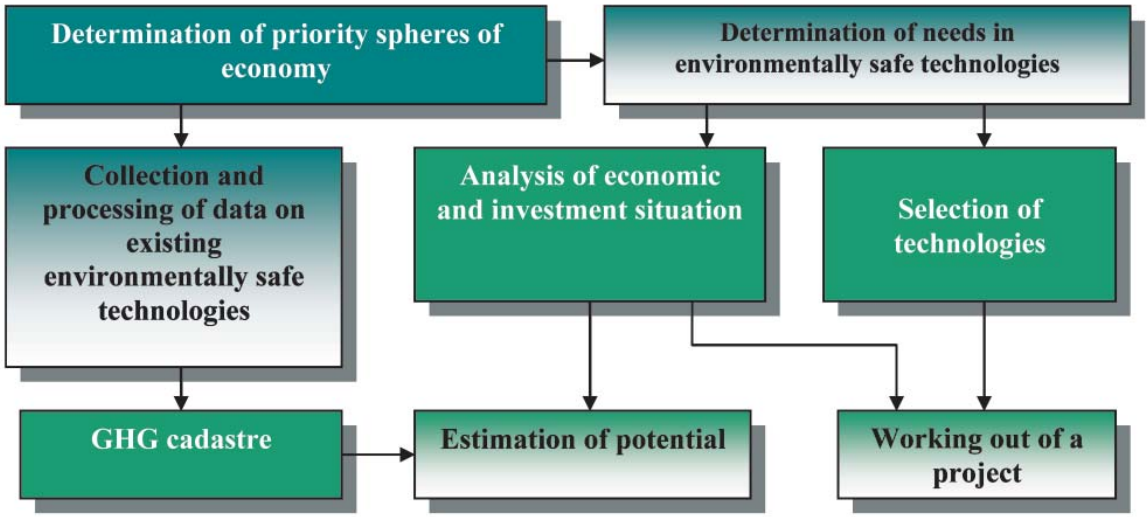

Figure 4.1.Scheme of identifying, estimating and presenting the technological needs

Identification of technological needs, selection of adequate climatic or "clean" technologies, development and implementation of projects on reduction of GHG emissions was done on a stage-by-stage basis, in accordance with results received during the 1st phase of research.

Preparing and assessment of technological needs for the priority sectors of economy was per-

formed in accordance with data of greenhouse gases emissions and sinks inventory in Turkmenistan (1994) and data of GDP structure over 1990-2002.

Criteria of technological needs estimation were as follows:

1. CO_2 and methane emissions by sector of economy. According to the results of GHG inventory, the energy sector emits the largest volume (48.49 %) of GHG in Turkmenistan.

The data of category "Energy" represent:

- GHG emissions after fuel combustion when generating electric and thermal energy at various kinds of power stations and regional, departmental and municipal boiler-houses;
- GHG emissions after fuel combustion when using electric and thermal energy in industry;
- GHG emissions from extraction, refining, transportation, storing and distribution of oil and gas;
- GHG emissions from motor transport.

Other emissions take origin at the following sectors of the economy:

- manufacturing industry and construction - 24.67 %
- other sectors (communal services, agriculture) - 18.00 %
- others – 8.83%

According to the greenhouse gases emissions and sinks inventory in Turkmenistan for the year 1994, the extraction, transportation, refining of oil and gas provide over 87% of methane emissions, while agriculture - about 12 %.

2. The share of a sector of economy in GDP structure is the criterion of its priority determination. According to data of 2001, the sectors of economy of Turkmenistan by their share in GDP structure (in priority order) take the following places:

- industry (power engineering, oil and gas mining and refining) - 38 %
- agriculture - 26 %
- construction - 26 %
- services sphere - 10 %

The share of fuel and energy complex is over 65% of total income received in industrial sector (2001), of which around 62% - from natural gas production, 28 % - oil production, about 8 % - oil refining industry and 2 % - heat and power engineering.

The branch structure of fuel and energy complex of Turkmenistan in 2000 included:

- gas production industry - 67 %
- oil production industry - 22 %
- oil refining industry - 6 %
- power engineering 5 %

3. Comparison of specific energy-consumption of existing and new technologies in Turkmenistan with the worldwide average indicators.

Two criteria were used in this method:

- comparison of specific energy consumption by main economic indicators with the worldwide indicators (Table 4.1);

Table 4.1.
Main indicators of energy consumption in some countries

Country, region	Population, million people	GDP, billion US$	FER/ person, t/person	FER/ GDP, t/ US$	CO2 emission, million tons	Tons CO2/ person	kg CO2/ US$
1998							
Whole World	5899.6	29648.48	1.664	0.33	22713.46	3.85	0.77
EU	303.565	6538.67	3.711	0.17	2428.52	8.0	0.37
Turkmenistan	4.920	2.862	3.321	5.71	27.2076	5.53	9.51
Russia	146.9	282.44	3.958	2.06	1420.523	9.67	5.03
USA	275.157	8720.2	7.928	0.25	5486.63	19.94	0.63
Germany	82.047	2144.48	4.202	0.16	825.393	10.06	0.16
1999							
Whole World	5977.73	30700.94	1.674	0.33	22536.04	3.77	0.73
EU	304.07	6684.74	3.791	0.17	2408.23	7.92	0.36
Turkmenistan	5.097	3.305	2.677	4.13	32.417	6.36	9.81
Russia	146.31	193.62	4.121	3.11	1436.76	9.82	7.42
USA	278.67	9206.9	8.066	0.24	5495.37	19.72	0.6
Germany	82.09	2103.39	4.155	0.16	792.17	9.65	0.38

- comparison of specific energy consumption by existing technologies with the consumption by advanced technologies

The specific energy consumption, i.e. the energy consumed per unit of GDP of Turkmenistan, according to data of 1998, exceeded 17.3fold the average world index and 33.5fold the EU index. In 1999, this index a little bit improved due to the introduction of new technologies, putting into operation of first in the country gas-turbine plant (GTP) at the Abadan State Regional Power Station. The excess of world level was 12.5, while the excess of European level equaled to 24.3 (Table 4.1). The specific energy consumption is an important index. It strongly influences on the products price and consequently on their competitiveness at the world market.

The abovementioned criteria are applied to determine the priority spheres of the economy and categories of sources for needs in technologies (Table 4.2).

Table 4.2.

Priority spheres for the needs in technologies

Sector	Category	Sources
1. Energy	1. Power engineering	1. Electric and thermal energy production
		2. Transmission and distribution of electric and thermal energy
	2. Production of natural gas, oil and petroleum products	1. Mining, transportation and storing of natural, casing-head gases, petroleum
		2. Oil and natural gas refining
		3. Gas combustion at fiare
	3. Industry	1. Chemical industry
		2. Building materials production
	4. Transport	1. Motor transport
		2. Railway transport
		3. Air transport
	5. Housing and municipality	1. Use of electric power and heat
	6. Alternative sources of energy	1. Sun
		2. Wind
2. Industry	1. Chemical industry	1. Mineral fertilizers production
	2. Non-ferrous materials production	1. Cement production

4.2. Main directions in working out the projects for priority sectors of the economy

Table 4.2 shows that Turkmenistan has rather large number of priority economic sectors where the technological modernization is required. However, at present time, the sectors that consume electric energy are the most important ones in this regard.

Low energetic efficiency of the economy remains to be one of main causes of a high share of energy consumption.

The main reasons of this situation include intense depreciation of a larger part of the existing technological equipment in chemical and building materials production, and also the backwardness of a number of technological processes. The power consumption by many technologies in our country exceeds considerably the level of power-consumption by similar technologies in the developed states.

The high level of consumption of energy resources by households is connected with the lack of strict control over energy use, free of charge supply of electric energy to the population. Turkmenistan is the only country in the world with at no charge electricity for the population.

Over the recent years, in accordance with the adequate investment policy of Government of Turkmenistan, the advanced energy conservation technologies came to the priority sectors of the economy. These are the oil and gas extraction, the oil refining and natural gas transportation industries, production of nitric fertilizers, the cement, textile and some other industrial branches.

In the meantime, the consumption of electric energy and fuel strongly grows due to increase of using it in the households, because people purchase more and more new electric appliances (air-conditioners, refrigerators, TV and video sets, computers and other home appliances).

Currently, there is a number of economic programs in Turkmenistan such as National Program

of President of Turkmenistan "Strategy of socioeconomic reforms in Turkmenistan for the period to 2010", National Program "10 years of stability" (up to 2000), national programs "Education", "Healthcare", "New village", " Grain", "Processing industry", "National Environmental Action Plan of Saparmurat Turkmenbashi, President of Turkmenistan"(NEAP), "Concept of oil and gas industry development in Turkmenistan throughout 2020" and other sectoral long-term programs.

The programs are adjusted annually in consideration of the actual position of the economy. For instance, to implement the tasks defined for the oil and gas, power engineering and chemical complexes of Turkmenistan, in accordance with the National Program of President of Turkmenistan Saparmurat Turkmenbashi "Strategy of socioeconomic reforms in Turkmenistan for the period to 2010", President of Turkmenistan approved by his Decree the Program for development of oil and gas, power engineering and chemical complexes, mineral resources and fishery of Turkmenistan in 2003.

Rather ambitious but achievable long-term goals of the development of Turkmenistan constitute the basis of "Strategy of socioeconomic reforms in Turkmenistan for the period to 2010". The Strategy determines four priorities: *economic, food, social and ecological security.*

Achievement of the goals and realization of the suggested measures on the basis of intensive labor and business initiative, reasonable and consistent economic policy provide the possibility to form a quite new and highly effective structure of the economy of the country with developed market institutes guaranteeing economic and political independence of the state with simultaneous preservation of ecological balance, creation of adequate living standard for the citizens.

Huge natural resources, rather high growth of the population and consequently large labor potential, and mainly the economic potential of the country created for today constitute objective grounds of such intensive socioeconomic development.

Implementation of the strategic tasks defined in National Program of President of Turkmenistan Saparmurat Turkmenbashi "Strategy of socioeconomic reforms in Turkmenistan for the period to 2010" and other national programs in conditions of a reliable supply of energy, high rates of economic reform and further development of investment process make a good basis for confidence that Turkmenistan has the appropriate potential for introduction of new technologies leading to reduction of GHG emissions (Table 4.3).

Table 4.3.

Main directions in working out the projects for priority sectors of the economy of Turkmenistan

Sectors	Measures
Mining and transportation of oil and gas.	- compilation and utilization of casing head gases, when mining the oil
	- introduction of less power intensive technologies of oil and gas mining
	- transition to less power intensive technologies of natural gas purification and transportation
Oil refining and petroleum products storing	- introduction of new technologies at refineries
	- reduction of losses of petroleum products at time of oil refining and products storing
Production of electric power	- replacement of existing technological plants for high-technology turbine plants (GTP)
	- upgrading of operating power-generating units with adding of steam and gas plants (SGP)
Industry	- modernization, reconstruction of operating production units;
	- introduction of less power intensive productions (in chemical industry, building materials production)
Transport	- introduction of modern transport vehicles
	- electrification of transport

5. Build up of potential for estimation of technological needs

Implementation of obligations stated in Article 4.1 of the Convention requires building up of national capacity for:

- identification of technological needs;
- estimation of the role of technologies in mitigating the climate changes;
- identification of mechanisms that promote development of technologies market and strengthen business relations for effective transfer of new technologies.

5.1. Development of institutional capacity

The existing institutional structure of the national system of Convention implementation in Turkmenistan and interaction with international agencies represents itself in Initial National Communication of Framework Convention on Climate Change (FCCC).

According to the Decree of Government of Turkmenistan, the Nature Protection Ministry of Turkmenistan performs functions on realization of UN Framework Convention on Climate Change.

The scheme of coordination of national implementing agencies and interaction with international institutions is in Figure 5.1.

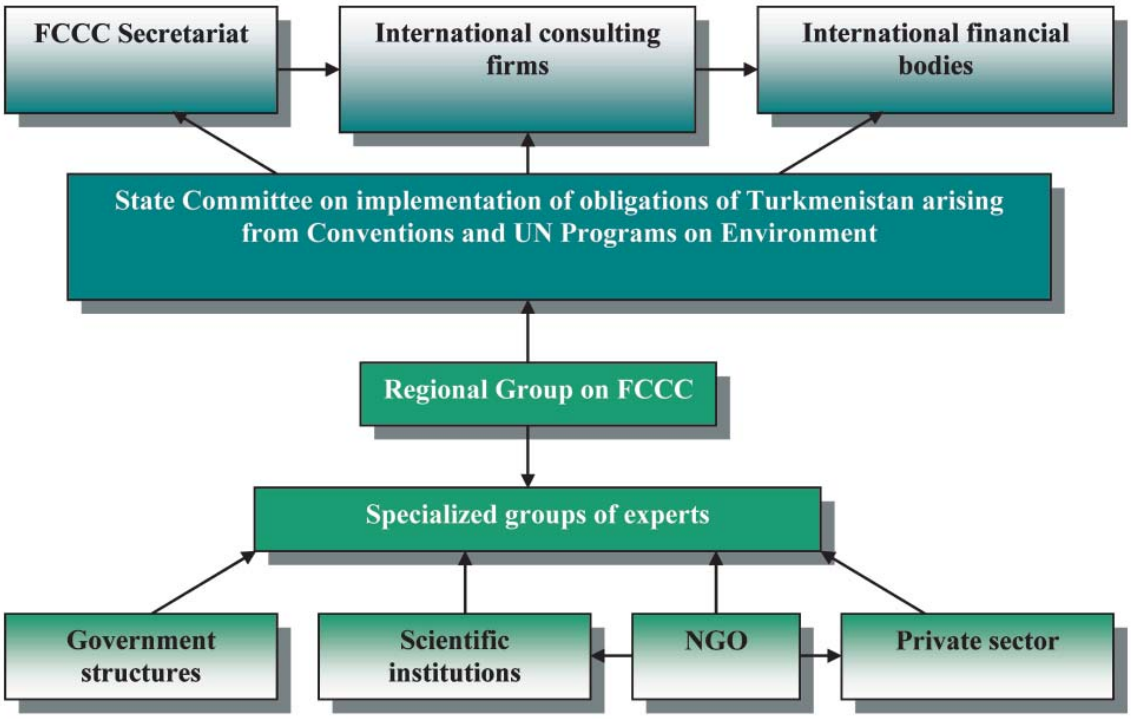

Figure 5.1. Scheme of interaction of national and international structures

To implement the project "Building up the priority economic potential of Turkmenistan in response to the climate change, Phase II" there were established the teams of national experts to determine technological needs of the priority sectors of the economy of Turkmenistan for promoting the reduction of greenhouse gases emissions and mitigation of negative effects of climatic change, as well as to analyze the climatic vulnerability and work out measures on adaptation to the possible climatic changes. They were the experts from various branches and institutions of the economy of the country having experience in the issues of technological modernization and energy-conservation in power engineering, oil and gas complex, chemical industry, municipal supply of heat and electricity, agri-

culture. The staff of National Hydrometeorology Committee, of research institutes on climatology, hydrology, agro-climatology, environment monitoring also participated in these discussions.

