Renewable Energy Roadmap for Armenia

Task 4 Report

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Abbreviations

AMD	Armenian Dram
DSM	Demand-Side Management
EU	European Union
GDP	Gross Domestic Product
FIT	Feed-in Tariffs
Gg	Giga gram
GHG	Greenhouse Gases
GW	Giga Watt
GWh	Giga Watt hour
HPP	Hydro Power Plant
IFC	International Finance Corporation
kW	kilo Watt
kWh	kilo Watt hour
LPG	liquefied petroleum gas
m/s	Meter/second
m^3	Cubic meter
mln	Million
MW	Mega Watt
NPP	Nuclear Power Plant
PPA	Power Purchase Agreement
PSRC	Public Service Regulatory Commission
PV	Photovoltaic
R & D	Research and Development
RE	Renewable Energy
RET	Renewable Energy Technology
RoA	Republic of Armenia
SHPP	Small Hydro Power Plant
TOE	ton of oil equivalent
TJ	Tera Joule
TPP	Thermal Power Plants
VAT	Value Added Tax
USD, US$	United States Dollar
USSR	Union of Soviet Socialist Republics
WB	The World Bank

1 Executive Summary

This first version of an Armenian Renewable Energy Roadmap[1] identifies the economically and financially viable potential of renewable energy (RE) in Armenia. It defines short (2013), midterm (2015), and long-term (beyond 2020) targets for the development of RE as well as outlines specific steps towards achieving those targets. It includes milestones to allow regular tracking of progress towards the established goals.

As a country possessing few raw materials, Armenia has no direct access to fossil energy and has to rely on their import (97% of prime energy sources). However, it can utilize different sources of RE available within the country. RE can be grouped in the following three main groupings:

- electricity from small hydropower (SHPP), wind power, photovoltaics (PV), geothermal power, and biomass;
- heat from heat pumps, solar thermal power, geothermal power, and biomass;
- energy for transportation from gas and liquid fuels extracted from biomass.

Several factors were taken into consideration during the development of the Roadmap, such as targets, technologies, legislative measures, and possible impact on the environment.

- The *Roadmap targets* set the priorities in the development of the RE and the energy system such as energy independence, potential of lowering the energy costs, creation of high tech industries, environmental benefits, as well as responsiveness to the technological and business changes in the world.
- The types of *technologies* available determine the potential for energy generation, suitable management structures, pre-requisite infrastructure requirements, and how the use of the generated energy can be optimised. These technologies include: small hydro, wind, solar PV, solar hot water, biofuel, heat pumps and electric vehicles, pumped hydro storage, hydrogen economy, demand-side management tools for load levelling, and also energy efficiency technologies and measures. The global energy industry, technology, and business resemble a dynamic field that develops fast and relies on technological, scientific, and business knowledge.
- Preparedness for *possible changes in the energy environment* can be achieved through planning and developing the appropriate capacities in these areas. The changes to the energy environment may include technological developments, emerging export/import opportunities, as well as overall industry and economic developments in Armenia and in the rest of the world.
- *RE legislation* represents a package of legislative measures intended to encourage and to support the business as well as the implementation of Renewable Energy Technologies (RET) by the population. Each RE option or technology requires a specific approach stemming from the Republic of Armenia targets. This set of variables serves as the catalyst for the RE development in Armenia. Managing these important factors through proper planning and regular updates would contribute to the achievement of the targets of the Armenian RE Roadmap.

Figure 1.1 on the next page illustrates the aforementioned variables.

According to the main results of the Armenian RE Roadmap project, the contribution of the renewable electricity in Armenia can increase by fivefold in 2020 in comparison to the present energy production from RE. In 2010 RE production generated 310 GWh, and it is forecasted to generate 740 GWh in 2015, and 1500 GWh in 2020. It is important to emphasise

[1] This project has been funded by the Global Environmental Facility (GEF) and by the World Bank (WB), under plan TF-056211. The results, conclusions and recommendations expressed in this report represent the points of view of the Danish Energy Management, A/S Denmark, and may not necessarily represent those held by GEF/WB, or by the R2E2 fund.

that the achievement of targets is much more dependent on politically implemented measures than on technical capabilities.

The findings of a comprehensive review of RE potential in Armenia have ranked SHPP (up to 10 MW) and solar hot water heaters as the most advanced RETs and the most economical for Armenia in the short to medium-term, followed by grid connected wind farms and the use of heat pumps.

Photovoltaics, geothermal power, and biofuels, especially bioethanol from cellulosic feedstock, are ranked as more costly in today's prices and are not expected to be commercially viable in the short to medium-term, but may play a more important role in the longer term, and in the development of RE high-tech industry.

Biomass was also considered for both heat and electricity production for the short term, under several conditions, including re-planting of harvested trees and biofuels using fractionation process. In addition, hydrogen was considered as a possible fuel for transportation in the longer term. Finally, although not strictly a renewable resource, municipal solid waste in landfills was considered a practical source for generating methane for power production near municipalities. Table 1.1 presents the estimated RE technical potential in Armenia in accordance to the findings of the Roadmap project.

Table 1.1. Estimated RE Technical Potential in Armenia

Technology Type	Capacity
PV	>1000 MW
Wind	300-500 MW
Geothermal	25 MW
Small Hydro	250-300 MW
Solar Thermal	>1000 MW
Heat Pumps	>1000 MW
Biofuel	100 thousand tons/year

One of the most important results of the Renewable Energy Roadmap for Armenia project is the establishment of the national targets for renewable energy technologies in all three energy sectors. The targets are established using a special methodology, based on the consumption data of the last decade. To that end, energy demand for Armenia in the of electricity, thermal energy, and transportation sectors were developed for various scenarios including the base case, where the demand can be fulfilled by utilizing a variety of energy sources such as renewable energy, fossil fuels, and nuclear power.

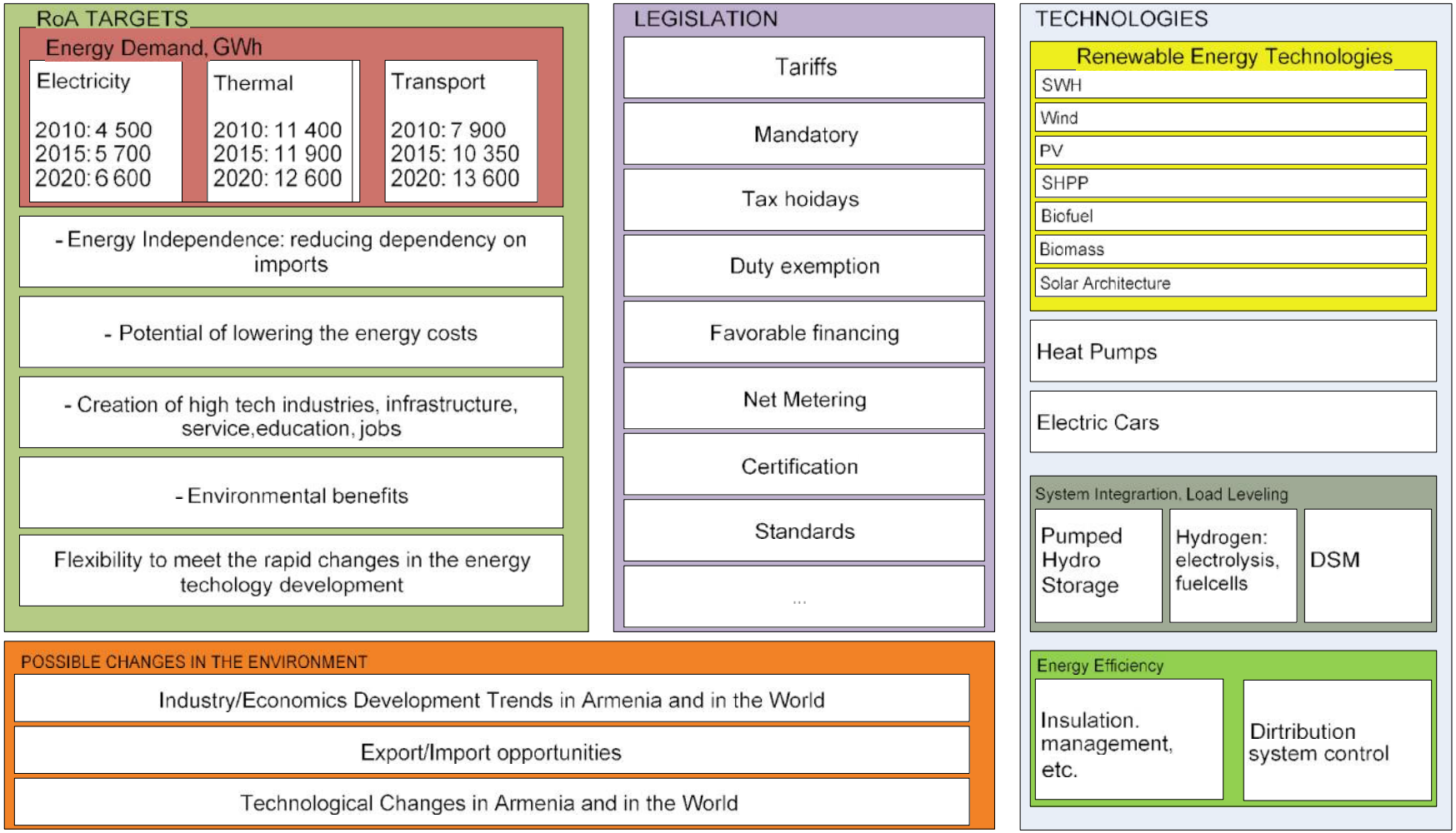


Figure 1.1. The roadmap variables

In order to provide ease of comparison of the calculated results, GWh units are used for all three sectors. Table 1.2 summarizes the demand forecast for the three energy sectors, using a base case scenario for each sector.

Table 1.2. Base Case Demand Scenario Forecast

Sectors	Year, GWh		
	2010	2015	2020
Electricity	4500	5 700	6 600
Thermal Energy	11 400	11 900	12 600
Transportation Fuel	7 900	10 350	13 600

One of the most important outcomes of the Roadmap related research indicate that for the base case the national targets for RE penetration could be **2.4%, 3.1%,** and **4.9%** for the years 2013, 2015, and 2020, respectively. If renewable energy is considered in its classical meaning, i.e. including large hydro and biomass (firewood), then the targets become **17%, 15%,** and **16%**, respectively.

