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Policy Paper

Alternative and Renewable Energy Outlook for Azerbaijan 2014

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Table of Contents

Acronyms and Abbreviations

A&RE	– Alternative and Renewable Energy
AG	– Alten Group
BES	– Bakielektikshabaka JSC
BP	– British Petroleum
CabMin	– The Cabinet of Ministers of the Republic of Azerbaijan
CDM	– Clean Development Mechanisms
CIC	– Caspian Information Centre
CTC	– Caspian Technologies Company
EE	– Energy Efficiency
EIA	– The U.S. Energy Information Administration
GHG	– Greenhouse Gas
GHCS	– Geothermal Heating and Cooling System
GHP	– Geothermal Heat Pump
HPP	– Hydro Power Plant
IET	– International Emission Trading
IFI	– International Financial Institutions
JI	– Joint Implementation
JSC	– Joint Stock Company
ME	– The Ministry of Energy of Azerbaijan Republic
MEI	– The Ministry of Economy and Industry of the Republic of Azerbaijan
MENR	– The Ministry of Ecology and Natural Resources of the Republic of Azerbaijan
REC	– Regional Environmental Center
RES	– Renewable Energy Sources
SAARES	– The State Agency on Alternative and Renewable Energy Sources
SOCAR	– The State Oil Company of Azerbaijan Republic
SSC	– The State Statistical Committee of the Republic of Azerbaijan
SES	– Solar Electric Stations
SPP	– Solar Power Plants

SWEP – Small Wind Electricity Plant

TPP – Thermal Power Plants

UNDP – United Nations Development Program

UNFCCC – United Nations Framework Convention on Climate Change

WtE – Waste-to-Energy

WPP – Wind Power Plants

Measurements

°C – Degree Celsius

AZN – The official currency of Azerbaijan (1 AZN = 1.27 USD)

CO_2 – Carbon dioxide

GW – Gigawatt (1 GW = 1,000,000 kW)

Kcal – Kilocalorie (1 kcal = 1000 calorie)

KW – Kilowatt (1 KW = 1 watt)

kWh – Kilowatt hour (1 kWh = 1000 watt hours)

MW – Megawatt (1MW = 1,000 kW)

TOE – Tone of equivalent (1 TOE = 11.63 MWh)

TW – Terawatt (1TW = 1,000,000,000 kW)

Introduction

As a net oil and gas exporter, Azerbaijan's energy revenues have driven significant economic growth, including in the non-hydrocarbon sectors of the economy. In particular, 2004 marked the beginning of a period of sustained rapid growth. For 2014, for instance, GDP growth was 4.5 per cent, and is forecasted at 4.3 per cent for 2015.

A key development in the power sector took place in the 2000's: the switch from oil to gas in thermal generation. At the same time, domestic energy consumption dropped below production rates. This trend has continued, with a widening gap between supply and demand. With its current levels of exports and reserves, Azerbaijan does not have pressing energy security concerns. However, the government is aware of the need to reduce the country's dependency on non-renewable resources, and accordingly has launched several initiatives to diversify its energy mix and increase energy efficiency.

The momentum for harnessing the potential of renewable energy sources (RES) has increased alongside the growing instability of the global energy market. The foundations for the development of Azerbaijan's RE sector are well-established, especially following the enactment of the State Program on the Use of Alternative and Renewable Energy Sources in 2004. The goal of this program is to promote energy production from renewable and environmentally sound sources and to utilize hydrocarbon resources more efficiently.

The creation of the State Agency on Alternative and Renewable Energy Sources (SAARES; in Azerbaijani ABEMDA) is responsible for the development and implementation of RE projects. In 2009, the Agency created additional incentives for investors by introducing regulations and preferential tariffs.

Along with SAARES, various stakeholders are contributing to the development of RE in Azerbaijan, including the State Oil Company of Azerbaijan Republic (SOCAR) – a state owned oil and natural gas company, AzerEnerji JSC – a state owned electricity company, and local private companies. Notably, international financial institutions (IFI) and development organizations are also supporting RE and EE projects in the country. Given that the development of this sector is relatively recent, the projects being implemented are mainly pilot ones.

Briefly, Azerbaijan has strong potential in terms of realizing RES, though there remains significant work to be done in terms of establishing sound RE capacity and achieving energy efficiency. The improvement of Azerbaijan's energy production and efficiency constitute essential steps towards more sustainable energy consumption. In regard to the

improvement of RE capacity, a National Strategy on the use of alternative and renewable energy sources for the period 2012-2020 is being prepared by SAARES and by the Ministry of Industry and Energy (MIE).The country's target for 2020 is to share of renewable energy in electricity 9,7 per cent and share of renewable energy in all energy consumption.

National energy efficiency targets, including increased use of RE, are set forth by the "Azerbaijan in 2020: Look into Future" state strategy. The goal of this program is to accelerate the development of alternative (renewable) energy sources, strengthen the institutional environment, increase scientific-technical potential, continue training specialists, and raise awareness among consumers. Alongside state initiatives, private sector involvement will be promoted, and the reforms for alternative energy tariffs will be ensured.

As demonstrated by the 2020 strategy, the country offers numerous opportunities for foreign companies interested in investing in alternative energy or penetrating the local market. However, there are still challenges, among them economic and technical barriers, poor public awareness, and counter-lobbying, all common barriers to developing an RE sector.

Azerbaijan already applies preferential tariffs for electricity generated by WPPs and small HPPs, and there are ongoing discussions on creating a smart grid system in Azerbaijan. Existing preferential tariffs and the establishment of a special governmental agency focused on utilizing the potential of RE demonstrates that there is political will for the development of the RE sector. Once political will is in place, other barriers are much easier to overcome. For instance, economic barriers such as high costs of infrastructure construction can be mitigated through loans, grants or preferential tariffs targeting the specific sectors. The absence of community support can be addressed though nationwide awareness programs on the benefits of RES, and by providing incentives for switching to RE.

The current report consists of two parts, followed by a concluding section and a list of recommendations. The first section addresses climate change as it pertains to Azerbaijan, providing a descriptive analysis of the energy sector and energy efficiency at the national level. Given that so far the country's main focus has been on establishing RE generating power plants, the second part focuses on Azerbaijan's renewable energy potential, its achievements to date, previous projects implemented in the RE sector, and upcoming and prospective projects. The conclusion provides an overall summary of the report, and focuses on the strength and weaknesses of the current situation in Azerbaijan regarding

the implementation of RE and EE projects. Finally, the report puts forth recommendations on how Azerbaijan can boost both RE and EE potential.

Part I

Energy and Climate Change in Azerbaijan

As a net oil and natural gas exporter, Azerbaijan's domestic energy consumption is covered by domestic energy production. According to British Petroleum's Statistical Review of World Energy, Azerbaijan's proven oil reserves were estimated at 7 billion barrels, 0.4 per cent of the world's total proven oil reserves. Natural gas reserves are put at 0.9 trillion m^3, or 0.5 per cent of total global proven natural gas reserves (2014).

Up to 93.6 per cent of Azerbaijan's electricity generation is based on natural gas and heavy oil (Table 1). The peak in energy production was 20 billion kWh in 2006, due to economic expansion and electrification processes between 2000 and 2006 (Figure 3) (SSC, 2014). In 2012 the electricity generation was 15 billion kWh. According to AzerEnerji JSC, the installed generating capacity is more than 7.5 MW (2014).