It would be necessary to establish the National Center on Climate Change Studies - the national intergovernmental body coordinating and managing the implementation of obligations arising from Convention and mechanisms of Kyoto Protocol on introduction of advanced technologies. At initial stage, the international agencies such as GEF and UNEP could provide financing in establishing this center.

Establishment of the Center will provide arranging and coordinating of the activity of all line ministries, as well as promote more effective transfer and use of environmentally safe technologies.

5.2. Development of information potential

Although the removal of information barriers is the critical factor in transfer and dissemination of advanced technologies, there is no system in Turkmenistan for collection and dissemination of data on environmentally safe technologies. This job is done only within implementation of the National Environmental Action Plan of President of Turkmenistan Saparmurat Turkmenbashi and international projects on climate change. The leading role in this issue belongs to the Ministry of Nature Protection. It has close relations with the respective governmental, scientific and engineering agencies.

Today, the annual reports of enterprises under Form "2-TP-air" enter directly to the National Institute of State Statistics and Information of Turkmenistan, passing by the Ministry of Nature Protection. The former practice should be restored in order to receive accurate information. In addition, whereas there is no currently the information on GHG emissions, it is suggested to include to this annual reporting of enterprises (ministries, departments) the data on fuel and energy resources consumption and using.

At the same time, the propaganda, the education in the sphere of energy-conservation policy with the use of information systems, electronic mass media may bring the big effect, for instance in energy conservation in the state.

For improvement of technological information potential in Turkmenistan it is required to establish the developed information systems and switch them to the regional and international networks through the specialized agencies and information firms. It is also required to intensify the activity on development of public awareness about the problems of climate change, rational use of fuel and energy resources, increase of the use of renewable energy sources.

5.3. Development of human potential

Transfer of many kinds of new technologies requires high qualification of a large number of managers, technical specialists and producers. In addition, these specialists should have proper understanding of national economy peculiarities and the ecological problems, be able to estimate the technological needs, be aware of peculiarity of the technologies transfer realization, be able to organize the required information exchange between the national producers and international donors.

Unfortunately, many agencies do not have the professionals of adequate qualification in the sphere of climate change and technologies transfer. When performing the inventory and preparing the Initial National Communication, as well as during implementation of the project there have been arranged in all regional centers of Turkmenistan a number of seminars on various aspects of the problem of climate change. However, after completion of the projects the expert teams usually stop their work.

Thus, the purposeful activity on increase of human potential, improvement of education system, strengthening of scientific and technical base of educational institutions and improvement of their programs, development of the regional and international cooperation is the matter of high priority in our country.

5.4. Monitoring and estimation of climatic technologies

Now, Turkmenistan has the portfolio of potential projects for implementation of them within the frames of the Clean Development Mechanism. The information base contains a short description of each project, volume of required investments, volumes of carbon dioxide and methane emissions reduction. It will not be difficult to calculate the specific capital investments per unit of emissions reduced upon the project performance. The information base at present time includes 29 proposals for projects from various economic sectors. The list of proposed projects is in Annex 2 to this report.

5.5. Barriers in new technologies introduction

Fulfillment of obligations under FCCC contemplates the assistance to organizations in intensification of their activity on technologies transfer and liquidation of some barriers. Barriers can be of organizational and legal, social, economic, financial, technological, information character.

In the meantime, Turkmenistan has proper opportunities for conduction of economically effective measures on mitigation of the climate change consequences.

The general barriers identified during the analysis have been grouped (Table 5.1.).

Table 5.1.
Barriers in technologies transfer, and measures to overcome them

Barriers	Possible solutions
• absence of national standards of energy consumption	• working out of standards and consumption norms for energy resources and effectiveness of technological equipment
• absence of national production of energetic equipment	• development of industrial production of technological equipment
• insufficient quantity of controlling and measuring devices	• availability of controlling and measuring devices
• low prices for organic fuel	• development of price policy reflecting the actual costs for power supply; introduction of taxes for greenhouse gases emission
• some difficulties in access to the technological information	• development of the system of specialized information services
• insufficient level of information about necessity of actions in the sphere of energy-conservation and reduction of emissions	• expanding of propagandistic and teaching activity on the problems of climatic change, mitigating and adaptation measures
• lack of investors' awareness about the potential technologies market in the country	• deepening of estimation of the technological needs of the country and development of the activity on projects selected for certain investors, as well as development of services in the sphere of entrepreneurship consulting
• Insufficient quantity of qualified staff in the sphere of energy-conservation and energy effectiveness	• build up of human potential, training of specialists for public and private sectors

6. Impact of climate change on agriculture, water resources and desert pastures of Turkmenistan

The main purpose of this section is to analyze the current situation and define the priority measures on adaptation of water management sector and agriculture to the climate change. In consideration of this purpose, the tasks to be solved within the frames of this research have been defined. Given the climate change probability it was necessary to analyze first of all the current situation in water management and agriculture of Turkmenistan and make a long-term forecast for agricultural production and for the needs of the economy in water resources in situation of the climate change.

6.1. Impact of climate change on agriculture Main targets of agriculture development in Turkmenistan

The agrarian policy drawn up for the nearest future period envisages:

- provision of a stable high growth of agricultural production;
- more effective development of agricultural branches owing to selection and seed-growing development, increase of crop yield and cattle productivity;
- improvement of agriculture structure and bringing it closer to the consumer market, introduction of science-based crop rotation for a stable increase of land fertility;
- deepening of degree and quality of agricultural products processing;
- priority development of export-oriented production in agriculture;
- renovation of logistics;
- improvement of specialization and territorial location of agricultural production.

The average annual growth of gross agricultural product in 2000-2005 accounted for over 20% against projected 14.3%.

Farmers' association is the main structural unit now in the agricultural production of Turkmenistan. There were 582 farmers' associations in 2003. The farmers' associations unite the individual leaseholders engaged in agricultural activity on a contract basis. The total number of leaseholders exceeds 400 thousand people.

In 2001, in Ashgabat etrap of Akhal velayat the farmers' associations were reorganized to the association of agricultural producers. At present time, the process of establishing and determining the mechanism of relationship between the new structural sub-division and associating organizations goes on. In case of positive outcome of the activity of this association the experience will be transferred to the other territorial units of Turkmenistan.

The special attention is paid to the issues of land reform, improvement of the system of branch management, reorganization of economic forms, deepening of integration relations, improvement of economic relations, expanding of legal framework of the government support to agricultural producers.

As it was noted above, the main indicators of the development perspective of agriculture of Turkmenistan have been defined in accordance with the National Program of President of Turkmenistan Saparmurat Turkmenbashi "Strategy of socioeconomic reforms of Turkmenistan for the period to 2010". The area of arable lands was determined as the indicative estimation.

Table 6.1.
Main indicators of agriculture development perspective in Turkmenistan

Kinds of products	Indicators	Measure unit	Rational norm, kg/person	2005	2010	2015	2020	2025
	Population	Thous. people		6932.7	8626.1	9920.0	11407.3	13118,4
wheat	Need	thous. tons	220	1525.2	1897.7	2182.4	2509.6	2886.1
	Output	thous. t.		2200	3000	3390	3680	4030
	Yield	thous / ha		3.25	4.25	4.44	4.53	4.60
	Area	thous ha		677.2	705.2	762.9	812.1	876.0
	Provision	%		144	158	155	147	140
rice	Need	thous. tons	12	83.2	103.5	119.0	136.9	157.4
	Output	thous. t.		90	130	150	175	200
	Yield	thous / ha		3.46	3.57	4.50	4.70	5.00
	Area	thous. ha		26.0	36.3	33.3	37.2	40.0
	Provision	%		108	125	126	128	127
vegetables	Need	thous. tons	110	762.6	948.9	1091.2	1254.8	1443.0
	Output	thous. t.		691	1137	1370	1615	1890
	Yield	thous / ha		34.87	35.38	37.00	38.50	40.00
	Area	thous.ha		19.8	32.1	37.0	41.9	47.3
	Provision	%		91	120	126	129	131
Melons and gourds	Need	thous. tons	32	221.8	276.0	317.4	365.0	419.8
	Output	thous. t.		347	583	720	835	965
	Yield	thous / ha		23.25	29.24	31.00	33.00	35.00
	Area	thous. ha		14.9	19.9	23.2	25.3	27.6
	Provision	%		157	211	227	229	230
potato	Need	thous. tons	45	312.0	388.2	446.4	513.3	590.3
	Output	thous. t.		295	454	540	625	705
	Yield	thous / ha		15.00	20.10	22.00	23.50	25.00
	Area	thous. ha		19.6	22.6	24.5	26.6	28.2
	Provision	%		94	117	121	122	119
fruits	Need	thous. tons	60	416.0	517.6	595.2	684.4	787.1
	Output	thous. t.		217	433	595	700	850
	Yield	thous / ha		15.00	25.80	27.00	28.50	30.00
	Area	thous.ha		14.4	16.8	22.0	24.6	28.3
	Provision	%		52	84	100	102	108
Grape	Need	thous. tons	18	124.8	155.3	178.6	205.3	236.1
	Output	thous. t.		347	645	780	925	1060
	Yield	thous / ha		8.63	10.90	12.00	13.50	15.00
	Area	thous.ha		40.2	59.2	65.0	68.5	70.7
	Provision	%		278	415	437	450	449
Sugar –beet	Need	thous. tons	72	499.2	621.1	714.2	821.3	944.5
	Output	Thous. t.		500	950	1170	1450	1670
	Yield	thous /ha		20.00	20.71	23.44	26.07	28.63
	Area	thous.ha		25.0	45.9	49.9	55.6	58.3
	Provision	%		100	153	164	177	177
Cotton	Output	thous. t.		2455	2939	3205	3480	3755
	Yield	thous / ha		4.03	4.53	4.60	4.65	4.70
	Area	thous.ha		609.6	648.2	697.0	748.6	799.1
Barley	Output	thous. t.		199	300	345	408	470
	Yield	thous / ha		2.75	2.80	3.00	3.50	4.00
	Area	thous.ha		72.4	107.1	115.0	116.6	117.5

Corn for grain	Output	thous. t.		125	240	340	410	510
	Yield	thous / ha		9.72	12.07	13.00	14.00	15.00
	Area	thous. ha		12.9	19.9	26.2	29.3	34.0
Corn for silage	Output	Thous. t.		160	250	425	630	845
	Yield	thous / ha		10.00	11.43	12.00	13.50	15.00
	Area	thous. ha		16.0	21.9	35.4	46.7	56.3
Lucerne	Output	Thous. t.		430	605	840	1025	1230
	Yield	thous / ha		4.50	6.00	8.00	9.00	10.00
	Area	thous. ha		95.6	100.8	105.0	113.9	123.0
Others	Area	thous. ha		356.1	331.5	331.5	331.5	331.5
	Area, total	thous. Ha		**2000**	**2167**	**2328**	**2478**	**2638**

The data in Table suggest the variant estimated for agricultural output volumes in accordance with the National Program of President of Turkmenistan Saparmurat Turkmenbashi "Strategy of socioeconomic reforms of Turkmenistan for the period to 2010". Indicators for the year 2025 were estimated in accordance with the growth rates up to 2010. For many kinds of products the level of provision of the population exceeds 100%.

When realizing this variant, the total volume of water for irrigation will be:

Table 6.2.
Need in irrigation water (without consideration of climat change) mln m^3

Indicators	2005	2010	2015	2020	2025
Need in water (gross), million cubic meters	24030	23833	24286	25190	26089

Given the climate change probability, the need in irrigation water was estimated in view of the increase of irrigation norm (net) by 30-40%. This indicator was justified in Initial National Communication on Climate Change.

In this connection, the total volume of water for irrigation, when realizing the variant in consideration of climate change (the accepted level of increase of irrigation norms – 35%), will make:

Table 6.3.
Need in irrigation water (in view of climat change) mln m^3

Indicators	2005	2010	2015	2020	2025
Need in water (gross), million cubic meters	32441	32175	32786	34007	35220

As far as the total volume of available water resources is about 25 cubic kilometers, the huge deficit will occur when realizing this variant, and consequently the projected yield of crop will not be reached.

The abovementioned predetermined the necessity to estimate the variant of agriculture development in view of the factor of climate change and achievement of 100% satisfaction of the needs of population in main foodstuffs.

