

Transition to Renewable Energy and Sustainable Energy Development in Azerbaijan

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Preponderance of industrial states is completely dependent on energy to fuel their economies. Besides, globalization has made the world to be so interconnected and interdependent that the energy industry is the biggest contributor of the climate change which doesn't affect a single country but have far wider implications. The growing awareness of the security of energy supply and climate change challenges associated with fossil fuels has triggered countries around the globe to find alternative energy resources. As a post-soviet country, the economy of the Azerbaijan Republic significantly based on oil production which is the biggest threat to sustainable energy development. Above all, Azerbaijan's dependency on the fossil fuel is the biggest obstacle for the long term economic growth due to decrease in oil prices and the depletion of oil resources. The combination of these newly emerged challenges give impetus for Azerbaijan to diversify its economy via a green economy that will pave a way for the long term economic stability while addressing environmental and social concerns in the country. In this regard, the principal purpose of this research is to explore the sustainable energy development in Azerbaijan through the transition to renewable energy and propose appropriate measures for policy framework.

1. (Un)Sustainable Future!

All countries around the globe should consider sustaining its welfare and resources to future generations through respecting sustainable development goals that comprise social progress, poverty reduction, equity, enhanced resilience, economic growth, and environmental sustainability. On the basis of the evidence currently available, it seems fair to suggest that all countries of the world community are interdependent that is to say they are committed to the "tragedy of the commons" unwillingly. To make it much more clear, tragedy of the commons means a situation within a shared-resource system where individual states acting independently and rationally according to their own self-interest behave contrary to the common environment and planet of all states by depleting that resource.

Energy politics affects all the aspects of daily life through the vast use of energy from household to industries, hence, the issue of energy security remains a very crucial yet compelling one. Before there was a challenge of Energy Security in front of the states to tackle, starting from 1990s the intrusion of climate change into energy issues stir up states to adopt costly policies on climate change and energy security that would reduce growing emissions that is the result of the dependence from the non-renewable energy sources such as oil, gas and coal which promise the unsustainable future.

World energy consumption is based on 80% upon fossil fuels which are the polluting sources that accelerate global warming. Besides, climate change revealed that current energy and environment equilibrium is unsustainable. Energy policies should now integrate climate change policies in order to save the environment that the people live in. This challenge is very crucial one in front of the not only a single country, but also all countries in the world. Thus, unsustainable patterns of energy production and consumption in any country threaten not only human health and quality of life but also affect ecosystems and contribute to climate change. There arises a question that who is going

to save or sustain our planet for the future generations? Who is going to pay for the proper maintenance of the planet? Can sustainable energy developments be an engine for (un)sustainable future?

The world has seen a sharp increase in renewable energy (RE) capacity over the past decades. This is thanks to a rise in RE promotion schemes; actions to make energy more secure in response to climate change; and a sharp fall in RE technology costs. This is an encouraging trend, as renewable energy solutions can yield important social, economic and environmental benefits, such as removing pressure on important ecosystems and allowing countries' electrical grids to be stable and reliable engines of economic growth.

Renewable energy and Energy efficiency are central to a transition to a sustainable future. Efficiency slows down energy demand growth so that rising clean energy supplies can make deep cuts in fossil fuel use. Moreover, Renewable energy presents major economic opportunities such in elimination of energy poverty. If non-renewable energy prevails renewable energy, the future becomes unsustainable that will affect all states around the world. Most of the studies concerning climate change and its consequences show that developing countries may be the first victims of climate change.

There arises contradiction that how is it possible to produce more energy in order to avert the energy poverty and simultaneously to reduce emissions significantly in order to be committed to the sustainable energy development? The resolution of the contradiction can be achieved via the actions, adaptations and higher prices. Because climate belongs to the citizens of the world that is to say climate change is a global public good that requires global governance by the International Community.

Some countries, particularly EU and U.S engaged in mitigation process specifically the process of emissions reductions and commitment to sustainable energy development. Many others, particularly the developing world countries escape the problem and give priority to economic growth. Powerful world organizations or lobbies are highly efficient at hiding problems which doesn't vest any interest to them in case of enlightening. Even, there is strong contradiction among the pursued policies by these leaders in the world. EU's 20/20/20 package on climate change and energy policy and the costly policies adopted by the US are not the best alternative to avert the growing emissions due the reason that these states are not the only polluters of the environment.

Climate Change is the global public good that needs not only developed world but the developing world all together to cooperate in adoption and mitigation of climate change policies, because the growing emissions are the outcome of activities of all states in the world. Heavy impact on nature is made considerably by industries, and it is no by chance that the concept of sustainable development forced countries, particularly developing states to convert their fossil fuel based industries to green industries.

Transition to a renewable energy under conditions of a dominant oil industry is a challenging proposition to the Azerbaijan Republic that based on its economy on fossil fuels. Considering the fact that this transition is costly and promises higher growth in the long term, it pose a challenge to Azerbaijan whether to sustain its fossil-fuel based economy in order to keep economic growth or to pass to sustainable energy development that requires long-term implementation rather than economic growth? It is a big challenge to face with because Baku's lifeblood stems from its hydrocarbon reserves, with over 90 percent of its exports coming in the form of petroleum. A key to success is to transit to renewable energy that promises sustainable energy development in Azerbaijan.

2. The upcoming challenge of Climate Change.

“An increasing body of observations gives a collective picture of a warming world and other changes in the climate system.”

IPCC (2001:1)

Climate change is one of the defining issues of the early 21st century. It represents a significant risk to global ecosystems, the world economy and human populations. The scientific evidence is compelling that human activities are changing the world's climate. Without a clean, secure and sufficient supply of energy we would not be able to function as an economy or as a modern society. Climate change will have far reaching consequences not only for a

specific country but for all of the countries of the world. The growing scientific consensus points to the need for urgent action to reduce carbon dioxide emissions. The Stern Review of the Economics of Climate Change is one of the many influential studies that highlight the economic costs of failing to tackle climate change (Stern, 2006).

