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Case study

AZERBAIJAN

AN ANALYSIS OF THE POLICY REFORM IMPACT ON SUSTAINABLE ENERGY USE IN BUILDINGS

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Abbreviations

ADB - Asian Development Bank
ASHRAE – United States Engineering Association on heating, cooling, ventilation and conditioning systems
BCM –billion cubic meter
BTC - Baku-Tbilisi-Ceyhan
b.kWt- billion kilowatt-hour
CDM- Clean Development Mechanism
c.f. –conditional fuel
CFL compact fluorescent lamps
CN&R(SNiP)- Construction Norms and Regulations (SNiP)
CO_2 - – carbon dioxide
EBRD - European Bank for Reconstruction and Development
EC-European Council
EE-energy efficiency
ERSP - Energy Reform Support Program
ESIP - Energy Savings in the building sector
HPP-hydro power plant
HVAC-heating, ventilation and air conditioning
GDP – Gross Domestic Product
GHG- Greenhouse Gases
GW- gigawatt
Kt - kilotons
kWh – kilowatt-hour
ISO/TC-international standardization organization/technical committee
LPG-liquid petroleum gases
MENR –Ministry of Energy and Natural Resources
MEPS- minimum energy performance standards
mln. –million
MPC –maximum permissible concentration
MW- megawatt
RES-renewable energy sources
SOCAR - State Oil Company of Azerbaijan Republic
SPPRSD - State Program on Poverty Reduction and Sustainable Development
thsd. – thousand
TPP –thermal power plant
TWh- terawatt-hour
USD- U. S. Dollar
VAT-value added tax

1. Background

The Republic of Azerbaijan is the biggest country among other South Caucasus states according to its territory, number of population, rich fuel-energy and other resources.

Situated in the south-eastern part of the Caucasus, Azerbaijan occupies an area of 86,6000 km^2. It borders Russia to the north, Georgia to the north-west, Armenia to the west, and Turkey and Iran to the south. The Caspian Sea forms its eastern border.

The total length of the country's border comes to 2646 km including: 390 km with Russian Federation, 480 km with Georgia, 1007 km with Armenia, 756 km with Islamic Republic of Iran and 13 km with Turkey.

Azerbaijan has a population about 9 million. As a result of occupation of 20% of the republic territory by Armenia, more than 10% of population migrated to other regions, in particular, to the capital of Azerbaijan- Baku city.

The territory of Azerbaijan is distinguished by its unique nature, physico-geographical and climatic peculiarities. It has significant amount of natural resources including oil-gas fields, ore deposits, and mineral waters. Oil-gas production and refining, petrochemical, chemical and other industries have been developed. The primary agricultural activities are: cattle-breading, grain-farming, gardening, cotton-growing, tea-growing and vegetable-growing.

Figure 1. Map of the Republic of Azerbaijan

Table 1. Energy resources of Azerbaijan

Traditional Energy Resources	Unit of measure	Quantity
Oil	Tonne	>1.2 billion
Qas	Meter^3	> 2 trillion
Coal	Tonne	20-25 billion
Alternative Energy Resources		
Wind	Billion kWh	> 2.5÷4 per year
Large Hydropower plant	Billion kWh	2.5÷3.0 per year
Small Hydropower plant	Billion kWh	2.5÷3.0 per year
Solar energy	ton c.f.	Equivalent to 100 thsd. ton of oil
Thermal Waters	ton c.f.	in a big quantity

Source: Ministry of Economic Development, 2010.

Findings of recent researches show that quantities of energy resources in the country exceed those figures indicated in Table 1.

Currently, Azerbaijan ranks among the world's fastest growing economies due to its gas and oil reserves. The international oil contract signed in September 1994 between the Azerbaijan State Oil Company and 11 foreign oil companies soon became a reality. A strong oil industry infrastructure has been created in Azerbaijan over the last decades. Since that time, the oil sector in the sovereign Azerbaijan has experienced heavy domestic and foreign investments. It provided the country with massive economic growth.

Azerbaijan also serves as an important gateway for oil and gas transportation. Construction of the Baku-Tbilisi-Ceyhan (BTC) oil pipeline in 2005 also contributed to the country's economic growth to some extent.

Because of Azerbaijan's economic growth, the demand for electricity was expected to increase by 4.7% each year until 2015. The Asian Development Bank is working to improve the aging transmission system to prepare for this growth, including rehabilitation of existing lines, as well as building new lines and subsystems. Over the past several years there has been interest in the use of renewables other than hydropower, and a few studies have been performed but actual interest has focused on infrastructure.

Sector characteristics

Despite the fact that the history of oil production in Azerbaijan dates to ancient times, industrial development of oil-gas fields have started from the middle of the XIX century. In the beginning of the XX century Azerbaijan shared about 20% of the world's oil production [1].

The developing oil industry was in need of electric energy. In 1900, the construction of two power stations were started in Azerbaijan, in Baku. In 1901, in the Bibi-Eybat enterprise the first power station began to operate. This date can be considered as the beginning of foundation of the electric energy industry in Azerbaijan. Thus, power engineering in Azerbaijan was developed earlier than in other Transcaucasia republics as well as in the near and Middle East [2].

At present, state energy policy in the Republic of Azerbaijan is conducted by the Ministry of Industry and Energy established according to the Presidential Decree from 6 December 2004. The main functions and authorities of the Ministry are:

- preparation of the country's fuel and energy balance;
- implementation of measures to meet the country's demand for energy resources;
- implementation of measures aimed at efficient utilization of energy resources in fuel and energy complex, while reducing energy losses and technological consumption;
- preparation and realization of state programs on the development of energy industry, fuel and energy complex;
- participation in the preparation of income-expense budgets of large state companies operating under industry, and fuel and energy complex.

The Ministry is also authorized to conclude agreements and issue licenses on specific activities related to survey, exploration, production, processing, transportation and distribution of energy resources.

State-owned SOCAR, Azerenergy and Azerigas are the major energy operating companies that dominate extraction/production, transmission, distribution and supply in the energy sector.

Generation of electricity is managed by the State company Azerenergy. Azerenergy is an open joint-stock company wholly owned by government. Until 2002, Azerenergy acted as a vertically integrated monopoly in generation, transmission, distribution and sale of electricity. In 2002, two separate distribution companies were established, one covering the regions of Absheron-Baku and the northern regions, and the other the remainder of the country. A map of Azerbaijan power supply system is shown in Figure 2.

Azerigaz is a closed joint-stock company owned by government which was established in 1992 and is a vertically integrated company with full monopoly in transmission, distribution and supply. Azerigas has 68 gas distribution subsidiaries (including 7 in Nakhichevan). The restructuring of Azerigas is not first priority for the government of Azerbaijan, but is forthcoming. There could be the possibilities to involve private sector into the gas distribution and supply activities, as with the electricity sector.

Azerbaijan's power sector has an installed generating capacity of approximately 6 (GW). Eight thermal plants (TPPs), six hydropower plants (HPPs) and seven module type power plants operate in Azerbaijan.

