

United Nations Development Programme and the UK Conflict Stability and Security Fund/Foreign, Commonwealth and Development Office



EXECUTIVE SUMMARY

ASSESSMENT OF SOCIAL AND ECONOMIC IMPACTS OF INCREASED AMBITION NDC ON ENERGY, AGRICULTURE AND WATER MANAGEMENT SECTORS IN UZBEKISTAN

UZBEKISTAN, 2021

The views expressed in this publication are those of the author(s) and do not necessarily represent those of the United Nations, including UNDP, or the UN Member States.

UNDP works in nearly 170 countries and territories, helping to achieve the eradication of poverty, and the reduction of inequalities and exclusion. We help countries to develop policies, leadership skills, partnering abilities, institutional capabilities and build resilience in order to sustain development results.

UNDP assistance to Uzbekistan is aimed at achieving common interrelated goals: supporting the Government in accelerating reforms in sustainable economic development, effective public administration, adaptation to climate change and environmental protection.

ACKNOWLEDGMENT

This report provides the results of modeling and assessment of the three sectors - energy, agriculture and water management that are the key ones for low-carbon development in Uzbekistan. They have been considered in the twofold: in terms of formation of a national socially-oriented model of transition to a green economy and, at the same time, the implementation of the international obligations committed nationally to reduce greenhouse gases emissions. The associated overall importance of these sectors for the Central Asia region and the need for appropriate concerted action was considered as well.

The research was conducted under the regional project “Policy action for climate security in Central Asia” implemented by the United Nations Development Programme (UNDP) and the Foreign, Commonwealth and Development Office (FCDO) in partnership with the Center of Hydrometeorological Services under the Cabinet of Ministers (Uzhydromet) of the Republic of Uzbekistan. Funding for the project was provided by the UK Stability and Security Fund (CSSF).

We wish to thank the experts from Uzhydromet: Natalya Agaltseva, Raisa Taryannikova, and Nadezhda Gavrilenko for their inputs and high-quality work.

We also thank the specialist of the State Committee on Statistics of the Republic of Uzbekistan, Hamza Yakubov, Shukhrat Mukhamedzhanov, an expert on agriculture, and Violeta Hristova, an international expert for their contribution and highly professional work.

Also, we are very much thankful to Janna Fattakhova and Sergey Chepel who conducted the modeling and assessment and greatly contributed to development of this study.

We would like to thank Bakhadur Paluaniyazov, Rano Baykhanova and Aleksandr Merkuskin from the UNDP Uzbekistan Country Office for supporting the research team throughout the preparation of the report.

Table of Content

Introduction.....	5
Sectoral Dynamics of GHG Emissions.....	7
Impact of Reforms on Dynamics of GHG Emissions.....	8
Trends in Low-Carbon Development: Uzbekistan and Developing Countries.....	10
Conditions Forming an Active Climate Policy: World Experience and Uzbekistan.....	11
Social and Economic Consequences of New Technology Introduction: Sectoral Assessments	13
Consideration of National Interests in Transition to Active Climate Policy: Conclusions and Recommendations	16

Introduction

The overall goal of this research is to develop recommendations for the formation of new commitments of Uzbekistan to reduce greenhouse gas emissions (GHG) undertaken under the Paris Agreement.¹

As part of the *first stage of the research* done in July 2021², it was found that developing countries have achieved the greatest success in switching to a low-carbon development trajectory managed to form a climate policy model that contributed to **strengthening social progress, expanding employment, and increasing the average income of citizens of their countries.**

In the process of searching for such a model for Uzbekistan, it was found also that *large-scale investments in green technologies alone are not enough to transition to a low-carbon economy.* Investments in green projects will be ineffective without proper strengthening institutions, improving the macroeconomic environment, changing the priorities of economy development policy aimed at reducing the pressure on nature resources, and diversifying the economy. This hypothesis was confirmed through analysis of national statistics on GHG emitting sectors, and an econometric analysis of statistics from 76 developing countries.

Approaches to the assessment of the carbon footprint for all sectors of the economy, including those that are not direct emitters, were also worked out. Recommendations on approach to the formation of a carbon regulation policy in Uzbekistan were formulated.