Table 1.3 presents the details of the Roadmap project results for all three energy sectors which are for near term, 2011-13, midterm, 2014-15, and long-term, 2016-20, as well as for the decade, 2011-2020. The data are the cumulative values for the particular periods.

Table 1.3. RE Penetration for Different Years

Energy Type	2011-2013	2014-2015	2016-2020	2011-2020
Electricity				
Generation, GWh	18 000	12 800	44 900	75 800
Renewable without large hydro, GWh	1 360	1 380	6 070	8 800
Percent of RE as of total generation*	2%	2.8%	4%	3.3%
Investment in RE, mln. $	$130	$140	$450	$720
Thermal				
Generation, GWh	31 600	23 300	61 700	116 500
Renewable without biomass, GWh	56	83	380	520
Percent of RE as of total generation*	0.08%	0.17%	0.26%	0.20%
Investment in RE, mln. $	$32	$21	$54	$108
Transportation				
Generation, GWh	26 000	20 100	61 200	107 300
Renewable, GWh	140	290	730	1 150
Percent of RE as of total generation*	0.21%	0.57%	0.49%	0.43%
Investment in RE, mln. $	$74	$ -	$ -	$74
Total Generation, GWh	67 900	49 700	149 600	267 200
Subtotal of RE generation, GWh	1 560	1 750	7 170	10 500
RE percent of total generation*	2.3%	3.5%	4.8%	3.9%
Total RE supply with large hydro and biomass, GWh	12 150	7 580	23 700	43 400
Total RE with large hydro and biomass percent of total generation*	18%	15%	16%	16%
Total Investment, mln. $	$240	$160	$500	$900

** Total percentages are cumulative for the particular period*

Figure 1.2 summarizes results of the base case scenario. The base case calculations are performed based on the following two assumptions:

1. The illegal cuttings that could amount in 2010 up to the equivalent of 2000 GWh, in 2015 they should decrease to the legally allowed levels and result in 773 GWh.
2. The new NPP with the 1000 MW installed capacity will start its operation at the beginning of 2017.

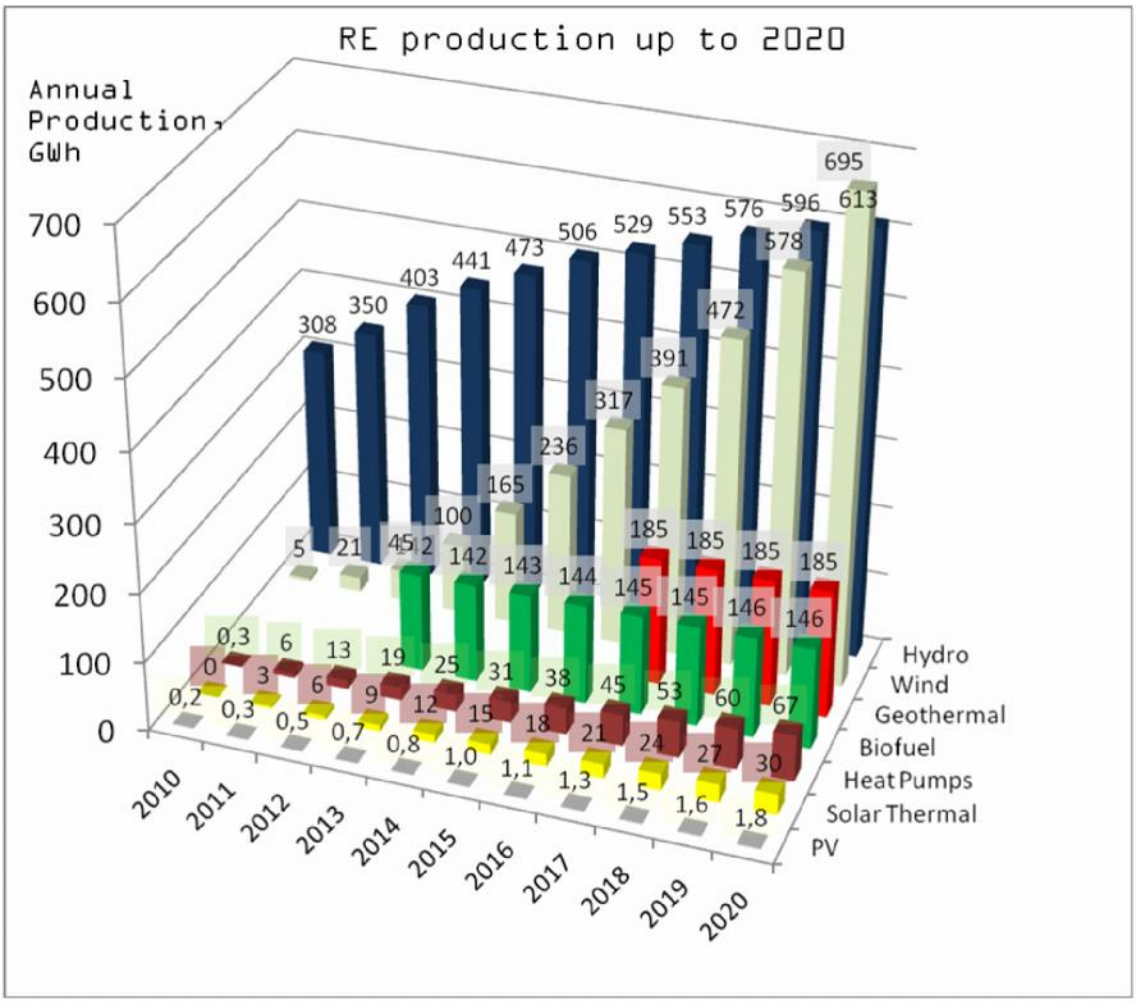


Figure 1.2. The Base Case RE Annual Production up to 2020

The project suggests building a bioethanol capacity by 2013 that will provide 10% blend to all of the gasoline used in Armenia, which could decrease the imports of the latter by 18,000 tons annually. It is anticipated that gasoline consumption would not increase in the future but the growth of the demand for fuel would mainly be met by natural gas. Therefore, during midterm, additional production capacity of biofuel may not be needed to satisfy the 10% blending requirements. The creation of a fleet of cars operating on bioethanol after 2020, will allow the increase of bioethanol production up to 100 thousand tons/year. This will create a possibility to use up to 85% bioethanol blending.

In 2020, with the commissioning of the new NPP in 2017, there would be a power excess of more than 2000 GWh, which could be exported, representing a good portion of export potential for Armenia. The use of this potential may become an important basis for the regional cooperation, first of all in the directions of Armenia-Iran, Armenia-Georgia, Armenia-Turkey, and in other directions. In addition, introduction and exploitation of a fleet of electric vehicles (EV) and electric rail transportation means (in Yerevan and between the cities) will have a

synergistic positive effect on the total power system, as well as on the improvement of the energy security of the republic[2], since:

1. The 100% dependency of the republic on the imported fuel would be eliminated.
2. Load levelling: since most of electric vehicles would be charging their batteries at night-time, they will be using the excess power of the new electric generation capacities most effectively, thus serving as a natural means of load levelling.
3. Environmental benefit by not releasing of approximately an equivalent of million tons of CO_2 every year. The air quality would significantly improve in the major cities, due to the substantial reduction of the emissions.

Development of various renewable energy sources and of industries associated with each of them is slow. Most of the time on a cost basis they cannot compete with traditional energy sources, with the exception of SHPP. Therefore, favourable laws and policies are necessary to stimulate the deployment of clean energy technologies. In general, laws and regulations of the RoA are adequately addressing issues related to renewable energy. However, a more favourable regulatory environment is needed for the large-scale development of renewable energy resources in Armenia in order to achieve the targets listed in Table 1.3.

Governmental interventions would be necessary to achieve targeted goals for the development of RE. These interventions have been grouped into two main categories of legislation as well as institutional development and education, each with a number of sub-categories. Table 1.4 on the next page summarises the suggested interventions.

Business driven development and exploitation of the potential presented in the Table 1 is possible only through appropriate legislative support. In the electricity generation it is possible through adoption of the tariffs calculated in terms of the Roadmap project. The break-even values of these tariffs (BET-s) that provide payback of expenses but no profit are presented in the Table 1.5. This system of supportive tariffs plays a central role for the achievement of the RE targets.

Several barriers that hinder the growth of RETs in Armenia are:

1-Obtaining the necessary permits and licenses for SHPP and wind power is cumbersome.

2-Coordination between different authorities in obtaining permits must be enhanced and the problems related to little transparency in procedures, long lead-times and high costs involved in obtaining permits or licenses must be solved

3-Turbines imported for small hydro power plants are free of VAT and customs duties; however, the law does not specifically mention that generators and other related control components are also exempt.

There are two main barriers to appropriately spreading the risk of investments in RE projects. These are: (i) the duration of the water permit of only three years and (ii) the issuance of the power purchase agreement.

[2] In early years of independence a contentious decision has been made by the RoA government to cut substantially the on-ground electric transportation such as trams and trolley buses.

Table 1.4. Interventions Summary

Intervention		Near to mid-term	Mid to long-term
1	Streamlining procedures for issuance of permits	√	
2	Develop a road map to obtaining permits	√	
3	Set up shorter deadlines for administrative decisions	√	
4	Establish a fast track procedure for smaller projects to significantly reduce transaction costs	√	
5	Establish a fast track procedure for land use category change	√	
6	Extend water permits to 15 years to significantly reduce project risk	√	
7	Move issue time of electricity sales agreement to time of development permit by including provisions of construction period limit and anticipated electricity generation to provide the utility company opportunity to plan the future demand and compensation in case of project cancelation or major delays.	√	
8	The possibility for opening for purchasing licenses already given might have a positive impact on the collateral issues for financing projects.		√
9	Establish a time limit or a sunset clause for land lease for a site that is suitable for SHPP development to prevent speculative activities. This means if a leaser does not start process of developing SHPP after a specified time, then the lease will be voided.		√
10	Experience show that the main reason for the wide spread use of biofuel has been government established mandates. It is recommended that government institute a 10% mandatory blend of bioethanol in gasoline.		√
11	Exempt harvesting mature trees in biofuel growing plantations from restrictions that apply to cutting mature trees in forests and green belts[3]	√	
12	Modify the VAT law to address the entire power generation train with its control components instead of just listing turbines.		
13	To improve the cash flow, VAT could be paid back over a number of years, based on a percentage of the electricity sold starting from fourth year of the electricity generation.	√	
14	A tax holiday for particularly large-scale wind farms could be an effective way of boosting project feasibility to foreign investors at a relatively low cost.		√
15	Eliminate import duties on solar thermal and heat pumps.		√
16	Eliminate customs duties on hybrid and electrical cars.		√

[3] The Intervention is meaningful if the restrictions against logging in national parks, preserves, and forests are strictly enforced. Otherwise there is increased risk of illegal logging in these protected areas. Another critical issue is the compliance of the plantation species with the biodiversity conventions to which Armenia is a signatory.