Figure 2. A map of a power supply system of Azerbaijan

Table 2. Power generation in Azerbaijan for 2001-2010 years [3]

Years	**Power generation, *million kWh***					
	Total generation	from its:				
		Generation in heat station	Generation in hydro station	Production by non-power enterprises	Production by generator	Wind energy
2001	18969	17521	1301	131.2	15.9	-
2002	18701	16558	2020	103.8	18.8	-
2003	21286	18681	2470	104.9	30.4	-
2004	21744	18589	2755	365.4	33.8	-
2005	22872	19344	3009	430.5	88.0	-
2006	24543	21407	2518	475.9	141.8	-
2007	21847	19051	2364	432.0	-	-
2008	21642	19090	2232	319.6	-	-
2009	18869	16289	2308	269.2	-	2.1
2010	18710	15003	3446	259.7	-	0.5

Source: State Statistical Committee of the Republic of Azerbaijan, 2011.

Table 3. Consumption of energy products by types of economic activity for 2010 (thsd ton oil equivalent)

Energy products	**Industry**	**Construction**	**Transport**	**Agriculture, forestry and fishing**	**Commerce and public services**	**Households**
Crude oil	6352,5	-	-	-	-	-
Natural bitum and asphalt	-	0,7	-	-	-	-
Refinery gas	266,3	-	-	-	-	-

LPG	7,0	5,5	15,8	0,1	0,8	65,9
Motor gasoline	-	-	1062,1	-	-	1,2
Kerosene type jet fuel	5,9	0,1	92,6	-	-	-
Other kerosene	0,1	-	-	-	-	1,5
Diesel fuel	11,1	26,2	456,8	342,8	3,3	12,6
Fuel oil-low sulfur	68,4	5,8	1,3	1,1	2,4	-
Fuel oil-high sulfur	-	0,8	-	-	-	-
Naphtha	212,5	-	-	-	-	-
Petroleum coke	5,0	-	-	-	-	-
Oil bitum	0,8	207,0	-	-	-	-
Other petroleum products	144,0	-	29,5	-	-	-
Natural gas	4900,6	21,5	-	24,3	32,8	2685,1
Heat	307,7	0,6	-	0,3	40,5	32,7
Electricity	275,3	41,3	46,8	57,2	322,0	495,0
Other fuel products	4,1	-	4,3	1,3	16,0	72,7

Source: State Statistical Committee of the Republic of Azerbaijan, 2011.

Current policy

Two strategic documents, namely the State Program of Poverty Reduction and Sustainable Development (SPPRSD) in the Republic of Azerbaijan for 2008-2015 and the State Program for Environmentally Sustainable Economic Development clearly state environmentally sustainable energy development concerns.

SPPRSD determined medium-term activities to ensure comprehensive developments in all spheres including non-oil sector. The provisions is made to efficient use of power resources, strengthen financial discipline and public awareness activities in energy sector. In order to increase efficiency in power sector and create more competitive environment, increase of the private sector's involvement in the area will be supported. These steps will help meet the investment needs of the non-oil sector, introduce new technologies and knowledge in the sector, and promote strategic cooperation with foreign companies [4,5].

Upon attaining independence, Azerbaijan started cooperation with world countries on environmental protection and ratified international conventions and agreements including:

- Convention about Climate Change, 1992 Rio-de-Janeiro (ratified in 1995);
- Convention on Environmental Impact Assessment in a Transboundary Context. 1991, ESPO Convention (ratified in 1999);
- Convention on the protection of ozone layer (Vienna, 1985) and Protocol on Substances that Deplete the Ozone Layer. 1987, Montreal Protocol (ratified in 2000);
- Convention on the Control Transboundary Movements of Hazardous Wastes and their Disposal. 1989, Basel Convention (ratified in 2001);
- Convention on Organic Pollutants. 2001, Stockholm Convention (ratified in 2003);
- UN Framework Convention about Climate Changes, 1992, Kyoto Protocol to this Convention July 18, 2000 (ratified in 2000).

Memorandum of Understanding on a strategic partnership between the European Union (EU) and the Republic of Azerbaijan signed on 7 November 2006 by president of the European Council Matti Vanhanen, president of the Commission of the European Communities Jose Manuel Durao Barroso and president of the Republic of Azerbaijan Ilham Aliyev is one of the principal documents regulating cooperation of Azerbaijan and EU in the field of energy sector.
According to the Memorandum [6], both parties decided to cooperate in the four specific areas:

1. Establishment of a strategy and a programme for the gradual harmonization of Azerbaijani legislation with the Community legislation in the energy field leading to the convergence of the electricity and gas markets.
2. Enhancing the safety and security of energy supplies and transit systems from Azerbaijan and Caspian basin to the EU.
3. Development of a comprehensive energy demand management policy in Azerbaijan, including concrete energy saving measures, and measures to tackle climate change, making use also of the relevant mechanisms under the Kyoto protocol. In this context, the development of renewable energies should also be priority.
4. Technical cooperation and the exchange of expertise.

In the 2nd item of the Memorandum it is stated: "The EU and Azerbaijan face common energy policy challenges. The diversification and security of energy supplies, the deepening of energy market reforms, the development and modernization of energy infrastructures, energy efficiency, energy savings and the use of renewable energy sources are key concerns for both parties. An enhanced energy cooperation between Azerbaijan and the EU could boost the necessary reforms and together with an enhanced investment climate, facilitate the attraction of further necessary investment."

With the aim of development of the energy sector, the Government of Azerbaijan undertook

the necessary structural reform of the sector in accordance with the State Programme for the development of the Fuel and Energy Complex in Azerbaijan for 2005-2015 and the State Programme for the Utilization of Alternative and Renewable Energy Sources [7,8].

The purpose of the State Program of the Development of Fuel and Energy Complex in the Republic of Azerbaijan for 2005-2015 is to develop the country's fuel and energy complex to achieve more reliable supply of the requirements of population and economic sectors for electricity, gas and other energy carriers.

The basic tasks of the State Program are:

- establishment of main directions of development of Azerbaijan's fuel and energy complex according to modern standards;
- implementation of necessary scientific-technical and organizational measures to increase efficiency of activities of industrial branches of fuel and energy complex ;
- promotion of advanced technological applications on the production, processing, transportation, registration and consumption of energy resources;
- establishment of a sound competitive conditions in fuel and energy sector;
- increase of the volume of investments involved into fuel and energy complex development;
- ensuring of ecological safety in fuel and energy complex;
- improving of payment system to ensure reliable payments for fuel and energy resource (electricity and gas) consumption;

The State Program envisages the construction of new heat and hydro-energy stations in the country's energy system, modernization of the existing energy blocks, and increasing and approximation of the present generation capacity to 6500-7000 MW till 2015 through utilization of renewable energy sources (small hydro, wind, solar, thermal waters and etc.).

A general state policy in the field of alternative and renewable energy source development is the State Program on the Use of Alternative and Renewable Energy Sources adopted in 2004.

