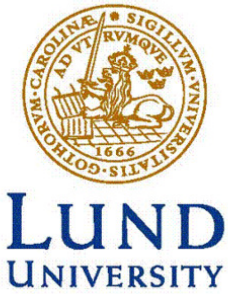

Renewable Energy
[R]evolution through Institutional Analysis in Azerbaijan:

Case Study of Solar Photovoltaic Local Application

LUMES Master Thesis

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Abstract

The objective of this study is to analyse the feasibility of using Renewable Energy sources in Azerbaijan; to reach this objective, I will analyze the institutional framework and how overcoming existing barriers within local institutions can support rapid development of RE sector from the top-down approach. Through this thesis I plan to take my readers to a journey with long-term development process and prospects for change – [R]evolution of Renewable Energy sector in Azerbaijan, its local potential and main barriers, inhibiting the shift towards sustainable development of the country. Acknowledging that Renewable sources contribute to reduction of GHG emission associated with Climate Change, our government set first steps in visioning a roadmap to maintain the mitigation of global environmental challenge on the local level. The methodology approach is based on multi-strategy research basis and as a theoretical framework, Ecological Modernization is applied here to analyze how changes within institutions could lead to major improvements in renewable energy sector in Azerbaijan on the basis of sustainability approach, where environmental, social and economic concerns are applied.

Key words: Institutional Framework, Renewable Energy sector, Azerbaijan, Sustainable Development, Climate Change, Ecological Modernization

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List of Acronyms and Abbreviations

ADB – Asian Development Bank
BP – British Petroleum
CDM – Clean Development Mechanism
CH_4 – Methane
CO_2 – Carbon Dioxide, the main greenhouse gas
CTC – Caspian Technology Company
EBRD – European Bank for Reconstruction and Development
EIA – Environmental Impact Assessment
et al. – et alii (and others)
etc – et cetera (and other similiar things)
FIT – Feed-in Tariff
i.e. – id est (that is)
ibid. – in the same source
GHG – greenhouse gas
GWh – Giga Watt Hour
HES – Hydro Electric Station
HPP – Hydro Power Plant
IEA - International EcoEnergy Academy
IRENA – International Renewable Energy Agency
IPCC – Intergovernmental Panel on Climate Change
JSC – Joint Stock Company
KfW Bankengruppe – Kreditanstalt für Wiederaufbau
km^2 – kilometre (s) square
kWh – Kilowatt Hour
m^2 – metre (s) square
MENR – Ministry of Ecology and Natural Resources
MIE – Ministry of Industry and Energy
MW – Mega Watt
N_2O – Nitric oxide
NOx – Nitrogen oxide
OSCE – Organization for Security and Cooperation in Europe
PPA – Power Purchase Agreement
PREGA – Promotion of Renewable Energy and Greenhouse Gas Abatemenet
PV – Photovoltaic
PVP – Photovoltaic Program
RE – Renewable Energy

RES – Renewable Energy Sources
REFIT – Renewable Energy Feed-in Tariff
ROI – Return On Investment
SAARES – the State Agency on Alternative and Renewable Energy Sources
SHP – small hydro power
SNC – Second National Communication
SOCAR – State Oil Company of the Azerbaijan Republic
SPRED – State Program on Poverty Reduction and Economic Development
SRES - Small-scale Renewable Energy Scheme
STP – Sumgayit Techno-Park (Electric Power Plant)
TES – Thermal Electric Station
UNDP – United Nations Development Programme
UNEP – United Nations Environemntal Programme
WB – World Bank
WTP – willingness to pay

Measurements

°C Celsius
€ Euro (1 € = 1.1707 AzN) exchange rate used here
$ USD (1 USD = 0.7913 AzN) exchange rate used here
1 square meter (m^2) = 10.7639104 square feet (ft^2)
1 square foot (ft^2) = 0.09290304 square meters (m^2)
GWh gigawatt hour (1 GWh = 1,000,000 kWh)
kWh kilowatt hour (1kW = 1,000 Watt)
MW megawatt (1 MW = 1,000 kW)

SECTION A

INTRODUCTION

One of the vital concerns humanity faces today is energy security and major environmental concern such as climate change. It was mentioned by UNEP 2010 that the energy system should provide energy service that is environmentally sound, socially acceptable and economically viable.

In stabilizing the climate, the world soon will have to reduce its consumption of fossil fuels; this entails not only improving energy efficiency but also developing major new energy sources; energy from the sun and other renewable sources (Flavin.C., 1990: 7-8). The gradual transition to solar-based economy would inevitably lead to the creation of entirely new industries, jobs and behavior – pro-environmental. We must start with a conviction that such a future is possible and through increasing the efficiency of energy use. A fundamental change of our current energy supply system is not an easy task since Renewable Energy Sector (RES) still faces a number of barriers.

The largest country in the South Caucasus Region, Azerbaijan Republic, with the average annual temperature of + 14,30°C (with winter average temperature + 4,80°C and summer + 24,40°C)[1], has a great potential to develop and use renewable energy sources in mitigating global environmental challenge of climate change through improving its local environmental situation. The Azerbaijan economy today is driven mainly by oil and gas production, according to SOCAR annual Report (2010): more than 50 mln. tonnes of oil and about 24 billion m^2 of gas were produced in 2009 as a countrywide record production.

Thinking globally and acting locally – that is the strategy Azerbaijan visions today in order to start utilizing its local geographical potential for developing renewable energy sources. Azerbaijan ratified the Kyoto Protocol in 2000 as a non-Annex I party, and is therefore eligible for participation in the Clean Development Mechanism (CDM) of the Protocol. In support of the initiatives towards the mitigation of climate change effects and, by ratifying Kyoto Protocol, Azerbaijan took 5% GHG reduction commitment.[2] A number of international and regional programmes were implemented in Azerbaijan towards raising the awareness of climate change and capacity-building toward implementation of projects aimed at GHG reduction. In 2005 the Ministry of Ecology and Natural Resources was declared by presidential resolution as the National Focal Point for enhancing participation of Azerbaijan in CDMs under Kyoto Protocol.

The actual problem is while acknowledging the importance of existing global (climate change) environmental challenge through taken commitments on Climate Change mitigation RE sector has not been widely developed in Azerbaijan. This research paper is attempted to identify the challenges that RE

[1] Renewable Energy Development Project by Asian Development Bank (ADB), Technical Assistance Country Report. (2007).

[2] Second National Communication to the United Nations Framework Convention on Climate Change, Baku. (2010).

sector faces today in Azerbaijan. The main obstacles that have been analyzed that during this short term how this sector has developed and been working so far and how it reaches out to the public and to which extend it accomplishes its initial strategic goals. The analysis of the findings is carried out mainly with regards to the basic criteria for the evaluation of institutions. The second part of the analysis gives an overview of the Energy Sector and Renewable Energy sector development, narrowed and brought up in a case study of how this innovative, environmentally friendly technology, lasting about 25 years could have looked like if successfully implemented locally with all existing challenges and barriers considered to overcome soon. A small-scale residential Solar PV (Electricity) is illustrated here as a contribution of my research to view renewable energy sector from another aspect also - socio-economic. This case study of Solar PV (Electricity) provides a useful insight of what should be considered in the future and done better in order for the RE sector wider local development to achieve real results.

*My **Hypothesis*** - It is Feasible to rapidly develop Renewable Energy Sector and use RE sources wider in Azerbaijan within the existing Institutional Structure. Here what I mean by the revolution is the shift from traditional to clean energy can happen and once it happens, it will bring to many positive changes in environmental and social situation on our country. Once such shift happens in a developing country with economy in transition like Azerbaijan, this road will be revolutionary.

BACKGROUND

Renewable energy is recognized internationally as one of the major contributors today in protecting our nature through provision a wide range of environmental, social and economic benefits towards long-term development, both globally and locally. Scheer, H. (2004) states that this widespread resistance to renewable energy is motivated by institutional fear of the changes this revolution would bring. Energy needs can be met from renewable energy all over the globe, though of course the palette of available sources varies from region to region and country to country. Environmental impacts can also not be assessed solely on the consequences of power generation itself – upstream activities are equally important. The regular aspect is ultimate source of energy: technologies, costs and prices of reduced energy while omitting local environment.

Various studies conducted by the German Kreditanstalt für Wiederaufbau (KfW Bankengruppe) and the European Bank for Reconstruction and Development (EBRD) have shown that Azerbaijan has a significant potential for the development of alternative energy sources. Initial surveys suggest that the Absheron peninsula has a good potential for wind energy, while the mountainous areas in the North and South West including Nakhchivan are endowed with attractive small-hydro power resources. In recognition of this potential, the government has launched new initiatives by setting vision and targets to maintain a strategy for local development of alternative energy sources. In diversifying energy sector, the government developed state fund in order profits from country's oil reserves exploitation and export could be used into renewable energy (non-oil) sector development.

The topic of Renewable Energy (RE) has gained greater importance in Azerbaijan in recent years, mainly since 2009. This is evident, for instance, Azerbaijan's accession to the newly established International Renewable Energy Agency (IRENA) on June 10, 2009 and, as a follow-up, local establishment of the State

Agency on Alternative and Renewable Energy Sources (SAARES) in July 2009 maintained. However, to date there are only a few examples of local practical applications of clean technology (2 wind mills installed other than hydro power), which I will broader discuss in the coming chapters.

Thus, before starting data collection process, which was based on semi-structured interviews, I decided to see what kind of research studies have been done so far in the renewable energy sector through literature and official documents review. I came up with various local and international scholars' reports and scientific works on renewable energy potentials, perspectives and main challenges, to overcome which, some valuable recommendations, based on international best practices, were suggested. During my literature review, I found out that RE sector has been studied many times by various scholars: from technical - Talışınski, R.I. (2007) and Jalilov, M. (2009); political - Baker, R. & Safarzade, E. for the ABD Report (2009) and; legislative - Isayev, R. (2010). However, with this research besides data collection and literature review, I aim to go further and view RES based on a holistic approach: where sustainability is linked with institutional frameworks arguing that simply reforms and improvements with legislation and tariff is not the only approach to be considered, it should go far beyond only top-down thinking.

Talışınski, R.I. (2007) suggests international experience on utilization of renewable energy with existing local advantages and further development of renewable energy source in our country while local challenges and obstacles as well as environmental and social impacts are not being discussed broader in his book "*Bərpa Olunan Saf Enerji Mənbələri*".

Jalilov, M. (2009) in "*Alternativ Regenerativ Enerji Mənbələri*" mainly uses technology available today globally bringing international experiences and achievements of developed. At the meantime, he analyzes how the shift towards renewable energy could mitigate environmental impacts as well as reduce GHG emissions into the atmosphere. Local potential of renewable energy sources are being described with broad description of general technological aspects of renewables such as wind mills installation, solar panels setting, however missing the fact how the shift from one socio-technical system to another and the co-evolution of technology and society could emerge in developing countries, such as Azerbaijan.

ABD Report (2009) "*A Roadmap for Renewable Energy in Azerbaijan*" by Baker, R. and Safarzade, E. highlights that It is very challenging for an oil-rich country to adopt alternatives because they have a cheap and easy alternative on hand, but that encourages the status quo since the state policy to develop alternative and renewable energy didn't lead to achievements in the renewable energy sector development. In practice not many changes emerge with regards to reforms within renewable energy legislation and institutional structures, yet the creation of the SAARES was initiated in developing renewable energy sector in an integrated way through collaboration and mutual process involvement of all actors involved in this sphere development.

Isayev, R. (2010) highlights and brings existing renewable energy policy and legislation though missing discussion of way on how efficient they are and what reforms could be essential and applied in order to improve current situation. What I define under the current situation is currently the RE sector is theoretically developed: many studies and research conducted both by local and international expertise,

yet it all remains in the papers only, not being transferred into practice, maybe not much environmental education, maybe not will at all, maybe no vision of how beneficial this sector in the future will be, I don't know in this regards I am going further with this research to see how this all actually looks like and could look in practice if certain things develop.

At present, Azerbaijan has serious environmental problems due to intensive development of the region's hydrocarbon resources, increasing amount of consumed fossil fuels and greenhouse gas emissions. While the level of pollution equated to 71.1 million tons of CO_2 in 1990, in 2008 this amount accounted for 50.6 million tons of CO_2 (SNC Report, 2010: 7). In addition, the estimations illustrated in the International EcoEnergy Academy Report (2010) show that, as a result of future development projects, the quantity of hydrocarbons emitted by the oil–gas sector will amount 80–85% of total emissions within the country. It is expected that compared to 1990, in 2025 the level of hydrocarbon emissions will be 1.8–2.0 times higher. Analysis of the present situation shows that in order to prevent such reliance and fossil-fuel dependency, our country must change the existing energy systems through diversifying its energy sources and oil-gas industry.