Global warming and long-term climate change are real. There have regularly been instabilities in the world's atmosphere, basically determined by changes in the sun's emissions and by volcanic activity on earth. The present changes are more prominent than those anticipated by computer reproduction models in light of the sun and volcanism, and are accepted to be brought about by the expansion in nursery gasses, strikingly CO₂, that have been released in great quantities since the Industrial Revolution. These progressions are man-made and if amounts of CO₂ emitted by human activity continue to increase, it will destroy our planet that we live in. Therefore, switching from fossil-based fuels to emission-free energy sources leads to a reduction in greenhouse gas emissions.

There is growing support for the claim that the uncertainties about climate change are vast, indeed so vast that the standard tools of decision-making under uncertainty and learning may not be applicable. As all these issues come together in the emission of greenhouse gases, climate change truly is one of the greatest intellectual challenges of our times. Ultimately, climate change will be a serious economic problem, causing loss of coastal areas as a result of rising sea levels, floods and droughts, and famine. The cost of dealing with long-term climate change is high, but almost certainly far less than the economic cost of failing to act (Richard S.J. Tola, 2008).

One of the essential inputs for the economic and social development of any country is its total energy consumption per capita. However these days, the energy production systems don't seem to be sustainable and that they don't seem to be atmosphere friendly. Growing fossil energy consumptions in production, transportation and standard of living within the rising population have the utmost impact on the atmosphere in terms of worldwide warming potential and air pollution that paved the way for the extremely important challenge of the climate change. Moreover, the depletion of the fossil fuel sources was one of the biggest providers to the increasing fossil fuel prices.

A closer look at the data indicates that the temperature increase in Azerbaijan throughout 1991-2000 (0.41 °C) augmented compared to the 1961-1990 years (0.34 °C). Besides, the typical annual temperature increase is predicted to be 1.50-1.60 °C during 2021-2050, and precipitation is predicted to extend by 10-20% compared with the 1961-1990 years. Global 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% of the baseline level by 2050. Further evidence support that global climate change has harmful effects on human health, increasing the long-run risk of an entire varies of diseases and infections (MENR, 2010). This information might give further motivation for Azerbaijan to rejoin global climate change negotiations.

With the emergence of the large Caspian oil and gas fields, Azerbaijan became the major hydrocarbon exporter starting from the 2000s. The country doesn't concern about energy security due to its high hydrocarbon production levels and available reserves. Azerbaijan enhances the development of renewable energy sources (RES) aiming at increasing its energy exports, satisfying the energy demand and diminishing its carbon footprint. Energy and industrial sectors are the critical generators of CO₂ emissions in Azerbaijan whereas the agriculture and forestry sectors generate the principal carbon sinks and land use change. Burning fuel in the production of energy, oil and gas extraction, transportation emits CO₂ emissions in the energy field which indirectly puncture the ozone layer in the atmosphere. The ozone layer is very important for sustenance of life on earth. Additionally, the industry sector consistent with the growth of the metallurgy sector led to vast increase in GHG emissions (MENR, 2010). According to the SSC, the complete GHG emissions were 75.5 million tons, and per capita emissions were 3.7 tons in 2013 (SSC, 2014). As the oil sector has a significant role in boosting Azerbaijan's economic development over the last decade and its contribution to the country's GDP has remained between 30-55%, promoting energy efficiency, energy saving and the use of renewable energy in energy generation are the best options to reduce GHG emissions.

With the purpose of reducing the country's GHG emissions and increase energy efficiency, Azeri government drafted the State Program on the Use of Alternative and Renewable Energy Sources (SAARES) in 2004 and it is established in 2009. As a positive incentive, 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 alternative and renewable energy sector has been waived for 10 years (Hajar Huseynova, 2014).

The data yielded by this study provides convincing evidence that crude oil prices have fallen dramatically over the past eighteen months, after four years of relative stability at around 110 USD per barrel. The persistent decline in oil prices, and therefore the certainty that they are going to be exhausted within the short term, has triggered discussions about the potential impact on Azerbaijan's renewable energy industry. Much of the current debate revolves around how long this decline of the oil prices will continue and whether larger profit lies in purchasing inexpensive oil or investing in renewable energy sector. The results provide confirmatory evidence that there is not a proven link between the decline of oil prices and the competitiveness of renewable energy. On these grounds, we can argue that decrease in the former will undesirably affect investment in the latter. Why it is so urgent challenge for Azerbaijan to tackle with? May be this challenge wasn't so important to consider a year ago but a tremendous decrease in oil prices and cut off the depletion of the oil resources until 2020 urges Azerbaijan to transit to renewable energy and base its economy on reliable renewable resources.

Recent trends for regional market integration vary. Where integration is difficult, renewable energy and energy efficiency measures are the most effective tools towards energy security. There is a significant lack of renewable energy development and demand management, despite approved legislation and available incentives in some cases. Rapid implementation of renewables and energy efficiency policies is essential to energy security and long term economic growth of Azerbaijan but it is also a key means for the country to reduce its significant carbon footprint which pollutes environment (common public good).

3. Sustainable Energy Development Indicators

The scope of the sustainable development takes into consideration not only the industrial development aspects but also concerns the environmental, social and economic sides. All countries around the globe should consider sustaining its welfare and resources to future generations through respecting sustainable development goals that comprise social progress, poverty reduction, equity, enhanced resilience, economic growth, and environmental sustainability. Davidson (Oyedepo SO, 2012) stated the definition of sustainable energy as follows;

“Sustainable energy is defined as energy providing affordable, accessible and reliable energy services that meet the economic, social and environmental needs within the overall developmental context of the society for which the services are intended, while recognizing equitable distribution in meeting those needs.”