The major objectives of this Program include:

- determine the potential of alternative (renewable) energy sources in electric power production;
- increase the efficiency of energy resources by attracting investment in renewable energy;
- ensure that additional new jobs are opened in the sector;
- and achieve growth in the overall energy generating capacity of Azerbaijan, thus increasing the country's energy security.

The Law on Regulated prices dated May 30, 2003 determines legal and economic bases of the state policy and concerned relations in the field of regulating prices and tariffs.

The authority to issue permissions is given to the Tariff Council according to the Order No 341 on the Approval of Regulations on the Tariff Council, dated December 26, 2005, and the Rules on the Organisation of State Control on the Formation of Tariffs (Order No 247), dated December 30,2005.

The rates for electricity were last increased in 2007. According to the Order No 03 on the Regulation of Electric Power Tariffs, dated January 6, 2007 the following electric power prices are approved:

Table 4. Current power prices in Azerbaijan

Item No	**Description**	**Tariffs per 1 kWh (with VAT) in gapikcs**

1	Wholesale price	
1.2	"Azerenerji" OJSC production	4.1
1.3	Production of private small hydropower plants	2.5
1.4	Production of wind power plants	4.5

Note: 100 gapiks =1manat (the manat currently exchanges at 1: 0.80 $US)

Energy efficiency potential

At present, the Azerbaijan's energy needs are met entirely with gas and oil. The improvement of Azerbaijan's energy intensity and energy efficiency are essential steps towards more sustainable energy consumption. Azerbaijan has one of the highest energy intensities in Eastern Europe, indicating a low level of energy efficiency.

Potential of energy efficiency is evaluated to be about 30% of total volume of energy consumption. The main indicators of energy efficiency development potential in Azerbaijan may be:

- increase of GDP and high economic growth;
- excessive consumption of fossil fuels by all sectors;
- increase of GHG emissions and aggravation of environmental situation;
- high proportion of obsolete facilities in energy sector;
- losses of energy resources during production, transportation and utilization of energy resources;
- insufficient application of energy efficient and renewable energy technologies.

In order to support the development of energy co-operation between the EU, the littoral states of the Black & Caspian Seas and their neighboring countries INOGATE programme was launched in 1992 [9]. The co-operation framework covers the areas of oil and gas, electricity, renewable energy and energy efficiency.

"INOGATE"' originally stood for "Interstate Oil and Gas Transport to Europe", deriving from the predecessor project, 'Interstate Oil and Gas Pipeline Management', completed in 1997. The enlargement of INOGATE's scope of activities began with an Energy Ministerial Conference held in Baku, known as the 'Baku Initiative' that culminated in the signing of the Astana Energy Ministerial Declaration in 2006.

Azerbaijan is among 11 partner countries of INOGATE. Russia and Turkey are part of INOGATE in an observer capacity.

Since one of the key issues faced by INOGATE partner countries are the energy losses, specifically those occurring in the building sector, European Commission and INOGATE Working Group 3 (WG3, Sustainable Development) decided to launch a dedicated project: Energy Savings in the building sector (ESIB).

ESIB is a EU funded project dedicated to the promotion of Energy Efficiency (EE) in partner countries of the INOGATE programme.

ESIB scope of activities covers all types of buildings: housing, public buildings, schools, hospitals, offices, shops, other tertiary buildings, etc.

ESIB main axes of action:

- Legal: analysis of the current state of EE legislation and policy advice for its further development;
- Financial: help to create stimulating conditions for EE financing, Technical assistance to demonstration/ pilot projects.
- Technical and professional: improving the regulations and technical norms to stimulate the use of EE solutions adapted to local conditions; capacity building.

- Public awareness: because raising awareness about EE is a major step towards changing the attitudes and practices, the program will provide the main actors with expertise on EE promotion.

The issue of energy efficiency in Azerbaijan is directly linked to the energy efficiency of buildings. Electricity consumption has been relatively flat since independence. In 2003, electricity consumption in Azerbaijan grew by 13.4% to 22.7 b. kWh and slightly reduced to 20.6 b. kWh in 2004. Significant changes have been observed in the country's energy consumption structure in the last years. Formerly, 48% of total energy was consumed by industry and only 8% by population. Further, population's energy consumption increased by 60%, while industrial consumption reduced to 16%. According to [10], currently in the EU 40% of energy consumption accounts for buildings, in Azerbaijan – the index is 55%. Table 5 and Figure 3 provide information about the level of GHG emissions electricity consumption in the republic in the recent years.

Table 5. The level of GHG emissions from stationary sources during 2006-2010 years (thsd. ton)

Greenhouse gases	**Years**				
	2006	**2007**	**2008**	**2009**	**2010**
Carbon dioxide (CO_2)	17664,4	14828,8	16013,3	15293,1	14399,6
Methane (CH_4)	16,6	24,3	49,5	24,2	18,3
Nitric oxide (N_2O)	0,8	1,7	6,4	10,4	11,8
Hydrofluorocarbons	0,6	0,5	0,2	7,0	6,8
Sulphur hexafluoride (SF_6)	0,1	0,1	0,2	0,8	0,3
Perfluorocarbons	0,9	0,6	0,3	6,4	5,6

Source: *State Statistical Committee of the Republic of Azerbaijan, 2011.*

As can be seen from Figure 3, notable reduction was observed in the energy consumption of some consumer types during 2007-2010 years.

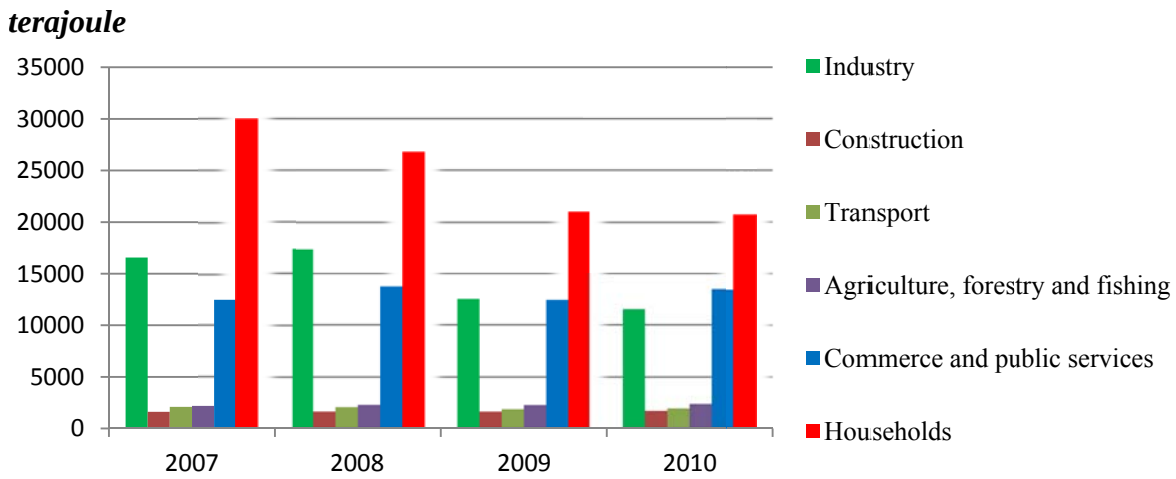

Figure 3. Consumption of electricity by economic sectors from 2007 to 2010 years.