In the research work of Mehlum, H., Moene, K. and Torvik, R. (2006), the institutional quality of the resource country is taken as the basic factor of the ineffective use of the natural resources and the consequent negative implications. They divide the public and to the larger extent the private institutions to two categories: grabber-friendly (prone to plundering and appropriation) and producer-friendly where the first category is more prone to the corruption, illegal revenues and thus sensitizing a socio-economic stability of the society. Jacobs (2009) suggested several most favored policy mechanisms that could be simply applied to Azerbaijan, which are - eliminating subsidies for conventional mature electricity, pricing electricity accurately, instituting feed-in-tariff and implementing a system benefit fund for public awareness, protecting lower income household and administering demand side management. All these mechanisms provide an insight for improvements and possible local application with variables required on large scale development, however how possible that can be with the current stage of the renewable energy sector itself, which I will discuss further through my entire research paper. Scheer, H. (2004) stated the importance and main driver in renewable energy development locally is, first of all, political will. In the ADB report (2009) "A Roadmap for Renewable Energy in Azerbaijan", the main outcome was – "the state possesses the status quo in energy sector", in this regards the political will was seen as the main challenge in the Renewable Energy Sector development.

The fundamental economic reality of fossil fuels is that they are found in only a relatively small number of locations across the globe, though consumed everywhere. The economic reality of solar resources is that they are available, varying to climate and geographical locations, all over the world. Differences are environmental effects and fundamentally different logic and the differing political, social and cultural consequences. These local differences must be acknowledged in order a full range of opportunity for solar resources is to be exploited. If real progress towards an alternative is to be made, the entire energy supply chain must be taken into account, right down to the ties between individual links (Scheer, H. 2004).

Evidently, in order to reduce CO_2 emissions and improve environmental situation locally, shift from conventional energy to renewable energy sources is vital. Then, what changes are required in order to manage this shift towards renewable energy and make energy [r]evolution?

OBJECTIVE

1. Main Research Question

What are the main challenges that Renewable Energy Sector in Azerbaijan faces today?

2. Additional Research Questions

1. *How collaboration between public and private sectors can contribute to the wider development of Renewable Energy sources in Azerbaijan?*
2. *If certain reforms within RE policy and tariffs occur, Is it actually economically feasible within society to implement and use clean technology domestically?*

The aim of the study is to analyse the institutions: while analyzing the institutional framework, the objective is to see the process from both aspects: go through current energy situation in Azerbaijan while examining how recently targets set for the renewable energy strategic development are vision to be achieved in the nearest future. In this regards, I will try to go through, suggested by previous scholars, recommendations on improvements within major aspects in renewable energy sector, see it from the other aspects also and compare how today renewable energy sector developed. During that in addition will try to come up with aspects that have not been discussed by previous scholars before. Thus, first of all, I need to know how collaboration of public-private sectors could lead to overcome and reduce existing barriers (which the reader will get across within the paper) within renewable energy sector. Secondly, if gradually major changes (reforms of existing legislations and tariff in RE) happen, how it will contribute to the renewable energy technology local market demand where lack of public awareness and environmental education exist. In the current state of RE sector in Azerbaijan, if the [r]evolution of RE to happen, it should be in an integrated way through top-down (State) approach with relevant policy and tariff reformations in order next step public awareness and social behavior emerge towards environmentally-conscious oriented behavior. In specifying institutional framework and main actors, it is essential to analyze long-term dynamics, shifts from one socio-technical system to another and the co-evolution of both the current institutions and society itself. The focus here is not only how major reforms in policy, energy tariffs and banking structures to be applied within the agenda of RE sector, but also how overcoming of these existing major barriers in renewable energy sector can lead to the socio-economic improvements.

OVERVIEW AND SCOPE OF THESIS

To reach this objective, in this research paper I will go through current status of renewable energy sector in Azerbaijan, view key actors involved (public and private) and how collaboration between public and private sectors could support promoting renewable energy on local market and major improvements towards evolution of a new, non-oil industry. The major findings will consist of how the system works today, what has changed since the last ADB report (2009) emerged with recommendations to further development and change. Through semi-structured interviews with public and private sectors and literature review, I will try to come up with my own aspects and indicators, based on existing institutional framework in order to see how and if any changes within structures to maintain the shift towards renewable energy sector happening today. In addition, I will look on economic and social aspects also, using sample calculations (costs and prices) conducted based on my planned implementation of the RES small-scale household project with Solar PV (Electricity) which I believe will help me picturesque how if changes would happen on the top level could affect the linked aspects of sustainability, social and economic. Let's start Our Journey!

RESEARCH DESIGN

1. METHODOLOGY

The methodology part will be based on the triangulation structure: I think it would be the best way in approaching the data analysis I have obtained during my research process. Bryman (2004) defines triangulation as a "search of convergence and validation of results from different methods and designs studying the same phenomenon". The triangulation is defined as mixing of data or methods so that diverse viewpoints or standpoints cast light upon a topic. The mixing of methodologies, interviews (with public and private sectors), official documents data collection and literature review and application of the sample calculation based on costs and prices are applied here. Apart from reviewing all relevant literature as data source, conducted various interviews (11) with local public and private sectors' representatives involved in RE sector (see Annex 1). In addition, the application of sample calculations and based on it financial analysis are aiming to view the full picture, assuming that if, gradually, relevant reforms within institutional frameworks occur such as legislation and tariff prices, then how will this affect local society with regards to raising environmental awareness and local market demand in Azerbaijan. Information used to address these issues are highlighted in the below research questions, the research study duration was within three months' period (January – March 2011).

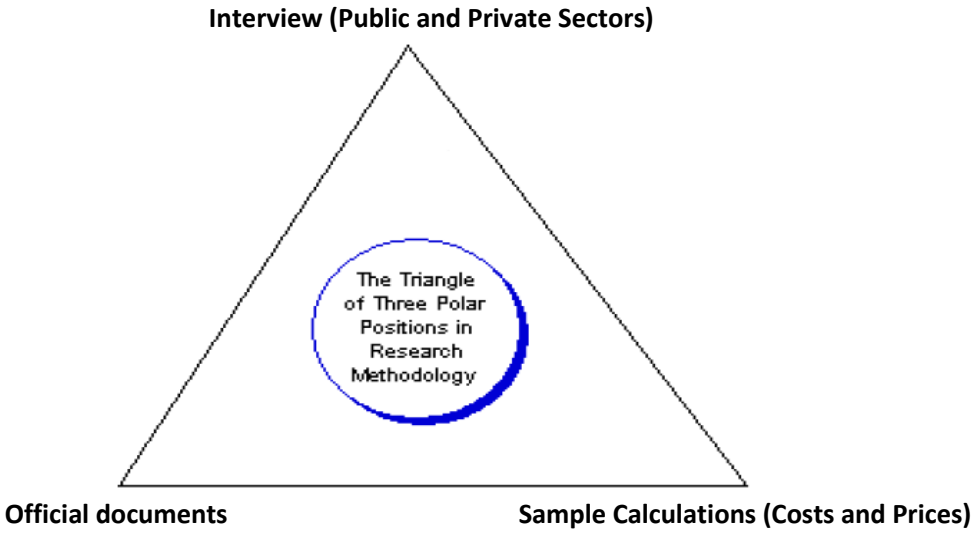


Figure 1. The Triangle of Three Pillar Positions in Research Methodology on RE sector for Azerbaijan
Source: http://www.ccsr.ac.uk/staff/Triangulation.pdf

Scope and Relevance

Bryman (2004) classifies three approaches to multi-strategy research such as triangulation, facilitation and complementarity. The methodology used here is based on a multi-strategy research applying triangulation approach mixing qualitative (interviews and official documents) and quantitative (sample calculations of costs and prices) methods. Though many potentials of renewable sources are applicable in Azerbaijan due to its climate and location, no any public projects have taken place so far Solar Energy which makes it challenging to illustrate how the process and methodology could be used here. However, the strategy I plan to use as methodology part is take an example of case study of Solar PV (Electricity) energy implementation on a household level where sample calculation on comparison with existing tariffs and existing state costs and benefits with Solar PV project costs and prices and how affordable this shift could be within society in order rapid shift take place in our country. My case is simplified due to I take here a summer cottage with more sunny hours and not going too deep into technical part in order how this project would fully look like during the whole year. So, here I will be using a summer cottage and how the project design could be implemented in real life.

Interviews - one of the major types of interview to be used in this research is *semi-structured interview*, Bryman (2004) defines "interview that covers a wide range of instances". Usually is applied when an interviewer has a series of questions that are in the general form of an interview schedule but is also able to vary the sequence of questions. In addition, the interviewer has usually some latitude to ask further questions in response to what are seen significant replies (Bryman, p.113). During the research, related questions were asked at the semi structured open-ended interviews and used during all interviews for both public and private sectors (see Annex 1).

Official Documents – the term "documents" covers a very wide range of different kind s of source (Bryman, p.380). The documents used as a methodological tool are official documents deriving from the state, international reports (ADB, BP, EBRD, OSCE, World Bank and UNDP) in addition official documents

deriving from private sources (Caspian Technology Company). The state is the source of a great deal of information of potential significance for social researchers. It produces a great deal of statistical information (Bryman, p. 386), which I am using in this research. However in order to see the process not only from one approach (state), I reviewed official documents from private (company) sources also.

Sample Calculations (costs and prices) - includes assessment of consumers' willingness to pay (WTP), using residential electricity bills consumers currently pay for conventional energy use and compare it with estimations made if shift to renewables occurs and how this affects consumers while increasing local market demand.

According to Bryman (2004), the combination of different methodologies will generally tend to have a leading strategy for starting out the research, and follow-up strategy for rounding out and widening the enquiry.

MAJOR LIMITATIONS

Certain limitations during mixed-methods approach occurred while data gathering process:

Interviewees' responses interpretation - since my interviewees were actors from both, public and private sectors, various approaches, behavior, cultural understanding and interpretation of the RE industry development were observed. However, my interpretations of their approach might cause a bias here hence mislead for data analysis.

Official documents – all major sources are available within governmental institutions mainly in Azeri (public sectors), while data in English was obtained mainly from the private sectors. In addition, some data is very old (for instance, Institute of Radiation) with no recent follow up or even involvement in any planned projects (in cooperation with SAARES). Also, private sectors preferred to provide data through interview responses or via presentations (leaflets, brochures). My general understanding and analysis of existing today institutional system are based on what was being discussed during the interviews mainly (Caspian Technology Company (CTC) and Total Energy).

Sample Calculations – set by the Tariff Council tariff prices are shown in Annex 2 – private companies hesitating to share existing price lists (future tender issues and competition, though today in the local market 3—4 companies actually involved in this sphere), the real costs and prices of renewable energy costs today were based on my assumptions and estimations of how the small-scale project would look like if implemented on the residential household level (though all major calculations were done at the CTC with Dr. N.Ramazanov).

2. THEORETICAL FRAMEWORK - ECOLOGICAL MODERNIZATION: FROM PRESENT TOWARDS SUSTAINABLE FUTURE

Does Azerbaijan need renewable energy and is it possible to shift towards renewables with existing institutional framework? Eckersley (2004) articulates useful understandings of changes in institutional structure that must accompany any "green democracy." In the "The Green State" Eckersley seeks to cover the relationship between state, the public sphere and civil society in terms of the ecological problems concerning society and the economic interests of the state. Eckersley (2004) identified four levels where reflexivity must be present for strong ecological modernization to emerge: policy instruments, policy goals, hierarchy of goals, and the role of the state. Relating to Azerbaijan, these four aspects could be considered, in my view, with regards to democratic accountability to a green rather than a liberal conception of state governance. Liberal democratic states provide public exposure of ecological problems, but their focus is on managing rather than on resolving ecological problems. They consider compensation for harm but do not address prevention of harm. Eckersley (2004) argues for enlisting domestic legal systems to serve transboundary communities, and sees the trajectory of international environmental law pointing towards the idea of states taking on the role of ecological trustees. Pursuing greener growth and eco-efficiency are short-term measures, while sustainable development is based on a changed hierarchy of policy and societal goals. This includes mutually reinforcing interactions between environmental multilateralism-in the form of treaties, declarations and standards, and sustainable development-as strategies of corporations and states. The transformations required by the ecological problems go beyond sheer technical fixes towards new policy principles, paradigms and societal goals.

It is primarily through the process of critical questioning and reflection in public spheres that it becomes possible to rethink not simply the means by which society pursues established goals but also the goals as well. At the same time the political transition toward a green democratic state requires not just rise of critical green public spheres but also politically oriented green movements for change (Eckersley, R. 2004: 246). Regardless of whether neoliberals may personally desire a greener world, their analysis assumes that states will not seek to move toward such a world unless it can be shown to be in their interest (economic terms here is taken) (Eckersley, R. 2004: 250). Relating this theory to Azerbaijan, I see the link however besides state profits, the huge gap of lack within environmental awareness of education within institutions causes to such long way of pursuing state goals with regards to the renewable energy industry development. Maybe actually it could be also cultural issue that institutions do not realize environmental challenges, another proof of that is the lack of environmental education within academic institutions. Besides underestimating economic profits that Eckersley brings up, in my research paper I would also bring the attention to cultural issue also then how can the state, where even no environmental education provided, set real goals in achieving clean energy that leads to the sustainable environmental and socio-economic development of the state, lacking clearly established tools and policy instruments, to achieve it?