Definition of the sustainable energy should be given as the production, conservation and use of energy sources in ways that promote or at least are suitable with long-term human well-being and ecological balance. As seen in Fig. 1, the sustainable development is a triangle consists of energy, environment and economy which are not superior to each other. Although renewable energy is very crucial indicator for sustainability, it does not provide the desired sustainable development without protecting the environment and taking the economic indicators into concern (Murat Ozturk, 2015).

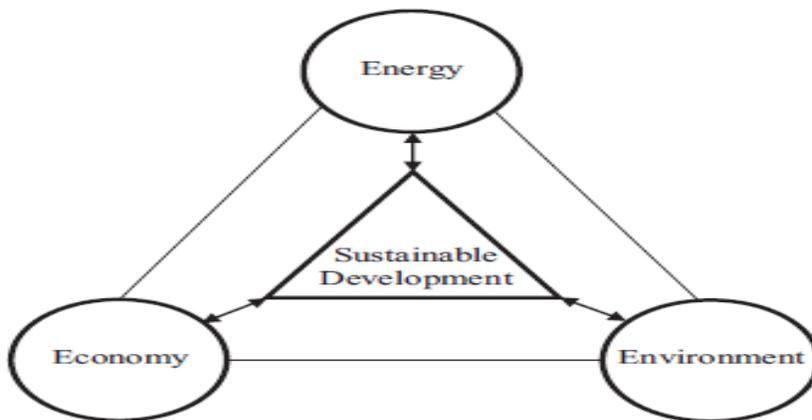


Fig. 1. The interdisciplinary triangle of sustainable development.

Five important targets for the sustainable energy view point should be given as;

- ✓ Low or zero emissions of carbon dioxide;
- ✓ No necessary ecological harmful impacts;
- ✓ Enhancing the security of the energy transit;
- ✓ Reducing the cost of the energy production;
- ✓ Improving the utilization of the green technologies.

It is an undeniable fact that high levels of carbon dioxide emissions cause the global warming effect. Due to this reason, low carbon emission technologies are very noteworthy for sustainable energy development. In addition, sustainable energy view point requires the operation of energy flow and removal of wastes without surpassing the carrying capacity of the nature. The security of the energy transit has a social impact as energy sources are utilized in daily life and access to energy sources is vital for well-being of the community. The cost of energy production is the other central issue for industrial and household uses. In the developed world, accessibility to the energy sources is human right, and also technological development should diminish the cost. An essential target for the sustainable energy development view point is transition to renewable energy sources and the growing renewable energy technology use in the world (Murat Ozturk, 2015).

There is a twin relationship between sustainable development (SD) and climate change (CC). In other words, they are the two sides of the same coin. On one hand, climate change influences core natural and human living conditions and thereby conjointly the premise for social and economic development; while on the other hand, society's priorities on sustainable development impact the GHG emissions that are promising (un)sustainable future. Recognizing the dual relationship between SD and CC points to a need for the exploration of policies that jointly address sustainable development and climate change. Sustainable development goals for transition economies are tightly connected with CC mitigation, as a result these countries have high-energy intensities of economies, low energy efficiency in energy production and consumption sectors, thus the sustainable development goals for these countries embody GHG mitigation challenges as well (Rammel and Van der Bergh, 2003).

4. Synergies between Renewable Energy and Sustainable Development

Due to some environmental concerns such as global warming, air quality, and environmental destruction, society and governments have started to become aware of sustainability term. Therefore to improve current energy strategies to sustainable development level, sustainable energy resources should be used. For this reason, studies have been conducted in order to find sustainable energy sources and to use current energy sources efficiently. Current research appears to validate the view that the use of fossil fuel sources should be limited and energy policies should be updated to renewable energy sources.

Sustainable development enhances standard of living economically and environmentally in the long term growth that has got to be supported by the economic structure of the country. To sustain energy convenience and keep atmosphere inhabitable for future generations, finding alternative sources of energy is crucial. In addition, growing awareness of society concerning environmental problems and the depletion of the fossil energy sources support renewable energy sources. These alternative sources of energy are the necessary and determinant policy areas for the countries, and will embody current and future energy policies.

The economic growth and prosperity of any country or region in the world is related to the level of its consumption of energy. With the Industrial Revolution, there has been a quantum leap towards the tremendous consumption energy which is supplied through fossil fuels such as gas, petroleum and coal. During 1920s, coal accounted for the maximum part of total energy supply of the world. Later in early 1990s, its share dropped to only 26%, while 40% of the world's energy needs was taken by oil. Now the depletion rate of fossil fuels has reached to 100,000 times faster than its formation rate.

When the resource under consideration is non-renewable energy source, the problem of depletion is an obvious addition to its consumption. At present, non-renewable fossil fuels (natural gas, coal and petroleum) contribute to

90% of world commercial energy production. The remaining 10% generated from non-conventional form of energy (nuclear, hydropower, geothermal, wind, solar, etc.). Even if the present reserves of fossil fuels may be sufficient enough to meet the global energy demand for years in future, any consumption of such resources represents an absolute loss in its finite supply. (Gunjan.N, 2010)

In modern world the demand for energy has increased dramatically in the past century and it will grow even further in the near future than ever before. Renewable energy is that energy which comes from the natural energy flows on earth. Unlike conventional forms of energy, renewable energy will not get exhausted. Renewable energy is also termed as “green energy”, “clean energy”, “sustainable energy” and “alternative energy”.

Merits:

- ✓ Renewable energy sources are available in nature free of cost;
- ✓ They produce no or very little pollution;
- ✓ They are inexhaustible;
- ✓ They have low gestation period.