Within development of the research, the **two key tasks** were set:

1) To deepen the previous study and strengthen recommendations for the *formation of a national socially-oriented model of transition to a green economy* with consideration of fulfillment of the *international commitments for GHG emissions reduction* to which the country would sign-in;

2) To deepen the analysis of sectors that are the key subjects to low-carbon regulation. For Uzbekistan, *in addition to energy sector, such sectors are agriculture and water resources management ones.* These sectors: a) make a decisive contribution to GDP production; b) host a significant part of the employed population, including those who are employed in agriculture (sector with the lower level of income generation); c) are crucial in terms of the structure of GHG emissions (energy and agriculture); and d) are the most vulnerable to the climate change impacts. At the same time, the problem of efficient use of water resources is very common for the countries in Central Asia and requires coordinated actions of all countries of the region.

As a result, **an active climate policy is largely formed in these three sectors.** Moreover, the sectors are key to ensuring the well-being of the population, and determining the success of **a number of long-term strategies adopted by Uzbekistan for the period up to 2030** (national SDG goals, Poverty Reduction Strategy, Employment Strategy, Social Protection Strategy, etc.).

The report consists of the 6 key sections:

- **The first section** presents the sectoral structure of GHG emissions based on the results of the GHG emission inventory conducted by the Center of the Hydrometeorological Service of the Republic of Uzbekistan (Uzhydromet) for the period 1990-2017.

¹ Law of the Republic of Uzbekistan “On ratification of the Paris Agreement” No. 491 of 02.10.2018

² The report “Assessment of the impact of measures to reduce greenhouse gas emissions on the social and economic situation in Uzbekistan”, Tashkent, 2020.

- **The second section** analyzes the impact of the reforms implemented in the three sectors that are under consideration of this study in 1993-2020 on the dynamics of their specific sectoral GHG emissions.
- **The third section** analyzes the experience of developing countries that have reduced GHG emissions and, at the same time, achieved significant economic and social progress.
- **The fourth section** analyzes the conditions at the macro level that ensure low-carbon development but are not limited only to the traditional investments' factor.
- **The fifth section** includes estimates resulted from assessment the social and economic effects of utilization of alternative green technologies in the three sectors. The section is presented in 4 blocks:
 - *Methodological issues related to carbon footprint assessment.* This block summarizes the existing approaches on the integral assessment of the level of economy carbonation, based on that the alternative estimates of amount of specific sectoral GHG emissions are made.
 - *Assessment of the social and economic impacts of utilization of alternative green technologies in the energy sector.* Which green technologies used in the energy sector are more promising: projects on use of the combined-cycle steam and gas units by the thermal power plants (energy saving), or projects focused on harnessing the technologies using the renewable energy sources (RES), in this particular case, the project on wind turbines? To answer this question, the criteria for efficiency of use of green technologies included financial stability of energy sector, reduction of carbon footprint of the economy as a whole, maximizing the projects' contribution to expanding employment and income of the employed ones, and minimizing the investment costs. The assessment was based on the results of the previous study (2020), supplemented by similar assessments of the specific project on piloting the first wind turbine in Uzbekistan.
 - *Assessment of the social and economic impact of utilization of alternative green technologies in agriculture.* For agriculture, the utilization of *biogas units* (BGU) for the period up to 2040 have been worked out with consideration of the growth of livestock and degree of its waste (manure) use by BGU. The associated effects on employment were estimated based on the two options: a) traditional one, which envisages import of equipment and consumables, and b) establishment of domestic production of biogas units. The comparison of options was done based on the criteria included reducing carbon footprint, expanding employment and investment costs.
 - *Assessment of water-saving technologies' contribution into adaptation of economy and population to water stress and deficiency.* The macroeconomic, sectoral and social effects with consideration of various degrees of water resources scarcity were assessed based on estimates of potential for increasing efficiency of the existing irrigation system and introduction of drip irrigation technology.

The sixth section contains recommendations on consideration of the national development priorities at formulation of next generation NDC commitments. The results and conclusions obtained from the modeling allowed to outline *a national model of transition to a low-carbon economy*, which ensures not only reduced GHG emissions, but also increased employment, income growth and poverty reduction.