Table 6.4.
Main indicators of agriculture development perspective in Turkmenistan (variant providing full satisfaction of the needs in main foodstuffs)

Kinds of products	Indices	Measure unit	Rational norm, kg/ person	2005	2010	2015	2020	2025
	Number of population	thous. people		6932.7	8626.1	9920.0	11407.3	13118.4
weat	Need	thous. t.	220	1525.2	1897.7	2182.4	2509.6	2886.1
	Output	thous. t.		1525	1898	2182	2510	2886
	Yield	thous / ha		3.25	4.25	4.44	4.53	4.60
	Area	thous. ha		469.5	446.1	491.2	553.8	627.3
	Provision	**%**		**100**	**100**	**100**	**100**	**100**
rice	Need	thous. tons	12	83.2	103.5	119.0	136.9	157.4
	Output	thous. t.		42	104	119	137	157
	Yield	thous / ha		3.46	3.57	4.50	4.70	5.00
	Area	thous. ha		12.0	29.0	26.5	29.1	31.5
	Provision	**%**		**50**	**100**	**100**	**100**	**100**
vegetables	Need	thous. tons	110	762.6	948.9	1091.2	1254.8	1443.0
	Output	thous. t.		691	949	1091	1255	1443
	Yield	thous / ha		34.87	35.38	37.00	38.50	40.00
	Area	thous. ha		19.8	26.8	29.5	32.6	36.1
	Provision	**%**		**91**	**100**	**100**	**100**	**100**
Melons and gourds	Need	thous. tons	32	221.8	276.0	317.4	365.0	419.8
	Output	thous. t.		222	276	317	365	420
	Yield	thous / ha		23.25	29.24	31.00	33.00	35.00
	Area	thous. ha		9.5	9.4	10.2	11.1	12.0
	Provision	**%**		**100**	**100**	**100**	**100**	**100**
potato	Need	thous. tons	45	312.0	388.2	446.4	513.3	590.3
	Output	thous. t.		295	388	446	513	590
	Yield	thous / ha		15.00	20.10	22.00	23.50	25.00
	Area	thous. ha		19.6	19.3	20.3	21.8	23.6
	Provision	**%**		**94**	**100**	**100**	**100**	**100**
fruits	Need	thous. tons	60	416.0	517.6	595.2	684.4	787.1
	Output	thous. t.		217	433	595	684	787
	Yield	thous / ha		15.00	25.80	27.00	28.50	30.00
	Area	thous. ha		14.4	16.8	22.0	24.0	26.2
	Provision	**%**		**52**	**84**	**100**	**100**	**100**
Grape	Need	thous. tons	18	124.8	155.3	178.6	205.3	236.1
	Output	thous. t.		125	155	179	205	236
	Yield	thous / ha		8.63	10.90	12.00	13.50	15.00
	Area	thous. ha		14.5	14.2	14.9	15.2	15.7
	Provision	**%**		**100**	**100**	**100**	**100**	**100**
Sugar –beet	Need	thous. tons	72	499.2	621.1	714.2	821.3	944.5
	Output	thous. t.		500	621	714	821	945
	Yield	thous / ha		20.00	20.71	23.44	26.07	28.63
	Area	thous. ha		25.0	30.0	30.5	31.5	33.0
	Provision	%		100	100	100	100	100
Cotton	Output	thous. t.		2455	2939	3000	3000	3000
	Yield	thous / ha		4.03	4.53	4.60	4.65	4.70
	Area	thous.ha		609.6	648.2	652.4	645.3	638.4
Barley	Output	thous. t.		199	300	315	331	347
	Yield	thous / ha		2.75	2.80	3.00	3.50	4.00
	Area	thous. ha		72.4	107.1	105.0	94.5	86.8

Corn for grain	Output	thous. t.		125	240	252	265	278
	Yield	thous / ha		9.72	12.07	13.00	14.00	15.00
	Area	thous. ha		12.9	19.9	19.4	18.9	18.5
Corn for silage	Output	thous. t.		160	250	263	276	289
	Yield	thous / ha		10.00	11.43	12.00	13.50	15.00
	Area	thous. ha		16.0	21.9	21.9	20.4	19.3
Lucerne	Output	thous. t.		430	605	840	1025	1230
	Yield	thous / ha		4.50	6.00	8.00	9.00	10.00
	Area	thous. ha		95.6	100.8	105.0	113.9	123.0
Others	Area	thous. ha		356.1	331.5	331.5	331.5	331.5
	Area, total	thous. ha		**1747**	**1821**	**1880**	**1944**	**2023**

The total volume of water for irrigation (million cubic meters, gross) when realizing this variant will make:

Table 6.5.

Needs in irrigation water (to ensure the 100% foodstuffs provision for the population) mln m^3

Indicators	2005	2010	2015	2020	2025
Need in water without consideration of climate change	20690	20047	19700	20116	20370
Need in water in view of climate change	21724	22051	22655	24139	26481

This variant seems to be more realistic. Here, even if the climate change happens, the deficit in water resources will not be so notable and not impact so strongly on crop yield.

6.2. Impact of climate change on water resources

Water resources of Turkmenistan and variants of their distribution among the economic sectors

In accordance with the National Program of President of Turkmenistan Saparmurat Turkmenbashi "Strategy of socioeconomic reforms n Turkmenistan for the period to 2010", the area of irrigated lands by 2005 will make 2000 thousand hectares, by 2010 - 2240.7 thousand hectares. The land-reclamation work and the all-embracing reconstruction of the existing irrigated lands will continue. Implementation of this complex of measures will provide a possibility to raise the efficiency coefficient on average in Turkmenistan from 0.58 to 0.67 (by 2010) and save 2.4 cubic kilometers of water.

For the stable supply of water resources to the economy of Turkmenistan the work on increase of carrying capacity of the Karakum River, the construction work of hydro-engineering systems and pump stations on this river, the reconstruction of intra-system water reservoirs will continue, as well as the flow of other waterways of the state will be regulated.

The reconstruction of Daryalyk and Ozerny collectors, as well as reconstruction of Main left-bank collector will be of enormous significance in improvement of sanitary and epidemiological situation in the Aral Sea zone.

For the purpose of ecological situation and land improvement, collector and drainage water use increase, President of Turkmenistan Saparmurat Turkmenbashi signed the Decree on August 31, 2000 № 3172 "On construction of Karakum Lake", later renamed into Turkmen Lake of the golden century, equally with the construction of the complex of water-drainage canals and respective engineering systems for diverting the drainage waters to the lowland Karashor and using this water for the needs of the economy of the country (watering of pastures, purification of water at bio plateau and reuse of it for irrigation).

It is envisaged to continue the work on improvement of legal acts and regulatory documents di-

rected on optimization of the structure and the activity of all subjects of agrarian sector. In this process of establishing the class of landowners the state will support and assist them as previously.

The needs in water for irrigation have been identified in accordance with the "agricultural crops irrigation regimes" (Ashgabat, 1989) approved by Water Management Ministry of Turkmenistan and used for working out of water-consumption plans.

The needs in water for municipal and social purposes make at present time 0.432 cubic kilometers. The consumption norm per capita makes 230 liters per day in city and 212 liters per day in rural human settlements.

When estimating the water volume required for municipal and social needs in 2025, the consumption norm per capita was accepted as 350 liters per day in cities and 230 liters per day in rural human settlements.

The industrial development plans do not stipulate creation of water-intensive productions. At present time, the total volume of water required for industrial needs makes 0.864 cubic kilometers. When estimating the need in water for perspective by development periods, the consumption norm is accepted in accordance with the industrial production growth rates.

To preserve the environment, Turkmenistan will have to pass through the Amudarya River 0.150 cubic kilometers of water to supply it to a part of the dried area of the Aral Sea.

Table 6.6.
Need in water resources, by economic branch (I variant – without climate change factor)

Indicators	2005	2010	2015	2020	2025
Population, thousand people	6932.7	8626.1	9920.0	11407.3	13118.4
Coefficient of efficiency of irrigation network	0.62	0.69	0.72	0.73	0.75
Area, thousand hectares	2000	2167	2328	2478	2638
Total water resources, million cubic meters	**23953**	**24104**	**24279**	**24467**	**24688**
Need in water:					
- for irrigation needs	24030	23833	24286	25190	26089
- for industrial needs	1167	1750	2625	3938	5906
- for needs of energy	38	65	68	71	75
- for needs of municipal and social water supply	587	776	942	1146	1391
- for ecological needs	150	150	150	150	150
- for other needs	9	9	9	10	11
Total needs	**25981**	**26582**	**28080**	**30505**	**33622**
Reuse of water	388	646	972	1303	1633
Balance	-1640	-1832	-2829	-4735	-7301
Degree of provision, %	**93.7**	**93.1**	**89.9**	**84.5**	**78.3**

The data of this Table show that the degree of provision with water resources by development periods varies between 78 and 93%, i.e. the deficit makes 7-12%, and the climate change factor is not taken into consideration in this variant, i.e. the irrigation norms for agricultural crops are accepted according to current standards. Provision of the planned volumes of agricultural output in consideration of irrigation norms will make the problem of water resources deficit more acute.

In II variant of agriculture development in consideration of climate change it is supposed to satisfy fully the needs of people in main foodstuffs. In this case the degree of provision with water resources by development periods will significantly increase, and the total irrigated area will reduce in comparison with I variant (without climate change consideration). In this variant the volumes of water consumption in other economic branches were left on a level of I variant.

Table 6.7.
Need in water resources, by economic branch (II variant)

Indicators	2005	2010	2015	2020	2025
Population, thousand people	6932.7	8626.1	9920.0	11407.3	13118.4
Coefficient of efficiency of irrigation network	0.62	0.69	0.72	0.73	0.75
Area, thousand hectares	1747	1821	1880	1944	2023
Total water resources, million cubic meters	**23953**	**24104**	**24279**	**24467**	**24688**
Need in water:					
- for irrigation needs	21724	22051	22655	24139	26481
- for industrial needs	1167	1750	2625	3938	5906
- for needs of energy sector	38	65	68	71	75
- for needs of municipal and social water supply	587	776	942	1146	1391
- for ecological needs	150	150	150	150	150
- for other needs	9	9	9	10	11
Total needs	**23675**	**24801**	**26449**	**29454**	**34014**
Reuse of water	388	646	972	1303	1633
Balance	666	-50	-1198	-3684	-7693
Degree of provision, %	**102.8**	**99.8**	**95.5**	**87.5**	**77.4**

Due to this estimation we can come to a conclusion that more stable development of water management and agricultural sectors of the economy ensure the higher guarantees of achievement of the planned levels of crop yield and provision of the population of the country with the basic agricultural foodstuffs produced domestically.

6.3. Impact of climate change on desert pastures

The estimation of climate change and its impact on pasture vulnerability performed within the framework of Initial National Communication of Turkmenistan on climate change confirms the probability of pasture yield decline in future.

The assessment of current state of desert pastures in Turkmenistan showed that over the last 10-12 years their yield strongly decreased. Comparison of annual maximal crop of the pastures over 1990-2001 with the mean many-year data demonstrated that over the mentioned period, in the Central Karakum desert and in north-west regions of the country the yield was lower of the mean level (120-200 kg/hectare) by 25-56 kg/hectare, and in the Eastern Karakums – by 18-40 kg/hectare. Only in Zaunguz area of the Karakum desert the reduction of yield was not so significant - about 6 kg/hectare.

The results of analysis of many-year climatic data show that the drought over period of 1997-2001 was the main reason of pasture yield decline.

The average annual air temperature over 1990-2001 in most areas of the Central Karakum, north-west regions of Turkmenistan and in Zaunguz Karakum was above the standard by 1.0-1.3°, in Yerbent area - even higher by 1.6–2.1°. In the Eastern Karakums the average annual air temperature over 1990-2001 was higher of the mean level by 0.8-0.9 degrees.

The increased temperature regime over 1990-2001 posed the strong drought. It was especially intensive in the middle zone of the Karakum desert - Akmala, Yerbent and Chagyl - where precipitations over 1990-2001 were lower of the standard by 27-34 mm on average. In the rest area of the Kara-

kum desert, precipitations over the last 10-12 years were lower of mean many-year level by 6-15 mm.

Such disproportion of heat and moisture over the period of 1990-2001, especially in 1997-2001, led not only to the decline of pastures yield, but also to the mass drying out of bushes and perennial herbs. This problem in future should be considered as the very important challenge, because the change of species structure and density of pasture plants impact both on crop volume and on qualitative structure of forage, etc.

The elaboration of particular and optimal agricultural, forestation and ameliorative measures for various ecological and forest conditions would be one of the important issues of rehabilitation of if only local degraded pastures. There are five forest vegetative conditions in Turkmenistan approximately in south to north profile: alpine terraces, mountain slopes, low mountains and foothills, takyrs and sand massifs of the Karakum desert. The concrete models of agricultural, forestation and ameliorative measures on creation of grasslands for the purpose of ecological improvement of desert conditions and mountain slopes have been developed and suggested.

6.4. Mitigation of climate change impact on the pastures of Turkmenistan through planting of forests

It is known that the forest bushes psammophits on the desert pastures are the precious components of fodder crops. Together with their pasture protection significance, they implement the anti-eroding and sand-fixing functions.

The pasture protection significance of natural pasture forest resources over long historical period strongly changed under the influence of anthropogenic factors. As a result of anthropogenic pressure on pastures, first of all the bush forest areas reduced considerably, thus, the trend of increase of extreme climatic conditions occurred. Currently, flora of Turkmenistan consists of forest – 8361.1 thousand hectares and non-forest – 1553.4 thousand hectares areas. The area of 4.6 million hectares in the country needs rehabilitation, and 4.2 million hectares of this area – through planting and sowing, the other part of the area – through promoting the natural renewal.

At initial stage of land-improvement works in Turkmenistan during 1951-1968 the forestry agencies of the Republic planted the pasture protecting and sand-fixing plants on the area of about 140 thousand hectares (Ovezliev, Frolov, Kurbanov, 1970).

During the next years, in 1968-1995 the artificial protective forests were planted. They were the pasture-protecting plantations created by sowing of seeds and planting of seedlings on the area of over 1 million hectares, half of which belonged to the agencies.

Over the last years the pasture improvement works have expanded. The seeds are sown when the land-improvement work is carried out on large territories of pastures. In cases when the land-improvement measures imply protection of objects from sands, the fixing of quicksand may be successful if the desert kinds of bushes are planted.

In the deserts of Central Asia the optimal width of stripes, when sowing seeds of bushes, is 1.5 meters (Leontyev, 1967) and 2.1 meters (Ovezliev and Romanov, 1971; Leshinski, 1967).

The experimental work of the Institute of Desert on creation of pasture-protecting forest belts consisting of bushes and forage plantations in the Central Karakum desert was implemented by sowing of seeds as 23% of physical plough per 1 hectare (1st variant – width of stripes is 2.4 meters, inter-stripe space is 8 meters; 2nd variant – width of stripes is 3.6 meters, inter-stripe space is 12 meters).

The forest pasture-protecting bushes and forage plantations in the arid zones strongly influence on microclimate of the surface air layer, water regime of soil and other factors and as a result the ecological conditions of the pastures notably improve.

The successful creation of forest pasture-protecting plantations in natural conditions of Turkmenistan through sowing of seeds of bushes depends to a larger extent on timely and duly implementation of agricultural and technical measures. The correct choice of the land area is very important

in this process. There are five large forest zones in the ecological profile of Turkmenistan from south to north.

Alpine terraces. These areas are located mainly in the forest-steppe region. Owing to their high location, they have enough moisture for pasture plantations. Their height above sea level is 1000 meters and higher. The quantity of atmospheric precipitations per year is 400 mm and more. The soils are the light and brown mountainous gray ground.

On the alpine terraces with different width the measures on creation of forest can be conducted only manually. The most effective method of forest planting on these areas is to plant the seedlings of archa, fig-tree, pistachio-tree, almond tree and others. The seedlings of trees are planted into holes dug in the middle of terrace with 4-5 meters interval. It is necessary to dig the moisture-accumulating holes to the soil capacity depth on both sides of terrace at the distance of 1-1.2 meters from the planting holes. The planting and moisture-accumulating holes are connected between themselves with furrow for collecting the surface water. The moisture-accumulating holes in case of their filling in by sink waters provide direct bringing of moisture to the soil.

Mountain slopes. Most of the mountain slopes territory is in transitional forest-steppe climatic zone. The height above sea level of the mountain slopes is mainly about 1000 meters and lower. The forest-ameliorative conditions in comparison with the alpine terraces are a little bit worse because of decline of precipitations – 400-300 mm.

The mechanized forest-ameliorative work is possible only on the slopes with inclination up to 12°. On the rest territories these measures can be conducted only manually.

The most effective method of forest planting on the mountain slopes is the planting of young trees on the banquets.