The ESIB mission was organized from November 20 to December 1, 2012, for carrying out one trainings on energy audits in Azerbaijan, in Baku on November 28-29-30, 2012. In Baku city, the Municipality selected a kindergarten of the Khazar District (Figure 4.). This building is

in an extremely bad condition, not only due to a high consumption of heat energy and huge heat losses, but also because the building structure itself would need a complete renovation: roof waterproofing, floors, walls' plastering and painting, windows broken or totally out, electricity, water, toilets, kitchen. The second floor is currently not used because of the huge water leakages. Therefore, the full renovation of the building is proposed together with the energy efficiency improvement, even if only the EE upgrading will be the object of the Integrated Pilot Project.

The local thermal engineers were hired by ESIB for preparing the training course on energy audit, and in particular collect data about the building and about the available technologies concerning energy efficiency in buildings in Azerbaijan. The information about the building, drawings, wall compositions, energy consumption were collected, and a pre-energy audit was accordingly performed. This audit became the base for the content of the training course.

Figure 4. Busovna kindergarden in the Khazar district of Baku city.

Energy audit was carried out on five stages including:

1. A study of initial state of the building including electricity and heat consumption, HVAC systems,etc.;
2. Identification of outside climatic parameters and necessary actual values. The results obtained was as following:
   Heat transfer coefficient of external walls - U = 1,519 W/m² °C
   Heat transfer coefficient of floor (parquet) - U = 3,25 W/m² °C
   Heat transfer coefficient of floor (metlah) - U = 3,85 W/m² °C
   Heat transfer coefficient of roof - U = 2,82 W/m² °C
   Heat transfer coefficient of wood framed windows with double glazing-U = 6,0 W/m² °C
   Heat transfer coefficient of double doors - U = 7,0 W/m² °C.

   Heat transfer coefficient for windows with double glazing accepted according the SNIP.

3. Study of availability of local heat insulation materials with low heat transfer coefficient. Calculation of heat transfer coefficients after reconstruction according to the cost provided with manufacturers on following two options:
   1. The results of the 1st measure:

- Heat transfer coefficient of external walls - U = 0,439 W/m² °C
- Heat transfer coefficient of floor (parquet) - U = 0,526 W/m² °C

- Heat transfer coefficient of floor (metlah) - U = 0,553 W/m² °C
- Heat transfer coefficient of roof - U = 0,502 W/m² °C
- Heat transfer coefficient of double glazing plastic windows - U = 2,2 W/m² °C
- Heat transfer coefficient of door - U = 2,7 W/m² °C

2. The results of the 2nd measure:

- Heat transfer coefficient of external walls - U = 0,261 W/m² °C
- Heat transfer coefficient of floor (parquet) - U = 0,526 W/m² °C
- Heat transfer coefficient of floor (metlah) - U = 0,553 W/m² °C
- Heat transfer coefficient of roof - U = 0,287 W/m² °C
- Heat transfer coefficient of double glazing plastic windows - U = 1,77 W/m² °C
- Heat transfer coefficient of door U = 2,7 W/m² °C.

Based on the results the second option was accepted.

In accordance with the proposed reconstruction project, the calculated energy efficiency will be 1.119. 980 kWt. h/year. The cost of this saving amounts to 30. 624 AZH with annual reduction of CO_2 - 193 tons (0,17271 kg/kWh).

The 4th and 5th stages were organization of energy audit of the Buzovna kindergarden and a training course on 28-30 November 2012.

The final objective of training was to require from the participant to perform by themselves, in small groups, the energy audit on the selected concrete case The Excel model used for training in ESIB projects was fully filled with all the collected information. Investment proposal of EE measures was duly included in this model. All pedagogical steps were filled.

The selected building (kindergarten in Buzovna of Khazar district) is supposed to be retrofitted, using some of the proposed solutions. This implementation of the energy efficiency measures should also be followed up by the trainees in order to bring a practical application that they can use again in their professional activities. It would be going along with the monitoring of the buildings before and after EE retrofitting.

Economic, environmental and policy analysis

The major initial energy related laws and secondary legislative acts of Azerbaijan (such as, Presidential Decrees and Resolutions; Regulations and Resolutions of the Cabinet of Ministers; the Legal Normative Acts - Rules, Orders, Instructions, Norms and Normative Acts of the Central and Local Executive Power Bodies of Azerbaijan) were established approximately 6-8 years after adoption of the Constitutional Act of Azerbaijan on State Independence of 1991. However, there are still some old legal-normative acts in force at present in the energy sector of Azerbaijan.

The Law about the Use of Energy Resources passed in 1996 is the first legislative act determining legal, economic and social bases of the state policy on energy resources' utilization and the main directions of realization of this policy.

According to the Law [11], the main principles of state policy on energy resources utilization are based on:

- state regulation of the activities of legal and natural persons in the area of energy efficiency through economic and administrative measures;
- effectiveness of energy saving requirements during the implementation of the activities related to production (extraction), processing, transportation, storage and utilization of energy resources, application of economic and legal stimulatory mechanisms;
- determination and application of advanced norms of energy resources' utilization;
- state control over efficient utilization of energy resources by organizations and enterprises;
- regulation and standardization in the field of energy saving and efficient utilization of energy resources, necessity of the observation of energy norms and standards;
- coordination of the interests of energy resource producers, suppliers and consumers;
- compulsory calculation of energy resources used by each enterprise and organization not depending on the property kinds;
- obligatory energy expertise of newly constructed and reconstructed objects;
- application of economic sanctions against inefficient use of energy resources;
- propagation about economic, ecological and social advantages of energy efficiency;
- international cooperation in resolution of energy efficiency problems of the republic;
- wide scale application of energy efficient technologies.

Azerbaijan has serious environmental problems due to intensive development of the hydrocarbon resources, increasing amount of consumed fossil fuels and greenhouse gas emissions.

The disruption or outright disappearance of power supply to many towns and settlements in the post-1991 period has been an indirect cause of deforestation and forest degradation, as the population of rural regions turned to fuel wood.

The module of harmful emissions to atmosphere is determined according to the amount of pollutants per each sq. km. Based on this parameter the country's territory is divided into the following groups: less polluted (18 districts), polluted (25 districts), highly polluted (14 districts) and critically polluted ones that includes 14 districts and the cities of Baku, Sumgait, Ganja, Mingachevir and Nakhchevan [12].

Transport emissions are main pollutants of atmosphere air in Azerbaijan, especially in

Baku city, where vehicles now outstrip industry as the major source of air discharges. Combustion of enormous amount of fossil fuels has led to the increase of greenhouse gas (GHG) emissions, especially CO_2.

The Law "About Environment Protection" passed in August 1999 is one of the principal documents regulating rational use and protection of the environment in the Republic of Azerbaijan [13].