Sectoral Dynamics of GHG Emissions

According to the data of the GHG inventory conducted by the Center of the Hydrometeorological Service of the Republic of Uzbekistan (Uzhydromet) for the period 1990-2017, the total GHG emissions in 2017 amounted to 177.8 million tons of CO₂-eq. (excluding CO₂ absorption by forests in the Land Use, Land Use Change and Forestry and 173.1 million tons of CO₂-eq., with consideration the absorption of CO₂ by forests. In general, during 1990-2017, the GHG emissions *decreased* by 9.5%, while only by 9.2% in 2010-2017 (Table 1).

TABLE 1 GHG EMISSIONS IN UZBEKISTAN, 1990-2017, MILLION TONS OF CO₂-EQ.

Year	Energy*	Industrial Processes & Product Use (IPPU)	Agriculture	Waste	Total GHG Emission	LULUCF**	Net-GHG Emission
1990	165.2	8.4	14.1	1.9	189.6	-12.1	177.5
2000	200.9	5.8	14.7	2.4	223.8	3.7	227.5
2010	162.8	8.3	23.3	2.5	196.9	8.4	205.3
2013	128.6	8.1	26.6	2.6	165.9	5.2	171.1
2014	130.9	8.6	27.4	2.6	169.5	-2.6	166.9
2015	124.3	8.3	28.5	2.6	163.8	-4.1	159.6
2016	129.0	8.6	29.9	2.6	170.1	-4.7	165.4
2017	136.1	8.3	30.6	2.7	177.8	-4.7	173.1
Trend							
Δ (1990 -2017)	-17.6%	-1.2%	117.0%	40.1%	-6.2%		-2.5%
Δ (2010 -2017)	-16.4%	-1.2%	31.3%	8.0%	-9.7%		-15.7%
Contribution							
1990%	87.1%	4.4%	7.4%	1.0%	100.0%		
2013%	77.5%	4.9%	16.0%	1.6%	100.0%		
2017%	76.6%	4.7%	17.2%	1.5%	100.0%		

Source: Hydrometeorological Service Center (Uzhydromet)

Notes: *According to the IPCC classification, the energy sector covers GHG emissions from the combustion of fuel in stationary and mobile sources (generation of electric and thermal energy, transmission of electric and thermal energy, transport), as well as GHG emissions from the extraction, processing, transportation of natural gas, oil and coal.

**Land Use, Land Use Change and Forestry

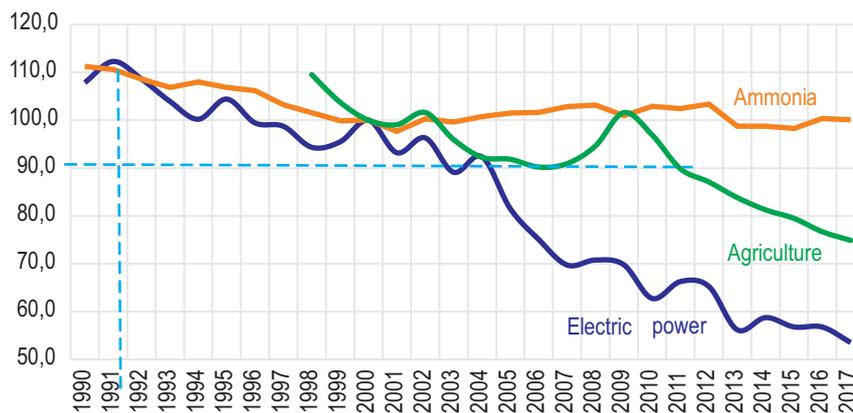
This table is based on preliminary GHG calculations performed as part of the preparation of the first biennial update report of the Republic of Uzbekistan (which was scheduled for completion at the end of July 2021).

In 1990-2017, the sectoral structure of GHG emissions changed: the share of the energy sector decreased (from 87.1% to 76.6%) and the share of the agriculture sector increased (from 7.4% to 17.2%) due to an increase in the number of livestock and the use of nitrogen fertilizers. In 2017, **93.8% of the total GHG emissions were accounted for energy and agriculture**. These sectors should be considered as the **key ones for climate policy**.