Demerits:

- ✓ In general , the energy is available in dilute form from these sources;
- ✓ Though available freely in nature, the cost of harnessing energy from non-conventional source is generally high;
- ✓ Availability is uncertain; the energy flow depends on various natural phenomena beyond human control;
- ✓ Difficulty in transporting such forms of energy.

Renewable energy and energy efficiency create one of the primary indicators for sustainable economic and social development. In line with the rising population, urbanization, industrialization, spreading of technology and rising of wealth, energy consumption rate of the country as the other developing countries are increasing. Energy consumption and consequently energy supply at minimum amount and cost are the primary targets, within the approach of a sustainable development that supports economic and social development and that have destructive impact on the environment at the minimum level.

Improvement of domestic production by increasing efficiency of plants by rehabilitation, diversification of energy sources to secure energy supply, accelerating the existing construction programs, initiation of latest investments are the basic strategy for the achievement of the sustainable energy development. Utilization of renewable energy sources in the country is very important in terms of the sustainable development and foreign capital flow by means of foreign investors. After using of the renewable energy potential, the country will become less dependent on imported fossil energy sources (especially oil and natural gas), reduce greenhouse gas emissions and may even export green electricity to other countries in need.

A closer look at the data indicates that Azerbaijan’s Energy efficiency development is in its early stages. With the purpose of achieving reduction of losses, prevention of theft and inefficient use of energy, several state programs accepted. Besides, Azerbaijan has joined international negotiations on developing energy efficiency by ratifying the Energy Charter Treaty and the Protocol on Energy Efficiency and Related Environmental Aspects (PEEREA). Despite the fact that Azeri government established state programs and joined the international agreements, in terms of institutional engagements, Energy Efficiency is somewhat undeveloped, and there is a need for targeted legislation on Energy Efficiency activities.

Further evidence support that the investments in generation and transmission and the conversion of some power plants from heavy oil to natural gas have enriched conditions for the electricity system since 2000, providing a significant step forward in terms of cultivating power plant efficiency and reducing environmental impact. Additionally, 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) predicts 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. Despite Azerbaijan’s commitment to realizing policies for the purpose of advancement in Energy Efficiency and lessen the environmental impacts of its energy cycle, Azerbaijan still necessitates additional developments in terms of strategy, action plans and legislation. Households, commerce and

public sector are the foremost electricity consuming sectors in Azerbaijan. Therefore, in addition to concentrating 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 (SSC 2014).

5. Renewable Energy Policy of Azerbaijan

Energy policy of Azerbaijan is realizing within the context of sustainable development discussions. To make the issues much clear, 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 on the international standard. However, the above-mentioned agreements have no legally binding provisions to reduce GHG emissions; they merely offer incentives for reduction through International Emission Trading (IET), Joint Implementation (JI) and Clean Development Mechanism (CDM). On the national standard, Ministry of Ecology and Natural Resources (MENR) of Azerbaijan has been implementing the CDM of the Kyoto Protocol. The initial commitment period of Kyoto Protocol ended in 2012, Azerbaijan needed to sign and ratify the second commitment period, Doha Amendments to the Kyoto Protocol in order to take advantage of the above-mentioned mechanisms. With the purpose of reducing the GHG emissions Azerbaijan adopted the “National Action Plan on Environmentally Sustainable Socio-Economic Development” in 2003 which become the crucial incentive in the usage of alternative and renewable energy sources in energy generation.

Azerbaijan’s energy policy relies on securing energy independence in the long term. Since the country is a net energy exporter, it has already achieved energy independence. However, so as to diversify the economy, increase energy efficiency and support GHG mitigation processes, the country has formally supported the growth of the RES for 2004-2013 through the SAARES with the following objectives:

- ✓ Recognizing the potential of alternative and renewable energy sources in electricity generation;
- ✓ Exploring A&RE sources for the sake of energy efficiency;
- ✓ Providing innovative vacancies through developing new energy generation areas;
- ✓ Diversify and improve the energy capacity of the country for the sake of energy security.

This document is about the discussion of the potential RES; however it doesn’t outline specific targets for renewable energy use. It outlines a complete of 20 measures in order to increase the utilization of RES. Some of them are followings:

- ✓ To draft legislation with the aim of having progress in RES;
- ✓ To conduct various research and development activities;
- ✓ To facilitate the training of the experts and raising awareness among energy consumers;
- ✓ To realize projects in the hydropower sector (including small hydro);
- ✓ To use RES such as solar, wind, biomass and geothermal energy.

There were not enough funds available to implement the ambitious targets in the first period of the programme. Although Azerbaijan has made some advancement in the field of small hydro, solar and wind, it is not enough evidence to validate the broad use of different RES at an optimum.

The State Programme for the Development of the Fuel and Energy Sector in the Republic of Azerbaijan for 2005–2015 outlines the priorities for the development of the country’s energy industry. Although, it doesn’t cover the crucial provisions regarding the utilization of RES, it does mention that the increase of the overall energy supply are going to be achieved mainly through the expansion of the use of RES and the share of RES in total power generation is anticipated to reach 15 % by 2015.

The State Programme for the Socio-Economic Development of Regions of the Republic of Azerbaijani for 2009–2013 was intended to deal with specific development requirements at the regional level. The document contains the provisions for the building of small HPPs as a local energy source in every economic region of the Azerbaijan. Although, it comprises the provisions for the construction of wind and solar power plants in landlocked exclave Nakhchivan, no crucial progress concerning solar and wind energy has been achieved so far.

The president of Azerbaijan ratified the document “Azerbaijan 2020: A Look into the Future” a development concept

projected to provide a vision for the new stage of the country’s development at the end of 2012. The document targets construction of a diverse, efficient and innovative economy through the extensive use of RES as a tool for the development of the national economic system. The following measures covered in the document:

- ✓ To provide incentives for the acceleration of the development of alternative and renewable energy sources;
- ✓ To create a satisfactory institutional environment;
- ✓ To reinforce research and development potential in renewable energy sector;
- ✓ To train experts and raising public awareness about the use of RES;
- ✓ To have flexible tariffs for renewable-based energy products in order to encourage the involvement of private sector.