Table 1.5. Break-even Tariffs for Selected RETs

RE Technology	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Wind, cents/kWh	10,3	10,4	10,5	10,7	10,8	10,9	11,1	11,2	11,4	11,8
Small hydro, cents/kWh	3,6	4,1	4,8	5,3	5,9	6,2	6,5	6,9	7,2	7,4
PV, cents/kWh	47,4	44,6	40,0	37,7	38,0	33,1	30,5	28,2	26,0	24,0
Geothermal low cost, cents/kWh	--	3,9	3,8	3,8	3,8	3,8	3,7	3,7	3,7	3,6

Awareness raising as well as capacity building are ongoing efforts, needed to implement the above recommendations as well as to facilitate a proper impact of the interventions. Incorporating awareness raising and capacity building into each of the interventions is thus necessary.

Constant monitoring and evaluation of the roadmap is necessary to ensure and improve effectiveness, efficiency, accountability, and capacity building. It is a key part of managing the implementation of the renewable energy strategy. These include: measurable, published, and legally binding targets as well as milestones and the identification of responsible parties are part of the monitoring plan.

Even though the Roadmap sets out a first strategy to advance the use of RE in Armenia, it is essential that a long-term vision of the ideal Armenian energy situation be developed. Eventually, binding national targets should be established to signal clearly, long-term government commitment to the vision, and to ensure that strategies through time aim at a common long-term vision.

The Time Bound Action Plan given in Appendix 1 of the Roadmap, reflects on the need for ongoing and proper monitoring of the interventions as well as the need to ensure medium-term evaluations to adjust the RE Strategy.

It is worth noticing that while during the second half of the 20th century the world experienced the fastest growth in energy technologies, it is only during the last two decades that the development of RETs has really taken off. The transition to increased use of RE while providing energy security and flexibility to a country is empowered by a sufficiently strong technological, scientific and educational basis as well as an infrastructure, which is well integrated in the world RET community.

Investment in the latter could be very effective compared to any other area, taking into consideration that the transition to RETs in the whole world has a 1000-fold growth potential. Armenia can benefit from this and create capacities that shall allow the country to become a credible player in the world energy market.

2 Current Status

Armenia has overcome the energy crisis of the 90's and has built a viable energy system. However, compared to the year 1988 – the peak of economic output of the Republic of Armenia – energy consumption lags far behind. The generation capacity in 1988 was over 3.5 GW, but the energy use in 2010 was on average below 1.2 GW. This can be explained by the fact that industry in Armenia has yet to recover fully from the economic decline that started with the collapse of the USSR[4]. On the other hand, this lag opens up opportunities for the future growth. Development of RE technologies would contribute to the growth of the economy and the improvement of living standards. Armenia, with its population of over 3.2 million[5], 64% of which is urban, has a strong tradition in science and engineering from the Soviet era, when the country was one of the most industrialized of all the Republics. Transition to a market economy has brought about substantial changes in the energy consumption pattern of Armenia.

Electricity

Electricity generation in Armenia substantially dropped since its peak in 1988. A number of Thermal Power Plants (TPP) have been mothballed and one of the two reactors at the Metsamor Nuclear Power Plant (NPP) has been shut down. Today, power generated from the Hrazdan-Yerevan and Vorotan Hydro Power Plant (HPP) cascades remain as important a power sources as it was during the energy crisis of the early 90s. At present, electricity generation depends mostly on imported nuclear fuel and natural gas; however, hydropower is still responsible for approximately 1/3 of total power generation. Almost half of the electricity generation capacity, which include Hrazdan TPP, Sevan-Hrazdan HPP cascade, and all small hydro power[6] plants (102.5 MW installed, 9% of current operational capacity) are privately owned. The Armenian government is planning to decommission Metsamor NPP between 2017 and 2021. There is a plan to build a replacement NPP with capacity of 1000 MW, which would become operational no later than 2021.

More than two thirds of the existing electricity generation capacity and the distribution system has been fully depreciated, allowing the cost of generation to be rather low. However, substantial investment will be needed in the coming years for renovation and upgrading of the system.

As of early 2011, the price of electricity for the residential consumer during the 16 hours of daytime is AMD 30/kWh (7.9 US cents/kWh) and during the eight hours of night time is AMD 20/kWh (5.3 US cents/kWh). The weighted average price of electricity for all consumers is AMD 25.8/kWh (6.9 US cents/kWh). These prices include VAT.

Thermal

Thermal energy generation capacity has also changed substantially during the last two decades. Three factors are responsible for this change. First, during Soviet era, there were no air conditioning (A/C) systems installed in either urban or rural buildings except for a very limited number of window-A/C units. Secondly, the multi-family buildings of the Soviet times did not have active centralized ventilation systems, but rather passive ones available only in the kitchens and bathrooms. Finally the district heating systems, powered by heavy oil (mazut) and natural gas were the main heating systems along with electrical heaters used in apartments to supplement these systems. After the collapse of the USSR most of the urban centralized heating systems were dismantled. A large portion of the population, approximately 30%, has installed individual natural gas powered heating systems. This trend has especially accelerated during the last five to seven years. The average cost of these gas powered heating systems for a family is estimated to be approximately $1500. The price of natural gas in Armenia as of early 2011 is AMD 132/m^3 ($350 per 1000 m^3)[7].

Most of the multifamily buildings were built using reinforced concrete panels with no thermal insulation. The construction boom in Armenia has generally involved modern engineering techniques, which have resulted in the introduction of energy efficiency measures, such as proper insulation, centralized heating and cooling, as well as double-glazed windows. However, according to some reports, interna-

[4] Costing out the Big Bang: Impact of external Shocks on the Armenian Economy at the Outset of Transition. Lev Freinkman, Vahram Avanesyan. Armenian Journal of Public Policy, Volume 1, Number 1.
[5] This number is forecasted to change very little during this decade.
[6] The only existing Lori-1 Wind Farm, 2.6 MW, is responsible for less than 0.1 percent of installed capacity in Armenia.
[7] Natural gas enters Armenia through pipeline at a cost of $180/1000 m^3.

tionally accepted efficiency standards are not being followed entirely at the newly constructed multi-family buildings. The present installed solar water heating capacity is no more than 250 kW and there are very few buildings constructed that employ solar architecture procedures.

Transportation

The major changes in transportation are related mostly to the slow but steady increase in living standards in Armenia and the increase in the GDP of the country, which in turn has increased the number of privately owned cars. The annual increase in the number of privately owned vehicles between 2009 and 2010 is 9%.

Increases in the use of natural gas as an alternative to gasoline has in turn increased the proportion of natural gas powered vehicles to more than 40%. This trend is continuing but it has levelled off. Converting an average car to operate with natural gas, costs approximately $1400 and it reduce the cost of fuel by half. Presently there are virtually no hybrid or electric vehicles in Armenia and there is no infrastructure to support electrical cars.

If the pressing need for high quality roads to replace existing ones was met, this would consequently provide a potential for fuel economy. Currently gasoline costs AMD 450/litre ($1.2/litre) and LPG AMD 160/kG ($0.42/kG) on the Armenian market.

Natural gas, which is essential for the operation of a substantial share of all three energy sectors (electricity, thermal energy, and transportation), is distributed through the monopoly gas company ArmRusGasProm of which the Russian company Gazprom owns 90%. In 2010 Armenia spent $224 million for different types of import liquid fuels (gasoline, diesel and jet fuel, etc.), and $244 million for natural gas.

Encouraging research and development will be one of the most effective measures to address the short-term and more notably the longer term targets for the development of the RE industry in Armenia. The three main universities in Yerevan, the Yerevan State University, the State Engineering University of Armenia, and the Yerevan Institute of Architectural and Construction, already have limited programs and research activities addressing various aspects of the science and technology of energy generation and utilization.

3 Energy-Related Goals of the Republic of Armenia

Key issues that would affect the future development of RE in Armenia and their effects are outlined in this section.

3.1 Energy Independence: Reducing Dependency on Imports

Renewable resources offer benefits because not only can they reduce pollution, but they also add an economically stable source of energy to the mix of electricity generation sources in Armenia. Depending only on imported fuel for energy production makes the country vulnerable to volatile prices and interruptions to the fuel supply. Since most Renewable Energy Technologies (RETs) do not depend on fuel markets, they are not subject to price fluctuations resulting from increased demand, decreased supply, or manipulation of the market. Since fuel supplies are local, renewable resources are not subject to control or supply interruptions from outside the region or country.

The nation's fossil fuel dependence also has serious implications for national security. Table 3.1 presents equivalent amount of various types of imported fuel that can be replaced by RE for every GWh of energy generated.

3.2 Potential of Lowering Energy Costs

An additional benefit of increased competition from renewable technologies and thus reduced demand for fossil fuels is the potential reduction in prices for electricity generated from fossil fuels. Several studies conducted in the U.S. have shown that competition from increasing renewable technologies could reduce natural gas prices.

The operational costs of renewable technologies are low, because renewable energy sources such as solar radiation, wind, or river water flow are free. While the initial investment in RETs is still high, the continuous increase of fossil fuel prices and further development of RETs would lead to lower priced RE alternatives for Armenia.