Impact of Reforms on Dynamics of GHG Emissions

The **key reforms implemented in the energy sector** in 1993-2020 were summarized, and their impact on dynamics of GHG emissions analyzed (Figure 1).

FIGURE 1 SPECIFIC GHG EMISSIONS IN “ENERGY” AND “AGRICULTURE” (LIVESTOCK) SECTORS, (2000=100%)



Source: authors

Sources of information: Emission statistics, Uzhydromet

Sectoral output in physical terms (million kWh, thousand tons of ammonia, meat, milk, State Committee for Statistics

Source: Report “Assessment of the impact of measures to reduce greenhouse gas emissions on the social and economic situation in Uzbekistan”, UNDP, 2020.

Energy

Key reforms:

- Institutional reforms to ensure the country’s energy security in the context of the collapse of the Soviet Union since 1991-1992;
- Expansion, retrofitting and modernization of generating capacities;
- Development of alternative (renewable) energy sources;
- Reduction of energy losses;
- Creating a competitive energy market.

With consideration of the following:

- Scale of the energy system
- Management System
- Growth of energy demand by 2030

Agriculture

Key reforms:

- Institutional transformations;
- Reducing lands for cotton growing and increasing lands for growing winter wheat, fruit and berry, vegetables, vineyards, etc.;

-
- Development of cooperation and cluster form of agriculture activities included the whole chain of production, harvesting, sorting, calibration, packaging and sale of fruit and vegetable products, and expansion of intensive gardens and greenhouses with use of resource-saving technologies;
 - Abolishing the state orders for grain and cotton growing (since 2020), and state regulated pricing for grain (since 2021);
 - a sharp increase in the number of cattle

With consideration of the following:

- Structure of GHG emissions
- Technology factor

Water resources management and hydropower sectors

Key reforms:

- Transition to water rationing since 1993;
- Rehabilitation of irrigated lands and promotion of efficient use of water resources;
- дополнительные меры поддержки в периоды маловодья;
- поддержка гидроэнергетики.

With consideration of the following:

- Factor of increasing water scarcity
- Factor of hydro power plants scaling

Overall, the reforms implemented in the three sectors did not have a systemic focus on reducing GHG emissions. Ambitious plans to reform the sectors up to 2030 will require huge investments that at the same time could be directed to solving the social and economic problems. To identify an optimal ambition of national commitments for **GHG emission reduction, with consideration of potential social and economic effects**, it makes sense to consider the international experience and best practices.

Trends in Low-Carbon Development: Uzbekistan and Developing Countries

The analysis was carried out for **76 developing countries** that are similar to Uzbekistan in terms of their development characteristics. Country selection criteria include: a) GDP per capita in the range of 3-25 thousand USD (PPP); b) population of at least of 5 million people; c) share of industry in the GDP structure is at least 20%. This approach ensured comparability with other countries, uniformity of data and applicability of the results of correlation and econometric analysis.³

Two samples were formed among 76 countries: 1) the CIS countries and 2) 5 benchmark countries, where the best trend of GHG emissions reduction and trend of strengthened social progress were observed. The decrease in carbon intensity in the 5 countries was accompanied by an **increase in social progress** (the **SPI** index included 54 indicators), which reflects progress in improving the environment, healthcare, security, and reducing income inequality, etc.

In 2000-2018, Uzbekistan has made significant progress on the indicator of CO₂ emissions per 1 USD of GDP (specific GHG emissions in kg of CO₂-eq. per 1 USD of GDP (2015 prices), **EM** indicator, Fig. 2). While in Uzbekistan in 2000 the level of specific GHG emissions (1.454 kg of CO₂-eq./USD) was 2.5 times higher than the average estimate for the group of the leading CIS countries (0.661 kg of CO₂-eq./USD), since 2011 Uzbekistan reached the level of Ukraine, since 2012 the level of Kazakhstan, and by 2018 the one of Kyrgyzstan and Russia. Such significant progress was made possible because of the implemented sectoral modernization programs and restructuring the technologically backward and unprofitable industries. However, starting from 2015-2016, the rate of decarbonization in Uzbekistan started to decline (Fig. 2 and 3).