President of Azerbaijan Ilham Aliyev requested the improvement of a national strategy on the use of alternative and renewable energy sources in the Republic of Azerbaijan for 2012–2020 on December 29, 2011. SAARES in cooperation with appropriate central and local authorities along with national and international enterprises was responsible to develop the document. The document aimed to deal with the following activities:

- ✓ To categorize the significant areas for the production of electricity and heat from RES in 2012-2020;
- ✓ To form a legal framework for the sector of alternative and renewable energy;
- ✓ To arrange incentives for the usage of RES;
- ✓ To stimulate the utilization of renewable energies in all economic spheres based on domestic and international scientific plus technology potential.

In order to enhance the national strategy in renewable energies, Azerbaijan adopted following targets by 2020 in 2013:

- ✓ 20% share of RES in total energy sector;
- ✓ 9.7% share of RES in total final energy consumption;
- ✓ 2,500 MW installed capacity of renewable-based generation equipment;
- ✓ 20% progress in energy efficiency;
- ✓ 20% reduction of GHG emissions.

Considering the fact that quite number of renewable energy–related decrees, orders and resolutions adopted by Azeri government were a real support and interest of country in RES, it is vital for Azerbaijan to adopt a dedicated renewable energy law in order to act properly. Even if it is vibrant to transit, but capital cost of renewable energy technologies are pretty high comparatively with its maintenance.

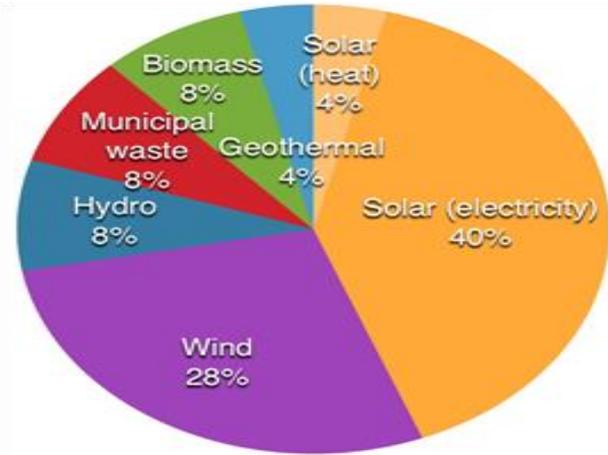


Figure 2. Projected breakdown of renewable- based energy supply by source in 2020 (Source: SAARES)

6. RES Potential and Achievements in Azerbaijan

Current data validates the assumption that Azerbaijan is rich with RES such as solar, wind, geothermal, hydro and biomass energy. Endowed with an abundance of renewable energy, Azerbaijan has a real advantage to transit to renewable energy in order to fulfill sustainable energy development targets that it is committed. The development of the renewable energy sources are the priority of the government strategy. The availability of small mountain rivers within various regions of the country paves the way for the development of small HPPs which are the promising aspect of the renewable energy policy. Wind energy is very famous among the RES of Azerbaijan due to its high annual velocities. The wind that blows more than 250 days per year and may generate approximately 2.4 billion kWh of electricity annually is the most preferred renewable energy source due to its unlimited availability. Besides, providing 2,400-3,200 hours of sunshine per year, solar energy potential is vast in the country due to the convenient geographical conditions. Biomass combustion and gasification are extensive due to the 2 million tons of solid domestic and production waste annually. It is noteworthy that geothermal power is also available in Azerbaijan that could somehow cover heat energy demand. Based on the numerous studies on RES since about 2004, endowed with wealth of the renewable energy, Azerbaijan have to realize this potential in a maximum level through government policy rather than leaving everything in the private hands which is quite risky.

Table 1: Estimated potential of RES in Azerbaijan (Source: SAARES)

Type	Potential capacity, MW
Solar	> 5,000
Wind	> 4,500
Bioenergy	> 1,500
Geothermal	> 800
Small hydro	> 350
Total	> 12,150

Hydrogen Energy

Hydrogen energy is not freely available in nature because it is attached to other compounds such as water and organic compounds. Thus, it is considered as an energy carrier not a principal energy source because it takes an effort to distinct the hydrogen from these compounds. It is used in areas such as thermal energy, transportation, electric power production, besides it is even used in portable devices in the form of liquid or gas. Additionally, hydrogen can be produced from both fossil energy and renewable energy sources. Despite the fact that hydrogen technology is quite expensive, it is much more proficient than fossil fuel technologies if the challenges such as production, storage, transmission and distribution would be solved.

In spite of being the biggest contributor to the country's total energy needs, hydropower potential of Azerbaijan are not developed at an optimum level. A closer look at the data indicates that complete hydropower potential of rivers in Azerbaijan was appraised at 40 billion kWh that contains feasible potential of 16 billion kWh. Considering the mentioned potential, it is conceivable to locate lots of small hydro power plants on rivers and water facilities which can generate up to 3.2 billion kWh annually. Concerns such as regulation of flood waters, environmentally sound electricity generation and the creation of new irrigation systems could be overcome through the construction of hydro power plants on irrigation canals and rivers with unregulated flow. The use of small HPPs can solve not only electricity but also social problems. According to AzerEnerji, the functional capacity of HPPs in Azerbaijan is 1200 MW. The share of large HPPs in functional capacity is 14% and the small HPPs are 2%. Approximately 1100 rivers of varying lengths are able to generate 40 TW electricity annually. Presently, the technically achievable hydro energy potential is equal to 1.6 TW, 0.5 TW of which can be generated from small HPPs (ADB, 2009).