3.3 Environmental Benefits and Impacts of Renewable Energy

Renewable Energy generation would have mainly positive, long-term environmental effects as it reduces the need for power generation based on fossil fuels, thereby reducing Greenhouse Gas (GHG) emissions. Renewable technologies can also reduce water consumption, thermal pollution, waste, noise, and adverse land-use impacts. Of course, RE also has environmental impacts during construction and operations. Construction impacts are normally temporary and similar to other industrial projects.

Table 3.1 - Equivalents of 1 GWh of generation to Imports of Fuel

Field of Energy	Imported natural gas, 1000 m^3	Imported gasoline, tons	Imported diesel, tons	in TOE
Electricity Production	250*	-	174	172*
Thermal Energy	125		87	86
Transportation	179	129	124	123**

* Efficiency of conversion = 50%

** Efficiency of conversion = 35%

These impacts could be reduced by using best management practices and appropriate mitigation measures.

The main potential impacts of Small Hydro Power Plant (SHPP) projects could be impacts to migrating fish stock if proper fish bypasses are not installed or proper precautionary measures are not implemented to avoid fish being sucked into the turbines. There is also the possibility of an adverse impact to wildlife if the required minimum water flow is not maintained in the river downstream of the plant.

The main impacts resulting from the operation of wind farms are low frequency noise and visual disturbance of the landscape. There is a possibility of birds colliding with turbine blades; therefore, avoiding bird migration paths for wind turbine farms would minimize this impact.

Bio-fuel production results in virtually no net carbon emissions during a complete life cycle if forests are not destroyed to make land available for planting feedstock. Even though gasoline that is mixed with bio-ethanol has less CO_2, the blend produces higher nitrogen oxide than gasoline, which is the main component of air pollution that causes smog. Depending on the feedstock, the leftover by-products could be useful as fertilizer, fuel for operating processing plants, or become waste.

Possible impacts from PV panels and solar water heaters could be the visual impact of reflected light. Burning fire wood crates air emissions and small particle matters that could be harmful to human health and there could be an impact to the ecosystem due to the unsustainable rates of harvesting biomass. There are no significant environmental impacts from the operation of heat pumps.

Many environmental impacts described above result in real costs to society and to individuals. When such costs are not included in energy prices, they are referred to as "externalities". The largest external costs from pollution are human health costs, in the form of health treatment costs, higher health insurance rates, missed work, and lost life. However, unless policies are adopted so that utility rates account for these health and environmental costs, advantages of the RE in reducing cost of externalities are ignored by customers and developers.

3.4 Creation of High Tech Industries, Infrastructure, Services, Education, and Jobs

RETs will not only keep hard currency in Armenia, but also create significant benefits through economic development. RETs create jobs using local resources in the form of a new, "green," high-tech industry with an important export potential. They also expand work indirectly in local support industries, such as banks and construction firms.

Biomass production is relatively labour intensive, which is one of the reasons it is slightly more expensive than fossil fuels. Growing, harvesting, and transporting biomass fuels all require local labour, as does maintaining the equipment, which contribute to the high cost of bio fuel. However, this means that jobs will be created in areas with a depressed agricultural economy.

Because some renewable technologies are small and modular, they can be situated in or near buildings where energy is used. This means that distributed generation technologies can avoid costly expenditure on power transmission and distribution. For example, a utility distributing in a new neighbourhood might be able to use smaller transformers or reduce the size or number of power lines going to the neighbourhood. Distributed generation reduces the wear and tear on existing distribution equipment, as well as reduces power losses through the transmission system.

Given overall the RE growth rate in the world, Armenia may be able to become an exporter of certain RETs if they are developed and improved in Armenia. Manufacturing goods for export will in turn encourage job creation.

3.5 Flexibility to Meet the Rapid Changes in Energy Technology Development

The perspective of RE (wind, solar, small hydro, and biomass) in the future energy strategy of Armenia involves three major technological changes: energy savings on the demand side, efficiency improvements in the energy production, and replacement of fossil fuels. Therefore, the activities must include strategies for integrating renewable sources in coherent energy systems influenced by energy savings and efficiency measures. The necessary RE sources are present in Armenia, and if further technological improvements of the energy system are achieved, an increased role for RE in Armenia can be created. The technologies of converting the transportation sector and the introduction of flexible energy system technologies are specifically crucial.

Flexible regulatory frameworks and improvements in the electricity grid infrastructure are essential to building a sustainable and secure energy system. Today, RE investments are highly dependent on legislative and financial incentives. Over the long-term, it is clear that future RE investments will depend on the operating costs without mandate or subsidy.

Improved operation and maintenance practices and technologies can reduce costs associated with utility-scale operations of renewable power plants. Up-to-date information is critical to explore new opportunities for the deployment, operation, and maintenance of renewable generation. Finally, tar-

geted research and large-scale demonstrations are necessary to reduce the cost of renewable generation, improve overall reliability, and facilitate widespread deployment.

It is worth noticing that while during the second half of the 20th century the world experienced the fastest growth in energy technologies, it is only during the last two decades that the development of RETs has really taken off. The transition to increased use of RE while providing energy security and flexibility to a country is improved by a sufficiently strong technological, scientific and educational basis as well as an infrastructure, which is well integrated in the world RET community.

Typically funding of R&D in the field of PV produces beneficial result. There is potential for in-depth and extended R&D in Armenia which could generate a number of benefits.

4 Renewable Energy Options

The Roadmap evaluates the technical potential of RETs pertinent to Armenia under three groupings:

- RETs that produce electric power: SHPPs, wind farms, and photovoltaics.
- RETs that produce heat: solar thermal, biomass, biogas, and the use of heat pumps.
- RETs that produce fuel for transportation: bio-ethanol and hydrogen.

The findings of a comprehensive review of RE potential in Armenia have ranked SHPP and solar hot water heaters as the most advanced RETs and the most economical for Armenia in the short to medium-term, followed by grid connected wind farms and the use of heat pumps. Photovoltaics, geothermal power, and bio-fuels, especially bio-ethanol from cellulosic feedstocks, are ranked as more costly in today's prices and are not expected to be commercially viable in the short to medium-term, but may play a more important role in the longer term, and in the development of RE high-tech industry. Biomass was also considered for both heat and electricity production for the short term, under several conditions, including re-planting of harvested trees and bio-fuels using fractionation process. In addition, hydrogen was considered as a possible fuel for transportation in the longer term. Finally, although not strictly a renewable resource, municipal solid waste in landfills was considered a practical source for generating methane for power production near municipalities.

Estimates of economic viability were based on quantifiable economic benefits including the avoided costs of conventional electricity supply and the avoided costs of fuel supply for transport. These analyses were conducted both with and without global externalities. They focused on the following promising RETs: small hydropower, wind energy, photovoltaics, bio-ethanol production, and geothermal power. Details of these analyses are presented in the Task 2 and Task 3 reports of the Roadmap project.

For SHPPs, funding sources are readily available for the construction of new run-of-the river systems or renovating existing, old systems. The main limitation is the availability of promising sites within reasonable proximity to good roads and transmission line access where more SHPP systems can be constructed by 2020. The base case estimate for the use of SHPPs in 2020 is estimated to be about 216 MW, or 613 GWh. On 2010 Armenia has more than 102.5 MW of SHPP installed and in operation.

Utility-scale wind farms are still not commercially viable under the existing tariff structure from the perspective of attracting private capital investment without either additional fiscal incentives or subsidies. The attractiveness of these investments would grow in all probability as lighter weight turbines exhibit increased efficiencies and the cost of the turbines decreases over time. However, the main technical barrier is the difficulty in transporting large turbines (1.5 to 3 MW) and composite blades (up to 52 meters in length) from a port of entry to the selected site in a landlocked, mountainous country like Armenia. Therefore, it is assumed that not more than 300 MW of wind-generated capacity in 2020 would be a realistic number. As of early 2011, only 2.6 MW of wind power is operative in the Lori region.

The economic viability of using PV for power production in Armenia is more complicated. The most cost-effective approach is currently to import solar cells and to assemble them into modules in Armenia with an overall projected penetration rate of 0.018% by 2020, if appropriate measures are implemented. The second alternative is the development of an industrial base in Armenia for manufacturing silicon-based solar cells in the country, using its abundant quartzite deposits. This alternative is expected to require an investment of approximately $300 million.

Bio-ethanol production is essential for Armenia in order to move in the direction of greater energy security of supply in the motor transport sector, serving as an octane enhancer, and to offset potential future increases in the cost of imported liquid fuels such as gasoline. One hundred percent of motor transport fuels (gasoline and compressed natural gas) are imported. Even a 5% blend of ethanol with gasoline will replace approximately 14 000 tons of expensive imported fuel per year. However, the cost of production of bio-ethanol using indigenous non-food feedstocks such as Jerusalem artichoke is presently above the wholesale cost of gasoline, which means that voluntary blending of bio-ethanol and gasoline is unfeasible unless mandated by the government.

Recent explorations and test drilling conducted in Armenia have identified a maximum geothermal resource potential of 75 MW. If the source were used for hot water distribution to nearby locations, the potential would increase. The economic viability for geothermal power in Armenia seems marginal, from both the perspective of cost (mostly for drilling and field development) and the total potential power output.

Table 4.1 presents an overview of the potential for four promising electricity-producing RETs for possible deployment in Armenia over various time horizons including estimated investment costs per kW and likely breakeven tariffs in the medium to long-term. It should be noted that the investment cost for a new NPP ranges between $4500 to $5000/kW installed.

Table 4.1 - Economically Viable Potential for Selected Renewable Energy Technologies

Economically Viable Potential of Selected Renewable Energy Technologies	2010	2015	2020
Small Hydro Power Projects			
Generation capacity in place [MW]	102.5	179	216.5
Investment cost installed [USD/kW]	500-700	1200	1500
Production costs [USD Cent/kWh]	3.3 - 4.9	6	8
Wind Power			
Generation capacity in place [MW]	2.6	100	300
Investment cost installed [USD/kW]	2400	1800	1500
Production costs [USD Cent/kWh]	9.6	8.0	7.0
Photovoltaics			
Generation capacity in place [MW]	0.1	0.3	1.0
Investment cost installed [USD/kW]	6000	5000	2700
Production costs [USD Cent/kWh]	40	30	19
Geothermal			
Generation capacity in place [MW]	0	25	25
Investment cost installed [USD/kW]	0	3000	3000
Production costs [USD Cent/kWh]	0	7.5	7.0

5 Renewable Energy Targets

As a country possessing no fossil fuel resources, Armenia has to rely on imports. However, it can utilize different sources of RE available in the country. These sources include large hydropower, SHPP, abundant sunshine, and a number of mountain passes with high average wind speeds. This section outlines how the supply of renewable energy technologies would develop over the next decade, alongside the existing power plants using natural gas and the planned 1000 MW nuclear power plant.