FIGURE 2 CARBON INTENSITY OF GDP OF UZBEKISTAN AND CIS COUNTRIES, 2000-2018, (KG OF CO₂-EQ./2015 USD OF GDP)

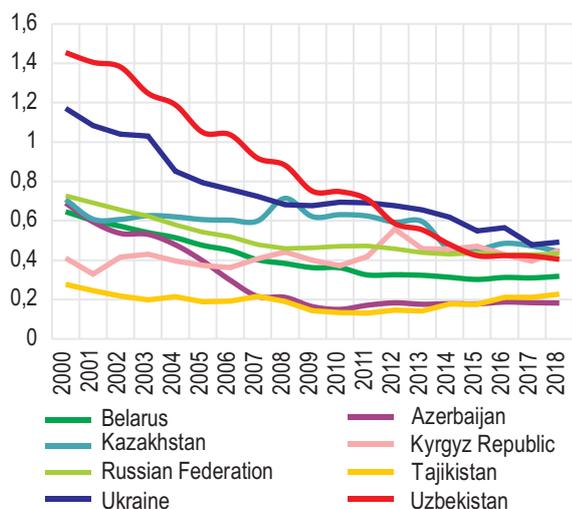
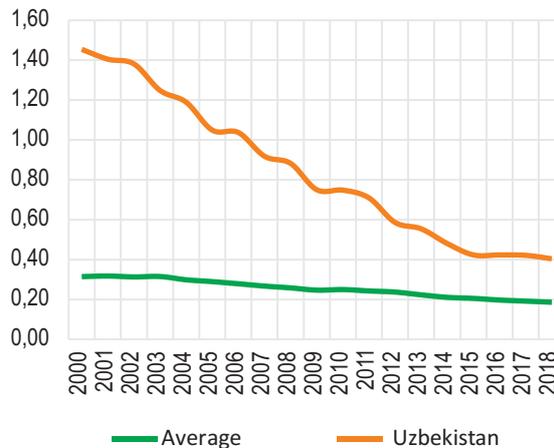


FIGURE 3 CARBON INTENSITY OF UZBEKISTAN'S GDP AND AVERAGE ESTIMATE FOR 5 BENCHMARK COUNTRIES, 2000-2018, (KG OF CO₂-EQ./2015 USD OF GDP)



Source: Data from the International Energy Agency

³The information base of the analysis includes 12 Excel matrices with a dimension (76x20), each of which corresponds to a specific indicator. The rows of the matrix correspond to 76 countries, and the columns correspond to the year of the reporting period (from 2000 to 2019). The analysis used both the matrices in their original form and different estimates obtained on their basis: average median estimates, average median changes in indicators in initial units and as a percentage.

Conditions Forming an Active Climate Policy: World Experience and Uzbekistan

The method of grouping countries. The average median estimates of carbon intensity indicators for 4 groups of countries selected from 76 developing countries according to the criterion of CO₂-eq. emissions per 1 USD of GDP (**EM** indicator) were compared. Group 1 includes the countries with the lowest specific GHG emissions, and Group 2 joins the countries with moderate GHG emissions, etc. (Table 2).

TABLE 2 AVERAGE ESTIMATES OF ENERGY INTENSITY OF GDP, INDICATORS OF ECONOMY STRUCTURE, INVESTMENTS AND QUALITY OF PUBLIC INSTITUTIONS FOR 4 GROUPS OF DEVELOPING COUNTRIES RANKED BY THE LEVEL OF SPECIFIC GHG EMISSIONS, (CO₂-EQ. PER UNIT OF GDP, EM INDICATOR)

Indicators/Factors	Group 1 (low level)	Group 2 (moderate level)	Group 3 (intermediate level)	Group 4 (high level)
Specific emission range (2018, kg CO ₂ -eq./USD)	0.07-0.17	0.18-0.26	0.28-0.37	0.39-0.62
Number of countries in the group	28	22	13	11
Average values for 2000-2018 (2019)				
Specific emissions (kg CO ₂ -eq./USD of GDP)	0.13	0.22	0.31	0.50
Energy intensity (kgoe/1,000 USD of GDP, 2015 prices)	75.2	102.9	129.3	200.0
Gross fixed capital formation (% of GDP)	22.3	22.8	24.7	24.8
Manufacturing, value added (as % of GDP)	13.9	15.5	13.9	13.8
Employment in industry (as % of employed)	20.4	23.2	25.4	25.5
Resource rent (as % of GDP)	2.5	5.1	15.7	12.1
Regulatory quality (from -2.5 to +2.5)	0.22	0.16	-0.03	-0.62
Control of corruption (from -2.5 to +2.5)	-0.20	-0.11	-0.17	-0.84
Rule of law (from -2.5 to +2.5)	-0.11	-0.04	-0.14	-0.77
Government effectiveness (from -2.5 to +2.5)	0.0	0.2	0.05	-0.46
Economic globalization Index (0-100)	55.8	61.8	67.1	52.7