Table 1. Electricity statistics 2007-2013

	2007	2008	2009	2010	2011	2012	2013
Total Generation	21,847	21,643	18,879	18,709	20,294	22,988	23,354
Oil and Natural Gas	19,483	19,410	16,558	15,259	17,618	21,167	21,863
Hydro	2,364	2,232	2,308	3,446	2,675	1,821	1,489
Wind	-	-	2,1	0,5	-	-	0,8
Solar	-	-	-	-	-	-	0,8
Electricity Imports	548	216	110	100	128	140	127
Electricity Exports	786	812	380	462	804	680	495
Final Consumption	15,953	15,650	12,259	12,223	13,266	15,394	15,981

Source: State Statistical Committee (2014);

Azerbaijan's energy policy is based on securing long-term energy independence (ECS, 2013). As a net energy exporter, the country has already achieved energy independence. However, in order to diversify the economy, increase energy efficiency and support GHG mitigation processes, Azerbaijan has officially supported the development of the RES in the country since 2004, through the State Program on the Use of Alternative and Renewable Energy Sources. The Program's objectives are as follows:

- Identifying the potential of alternative and renewable energy (A&RE) sources in electricity generation;
- Increasing energy efficiency by exploring A&RE sources;
- Providing cutting edge vacancies through developing new energy generation areas;

- Ensuring energy security by diversification and improvement of the energy capacity of the country.

Energy planning in Azerbaijan is taking place in the context of sustainable development discussions. On international level Azerbaijan has signed, ratified and become a party to the United Nations Framework Convention on Climate Change (UNFCCC), and adopted the Kyoto Protocol as a non-annex country. However, these agreements do not entail any legally binding requirements to reduce GHG emissions; rather, they simply provide incentives for reduction, for instance through International Emission Trading (IET), Joint Implementation (JI) and Clean Development Mechanism (CDM). The Ministry of Ecology and Natural Resources (MENR) has been Azerbaijan's National Focal Point in implementing the CDM of the Kyoto Protocol. The first commitment period of Kyoto Protocol ended in 2012; in order to be able to further take advantage of the above-mentioned mechanisms, countries must sign and ratify the Doha Amendments to the Kyoto Protocol. Azerbaijan has not yet done so.

On the national level, in 2003 Azerbaijan adopted the "National Action Plan on Environmentally Sustainable Socio-Economic Development" aimed at reducing GHG emissions. Among other things, this action plan set forth priorities to stimulate the usage of alternative and renewable energy sources in energy generation. Additionally, the Azerbaijani government plans to increase the share of RES in the electricity generation by up to 20 per cent by 2020.

1.1 Climate Change and Existing Policies

According to the MENR, the temperature increase in Azerbaijan during 1991-2000 (0.41 °C) tripled in comparison to the 1961-1990 period (0.34 °C). Additionally, the average annual temperature increase is expected to be 1.50-1.60 °C during 2021-2050, and precipitation is expected to increase by 10-20 per cent in comparison with the 1961-1990 period. Climate change will lead to a higher occurrence of water shortage by a factor of 3.5 to 4, and increase humidity by at least 15 per cent of the baseline level by 2050. It has been widely argued that climate change has adverse effects on human health, increasing the long-term risk of a whole range of diseases and infections (MENR Report, 2010). This data could provide additional motivation for Azerbaijan to re-join Climate Change negotiations.

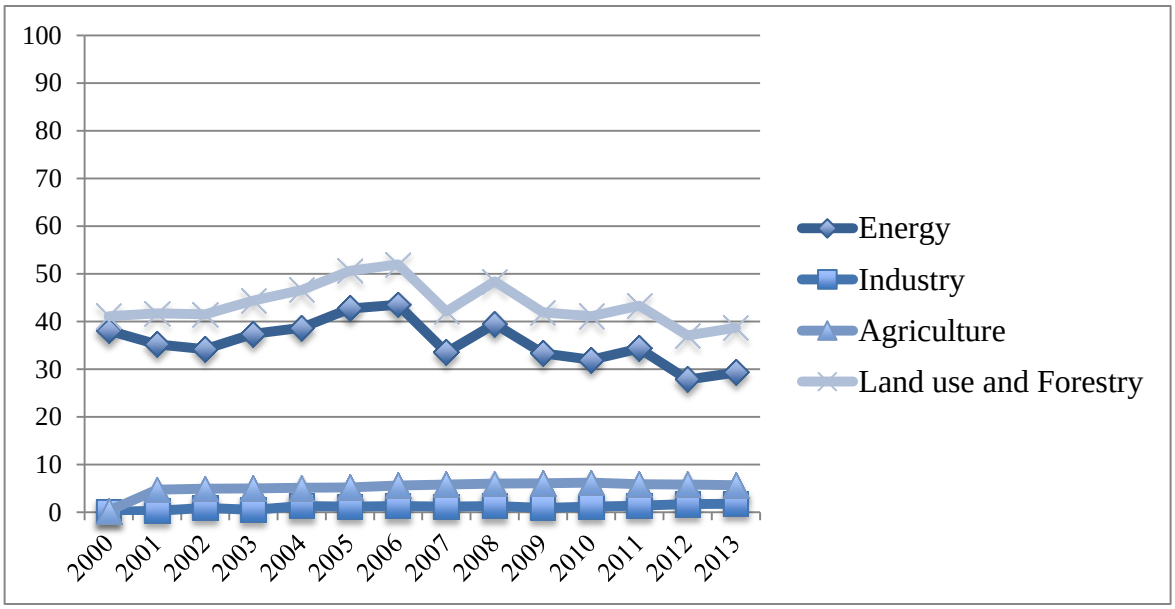
The main generators of CO_2 emissions in Azerbaijan are the energy and industrial sectors, while the agriculture and forestry sectors generate the principal carbon sinks and land use change (Figure 1). CO_2 emissions in the energy sector are generated from burning fuel in the production of energy, oil and gas extraction, and transportation. GHG

emissions by the industry sector have increased since 2004, consistent with the growth of the metallurgy sector (MENR, 2010). According to the SSC, in 2013 the overall GHG emissions were 75.5 million tons, and per capita emissions were 3.7 tons (SSC, 2014).

Since electricity generation in Azerbaijan primarily involves burning hydrocarbons, it is possible to reduce GHG emissions by promoting energy efficiency, energy saving and the use of RE in energy generation.

In order to cut down the country's GHG emissions and increase energy efficiency, in 2004 the government drafted the State Program on the Use of Alternative and Renewable Energy Sources, and in 2009 established the SAARES. As a result of these actions, companies operating in the renewable energy sector are exempt from customs duties and taxes. As per Decrees No. 112 and 113 of the Cabinet of Ministers (April 2014), customs duties and VAT on the import of equipment and technology used in energy efficiency and A&RES sector has been waived for ten years (CabMin, 2014).

Figure 1. GHG emissions (in millions of tons) per sector during 2000-2013 (CO_2 eq)



Sources: State Statistical Committee (2014); Ministry of Ecology and Natural Resources. (2010);

1.2 Energy Sector Overview

1.2.1. Institutional Structure

The Ministry of Energy (ME) is the central executive and policy-making institution in the energy sector, responsible for the implementation of state policy and the regulation of activities in the country's energy sector, including energy production, supply, transmission and distribution. The ME works with the Ministry of Economy and Industry (MEI) of the Republic of Azerbaijan, SOCAR, AzerEnerji JSC, and other energy related institutions. The ME identifies the energy security and development priorities of the energy sector.

AzerEnerji JSC manages electricity production, transmission and distribution, and also operates the country's thermal, fossil fuel and hydropower plants (except few small HPPs). In addition, it is responsible for the national grid and electricity supply across Azerbaijan, with the exception of Baku, which is supplied by Bakielektrikshabaka (BES) JSC.

The SAARES, part of the ME, is a governmental body tasked with the development of RES in Azerbaijan. Azalternativenerji LLC is a state company operating under the auspices of the SAARES. Both the SAARES and Azalternativenerji LLC are the main governmental institutions responsible for the implementation of state RE projects in Azerbaijan, with the exception of hydropower projects. As mentioned above, AzerEnerji JSC operates the national transmission grid; in order to be connected to the grid, any traditional electricity generating company must obtain a license from AzerEnerji JSC (in Baku, in order to get connected to the distribution lines, the license should be obtained from BES JSC). However, RE generating power plants across the country should obtain their license from the SAARES.