This law includes:

- Basic principles of environment protection, responsibilities of government, public entities and citizens in the field of environment protection;
- Responsibilities of nature users during conducting environmental control and monitoring;
- Issues of insurance of environmentally dangerous activities and performing voluntary and compulsory ecological audit of industrial processes;
- Basics of solution of the problems related to responsibilities for the violation of environment protection norms;
- Economic basis of environment protection and nature use regulation: observation of material interests' principles in rational use of nature, regular payments and compensations for environment pollution.

The Law confirms main regulations of ambient air quality and ecological requirements to economic activities.

UN framework Convention about Climate Change and Kyoto Protocol to this convention are important documents to be observed. Azerbaijan government pays great attention to the execution of the Kyoto Protocol terms.

SPPRSD includes important measures on the protection of atmosphere air, such as reduction of GHG emissions, minimization of the negative impact of climate change on the ecosystem, people health and the country's economy. The program aimed to establish a Carbon Fund to provide financial support to enterprises in reducing the amount of CO_2 and other atmosphere emissions. In order to prevent atmosphere pollution caused by transport emissions, installation of gas analyzers in the intense traffic sites of the large cities is planned. Industrial enterprises are committed to give annual reports on CO_2 and other GHG discharge.

The increase of heating efficiency by 1% led to the reduction of both the consumed fuel and CO_2 emissions in 2000-2004 years (Table 6).

Table 6. The results of the increase of heating efficiency by 1%.

Years	**Annual reduction of fuel and CO_2 (%)**			
	Fuel		**CO_2**	
	Conventional fuel (thsd. tons)	%	CO_2 (thsd. tons)	%
2000	235	3,1	488	3,1
2001	222	3,0	447	2,9
2002	215	3,2	442	3,2
2003	204	2,8	421	2,8
2004	196	2,8	412	2,8

Source: "Energy, Ecology, Economy" International Congress, Baku 2005.

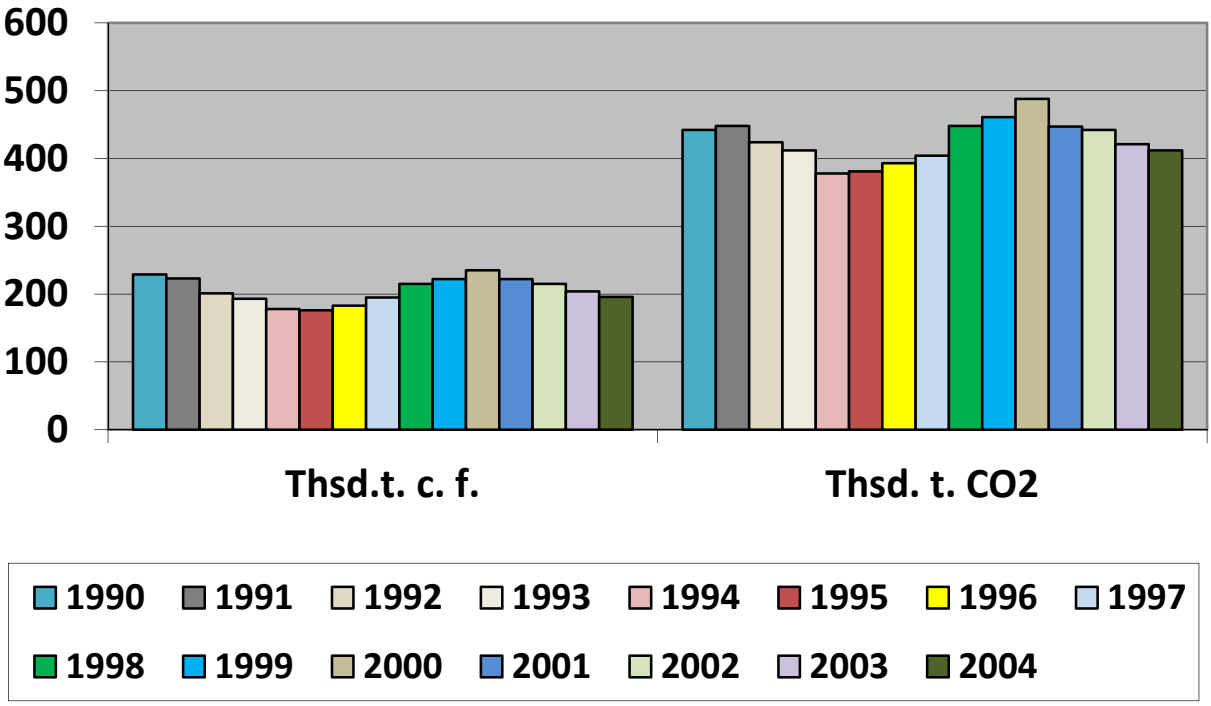

Figure 5. The results of 1% heat efficiency in fuel and CO_2 **reduction.**

Further economic growth and increased consumption of fossil fuels has led to the increase of GHG emissions. The data in Table 7 show the amount of total atmosphere emissions from stationary sources in 2010 and GHG emissions for years 2006-2010.

Table 7. Atmosphere emissions from stationary sources by economic activity types and ingredients in 2010 (thsd. ton)

Sources	Atmosphere emissions				
	Solid particulates	Gaseous and liquid matters	Of which:		
			Sulfuric anhydride (SO_2)	Carbon monoxide (CO)	Nitrogen oxides (NO_x)
Agriculture, forestry and fishing	0.1	0.0	0.0	0.0	0.0
Mining	6.6	105.0	0.3	9.2	8.0
Manufacturing	12.0	28.4	1.4	1.8	2.5
Electricity, gas and steam production, distribution and supply	0.1	28.8	0.3	14.5	8.7
Water supply, waste treatment and disposal	0.0	0.4	0.0	0.3	0.0
Construction	0.3	1.3	0.1	0.3	0.1
Trade: repair of transport means	0.0	1.8	0.0	0.0	0.0
Transportation and storage	0.0	29.0	0.0	0.7	0.2
Other branches	0.2	0.8	0.2	0.3	0.2
Total	**19.3**	**195.5**	**2.2**	**27.2**	**19.8**

Source: *State Statistical Committee of the Republic of Azerbaijan, 2011.*

One of the measures aimed at energy saving was the application of gas counters in buildings. According to long term forecasts, significant successes in CO_2 **reduction can be achieved through application of gas counters, and a new automated system controlling and management technology (Figure 6).**