Five major transformations for existing scholarships on ecological modernization emerged, these are: 1) Changing role of science and technology; 2) Increasing importance of market dynamics and economic

agents; 3)Transformations in the role of the nation-state; 4)Modifications in the position, role and ideology of social movements and 5)Changing discursive practices and emerging new ideologies. Here, I will focus on the third point which is Transformations in the role of the nation-state: more decentralized, flexible and consensual styles of governance emerge, with less top-down, national command-and-control environmental regulation -- often referred to as political modernization [cf. Jänicke, 1993; Jänicke and Weidner, 1995].[3] More opportunities for non-state actors to assume traditional administrative, regulatory, managerial, corporate, and mediating functions of the nation-states, referred to by some as subpolitical arrangements [cf. Beck, 1994; Hogenboom et al., 1999]. Emergent supra-national institutions also undermine the nation-state's traditional role in environmental reform [cf. Spaargaren and Mol, 1992; Hajer, 1995].

SECTION B
FROM CONVENTIONAL TO RENEWABLE ENERGY IN AZERBAIJAN

1. Overview of Conventional Energy Sector

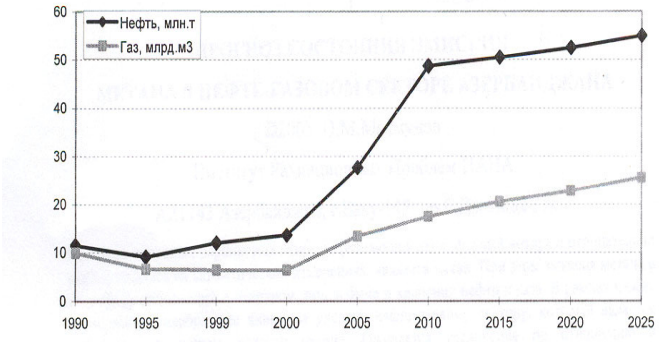


Figure 2: Comparison and Forecast of hydrocarbon level production (1990-2025)

Comparing two energy sectors (fossil fuels based and clean energy) I want to overview current energy situation, the strategic goals and vision set by our government in developing renewable energy sector in Azerbaijan. Historically, the Azeri energy sector has been affected by below cost tariffs, low collections, deteriorating infrastructure and high energy losses.

In 2009 50.4 mln. ton oil and 16.3 milliard m^3 gas was produced during the year. Oil extraction increased natural gas supply of the country as well as export of the natural gas continued (State Statistical Committee).

Electricity Demand and Consumption - At present, the structure of the electric power system is: 13 hydroelectric power plants are thermal power stations and 6 hydro power plants: total production capacity is close to 6400 MW: TESs account for 89% of output, while 10% is contributed by HESs and only 1% comes from renewable sources. Based on data from the Ministry of Industry and Energy,

[3] Arthur P.J. Mol and David A. Sonnenfeld (2000): http://www.tricity.wsu.edu/sonn/ecomod_intro.htm

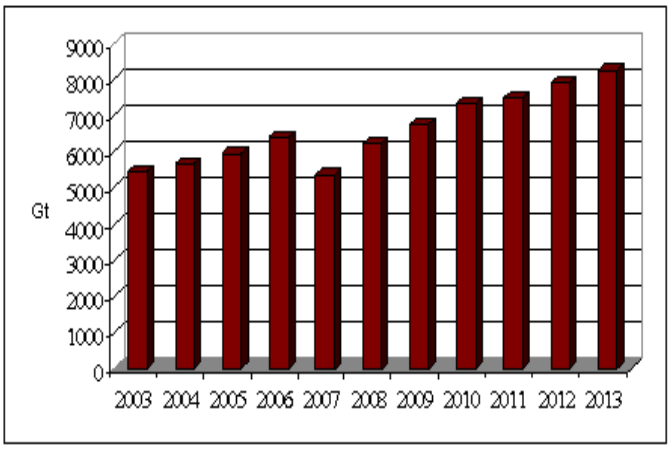
general electricity consumption today within the country is 4500MW (i.e., electricity production exceeds existing local consumption). There are 17 power plants in Azerbaijan with total available capacity 4944 MW and 113 number of units, 7 of which are hydro type: Table 1 illustrates current energy generation by percentage. SNC Report (2010) indicates the levels of GHG (CO_2, CH_4, N_2O) generated in Azerbaijan by the energy sector during 1990-2005: if in 1990 CO_2 emission level was 50677, in 2000 CO_2 it was reduced up to 29274 and in 2005 it rose again till 35845. At the mean time, recent studies on the comparison and forecast by the International EcoEnergy Academy in 2010 (**Fig.2**) show that the amount of hydrocarbons emitted by oil–gas will in 2025 will amount 80–85% of total level of hydrocarbon emissions within Azerbaijan will be 1.8 times higher in comparison with 1990 level.

Table 1: Current Energy Situation in the Azerbaijan Republic

Power Plant Stations	17
Thermal Power Plant	89%
Hydro Power Plant	10%
Renewable	1%

Source: Azerenergy JSC, 2011

According to the World Energy Outlook Report (2010), CO_2 emissions within Azerbaijan in 2009 made in total 24.8 mln.tonnes. Oil – production: 1.011 million bbl/day (2009 est.), Natural gas – production: 23 billion cu m (2009 est.).



UNDP in Azerbaijan in the SNC Report (2010) conducted forecasts comparing CO_2 emissions from the consumption of electricity and natural gas between 2003-2013 and forecasted that in 2013 the increase of CO_2 emissions will be 2.8 mln. tons higher in comparison to the CO_2 emissions level of 2003 (**Fig. 3**).

Figure 3: CO_2 emissions from the consumption of electricity and natural gas

United Nations Environmental Statistics on Azerbaijan (2009): around 60% of electricity is consumed in the Absheron peninsula (the East of the country – see the map, **Fig.4**), while the main generation facilities are located to the West of Azerbaijan, thus increasing technical losses (21%) and fuel transportation costs since fuel sources are located on the Absheron peninsula and offshore.[4] From the above mentioned studies and estimations conducted, it is obvious that consequently the level of GHG

[4] Renewable Energies in Central Asia, 2009: 16

Figure 4: Economic Map of the Azerbaijan Republic[5]

emissions will gradually increase. Thus, in order to decrease the problem, energy effectiveness must be enhanced through gradual shift causing the reduction of carbon dioxide (CO_2) emissions as well as promote energy diversification in our country; the shift from traditional system must be considered and gradually accomplished and the core solution here is development and promotion of the alternative renewable energy sources.

2. Overview of Renewable Energy Sector

So, from conventional let's step into the current Renewable Energy Sector and try to rationalize why Renewable Energy has to be developed in Azerbaijan. Definition the International Energy Agency (2010) gives to RE is: "Renewable energy is derived from natural processes that are replenished constantly. In its various forms, it derives directly from the sun, or from heat generated deep within the earth. Included in the definition is electricity and heat generated from solar, wind, ocean, hydropower, biomass, geothermal resources, and biofuels and hydrogen derived from renewable resources" (OSCE Report, 2009).

As was stated before, within the framework of the State program on Renewable Energy (issued in 2004), our government in 2010 planned to broad this sector through the State budget and the State Oil Fund of the Azerbaijan Republic which will lead in the future to the energy security and diversification of the energy sector with less reliance on conventional energy (Isayev, S.N., 2010).

According to **BP Energy Report (2010),** renewable energy is seen as a minor player in energy provision, and renewable resources are thought even less important. The costs of fossil resources evaluated solely in terms of their market prices. Environmental damage arising from the consumption of fossil fuels and environmental costs is difficult to calculate exactly; the environmental costs are so vast that it would be irresponsible to ignore them. Scheer, H. (2004) argues that the concept for the future is not the "global city" but the "solar city"; the "sustainable city" strengthens the economy of the state by the quantity of renewable energy it produces which is entirely possible in the long-term, cities can meet all their energy needs from renewable energy only in the future.

[5] United Nations Environmental Statistics Country Division: Azerbaijan.(2009).

Sustainable Development, protection of environment and improving socio-economic state here shouldn't be looked upon as isolated matter (Zulfugarov, E.I., 2003: 753). So far Pilot Projects – Wind (March 2009) and Solar Pilot Projects (Institute of Physics) and Shurabad Project (June-July 2009) were developed and implemented by the Caspian Technology Company.[6] In Yeni Yashma, Khizi Region, the pilot project consisted of two Vestas V52 with each 850kW power was connected to the grid (Baker, R. & Safarzade, E., 2009: 8). Aliyev F.F. et al. (2007) mentions that the potential of wind energy resources in Azerbaijan allows to produce 4 billion kWh electrical energy which leads to save 1 billion kWh conditional fuel, while reducing 3.7 million tons of CO_2 per year (Aliyev, F.F: 257). Several measures have been implemented by the state to encourage wider utilization of alternative energy resources. These measurements show that up to 8 bln.kWh of electric energy may be produced annually using renewable energy sources (hydro, solar, wind). According to SAARES, projects for the development of RES are targeted to be placed by 2013.

Isayev (2010) brings calculations where he shows that annually we can save 1 mln.ton oil eq. if shift to renewable, in the meantime, no emissions of CO_2: renewable energy technology involves quite little emission (shipping, mainly). Azerbaijan has great potential for development and use of wind and solar energy, studies conducted on sources use have been indicated great potential of these two sources, about which I will talk broader in this and next sections.

EBRD (2003) conducted study to indicate major areas with high potential for wind energy within Azerbaijan (see Table 2).

Table 2: Wind resources of Azerbaijan - Areas/Projects with High Potential for Wind Energy

Project Name and Location	**Size (MW)**	**Description**
Absheron peninsula	1500MW	All the territory of the peninsula including the towns of Baku and Sumgayit and adjoining islands. Wind regime is exceptionally intensive.
Caspian Sea zone and the Kura river lower reaches	500MW	From the Kura spit in the South to the border with Dagestan in the North.
Nakhchivan Autonomous Republic	70MW	Separate localities on the Zangezur ridge (wind potential is at lower limit).

[6] Caspian Technologies, which operates the country's only wind farm, is raising its capital abroad with the assistance of its German joint-venture partners. This option is not available to any but the largest potential investors, and the local sources of funding are constraining the transition to R&AE at present because of their very cautious, and risk-averse lending, which makes potential entrepreneurs risk-averse also (ADB Report, 2009).

In March 2009 the first wind project on Caspian Sea started to produce green energy and deliver it to distribution grid close to Sumgayit with generated energy - 1,3 mln. kWh with 400 thous.m^3 of natural gas saved (data from the Caspian Technology Centre). Another large-scale project named "Boyuk Zira Resort Project" with international coordination is planned to be conducted by the "Danish Bjarke Ingels Group" company based on the resort Nargin Island in Azerbaijan, a future zero carbon footprint area. In addition, some recent studies for PV Project development potential were conducted by **Kofler Energies** for Azerbaijan (SAARES, 2011) with below indicators (Table 3):

Potential

- relatively high insolation (3 up to 4.7 kWh/m^2/day (year average)
- Most promising sites are on Absheron peninsula and in Nakhchivan
- Facility to produce 250MW Modules under German license to start production in the near future
- Project ideas on 25MW plants existing

Existing PV power plant

- So far No PV power plants exist

Table 3: Potential PV projects, examined and studied by **Kofler Energies** (SAARES, 2011)

Photovoltaic	**Installed capacity**	**Annual generation**	**Investment**	**Prime cost**	**Developer**	**Status**
	MW	**GWh**	**Mio Euro**	**c/kWh**		
Qaradag PV 25	**25**	**56.9**	**85.2**	**23.2**	**SAARES**	**Project idea**
Qobustan PV1.6	**1.6**	**3.8**	**7.0**	**31.2**		
Qobustan BG0.1	**0.1**	**0.8**	**1.9**	**43.1**		
Total PV	**26.7**	**64.5**	**94.1**			

Source: Ministry of Energy and Industry, by SAARES, March 2011

Below I will go deeper into one of the RE sources looking at Solar Energy: my case study will be based on setting of Solar PV (Electricity) system for the household use in Absheron peninsula where the potential for developing wind and solar energy is exploited. As for the case study of installation I consider Absheron as location and a small house in order to illustrate how this project could have been illustrated if in reality started.