The Tariff Council is the collegiate executive body, which under the chairmanship of the MEI, establishes tariff methodology, approves the tariff level proposed by regulated companies, proposes changes to the legal framework of the pricing of public goods and services, and settles disputes over price regulation and tariff applications in Azerbaijan. The Council also sets rates for electric power production and consumption, and decides whether or not to apply feed-in tariffs for renewable-based electricity.

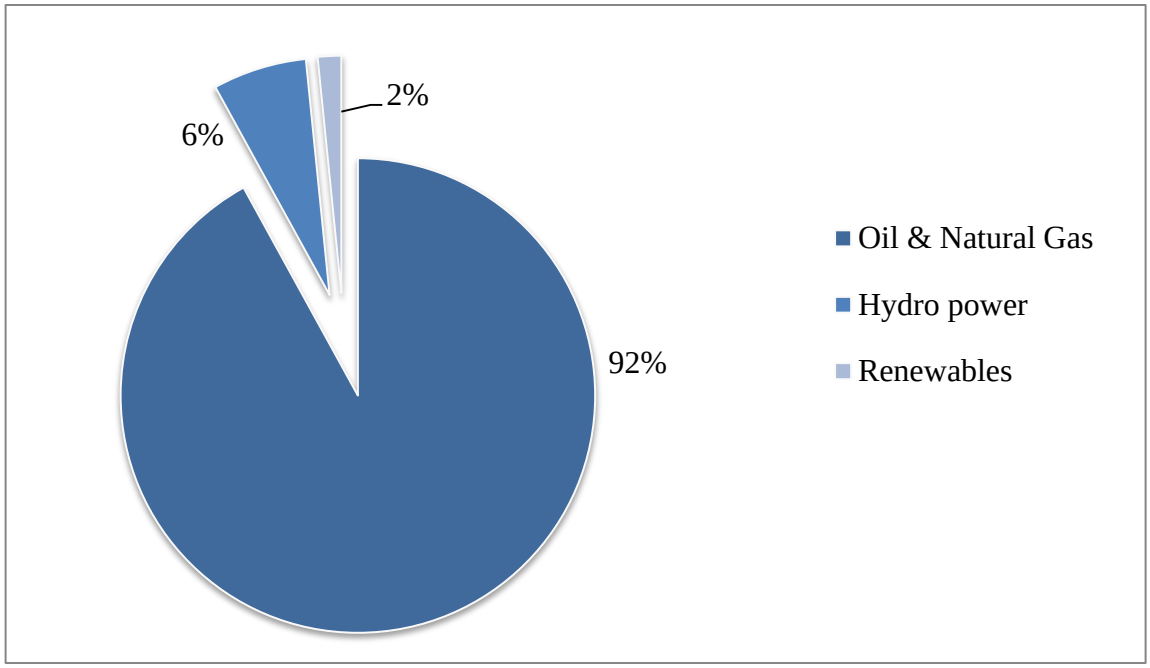
Currently, no feed-in tariffs are implemented in Azerbaijan, and only electricity produced by small HPPs and wind farms are subject to the preferential tariffs. Since 2008, the tariff for electricity generated from small HPPs is 0.025 AZN/kWh, and from wind

turbines is 0.045 AZN/kWh. The tariff for electricity generated from hydrocarbons is 0.06 AZN/kWh.

1.2.2. Power Sector

The electricity market is a closed market, and operated mainly by the state-owned company AzerEnerji JSC. According to national legislation, there is no requirement on the disaggregation of transmission and distribution from generation and/or the separation of transmission system operator and distribution system operator. However, several small power plants have been privatized, and an independent regional distribution company, BES JSC, has been established. Additionally, the SAARES is responsible for the construction and operation of the RE generating power plants.

Figure 2. Share of energy generating sources in energy primary consumption in Azerbaijan, 2013



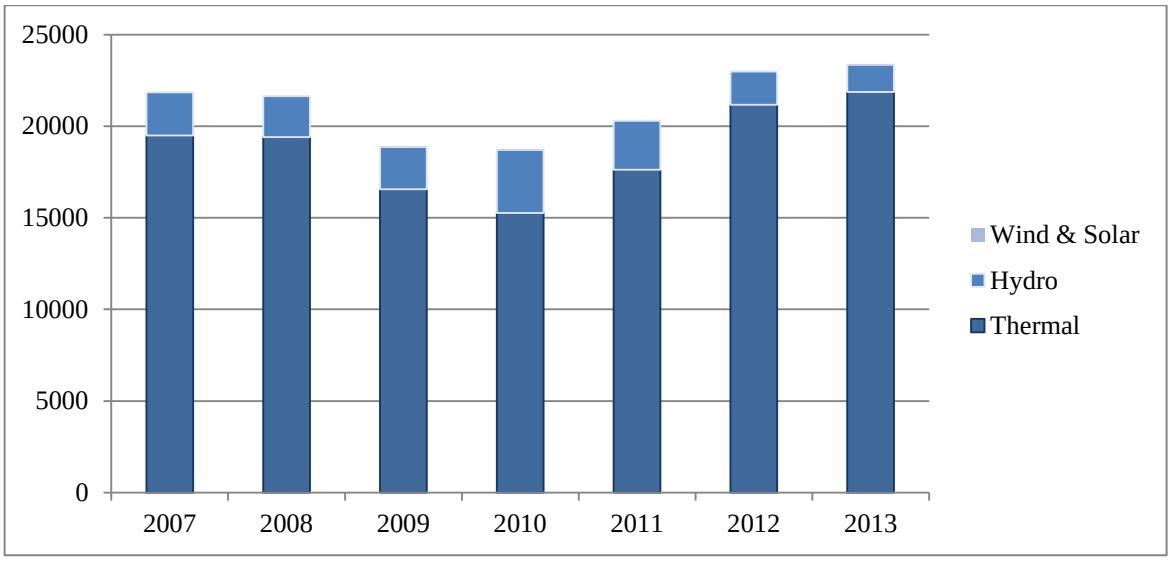
Source: State Statistical Committee (2014);

Currently, Azerbaijan is fully electrified and the energy sector plays the leading role in the country's economy. According to the AzerEnerji JSC, the installed generating capacity of power stations is 7,232 MW; the share of thermal power stations in electricity generation is 83.4 per cent (6032 MW), while hydropower stations contribute 16.6 per cent (1200 MW) to the country's electricity generation.

According to Azerbaijan's State Statistical Committee (SSC), renewable energy sources, consisting primarily of wind and solar energy, provided approximately 2 per cent of the country's overall energy consumption (Figure 2, 3) (SSC, 2014). The generation of the

renewables experienced a particular increase in 2013, when both wind and solar power plants contributed to the national grid by 0.8 per cent.

Figure 3. Electricity generation by power plant type, 2007 – 2013



Source: State Statistical Committee (2014);

Table 2 presents the installed generation capacity of the power stations in Azerbaijan in capacity order. As noted in the table, the main power stations are TPPs. With this capacity, AzerEnerji JSC is able to meet the country's net electricity demand. Under these circumstances, the development of the A&RE sector is quite competitive. However, since electricity is primarily generated from natural gas and diesel, it is posited that selling natural gas to the world market has higher opportunity cost than selling electricity to the neighboring countries. Additionally, although AzerEnerji JSC has the state monopoly, the establishment of the SAARES as part of the ME, the implementation of RE projects and continuing feasibility studies on the country's RES potential shows that there is strong political will to develop this sector.