Targets are established for renewable energy technologies in all three energy sectors compared to the existing energy demand scenarios and their growth over the next decade. To that end, energy demand for Armenia in the sectors of electricity, thermal energy, and transportation were developed for various scenarios including the base case, where the demand can be fulfilled by utilizing a variety of energy sources such as renewable energy, fossil fuels, and nuclear power.

The average annual growth rate for electricity demand was calculated for the low, base, and high cases using growth rates of 1.53%, 2.71%, and 4.56%, respectively. Tables 5.1, 5.2, and 5.3 list the energy demand for Armenia for the period 2010 through 2020 for all three sectors: electricity, thermal, and transportation, respectively.

Table 5.1 - Electricity Demand Forecast (end user)

Scenarios	Year, GWh		
	2010	2015	2020
Low		5500	6350
Base	4500	5700	6600
High		7300	8100

For all three cases, two options were developed to help Armenia meet its energy demands in the electricity, thermal, and transportation sectors. These two options were based on the following two assumptions. The first option assumed that the new NPP will be commissioned in 2017 and the second is that it will be commissioned after 2020.

Table 5.2 - Thermal Energy Demand Forecast (end users)

Scenarios	Year, GWh		
	2010*	2015	2020
Low	10 500	11 000	11 700
Base	11 270	11 900	12 600
High	12 400	13 100	13 900

Table 5.3 – Transportation Fuel Demand Forecast

Scenario	Year, TJ		
	2010	2015	2020
Low (Energy efficient)		35 800	45 800
Base	24 150	37 300	49000

Calculations were then conducted assuming that the NPP, the large HPP, and the SHPP would be given priority to satisfy the energy demands of the country in the near term (2013), medium term (2015) and in the long term (2020), and the gap would then be filled by new RE sources. Cost effectiveness of these sources helped prioritize their use in the energy budget recommended. For SHPPs, wind, and solar, their seasonal or intermittent nature were taken into account, and recommendations were made to assist in load levelling of the electricity produced.

It is anticipated that gasoline consumption would not increase in the near future but the growth of the demand for the fuel would mainly be field by natural gas. Therefore, during midterm, additional production capacity of bio fuel may not be needed to satisfy the 10% lending requirements. However, new plants may be needed after 2020.

Table 5.4 presents the base case electricity production for the existing and new NPP (the latter commissioned at the beginning of 2017), large hydro, and the existing thermal power plants, and the contributions expected from the renewable technologies, over the period of 2010 to 2020. According to the two options considered within the base case scenario the new 1000 MW NPP is assumed to come on line either at the beginning of 2017 or after 2020, and at the same time, the old 400 MW NPP will be decommissioned. Comparison with the demand figure in the Table 5.1 for base case, shows that with the option of the new NPP commissioned in 2017, there will be a power excess of more than 2000 GWh in 2020 (actually staring 2017). This surplus could be exported or effectively used for decreasing the dependency on imported fuel by introduction and exploitation of a fleet of electric vehicles and related infrastructure[8] (see more in the textbox on page 20). With this extra available electric power the fleet of electric vehicles can make approximately one third of the total number of vehicles.

Tariffs are important support mechanism to promote and attract new investments in the various renewable energy fields. Table 5.5 shows the associated costs for the installation of the different renewable technologies tariff expenses. In fact the same is with all renewables – the government pledges to purchase all production, otherwise, naturally the tariff regulation would not work. The peak producers are mainly through the TPP-s, government has obligation to pay only when there is a need in generation (but always pays overheads when they are idle).

[8] In early years of independence a contentious decision has been made by the RoA government to cut substantially the on-ground electric transportation such as trams and trolley buses.

Table 5.4 - Electricity Production

	Capacity Installed, MW				Generation, GWh				Percent of Total Generation			
Power Generation Type	**2010**	**2013**	**2015**	**2020**	**2010**	**2013**	**2015**	**2020**	**2010**	**2013**	**2015**	**2020**
Nuclear	400	400	400	1000	2,400	2,400	2,400	5,600	41.3%	38.8%	36.7%	57.3%
Thermal Power plants (peak load)	2,082	2,082	2,082	2,082	1,059	1,210	1,362	0	18.3%	19.7%	20.9%	0.0%
Subtotal of non renewable	*2,500*	*2,500*	*2,500*	3100	*3,400*	*3,600*	*3,700*	5,600	59.6%	58.4%	57.6%	57.3%
Large Hydro	960	960	960	1100	2,020	2,020	2,020	2,700	34.9%	32.8%	31.0%	27.3%
Small Hydro	103	153	179	217	308	440	500	610	5.34%	7.16%	7.78%	6.30%
Wind	2.6	43.6	102	302	4.6	100	236	700	0.08%	1.63%	3.62%	7.14%
Geothermal	0	0	0	25	-	-	-	185	0.00%	0.00%	0.00%	1.90%
PV	0.1	0.4	0.6	1.1	0.16	0.65	0.98	1.80	0%	0.01%	0.02%	0.02%
Subtotal of renewable	*105*	*197*	*282*	545	*313*	*541*	*743*	*1,494*	*5.42%*	*8.80%*	*11.41%*	*15.4%*
Subtotal of renewable with large hydro	1,070	1,160	1,240	1640	2,330	2,560	2,760	4,160	40.4%	41.6%	42.4%	42.7%
TOTAL	**3,550**	**3,640**	**3,700**	**4700**	**5,780**	**6,160**	**6,510**	**9,730**	**100%**	**100%**	**100%**	**100%**

Table 5.5 – Investment Cost of Different Renewable Technologies for electricity

Technology	Cost, mln. $ 2011-2013	2014-2015	2016-2020	Total 2011-2020
Small Hydro	43	30	51	125
Wind	86	109	321	517
PV	1.7	1.0	1.8	4.5
Geothermal	-	-	75	75
Total Investment in Renewable Energy	132	140	450	722
Total Tariff Support	**21**	**50**	**317**	**388**

Tables 5.6 and 5.7 in the next page show the thermal energy production option and the investment dollars needed for the country to obtain this level of thermal energy production from biomass and solar energy, as well as the use of heat pumps to conserve energy.

Table 5.6 - Thermal Energy Production

Thermal Generation Type	Capacity Installed, MW				Generation, GWh				Percent of Total Production			
	2010	2013	2015	2020	2010	2013	2015	2020	2010	2013	2015	2020
Natural Gas	n/a *	n/a	n/a	n/a	5,600	6,800	7,600	8,000	58.1%	62.2%	64.4%	63.1%
Electricity (heating/cooking)	n/a	n/a	n/a	n/a	2,030	2,860	3,400	3,800	21.1%	26.0%	28.7%	30.0%
Biomass	n/a	n/a	n/a	n/a	2000	1260	770	770	20.8%	11.5%	6.5%	6.1%
Solar Thermal	0.25	7.6	12.5	25	0.3	9.1	15	30	0%	0%	0.13%	0.24%
Heat Pumps	0.25	15.6	26	56	0.3	18.7	31	67	0%	0%	0.26%	0.53%
Subtotal Renewable without biomass	0.5	23.2	38	81	0.6	27.8	46	97	0%	0%	0.39%	0.77%
Subtotal Renewable	n/a	n/a	n/a	n/a	2000	1290	820	870	20.8%	11.8%	6.9%	6.9%
TOTAL	**0.50**	**23**	**38**	**81**	**9,630**	**10,970**	**11,850**	**12,670**	**100%**	**100%**	**100%**	**100%**

** Natural gas and electricity supply capacities are sufficient*

Table 5.7 shows for the investment needed in renewable thermal energy for the base demand and base growth scenario. Although there are no tariffs for thermal energy, investment needed to achieve the mentioned target per capita is less than $4. Table 5.8 provides transportation fuel usage by different fuel types as well as effects of 10% bioethanol blending and associated cost for such a blending. Table 5.9 provides a summary of the energy generated in the three major sectors and estimated investment needs.

Table 5.7 - Investment in Renewable Thermal Energy

Technology	Cost, mln. $ 2011-2013	2014-2015	2016-2020	Total for 2011-2020
Solar Thermal	8.8	5.4	13.0	27.3
Heat Pumps	24.3	15.5	41.4	81.2
Total Investment	**33.2**	**20.9**	**54.4**	**108.5**

Table 5.8 – Transportation Energy Demand

Fuel type*	2011-2013	2014-2015	2016-2020	Total for 2011-2020

Gasoline, GWh	6,930	4,690	11,900	23,530
Diesel, GWh	1,850	1,760	7,370	10,982
Kerosene, GWh	4,160	3,130	9,050	16,341
LPG, GWh	38.3	21.7	46.0	106.0
Natural gas, GWh	13,000	10,530	32,840	56,388
Subtotal	**25,990**	**20,130**	**61,200**	**107,347**
Using 10% blending (E10)				
Gasoline	6,790	4,400	11,190	22,519
Bioethanol	142	285	726	1,011
Bioethanol, % of total fuel	0.54%	1.42%	1.19%	0.94%
Bioethanol, ton/year	30400	30400	30400	30400
Investment Cost, mln. $	**74**	**0**	**0**	**74**

**It is assumed that the bioethanol plant will operate starting 2013, E10 will be available from 2013 to 2020 and beyond.*