Banquets are the ditches dug horizontally at various distances for the collection of surface water flows.

The young trees are planted in the bottom of the ditch. The width of stripes between the ditches is determined depending on the coefficients of atmospheric precipitations and deficit of atmospheric precipitations for the normal development of young trees.

The deficit of atmospheric precipitations for the optimal moisture provision for young trees in various climactic regions can be replenished by surface flow of atmospheric precipitations. The adequate width of water-collecting stripe providing the additional moisture for covering the deficit of precipitations is selected in consideration of the coefficient of accumulation of autumn and winter precipitations and flow of spring precipitations of the territory on which the forest rehabilitation work is conducted.

Lowlands and foothills of the Kopetdag Mountains. The main territory of these areas is in the semi-arid climatic zone. The height above sea level of lowlands varies within 625-988 meters, at foothills – 204-308 meters and in the southeast – from 25 to 30 meters. The forest planting is not easy here because of large deficit of atmospheric precipitations for normal growth of young trees. The quantity of precipitations per year is 200-300 mm.

The most effective methods of forest planting on these areas is the planting of young trees on the banquets on the lowlands, planting of young trees and sowing of seeds in the moisture accumulating furrows.

Takyrs in the Karakum desert. The main space of takyrs is located in the Central Karakum desert. The dense surface horizons of typical takyrs hamper the penetration of precipitations to the lower horizons. Therefore, considerable flow of atmospheric precipitations is observed in these areas. In this connection, rifling of moisture-accumulating furrows promotes considerable accumulation of moisture in the soil. Thus, when rifling the furrows on the typical takyr, the reserve of accessible moisture increases in winter to 72 mm and in spring – 42 mm. According to T.G. Leshinski (1967), the volume of flow on takyrs and takyr-typed soils is distributed by zones and increases from 30-40% m^3/ha in the north to 120 m^3/ha and more in the south of Turkmenistan.

In consideration of peculiarities of soil and climatic conditions of Turkmenistan, the optimal parameters of moisture-accumulating furrows represent the triangle form with basis on earth surface

and with angle of about 90° on the top. The depth of furrow is suggested as 0.5 meters, the distance between adjacent moisture-accumulating furrows - 26 meters. The selection of width of stripes for flow between two adjacent furrows is done with the help of the model mentioned above in sub-section 3. In this case it is required to take into account the volume of flow of rainy water from takyr surface, the degree of their mixing with sand, projected cover and inclination.

Sandy massifs. They are the vast areas in arid regions of the Karakum desert. The light sand soils are permeable to water, therefore there is no the surface flow on the sandy soil.

The differentiated accounting of climatic factors of various years and micro-climatic peculiarities of the main elements of the relief is important for the successful conduction of ameliorative work at the sandy massifs (Nurberdiev, 1978).

Considerable fluctuation of the quantity of atmospheric precipitations and connected with it depth of soil soaking and reserves of accessible moisture in the soil create a certain risk for conduction of forest ameliorative work. These factors essentially change on the various elements of the relief.

The most favorable conditions for forest ameliorative work are on the intra-range small hilly sands and northern slopes of sandy ranges. The most unfavorable conditions are on the southern slopes. The moderate situation is on the eastern and western slopes of sandy ranges.

During the years with high quantity of precipitations (3 of 10 years) the forest land-improvement work can be done everywhere, while during the years with medium quantity of precipitations (4 years of 10) the work can be done on the intra-range small hilly sands and during the dry years (3 years of 10) it is necessary to refrain from forest land-improvement work and save money and material resources for the damper years.

The most effective method of conduction of forest land-improvement work on the sandy massifs is to sow seeds on ploughed stripes of various widths in the beginning of spring and to plant young trees on the bottom of deep furrow (0.5 meters) in winter and spring periods.

7. Potential build up for participation in methodical observing networks

7.1. National system of climate observations

The National Hydrometeorology Committee (Turkmengidromet) under the Cabinet of Ministers of Turkmenistan is the main institution that conducts methodical observing of climate. The Cabinet of Ministers of Turkmenistan and Turkmengidromet are responsible for the government regulation and management of hydro-meteorological activity, in accordance with the law on hydro-meteorological activity in Turkmenistan. Thus, the Cabinet of Ministers of Turkmenistan performs the coordination and regulation functions determining the national policy on hydro-meteorological activity, while Turkmengidromet directly performs this national policy. In this connection, the main function of Turkmengidromet is to organize monitoring over the condition of atmosphere, sea environment, surface water, agricultural plants and pastures, radiation at the earth surface. Observation over ozone content in atmosphere is not specified in the law as the prerogative of Turkmengidromet, but it is regularly included into the work plans. In this regard, Turkmengidromet performs development and functioning of observations network, system of information collecting, keeping, processing, analyzing and disseminating.

The Ministry of Nature Protection is responsible for the control over atmosphere pollution. The Scientific Production Center of Ecological Monitoring is in charge for this function in the Ministry. The main purpose of this activity is to provide the government authorities and the sectors of economy with information of environment pollution as well as to inform urgently on emergencies arising because of high level of pollution.

7.1.1. Meteorological, agro-meteorological, aerologic and ozone layer observations

Currently, in Turkmenistan, meteorological observations are conducted at 48 points under the work program of 2nd class stations. These are regular, eight times a day observations over wind regime, air temperature and humidity, cloudiness, precipitations, soil temperature, visibility, length of sunlight, atmospheric phenomena. The observations under program of meteorological post are conducted at 37 reference stations, i.e. regular, two times a day observations over maximal and minimal air temperature, precipitations, and atmospheric phenomena. Compared to 1980-1989 period, when the largest quantity of meteorological stations and posts functioned, their total number by the year 2002 reduced by over 30% and the number of stations - by 20%.

As far as the territory of Turkmenistan is to a larger extent an undulated plain (nearly 90%), and the medium high mountains and small mountains occupy 10% of total area, then in respect of spatial distribution the meteorological observations cover relatively equally the whole territory, rather than in respect of high-altitude distribution. The number of stations and posts located on the levels of up to 500 meters equals to 71, thus covering nearly 400 000 km^2 or 81% of the territory of Turkmenistan. Fourteen points are located on heights of over 500 m, while 4 points of this number are on the height of over 1000 m.

Nine stations possess the observation series of over 100 years. These are Howdan (Gaudan), Bairamaly, Yoleten (Iolotan), Serhetabat (Kushka), Atamurat (Kerki), Serdar (Kyzyl-Arvat), Turkmenabat (Chardjev), Serakhs and Guvly-Mayak. Thirty-six stations possess observation series of over 50 years.

Agro-meteorological network was organized to cover every etrap (district) of the farming zone of Turkmenistan. Before 1940s, there was no regular agro-meteorological observation. In 1940-1949 the regular observing was done at 10 points.

The agro-meteorological observations reached their maximal quantity in 1980-1989 - full observations at 46 stations and observations at 15 stations under reduced program. Currently, three regional hydrometeorology centers, agro-meteorological station Yoleten, 24 meteorological stations and 18 agro-meteorological posts conduct observing. The work plans of the stations include observing over pastures and arable lands (every two days), determining of yield of pastures and agricultural plants (on 9th, 19th and 29th dates) and determining of productive moisture stock in the soil (on the 8th, 18th, 28th dates).

At the agro-met-posts only human observation is performed over agricultural plants and pastures.

At present time, aerologic observation is performed only in Turkmenbashi city, having started in October 1957. Here, they do temperature-wind sounding of atmosphere with determination of such features as direction and speed of wind, temperature and humidity of air, atmospheric pressure. In 1998, the station was temporarily closed because of the lack of expendables - radiozondes, casings. Since February 2002, the regular observation renewed. Due to technical and economic reasons, the stations watch atmosphere only in autumn-winter period, when the weather is especially complicated.

The observing is done with the help of radiolocation station ABK-1 and radiozondes MP3 3A once a day.

In Turkmenistan, there are five points of regular watching over the quantity of atmospheric ozone - Ashgabat, Turkmenbashi, Turkmenabat, Repetek and Murgab. Observing of overall content of ozone started in December 1961 in Ashgabat.

In Turkmenabat, ozone observation started in 1965 and stopped in 2001. In 2001, the observation started in Repetek.

In Turkmenbashi, the observation was performed from 1993 to 2000, suspended at technical reasons and renewed from October 2002.

Observation in Murgab started in October 2001 due to expansion of work in this aspect.

Thus, Turkmenistan has 5 points of controlling the overall content of ozone in atmosphere. They regularly measure ozone by sun and by zenith. At each point, every summer day they perform 7 times observation, and every winter day - 9 times. Turkmengidromet applies the ozone meter M-124 to measure the overall ozone content.

7.1.2. Atmosphere pollution observation

Monitoring of atmospheric air pollution in Turkmenistan is performed at stationary posts available in such cities of the country as Ashgabat, Abadan, Turkmenabat, Mary, Dashoguz, Turkmenbashi and Balkanabat. These posts function from 1977. Observations are performed for such ingredients as solid substances (dust), carbon monoxide, nitrogen dioxide and nitrogen oxide, sulfur dioxide, formaldehyde, phenol, sulfates, hydrocarbons, hydrogen sulfide, chlorine, ammonia and hydrogen. Samples are taken 3 times a day (at 7a.m., 1p.m. and 7 p.m.).

In sanitary zone of large industrial objects the near-flare observations are performed periodically over emissions to atmosphere of basic contaminants. Also, the observation is made over the concentration of carbon oxide coming to air from automobile transport.

The air samples are processed and analyzed in laboratories in all large cities: Ashgabat, Turkmenbashi, Balkanabat, Mary, Turkmenabat, Dashoguz.

7.1. 3. Hydrologic observations

Water resources play vitally important role in Turkmenistan where 96% of the territory are arid lands. The main surface water objects include the Amudarya River with 64.3 km^3 of mean long-term flow, the Murgab River with Gyshgy and Kashan tributaries. The mean annual flow of the Murgab

River nearby Tagtabazar town is 1.65 km². The Tedjen River flow is 0.73 km³, according to observation data. The water resources in the south-west of the country include the Atrek River with Sumbar tributary of 0.34 km² mean annual flow. The surface water of Turkmenistan involves also the surface-stream flows of the Kopet-Dag Mountains, which are small but meaningful for local water use.

The Karakum River that diverts annually 11.3 km³ of water from the Amudarya River and carries it along 1000 km from east to west is also considered as the natural water object subject to watching.

The main principle in placing of hydrologic observation points was to cover all water objects and receive the main indicator - annual water flow. Besides, the observation is done in respect of water level and temperature, thickness of ice and ice gruel, discharge of turbid matters, textural composition and sediment concentration of turbid matters,

The observation at the Amudarya River takes place at 7 posts: Kelif, Mukry, Atamurat, Turkmenabat, Eldjik, Darganata and Lebap, three of these posts measure water consumption and discharge of turbid matters.

The hydrologic net of the Karakum River has waterway posts such as Main Facility, River Regulator (canal to Zeid water reservoir), Zakhmet, the 969th km, Main Canal 475km (outlet from Denizhan water reservoir) and two lake posts Denizhan and Zeid. Two posts watch the water flow.

The hydrologic net of the Murgab River has four posts: Soyunali, Tagtabazar, Saryyazy (outlet from Saryyazy reservior), Saryyazy post on the lake. Each of tributaries of Murgab has one post: Gushgy river (Kushka) - the railway bridge - river Kashan - Guldja (Kuldja).

The Atrek River has two posts: Chat and Etrek (Kyzylatrek). The flow is watched at the post Chat. There are two posts Karakala and Duzlydepe on the Sumbar River- tributary of Atrek River. These posts measure the water consumption.

Three posts do watching of the Tedjen River: Pulihatun, Ata, Tedjenstroy. The post Ata measures water consumption.

The Kugitang River is observed from one post.

The observations are also performed over the water regime of small rivers: Koyten river (Kugitang), Archabil (Phiruzinka) and Sekizyab river.

The post Amudarya River - Turkmenabat has the largest series of observations over water level-between the year 1886 and the present time. The posts Atamurat on the Amudarya River, Polihatum on the Tedjen River, Chat on the Atrek River, Soyunali on the Murgab River, Tagtabazar on the Murgab River have the observation series for water flow from 1910, 1912, 1913, 1924 accordingly.

7.1.4. Sea basin watch

The watch of the Caspian Sea water regime is carried out at six marine stations - Turkmenbashi (Krasnovodsk), Bekdash, Garabogazgol, Guvly Mayak, Khazar (Cheleken) and Ogyrdja (Ogurchinski). This is the 4 times a day watch of the level, temperature, salinity of water and coastal waves. At Garabogaz station, they measure the water flow of Garabogazgol channel and level and mineralization of Garabogazgol Bay.

The posts Guvly Mayak and Turkmenbashi possess the longest series of water regime observations.

7.1.5. Satellite based watch

There is no such program.

7.2. Collection, processing, using and exchange of information

Meteorology. Meteorological information from all reference stations is sent at each of 8 standard watch periods (even more frequently, if required) to the Technical Center of Hydrometeorology

Committee. Collection and dissemination of the information is done through the central server and personal computers with "UniMAS" software. The encoded information is sent to Technical Centre by telephone, fax, e-mail, and also by radio with using of Morse code from 6 stations difficult for access. In Technical Centre, operators check the information, send the telephone and radio information to the server and then draw up the bulletin for dissemination.

The meteorological information for international exchange is transmitted from 34 stations in a form of bulletin through direct IP channel to Regional Information Centre in Tashkent. From Tashkent, the information on 19 stations is transmitted to International Information Centre to Moscow.

In addition to transmission of operational information, all meteorological network subdivisions prepare monthly reports in a form of encoded urgent data. These monthly reports undergo the syntactical and semantic control based on PersonaMis Program in meteorological unit of Hydrometeorology Center. Then, the unit issues monthly tables TMC and TMP on all stations and posts.

Further, these tables are used for consolidation and analysis of climatic characteristics on CLICOM software, for formulation of directories on climate and providing services to governmental and business organizations. The CLICOM operates from 1996 and observation data input started from 1996. Data of previous years are available on hard copies.

Agro meteorology. Agro-meteorological information is transferred once a day over the whole net of agro-meteorological observations. In addition, every ten days, the reports on meteorological conditions and vegetation phases are sent to Technical Centre of Turkmengidromet and through the center of commutation it is distributed to internal users - experts of agro meteorology. Turkmengidromet does not participate in regional and interstate exchange of agro-meteorological information; however, before 1990, the data on a number of stations were transmitted to Tashkent and Moscow.