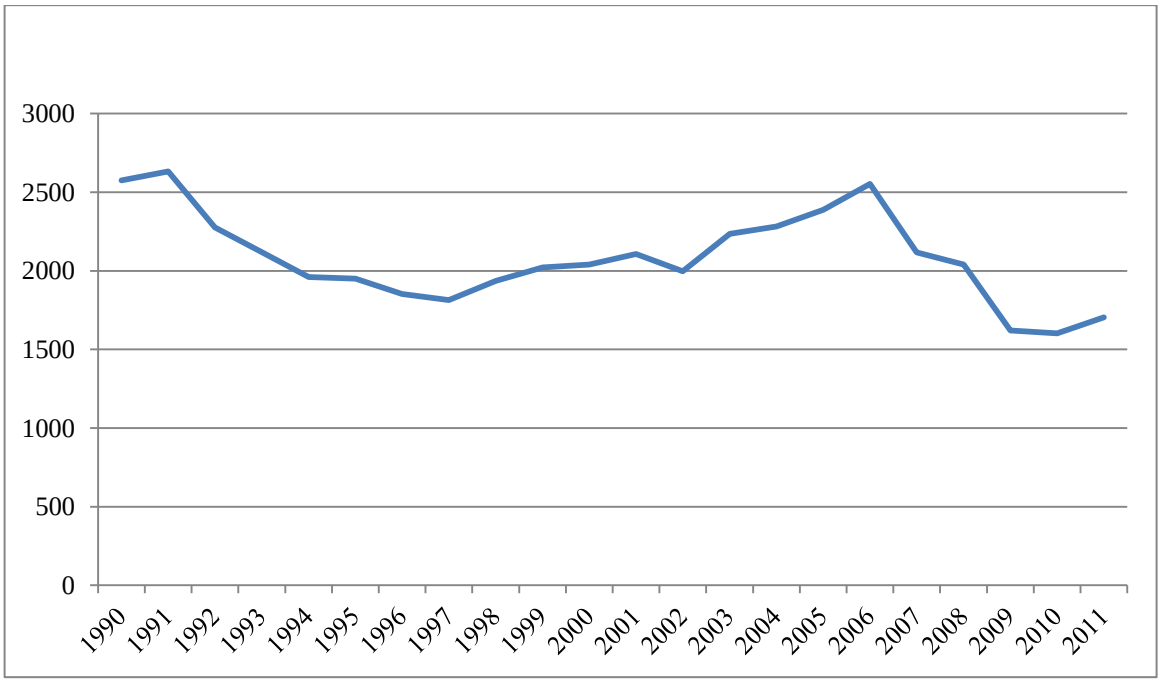
Table 2. Installed generation capacity (MW) of power stations in Azerbaijan

	Power Station	Type	Installed Capacity (MW)
1	Azerbaijan	Oil-fired, steam – TPP	2400
2	Ali-Bayramli	HPP	–
3	Shirvan	Gas-fired, turbine – TPP	900
4	Janub	PP	780
5	Sumgayit	Oil-fired, steam – TPP	525
6	Mingachevir	HPP	402
7	Shimal	Combined heat and power – TPP	400
8	Shamkir	HPP	380
9	Sangachal	Gas fired – PP	300
10	Yenikand	HPP	150
11	Fuzuli	HPP	150
12	Baki	Gas fired – TPC	107
13	Baki	Gas fired – PP	104
14	Shahdagh	Milti fuel – PP	104
15	Astara	Gas fired – PP	87
16	Shaki	Gas fired, combined cycle – PP	87
17	Xachmaz	Gas fired	87
18	Nakhichevan	HPP	87
19	Nakhichevan	Gas fired, combined cycle - GTES	64
20	Tartar	Gas fired, combined cycle – PP	–
21	Takhtakorpu	HPP	25
22	Bilav	HPP	22
23	Araz	HPP	22
24	Arpachay-1	HPP	20.5
25	Varvara	HPP	16
26	Vaykhir	HPP	5
27	Goychay-1	HPP	2.3
28	Ismayilli-1	HPP	1.6
29	Arpachay-2	HPP	1.4
30	Gusar-1	HPP	1
	Total		**7230.8**

Sources: AzerEnerji; Energy Information Agency;

Electricity consumption per capita increased during 1997–2006 in Azerbaijan (Figure 4). However, from 2007 to 2010, this trend was reversed. The rise of electricity tariffs from 0.023 AZN/kWh to 0.06 AZN/kWh in January 2007, the implementation of the metering system, and the gasification program in the regions are the main causes for the drop in demand. Electricity consumption per capita was 1703 kWh in 2011. According to AzerEnerji, demand for electricity is expected to increase by almost 140% by 2025. The peak demand is also expected to double by 2022–2023 (ECS, 2013).

Figure 4. Electricity consumption per capita (kWh), 1990-2011



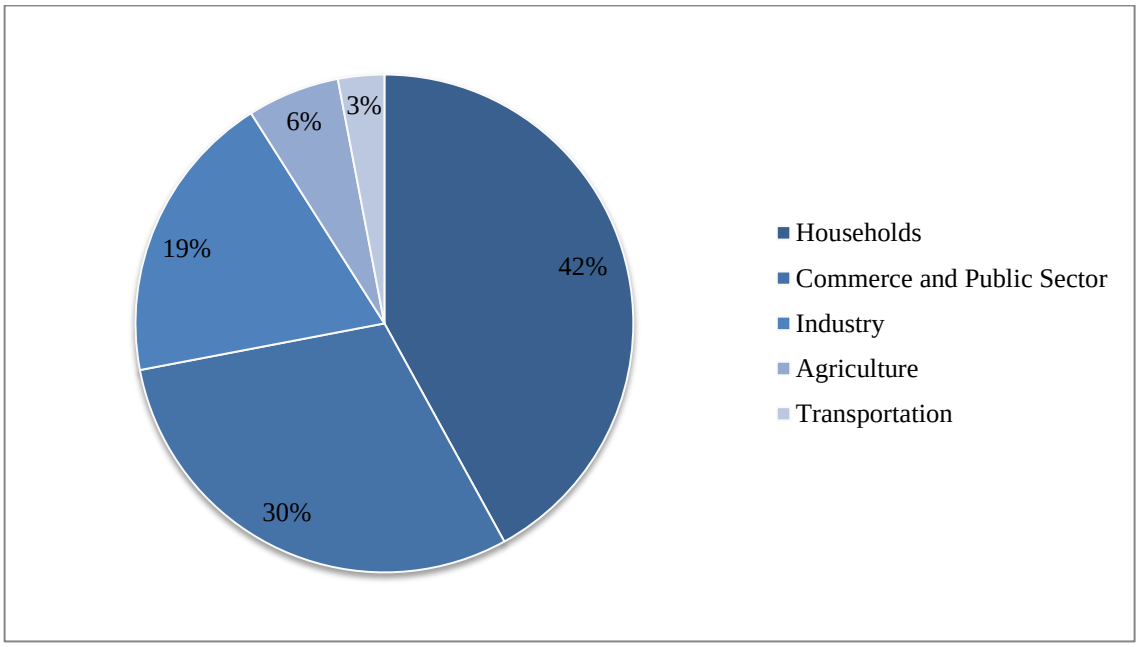
Source: State Statistical Committee (2014);

1.3 Energy Efficiency in Azerbaijan

Energy efficiency development in Azerbaijan is in the very early stages. There are several state programs targeting EE through the reduction of losses, prevention of theft and inefficient use of energy. Additionally, Azerbaijan has joined international negotiations on developing EE by ratifying the Energy Charter Treaty and the Protocol on Energy Efficiency and Related Environmental Aspects (PEEREA). Although the government is establishing state programs and has joined the agreements targeting EE, in terms of institutional arrangements EE is relatively undeveloped, and there is a need for targeted legislation on EE activities.