The state program on the enlargement of the small HPPs resulted with the privatization of “Guba”, “Gusar”, “Sheki”, “Chichakli”, “Mughan”, “Zaykhur” Nugandy”, “Balakan” and “Chinarli” HPPs. The annual power of the plant has increased from 720 kWh to 1,2 MW as a result of the restoration of the small HPP on Kish river in Sheki. In addition, the UNDP office in Azerbaijan has supported the reconstruction and rehabilitation of a small 580 kWh capacity HPP in Sheki (ME, 2009).

Over the last decade, Azerbaijan has launched new power stations operating on modern technologies that has reached 7,149 megawatts capacity of electricity generation system in the country. In recent times, it is announced by Azerenergy JSC that Azerbaijan just about finished the construction of three small hydro-electric power stations which contain two in Ismayilli and one in Astara. The construction of small hydropower plants can address the concerns with nationwide importance such as controlling floods, producing clean electricity and building new irrigation systems. The small hydropower station in Goychay plant with installed capacity of 3.1 megawatts generated more than 746,000 kWh of electricity during the first quarter of 2016.

Although, Azerbaijan challenged with power supply of the population due to the outdated power plants and transmission lines during 2003-2004. With the restoration of the existing infrastructure and construction of new power plants, the country not only succeeded to cover the domestic demand, but also began to export electricity. According to the State Statistics Committee of Azerbaijan, hydroelectric power plants of the country generated 376.7 million kilowatt per hour of electricity during the first quarter of 2016, which is 60.4% more compared to January-March 2015. In total, 5.98 billion kilowatt per hour of electricity was produced in Azerbaijan in January-March 2016. (SSC, 2016)

Wind Energy

In comparison with other alternative energy sources, wind energy is the most desirable renewable energy source in Azerbaijan due to its excessive perspective for an application of wind power facilities. The data appear to suggest that due to its geographical location and economic infrastructure, Azerbaijan Republic owns approximately 800 MW annual wind power capacities. Roughly, with the 2.4 billion kWh of electricity from available potential would save 1 million tons of conventional fuel while evading of emitting a large quantity of carbon dioxide.

Since the convenient windy conditions excel in the Absheron Peninsula, and along the Caspian seashore and islands in the north-west of Caspian basin, it is reasonable to use medium capacity wind power facilities in Ganja-Dahskesen zone and Sharur-Julfa area of the Nakhchevan Autonomous Republic based on the fact that the annual average speed of wind in those regions is 3-5 m/sec. Azerbaijan Scientific-Research Energy and Power Design Institute in cooperation with the Japanese company, Tomen determined that the annual average wind speed is 7.9-8.1 m/sec in Absheron. Furthermore, the 6 m/sec average speed of long-lasting wind demonstrates the economical and technical potential for using wind power. The two wind turbines run by Caspian Technology at Yani Yashma on the Caspian Coast north of Baku with a capacity of 1.75 mw is a current engagement of the country in wind-energy power generation.

With the purpose of expansion of a wind park with a capacity of 40 mw, proceeding policies reached to its advanced stage in the form of a German joint venture. This would mostly function for the Sumgait area under a special tariff discussed with the tariff authority. The company predicts that this park is going to escalate to a possible 250 mw capacity.

With the intention of developing offshore wind generating capacity to serve rigs in the Caspian Sea, the first wind turbines were erected 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 yields 6.5 mln KW energy and saves 2.5 mln m³ of natural gas annually (ADB, 2009)

The CTC’s Shurabad Project, an onshore wind park in Khizi region involves the 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/m³). The complete capacity is 48 MW and the installation will occur in three phases: in the first, 15 MW; in the second, 18 MW; and in the third, 15 MW. It is predictable that 47 % 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 CO₂ is approximately 101,482 tons (CDM, December 2011). The design of the turbines and the installed software permits each turbine to be organized independently.

Eventually, Azalternativenerji LLC is supervising several programs on the application of solar panels and collectors, wind turbines and heat pumps within the framework of The State Program on Socio-Economic Development of the Regions of the Republic of Azerbaijan in 2014-2018.

Solar Energy

Solar energy is the plentiful, easily obtainable and one of the safest form of the sustainable energy production systems. Solar energy technologies should be divided in three sets. Photovoltaic (PV) system produces electricity through direct conversion of solar radiation by using the semi-conductor material. Concentrating collectors use concentrating solar energy to heat a receiver, which is placed on the focus point of the collector, to reach high temperature, after that heat energy is transformed into mechanical energy by using turbine system and then into electricity. Solar heating and cooling systems use the solar thermal energy for heating and cooling of domestic water and building space. On the basis of the evidence currently available, it seems fair to suggest that solar thermal collectors have a significant potential in reducing the fossil energy consumption for heating and cooling applications. Applying solar technology in desalination system is one of the clear options to supply fresh water from saline or sea water. Efficiency and suitability of the solar energy systems are enormously dependent on the daily solar radiation and radiation flux.

Due to its geographical location, Azerbaijan is one of the luckiest countries in terms of solar energy potential. The climate condition of the country gives great opportunities for production of electric and heat energy using solar power. These conditions provide confirmatory evidence that the 2400-3200 annual number of sunshine hours in Azerbaijan doesn't hold back in terms of potential progress of the annual number of sunshine hours in USA and Central Asia that is 2500-3000 hours. Besides, involvement of Azerbaijan in application of the Photovoltaic Program (PVP) can partially solve its energy problems.

The solar power that comes down to earth totals 1500-2000 kWh/m² annually in USA, 800-1600 kWh/m² in Russia, 1200-1400 kWh/m² in France, 1800-2000 kWh/m² in China and 1500-2000 kWh/m² in Azerbaijan (ADB, 2009). It is apparently clear that the quantity of solar intensity in Azerbaijan stands up very well in comparison with other countries. Solar is better-suited to the central river valleys and the north and northwest.