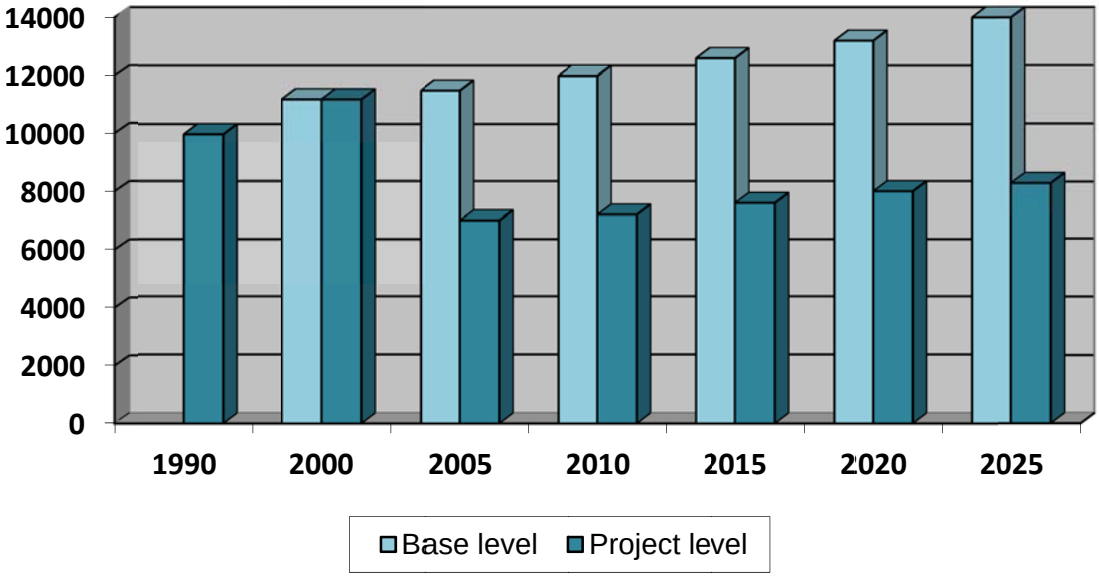

Fig. 6 Forecast of CO_2 reduction by 2025 through application of gas counters.

One of the ways to achieve sustainable energy use and GHG reduction is the use of automated system controlling and management technology. Potential of GHG reduction have been determined by the specialists for 2000-2025 years (Figure 7).

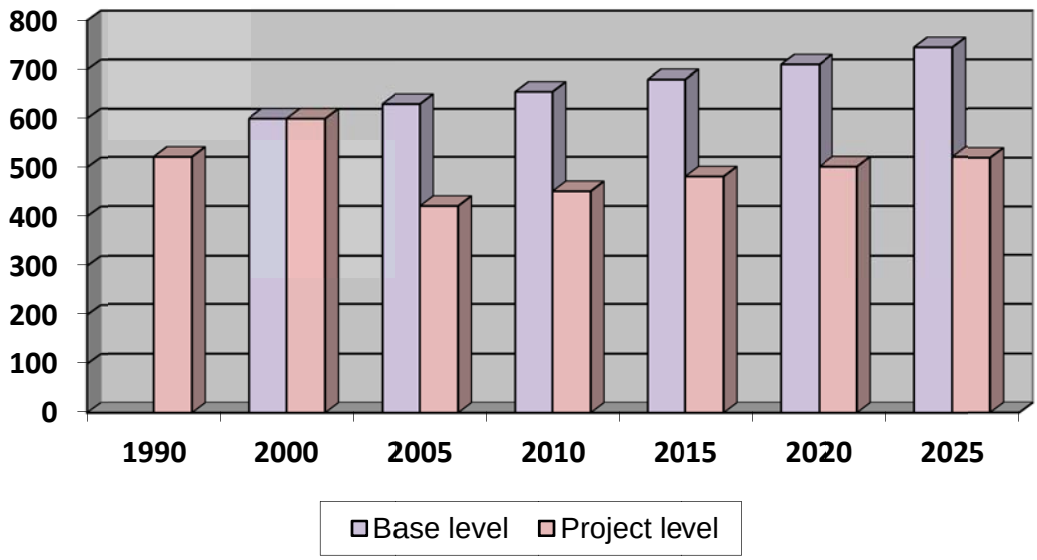

Figure 7. Forecast of CO_2 reduction by 2025 through application of an automated system controlling and management technology

Due to significance of the electric power for all branches of national economy and population, the qualitative characteristics of electric power were specified by state standards (Intergovernmental standard GOST 1310997. Quality rates of the electric power in general purpose power supply systems.), in accordance with which 11 characteristics were stipulated for specification of normal (95% of time during a day) and maximum allowable deviation normal ratings. These characteristics specify quality of voltage and frequency. Control and management of the qualitative characteristics of electric power is executed according to the Rules of Use of

Electric Power which were approved in a new edition on February 2, 2005, by Cabinet of Ministers of the Republic of Azerbaijan. The Rules provide regulations for connecting consumers to electrical networks [14].

In respect of the Decree dated September 28th, 2006 by the president of Azerbaijan Ilham Aliyev, entitled "Comprehensive Action Plan for Improving the Ecological Situation in the Republic of Azerbaijan during 2006 – 2010" steps were undertaken for the removal of industrial uses to the edge of the city, decontamination of land, and improvements of the coastal boulevard. In accordance with the order of the Head of Baku Executive Power dated June 11, 2010, it was decided to restore and redevelop the Black City with an area of 221ha, which has played a major role in the oil industry for more than 100 years, performing activities of refining, storage and transportation of "black gold".

"State program on acceleration of socio-economic development of settlements of Baku city for 2006-2007 years" approved by Presidential Decree № 1338 from 27 February 2006 provided important provisions for energy sector's improvement [15]. According to this Program the following measures were implemented:

- During the period of 2006-2007 a new gas pipeline with 272,2 km length and appropriate gas equipment were constructed and put into operation;
- A part of 933 electrical motors were reconstructed and another part replaced with 491 water pumps;
- 21,3 km electrical cables were renewed;
- In order to improve centralized heat supply of buildings, 29 boilers were constructed in Baku city in 2007;
- Since 2006, a number of measures aimed at infrastructure rehabilitation and improving of people's electricity, gas and water supply systems have been implemented in Baku and its settlements.

"State Program on socio-economic development of regions in the Republic of Azerbaijan for 2009-2013" approved by Presidential Decree 2009 stipulated important measures on reliable energy supply to Baku city and other regions [16]. The following measures were planned under "State Program on socio-economic development of Baku city and its settlements for 2011-2013" to continue works on sustainable energy use:

1. Implementation of projects aimed at the construction of modern electro-stations;
2. Rehabilitation of gas supply in the settlements of Baku city;
3. Reconstruction of substations and electricity transmission lines;
4. Rehabilitation, reconstruction and modernization of the existing heating systems;
5. Development of improved information and communication infrastructure;
6. Development of incentives to support the activities of private sector;
7. Improvement of environmental situation including reducing, accumulation and utilization of various wastes, etc.

In order to continuously supply Baku city and settlements with electricity, construction of new lines and two substations with 220 kWt capacity, and reconstruction and modernization of two substations were planned. In addition, the Program stipulates application of modern energy efficient and alternative energy technologies.

Energy efficiency investments are a great opportunity for the Azerbaijan, which is already making some strides.

A thermal power plant in Azerbaijan, AzDRES, will become the first in the world to be able to sell carbon credits earned thanks to an energy efficiency modernization project. The project was financed by the EBRD in 2006; the $207 million loan allowed the plant to rehabilitate old and inefficient turbines and boilers, modernize command and control systems, repair chimneys and water cooling systems and make a number of other improvements [17].