Since 2000, investments in generation and transmission and the conversion of some power plants from heavy oil to natural gas have improved conditions for the electricity system, providing an important step forward in terms of improving power plant efficiency and decreasing environmental impact. Furthermore, the State Program on the Use of Alternative and Renewable Sources (2004) and the State Program for the Development of the Fuel and Energy Sector (2005–2015) envisages the efficient utilization of hydrocarbon energy sources, targeting the reduction of losses, prevention of theft and combating the inefficient use of energy in order to cover electricity and natural gas demand. Additionally, according to Article 5 of PEEREA, Azerbaijan is committed to implementing policies to improve EE and reduce the environmental impacts of its energy cycle. EE in Azerbaijan still requires further developments in terms of strategy, action plans and legislation.

Figure 5: Final electricity consumption by sectors, 2013



Source: State Statistical Committee (2014);

Figure 5 shows the final electricity consumption by sectors in 2013 in Azerbaijan. According to the SSC, households and commerce and public sector are the main electricity consuming sectors in Azerbaijan (2013). Therefore, in addition to focusing on the rehabilitation and reconstruction of the transmission and distribution lines, energy efficiency requires energy management and audits of large buildings, governmental, residential and corporate.

Part II

Renewable Energy in Azerbaijan

2.1 Potential of Renewable Energy in Azerbaijan

Azerbaijan has extensive resources of solar, wind, geothermal, hydro and biomass energy. The development of RES is underway and stands among the government's strategic priorities. The existence of small mountain rivers in the various parts of the country makes the development of small HPPs one of the most promising aspects of the RE sector. High annual wind velocities create favorable conditions for the efficient utilization of wind power. Additionally, due to advantageous geographical conditions, solar energy holds vast potential. It is noteworthy that significant agricultural operations in the country provide material for biomass combustion or gasification. The country is also rich in geothermal power.

2.1.1 Hydropower Potential

Currently, the most widely used alternative energy source in the country is hydropower, which contributes by 6.4 per cent to the overall power system. According to AzerEnerji, the operating capacity of HPPs in Azerbaijan is 1200 MW. The share of large HPPs in operating capacity is 14 per cent and the small ones is two per cent.

There are 1100 rivers of varying lengths in Azerbaijan, able to generate 40 TW electricity annually. Currently, the technically feasible hydro energy potential is equal to 1.6 TW, 0.5 TW of which can be generated from small HPPs (ADB, 2009). Feasibility studies conducted since 2010 show that there is potential for the construction of more than 280 small HPPs in Azerbaijan (ADB, 2009).

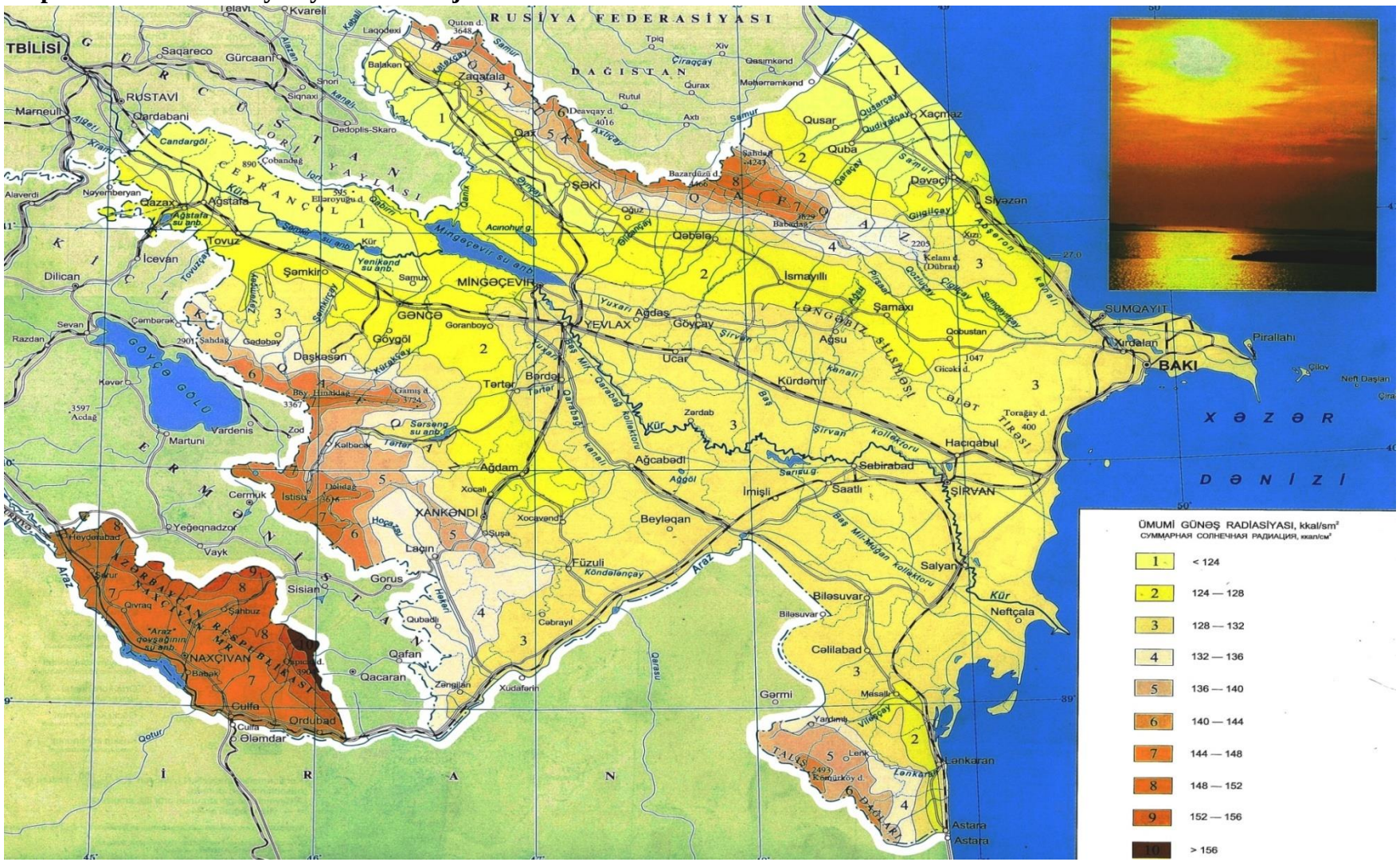
As well as providing environmentally friendly energy, small HPPs are also extremely useful in terms of floodwater regulations and the creation of new irrigation systems. Small HPPs can be constructed on irrigation channels, unregulated river flows and water reservoirs. Notably, the SAARES recognizes both small and large HPPs as RES.

2.1.2 Solar Energy Potential

The 2400-3200 hours of sunlight Azerbaijan receives annually offers significant opportunities in relation to the production of heat and electric energy from solar energy. The steppe and foothill areas of Azerbaijan are rich in sunshine. For instance, the annual number of sunshine hours in the Kura-Aras lowlands and Absheron penninsula is 2200-2400, and in Nakhichevan the number ranges from 2600 to 2800 hours. Additionally,

solar radiation in Kura-Aras lowlands is 128-132 kcal/cm^2 per year, and the highest solar radiation is in Nakhchivan AR (148-160 kcal/cm^2). Meanwhile, the lowest levels are in the plains and foothill areas of Azerbaijan such as Lankaran (40-60 kcal/cm^2). In high mountainous areas, the solar radiation is 15-25 kcal/cm^2. Kura-Aras lowlands, Absheron peninsula, Gobustan district and Nakhichevan AR experiences about 250-300 days of sunshine per year (AGA, 2013). The technically feasible potential of solar energy in Azerbaijan is up to 16 billion kWh (ADB 2009, Aliyev, F. 2013, East Invest, 2011).