The construction of a SES in the Surakhani and Pirallahi districts of the Baku city has been finalized. 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 m³ natural gas annually. The SES is going to be connected to the grid by 2015. 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 (AzerTag News Agency, 2014).

Additionally, Azguntech LLC 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. These projects aim to increase the awareness of environmental pollution and support environmental sustainability by providing the inhabitants with green electricity and heating. Several following achievements by the company:

- In order to supply schools with eco-friendly electricity and heating; and increase the alertness of environmental sustainability among the schoolchildren, Solar panels and heat pumps installed in 10 schools in different districts of Baku.
- The company has installed solar panels and heat pumps in indoor playgrounds in Beylagan and Masalli which

possess 50 kWh, and 76 kWh power generation capacities for the heat pumps.

➤ The company 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).

Considering the huge potential for solar energy in Azerbaijan, the construction of Solar Electric Stations (SES) in the country is ongoing.

Biomass energy

The biomass energy is organic material that have been derived from several sources such as wood, wood wastes, agricultural crops, animal wastes, food wastes, and aquatic plants etc. Due to its low cost, biomass energy is seen as a near term solution for energy crisis during transition to the renewable energy sources. Beside the direct combustion of biomass, there are cleaner ways to use biomass like gasification and pyrolysis methods. In order to use biomass source in a gasification process, biomass source should have a moisture content of 5–30%. There are two ways of gasification such as indirectly heated and directly heated gasification. Biomass sources can be also used in pyrolysis method to produce hydrogen and methane.

The rapid growth of industry, agriculture and social service in Azerbaijan releases new opportunities for electricity generation from biomass that is derived from following bio substances:

- ✓ Combustive industrial wastes;
- ✓ Wastes of forestry and wood-working;
- ✓ Agricultural and organic wastes;
- ✓ Domestic and communal wastes;
- ✓ Wastes processed from areas polluted with oil and petroleum products.

Many countries have already found methods to solve these problems through the waste combustion plants that are built in densely populated areas in order to fire any kind of domestic wastes in those plants. The nearby residential settlements are then provided with electricity and heat at the expense of energy produced from waste combustion. The remains of fired wastes are widely used as a fertilizer to increase fertility of soil. Therefore, construction of such plants would be significant for Azerbaijan.

The French Company CNIM has led the construction of the first municipal solid waste incineration plant in Azerbaijan under the Comprehensive Action Plan on Improving the Ecological Situation in the Republic of Azerbaijan, 2006-2010. The plant that generates 231.5 mln kWh per year meets the EU's environmental protection requirements. The smoke of the plant is captured by special filters and neutralized as part of the process. In addition, Balakhani Solid Waste Incineration Plant contains the 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).

Besides, Azalternativenerji LLC is leading feasibility studies on the production of biomass from industrial, agricultural and municipal waste, and is investigating the potential of alternative and renewable energy sources in the Mountainous (Daghlig) Shirvan, Guba-Khachmaz, Lankaran, Ganja-Gazakh, and Sheki-Zagatala economic regions. Remarkably, the Siyazan Poultry Farm has the capacity both for heating and generating electricity out of biomass waste.

Based on the conducted research, waste combustion plants are mostly positioned near residential settlements which open opportunity to them to utilize energy that is generated from the waste burning. At present, roughly more than 200 landfills covering 900 Ha in total are available in Azerbaijan (MENR, 2010). Institute of Energy Research and Design of AzerEnerji JSC projected the amount of municipal solid waste as follows (Hajar Huseynova, 2014):

Baku – 30 400 tons (42.8 million m³)

Ganja – 5 100 tons (7.2 million m³)

Sumgayit – 4 900 tons (6.9 million m³)

Mingachevir – 1 600 tons (2.3 million m³)

Nakhichevan – 1 200 tons (1.7 million m³)

Shirvan – 1 200 tons (1.7 million m³)

Studies suggest that much of the composition of production wastes in all industrial sites is biomass substances. It is possible to produce biogas, bio-liquid and solid bio-substance that can be used for electricity generation. Annually, more than 2.0 million tons of solid domestic and production wastes are thrown into waste treatment sites in the Azerbaijan. Processing of solid domestic and production wastes would to some extent resolve the problems in heating public buildings in Baku and other large industrial cities.

Geothermal Energy

Geothermal energy is renewable, sustainable, limitless, cheap, and eco- friendly energy source. Geothermal (geo means ground, thermal means heat energy) is a component of hot water, vapor and gases containing some chemicals. The source of geothermal is hot magma and destroyed radioactive materials that exist in deep levels of earth crust. The capacity of geothermal energy in the world is enough for human energy needs but only a very small fraction of geothermal energy is profitable in order to produce electricity. The heat of earth depth is extensively used in industry, agriculture, domestic, communal and health sector in many countries around the world. The benefit of using geothermal power in energy production and consumption is that its employment doesn't require large amount of funding.

There is no suspicion of the significant potential for thermal waters in Azerbaijan which has much to do with economic, legislative, administrative and confidence issues, but has little to do with technical concerns. They are generally found in the Great and Small Caucasus, the Absheron Peninsula, Talish mountain zone, Kur lowland and Caspian-Guba area (ADB, 2009). The domestic and other heat energy needs would partially covered by the exploitation of thermal waters in these areas.

According to the SAARES, Azerbaijan's geothermal energy potential is up to 800 MW. Initial studies illustrate that the available 11 geothermal zones in Azerbaijan hold the 30-100°C temperature of water in these wells. They can generate either electric or heat energy depending on the type of the thermal waters. For illustration, the temperature is around 36-85 °C in the Guba region and it goes up to 95°C in the Kura-Aras lowland (ADB, 2009). Taking everything into account, the role of the Azeri government will be critical in realizing this potential, and enabling the private sector to participate effectively through the realization of alternative and renewable energy ambitions.