Source: Calculations based on data from the World Bank and other international organizations

First of all, the analysis confirmed a **strong relationship between GHG emissions (EM) and energy intensity (EI)**⁴. The analysis also showed the **importance of institutional factor for reducing GHG emissions**. Thus, three of the four indicators of the quality of state institutions showed a significant negative relationship with specific emissions:

- **CoCor**, control of corruption indicator (the relation with the emission (**EM**) $R^2 = - 0.35$, with energy intensity (**EI**) $R^2 = - 0.45$);

⁴The corresponding correlation coefficients are high (0.94 in Annex 4 and 0.91; 0.78 in Annex 5 available un the full report) and statistically significant (P-val < 0.1).

- **RoL**, rule of law indicator (the relation with the emission (**EM**) $R^2 = -0.42$;
- Regulatory quality indicator (the relationship with the emission (**EM**) $R^2 = -0.36$, with the energy intensity (**EI**) $R^2 = -0.46$.

Development of the manufacturing industry constrains GHG emissions and the growth of energy intensity (**ManVE** indicator, correlation coefficients -0.55 and -0.42, respectively), and **growth of the pressure on natural capital stimulates carbon and energy intensity** (resource rent indicator **Res**, correlation coefficients +0.57 and + 0.69, respectively).

The analysis did not reveal a link between GHG emissions (energy intensity) and investments (GFCF). This indicates that the green investments are not an exclusive key condition for success in the transition to low-carbon development.

Econometric analysis was done to quantify the relationship between the indicators of carbon and energy intensity, on the one hand, and the factors that form their dynamics, on the other hand. Since the main tool of climate policy is **green resource-saving technologies**, the emphasis was placed on identification of conditions that strengthen contribution of the investment factor into accelerating decarbonization of economy. The analysis was performed for 2000-2018:

- for 76 developing countries (all indicators - **EM**, **EI**, etc. are used in the form of levels);
- based on the statistics of international organizations for Uzbekistan (all indicators-EM, EI, etc. are used as a difference (for example, EM-EM(-1)), which ensured their stationarity for analysis.

Social and Economic Consequences of New Technology Introduction: Sectoral Assessments

This section aims to define a set of conditions for low-carbon development at the micro level. This problem is solved through: a) analysis of approaches applied to estimate the size of specific sectoral GHG emissions; and b) evaluation of the effects of typical projects implemented in the three sectors under consideration.

Methodological approaches on assessing carbon footprint by sectors and economy as a whole

The specific sectoral GHG emissions are a key indicator in climate change. Indicator is considered in the twofold: the assessment of direct emissions (possibility of control) and assessment of indirect emissions that occur during the product life cycle (which are not easily controlled). While the traditional methodology on calculating the specific GHG emissions can be used for a direct assessment, the indirect assessment requires consideration of closeness of interrelations of sectors that arise within the process of production, distribution and consumption of products. The methodology that takes these relationships into account to the greatest extent is the Input-Output method (I-O) or the Leontiev model.⁵

Power sector: Scenarios of resource saving and use of renewable energy sources focused on environment, employment, and income of population

The energy sector is the major source of specific GHG emissions. This study examined on which green technologies in the energy sector are more promising for Uzbekistan: projects that increase energy efficiency (combined-cycle steam and gas units), or projects on harnessing technologies using renewable energy sources (wind turbines). At the same time, the results obtained based on the analysis of operation of the combined steam and gas units in the power sector in 2020 were used.⁶

The effects of harnessing energy saving and renewable energy sources (RES) using technologies. There are two possible channels for the impact of green projects on the carbon footprint and the financial sustainability of the sector:

a. Direct channel: new technologies that reduce the specific GHG emissions of the sector -> reduce the multiplier of emissions for this sector and interlinked sectors -> reduce carbon footprint of the economy as a whole.

b. Indirect channel: new technologies that reduce the specific consumption of natural gas, electricity, transport -> reduce the multiplier of GHG emissions for this sector and interlinked sectors -> reduce carbon footprint for the economy as a whole.