3. SOLAR PHOTOVOLTAICS

One of direct uses of solar energy is Solar photovoltaics. Several developed countries have recently started to widely apply Photovoltaic Program (PVP). Azerbaijan since hasn't developed any projects on wider range, could consider an Involvement in this Program based on existing practices. The efficiency of solar stations depends on country's natural climate condition and geographical location. 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. In comparison with other countries, the quantity of solar rays in Azerbaijan prevails giving an impetus to develop the RE sources wider for social benefit and environmental protection (Baker, R. & Safarzade, E., 2009: 16).

In general, talking about technology of Solar PV, conventional PV modules can simply be incorporated into the roofs of houses, where all or part of the conventional roof can be replaced. In Germany, the government has been strongly encouraging the installation of domestic PV systems and the development of its PV industry. In Japan, subsidies have successfully encouraged the installation of tens to thousands of PV systems, mainly on houses, and the government provides generous long-term R&D funding to its PV industry (Boyle, G. 2004: 87).

Environmental Impacts – Even though there are certain environmental impacts associated with solar technology installation, for instance, depending on soil, location and climate (example of Spain, insects). In general, the environmental impact of PV is lower than that of any other renewable electricity generating system. It doesn't emit gaseous or liquid pollutants, and no radioactive substances though include very small amounts of toxic substances. Certain locations, topography should be considered prior setting such a project. For instance, in southern Spain an issue arose when after setting Solar PV projects, it caused some impacts on biodiversity (insects). PV don't emit noise and if PV arrays are located on building roofs, they require no additional land, but obviously the magnitude of the installation will cause to abundant (if available) land to be used, ideal for remote power supplies and can be attached outside if viable (sides of buildings, roofs). In addition, ambient temperature is also crucial for PV: panels are working more efficient at 20 degree rather than 50, hot climate makes efficiency drop due to the thermal factor. By the end of their lifecycle, PV arrays have to be disposed on recycled.

For instance, in countries like Israel or Spain due to high potential of solar radiation, these countries are successfully implementing Solar PV electricity projects as well as costs and prices are going down while improvements in this system occurs.

Boyle, G. (2004) states that without large quantities of cheap electrical energy storage intermittent renewable energy sources like PV, cannot make a major contribution (97). To underline the enormous contribution that PV could make on a world scale, the European PV Industry Association and Greenpeace published in 2001 a report: Solar Electricity for over 1 Billion People and 2 Million Jobs by 2020 (Boyle, G., 2004: 100). In order to see how a small-scale project with Solar PV (Electricity) could be installed today on the household level, a sample calculation will be conducted and illustrated here in the section following the **Tariff Structure** below.

4. TARIFF STRUCTURE

Currently existing energy tariffs (prices), set by the Tariff Council, were approved in January, 2007 (see Annex 2). Since previously the major issue in the tariff area was the lack of a comprehensive tariff methodology reflecting a clearly stated strategy on the nature of energy production, Baker, R. (2009) suggests to set an agreement among stakeholders on the methodology of setting the tariff or how in the future tariff to be updated (ADP Report: 20).

Methodology of setting tariff - method used to determine the required tariff for potential RE projects was conducted in March 2011 by **Kofler Energies**[7] where *i* (discount rate) and *T* is project lifetime considered (for instance 25 years), then the required tariff would be calculated as below for the RE project:

$$PV = \sum_{\tau=1}^{T} \left(\frac{C \text{ or } W}{(1+i)\tau} \right)$$

Required Tariff [cEuro/kWh] = dynamic prime cost = $\frac{\text{PV (C=annual cost)}}{\text{PV (W=annual generation)}}$

In addition the model for the determination of a cost covering tariff for RE (macroeconomic) was also indicated by SAARES recently; the model total cost of the project (23,5M€) and generation (242GWh) comes to cost of tariff 0,097€ /kWh[8].

Though, widely in many countries, local tariffs are structured to reflect major differences in consumption patterns (between day and night). Yet there is no such model for Azerbaijan applied. Now during discussions with private sectors, tariff issue is major concern due to investments in R&AE projects.

Hence if the government subsidizes at present fuel costs of Azerenergy, why not to subsidize renewable energy costs? Obviously, the special tariff is the first requirement for successful renewable energy project development and implementation, but not only. In this regards, let's now look at Legal Aspects on other RE normative-legal acts.

Another Policy improvement for Direct promotion of Renewable Energy is Feed-in tariff (FIT) system where a set of fixed price for the purchase of one unit renewable electricity. This rate is usually above the market price or above the cost for conventionally produced power and guaranteed for a long period of time (e.g. 15 to 20 years). For instance, Sweden has a system of certificates to allow R&AE to competed with established fossil-fuel systems.

[7] Renewable Energy Sector Development (SAARES), presentation by Malikov, J. Baku. (March 2011).

[8] here: 0,097€ ≈.0,12¢

Here I am taking both international experience of developed states (Germany, Japan) and developing (Nicaragua). Nicaragua current RE sector state is similar to Azerbaijan, it is also in its infancy level of development with limited implementations and going on local projects. The potential of implementation of RE is high with several. Example of key energy-related institutions and how the generation, transmission and distribution of electricity if divided between public and private companies is a good example on how the system is divided and interconnected at the same time.

The German renewable energy law of 2000 was the first feed-in tariff mechanism calculating the remuneration for all technologies, including solar power, based on the technology specific generation costs. This way, windfall profits for producers can be reduced without damaging the high level of investment security (Jacobs, D., 2009: 8). The German feed-in law led to a rapid increase in installed capacity and development of commercial renewable energy markets. The law also distributed the costs of the policy (i.e., the additional costs of wind power over conventional power) among all utility customers in the country (Bryman, 2004). Some other examples Bryman (2004) brings, for instance, Japan and Germany where the "capital costs of Solar PV are subsidize as part of their "market transformation" programs:

- Japan's Sunshine Program provides capital subsidies and net metering for rooftop PV systems. From 1994 to 2000, the government invested 86 billion yen ($725 million USD), resulting in 58,000 system installations and over 220 MW of PV capacity. Subsidies began at 900,000 yen/peak-kW (US$5/peak-watt) in 1994, and were gradually reduced to 120,000 yen/peak-kW (US$1/peak-watt) in 2001 as PV prices fell.

- Germany began a "1000 solar roofs" program in 1991 that offered subsidies for individual household purchases of Solar PV of up to 60% of capital system costs. The program was expanded in 1999 to 100,000 roofs over five years, providing 10-year low-interest loans to households and businesses. As a result of favorable FITs and low-interest loans, the program was expected to provide 300 peak-MW of PV capacity.

5. COSTS AND PRICES EFFICIENCY: CASE OF SOLAR PV (ELECTRICITY) PROJECT

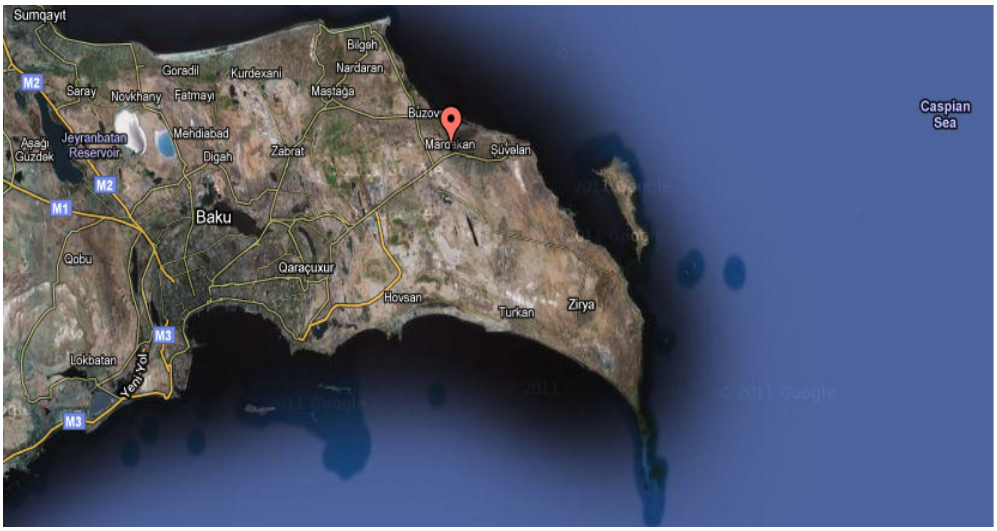


Figure 5: Satellite Image of Baku settlement in Absheron peninsula (Latitude: 40.4922, Longitude: 50.1388)

In my study a sample calculation was established to illustrate how the implementation of small-scale local project for generating residential electricity from Solar PV could be set. Here I will use as an example our summer cottage, located 25 km apart from Baku, on the Absheron peninsula (Fig.5). In order to see and conduct such cost-benefit analysis, I contacted local private sectors on how the process of setting Solar PV works, calculations were mainly done based on my discussion with Dr. N.Ramazanov from the Caspian Technology Company. Having collected main variables needed for a small project with Solar PV (Electricity) installation, I will try to apply same technique here. My Project data is built on:

1. Demand – we need to see what the household energy demand is.
2. How many panels to be installed – number of solar panels per average household demand.
3. Financial calculation - here I calculate what input and output is.

1. Demand

In order to specify household demand, all electrical devices at home have to be counted; afterwards the frequency of their usage needs to be specified. I could have gone one by one, for instance, iron – 2 KW – used 1 hour each 3 days. That would be 30days/3days= 10 times. That means 1hour * 10 time * 2 KW = 20 KW per month. This is how it is done in more accurate. However, since this is a tremendous calculation not to overburden the reader and simplify a complex design, I would rather calculate just the entire household demand, for instance, the whole installed equipments are 15 KW, then multiply it with 0,8 coefficient (which is simultaneity operation coefficient). Well, we assume that whole devices will

work with 80% of installed capacity.[9] In Annex 3 the load reference with loads, power and working days are indicated, taking our monthly electricity bill (an average Azeri family spends monthly with existing wholesale tariff[10]), my calculation will look as following:

kWh/per month * Wholesale Tariff = Monthly El.bill (AzN) - 500kWh*0.06=30AzN[11], annually makes 360 AzN (30AzN*12). If we now take the amount we pay today for household electricity bill and assume it for a time period of 25- years, exl.inflation and oil prices rise with the same tariff price set today for electricity production from conventional energy, it will look this way: 360AzN*25= 9,000AzN.

2. How many panels to be installed

All below data and estimations were discussed and obtained from Dr. N.Ramazanov (CTC). Here we come up with following: If I request from the local market Solar PV 180W output (each 1,8m$^{2)}$ then my estimations show that for area I need in my case project calculations are as follows: 23m^2/1,8m^2 estimates for my area 13 panels, which means 13*180= 2340=2.3 KW. Now number of panels and solar system capacity required are know, so during the purchasing electrical and technical details to be obtained from the local provider that I need to know while purchasing solar panels such as: Installed Capacity, Efficiency Factor (Maximum Power, Maximum Current, Maximum Voltage), Thermal factor (Solar Thermal Capacity Factor), Dimensions, Weight, Inverter[12] (Installed Capacity, Efficiency Factor), then materials (Control unit, steel, cables, switches). Later calculate how efficiency, thermal factors make an impact on generated electricity while keeping in mind orthometric height (above sea level). Here obviously just to count number of sunny days is correct and at the same time is incorrect to consider, key points for solar are solar radiation and altitude above sea level.

3. Financial calculation

In financial calculations we input data from calculations suggested in 1 and 2 above. Plus by adding the price of equipment, we assume and plan on how we would finance this project. Now after we have – demand and installed system capacity, the price of the project (initial equipment price, exl.transportation, installation, operation and maintenance) plus electricity tariff are to consider for main mathematical calculations to come. For this we need to know generated electricity from the system, import from the grid so in order at the end of the day, savings from generated electricity could be enough to cover my credit back. And this might be real if we have quite good electricity tariff and climate conditions. Calculating the costs - first we identified initial capital for the project, later we define financial resources such as % of equity and credit. Right afterwards Operation and Maintenance costs for life period and plus depreciation can be added. Only then we will get an entire table of how efficient

[9] 5 years with 100% product guarantee, 12 years 90% rated power output and 25 years 80% rated power output,obtained
from Total Energy web page, available at: www.totalenergy.az

[10] Electricity Retail Tariff in Azerbaijan, set by the Tariff Council in 2007 for All Consumers (VAT incl.) - 1kWh = 6,0¢

[11] here: as on April 25th 2011 - 1€=1.1707AzN - Central Bank of Azerbaijan Republic, Available online at: www.cbar.az

[12] because the sun only shines part of the time, you would need to purchase a battery bank, an inverter, etc., and that often doubles the cost of the installation

our system is: let's say here we assume that PV system for residential house with demand of 2.5 Kwp costs around 10 000 AzN. Our current monthly payment for electricity is around 30 AzN. Theoretically that is how we calculate payback 10 000/360 = 27 YRS.[13] That means if the life cycle of PV system is 25 years, the return on investment (ROI) is more than life period. And this is not feasible, besides that yet we didn't calculate operation and maintenance expenses, depreciation repayments on loan if we get support from a local bank. Here the main conclusion comes is – the electricity retail tariff in Azerbaijan is too low. When everything works right, assuming that tariff is sufficient, for instance, let's say 12 ¢, then the period of the ROI automatically becomes 13 years, which is normal. Then here the main argument comes whether anyone can afford this, to buy a system for 10 000 AzN. Here we start thinking about long term bank credits with low interest rate. Current minimum interest rate for physical person is 17%. At the end of the day we need to come up with barriers and main limitations that are today in the whole process which sample calculations just presumably estimated. Hence this will help us to see the real picture of what needs to be changed or what the approach should be considered here, which I will discuss in my discussion part.