The project, "AzDRES Energy Efficiency Improvement", has been registered under the Kyoto Protocols' Clean Development Mechanism (CDM) by the CDM Executive Board. The project on rehabilitation of seven dual fuel, gas and heavy fuel oil units of 300 MW each is estimated to generate over 10 million carbon credits over the ten-year crediting period. These credits can now be sold on global carbon markets, including the EU's Emissions Trading Scheme.

The energy efficiency improvement of the AzDRES thermal power plant (TPP) is the first power plant rehabilitation project registered under the CDM and the second CDM project in Azerbaijan. It is also the largest CDM-registered project in the Caucasus. Owned by the national energy operator Azerenerji, the AzDRES TPP is the largest power plant in Azerbaijan, generating half of the country's electricity (Figure 8). The rehabilitation project significantly increased efficiency and capacity at the plant, which is now better able to meet the increasing demand of a rapidly growing economy. Moreover, the project has improved Azerbaijan's energy security and increased reliability of its energy infrastructure.

Figure 8. AzDRES reconstructed thermal power plant

Azerenergy has noted a small decline in consumption recently due to its efforts to improve efficiency. Improvements in natural gas supply and the introduction of electricity meters across the Azerbaijan have improved efficiency while also addressing access and security.

Azerbaijan has begun to promote energy efficient lighting. Namely, a proposal for the Parliament is considering MEPS for lamps and the National Standard Agency is preparing mandatory labels for lamps. Energy efficiency awareness raising campaigns through media and school educational programmes have been conducted in some cities. Baku is planning to establish CFL collection points and to build a recycling facility for electronic waste.

Most of these activities have yet to be implemented and most are not planned on a national level. Azerbaijan still needs to define the absolute levels of the lamp MEPS and make sure that these standards incorporate global best practices. A thorough transition to efficient lighting in the residential, commercial/industrial and outdoor sectors would yield environmental

benefits of 454.6 kilotons of CO_2 annually Electricity consumption would be reduced by 1.1 TWh annually (approximately 8% of total national electricity consumption). Lighting electricity consumption would be reduced by 50%. Annual cost savings would be approximately 55.8 million USD.

Table 8. Annual benefits of the transition to efficient lighting in Azerbaijan

(residential, commercial/industrial and outdoor sectors)

CO_2 reduction (Kt)	Energy saving (TWh)	Cost saving (million USD)
454,6	**1,1**	**55,8**

The phase out of inefficient incandescent lamps would result in reductions of approximately 380 kilotonnes of CO_2 annually, electricity consumption would be reduced by 0.92 TWh and costs savings would be 53 million USD [18].

Policy design considerations

Analyzing provisions of the energy legislation of Azerbaijan with respect to energy efficiency and use of renewable energy sources we should note, that they have a general character and are not duly applied in practice. The State Program on the Use of Alternative and Renewable Energy Sources has set the frame which will have to be filled by corresponding measures and activities. In addition to the requirements on energy efficiency and usage of renewable energy sources, the issues on protection of environment should be brought in compliance with the EU Energy Directives.

Recently, Azerbaijan has made important steps at the national level aimed at creating conditions for an extensive development of energy saving. It's worth mentioning that in September 2012 the "City Planning and Construction Code of Azerbaijan" was adopted, incorporating the issues of energy saving and energy efficiency at the stage of designing and constructing new facilities. The government was given a task to develop the relevant norms and regulations on this subject within a 5-month period.

Thus, the foundation was laid for creating a legal framework required for implementation of energy saving in construction.

There are already examples of practical implementation of an energy efficient building concept such as, for instance, the building of the Diplomatic Academy built in 2012 in Baku, and where all cutting edge architectural, construction and technological energy saving solutions were applied (Figure 9).

Figure 9. The building of Azerbaijan Diplomatic Academy.

A good deal of works has been implemented within the framework of the Energy Sector Reform Program (ERSP) in Azerbaijan supported by the European Union. One of the conditions of the Energy Reform Program was draft legislation on use of RES and EE.

In 2010-2011, under the EU ERSP the International Ecoenergy Academy implemented a project "Improvement of Azerbaijan's legislation relating to Renewable Energy Sources and Energy Efficiency and its bringing in conformity to the EU legislation".

Draft laws and standards regulating development of non-traditional renewable energy sources and energy saving were developed. Among them there are draft laws "On Energy Saving and Increasing Energy Efficiency" and "On utilization of Renewable Energy Sources" and 21 secondary legislation documents needed to ensure the implementation of these laws. In addition, a package of proposals on the amendments in 17 of the existing laws were prepared and submitted to Azerbaijan government. At present they are at the stage of approval by the Cabinet of Ministers of the Republic of Azerbaijan.

The Law on Utilization of Renewable Energy Sources is developed to regulate relations in the fields of renewable energy source utilization for electric and heat energy generation, its transmission and consumption, and also determine the basic principles of governmental support to electric and heat energy generation from renewable sources in the Republic of Azerbaijan.

The main purpose of the Law on Energy Saving and Increasing Energy Efficiency is to regulate relations for efficient use of energy sources, electricity and heat energy while avoiding waste and protecting the environment. The law provides basic principles of state regulation in the field of energy efficiency increasing and effective use of energy sources in all spheres including state control and expertise, financial and economic mechanisms of energy efficiency, personnel training and people awareness raising, etc.

Most of the secondary legislation documents provide the principles of regulation of rational use of energy resources in buildings and were developed according to European standards, especially Directives 2002/91/EC and 2010/31/EU of the European Parliament and of the Council on the energy performance of buildings (the EPBD).

Among these draft regulations and standards there are:

1. Regulations proposed for energy performance of buildings
2. Rulebook for performing state energy expertise
3. Building automated management system standards
4. Heat consumption calculation for existing residential buildings
5. Calculation of smoke protection systems for residential and commercial buildings

6. Standards for apartment heating units in multicompartment buildings
7. Standards for complex intelligent systems for low-rise buildings and cottages
8. Guidelines for the rating of economic efficiency of heat supply investment project
9. Air change norms for residential and public buildings
10. Regulations for increasing energy efficiency and energy resource saving
11. Methods proposed for energy consumption calculation of buildings (BEC –Az)
12. Regulations on the methods and rules of energy efficiency increasing in transport
13. Urban development model regulations for solar energy use
14. Automated single house water heating and hot water supply nodes in exchange for the centralized nodes and others.

One of these regulations **"Building automated management systems' standards"** were developed on the basis of cooperation between EU Committee on CEN standardization and the Technical Committee on "Building environment design" ISO/TC 205.

The principal goal of this complex of standards is accurate definition of primary requirements ensuring effective and highly qualitative realization of automated building management system (ABMS). The standards may be greatly important to all specialists engaged in ABMS training, designing, installation, preparatory processes, putting into operation, maintenance and many other services.

The standards **"Automated single house water heating and hot water supply nodes in exchange for the centralized nodes"** is developed for the connection of centralized heating nodes (CHN) of residential and public houses into automated single heating nodes (SHN). These standards can be used in CIN design in order:

- to increase the building's heat supply efficiency through bringing hot water preparation systems nearer to hot water consuming areas, while increasing the effect of regulation of heat energy supply to heating systems;
- to simplify the details of heat energy demand calculation;
- and to improve consumer services.