Table 5.9 - Total Production

Energy Type	2011-2013	2014-2015	2016-2020	Total for 2011-2020
Electricity				
Generation, GWh	18,060	12,837	44,882	75,775
Renewable without large hydro, GWh	1,360	1,380	6,065	8,808
Percent of RE as of total generation*	2.01%	2.78%	4.05%	3.30%
Investment in RE, mln. $	$ 132	$ 140	$ 450	$ 722
Thermal				
Generation, GWh	31,570	23,260	61,710	116,544
Renewable without biomass, GWh	56	83	383	522
Percent of RE as of total generation*	0.08%	0.17%	0.26%	0.20%
Investment in RE, mln. $	$ 32	$ 21	$ 54	$ 108
Transportation				
Generation, GWh	26,000	20,125	61,234	107,350
Renewable, GWh	142	285	726	1,153
Percent of RE as of total generation*	0.21%	0.57%	0.49%	0.43%
Investment in RE, mln. $	$ 74	$ -	$-	$ 74
Total Generation, GWh	**67,900**	**49,700**	**149,626**	**267,192**
Subtotal of RE generation, GWh	*1,559*	*1,749*	*7,174*	*10,483*
RE percent of total generation*	2.3%	3.5%	4.8%	3.9%
Total RE supply with large hydro and biomass, GWh	12,140	7,580	23,701	43,419
Total RE with large hydro and biomass percent of total generation*	17.9%	15.2%	15.8%	16.3%
Total Investment, mln. $	**$238**	**$ 161**	**$504**	**$903**

** Total percentages are cumulative for the particular period*

It should be noted that there could be the possibility of different combinations of energy sources, e.g. in electricity sector. Curves were developed to cover “what-if” scenarios based on the desired level of penetration of RE. Figures 5.1 and 5.2 illustrate possible RE penetration rates based on the kWh unit cost and total investment in the base case when 400 and 1000 MW NPP are operational, respectively. The blue dashed line along the axis on the right is for the investment cost and sold red line

along the axis on the left represent unit cost for different penetration levels. In Section 7 of this report, various policy issues are introduced that should be addressed to encourage the further use and development of renewable technologies in Armenia to achieve higher penetration levels.

Figure 5.1 – Investments & Electricity Average Cost 2020 Demand Base Scenario, NPP 400 MW

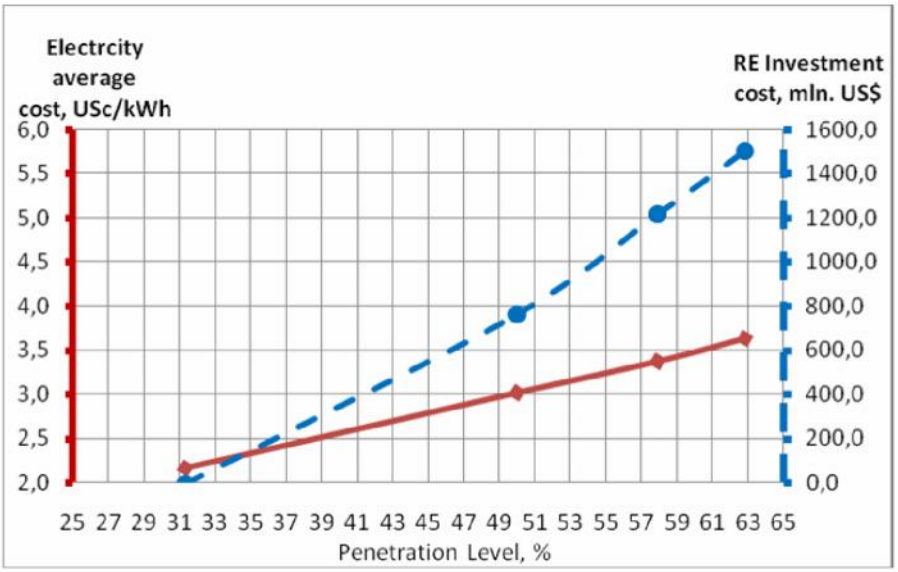
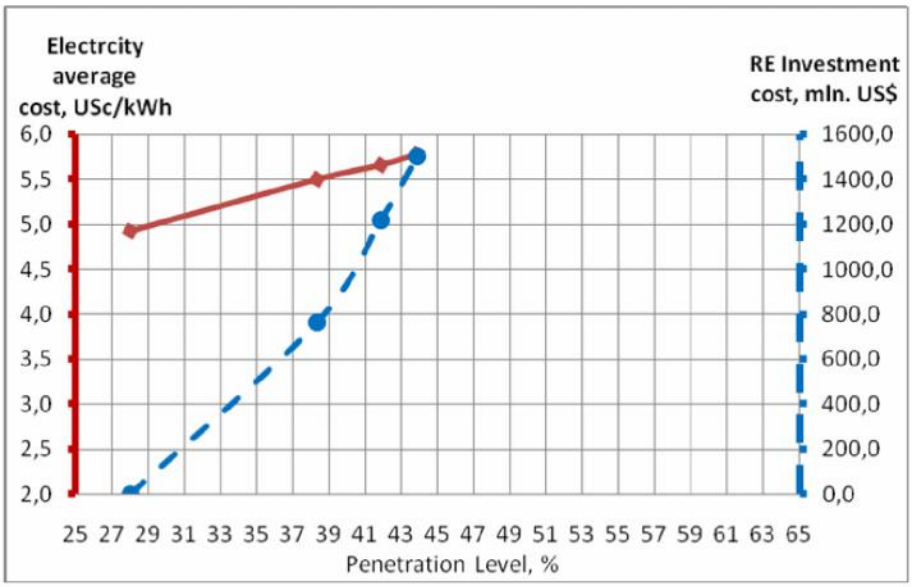


Figure 5.2 – Investments & Electricity Average Cost 2020 Demand Base Scenario, NPP 1000 MW



6 Assessment of Alternative Energy Policy Instruments for Increasing the Share of Renewable Technologies

Development of various renewable energy sources and of industries associated with each of them is slow. Most of the time on a cost basis they cannot compete with traditional energy sources, with the exception of SHPP. Therefore, favourable laws and policies are necessary to stimulate the deployment of clean energy technologies. In general, laws and regulations of the RoA are adequately addressing issues related to renewable energy. However, a more favourable regulatory environment is needed for the large-scale development of renewable energy resources in Armenia.

6.1 Summary of Existing Regulations and Tariffs

The general energy-related issues in Armenia are regulated by the Law on Energy of the Republic of Armenia and specific issues related to RE are regulated by the Law on Energy Saving and Renewable Energy. These laws define the main principles of state policy in the energy sector:

- Effective use of local energy reserves and alternative sources of energy as well as application of economic and legal mechanisms for that purpose;
- Ensure the energy independence and security of Armenia;
- Create new industries and organize new services, implement targeted national programs and apply new technologies in order to promote the development of renewable energy and energy saving;
- Promote energy-efficient and energy-saving technologies;
- Reduce environmental impacts.

The main purpose of the Law on Energy Saving and Renewable Energy is to define the principles of the state policy on development of the energy saving and RE. The idea is to strengthen the economic and energy independence of Armenia by increasing the level of indigenous RE production.

The functions of regulation in energy sector were given to the Public Service Regulatory Commission (PSRC) in accordance with the Law on Energy. Each year the Commission presents its operation program for the following year to the National Assembly. The program includes a forecast of consumption of electrical, thermal energy, and natural gas; generation, export, and import of electrical energy; import volumes of natural gas; tariffs for electrical, thermal energy, and natural gas. PSRC also issues a directive each year that specifies feed-in tariffs for different energy sources. The Commission has control over licensing and establishing tariffs in the energy sector.

2011 Tariffs in Armenia per kWh

SHPP	
Rivers,	19 AMD
Irrigation channels	13 AMD
Drinking water streams	9 AMD
Wind	33 AMD

6.2 Examples from Different Countries

Four neighbouring countries of Armenia have related laws at various stages of development, with Turkey having the most developed and Azerbaijan with the least developed. A summary of relevant laws and regulations of the four neighbouring countries as well as Russia, EU, and U.S. are summarized in Annex 2. Iran and Turkey have established procedures to calculate tariffs from RE but Georgia and Azerbaijan does not have specific tariffs for RE.

Tariffs in Neighbouring Countries

Iran (2009)
During peak time - $0.127/kWh
During off peak time – $0.088/kWh

Turkey (2011)
$0.073/kWh for wind and hydroelectric power, $0.105/kWh for geothermal energy, $0.13/kWh for energy from either waste (such as biomass or municipal solid waste-to-energy projects), and for solar energy

Georgia
Does not have Feed-in tariffs for RE

Various EU countries use different approaches and tariffs for RE to meet general goals established by the EU Parliament. Most of the states in the U.S. have specific incentives and tariffs in addition to some general regulations enacted by the Federal Government.

The EU Renewable Energy Directive (2009/28/EC) addresses various subjects related to the development of RE in the European Member States, among others the legally binding share of RE in gross final energy consumption. In Article 4 of the Directive, each of the 27 Member States is requested to provide a National Renewable Energy Action Plan (NREAP) by 30 June 2010. In order to draft this plan, a template was published by the Commission. Each Member State is obliged to complete a set of tables in this template on how it expects to meet its 2020 target, including the technology mix and the trajectory to reach it.

6.3 Summary of Various Policy Instruments

Various regulations and incentives are used by different countries such as EU countries and the U.S. to promote the investment and use of energy from renewable sources. Some of these incentives and tools for promoting RE are outlined in this section. There are many contextual factors, other than policies, that affect RE development. These include, but are not limited to, resource and technology availability, the economic context, land use and public perception issues, transmission availability, institutional structures, and financing. Understanding the contextual factors within which policies are placed is essential to defining the most appropriate policy features. The following is a list of different possible incentives to promote RE.

A - Tax Incentives

RE systems may be eligible for multiple types of tax incentives. The five primary categories that apply to RE development are corporate, industry recruitment and support, personal, property, and VAT tax incentives. The income tax incentives are divided into two categories (personal and corporate) because the size of technology and incentive size depend on the end user. Because tax incentives can result in an investment that would not happen without them, such credits cannot be considered as a burden on the government budget. On the contrary, they could create income streams, which otherwise would have not materialized, once incentives are expired.

B – Feed-in Tariffs

The use of Feed-in Tariffs (FIT) is an effective and popular policy option for encouraging RE development. It is important to distinguish between utility-based and government-level FIT policies. Utility-based FIT policies differ considerably in design and effectiveness and they are generally put forth by utilities to help meet utility-specific goals. Government FIT policies, in contrast, are mandated by the government and require utilities operating within their jurisdiction to purchase electricity generated from RE sources. There are substantive differences between the FIT policies in the U.S. and those currently implemented in Europe.