Based on all above mentioned, my calculations revealed this table where the estimated system size, estimated capital cost, savings & benefits I assumingly might gain here in order to install in our summer cottage Solar PV, in the meantime the amount of CO_2 saved is calculated through the system as well. Using a Solar estimator[14] as an example I adapted my solar electric estimator to our household based on household energy demand and with local tariff prices applied:

Table 4: Solar PV (Electricity) Project Estimations

Solar PV (Electricity) Estimations	
Building Type	Residential (Summer Cottage)
Location	Absheron peninsula, 25km. north of Baku
My average Monthly Electricity Bill: (Assumed rate x average monthly useage)	30 AzN
ESTIMATED SYSTEM SIZE	
Solar Rating of the Area	4.7 kWh/m^2 per day[15]
Solar System Capacity Required	2.3 kW of peak power

[13] Total cost of system / Annual savings = Simple payback time

[14] http://estimator.solar-estimate.org/index.php

[15] 3.0 – 3.5 kWh/m^2/day (during worst month); up to 4.7 kWh/m^2/day (year average) in Absheron peninsula, EBRD (2002)

Roof Area Needed	245 sq-ft [16] (12-13 solar panels with power 2.3kWp required)
Equivalent Annual Production	5500- 6000 kWh electricity
ESTIMATED CAPITAL COST	
Assumed Installation Gross Cost: "Gross Cost" is the cost before any rebates, incentives, tax credits, etc. are applied	10,000 AzN
SAVINGS & BENEFITS	
First-year Utility Savings:	180 AzN to 268 AzN
Average Monthly Utility Savings: over 25-year expected life of system	19AzN to 45AzN
Average Annual Utility Savings: over 25-year expected life of system	300AzN to 510AzN
25-year Utility Savings:	7,500AzN to 12,750AzN
Levelized Cost of Solar Energy (incl. costs of construction, annualized costs for operation and maintenance and the costs of grid connection):	0.12 ¢ per kWh
Greenhouse Gas (CO_2) Saved: over 25-year system life	79 tonnes [17]

Source: Adapted from http://estimator.solar-estimate.org/index.php based on local case

Comparison of today costs with assumptions estimated for 25-years time period are shown in Table 5 in order to realize whether local residents are willing to pay (WTP) for setting such a project in their household:

[16] 245 (sq. feet) = 22.7612448 m^2

[17] According to "Carbon Footprint Calculator" <http://www.carbonindependent.org/> - if in our household annual electricity consumption is 6000kWh , it makes 3.16 tonnes of CO_2 emitted annually, thus 3.16*25YRS=79 tonnes of CO_2 saved by using Solar Electricity (PV) on household

Table 5: Household expenditures for electricity from Fossil Fuel in comparison with RES

Household CBA Comparison of Electricity Bill from Fossil Fuels and Total Project Capital Cost from Solar PV Installation					
Source	**Average Monthly Consumption**	**Monthly Cost, AzN**	**Yearly Cost, AzN**	**Source**	**Total Cost, excluding O&M per year, AzN**
Conventional Energy (Electricity), kWh	500	30	360	Solar PV (Electricity), 2.5KW	10,000
Estimations made for 25 years period of time	**9,000AzN**			**10,000AzN**	

However CBA is being used, it should be acknowledged that an economic interest rate does not provide information about long-term ecological sustainability, so one should not rely on CBA only. In CBA any type of cost may be potentially compensated for by any type of benefit, and any long-term effect by any short-term effect.[18] In this regards, one of the best ways to view same case for me was to use not only from economic perspective, but also from environmental and social, i.e. sustainability approach is one of the possible ways to view renewable energy sector development in Azerbaijan.

6. CHALLENGES

The prices I used here for my sample calculations were mainly based on assumptions how the process would have looked like if implemented in practice. My estimations were based on the obtained approx. prices for general Solar PV project from the CTC. In general, private sectors due to confidentiality or possible competition on the local market didn't provide me with any locally applicable Solar PV (Electricity) project. In addition, challenges of existing solar energy situation now in Azerbaijan lead to certain limitations for businesses and individuals:

Businesses – lack of soft loans and financial incentives as well as vague and ambiguous policies related to renewable energy bring challenges for broader local implementation of the projects with such a scale. Another point is the lack of solar tariffs as well as legislation on investment in general with existing nationalization trends and lack of internationally recognized banks for financing might cause another challenge for private sectors' activities. In addition, lack of governmental subsidies and existing RE tariff for wind and hydro and bureaucracy and lack of legislation transparency are spheres that need to be improved if private sectors' involvement to be supported by the state in the future.

[18] ICRA Learning Materials – Cost benefit analysis III - Key Concepts, 2007: 8

Individuals – according to local media and TV news on recent activities with pilot RE projects, the lack of information on environmental impacts and costs and benefits, the awareness of RE technology, availability on the local market today and how the process actually works leads to the point that no local awareness on RE sector and system exists. Financial incentives (example of household Solar PV installation illustrated) are also not introduced for individuals as well as due to high costs, banks could lend credits to persons applying for them, yet lack of RE credit lines and soft loans are major limitations for now.

In addition, this sample calculation to be considered as for the use of example, since many variables were based on assumptions derived from approximate costs and expenses that might be available in the local market today. However, omitting the inflation and rise of oil prices in the future, this kind of calculations might cause to many biases if not precise numbers and data obtained as well as depreciation should be considered when valid data obtained and calculated.

7. AN INSTITUTIONAL ANALYSIS OF RENEWABLE ENERGY GOVERNANCE MODEL

Country Strategic Goals in Renewable Energy Development: Target and Vision

Previously, environmental concern in the energy sector meant energy conservation and energy efficiency. Now, as technology improves, the core notion becomes shifting towards renewable energy. The roadmap has its own benefits and barriers, however with clear Vision and Targets exist, the strategic goals can be set and achieved. For instance, according to the SAARES, Azerbaijan set targets for years 2015 and 2020 in proportion of using RES which are split into two pie charts here (**Fig.6**).

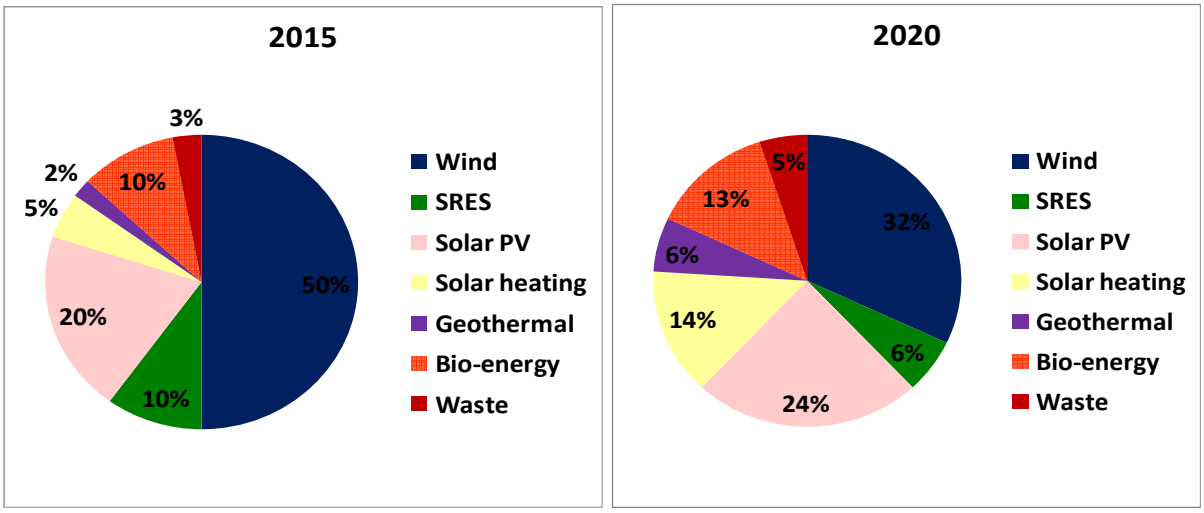


Figure 6: Strategic Goals for RES Development in Azerbaijan for 2015 and 2020, March 2011
Source: SAARES, arch 2011

The pie chart in **Figure 6** illustrates that all potential of RES are considered and set today by the State, here it is showed that so far 25% by 2015 is targeted for implementation of Solar PV and heating local projects while by 2020 it is assumed to increase up to 38% which will equalize it with set wind targets.

The country's aim within the Energy sector in Azerbaijan is to raise the utilization of renewable energy sources (small hydropower, wind, solar, thermal and others) up to 6500-7000MW by 2015. Reforms within legislation, tariff and institutional frameworks would, if implemented, have a real impact on energy demand and related CO_2 emissions. Renewable energy sources will have to play a central role in moving Azerbaijan into an environmentally friendly, secure, reliable and sustainable energy pathway. This is one of the major aim to develop renewable energy in our country is since renewable energy are clean and will help reducing CO_2 emissions in the atmosphere of greenhouse gases all over the world, is one of the important directions for our country also to contribute to this common aim through developing this sphere on local level.

Targets may specify total primary energy from renewables and/or minimum renewable energy shares of electricity generation. Several countries have adopted or are proposing national renewable energy targets. Recent legislative proposals in the United States would require 10% of electricity generation from renewables by 2020. China and India are the first developing countries to propose renewable energy targets. India has proposed that by 2012, 10% of annual additions to power generation would be from renewable energy; China has a similar goal of 5% by 2010.

The target set by the Ministry of Industry and Energy - by 2015 increase energy production generated from the alternatives between 1% up to 15%. Mainly, the focus now is – if the target to be reached, as the main source wind energy is considered (50% of total RES). In order to start developing projects on RES implementation, first of all potential territory within the Republic must be accordingly analyzed with all existing potentials (so far the map with existing potentials is developed, see **Figure 7**) and then involve specialists (environmentalists, financial analysts, engineers, policy-makers) in project implications. However, one thing is still remains uncertain, how will it look once the process takes over, what costs and benefits will be, how will it be supported by current ambiguous legislation and low energy tariff prices? In this regards, I decided to conduct my own basic calculation and base my assumptions on how this process probably will look like, if started.

However, so far no wide implementations and utilization of renewable energy, in our case **Solar PV Energy**, happening; several projects conducted by local private sectors in application of know-how and international practices with local expertise and imported clean technologies involved. However, considering existing situation of renewable energy sector, it is neither possible to meet entire country's energy demand nor broadening this sector due to existing barriers within the institutional framework. The targets and vision for 2015 and 2020 are set for Azerbaijan (illustrated above), in comparison, for instance, EU's lately set target of 20% use of renewables by 2020), Azerbaijan doesn't have such a clear target, the only target is between 1-15% use of renewable by 2015. The concern here is how does the state plan to achieve this ambiguous target with barriers existing within institutional frameworks?