All agro-meteorological data are written down in KCX-1 - books for recording of agro-meteorological observations during vegetation period (seasonal), in areas of pasture cattle-breeding; TCX-1- contracted tables of observations; TCX-6 - tables of soil humidity (in % of absolutely dry soil) and moisture stock in soil, and TCX-7 - tables of productive moisture in soil. At the end of the year the agro-meteorological year- book is formulated. This yearbook is not prepared in electronic version because of the lack of appropriate software.

Then, the analysis of current and expected weather conditions, their further development in comparison with last year data is performed. Phenological forecast is done for the main agricultural plants, for the yield and gross crop of winter grain, cotton, spring herbage at grasslands. The long-term forecast is prepared in respect of heat provision for heat-loving plants at vegetation period. Agro-meteorological bulletins with consolidated data of Turkmengidromet are formulated every ten days. The rates of fruit elements accumulation are analyzed every ten days against the indicators of previous year and many year average indicators. The effective temperatures (above 10%) characterizing heat provision for agricultural plants are summed up. The assessment is given for stock of productive moisture in different soil horizons at arable lands and pastures, for soil warming up, as well as sown area assessment after winter.

Analytical and projecting information goes to the government authorities and economic institutions.

Aerology. Results of atmosphere sounding enter the Technical Centre of Turkmengidromet where it becomes accessible through LAN for weather forecasters and specialists of aerology.

The aerologic information subject to international exchange goes through direct IP channel to the Regional Information Center in Tashkent. Tashkent sends this information to Moscow where the analysis is done in respect of observations quality and monthly table on results of atmosphere radiosounding are prepared.

Ozone content. Every station carries out ozone content observations 7 times a day in summer and 9 times a day in winter. The observations results are recorded in a book consisting of tables O-2. These working tables and nomographic charts are filled in manually. The daily observations results on general ozone content enter the Hydrometeorology Center by telephone, teletype, e-mail. Monthly

reports are sent by mail in a form of table O-3. In meteorology unit the experts perform final examination and file these materials.

There is no these data exchange with organizations outside Turkmenistan.

Hydrology. All operational hydrological information is sent regularly once a day (except dangerous phenomena) to the Technical Centre of Turkmengidromet where it becomes accessible through LAN for the specialists. The telephone and e-mail communication is applied for transmission of information to the center of information commutation. After examination, the information about the Amudarya River is sent by IP channel to Regional Center of Information in Tashkent. Then, through the same system the hydrological information about other area of the Amudarya River (Uzbekistan and Tajikistan) is sent from Uzgidromet.

On the basis of operational data the forecast is prepared for daily, decade, monthly water content of the rivers Amudarya, Murgab, Tedjen, Atrek, Sumbar, Sekizyab.

The units of hydrological network send reports at the end of every month, according to their work plans. They include level and consumption books KG-1 and KG-3, books of water turbidity KG-10 and books of water consumption KG-6. After the quality control of information from these books and tables it is captured to the computer for the purpose of hydrological yearbook formulation. To this end, the HYDATA software is applied. Because of this program imperfection, the estimations of water flow and turbid matters are fulfilled manually and then the data are inserted to the tables. The insertion of hydrological data to electronic copies is done since 1995. Therefore, the larger part of information may be found only on hard copies.

The sea observation data. The results of the sea observations (4 times a day) are sent in encoded form to HMC of Turkmenbashi city by phone, then through e-mail to the Technical Center of Turkmengidromet. The information from 2 difficult for access stations Ogrydja and Garabogazgol is sent directly to TC by radio. In addition, reports in table forms are prepared on a monthly basis, which help to control data and formulate the sea yearbook. The input and processing of data is done manually, because of the absence of computer model of the yearbook. Since 1993, after the sea stations were transferred under subordination of Turkmengidromet, the yearbooks are kept in electronic and hard copies.

Since 1978 to 1988, one copy of yearbook for each of these years is available. The whole sea information is available in Research Hydro-Meteorological Institute in Obninsk town, Russia.

There is the exchange of operational sea information between Turkmengidromet and Kazgidromet, Turkmengidromet and Rosgidromet. Besides, Rosgidromet advises annually the projections for the sea level in the coming year and sea water balance of the last year.

Quality of atmospheric air. Information Unit of the Center of Ecological Monitoring receives by phone daily the operational information on atmospheric pollution and prepares daily bulletin. Every month they receive reports in formats TZA-1 and TZA-1D for quarterly and annual reports. Full chemical analysis of samples is made in the laboratory of the Center. Results of this analysis appear in journals of the laboratories and then are sent to the Information Unit in TG- 52 format. Information exchange between the velayat (province) subdivisions comes through the Ministry of Nature Protection of Turkmenistan.

Scientific-Production Center of Ecological Monitoring issues the information material in the following forms:

- on-line information: daily express bulletin of atmospheric air pollution in Turkmenistan;
- regime information: semi-annual reference about polluting of environment in Turkmenistan; annual review of atmospheric air pollution.

7.3. Shortcomings

The following shortcomings of the climate observation system in Turkmenistan may be highlighted:

- obsolete and worn-out tools and equipment;
- absence of some tools, equipment and consumables;
- insufficient structure of observation net on some kinds of observation;

- insufficient metrological maintenance of devices;
- poor computer base for data processing;
- lack of electronic data bases;
- insufficient application of satellite information.

7.4. Regional and international cooperation

International and regional cooperation of Turkmenistan in the sphere of systematic observations over climate exists through the World Meteorological Organization within the framework of Intergovernmental Council on Hydrometeorology, the International Fund for the Aral Sea, bilateral agreements and treaties on hydrometeorology and control of atmosphere pollution, through the participation in international ecological programs and conventions, international courses and seminars.

7.5. Perspectives of the potential build up

For the time being, the build up of technological potential is the priority target. It is connected with the depreciation and absence of a number of tools, with outdated methods of work that leads to lower quality of work performed or even to stopping of some observations. Therefore, the priority task in the sphere of climatic observations development and monitoring of pollution is to reconstruct and modernize the tooling base, restore the suspended observations and organize the fulfillment of work that earlier was done outside Turkmenistan or with the help of invited foreign specialists (calibration and verification of some devices, chemical analysis of separate ingredients, targeted surveys), use more actively the satellite information.

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ABBREVIATIONS, ACRONYMS AND TERMS

AMS	Agro-Meteorological Station
CAHMRI	Hydro Meteorological Research Institute of Central Asia
CDW	Collector-Drainage Water
ECO	Economic Cooperation Organization
EST	Environmentally Safe Technologies
EU	European Union
FCCC	Framework Convention on Climate Change
FEC	Fuel and Energy Complex
FER	Fuel and Energy Resources
GDP	Gross Domestic Product
GEF	Global Environmental Facility
GHG	Greenhouse gases
GSCM	Global System of Climate Monitoring
GTP	Gas Turbine Plant
HMC	Hydrometeorology Center
SPS	State Power Station
JSC	Joint-Stock Company
NCCCS	National Centre on Climate Change Studies
NEAP	National Environmental Action Plan
NGO	Non-Governmental Organization
PA	Production Association
PTL	Power Transmission Line
SC	State Concern
SDP	Solar Desalinating Plant
SDW	Solid Domestic Wastes
SGG	Steam-and-Gas Generator
SPCEM	Scientific Production Centre of Ecological Monitoring
SRPS	State Regional Power Station
HPP	Heat and Power Plant
UN	United Nations Organization
UNEP	United Nations Environmental Program
UNPD	United Nations Development Program
WG	Working Group

SYMBOLS

CO	-	Carbon oxide
CO_2	-	Carbon dioxide (Carbonic gas)
CH_4	-	Methane
N_2O	-	Nutrios oxide

MEASURE UNITS

W	-	Watt
J	-	Joule
C	-	Calorie
t.c.f	-	Ton of conditional fuel
t.o.e	-	Ton of oil equivalent
t		Ton
g	-	Gram
centner		Centner (100kg=10^5g)
l	-	Liter
Dl		Decaliter
m	-	Meter
m^2		Square meter
m^3		**Cubic meter**
ha	-	Hectare (10000 m^3)
s	-	Second
^{o} C	-	Degree Celsius

MULTIPLES

M	-	Mega (10^6)
G	-	Giga (10^9)
T	-	Tera (10^{12})
P	-	Peta (10^{15})
K	-	Kilo (10^3)
Thous	-	Thousand
Mln	-	Million
Bln	-	Billion
Trln	-	Trillion

Annex 1.1

Main Macroeconomic Indicators of Turkmenistan

	Years							
	1994	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
Gross domestic product, bln manat	87.1	652	7751	11109	13995	20056	22895	31113 **
Cash income per household, thous. Manat	23	159	1684	4102	5766	9078	14316	22176
Provision of residential area for population / m^2 per person	13.8	14.5	15.0	15.4	16.0	16.9	17.8	18.3
Industrial output, bln manat	29.1	280	5075	6231	6733	9996	16632	20826.7
Agricultural output, bln manat	37.7	138	1349	2771	4618	6544	7871	11133
Capital investments, bln manat	21.5	143.4	3112	4297	6367	7956	9072	11434
Retail goods turnover, bln manat	24	152	1730	3205	3800	6727	9324	13333
Freight, all kinds of transport, mln tons	372.6	288	288.6	435.7	435.1	442.2	463.6	475.3
Passenger transportation, all kinds of transport, mln people	523.1	505.5	697.8	702.8	708.5	718.0	738.5	759.1
Foreign trade turnover, mln US$ of which:	… *	3260.1	2692.6	1934.5	1601.4	2665.3	4291.0	4969.0
Export	… *	2146.7	1681.5	751.1	594	1187	2505.5	2620.0
Import	… *	1113.4	1011.1	1183.4	1007.4	1478.3	1785.5	2349.0

* Not available
** Estimations

Annex 1.2

Dynamics of oil, gas, electricity production, consumption and export in Turkmenistan

	Years						
	1995	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
Production:							
Oil, including gas condensate, mln tons	4.5	4.9	5.4	6.8	7.2	7.2	8.34
Natural gas, bln м³	32.3	35.2	17.3	13.3	22.9	47.2	51.3
Electric energy, bln kW/h	9.9	10.1	9.5	9.4	8.9	9.9	10.61
Domestic consumption:							
Oil, including gas condensate, mln ton	4.1	4.7	5.1	6.2	5.3	5.5	6.04
Natural gas, bln м³	10.0	10.9	10.8	11.6	12.3	13.6	14.0
Electric energy, bln kW/h	7.3	7.2	6.9	7.0	7.5	8.0	8.2
Export:							
Oil, including gas condensate, mln ton	0.4	0.2	0.3	0.6	1.9	1.7	2.3
Natural gas, bln м³	22.3	24.3	6.5	1.7	10.6	33.6	37.3
Electric energy, bln kW/h	1.4	1.6	1.5	1.2	0.4	0.9	1.1

Annex 1.3

Some indicators of oil and gas and oil refining industry of Turkmenistan

	Years									
	1991	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
Oil extraction, including gas condensate, thous. tons	5449	5200	4754	4408	4524	4923	5368	6819	7160	7181
Gas extraction, bln м^3	84.3	60.1	65.3	35.7	32.3	35.2	17.3	13.3	22.9	47.2
Gasoline, thous. tons	855	949	733	739	633	751	766	731	864	1012
Tractor-fuel kerosene, thous. tons	40.5	32.3	25.3	22.0	12.5	17.3	13.1	26.1	12.0	0.2
Burning kerosene, thous. tons	58	26	17	13	2	10	12	55	93	105
Diesel fuel, thous. tons	2236	1942	1562	1588	1371	1458	1517	1575	1347	1453
Furnace fuel oil, thous. tons	1959	1667	1352	1467	1368	1505	1596	2214	1479	1549
Oil bitumen, thous. tons	21.4	10.7	22.3	32.0	68.5	44.7	32.1	56.3	54.9	59.5
Polymer films, thous. tons	3330	1153	2626	1477	316	565	233	215	244	176
Detergent, thous. tons	15.9	13.0	5.4	5.2	5.1	1.1	0.8	0.7	2.0	2.1

Annex 1.4

Dynamics of electricity production and consumption in Turkmenistan, mln kW/h

	Years									
	1991	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
Electricity output	14953.5	13182.8	12636.8	10520.2	9905.0	10130.2	9498.0	9415.5	8859.7	9943.4
Electricity consumed:										
in industry	3657.0	3651.7	3918.3	3904.7	3356.7	3280.0	3188.7	3229.0	3621.4	3445.5
in construction	232.7	201.7	185.3	147.7	125.4	94.4	126.4	110.0	105.3	106.8
in municipal economy	1036.2	1068.3	1281.9	1351.1	1406.6	1442.5	1228.0	1359.7	1444.4	1563.9
in agriculture	1852.7	1824.2	1938.9	1566.4	1492.0	1475.4	1544.0	1462.4	1490.9	1818.4
in transport	945.0	504.6	429.1	221.6	237.6	241.3	282.5	318.6	269.2	284.8
in other sectors	541.4	533.2	520.7	590.6	693.3	693.5	553.3	542.5	547.5	795.1
losses	1321.5	1094.9	1170.4	1026.1	1156.0	1327.0	1079.9	1181.5	960.5	1035.3
Export	5367.0	4304.2	3192.2	1712.0	1437.4	1576.1	1495.2	1211.8	420.5	893.6

Annex 1.5

Main products of machine engineering and metalworking industry of Turkmenistan

	Years									
	1991	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
Centrifugal pumps, pieces	1068	1069	1035	803	725	394	408	409	329	330
Equipment of chemical industry, spare parts, mln manat*	3	6	179	1.0	12.3	122.5	444.0	364.7	1961.5	2497.2
Lighting engineering equipment, mln manat*	11	77	614	3.7	17.3	13.5	766.2	460.2	682.1	346.4
Cable items by copper mass, ton	9258	3488	4414	3170	1498	2955	3004	3247	3247	3370
Adjusting wires, thousand km	7.4	3.4	2.6	0.7	0.6	1.2	1.2	1.2	1.6	2.0
Technological equipment for trading and catering, spare parts, mln manat*	28	234	1723	5.2	23.9	216.2	655.5	1182.4	363.8	4671.2

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* 1991-1994 – in thous. manat

Annex 1.6

Main products of building materials industry in Turkmenistan

	Years									
	1991	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
Cement, thous. tons	903.5	1050.1	1118.2	689.9	437.3	437.5	601.0	750.0	780.0	419.7
Reinforced concrete constructions and items, thous. m³	1110.8	1088.8	1071.2	668.6	381.0	383.3	252.2	228.5	203.2	193.3
Wall materials, mln conditional bricks	624.6	561.6	514.0	473.8	474.4	473.1	392.5	347.0	393.8	413.9
Non-metallic building materials, thous. м³	11930.3	9711.6	8175.6	6657.3	5240.6	4652.1	4339.8	4582.2	5128.2	5781.2
Asbestos-cement sheets (slate), mln conditional slates	67.0	66.6	43.3	37.3	57.6	46.4	56.0	60.6	41.0	10.1
Asbestos-cement pipes and clutches, km. conditional pipes	1590	1575	1180	327	208	232	240	306	191	117
Glass as building material in physical volume, thous. м²	6098	6122	5308	1335	4403	3560	336	1158	1357	1358