C - Rebate Programs

Rebates are offered to promote the installation of RE systems. The majority of rebate programs that support RE are administered by government, municipal utilities, and electric cooperatives. These programs commonly provide funding for solar water heating and/or PV systems. Rebate amounts vary widely based on the technology and program administrator. Rebates act as a financial incentive

mechanism for boosting RE development – especially small, customer-sited projects – by effectively reducing high capital costs associated with renewable energy installations. Unlike production incentives, rebates do not require a long-term policy and financial commitment to a specific project, which allows for flexible support based on changes in the market. However, it is important that rebate programs run for several years (with few changes) to build market awareness and dealer support. Rebates by themselves will not help build a market if potential customers are thwarted by policy barriers ranging from unfriendly local building codes and zoning restrictions to restrictive net-metering and interconnection rules.

D - Net Metering

Net metering allows for the flow of electricity both to and from the customer. Typically, this process is accomplished through a single, bi-directional meter. During times when a customer's generation exceeds the customer's use, net metering allows electricity to flow from the customer back to the grid, offsetting electricity consumed by the customer at a different time. In effect, the customer uses excess generation to offset electricity that the customer otherwise would have to buy at the utility's full retail rate. Net-metering policies can play an important role in effectively removing market barriers to RE development. Net-metering policies that follow best practices, improve the financial environment by increasing the return on investment for distributed-generation systems. Because the supply of RE may not coincide with the demand placed on the system, net-metering policies smooth out this irregularity in the most cost effective way for the individual generator.

E - Renewable Energy Access Laws

RE access laws typically apply to solar and wind resources. Solar and wind access laws are designed to protect a consumer's right to install and operate a solar or wind energy system at a home or business. Some solar access laws also ensure a system owner's access to sunlight. In some cases, access rights prohibit homeowners associations, neighbourhood covenants, or local ordinances from restricting a homeowner's right to use solar energy.

F - Contractor-Licensing Policy

Contractor-licensing policies are focused mainly on solar thermal systems. Certification requirements are important for RE development because they ensure proper installation and maintenance of systems, which leads to maximum possible returns on investment. These policies can play an important role in increasing the efficiency of RE systems. Properly installed systems and optimal system performance will improve the experience that consumers have of RETs.

G - Grants

Grant programs are designed to foster the development of RETs. Most grants pay down the cost of equipment or systems or are offered to encourage either research or development of renewable technologies. Grant programs could be for a range of renewable resources or they could be designated to support an individual technology, such as wind or PV. Grants are primarily available only to commercial, industrial, utility, education, and government sectors.

H - Renewable Portfolio Standards

Renewable portfolio standard policies require utilities to own or acquire RE or RE certificates to account for a certain percentage of their retail electricity sales, or a certain amount of generating capacity, within a specified timeframe.

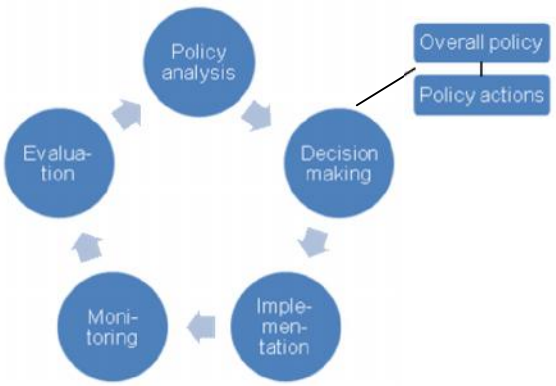
I - Time-of-Use Rates

These rate structures allow certain technologies, like PV, to maximize economic value from RE generation by providing market price signals for net-metered systems. Because maximum daily PV power generation often correlates well with peak electricity demand periods, time-of-use rates allow net-metered PV to benefit from peak retail electricity rates. Higher prices for excess power during peak electricity demand periods increase the benefit that accrues from net-metered PV systems.

7 Time- Bound Action Plan for Meeting Renewable Energy

The development of a comprehensive policy and action plan for RE in Armenia can be divided into five overall steps as shown in Figure 7.1.

Figure 7.1 - Circle of Policy Strategy and Development



7.1 Overall Policy

Creating an overall policy should ideally consist of three levels:

- The long term overall energy vision
- The strategy with defined targets to reach the vision
- The action plans to support the strategy

Monitoring should be seen as an integrated part of the policy development, constantly feeding into action plans and strategy to stay on course to the vision. While the vision should remain constant, the strategy and action plans are live documents, reflecting on the effectiveness of interventions. A strategy for intervening in the market is needed to advance the growth of RETs.

While there are compelling energy security arguments to increase the amount of renewable energy in the Armenian energy mix, it remains a fact that significant barriers inhibit private sector driven growth in the sector:

- Most RE sources are not commercially competitive in today's tariff regime and RETs are at different stages of commercial maturity.
- Administrative hurdles in developing and implementing RE projects.
- Technical hurdles in grid connecting and in large-scale penetration of RETs on the overall energy system with regard to overall cost efficiency and system reliability.

Even though this report sets out a first strategy to advance the use of RE in Armenia, it is essential that a long-term vision of the ideal Armenian energy situation is developed. Eventually, binding national targets should be established to signal clearly long-term government commitment to the vision, and to ensure that strategies through time aim at a common long-term vision.

Figure 7.2 summarises the specific interventions recommended and indicates a time line for when the interventions should be implemented.

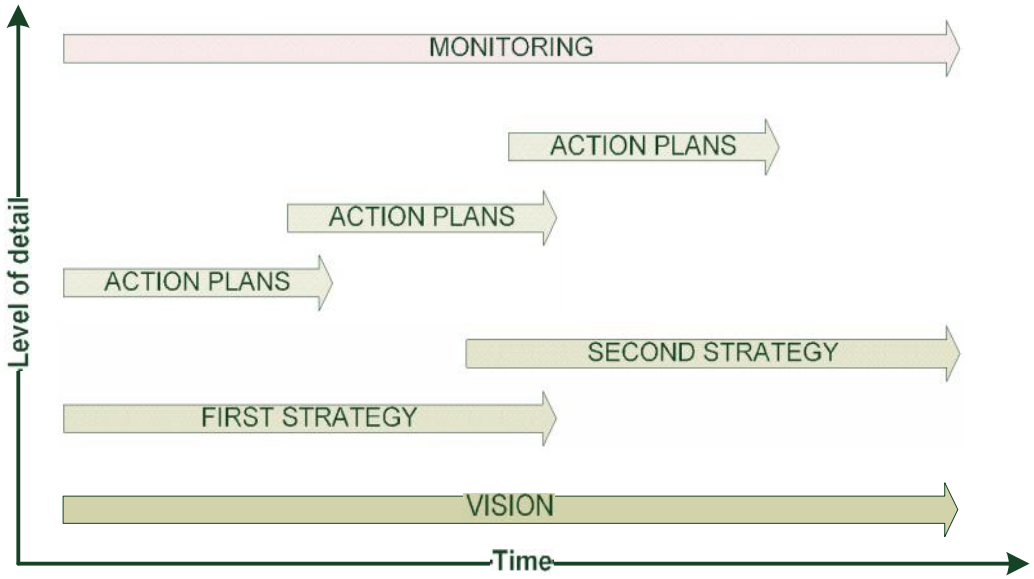
It is equally important that RE targets are set realistically. While RE has the advantage of being environmentally friendly, one of the key arguments to advance in Armenia, as in most of the world, is security of energy supply.

RE initiatives must be combined with other key energy security initiatives to improve comprehensively energy security:

- Hydro pump storage facilities: A valuable resource for using excess night-time electricity generated by NPP and RE power sources, such as SHPP. Pumped storage plants are used to generate electricity when demand is high. Results of the preliminary studies conducted by the World Bank indi-

cate that pump storage would be practical at Aghbara, Tolors, and Shamb reservoirs on Hrazdan, Sisian, and Vorotan rivers, respectively. Building 200 MW pump storages should be considered at these three locations for better managing demand and supply, especially when the new NPP is commissioned.

Figure 7.2 - Vision, Strategy and Action Plans



- Expansion of gas storage facilities: Natural gas is one of the main energy sources for Armenia and its uninterrupted supply is essential to not only increase RE supply, but for overall economic development. Increasing its gas storage capacity can significantly improve the security of short-term energy supply, particularly considering supply interruptions on the gas pipeline in the past. At present, Armenia has a relatively small gas storage capacity of only 127 to 130 million m^3, approximately equal to 10 days of supply during winter at peak consumption. Current plans would increase the capacity to 190 to 195 million m^3 by 2013; however, to have a 90-day supply security would require an increase to 340 to 400 million m^3.

In 2020, or, in fact, since the commissioning of the new NPP in 2017 there will be a power excess of more than 2000 GWh, which could be exported, or effectively used for decreasing the dependency on imported fuel by introduction and exploitation of a fleet of electric vehicles (FEV) and related infrastructure. With this extra available electric power the can make approximately one third of the total number of vehicles. Thus, having an electric vehicle fleet and infrastructure delivers the following benefits:

1. **Decrease of imports** of fossil fuel, mainly natural gas, diesel and gasoline
2. **Load levelling**: since most of electric vehicles will be charging their batteries at the night-time, they will be using the excess power of the NPP most effectively, thus serving as a natural load levelling means.
3. **Cost reduction**: a simple calculation shows that electric vehicles have less cost for the same mileage, thus contributing to the increase of the living standard in Armenia.
4. **Environmental benefit** by not releasing of approximately a million ton of CO_2 every year.

Support by customs tax exemption for all electric vehicles will be needed (see intervention 16).

7.2 The Action Plan

A key component in facilitating an increase in the use of RE is planning specific actions within a given period. The action plan translates interventions into operations to be carried out. This action plan has been developed from the following key assumptions:

- An objective of increasing RE in the Armenian energy mix as per targets set forth in Chapter 5. A suggested binding target for RETs in the next decade is shown in Table 7.1.
- Feasibility of technologies over time as set forth in the comprehensive review, summarized in Chapter 4 and in Table 7.2.