Map 1. Number of sunny days in Azerbaijan



Source: SAARES;

2.1.3 Wind Power Potential

Wind power is the other environmentally sound renewable energy source that offers major development potential for Azerbaijan. Taking into account geographical, natural and economic conditions, the country currently has an annual capacity of 800 MW from wind energy. High average annual wind velocities create extremely favorable conditions for electricity generation. There are over 250 days of wind at speeds of 3-7 m/sec speed, which means an annual electricity capacity of 2.4 billion kWh (CIC, 2013). Feasibility studies show that the Absheron Peninsula, located by the shore of the Caspian and its islands, at the northwest of the Caspian basin, experiences winds of an average 6 m/sec. The Ganja-Dashkesen zone and the Sharur-Julfa area of the Nakhichevan AR have a medium capacity, with an annual average 3-5 m/sec wind speed. Two wind towers by installed by Tomen Corporation in cooperation with the Azerbaijan Scientific-Research Energy and Power Design Institute determined wind speed of 7.9 - 8.1 m/sec in Absheron (ADB, 2009).

Statistical data provided by Shimal DRES shows that the average wind speed in the Gobustan area is more than 6 m/sec, placing it in the category of 'high and reliable'. Overall, the country has 800 MW of technically feasible wind energy. Wind power is best suited to the Absheron peninsula, for two main reasons. First of all, this region has the highest demand for electricity in the country, and secondly, the Absheron peninsula is the most polluted area of the country. In this respect it is important to note that land contamination along the Caspian coastline, which extends for more than 600 km, makes the land available for the construction of wind power stations (ADB, 2009). The monthly average wind speed is 6.22-8.92 m/sec along the Caspian Sea coastline. There are strong winds in this area during January-April and September-December, and light breezes from May-September. The annual capacity of the wind power in the peninsula is considered to 2000 MW (Karimov, et al., 2013).

2.1.4 Bio-energy Potential

More than two million tons of solid and production waste end up in waste treatment sites in Azerbaijan every year, which opens up opportunities for biomass energy production. The rapid development of industry, agriculture and social services in Azerbaijan provides significant opportunity for electricity generation from biomass. The most widely available bio-substances in Azerbaijan are:

- Combustive industrial waste;
- Forest and woodworking waste;
- Agricultural – organic waste;

- Domestic and communal waste;
- Oil and petroleum products related waste.

Studies show that certain agricultural operations generate significant levels of biomass substance waste, which can be use to produce biogas, bio-liquid and solid bio-substance, and enable electricity generation. For instance, many European countries already use Waste-to-Energy (WtE) plants in energy generation. Sweden has become so advanced at waste management and treatment that it already buys garbage from UK, Norway and Italy (Lum, 2 September, 2014). Currently, as a result of support by Norwegian government with cooperation the ME of the Republic of Azerbaijan, Tamiz Shahar JSC and National Academy of Sciences, development of this industry is underway and needs more institutional support and development (MENR, 2010).

Waste combustion plants are mainly located near residential settlements, enabling them to use energy that is generated from the waste combustion. Currently, there are more than 200 landfills in Azerbaijan, covering 900 Ha in total (MENR, 2010). According to the Institute of Energy Research and Design of AzerEnerji JSC, the amount of municipal solid waste is estimated as follows:

Baku – 30 400 tons (42.8 million m^3)
Ganja – 5 100 tons (7.2 million m^3)
Sumgayit – 4 900 tons (6.9 million m^3)
Mingachevir – 1 600 tons (2.3 million m^3)
Nakhichevan – 1 200 tons (1.7 million m^3)
Shirvan – 1 200 tons (1.7 million m^3)

Small waste-to-energy plants in these landfills can provide nearby residents with electricity and jobs, as well as improve community management of the landfill sites.

2.1.5 Geothermal Energy Potential

Geothermal energy is another environmentally friendly renewable energy source in which Azerbaijan has potential. Unlike wind and solar, geothermal energy is a stable renewable energy source that can be used in energy and heat generation, agriculture and balneology. The country is rich with thermal waters, located in the Great and Small Caucasus, the Absheron peninsula, Talish Mountains, Kur-Araz lowlands, Nakhichevan AR and on the northwest coast of the Caspian Sea. The utilization of the existing thermal waters would partially cover the heating demands of the nearby population, as well as contributing to the agriculture and tourism sectors.

According to the SAARES, Azerbaijan's geothermal energy potential is up to 800 MW. Preliminary studies show that there are 11 geothermal zones in Azerbaijan. The temperature of water in these wells is about 30-100°C, and, depending on the type of the thermal waters, they can generate either electric or heat energy. For instance, in the Guba region, the temperature is around 36-85 °C, and in the Kura-Aras lowland it goes up to 95°C. Given that the excavation of geothermal wells is extremely expensive, the SAARES mainly supports the development of the wind, solar and hydro power sectors.

All in all, Azerbaijan's technically feasible renewable energy potential is 8 GW may not be sufficient to meet the country's electricity demand, due to the intermittent nature of solar and wind energy. However, TPPs and HPPs have the capacity to fill the gap during these sporadic intervals (SAARES, 2010).

2.2 Achievements: Previous and Ongoing Projects

The share of renewable energy sources in the energy production of Azerbaijan is increasing annually. The peak was 386.5 TOE in 2010, excluding hydropower. This comprised 0.6 per cent of overall energy production. The peak can be explained by the implementation of the pilot projects in 2010. Wind and solar power plants contributed up to 1.6 per cent of total national electricity generation in 2013 (SSC, 2014). However, as part of its national development strategy, Azerbaijan aims to provide up to 20 per cent of its electricity through RES. With this huge renewable energy potential, RES projects in the country have served as pilot projects that are aimed at ensuring long-term continuity. Along with the SAARES, other governmental institutions and business companies also contribute to the development of the RE sector.

Currently, the SAARES is preparing a dictionary of terminology, in order to ensure the correct usage of A&RE terms and notions in the Azerbaijani language. The dictionary will include definitions of solar, biomass, geothermal, hydropower and wind energy related terms, and is scheduled to ready by the end of 2015.

2.2.1 Hydropower Plants

The state program on the development of the small HPPs was established with the purpose of incentivizing the development of this sector. As a result, nine of them – "Guba", "Gusar", "Sheki", "Chichakli", "Mughan", "Zaykhur" Nugandy", "Balakan" and "Chinarli" have been privatized. The small HPP on Kish river in Sheki has been reconstructed and, as a result, the annual power of the plant has increased from 720 kWh

to 1,2 MW. In addition, the UNDP office in Azerbaijan has supported the reconstruction and rehabilitation of a small 580 kWh capacity HPP in Sheki (ME, 2009).

Below is a list of small HPPs (both public and private) in Azerbaijan:

Ordubad HPP	– 40 MW
Takhta-Korpu	– 36 MW
Fuzuli HPP	– 25 MW
Varvara HPP	– 16.5
Vaykhir HPP	– 4.5 MW
Goychay-1 HPP	– 3 MW
Mughan HPP	– 3 MW
Zurnabad HPP	– 2.76 MW
Guba-1 HPP	– 1.2 MW
Sheki	– 1.6 MW
Gusar HPP	– 1.2 MW
Nugadi HPP	– 0.83 MW
Leninkand HPP	– 0.8 MW
Balakan HPP	– 0.3 MW

2.2.2 Solar Power Plants

Given that Azerbaijan has a huge potential for solar and wind energy, the main projects are focused on determining the potential of these energy sources, and their development trajectories. There are several operating Solar Electric Stations (SES) in the country, and construction of additional ones is ongoing.

The construction of a SES in the Surakhani and Pirallahi districts of the Baku city has been finalized. Additionally, the construction of SESs in Garadagh district (3 MW) and in Sumgait city (2.8 MW) is continuing. Their connection to the grid is expected by mid-2015.