Annex 1.7

Main products of chemical and petrochemical industry of Turkmenistan

	Years									
	1991	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
Mineral fertilizers (in terms of 100% nutritious matters), thous. tons	190.1	103.4	127.4	86.4	68.3	62.5	54.2	67.9	76.0	99.9
of which:										
Nitric	59.1	70.8	82.8	73.5	54.4	49.9	48.8	62.2	67.7	89.2
Phosphate	131.0	32.6	44.6	12.9	13.9	12.6	5.4	5.7	8.3	10.7
Ammonium nitrate, thous. tons	110.7	189.9	220.5	200.2	149.3	137.2	127.3	165.1	175.7	229.8
Polymer films, thous. tons	3330	1153	2626	1477	316	565	233	215	244	176
Synthetic detergents, thous. tons	15.9	13.0	5.4	5.2	5.1	1.1	0.8	0.7	2.0	2.1
Iodine technical, tons	552	509	458	251	137	33	88	137	153	291
Carbone technical, thous. tons	8.3	6.2	6.1	6.3	6.3	4.7	4.7	3.3	1.5	1.5
Sulfur, thous. tons	343.1	243.6	185.7	47.4	13.7	8.1	9.2	11.9	5.4	3.7
Sodium sulfate, thous. tons	259.4	214.5	166.1	67.5	22.2	30.8	56.6	29.5	10.3	19.6
Sulfuric acid, thous. tons	788.1	352.6	205.9	69.5	76.4	120.4	31.3	47.0	104.2	92.5
Nitric acid, thous. tons	89.4	153.9	194.2	166.9	121.7	121.2	109.3	144.8	157.2	191.8
Pharmaceuticals, mln. manat	0.09	0.8	2.6	21.9	72	4464	7888	12761	27669	14367

Annex 1.8

Main products of light industry of Turkmenistan

	Years									
	1991	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
Cotton fiber, thous. tons	419.9	440.4	426.4	387.6	323.8	298.0	141.7	158.6	239.9	235.1
Cleaned wool, thous. tons	13.0	7.3	7.0	4.2	5.5	4.2	4.2	4.2	4.9	5.1
Cotton yarn, thous. tons	5.3	5.4	5.1	5.3	11.4	20.8	23.1	28.8	40.5	49.0
Fabric, total, mln м²	52.0	53.5	47.9	33.1	35.0	40.2	41.1	43.3	47.2	63.9
Cotton fabric	29.2	31.2	30.9	24.8	23.2	32.2	35.0	38.9	41.3	55.1
Wool fabric	2.9	2.7	2.3	0.5	0.5	0.2	0.01	0.01	0.001	-
Silk fabric	7.4	8.0	6.5	2.4	1.7	0.9	0.5	0.4	0.2	0.2
Non-woven fabric	12.5	11.6	8.2	5.4	9.7	6.9	5.6	4.0	5.7	8.6
Stockinet, thous. tons	-	-	1.0	0.6	2.7	4.4	2.9	2.4	4.8	7.0
Hosiery, mln. pcs	12.7	10.8	7.6	6.3	14.5	17.9	14.8	8.3	8.9	11.4

Knitted wear, mln. pcs	10.5	6.3	7.1	4.9	6.7	6.6	5.6	6.6	7.9	19.4
Footwear, all kinds mln. pcs	4.2	3.2	3.4	1.9	1.9	1.5	1.3	0.8	0.6	0.6
Carpets and carpet items, mln м²	1.4	1.1	0.9	0.4	0.8	0.8	0.8	0.6	0.7	1.0
Leather haberdashery, mln manat *	7.5	79.8	765	19.4	64.5	1196.5	1412.2	694.5	356.6	556.7
Box-calf leather goods, mln dm²	28.8	27.8	25.3	18.0	16.2	23.4	21.5	7.7	3.1	5.4

* 1991-1993 – in thous. manat

Annex 1.9

Main products of the agriculture of Turkmenistan, thousand tons

Goods	**Years**									
	1991	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
Grain and grain legumes*	517	722	974	1106	1109	556	760	1290	1544	1759
of which:										
Wheat	205.6	373.6	508.7	711.7	878.7	453.1	707	1229	1511	1705
Raw-cotton	1433	1300	1341	1283	1294	435	635	705	1304	1031
Vegetables	388	312	286	386	376	310	241	295	306	345
Gourds and melons	294	199	176	215	199	190	118	122	134	135
Potato	30	35	31	20	21	21	17	29	44	89
Fruit	56.3	48.5	39.5	42.7	36.2	24.0	30.0	34.0	42.0	62.0
Grapes	167	125	114	133	163	94	131	140	153	195
Meat (live weight)	175	172	192	189	196	199	198	228	234	288
Milk	458	471	711	716	727	755	755	766	878	989
Eggs, mln pcs	300	292	267	270	270	273	274	277	325	376
Wool (physical weight)	16	17	18	19	19	19	18	19	20	24

Annex 1.10

Structure of sown areas in Turkmenistan (all categories of activity) %

Goods	Years									
	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Total sown area	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
of which:										
Grain	19.4	26.5	32.8	40.9	44.0	44.7	45.3	50.8	49.8	51.2
of which: wheat	9.3	15.7	19.6	29.5	36.9	38.1	40.4	48.9	48.7	49.9
Industrial crops	48.9	45.6	43.8	38.2	37.7	37.7	38.1	39.8	42.4	42.3
of which: cotton	48.7	45.5	43.7	38.1	37.7	37.7	38.1	39.5	41.6	41.7
Potato	0.2	0.2	0.3	0.4	0.4	0.5	0.5	0.3	0.5	0.6
Vegetables	2.3	2.1	1.5	1.7	1.5	1.5	1.5	1.4	1.3	1.1
Gourds and melons	2.9	2.2	1.4	1.7	1.6	1.6	1.3	0.9	0.7	0.5
Fodder base	26.1	23.3	20.1	17.0	14.7	13.8	13.2	6.8	5.3	4.2
Other	0.2	0.1	0.1	0.1	0.1	0.2	0.1	-	-	-

Annex 1.11

Main machinery available in agricultural enterprises of Turkmenistan, thousand units

	Years									
	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Tractors *	46.1	52.2	51.5	47.6	43.8	39.2	32.2	29.0	27.0	26.9
Trucks	14.1					14.5	13.1	10.8	11.0	11.2
Combines:										
Harvesters – total	2.3	2.7	3.5	3.5	3.1	3.1	2.7	2.7	2.6	2.8
of which:										
Forage picking machine	1.2					0.8	0.7	0.7	0.5	0.4
Cotton picking machine	13.2	13.1	12.7	10.7	9.4	8.1	4.9	4.9	3.7	3.5
Ploughs	14.3	13.3	14.9	13.3	11.9	9.9	8.0	6.9	6.4	6.0
Cultivators	21.7	21.6	20.9	18.8	17.1	14.6	12.2	10.1	9.6	9.5
Seeders	9.1	8.6	8.8	7.6	7.0	6.3	5.3	4.9	4.8	5.3
Sprinklers and insecticide dust sprayers	4.8					2.8	2.1	1.6	1.4	1.3

*Excluding tractors bearing land-reclamation and other machinery

Annex 1.12

Quantity of livestock at all types of farms of Turkmenistan, as of January 1, thousands

Years	Cattle	of which: cows	Pigs	Sheep and goats	Horses	Camels	Poultry
1992	899	360	260	5599	19	93	6483
1993	1004	416	212	6265	21	98	6461
1994	1104	478	159	6313	22	101	6528
1995	1181	534	128	6503	25	111	5781
1996	1199	566	82	6574	26	108	4991
1997	1155	557	38	6138	27	105	4237
1998	1128	546	32	5957	25	107	4235
1999	1424	651	18	6052	24	101	3156
2000	1572	698	31	7200	26	109	4034
2001	1602	738	32	8835	27	115	5451

Annex 2

Indicative response strategies

Project Category:	**Oil and gas**	**Project № 1**
Project Name	Utilization of casing head gas at hydrocarbon fields in the west of Turkmenistan.	
Project Goal:	Stopping of casing head gas flaring; reduction of GHG emission; extraction of valuable components from casing head gas by means of modern technologies at hydrocarbon fields in the west of Turkmenistan.	
Country	**Sector**	**Budget (mln.US$)**
Turkmenistan	Energy	80
Project Description:	Withdrawal of casing head gas for compressing and further transportation by gas pipe lines to sell it or use it in gas lift operation for oil beds.	
Key performance indicators:	Realization of the project will promote the expedient usage of hydrocarbon resources. Usage of casing head gas has the following basic advantages compared to its simple release to the atmosphere: - end of gas emissions from oil extraction objects; - potential reduction of using the natural gas domestically; Usage of casing head gas instead of natural gas is profitable, as the additional volumes of natural gas of high pressure become available for export.	
Required technologies:	For realization of the project it is necessary to build mini plants for processing the casing head gas to the commodity product.	
Potential reduction of GHG emission	Atmospheric emission of methane will reduce to 2 - 8 billion m^3 per year, in view of the perspective increase of oil production.	

Project Category:	**Oil and gas**	**Project№ 2**
Project Name	Utilization of casing head gas at hydrocarbon fields in the west of Turkmenistan.	
Project Goal:	Stopping of casing head gas flaring; reduction of GHG emission. Extraction of valuable components from casing head gas by means of modern technologies at hydrocarbon fields in the west of Turkmenistan.	
Country	**Sector**	**Budget (mln.US$)**
Turkmenistan	Energy	120
Project Description:	Withdrawal of casing head gas and its processing to liquefied gas, chemical fertilizers (ammonia, urea) and for getting liquid fuel (methanol and other).	
Key performance indicators:	Realization of the project will promote the expedient usage of hydrocarbon resources. Usage of casing head gas has the following basic advantages compared to its simple release to the atmosphere: - end of gas emissions from oil extraction objects; - potential reduction of using the natural gas domestically; Usage of casing head gas instead of natural gas is profitable, as the additional volumes of natural gas of high pressure become available for export.	
Required technologies:	For realization of the project it is necessary to build mini plants for processing the casing head gas to the commodity product.	
Potential reduction of GHG emission	Atmospheric emission of methane will reduce to 2 - 8 billion m^3 per year, in view of the perspective increase of oil production.	

Project Category:	**Oil and gas**	**Project № 3**
Project Name	Utilization of casing head gas at hydrocarbon fields in the west of Turkmenistan.	
Project Goal:	Stopping of casing head gas flaring; extraction of valuable components from it; reduction of GHG emission	
Country	**Sector**	**Budget (mln.US$)**
Turkmenistan	Energy	50
Project Description:	Casing head gas of oilfields in the west of Turkmenistan is released to the atmosphere. It is suggested to build advanced facilities for casing head gas using. Generating of electric energy on the basis of casing head gas and selling of this electricity at foreign and domestic markets.	
Key performance indicators:	End of gas emissions from oil extraction objects. Getting of additional volumes of natural gas of high pressure for export, owing to using the casing head gas for local needs instead of natural gas.	
Required technologies:	For realization of the project it is necessary to build mini plants for processing the casing head gas to the commodity product.	
Potential reduction of GHG emission	Atmospheric emission of methane will reduce to 2 - 8 billion m^3 per year, in view of the perspective increase of oil production.	

Project Category:	**Oil and gas**	**Project № 4**
Project Name	Reconstruction of flare system at main facilities in Dovletabad-3 gas field.	
Project Goal:	Utilization of flare gas and respective reducing of gas volume burnt up at flares. Reduction of GHG emission.	
Country	**Sector**	**Budget (mln.US$)**
Turkmenistan	Energy	60
Project Description:	The existing flare system is obsolete and physically old. Reconstruction of flare system would allow to collect the burnt up low-sulfur gases and to return them to the system by means of compressing, to reduce CO_2 gas emission.	
Key performance indicators:	Realization of the project will promote utilization of flare gas in a volume up to 300 million $м^3$ per year. Correspondingly, gas volume burnt at flares will decrease and GHG emission will reduce.	
Required technologies:	Modern, efficient flare systems.	
Potential reduction of GHG emission	Realization of reconstruction would result in decrease of CO_2 emission by 50% per year.	

Project Category:	Oil and gas	Project № 5
Project Name	Development of Environment Protection Regulations for oil and gas complex.	
Project Goal:	Introduction of environment protection regulations for branches of the economy. Consolidation of blowouts registration system. Reduction of GHG emission.	
Country	Sector	Budget (mln.US$)
Turkmenistan	Energy	0.5
Project Description:	Oil and gas industry of Turkmenistan is the ramified sector of the economy that has rather big spheres of close link with environment, including surface zone and bowels of the Earth. Here, nearly each branch of this sector is the potential source of harmful blowouts. It is necessary to develop Environment Protection Regulations for oil and gas complex that will specify requirements for the system of environment protection management and health of the nation, and also for environment protection monitoring system for oil operations.	
Key performance indicators:	Development of Environment Protection Regulations will establish exact technical, operational, organizational requirements that would be compulsory components of the environment protection plans. The documents would essentially decrease uncertainty of contractor's obligations before the environment protection authorities and will increase effectiveness of development and realization of environment protection measures and control over the implementation of environment protection requirements, and the result will be prevention of adverse environmental impact and decrease of GHG emission.	
Required technologies:	It is necessary to attract international organizations and foreign companies operating in oil and gas sector of Turkmenistan.	
Potential reduction of GHG emission	Introduction of appropriate regulations for economic branches would lead to the decrease of GHG emission up to 30%.	