The **"Regulations on heat consumption calculation for existing residential buildings"** provides provisions for the calculation of heat energy consumption in heating, ventilation and hot water supply systems up to 25-store residential buildings. The regulations are not intended to apply in the buildings with conditioning systems. The methods of calculation of heat energy consumption for heating, ventilation and hot water supply systems in existing buildings can be useful for the organizations engaged in heat supply, managers of housing funds, landlords and house owners.

The proposed calculation method will allow to determine the followings:

- heat energy consumption of heating, ventilation and hot water supply systems in residential buildings, when the values of outside climate parameters remain regulatory during heating period;
- heat energy consumption of heating, ventilation and hot water supply systems, when the values of outside climate parameters remain actual throughout the heating period or several times of the heating period;
- distribution of the amount of heat energy consumed by heating and ventilation systems among the buildings with different heat peculiarities;
- buildings' heat peculiarities according to the measurements of heat counters;
- heat energy limits required for heating, ventilation and hot water supply of residential buildings.

The **"Guidelines for the rating of economic efficiency of heat supply investment project"** these guidlines are prepared to provide practical assistance to specialists for the evaluation of economic efficiency durung investment projects' development, and also to legal and natural persons who interested in the proqrams and investment projects aimed at modernization of communal infrastructures, energy and heat supply facilities,etc.
The gudelines include a system of evaluation methods and indexes of economic efficiency of investment projects.
The following basic principles of the rating of economic efficiency of investment projects are used:

- comparision of the project results (efficiency) with alternative investment variant;
- modelling of both the product and monetary flows. All flows should belong to a concrete period of time;
- evaluation of possible risks related to the project implementation.

The guidelines are designed to promote the solution of the following tasks:

- rating of economic efficiency of investment projects at their development stage;
- substantiation of the expediency of participation of interested enterprises and investors in the implementation of investment projects;
- carrying out of a comparative analysis of several variants of investment projects according to exploitation periods of technical facilities;
- expert examination of investment projects.

The quidelines will allow implementing investment projects easily and in a short term, forming projects database on the basis of special softwere, automatic selection and examination of investment projects using computer programs and internet technologies.

The regulations for **"Air change norms for residential and public buildings"** present two methods of calculation of minimal air change rate to obtain permissible inside air quaity. Optimal air change rates for residential and public buildings, maximum permissible concentration of some radioactive gases and other toxic pollutants (hydrocarbons, Pb, CO, CO_2, NO_2, SO_2, dust and phenols) are provided.

The basic air-temperature indexes of rooms are: the content and quality of the inside air provided with heating, ventilation and conditioning systems and microclimate parameters.

The quality of the inside air is dependent on a number of factors including the existing pollution sources and extent of their effect and location, construction of ventilation and conditioning systems, and methods of management and exploitation quality of these systems, etc.

Inside air should be free of pollutants that cause discomfort and danger to human health. Various gases, vapuors, microorganisms, cigarette smoke, dust and aerozils are among air pollutants. Outside air, sources of various polluting substances, prodicts of technological processes and people's everyday activities, furnitures, carpets as well as construction and decorative materials can be the origins of inside air pollution.

The existing air quality norms such as CN&R-SNiP, BCN (Construction norms on branches) and CN (Consruction norms) and the documents of Azerbaijan state sanitary-epidemiological control are not comprenhensive, sometimes contradicting each other.

There are several air quality standards applied currently in EU, USA and other countries. A number of local and foreign regulations are used in the development of this regulation including ASHRAE standards developed in 1999 by US Engineering Association on heating, cooling, ventilation and conditioning systems (ASHRAE 62-1999 "Ventilation for acceptable indoor air quality").

5. Conclusion and Recommendations

Two problems - energy saving and environment protection are current concern in Azerbaijan. Since independence, Azerbaijan government has established new legislation framework and implemented a number of state programs to solve the existing problems. Despite the fact that majority of the laws regulating energy sector in Azerbaijan were prepared by the participation of EU Experts Group under the relevant TACIS project funded by EC by taking into consideration the appropriate energy laws of the European countries they required changes to be harmonized with the EU legislation and relevant Directives to promote sustainable utilization of energy resources. Provisions of the energy legislation of Azerbaijan concerning the issues on energy efficiency and usage of renewable energy sources have also a general character and are not duly applied in practice.

Recently, within the framework of the Energy Sector Reform Program (ERSP) in Azerbaijan supported by the European Union a project was implemented to improve Azerbaijan's legislation relating to Renewable Energy Sources and Energy Efficiency and bring it in conformity to the EU legislation.

Several important measures have been implemented under INOGATE programme. On 28-30 November, 2012 a training course on energy audit, and in particular collect data about the building and about the available technologies concerning energy efficiency in buildings in Azerbaijan was held in the frame of INOGATE's ESIB project.

In the last year, the "City Planning and Construction Code of Azerbaijan" was adopted, incorporating the issues of energy saving and energy efficiency at the stage of designing and constructing new facilities.

For future development of buildings' energy efficiency and reducing the negative environmental impact of energy resource use the following measures are proposed:

- Establishment of a governmental entity to coordinate the activities related to energy efficiency in all spheres including industrial sectors, public and residential building;
- Development of long-term National Energy Efficiency program with participation of the related governmental bodies and scientific-research institutes;
- Development and implementation of projects on increased energy efficiency in both new and existing buildings.
- Development and use of new energy efficient building models according to advanced world practice.
- Application of automated building energy management and control systems;
- Organizing of the manufacture of modern and high-quality building materials and structures;
- Development and adoption of new standards, norms and regulatory acts on building energy performance, and establishment of institutional and financial mechanisms of their management;
- Establishment of incentives and economic motives to stimulate energy efficiency of buildings;
- Development of legal and policy framework for energy efficiency of buildings in compliance with international standards to regulate:
    1. Establishment of enterprises manufacturing energy-intensive construction materials involving private sector, small- and medium enterprises;
    2. Organizing of training courses to train specialists on production and use of modern materials and techniques for the construction of energy efficient buildings;
    3. Implementation of experimental project using energy efficient engineering systems for various kind of buildings;
    4. Effective use of natural raw material resources and industrial wastes for the production of energy saving construction materials;

5. Wide-scale application environmentally friendly renewable energy technologies for electricity, heat and hot-water supply of buildings;
6. Implementation of training and awareness raising activities to promote effectiveness of energy efficiency services;
7. Implementation of building energy audits;
8. Involving of foreign and local funds to invest in energy efficient measures;
9. Involving of TV and radio channels making national and/or regional broadcast, mass representatives in training programs on sustainable use of energy resources in buildings;
10. Creation of a favorable business climate, progressive integration energy market into the EU energy market and development of new tariff mechanism;
11. Expanding of the scope of international and regional cooperation in the projects aimed at the increase of buildings' energy security.

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