The Surakhani SES occupies an area of 6 Ha and will generate up to 1.2 MW electricity via 8000 solar panels. An additional 4000 solar panels are to be installed in this station. The capacity of the project is 2.8 MW, and the annual generation power is 4000 MW, which is equivalent to saving 1.5 mln m^3 natural gas annually. The SES is going to be connected to the grid by 2015. Additionally, wind and biogas stations are to be constructed onsite. In order to meet the electricity demand of the Chilov settlement of the Surakhani district, the SAARES has launched feasibility studies on the establishment of an additional hybrid station with 10 MW capacities. Currently, the SAARES has installed

an 80 m tall wind turbine for observation and measurement purposes. The initial capacity of Pirallahi SES is 1.2 MW. This SES is the first electric station to be built in the Pirallahi Island (ANA, April 19, 2014).

Azguntech LLC, established by the SAARES, also installs solar panels (PV modules) and heat pumps in schools, kindergartens and health care sector in accordance with the State Program on Use of Alternative and Renewable Energy Sources in the Republic of Azerbaijan and the State Program on Socio-economic Development of Baku and its Settlements in the year of 2011-2013. The aim of these projects is to raise awareness of environmental pollution and support environmental sustainability by supplying the inhabitants with green electricity and heating. The company has already achieved the following:

1. Solar panels and heat pumps installed in 10 schools in various districts of Baku. The overall power capacity of the solar stations is 420 kWh; 890 kWh for the heat pumps. The primary objective of these projects is to supply schools with environmentally friendly electricity and heating, and raise awareness on environmental sustainability among schoolchildren.
2. In Beylagan and Masalli, the company has installed solar panels and heat pumps in indoor playgrounds. The power generation capacity of each solar station is 50 kWh, and 76 kWh for the heat pumps.
3. In order to meet a proportion of the electricity demand of a boarding school in the Turkan settlement of Baku, Azguntech LLC has installed a solar station with capacity of 25 kWh.
4. The Azguntech LLC has installed a solar station with a capacity of 35 kWh and a heating system with a capacity of 60 kWh in a child healthcare center in Hovsan settlement, Baku (Azguntech LLC, 2014).

In Sheki and Siyazan, Azalternativenerji LLC is planning to construct gyms electrified and heated via solar panels and heat pumps (each with 100 kWh capacities).

With 2014 announced as the ‘Year of Industry in Azerbaijan’ by the President of the Republic of Azerbaijan, Azguntex LLC is also planning to finalize the construction of the second part of Solar Panels Production Factory in order to widen its production area, equipment and facilities. As a result of this expansion, the production capacity of the plant will be doubled, meaning that annually it will achieve power generation capacity of 50 MW, or 200,000 solar panels.

2.2.3 Wind Power Plants

The first wind turbines were constructed by the Caspian Technology Company (CTC) with the cooperation of the Energy Competence Center GmbH (ECC). These two 1.7 MW capacity wind turbines along the Baku-Guba highway, in Yeni Yashma, Khizi Region contribute 35 KW of green electricity to the national energy grid. This project produces 6.5 mln KW energy and saves 2.5 mln m^3 of natural gas annually (ADB, 2009; SAARES, 2010).

The CTC's Shurabad Project, an onshore wind park in Khizi region, located 50 km northwest of Baku, consists of 16 wind turbines, each with an energy capacity of 3 MW. The wind park plans to benefit from the high wind velocity in the area (8.5 m/sec and with a density of 1.22 kg/$m^{3)}$. The overall capacity is 48 MW and the installation will take place in three phases: in the first, 15 MW; in the second, 18 MW; and in the third, 15 MW. It is expected that 47 per cent of the electricity generated will be connected to the national grid, equal to 183 GW per year. Each wind turbine will be connected to the grid via a 110/35 kWh distribution line. The annual estimated reduction in CO_2 is approximately 101,482 tons (CDM, December 2011). The design of the turbines and the installed software allows each turbine to be controlled separately. Data collection, data storage and data transfer (SCADA) are centralized and digitalized, and the control building will be constructed onsite for the monitoring purposes (CDM, April 2011).

In addition, construction of wind power stations in the Lokbatan settlement will soon begin. Within the framework of The State Program on Socio-Economic Development of the Regions of the Republic of Azerbaijan in 2014-2018, Azalternativenerji LLC is managing various programs on the implementation of solar panels and collectors, wind turbines and heat pumps.

2.2.4 Hybrid Power Plants

Taking into account the intermittent character of RES, the SAARES is focusing in particular on the construction of hybrid power plants in order to ensure consistent electricity supplies. Thus "Azalternativenerji" LLC has established an experimental hybrid renewable energy system for the purposes of ensuring a regular electricity supply to inhabitants. The overall capacity of this experimental hybrid power station is 5.6 MW, and it is able to provide electricity for the whole Gobustan district. The wind stations in this hybrid system generate 2.7 MW. For comparison, solar panels produce 1.8 MW, and biogas stations produce 1.1 MW. During 2014 the hybrid energy plant contributed 2 MW to the country's overall electricity generation (REC, 2014).

SOCAR also implements green projects within its corporate social responsibility framework. SOCAR's Ecological Park project is located in an area of 9.3 Ha, and includes four wind turbines, each with a 10 kWh capacity, and solar panels, each of which has a capacity of 20 kWh. The main idea of the EcoPark is to ensure environmentally sustainable energy in each stage of ecological restoration, rehabilitation and planting. This project promotes the principle of "zero impact" on the environment along with environmentally friendly technologies.

The Agro-Energy complex in the Samukh region, with the initial capacity of 2.8 MW, is expected to meet the energy demand of 300 houses and provide 2000 people with work. It is planned that solar capacity will be increased up to 15 MW, wind capacity up to 7 MW, geothermal capacity by 3 MW and biomass capacity by 5 MW.

2.2.5 Bio-energy

In accordance with the Comprehensive Action Plan on Improving the Ecological Situation in the Republic of Azerbaijan, 2006-2010, the French Company CNIM has led the construction of the first municipal solid waste incineration plant in Azerbaijan. The plant is located over 20 Ha and generates 231.5 mln kWh per year. The plant meets the EU's environmental protection requirements. As part of its process, the smoke of the plant is captured by special filters and neutralized. Then, the harmless ashes of the burned waste are used in road construction, while the water used in this process is treated and released to the wastewater system. The Balakhani Solid Waste Incineration Plant consists of two electricity generation turbines, each of which has a 250 mln kWh capacity, meaning that the overall installed capacity of the plant is 500 mln kWh power (Tamiz Shahar JSC, 2012).

In addition, Azalternativenerji LLC is conducting feasibility studies on the production of biomass from industrial, agricultural and municipal waste, and is researching the potential of alternative and renewable energy sources in the Mountainous (Daghlig) Shirvan, Guba-Khachmaz, Lankaran, Ganja-Gazakh, and Sheki-Zagatala economic regions. Notably, the Siyazan Poultry Farm has the capacity both for heating and generating electricity out of biomass waste. The available 520 Ha area of farmland also makes it possible to construct solar panels and wind turbines. The generated energy will be either connected to the grid or transmitted directly to the generator of the electricity.

2.2.6 Geothermal Heating and Cooling System

Among the pioneers of the implementers of RE projects, ADA University (ADAU) also warrants mention. ADAU uses Geothermal Heat Pumps (GHP), also known as

Geothermal Heating and Cooling System (GHCS) or GeoExchange, to provide about two-thirds of its energy demand. Its annual power output of 1390 kW/h is produced from a geothermal field under the lake in the Dada Gorgud Park. This system provides an annual saving of 702,000 liters of fuel, meaning that ADAU saves 1,500 tons of CO_2 per year. In another metric, the geothermal heating-cooling system saves 130 Ha of forest area annually. GHPs also provide ADA with hot and cold water. Additionally, the system uses fan coil units, which are more energy-efficient than air conditioning motors (Huseynova 2014).