7. Conclusion. Measures for Policy Framework

Uncertainty does not mean that a nation or the world community cannot position itself better to cope with the broad range of possible climate changes or protect against potentially costly future outcomes.

(IPCC,1995:28)

The fight against global climate change has recently dominated the global agenda. The question that then arises is whether climate change should be seen as an integral part of global challenges. Many experts and political leaders support the current focus on stopping global climate change, arguing that if the world community fails to do so, the world will face a global disaster within this century. The foregoing discussion implies that climate change and global warming challenges promise the potential unsustainable future. Thus, the above-mentioned challenges should emphasize two points. Firstly, progress with respect to global warming requires a heightened level of international cooperation. Secondly, enlightened common action by nations can substantially lower the cost of adapting to our energy future.

Therefore, fighting climate change requires a substantial reduction of carbon dioxide (CO₂) emissions. Doing that would create serious problems for national energy policies and would lead to economic, social as well as political problems for the country. However, Climate change is a global challenge that will affect all countries in the world. That is the reason why many countries particularly developing countries face a very difficult dilemma: should they implement their national energy development plans to improve the living conditions of their people and by doing so, take the risk of future generations paying a very high price in terms of severe problems as a consequence of climate change or should governments invest national resources now to help address climate change, and by so doing so,

keeping the living conditions of their people at a lower level for the sake of sustainable future? This is a very difficult and painful decision governments have to make. However, the answer is very simple in the sense that global challenges need global governance. Global governance requires leaders who are able and willing to take on the task of balancing the interests and goals of countries on a national level with the necessity of cooperation to find solutions for global public good such as climate change.

Because of many superiorities of renewable energy sources over conventional energy sources such as inexhaustible, green, clean, and ability to use in district areas, renewable energy sources play crucial role in the transition to the sustainable development. Also, renewable energy is considered as a source which is suitable to meet the energy consumption of the humanity since they are sustainable. As mentioned above, Azerbaijan has great potential in terms of renewable energy sources especially in wind and solar energy. By using these renewable energy sources, Azerbaijan can meet their own energy needs, grow in energy economy, and preserve the environment by decreasing emissions. With the growing demand for energy and increasing emissions and air pollution, transition to the sustainable energy development based on renewable energy becomes compulsory. The sustainable energy development advances the quality of human life in economic and environmental aspects over the long term in a way that must be supported by the renewable energy sources, technologies and policies of the country.

Considering the fact that renewable energy concept is quite young in Azerbaijan, there are apparent challenges such as institutional operation, costly renewable energy plants along with other economic and policy obstacles which obstruct the development of alternative and renewable energy sector and the implementation of EE projects. As the private companies and businesses are very meticulous to invest to the newly launched sectors, Azeri government should simplify regulations for the sake of foreign investment attraction.

There is lack of public awareness about environmental issues and renewable energy in Azerbaijan which necessitates formal or informal alertness programs in order to completely embrace this challenge. The data yielded by this study provides convincing evidence that Individuals are usually not good at making decisions that necessitate that they trade off uncertain future benefits against certain and immediate costs. Humankind is collectively responsible for current state of the Earth's atmosphere through their historical and continued activities that caused the unstable level of GHGs. As citizens in their respective states, the public will ultimately bear the benefits as well as costs of governmental actions, in the form of regulations of GHG emissions, or inactions. Thus, the public plays a key role in shaping the future of precautionary actions. This is very apparent today. The growing awareness among the public on the reality of climate change has the potential of changing the political scenario significantly. It is the people's perceptions and acceptance of the science of climate change that would determine actions to be taken. Public pressure and lobbying can lead to a change in domestic policies as well as the states' position in international negotiations on the matter of climate change.

The advancement in media and communications has certainly helped spread the knowledge on climate change. The people experience first-hand the impacts of climate change, their call for political action will be louder. With more severe weather events occurring, hopefully greater attention will be paid to climate change together which will bring the sustainable development. It also means that the public has to put pressure on policy makers to change and adopt more precautionary measures. Above all, Azerbaijan's complete transition to renewable energy sources will bring long-term economic and environmental benefits, and this would lead to sustainable energy development in Azerbaijan.

The concluding remarks about the measures for the renewable energy policy framework are listed below:

- Sustainable development is a triangle of energy, environment and economy which necessitates Azerbaijan's complete transition to renewable energy that is very crucial indicator for sustainable future of the country.
- Azerbaijan should aim to get foreign financial and technical assistance in renewable energy technologies that cause no harm to environment while respecting sustainable supplies of energy sources.
- Sustainable development should be applied in all sectors of the economy bearing the climate change challenge in mind.

- In order to build a more secure and sustainable future, Azerbaijan should develop sustainable energy development indicators through the appropriate policies and actions.
- The country should apply the European know-how in structuring its Sustainable Energy development strategy.
- Public awareness in Environment and Renewable Energy policy should be adopted separately in the country for broader attention and consideration.
- Both short and long-term sustainable energy development programs in Azerbaijan should provide the opportunities for foreign energy investors to work closely with the national energy companies.
- International financing to support climate change adaptation investment should be included to the renewable energy policy measures of the country.
- The country should remain vibrant in the exchange of know-how information and best practices with European countries on effective alternative and renewable energy projects.
- Azerbaijan should pass legislation concerning to energy efficiency and renewable energy with straightforward norms and instructions for the proper sustainable energy development.
- Azerbaijan is better to continue its participation in sustainable energy development negotiations while keeping in mind environmental concerns such as climate change.
- The country would respect the protection of the environment through enforcing the minimum energy performance (MEP) standards for electrical devices and adopting international energy efficiency standards for newly constructed buildings.
- The country should enable the involvement of other stakeholders NGOs, think tanks, businesses and banks in the development process of renewable energy sources and energy efficiency.

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