An example of the *direct impact* of green technologies is RES based units that do not require use of fossil fuel. The higher share of RES in the structure of the country's energy mix, the lower specific GHG emissions in the economy as a whole. An example of *indirect effects* is modernization of irrigation system that ensures delivery of the same amount of water with less electricity consumption by pumping stations. There are also *mixed options*, when the green technologies both reduce GHG emissions (through increasing energy efficiency) and save natural resources (e.g. use of biogas units to generate electricity and heat).

⁵UN Handbook on Supply, Use, and Input-Output Tables with Extensions and Applications. New York, 2018.

⁶The report "Assessment of the impact of measures to reduce greenhouse gas emissions on the social and economic situation in Uzbekistan", prepared under the auspices of UNDP in 2020.

The main reason for the lower relative values of conditional profit in the energy saving scenario is the price of natural gas in Uzbekistan, which is artificially underestimated compared to the global average estimates.⁷ This is reflected in the low estimate of the share of natural gas consumption in the sector's output structure (0.145, or 14.5%). It is known that in the countries where natural gas dominates in the structure of primary energy sources and its price is close to the global average price, this share is much higher.⁸ **Only in this case, the resource-saving projects become more promising and efficient compared to renewable energy projects.**

AGRICULTURE: ASSESSMENT OF IMPACTS OF BIOGAS PLANT UTILIZATION ON ENVIRONMENT, RESOURCE CONSERVATION AND EMPLOYMENT

Agriculture is the leading sector of economy. According to the data in table I-O for 2017, agriculture was accounted for 30.7% of the total output of economy (29.5% for industry and 33% for services sector; 33.7% of the total value added (21.3% for industry and 39.5% for services sector) and 25.2% of the total number of employees (14.7% for industry and 55.9% for services sector). Agriculture is the leading sector in terms of the gross profit amounted to 41.9% (21% for industry and 31.1% for services sector) and share of products in household consumption 40.6% (27.5% for industry and 13.1% for services sector). Unlike other sectors, agriculture is least dependent on the import of intermediate raw materials: the share of agriculture was only 4.9% (88.2% for industry and 6.6% for services sector). At the same time, agriculture is one of the sectors, which is most vulnerable to climate change impacts.

The analysis resulted on formulation of the following on benefits from using biogas units in agriculture sector:

- Introduction of biogas units is a promising direction for agriculture sector's transition to a low-carbon development trajectory;
- Reduction of GHG emissions will be achieved despite increase of cattle heads;
- Saving of natural gas due to the production of biogas using the livestock waste (manure);
- Use of mineral fertilizer in agriculture can be reduced by 17% by 2040 compared to the total production volume in 2017;
- Transition to local manufacturing of biogas units will provide more new jobs compared to the traditional scenario of importing biogas units at the same level of GHG emission reduction.

A comparison of the effects of harnessing green technologies in energy and in agriculture sectors allows confirming the *conclusion of efficiency BGU technologies*. While carbon footprint reduction of the economy as a whole a per USD1 billion of investments into construction and operation of WPP was 14.5-21.6 kg CO₂-eq.(depending on the efficiency of WPP), the modernization of the existing TPPs results in reduction by 31.5 kg CO₂-eq., but BGU utilization in agriculture is about 42 kg CO₂-eq. (Table 3).

⁷ About \$ 50-60 per 1000 m³ against \$ 140-160 in Germany and other European countries in 2016.

⁸ In Russia, gas generates about 50% of electricity, and in the cost structure of the largest generating companies operating mainly on gas (MosEnergo, OGK-2, Interrao, T Plus), fuel costs account for 60-85% of the electricity price.