Azerbaijan has high potential for alternative energy generation. Annual total solar radiation in many regions is up to 4.7kWh/m^2/day and about 5,000–6,500 MJ/m^2/year. The wind speed in the Caspian Sea is estimated about 8.5m/s at the height of 80m (obtained from the Caspian Technology Centre).[19] The number of sun hours per year varies, depending on the area and the number of sunny days – 260-280 (MENR, 2010). Duration of solar radiation varies from 1,900 to 2,800 h on different regions including high-mountain zones of the Great and Small Caucasus. Practical use of solar installations is depending on the characteristics of solar radiation of individual regions. The map of Azerbaijan used below represents renewable energy development potentials within various areas in Azerbaijan with high and low potential zones indicated (IEA, 2010):

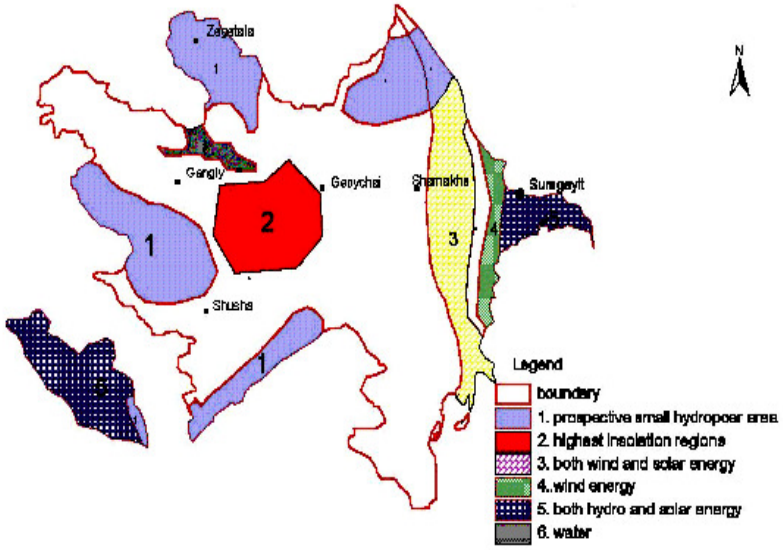


Figure7: Map of Renewable Energy Sources of Azerbaijan
Source: International EcoEnergy Academy. (2010)

<u>Most prospective areas are:</u>

1. The territory of Absheron peninsula including the towns of Baku and Sumgayit and adjoining islands. Wind regime here is exception.
2. All intensive with estimated potential of 1,500 MW.
3. Caspian Sea zone and the Kura River lower reaches – 500 MW from the Kura spit in the South to the border with Dagestan in the North.
4. Nakhchivan Autonomous Republic (70 MW), which includes separate localities on the Zangezur ridge.

8. KEY ACTORS AND INSTITUTIONAL STRUCTURE

Here I intend to look through, first main actors, institutions and organizations (also see Annex 4). It is essential to distinct actors involved in maintaining and changing the system and the institutions which guide actor's perceptions and activities (Geels, F.W. 2004: 898). In the State Program on Use of Alternative and Renewable Energy Sources in Azerbaijan Republic (2005-2014), the main Member and

[19] I use this data here since it is the most recent measurement conducted apart from MENR, 2011

Coordinating Council on Alternative and Renewable Energy Sources is indicating the SAARES. The stakeholders in the RE sector Governmental Institutions which are CabMin – Cabinet of Ministers, Ministry of Industry and Energy, Ministry of Economic Development, Ministry of Finance, "Azerenergy" Joint-Stock Company, Ministry of Ecology and Natural Resources and SOCAR.

Creation of the SAARES was a first step forward in RE sector, aiming to integrate various actors in RE and manage common aim and strategy jointly with clear targets and vision set. The tasks of SAARES are as follows:

- RE Policy and legislation
- RE programming
- RE Potential analysis
- RE Promotion/Information/awareness raising
- RE Project Development

In addition, ADB (2009) summarizes the main objectives of the SAARES is "to promote the power generation from renewable and environmentally sound sources and to more efficiently utilize hydrocarbon energy sources" – major tasks of the SAARES include:

- define the potential of alternative (renewable) energy sources for electric power generation (the technical aspects of this are largely completed);
- raise the efficiency of utilization of country's energy sources by developing RES;
- ensure the opening of additional jobs with creation of new energy production sites;
- increase the energy capacities at the expense of alternative energy sources and therefore, achieve the country's energy security (Baker, R. & Safarzade, E., 2009: 13).

In **Figure 8** potential projects' structure with related financial flows is illustrated in order to show how State is planning to develop or implement in the future local RE projects indicating the main power sales and supervision of an institution that exists locally today, AzerEnergy JSC, state monopoly. In comparison, for instance, with Nicaragua where process of energy generation, transmission and distribution is divided between state and private energy companies, in Azerbaijan this process today and in the future is planned to be managed by AzerEnergy mainly, a Joint Stock Company subsidized by the State with no intention of sharing or involving in the process other existing private sectors in local energy market.

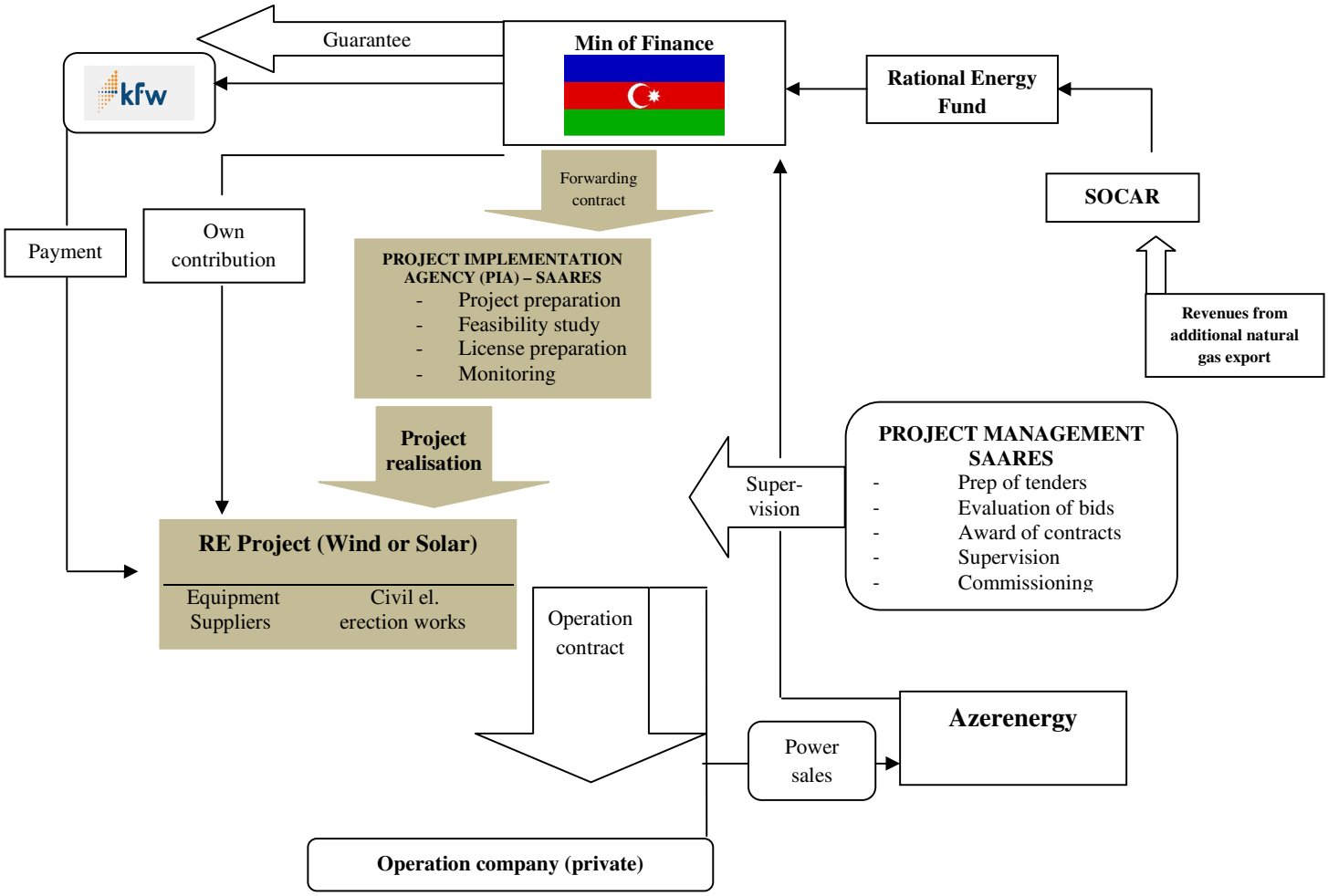


Figure 8: Potential project structure and financial flow
Source: SAARES, March 2011 (by Koefler Energies)

The potential project structure and financial flow, developed recently by SAARES is shown above; apparently, SAARES has supervisory approach in managing the project. However, with only project structure it is not enough to roadmap the vision, here, I think the rules in different regimes, suggested by Geels, F.W. (2004), could be applied in Azerbaijan during RE projects' implementation as below:

It is essential to analyze not only how institutional structures could be formed, operated and changed, but also how consequently they could influence behavior within local society. For instance, E. Ostrom's book "Understanding Institutional Diversity" provides a consistent method for undertaking the analysis of diverse economic, political, and social institutions in understanding the institutional analysis. In this regards, it is analyzed in this work that same phenomena of existing institutions from various interlinked perspectives.

Policy Regimes: administrative regulations and procedures which structure the legislative process, formal regulations of technology (e.g. safety standards, emission norms), subsidy programs; Policy goals, interaction patterns between industry and government; ideas about the effectiveness of instruments, guiding principles;

Socio-cultural regimes (societal groups, media): Rules which structure the spread of information production of cultural symbols; cultural values in society or sectors, ways in which users interact with firms, mutual perceptions and expectations; symbolic meanings of technologies, ideas about environmental and social impacts, cultural categories (Geels, F.W. 2004: 906).

Also, there are a few private sectors involved in Renewable energy sector, which are International EcoEnergy Academy (IEA), "Caspian Technology Company" LLC (CTC), Total Energy and some other local companies such as "Alten Group", Azerbaijan Energy Construction Company, Ecological Innovation Centre and Solaris LTD. However, I will briefly mention only three private sectors (see Annex 4) I maintained contacts and visited; these are IEA, CTC and Total Energy. Here arises a question whether the private sector can undertake the implementation of RE alone? My response would be, it is impossible to have only private sector involved alone since there are institutional and legal aspects that have to be met and arranged by the government where the private sector could meet the criteria, have clear commitments and licenses for certain projects implemented with appropriate environmental and social impacts assessments conducted.

Widely known cliché is that the main objective of business is to maximize profit. However in order to meet this objective business have to consider other indicators that have an impact on the business in one way or the other. These groups include employees, customers, society as a whole. With these indicators in mind, these objectives of business can be summarized as socio-economic. The economic objective of business looks not just as maximizing profit but also on the driving factors necessary to maximize profit. The private sector contributions to economic development comes through the creation of jobs, providing tax revenue, providing finance, creating technology and developing skills (Mason, M. 2008). The Framework of the public-private partnership (PPP) suggested for Jamaica by Mason, M. (2008), could be used as example of how PPP within Azerbaijan based on Jamaica practice applied within RE sector could be developed (**Figure 9**):

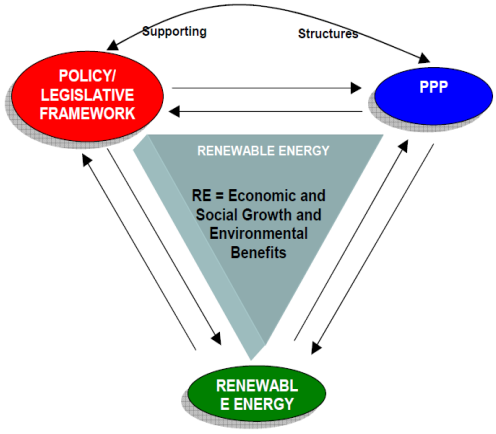


Figure 9: Public Private Partnership Framework: Energy Planning Social and Institutional Framework

9. LIMITATIONS

The main challenge in mapping and indicating main actors was – there is no certain list of companies and actors involved, all searches were done either through internet source engine or through different organizations who have somehow been involved in this sector and could at least give a track. In this regards, I decided in the Appendix 4 to state all parties and key actors involved.
It is obvious that cooperation between private companies and various public organizations is playing an important role in developing the RE energy sector since this circulation within the triangle goes far beyond its boundaries and the changes in the nearest future could emerge from this collaboration while sustainable development not only the country itself but also for social benefit. In addition, mutual collaboration in raising environmental awareness within the public as well as mutually contributing to RE sector development indeed can make the change happen.

SECTION C

RESULTS AND ANALYSIS OF THE FINDINGS

The findings are derived from the conducted semi-structured interviews, review of official documents as well as literature review and sample calculations with an example of domestic Solar PV Electricity installation. Partially, here statistical data was applied to show improvements or discrepancies that exist today within the institutional frameworks. In the research paper I refer to example of mainly developing country since it is hard to compare Azerbaijan RE structure with countries where this sphere has been gone through many changes within last 20 years. In Azerbaijan RE sphere is quite novel and comparing it with similar states that might face similar challenges and ways they manage these barriers could be a better sample in my Research Paper. In this regards, for instance, comparison was going based on developing countries examples.

My initial argument here, before I started data collection, was based on common notion that renewable technology is expensive hence not affordable for the local community, in thus not much enthusiasm would emerge in the development of Renewable Energy Sources in an oil-exporting country. My deductive study (as an outcome of the Ecological Modernization theory) lead my initial hypothesis based on institutional framework, which I assumed were the only barriers leading to a gap that currently exists in the country on RES, inhibiting wider implementation and rapid shift. However, during the research study while literature review and interviews, my findings revealed two aspects: 1) it is not that only legislation or tariff vaguely set within institutions cause to main barriers of the RE development, rather next item of the chain emerges, economic and financial, will there be local market demand for RE technology with low salary of people, 2) there is actually culturally barrier that society, institutions don't realize environmental challenges, simply because there is no environmental education.