Project Category:	Oil and gas	Project № 6
Project Name	Creation of environment monitoring system for gas extraction and refining enterprises of State Concern "Turkmengaz".	
Project Goal:	Introduction of environment protection monitoring in gas extraction enterprises will increase responsibility of operator, provide registration of ecological data and give an opportunity for timely taking of measures on liquidation of unauthorized emissions of hydrocarbon gases.	
Country	Sector	Budget (mln.US$)
Turkmenistan	Energy	0.5
Project Description:	According to the Law of Turkmenistan "On hydrocarbon resources" and to the rules of hydrocarbon field development it is necessary to conduct monitoring of environment conditions at operating fields, to create laboratory with the group of emergency measures.	
Key performance indicators:	Introduction of monitoring system will make it possible to keep true recording of ecological information, take timely measures on reduction of atmospheric emissions, and forecast the environmental impact.	
Required technologies:	For realization of the project, it is necessary to develop and introduce monitoring programs, acquire laboratory equipment, devices on environmental monitoring for the gas complex.	
Potential reduction of GHG emission		

Project Category:	Oil and gas	Project № 7
Project Name	Using of mini plants on utilization of hydrocarbons operational blowouts for getting industrial product from condensate (diesel oil, low octane gasoline, fuel oil).	
Project Goal:	Reduction or liquidation of hydrocarbon contamination in environment and industrial processing of these hydrocarbon emissions to a marketable product.	
Country	**Sector**	**Budget (mln.US$)**
Turkmenistan	Energy	
Project Description:	In oil and gas practice the volume of gas coming from one well may reach several million м^3, of condensate – two digit volume of tons. It is done when testing the exploration and operational wells, when investigating, and also after capital repair of operational wells and during repair works on gas pipe lines. Such release of hydrocarbons leads to the atmosphere pollution and has adverse impact on biodiversity, may pollute ground water. On the other hand, large quantity of hydrocarbons and condensate is lost. In this case, the direction of hydrocarbons through pipe line is not profitable or, there is no pipe line near the object. The environmental and economic problems could be solved by using the mobile mini plants for refining of hydrocarbons at the fields.	
Key performance indicators:	Selection or rebuilding of mobile mini plants to receive marketable products from hydrocarbons released to environment, in conditions of Turkmenistan. Reconstruction versions of the existing plants and construction of new mini plants adopted for particular conditions in oil and gas industry of Turkmenistan.	
Required technologies:	Mobile mini plants for hydrocarbons refining	
Potential reduction of GHG emission		

Project Category:	Oil and gas	Project № 8
Project Name	Reconstruction of marine pipeline for prevention of oil, gas escape and emergency outbursts of hydrocarbons (fields Banka Zhdanova and Banka LAM – Cheleken)	
Project Goal:	Prevention of sea water pollution and economic losses because of hydrocarbon escape from marine pipelines	
Country	**Sector**	**Budget (mln.US$)**
Turkmenistan	Energy	
Project Description:	Marine pipelines from oil and gas fields Banka Zhdanova and Banka LAM have been operating over 30 years, their amortization period expired. Because of depreciation of pipes, welds, stop and other valves, permanent harmful effect of aggressive sea water, the fistula formations and emergency breakings often happen in these pipes. It is accompanied by hydrocarbon leakage to the sea water. The leakage of transported fluids results in economic costs arising from hydrocarbon losses. Social impact includes sea water pollution, threat to marine fauna and flora and deterioration of conditions for swimming and recreation. The project stipulates reconstruction of pipes transporting hydrocarbons from offshore fields Banka Zhdanova (Jeitun) and Banka LAM. Pipelines consist of 2 lines.	
Key performance indicators:	Full or partial replacement of the line part of pipes together with their armature.	
Required technologies:	Financing from foreign and joint companies that work in the region of offshore fields	
Potential reduction of GHG emission		

Project Category:	Oil and gas	Project № 9
Project Name	Application of effective methods of settling the technical carbon particulates in Hazar chemical plant.	
Project Goal:	Reduction of emissions to atmosphere, efficient using of natural gas. Increasing carbon settling efficiency by using of highly effective physical and physic-chemical methods of technical carbon catching.	
Country	Sector	Budget (mln.US$)
Turkmenistan	Energy	
Project Description:	Low efficiency of technical carbon settling causes ecological and economic expenses, in particular, inefficiency of burnt up natural gas volume and escaping of larger part of carbon together with smoke. Technical carbon production XX3 annually blows out to atmosphere about 7-9 thousand tons of substance mainly containing the soot; in separate years, when demand on fuel grows, the volumes of emissions reach 24 thousand tons. With the existing canal method of XX3 production the most part of technical carbon received by means of neroleze of hydrocarbon natural gas goes to atmosphere and pollutes the air. The current small quantity of technical carbon settling would be increased through effective methods of technical carbon settling, in particular through electromagnetic separation and filtering of smoke, using of adhesion methods, as well as through granulation (enlargement) of particles.	
Key performance indicators:	Increase of the effectiveness of natural gas and technological equipment using. Reduction of emission to the atmosphere of gaseous oxides and soot.	
Required technologies:	The lending and the funds granting is required in addition to investment.	
Potential reduction of GHG emission		

Project Category:	Oil and gas	Project № 10
Project Name	Development of the technology of using the inhibitors produced from local raw materials for prevention of equipment corrosion at sulfur gas-condensate fields of Turkmenistan.	
Project Goal:	Abatement of harmful substances emission to environment and reduction of economic expenses connected with corrosion of equipment at gas-condensate fields of Turkmenistan.	
Country	Sector	Budget (mln.US $)
Turkmenistan	Energy	
Project Description:	When exploiting sulfurous gas condensate fields in the east of Turkmenistan, the equipment is corroded due to aggressive effect of sulfurous compounds. It causes the destruction of equipment parts, the accidents and uncontrolled emissions of hydrocarbons and other components of formation fluids to environment. The project suggests development of antirust inhibitors on basis of reagents received from using the petroleum acids of the Turkmenbashi Refinery and methods of their application in antirust protection practice at the gas fields.	
Key performance indicators:	Development of corrosion inhibitors through using of petroleum acids of oil fields of Turkmenistan will essentially reduce corrosion processes, thus improving ecological situation and will reduce non-operational spending of resources Prevention of field equipment corrosion will provide improving of working conditions, reducing of sickness rate of the population, improving of conditions for biodiversity	
Required technologies:	The lending and the funds granting is required in addition to investment.	
Potential reduction of GHG emission		

Project Category:	**Power engineering**	**Project № 11**
Project Name	Reconstruction of heat and power generating station in Turkmenbashi city	
Project Goal:	Increase of the effectiveness of organic fuel usage and abatement of greenhouse gas emission owing to introduction of modern technology of generating electric energy with the help of steam and gas turbine	
Country	**Sector**	**Budget (mln.US$)**
Turkmenistan	Energy	194.85
Project Description:	It is suggested to replace the condensation blocks with total capacity of 590 MW at the TPS in Turkmenbashi city with fuel consumption of 408 g \ kW\h for combined-cycle blocks with a capacity of 550 MW with fuel consumption of 238 g\ kW\h.	
Key performance indicators:	Realization of the project will largely promote further development of energetic system of Turkmenistan. Introduction of combined-cycle plant would permit to save 236.93 thousand t.c.f. of organic fuel per year through reduction of specific consumption of fuel per unit of produced electric energy.	
Required technologies:	Two blocks of steam-and-gas plants (combined – cycle) of scheme (2 x70+1x80) MW and (3 x 70+1x120) MW	
Potential reduction of GHG emission	Introduction of combined cycle plant would permit to decrease using of organic fuel and reduce CO_2 emission by 391 thousand ton per year.	

Project Category:	**Power engineering**	**Project № 12**
Project Name	Construction of power station at the Refinery in Turkmenbashi city	
Project Goal:	Raising of the effectiveness of organic fuel and reducing of greenhouse gases emission by means of modern technology of generating electric energy with the help of steam-and-gas turbine	
Country	**Sector**	**Budget (mln.US$)**
Turkmenistan	Energy	63.0
Project Description:	It is proposed to build electric power station with highly efficient combined-cycle plant with total capacity of 172 MW on the territory of the Turkmenbashi Refinery with fuel consumption as 238 g\ kW\h In comparison with the condensation blocks of the same capacity the suggested technology will allow to decrease organic fuel consumption by 25.0 %.	
Key performance indicators:	Realization of the project will boost the development of energetic system of Turkmenistan. Introduction of combined-cycle plant will permit to save 84 thousand t.c.t. of organic fuel per year through reduction of specific consumption per unit of produced energy.	
Required technologies:	Block of steam-and-gas plant (combined-cycle)of scheme (3x43+1x43) MW.	
Potential reduction of GHG emission	Introduction of combined cycle plant, in comparison with condensation blocks of the same capacity will permit to decrease using of organic fuel and reduce CO_2 emission by 139.3 thousand tons per year	

Project Category:	Power engineering	Project № 13
Project Name	Reconstruction of SRPS in Balkan velayat	
Project Goal:	Raising of the effectiveness of organic fuel and reducing of greenhouse gases emission by means of modern technology of electric energy production with the help of steam-and-gas turbine	
Country	Sector	Budget (mln.US$)
Turkmenistan	Energy	63.0
Project Description:	It is proposed to reconstruct the power station with introduction of highly efficient combined-cycle plant of total capacity of 172 MW with fuel consumption as 238 g\ kW\h. In comparison with condensation blocks of similar capacity the proposed technologies will permit to decrease organic fuel consumption by 25.0 %.	
Key performance indicators:	Realization of the project will boost the development of energetic system of Turkmenistan. Introduction of combined-cycle plant will permit to save 84 thousand t.c.f. of organic fuel per year due to reduction of specific consumption of fuel per unit of produced energy.	
Required technologies:	Block of steam-and-gas plant (combined-cycle) of scheme (3x43+1x43) MW.	
Potential reduction of GHG emission	Introduction of combined cycle plant, in comparison with condensation blocks of similar capacity would permit to decrease organic fuel consumption and reduce CO_2 emission by 139.3 thousand tons per year	

Project Category:	Power engineering	Project № 14
Project Name	Reconstruction of SRPS in Abadan town	
Project Goal:	Raising of the effectiveness of organic fuel and reducing of greenhouse gases emission by means of modern technology of generating electric energy with the help of steam-and gas turbine.	
Country	Sector	Budget (mln.US$)
Turkmenistan	Energy	97.0
Project Description:	It is proposed to replace the condensation blocks with total capacity of 125 MW at SRPS in Abadan town with 408 g \ kW\h fuel consumption for the combined-cycle plant with the capacity of 369 MW and fuel consumption as 238 g\ kW\h. (First gas turbine of steam-and-gas plant with capacity of 123 MW was launched into operation in 1997)	
Key performance indicators:	Realization of the project will provide another impulse to the development of energetic system of Turkmenistan. Introduction of steam-and-gas plant (combined cycle) would allow to save 287 thousand. t.c.f. of organic fuel per year due to reduction of specific consumption per unit of produced energy.	
Required technologies:	Block of steam-and-gas plant of scheme (2x123+1x123) MW.(First gas turbine of steam-and-gas plant of 123 MW was launched in 1997)	
Potential reduction of GHG emission	Introduction of steam-and gas plants (combined cycle) will result in decrease of organic fuel consumption and reduction of CO_2 emission by 473 thousand tons per year.	

Project Category:	Power engineering	Project № 15
Project Name	Reconstruction of SRPS in Mary	
Project Goal:	Raising of the effectiveness of organic fuel and reducing of greenhouse gases emission by means of modern technology of generating the electric energy with the help of steam-and-gas turbine.	
Country	**Sector**	**Budget (mln.US $)**
Turkmenistan	Energy	156.0
Project Description:	The efficient method is proposed for modernization of operating power units with capacity of 210 MWt – to mount the topping gas-turbine units of GT8C series. Before modernization the total capacity of electric power station was 1685 MW with fuel consumption as 408 g \ kW\h, and after modernization the capacity of electric power station will be 2165 MW and the fuel consumption will be 292 g \kW\h.	
Key performance indicators:	Realization of the project will promote further development of energetic system of Turkmenistan. Introduction of steam-and-gas plant (combined cycle) would allow to save 1184 thousand t.c.f. of organic fuel per year through reduction of fuel specific consumption per unit of produced energy.	
Required technologies:	Eight currently operating power plants each with the capacity of 210 MW will be equipped with topping gas-turbine units of GT8C series. After modernization the capacity of each block will be 270 MW.	
Potential reduction of GHG emission	Introduction of steam-and-gas plants (combined cycle) will permit to decrease using of organic fuel and reduce CO_2 emission by 1954 thousand tons per year.	

Project Category:	Power engineering	Project № 16
Project Name	Reconstruction of heat and power generating plant in Seydi town	
Project Goal:	Raising of the effectiveness of organic fuel and reducing of greenhouse gases emission by means of modern technology of generating the electric energy with the help of steam-and-gas turbine.	
Country	**Sector**	**Budget (mln.US $)**
Turkmenistan	Energy	16.25
Project Description:	The efficient method is proposed for modernization of operating power units with capacity of 80 MW - to mount the topping gas-turbine units of GT8C series. Before modernization the total capacity of the power station was 160 MW with fuel consumption as 408 g \ kW\h, and after modernization the capacity of electric power station will be 210 MW and the fuel consumption will be 292 g \ kW\h.	
Key performance indicators:	Realization of the project will add accordingly to the development of energetic system of Turkmenistan. Introduction of steam-and-gas plant (combined-cycle) will permit to save 143.9 thousand t.c.f. of organic fuel per year through reduction of fuel specific consumption per unit of produced energy.	
Required technologies:	Two operating power units each of 80 MW capacity will be equipped with topping gas-turbine units of GT8C series. After modernization the capacity of each block will be 105 MW.	
Potential reduction of GHG emission	Introduction of steam-and-gas plant (combined cycle) will permit to decrease using of organic fuel and reduce CO_2 emission by 237 thousand tons per year.	

Project Category:	Renewable energy sources	Project № 17
Project Name	Solar dryer room for processing of agricultural products	
Project Goal:	Using of solar energy for processing of agricultural products. Reduction of non-renewable energy consumption and decrease of greenhouse gases emissions.	
Country	Sector	Budget (mln.US $)
Turkmenistan	Energy	0.1
Project Description:	Annual solar radiation is 2000 kW\h and more, duration of solar radiance – 3100 hours, duration of day time in June is 16 hours, in December 8 -10 hours, number of sunny days is from 260 to 300 days, which is economically and ecologically expedient for processing of agricultural goods, for drying of vegetables, melons and gourds, fruits, silk cocoons, herbage, timber and so on.	
Key performance indicators:	Realization of the project will save 540 million t.c.f over 20 years. The term of project payback is 3-4 years	
Required technologies:	Modern equipment and new technologies that improve quality of products.	
Potential reduction of GHG emission	The project performance will add to reduction of CO_2 emission by 1.3107 Tg (1.3107 million tons) over 20 years.	

Project Category:	Renewable energy sources	Project № 18
Project Name	Using of solar energy for water heating	
Project Goal:	Introduction of alternative energy sources to supply heating to rural houses, cattle breeding farms, shower rooms and so on.	
Country	Sector	Budget (mln. US$)
Turkmenistan	Energy	0.045
Project Description:	Annual solar radiation is 2000 kW\h and more, duration of solar radiance – 3100 hours, duration of day time in June is 16 hours, in December - 8-10 hours, number of sunny days is from 260 to 300 days that would add to reduction of GHG emissions. For supplying of hot water on average to one rural man, 0.55 MW per year will be required. With the help of solar collector we can get 85 liters of hot water with temperature 60-65° C over summer day time if solar radiation density is 1100 W/м^2.	
Key performance indicators:	The project will permit to resolve the critical issues connected with supplying of fuel to consumers who live far in the deserted region, permit to use renewable energy sources for improving the life conditions and provide 80% of annual thermal loading, 20% - by means of thermal alternate.	
Required technologies:	New solar technologies for water heating, i.e. solar collectors.	
Potential reduction of GHG emission	Introduction of the project will save per year 0.15 t.c.t from one 1 sq, m. of water heating unit, will reduce CO_2 emission by 0.364 Mg. Given the numerous quantity of distant pastures, it would be possible to replicate the project.	