TABLE 3 COMPARATIVE EFFICIENCY OF VARIOUS ALTERNATIVE TECHNOLOGIES BASED ON CARBON FOOTPRINT REDUCTION CRITERION FOR ECONOMY AS A WHOLE (AS PER USD1 BILLION OF INVESTMENTS)

Technologies	General assessment of carbon footprint reduction for a typical project (kg CO ₂ -eq./mln. UZS of final consumption)	Required investments (USD, billion)	Reduction of carbon footprint of economy as a whole per USD1 billion of investments
Introduction of WPPs with an efficiency of 20% (energy)	28	1.9	14.7
Introduction of WPPs with an efficiency of 30% (energy)	41	1.9	21.6
Modernization of TPP with the introduction of CCGT (energy)	126	4.0	31.5
Introduction of BGU in agriculture	80	1.9	42.1

Source: Results of expert's calculation

WATER MANAGEMENT: ASSESSMENT OF CONTRIBUTION OF WATER-SAVING TECHNOLOGIES TO ADAPTATION OF ECONOMY AND POPULATION TO WATER DEFICIENCY

The purpose of the calculations is to assess the economic, sectoral and social impacts of various degrees of water scarcity (reduction of available water resources by 10%, 20% and 30%). The calculations are based on the I-O methodology. The input parameters were expert estimates of the forecasted decline in agricultural production capacities at various degrees of water scarcity within the two scenarios: 1) with maintaining the current trends in agriculture adaptation to droughts, and 2) with the mass use of drip irrigation technology.

The calculations show that *low availability of water resources poses serious threats not only for agriculture, but also for interrelated sectors, national economy, and population*. With a decrease in water flow from 10% to 30%, the decline in agricultural production could amount to 6.1%-28% that may result in decline of the households⁹ consumption of goods and services by 3.6%-9.3%, but their consumption of agricultural products would reduce by 9.3%-42.6%. This can lead to a *noticeable decrease of living standards of population*.

The scale of the negative impacts of drought periods can be significantly limited if measures are taken to adapt agriculture and population to negative climate change impacts. *The use of drip irrigation, strict water consumption metering and accounting, and improved water resources management can significantly reduce the forecasted decline in agricultural production*.

Another positive effect of harnessing drip irrigation technology is **reduction of carbon footprint** due to water savings as well as associated energy savings related to irrigation water delivery by pumping stations. There is a **significant potential for use of drip irrigation and improvement of water management system with implementation of adaptation measures to mitigate climate change impacts**.

⁹ In accordance with the terminology of the system of national accounts, the most important element of which is the input-output methodology, the term "household" (along with the concepts of "government", "real sector", etc.) is key in macroanalysis. In this case, the concepts of "households" and "population" are identical to each other.

Consideration of National Interests in Transition to Active Climate Policy: Conclusions and Recommendations

The analysis of world experience and sectoral modeling suggest that an active climate policy in Uzbekistan should be formed at **two levels: macroeconomic and sectoral** ones.

The following conclusions and recommendations were formulated:

Macroeconomic Level

- Development of more systemic measures to accelerate the process of the economy's decarbonization at the level of sectoral development programs;
- There is a need in combining climate policy with solving social problems;
- Development of tools for prioritizing "green" projects;
- Improvement of quality of institutional environment.

Sectoral Level

- Changing the methodology for calculating the sectoral carbon footprint;
- Priority of the climate policy in the coming years should be energy conservation, not only in energy infrastructure, but also in all energy-intensive industries;
- Time for the large-scale investments into renewable energy focused projects will come when the price for natural gas in Uzbekistan reaches the global average level;
- Currently, in Uzbekistan the traditional recommendations on the need in large-scale investments in renewable energy are ineffective;
- Use of biogas units is the most promising direction of agriculture sector transition to low-carbon development trajectory;
- Uzbekistan needs to develop mechanical engineering sector (but only automotive industry) that creates new green technologies for agriculture;
- Harnessing drip irrigation technologies will significantly reduce the scale of negative impact of water resources deficiency on the national economy (GDP) and particular sectors;
- Methodological approach to assessing the carbon footprint of industries and sectors of the economy makes it possible to perform such calculations on an ongoing basis when the original statistics change, and new reporting data appear.