During scheduled semi-structured interviews (Annex 1), several issues and challenges were brought up by both public and private sectors which were stated in limitations and will be discussed here as well. In the meantime, it is realized there is not only lack of an essential link between required reforms within institutions, but also by only considering reforms needed for RE sector improvement is not panacea to overcome the barriers. In this regards three aspects were analyzed and discussed through the whole research where major challenges and limitations from Environmental, Economic and Social perspectives were considered:

ENVIRONMENTAL – during semi-structured interviews (Annex 1) and literature review, it was observed that the level of awareness both among institutions and society on what environmental impacts of conventional energy are and how implementation of clean technology could support local ecological improvements in our country are not deeply realized. Hence how local environmental improvements could affect global environmental challenge (climate change) is not prioritized or mentioned neither by private or public institutions.

Climate Change – how seriously this challenge is being seen? Sustainable energy system: such a system is possible only if energy efficiency is vastly improved. The spectrum of opportunity is further enlarged by the possibility of replacing fossil fuel-derived materials with solar resources, which would allow regions with the right land and climate conditions to grow their own resource base. Fossil fuels are assumed to offer lower prices and greater potential, whereas renewable energy is thought to have the edge solely in terms of reduced environmental impact. Other barriers include the high initial investment costs of renewable energy technologies and the fact that external costs of conventional energy production, such as environmental pollution, are not included in the electricity retail price. Essential reforms of renewable energy institutions and businesses are not the stage to accomplish and halt; the stage of achieving favorable condition for improvements while raising public awareness on economic feasibility and environmental education are not of less importance here also. UNDP Report (2010) states no registered CDM projects currently exist in Azerbaijan however when referred to AzerEnergy, it was mentioned currently there are three local ongoing pending to registration.

ECONOMIC – Financial Analysis are based on the case of Solar PV (Electricity) Project Costs and Prices Efficiency I bring as an example of how this affects society. Widely renewable energy systems require a large amount of capital invested and, in most cases, financial incentives from an external source is another mechanism to move. Today the banking sphere in Azerbaijan is too weak in renewable energy sector. In general there is no progress with soft loans except mortgage credit for real estate supported by the government. So this kind of approach needs to be developed for the renewable sector as well. The real picture of how this currently works in Azerbaijan is: except mortgage credit for 15 up to 25 YRS for real estate, other credits for private persons are working as following: request for a credit (as a physical person) with interest rate of 17% and minimum equity of 40% no longer than 5 years. At the meantime, based on secured monthly income, the credit line will vary. Is it possible for an individual to afford more than 40% of equity, consume so much electricity that whole system be paid back within 5 YRS with interest of 17%? On another hand, person who consumes less electricity can't afford more than 40% equity, means he needs longer period and less % for equity. So where is the middle way, where is the dilemma? Due to this high initial capital cost, long-term security and predictable returns on investment are essential for renewable electricity producers. As for banking system, there is no such credit line, and in order to address all these challenges, it is essential to understand them first, in order to raise these concerns and lead for necessary improvements occur.

Public willingness-to-pay faces two major problems here: first, people may be insufficiently aware of the environmental impacts and their consequences; second, willingness-to-pay being constrained by a social income, an environmental problem will be valued differently by a poor and a wealthy person. Presently, the utilization is limited to only one or two facilities for water heating of individual and isolated houses. The use of solar energy could be difficult due to the high rate of air pollution and frequent sand storms, particularly on the Absheron peninsula.[20]

[20] Renewable Energies in Central Asia, 2009: 19

However, institutions should manage reforms within existing legislation and prices not only for state or market benefit but also for the social. For instance, there is no yet set all RE sources tariffs, in my case no solar tariff, no precise market prices available to public or negotiated with AzerEnergy today.
Technological Knowledge (Know How) – So far only CTC is practicing know how which is selection of rational location, proper wind measurements (example of proper wind measurement which I rely mainly on), infrastructure inspection, soil investigation, topography, selection of proper turbine, Micrositing, site planning, grid connection, earthquake calculations and Environmental and Social Impact Assessments of areas where 2 wind turbines were implemented.

So far Azerbaijan has experienced (foreign direct) investment mainly in the oil-sector. The non-oil industrial sector has been rather neglected, but needs to be developed in order to reduce dependence of the oil-sector and offer the Azerbaijan economy future development perspectives. Strong investment policies aiming to support the expansion process of the non-oil-sector, by ensuring transparency of public and private investments, are essential to develop. Transition to solar global economy cannot be achieved without the combined activities of local and independent agents and innumerable small investors. Even though the promotion of renewable energy sources has become a priority for a large number of governments around the world, renewable energy market is not "open" for foreign investors since no transparent legislation, supporting the rights of foreign investors, currently exists as well as low tariff prices which prolong the payback time (in my case study if life cycle of PV system is 25 years, then return on investment (27 years) is more than life period). There are no restrictions for foreign investors, but the Government's permission is needed.

Günther (2009) suggests an important step forward on the way of economic diversification is the combination of local and foreign investment. The two sources of investment should be regarded as complementary, also in order to avoid heavy dependence on foreign investors in the sense of a dual economy. Without a strategic investment policy, including investment incentives, it is hardly possible to attract substantial investment both domestically and from abroad. The need to develop a comprehensive strategy with regard to investment incentives in Azerbaijan is essential (Günther et al. 2009). In addition, in a market economy, investment plays an indispensable role for economic growth, employment and competitiveness. In the end of the day, the incentives are essential not only to support new industry development, but also to lead to modernization of the infrastructure, diversification of economy, upgrade know-how skills while improving the overall business and institutional climate.

SOCIAL: PUBLIC AWARENESS OR MAYBE A CULTURAL THING – The Italian science historian Federico Di Trocchio shows how often new developments have been rejected, this is psychological and cognitive source of the stubborn refusal to let old theories go, even when those theories have long since sunk to the level of prejudice. The question of what gets researched, developed and introduced depends more on social values and powerful interest groups than on scientific results. Knowledge base and awareness of local community is the key to the success of RE development within local society also. As such, there should be timely information release, media information on financial, environmental and technical benefits of RE technology where consultations and all queries addressed to clarify any negative premise that may exist are available. In the case of institutional analysis, another not least vital aspect is lack of

environmental awareness is one of the ways in mitigating and solving emerging environmental issues challenges. But it is still environmental considerations that dictate the primacy of renewable energy, thus bringing about a fundamental shift in policy in an era of electricity market liberalization. Public participation and lack of awareness of all attributes (environmental, economic and institutional) of renewable energy can be raised through provision of clear situation how the renewable energy sectors looks today and improvements achieved to attract consumers, investors in developing this industry locally.

Societal innovation requires many small adjustments that culminate in fundamental changes in the broadest sense imaginable. These fundamental changes would have to constitute the basis for a sustainable process of modernization (Rotmans, 2005: 5). What is actually wrong with the institutional system in Azerbaijan? When we consider societal innovation at the level of broad societal themes and challenges, we speak of a societal transformation. A transformation is a structural societal change that is the result of economic, cultural, technological, institutional as well as environmental developments, which both influence and strengthen each other (Rotmans, 2005: 11).

Then we admit that indeed ecologically friendly technology is important, but only with such technologies for addressing ecological problems. In the case of Azerbaijan renewable energy development, there is vision and strategy set to be actioned in developing renewable energy sector in the future, however with only strategy and vision, it is not enough to shift rapidly towards renewables, major reforms within legislative (clear renewable energy policy) and economic (tariff) need to happen starting from appropriately managed institutions involved in this sphere and while improving current state think not only of state benefit, but also society's as well.

Rotmans (2005) concludes his work highlighting that the drive for societal innovation towards a sustainable society sets high standards for all parties involved: here a great deal of resistance has to be overcome. An important condition for R-Evolution is a change in the dominant perspective from which society is currently viewed. The dominant short-term perspective that is focused on growth, profit and efficiency, and in which everything is expressed only in terms of costs and prices, is poor in relation to sustainability thinking: there is more to a sustainable society than just financial. It is also about living and let live, culture and understanding, respect for people and nature, it's about well-being and prosperity, a balance between humans and their environment, between mind and materialism. Thus, to achieve this, all relevant parties – the government, scientific institutes, private sectors and society – must combine their efforts and create the conditions that will make the shift to a sustainable society possible. But then another issue comes - do institutions and society in a whole understand and consider environmental problems, as part of their culture and lifestyle? A new interdisciplinary and trans-disciplinary knowledge infrastructure is required, that focuses on effective development, distribution and utilization of the knowledge about transitions and system innovations.

STRATEGIES AND POLITICAL RESOLUTIONS – Currently the only available legal aspect for RES is "State Program on Use of Alternative and Renewable Energy Sources in Azerbaijan" approved in 2004 for this sphere development. It doesn't provide commitments and strategy for the process development. SAARES states that revenues from additional gas export to be used for RES development: do we actually

have enough natural gas to export? The strategy and the vision are clear since we possess extra natural gas resources to meet both local demand and export; thus revenues from additional gas export could be invested into the non-oil industry development. However, is it really what the actual vision and strategy pursued by the state? In the pursuit of contributing to this sphere as a researcher I decided to look at this sphere from sustainability perspective and see the real or omitted indicators from the previous studies.

Today in Azerbaijan Energy sector the only company dealing with energy process is a state monopoly "AzerEnergy" JSC, responsible for country's energy generation, transmission and distribution. In comparison with another developing country which is like Azerbaijan is in infancy of shift towards clean energy, Nicaragua, the energy structure in Nicaragua is divided where generation and transmission distribution are divided between several privatized companies. Referring back to Azerbaijan, roles must be divided and set in order collaboration and the main chain of responsibilities could take place.

STATISTICS – The IEA (2010) in their report states that the statistical committee is planning to set a new tool on data to be available in the future on renewable energy sector indexes. However, they also should improve other tools in addition since my research was basically limited to lack of recent and precise data available; either there is data for between 2000 and 2006 or 2007 and 2009; no data available for 2010 even on conventional energy sector. The statistical data would be too costly to collect all benefits humans might get from the sun's energy, but also because the conventional understanding of energy is too narrow. Hence solar energy is not measured. Maybe because of its ubiquity this solar heat input is omitted from the statistics.

Risks associated with fluctuations in future fossil-fuel prices may not be quantitatively considered in decisions about new power generation capacity because these risks are inherently difficult to assess. Historically, future fuel price risk has not been considered an important factor because future fossil fuel prices have been assumed to be relatively stable or moderately increasing. Thus, risks of severe fluctuations are often ignored. However, with greater geopolitical uncertainties and energy market deregulation brings new awareness about future fuel price risks.

The "grand strategy" for the rapid shift to a solar global economy has to be realized by innumerable agents and actors involved through public-private cooperation. Here each taken step and part of the chain is valuable, in that it approaches closer towards the shift to a new economic base. Any strategy for an across-the-board introduction of solar resources will be inappropriate or limited in scope if it does not also provide for the strategies of individual energy companies. There is a wide variety across the industry in terms of the way that these companies are responding to change and to new challenges.

Through reducing subsidies for fossil fuels and raising their taxes to reflect security and environmental costs; increasing research and development of efficiency and renewable energy technologies; reforming the electric utility industry and strengthening local energy policies. Energy tariff (price) reform is a prerequisite to the development of sustainable energy system. Renewable energy has the potential to address many of the most significant challenges that governments and societies all over the world face today: climate change, energy security, national security, energy access, and urban, rural economic

development. If AzerEnergy is subsidized by the state and the recent tariff calculations showed the whole RE system is paid back with the electricity price (0,12¢), which means the price can be set and continue being subsidized by the state, then why not placing this tariff for renewables and promote development of this sector. Then dilemma comes here, can actually the society afford it on residential household level with existing socio-economic indexes?

Like previous scholar I could have state here my recommendations on applying other international best practices in RE sector based on experiences of Germany, Denmark, Sweden and the UK, however, since Azerbaijan in its infancy stage right way could be comparing and observing what in other developing countries experiences used to overcome similar challenges in RE sector. The crucial point is to make the framework dynamic, i.e. indicate how economic activities and processes may influence and transform the sociological structures in which they are embedded (Geels, F.W. 2004: 899).

FURTHER RESEARCH

My main contribution - with this research paper I also contributed as a researcher to bring up this case of Solar PV (Electricity) with suggestion of further research to be conducted in the future. Thorough Environmental Social Impacts (ESIs) have to be further studied as well as financial areas of project implementation split and presented to public with costs and benefits of the project.