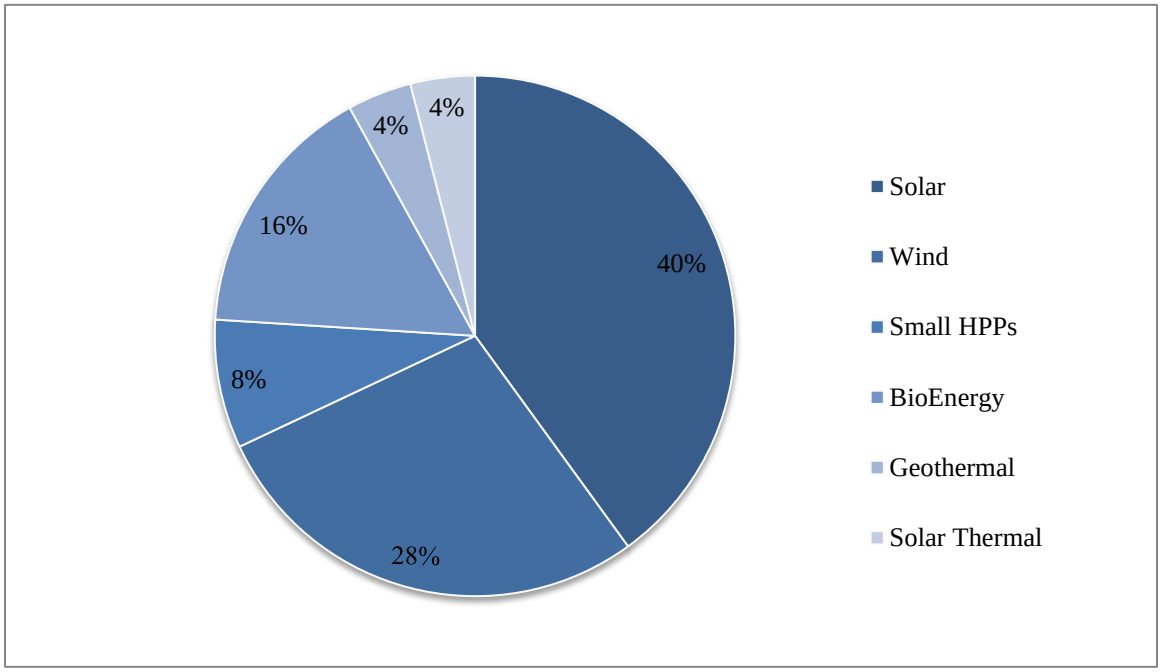
2.3 Prospects & Opportunities

The SAARES plans to obtain 20 per cent of Azerbaijan's electricity from renewable energy sources by 2020. The anticipated share of various renewable energy sources is as follows (Figure 6): 40 per cent solar, 28 per cent wind, 8 per cent small HPPs, 16 per cent solid waste and biomass, 4 per cent geothermal and 4 per cent solar thermal (AzerNews, 2014).

The SAARES envisages the establishment of hybrid electric stations in every city of Azerbaijan by 2020. Currently, feasibility studies are taking place in the cities. These stations will be located close to the residential areas in order to ensure energy efficiency by decreasing energy losses during the transmission, and thereby provide cheaper electricity. Overall, the established renewable energy capacity is projected at about 2500 MW, and it is estimated that it will provide 11 billion kWh electricity per year, resulting in savings of 2.5 mln m^3 natural gas annually (AzerNews, 2013).

According to APA-Economics, by 2020 SAARES plans to increase the capacity of the HPPs to 60 MW and Small Wind Electricity Plants (SWEP) to 512.5 MW. The implementation of the project will be in three phases. During 2014-2016 the capacity of the SWEPs will be increased by 150 MW; in the second phase (2017-2018) 150 MW; and in the final stage (2019-2020), by 2125 MW. Additionally, the construction of another biomass station with a capacity of 515 MW is expected by 2020. This is also a three-stage process: during the first stage (2014-2016) the construction of the plants will generate 100 MW; in the second stage (2017-2018) 200 MW; in the final phase (2019-2020) 215 MW (News.Az, March, 2014).

Figure 6: "20 per cent renewables by 2020", achievement goals set by SAARES



Source: AzerNews, 2014;

Considering the promising capacity of small HPPs, the construction of small HPPs is also listed among the priorities of the SAARES, Azerenerji JSC and private companies like the AG. Further, the Gobustan-2020 pilot project is aimed at the implementation of the smart grid concept in Azerbaijan. The system will ensure energy efficiency, reliability and sustainability (AzerTag, July 2014).

Conclusion

Azerbaijan has fairly high RE potential and plans to increase its green energy production up to 20 per cent by 2020. The focus is on solar (40 %) and wind energy (28 %) due to the relatively high and untapped capacity of these sources. Therefore the SAARES is focusing on the construction of SPPs, WPPs and hybrid power plants combining several types of renewable-based electricity generating facilities, mainly solar PVs and wind turbines. Although Azerbaijan's hydro capacity has been already utilized to a far greater extent the solar and wind potential, this sector also continues to expand.

However, considering that the RE notion is fairly young in Azerbaijan, there are general institutional challenges that hamper the development of A&RE sector and the implementation of EE projects. Economic and policy barriers remain the primary challenges for the RE sector. Taking into account the high cost of constructing new RE plants, specific short and long term policy actions in electricity market are necessary. Additionally, regulations should be further simplified in order to ensure investments from private companies, since businesses usually do not invest in newly launched sectors. The other challenge is the lack of community support. Currently, there is little public discourse around the benefits of RE and EE, and few people are aware of these concepts. Therefore, awareness programs are essential in order to fully embrace this challenge. All in all, renewables promise long-term economic and environmental benefits, and this is bolstered by the political to advance the RE sector in Azerbaijan.

Recommendations

Domestic Energy Usage

- Keep the usage of renewables and energy efficiency projects as a priority in both short and long-term goals on the basis of economic efficiency and sustainability.

- Review the current electricity tariffs and recalibrate them with the aim of stimulating RE and EE projects.

- Continue the restoration, reconstruction and rehabilitation work on the grid system, namely generation, transmission and distribution lines in order to achieve energy efficiency.

Legislative Arrangements

- Enact legislation pertaining to energy efficiency and renewable energy with clear-cut norms and instructions.

- Introduce incentives such as feed-in tariffs, preferential loans, subsidies to the RE sector to attract private sector investment.

- Focus on PPPs in order to ensure private sector involvement in RE and EE projects.

- In order to monitor the energy-saving potential, introduce compulsory energy audits and energy management systems, starting with the largest buildings and companies.

- Adopt international energy efficiency standards for newly constructed buildings, energy efficiency labeling and minimum energy performance (MEP) standards for electrical equipment, and ensure that compliance and enforcement procedures are in place.

- Allocate sufficient financial resources for the development of the energy efficiency in public and state owned companies, and for public awareness campaigns.

International and Institutional Arrangements

- Continue the exchange of information and best practices with other countries on successful EE and RE projects.

- Ensure that each electricity-generating entity provides its progress report to the SSC.

- Use existing statistics to support the policymaking process and estimate the energy saving potential in the country.

- Analyze the responsibility matrix of each institution dealing with energy-related issues and ensure that their obligations do not overlap too much.

- Continue participating in climate change negotiations.

- Raise awareness of energy efficiency and the benefits of switching to the renewables in order to integrate the energy efficiency and renewable energy concepts into public consciousness.

- Other stakeholders such as NGOs, think tanks, and businesses should promote renewable energy sources and energy efficiency.

- Various economic actors such as banks and other companies should embrace RE and EE projects aimed at achieving energy efficiency and contributing green energy to the grid.

- Focus on the development of the existing solar and wind potential, but also continue to assess other possibilities such as biomass and geothermal.

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