Project Category:	**Renewable energy sources**	**Project № 19**
Project Name	Using of solar energy for water desalting	
Project Goal:	Introduction of alternative energy sources to supply drinking water to desert areas or sea regions.	
Country	**Sector**	**Budget (mln. US$)**
Turkmenistan	Energy	0.1
Project Description:	Solar water desalting units provide the necessary productivity of distiller, the evaporation of high concentration brine up to solid residue. Water desalting units desalt mineralized water of water wells in deserted territories, and also sea water to make it suitable for drinking, for growing of various plants.	
Key performance indicators:	Annual output from 1 м^2 of the unit, with average depth of filling in 0.16 m, with maximum salt concentration as 0.158 kg/l, is 1.2 m^3/ m^2 per year or the speed of precipitation is 0.5 cm per day.	
Required technologies:	Modern solar technologies for desalination of mineralized water.	
Potential reduction of GHG emission	Introduction of the project will save thermal energy spent for desalination - 2512 MJ (0.60 Gc) per 1 м^2 of mineralized water, will reduce CO_2 emission by 0.146 Mg.	

Project Category:	**Renewable energy sources**	**Project № 20**
Project Name	Introduction of modern technologies to receive biogas.	
Project Goal:	Processing of agricultural and industrial organic wastes and also domestic wastes and any biomass with the help of microbes.	
Country	**Sector**	**Budget (mln.US $)**
Turkmenistan	Energy	0.15
Project Description:	Using biogas units is perspective for using of biomass in receiving the biogas – source of energy comprising methane, ethanol, methanol, butyl alcohol, acetone and other components.	
Key performance indicators:	Total volume of escaping gas is 340 l/kg of solid product. Characteristics of produced gas: 60-80% methane, 20-40% carbonic acid gas. Calorific value of biogas is 20-26 mJ/ m^3. Beside the gas this unit permits to get high quality fertilizers.	
Required technologies:	Modern technologies for wastes utilization, collection of methane, getting fertilizers for agriculture.	
Potential reduction of GHG emission	From cattle-breeding wastes in Turkmenistan we can get 460*10^6 m^3 of biogas per year, which is equal to about 400 thousand. t.c.f (with 70% methane concentration in biogas). Introduction of the project will permit to reduce CO_2 emissions by 720 thousand tons.	

Project Category:	Renewable energy sources	Project № 21
Project Name	Solar unit for micro alga growing	
Project Goal:	Growing of micro alga (chlorella vulgaris, spirulina platensis, scendesmus obliguus) in technological devices (photo reactors) with controlled outside parameters and nutrient medium.	
Country	**Sector**	**Budget (mln.US $)**
Turkmenistan	Energy	20
Project Description:	Productivity of photosynthesis may be considerable, the crop yield in terms of protein increases 8-10 times. The received biomass contains all important amino acids, it is rich with vitamins. Chemical analysis of solid component of chlorella makes it clear that it contains 45% protein, 20-30% carbohydrate, 7-10% fat and 23 types of amino acids, including thryptophan and methionine. Using of it in farming, fragrance, medical, and other industries is very perspective.	
Key performance indicators:	Annual volume of forage chlorella production on basis of solar photo reactors (210 days) will be possible with the construction in Turkmenistan of 392 solar units each of 7.2 м^3 capacity.	
Required technologies:	New solar unit for cultivating of micro alga.	
Potential reduction of GHG emission	Fuel saving in this production of chlorella biomass by using of solar energy will be preliminarily 30 thousand t.c.f per year, CO_2 emissions will reduce by 0.072 Tg/year, and over 20 years it will be 60 and 1.44 accordingly.	

Project Category:	Renewable energy sources	Project № 22
Project Name	Autonomous solar complex	
Project Goal:	Using of solar unit in housing by shepherds in desert regions of the country.	
Country	**Sector**	**Budget (mln. US $)**
Turkmenistan	Energy	0.35
Project Description:	The solar unit is agro-production object the structure of which may differ depending on environment-climatic conditions It includes solar unit for water desalting, solar energetic unit for water lift from water well and for energy supply, stand by diesel electric power station of small capacity, sheep-fold for sheep-keeping, solar greenhouse with drip irrigation, shepherd house with solar heating unit and distribution tank system for salt, distilled and sweet water, closed photo reactor for production of chlorella and enzymes for processing of wastes from animal husbandry.	
Key performance indicators:	No expenses for PTL construction. Autonomous supplying of electric energy for remote human settlements.	
Required technologies:	New solar units (It is possible to replicate units).	
Potential reduction of GHG emission	Autonomous solar complex would permit to save within 10 years 1.8-2.0 t.c.f and reduce CO_2 emissions by 4.37-4.85 Mg.	

Project Category:	Renewable energy sources	Project № 23
Project Name	Solar amelioration complex	
Project Goal:	Creation of autonomous systems for small oasis farming that will function on basis of alternative energy sources.	
Country	**Sector**	**Budget (mln. US $)**
Turkmenistan	Energy	0.45
Project Description:	The solar complex is aggregation of functionally connected solar hydro technical units based on studying of the parameters of energy and mass exchange in such system as soil - plant – atmosphere and water supply defining systems of small oasis farming for separate users in the desert.	
Key performance indicators:	1000 sheep, 100 km far from culture zone, salt in water 25 g/l, depth of salty water bed 18m, annual need in sweet water 2000 m^3, desalinating unit area – 1100m^2. It is possible to replicate the unit.	
Required technologies:	New solar units together with using of solar energy for deserted territories irrigation.	
Potential reduction of GHG emission	Solar unit for amelioration will permit to save 5024 GJ per year, at the same time to reduce CO_2 emissions by 292 Mg.	

Project Category:	Renewable energy sources	Project № 24
Project Name	Solar greenhouse with autonomous energy supply	
Project Goal:	Growing of agricultural plants in regions where there are no sources of drinking water (deserted zone, seaside of desert).	
Country	**Sector**	**Budget (mln.US $)**
Turkmenistan	Energy	0.5
Project Description:	Solar greenhouse with autonomous supply of energy is designated for growing of agricultural plants in regions where there are no sources of sweet water (deserted zone, seaside of deserts). It consists of greenhouse with accumulator, solar power desalting unit and sediments collection area. From the southern inside of the greenhouse there is the solar desalting unit (15% of greenhouse area), which produces sweet water and at the same time is used as accumulator of the heat.	
Key performance indicators:	Solar greenhouse permits to grow vegetables in spring and fall periods, citrus plants and some heat-loving plants within the whole year. Calculations show the possibility to save organic fuel up to 70-100%.	
Required technologies:	Technology of solar greenhouses for organization of greenhouse farming in desert and seaside.	
Potential reduction of GHG emission	The introduction permits to save 968.76 MJ of energy from 100 m^2 of greenhouse, to reduce greenhouse gas emissions to 269.1 ton.	

Project Category:	Renewable energy sources	Project № 25
Project Name	Solar photoelectrical complex	
Project Goal:	Autonomous energy supply of all common energy users in future apartment house – light, home appliances.	
Country	**Sector**	**Budget (mln.US$)**
Turkmenistan	Energy	0.5
Project Description:	The solar photoelectrical station is the basis of solar photoelectrical complex with plus capacity as 1800 W, which works on silicon elements with the efficiency coefficient as ≈16%. SPC-1800 represents module blocks on basis of solar silicon boards of «Start» type mountable on spatial construction (installation time 3-4 часа) either on the ground or on the roof of the house. Taking into consideration the probability of using the electricity by 4 and more users at the same time, the capacity of accumulator blocks (1200 A/h) will permit to provide continuous energy supply for the apartment house only in buffer regime during 14-16 hours.	
Key performance indicators:	Transforming block (inverter) is for energy supply of home appliances, apparatus with connection only to 220 V of alternating current.	
Required technologies:	- solar photoelectrical complex (SPC) with capacity of 1800 W. - block of accumulators (BA) – 1200. A/h. - transforming block – inverter (I) for 220V with output power 400 Wt (2 blocks).	
Potential reduction of GHG emission	The introduction of SPC will permit to save 1.8 kW of energy, to reduce greenhouse gas 1700 g \kW. It is possible to replicate the complex.	

Project Category:	Renewable energy sources	Project № 26
Project Name	Autonomous solar water-desalinating plant for using at home (SDP-50).	
Project Goal:	Monitoring of pollution of water sources on the Aral Sea zone of Turkmenistan. Creation of autonomous solar water-desalinating plant. Supplying family of 8-10 persons and group of workers in fields with sweet water.	
Country	**Sector**	**Budget (mln.US $)**
Turkmenistan	Energy	0.065
Project Description:	Ecological situation in the Aral Sea zone of Turkmenistan has an influence on people's health. Autonomous solar energy plants SDP-50 on solar photoelectrical battery may solve the problem of sweet water deficiency. The portable version of such plant is suggested, that will permit to supply family of 8-10 persons and group of workers in fields with sweet water.	
Key performance indicators:	As a result of project implementation, equally with monitoring of polluting substances content in water sources on the territory of Turkmen part of Aral Sea region, there will be developed and created autonomous solar water-desalinating plant (SDP-50) with productiveness up to 50 l/h – for supplying the family of 8-10 persons and group of workers in fields with sweet water. Additional resource of solar battery (SPB– 120) of SDP-50 plant will permit to supply electricity for home appliances and for lighting	
Required technologies:	Modern te chnology of desalination through using of autonomous solar water-desalinating plants with following specifications: 1. Productivity for water – up to 50 l/h. 2. Mineralizing of initial water– up to 7g/l. 3. Output power SPB – 120 – 120 W. 4. Life period of photoelectrical battery – 20 years, desalination block – 10 years.	
Potential reduction of GHG emission	Introduction of one SDP will permit to save over 9000 kW of energy per year and reduce greenhouse gas emissions.	

Project Category:	**Renewable energy sources**	**Project № 27**
Project Name	Helio-biologic complex	
Project Goal:	Usage of environmentally safe waste-free biologic complex in agricultural practice.	
Country	**Sector**	**Budget (mln.US $)**
Turkmenistan	Energy	0.2
Project Description:	Waste-free biologic complex will permit in combination hen house and greenhouse for mushrooms with split system to use not only solar energy, but the heat from animals and thermal energy from biotechnological processes of mushrooms growing. Excretion of big quantity of carbonic gas during these processes will promote development of plants in greenhouses.	
Key performance indicators:	Due to the calculations, it will be possible to save organic fuel by 70-100%. In sowing of agricultural plants the coefficient of efficiency is 0.5 – 1%, although it is possible to come to 5-6%. It is possible to get maximum productivity of fields if the efficiency of photosynthesis is 12-13% in biocenoses, respiration – not more than 20% of energy. Date of payback is 4 years.	
Required technologies:	New waste-free biologic complex in combination with hen house and greenhouse for mushrooms growing.	
Potential reduction of GHG emission	Introduction will permit to save 968.76 MJ of energy per year from 200 m^2 of greenhouse and reduce greenhouse emissions to 269.1 tons.	

Project Category:	**Renewable energy sources**	**Project № 28**
Project Name	Waste-free helio biotechnological complex	
Project Goal:	Cultivation of tropical and subtropical plants, keeping animals in helio bio house.	
Country	**Sector**	**Budget (mln.US $)**
Turkmenistan	Energy	0.3
Project Description:	Waste-free helio biotechnological complex – closed environmentally safe system with helio bio greenhouse for cultivation of tropical and subtropical plants and simultaneous keeping of animals in enclosed space. Thermal pumping unit for microclimate maintenance will permit to heat in winter and to cool in summer. The thermal pump working with the help of gas-engine unit on the basis of gas generated by biogas unit with using wastes of plants, animals in helio greenhouse. Wastes of carbonic gas feed the greenhouse for intensification of the process of plants photosynthesis. Products of photosynthesis in a form of oxygen feed the gas-engine unit of thermal pump and are used in life-time process by animals. Waste-free helio biotechnological complex – energy-saving system. The heat of low potential sources is utilized with the help of thermal pump (the heat saved by the ground in the depth of 1.5–2m), and at the same time it is possible to receive 3-4 fold thermal energy per unit of consumed power, which is necessary for heating the greenhouse.	
Key performance indicators:	Saving FER by 70-90% through using of thermal pump system and biogas-engine unit, and as a result reducing CO_2 emissions to environment Increasing coefficient of efficiency of photosynthesis to 13%.	
Required technologies:	New technology for utilization of bio wastes, reduction of harmful gas emissions to environment and regulation of microclimate in helio greenhouse of closed cycle.	
Potential reduction of GHG emission	Introduction of the project will permit to save 584.1 MJ of energy per year from 100 m^2 of helio greenhouse and reduce greenhouse gases emissions in a volume of 0.162 Gg.	

Project Category:	**Renewable energy sources**	**Project № 29**
Project Name	Helio greenhouse with bio accumulator of heat	
Project Goal:	Cultivation of plants, and also keeping of animals and poultry	
Country	**Sector**	**Budget (mln. US$)**
Turkmenistan	Energy	0.07
Project Description:	Helio greenhouse with bio accumulator of heat is designated for cultivation of plants and also for keeping of animals and poultry. The heat excretion from animals is used as additional source for heating of greenhouse at winter period, and wastes of animals are used as fertilizers. CO_2 coming from animals promotes the vegetation.	
Key performance indicators:	Technical and economic computations show expediency of using of animals as additional source of heat. Plants in greenhouse are filters of CO_2 and evolve oxygen, which is necessary for animals.	
Required technologies:	Usage of solar energy and heat from animals for heating the greenhouses.	
Potential reduction of GHG emission	Introduction of this greenhouse will permit to save 467.3 MJ of energy per year from 100 m^2 of greenhouse, reduce greenhouse gases emissions by 0.13 Gg.	

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Editor M.Akmuradov
Project Manager: A. Durdyev
Assistant of Project Manager: I. Atamuradova

Research-Production Center of Ecological Monitoring
Turkmenistan, 744000
Ashgabat, "Bitarap Turkmenistan" str., 15
Tel: (993 12) 39-85-87
Fax: (993 12) 39-20-39
E-mail: rpcem@online.tm