The case of Solar PV (Electricity) I attempted to illustrate in this research study, in comparison to other similar experiences applied in Nicaragua, Germany or Japan, is now rather difficult to be conducted in Azerbaijan due to the existing local institutional challenges. Nonetheless the notion for a research that would attempt to connect technology innovation with behavioral response could create the ground for the research that is related field to take a step forward.

In addition, the extent to which renewable energy creates new jobs has not yet been quantified in any way and how emerge of such a job market could impact Azerbaijan in the future.

CONCLUSION

The main challenge that RE sector in Azerbaijan faces today is institutional non-collaborative structure with limited actions on improvements to be taken and considered in order to overcome these barriers. Non-collaboration between public and private and not closely working and sharing of skills and knowledge is one of the main challenges inhibiting improvements within RE sector today in Azerbaijan. Established in 2009 State Agency is still in the process of visioning main strategy and goals for actions to be considered yet it is not enough just to "having a vision", follow-up actions should come after.

Collaboration between public and private sectors would definitely contribute to the implementation of Renewable Energy sources in Azerbaijan and expanding this sphere in a wider context. In consequence this challenge brings to a chain of interconnected challenges which is no deep understanding and awareness on changes that should be taken within RE policy and system as well as what awareness exists among society and how public is eager and willing to pay for this change in order this change could happen and shift towards another step, from its infancy into maturity of the renewables sphere.

Referring to Solar sources, I mean here all renewable sources we get from sun (biomass, solar, wind e.t.c.) Knowledge sharing, experience sharing as well as bringing up main challenges and discussing ways to overcome them can be managed through mutual work on the same sphere. Here I tried to come up to this accepted widely notion from another perspective: sustainability. Since it is actually not only how we manage this shift, it is also how sustainable that structure will be. A stable and predictable commercial framework is needed to be established for securing investments and large-scale deployment of renewable energy, in the case with solar, the top-down approach should be taken: starting from policy, financial incentives and state subsidies. Financial analysis, technologies and strategies must be developed to exploit its advantages to the full. Once this areas are thorough developed and recognized, this setback will become a pattern for renewable energy revolution to come in our country. The shift from fossil fuels to solar energy is inevitable: the only query is whether it happens in time to prevent the existing environmental, economic and political blow of fossil-fuel consumption, and for new industry to bring new ecological stability and ecological modernization (Scheer, H., 2004).

New specializations such as wind prospectors, photovoltaic engineers, and solar architects are among new specializations that might extend rapidly soon. It will allow opening up new local job opportunities and, gradually, real change can happen through widening this sphere not only with regards to profit calculation, but also on society benefit considerations. Concluding with the idea of Scheer, H. (2004) "it is the predominant belief that a stable economic future can be achieved through the famous "invisible hand of the market" which is utopian". Thus he proposes to rely above all on the visible hand of the sun, on desirable and direct benefits, more accessible, more appropriate to people's needs and more realistic. It is also free of danger and definitely less utopian.

Word Count: 14, 957 in main text body

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ANNEXES:

Annex 1.

A. List of Respective Stakeholders and Respondents from Public and Private sectors (Semi-structured open-ended interviews)

Name	Type of Data	Date yyyy-mm-dd	Discussion
Interview at Azerenergy JSC - Afsana Javanshirova, Environmental Advisor	**Semi-structured interview**	**2011-01-10**	Any future planned Renewable Energy projects, was advised that so far mainly small-scale hydro projects developed by AzerEnergy
Interview at OSCE office in Baku - Michel Viland, Economic and Environmental Officer	**Semi-structured interview**	**2011-01-19**	Role of OSCE in RE sector development in Azerbaijan, Reports on Barriers and Recommendations
Institute of Architecture – Prof. Mardan Jalilov	**Semi-structured interview**	**2011-01-21**	Discussion of potentials to develop RE locally
Institute of Radiation problems of the National Academy of Sciences – Prof. Parviz Rzayev	**Semi-structured interview**	**2011-01-24**	Scientific data obtained on solar radiation, insolation, collaboration with the State Agency
Ministry of Industry and Energy, (the State Agency on Alternative and Renewable Energy Sources) - Nazim	**Semi-structured interview, Review of Official Documents and**	**2011-01-25**	discussed developed strategy, involvement of foreign investors and further collaboration with

Mammadov	**Legislation**		private sectors
Total Energy – Mr. Elman Bakhadurov, CEO & President	**Semi-structured interview**	**2011-01-27**	Local market, barriers private sectors face
UNDP, Chingiz Mammadov, Senior Programme Advisor	**Phone conversation**	**2011-02-02**	Current CDM project implementation under Kyoto Protocol
"Caspian Technology Company" LLC - Dr. Nazir Ramazanov, Technical Director & Project Coordinator	**Semi-structured interview**	**2011-02-07**	Private sector role in RE sector, local pilot projects implemented and future projects, barriers faced. Obtained data for payback calculation for local setting a Solar PV (Electricity) small-scale project within household.
International Ecoenergy Academy - Dr. Fagan Aliyev	**Recent Publications reviewed**	**2011-02-22**	Role of the IEA in RE sector, scientific research conducted, collaboration with public and other private sectors
Dr. Randall Baker (Author of **ADB report** *"A Roadmap for Renewaable Energy in Azerbaijan"*, 2009)	**Semi-structured interview**	**2011-03-15**	Discussion on changes comparing to 2009 and today, what has improved, not yet being implemented
Ministry of Industry and Energy (the State Agency on	**Semi-structured**	**2011-03-17**	Obtained tariff calculation methodology and the

Alternative and Renewable Energy Sources) - Jamil Malikov, Deputy Director	**interview**		Strategy and Target developed for RE sector

B. Type of questions asked during the semi structured open-ended interviews

1. What are the challenges RE sector faces today?

2. What inhibits public-private collaboration within RE sector?

3. Do you think that the overall RE policy design and application can be regarded as successful? How can the main policy reforms influence RE sector implementation?

4. How accessible today the information about clean technology for the wide public?

5. How do you think current RE Institutions could be improved in order to accomplish better results?

6. What is the role ad how effective in general is the State Agency in development of RE sector?

7. Do you think that the actions taken by the SAARES are promoting the interests of the PV sector? If no, why? (Particular questions asked to the private company representatives)

8. What are the future plans for improvements towards RE institutions' development?

9. What are the main potentials for today's rapid shift from conventional energy system towards renewables?

10. Can RE fully substitute local conventional energy supply and meet existing country's energy demand?

Annex 2. Local Tariff set on Energy Prices, Tariff Council

The Tariff (Price) Council of the Azerbaijan Republic

RESOLUTION № 3

Baku city, January 06, 2007
About Regulation of the electricity tariffs within the Republic

According to the Degree № 341 dated December 26, 2005 of the President of Azerbaijan Republic, "On Ratification of the Tariff (Price) Council Charter of Azerbaijan Republic, "Rules for organization of state control over formation and application of the tariffs (prices) applied for the state regulation"approved by the Resolution № 247 dated December 30, 2005, of the Cabinet of Ministries and Minutes of the Tariff (Price) Council Meeting, dated January 06, 2007, DECIDES:
1. To approve the above prices for the electricity:

Number	The name of service	Tariffs, for 1 kWh (including VAT), ¢
I	Wholesale tariffs	
1.2.	Generation by "Azerenergy" OJSC	4,1
1.3.	Generation by the private small scale hydraulic stations	2,5
1.4.	Generation by the Wind Power Stations	4,5
II	Retail tariffs	
2.1.	For all consumers	6,0
III	Tariffs for the transit transmission	
3.1.	Transit transmission of the electricity	0,2

2. The wholesale tariffs of the electricity generated by "Azerenergy" include all expenditures related to generation and transmission to the distribution network.

3. Define generated by "Azerenergy" heating energy wholesale tariffs at the rate of 29 manat for per 1 h/calorie.

4. The tariffs of the sold electricity, generated by the private small-scale hydraulic stations and wind stations, do not include electricity transmission tariffs.

5. Transmission of the electricity by the electricity network and transmission facilities of the other entities is held by the transit tariffs of the electricity transmission.

6. Approved tariffs come into force from January 08, 2007 and to consider, tariffs approved for these services before, looses their force.[21]

Chairman of the Tariff Council of Azerbaijan Republic H.Babayev

[21] http://www.tariffcouncil.gov.az/?/en/resolution/view/5/

Annex 3. Load Reference of Household Appliances

Load Reference:				
Name of Load	**Power (W)**	**QTY (pcs)**	**Working Time per Day (H)**	**Working Days**
Color TV	**65**	**1**	**6**	**3 days**
Satellite TV Receivers	**25**	**1**	**6**	
LCD Computer	**100**	**1**	**2.5**	
Energy-saving lamp	**11**	**6**	**6**	
Printer	**30**	**1**	**1**	
Refrigerator	**100**	**1**	**24**	
Washing Machine	**300**	**1**	**0.5**	
Water Pump	**200**	**1**	**1**	
Clock Radio	**10**	**1**	**1**	

Annex 4. Summary of Key Renewable Energy-Related Institutions

Institutional Structure	Contacts	Role
Academy of Science: Institute of Radiation Problems	9 F. Agayev str., AZ1143, Baku, Azerbaijan Tel: +994 12 439 33 91, +994 12 438 32 24 Fax: +994 12 4398318	Deals with radiation problems, all data on solar insolation, radiation and Maps were obtained there. Currently not involved in any local projects on Renewables, no EIAs conducted.
Azerenergy Joint Stock Company (JSC)	Afsana javanshirova, Head of Ecology and Environmental Protection Division Department, 10 Ac.Abdulkerim Alizade4th fl. Baku, Azerbaijan Tel: +99412 497-41-90 (43-18) http://www.azenerji.com/	"Azerenergy" Joint Stock Company (JSC) was established in 1996, a state-owned enterprise and the largest power producer in Azerbaijan (derives only about 11% of its capacity from hydropower).Azerenergy, is responsible for the production of electric and thermal energy. As from 2007, part of the energy Azerenergy is operationally involved, other than its hydro generating capacity, in RE.
"Caspian Technology Company" LLC	Dr. Nazir Ramazanov, Technical Director & Project Coordinator 15 Ahmad Javad str., City Center, 3rd fl. AZ 1003 Baku, Azerbaijan E-mail: info@ctc.az Tel: +99412 497 48 13/14 www.ctc.az	First locally established company (2004) in Azerbaijan, in Renewable and Alternative Energy (wind and solar), today operates the country's only wind farm; raising its capital abroad with the assistance of its German joint-venture partners (ADB report 2009: 33).
International Ecoenergy Academy	Prof. F.G.Aliyev, Chairman 5 M. Arif str., Institute of Architecture Baku AZ1073, Azerbaijan Tel.: + 994 12 438 23 70; + 99412 438 40 25 E-mail:ie_academy@yahoo.com	IEA was foundation in 1994. The main directions are environment protection and replacing fossil fuels with renewable energy technologies. One of the main activity areas of the IEA is "promotion of the development and application of modern environmental standards in partnership with relevant governmental agencies".
Ministry of Industry and Energy (MIE) State Agency for Alternate	Mr. Jamil Melikov, Deputy Director House of Government	**C**entral executive authority implementing state policy and regulation for the energy sector in

& Renewable Energy Sources under the Ministry of Industry & Energy	(Hökümət Evi) Baku , Azerbaijan Tel: +99412 493-1526, +994 12 4987586, 5981675, 5980384	Azerbaijan. In 2009 established **State Agency on Alternative and Renewable Energy Sources (SAARES)**, established in 2009 is in charge of developing programs and projects related to the sphere improvement, collaborating within main actors in this sector as well obtaining international skills and knowledge, approving special permissions/license, development and viewing potentials of existing renewable energy sources in the country.
Organization for Security and Co-operation in Europe, OSCE Office in Baku	Mr. Michel Viland, Economic and Environmental Officer 96 Nizami str., The Landmark III Baku, Azerbaijan Tel: +994 12 497 23 73 www.osce.org/baku	In order to contribute to the further development of the renewable energy sector in Azerbaijan, the OSCE Office in Baku - in co-operation with the Ministry of Industry and Energy and the EU Twinning Project on Legal Approximation and Structural Reform in the Energy Sector of Azerbaijan - organizes a conference on international best-practice in creating a legal and regulatory framework conducive to the development of renewable energy.
Total Energy	Mr. Elman Bahadurov, CEO & President Villa Electra 1, Sharifzadeh str. Baku, Azerbaijan Tel. (+994 12) 502 55 58 www.totalenergy.az	(estabslished in 1999), is specializing in renewables, mainly photovoltaic and wind power supply, specializing in the system integrating, development, manufacturing and distribution of solar energy products and systems
UNDP in Azerbaijan	Mr. Chingiz Mammadov UNDP Senior Development Adviser Tel: +994 12 498 98 88 Email:Chingiz.mammadov@undp.org	Second National Communication to the United Nations Framework Convention on Climate Change, 2010, CDM Project Monitoring