Table 7.1 – Suggested binding targets for RET in the next decade

	Generation, GWh				Percent			
	2010	2013	2015	2020	2010	2013	2015	2020
Electricity Renewable*	2,330	2,560	2,760	4,160	40.4%	41.6%	42.4%	42.7%
Thermal Renewable**	2,000	1,290	819	870	20.76%	11.78%	6.91%	6.87%
Transportation Renewable	-	141.5	143.1	146.5	-	0.60%	0.57%	0.45%

** Includes Large hydro*

*** Includes biomass (firewood). It is expected that the illegal firewood cuts amounting more than 1200 GWh in 2010 should not exist by 2015.*

Table 7.2 - Feasibility of Technologies Over Time

Sector/ time	Near to mid-term	Mid to long-term	Long-term
Electricity	SHPP, biomass	Wind	PV
Heating	Solar hot water, biomass	Heat pumps	Geothermal
Fuel			Biofuels, hydrogen

Action Tool Box

A mix of interventions is typically necessary to reach the desired results, as each intervention category has strengths and weaknesses to overcome barriers. In the interaction between the different tools, it is necessary also to consider that the total effect of interventions can turn out to be less than the sum of the separate effects, with the interventions "negating" each other. On the other hand, an alternative mixture of incentives may work as a "stick and carrot" mechanism. Interventions have been grouped into two main categories of (a) Legislation and (b) Institutional development and education, each with a number of sub-categories.

(a) Legislation sub-categories

Regulation: Regulatory measures with adequate control, i.e. introducing legislation and ensuring that it is implemented through control.

Financial incentives: A financial incentive subsidises or awards decisions to advance renewable energy directly or indirectly.

Tax incentives: The tax incentives are financial incentives and regulatory measures holding hands, demanding regulatory backing to be implemented and providing a financial incentive when used.

(b) Institutional development and education subcategories

Administrative streamlining: Barriers associated with "red tape".

Capacity building: To advance ability to consistently enforce policies and monitor effectiveness of interventions and advance ability to service and correctly maintain the deployed RE.

Awareness raising: Raising awareness about RE amongst the public.

The specific interventions suggested for Armenia are categorised accordingly as is the action plan.

7.3 Barriers and Suggested Interventions

A feed-in tariff for RE is at the heart of the suggested interventions to increase the use of renewable energy in Armenia. It is included in the legislation category and is a financial incentive. Based on the Break-even tariff calculations in the Task 2 Report, the following feed-in tariffs are suggested for introduction:

Table 7.3 – Suggested feed-in tariffs

Tariff, US cents/kWh*	2011	2015	2020
Wind	10,3	10,8	11,8
Smal HPP	3,6	5,9	7,4
Photovoltaic	47,4	38,0	24,0
Geothermal low cost			3,6
Geothermal high cost			6,8

Together with the feed-in tariff, a number of other interventions are suggested to further support the strategy, e.g. to overcome administrative barriers etc. Several of the interventions will be mutually reinforcing, i.e. a fast track for smaller SHPP projects in obtaining permits together with extended water permit and VAT exemption for the entire SHPP power generation train will all work towards increasing the use of SHPP.

A. Administrative Streamlining

Obtaining the necessary permits and licenses for SHPP and wind power generation is cumbersome. Coordination between different authorities in obtaining permits must be enhanced and the problems related to little transparency in procedures, long lead-times, and high costs involved in obtaining permits or licenses must be solved.

Specific interventions recommended are:

1. Streamlining procedures for issuance of permits
2. Development of road map to obtaining permits
3. Shorter deadlines for administrative decisions
4. Fast track for smaller projects
5. Fast track for land use category change, including better coordination between different authorities like central and municipal levels

B. Regulation

There are significant barriers to appropriately spreading the risk of investments in RE projects. Two of the main barriers are: (i) the duration of the water permit of only three years and (ii) the late issuance of the electricity sales agreement.

Specific interventions recommended:

6. Aligning length of water permit with length of operational permit and electricity sales agreement, i.e. extending permits from three to fifteen years.
7. Move issuance of electricity sales agreement from project completion to time of development permit by including provisions of construction period limit and anticipated electricity generation (to provide the utility company opportunity to plan the future demand and compensation in case of project cancelation or major delays).

Collateral security agreements are critical to all loans that include a pledge of assets. Everyone who has received a secured loan has also normally executed a security agreement. The possibility for opening for purchasing licenses already given might have a positive impact on the collateral issues for financing projects.

A key ownership question is related to land tenure, where the possibilities for developing potential SHPP sites may be constrained, if there is property speculation through the possibility of getting a 99-year lease agreement and / or land privatization.

Specific interventions recommended:

8. The possibility for opening for purchasing licenses already given might have a positive impact on the collateral issues for financing projects.
9. Establishing a time limit or a sunset clause for land lease for a site that is suitable for SHPP development could prevent speculative activities. This means if a leaser does not start process of developing SHPP after a specified time, then the land lease will be voided.

Lastly, regulatory intervention is recommended to increase the use of bio-fuels and biomass while ensuring that the use of wood for firewood be limited to the amount of dedicated planted trees.

Fuel economy tends to go down with blending bio-fuel into gasoline and there are no incentives to blend gasoline with bio ethanol, nor a demand for it.

Specific intervention recommended:

10. Experience shows that the main reason for the wide spread use of bio-fuel has been government established mandates. It is recommended that government institute a 10% mandatory blend of bio-ethanol in gasoline. As the low case (scenario), 5% mandatory blend of bio-ethanol in gasoline can be considered.

Biomass for fire wood using short rotation fast growing tree plantations could be economically viable venture even though a large initial capital investment is needed for purchasing and developing the land.

Specific intervention recommended:

11. A minor change in the law is needed to exempt harvesting mature trees in these plantations from restrictions apply to cutting mature trees in forests and green belts[9].

C. Tax Incentives

Turbines imported for SHPP are free of VAT and customs duties. However, the law does not specifically mention that generators and other related control components are also exempt.

Specific intervention recommended:

12. Modifying the VAT law to address the entire power generation train with its control components, instead of just listing turbines. In order to streamline the process it should only be for equipment easily identified as equipment for RE.

For wind energy project, there is already a three-year long holiday from VAT. However, paying the full VAT back three years later it is a substantial burden on the project cash flow at a relatively early point in time. At the same time, corporations are required to pay a 20% tax on profits plus a 10% withholding on all dividends, lease payments, insurance premiums and interest payments, constituting a significant burden for foreign investors.

Specific interventions recommended:

13. To improve the cash flow, VAT could be paid back over a number of years, based on a percentage of the electricity sold starting from fourth year of the electricity generation.
14. A tax holiday for particularly the large-scale wind farms could be an effective way of boosting project feasibility to foreign investors at a relatively low cost to government.

[9] The Intervention is meaningful if the restrictions against logging in national parks, preserves, and forests are strictly enforced. Otherwise there is increased risk of illegal logging in these protected areas. Another critical issue is the compliance of the plantation species with the biodiversity conventions to which Armenia is a signatory.

For solar thermal and heat pumps the barriers are different from those of SHPP and wind power, as solar thermal and heat pumps are installed for a single user or a group of users (such as residences of an apartment building). Awareness and the up-front cost of the technology is usually the key barrier to these user groups.

Specific interventions recommended:

15. Eliminating import duties on solar thermal and heat pumps.

Electrical cars face a key barrier of cost – the extra cost of electrical cars compared to their gasoline counterparts is approximately the same as the custom duties in Armenia.

Specific interventions recommended:

16. Eliminate customs duties on electrical cars.

Table 7.4 summarises the specific interventions recommended and indicates a time line for when the interventions should be implemented. Actions are further detailed in the Action Plan in Annex 1, referring back to each of the numbered interventions.

It must be underlined that awareness raising and capacity building are ongoing efforts needed to implement the above recommendations as well as to facilitate a proper impact of the interventions. Incorporating awareness raising and capacity building into each of the interventions is thus necessary.

7.4 Monitoring Plan

Systematic and constant monitoring and evaluation is necessary to ensure and improve effectiveness, efficiency, accountability, and capacity building. It is a key part of managing the implementation of the renewable energy strategy: measurable, published, and legally binding targets as well as milestones and the identification of responsible parties are part of the monitoring plan.

The Action Plan reflects on the need for ongoing and proper monitoring of the interventions as well as the need to ensure medium-term evaluations to adjust the RE Strategy.

The Ministry of Energy along with the R2E2 Fund shall be responsible for the monitoring of progress for meeting the goals of the action plan, including the monitoring of fast track compliance, and monitoring of compliance with amendments.

Table 7.4 - Intervention Time Line

Intervention		Near to mid-term	Mid to long-term
1	Streamlining procedures for issuance of permits	√	
2	Develop a road map to obtaining permits	√	
3	Set up shorter deadlines for administrative decisions	√	
4	Establish a fast track procedure for smaller projects to significantly reduce transaction costs	√	
5	Establish a fast track procedure for land use category change	√	
6	Extend water permits to 15 years to significantly reduce project risk	√	
7	Move issue time of electricity sales agreement to time of development permit by including provisions of construction period limit and anticipated electricity generation to provide the utility company opportunity to plan the future demand and compensation in case of project cancelation or major delays.	√	
8	The possibility for opening for purchasing licenses already given might have a positive impact on the collateral issues for financing projects.		√
9	Establish a time limit or a sunset clause for land lease for a site that is suitable for SHPP development to prevent speculative activities. This means if a leaser does not start process of developing SHPP after a specified time, then the lease will be voided.		√
10	Experience show that the main reason for the wide spread use of bio-fuel has been government established mandates. It is recommended that government institute a 10% mandatory blend of bio-ethanol in gasoline.		√
11	Agree on a minor change in the law to exempt harvesting mature trees in these plantations from restrictions that apply to cutting mature trees in forests and green belts	√	
12	Modify the VAT law to address the entire power generation train with its control components instead of just listing turbines.		
13	To improve the cash flow, VAT could be paid back over a number of years, based on a percentage of the electricity sold starting from fourth year of the electricity generation.	√	
14	A tax holiday for particularly the large-scale wind farms could be an effective way of boosting project feasibility to foreign investors at a relatively low cost.		√
15	Eliminate import duties on solar thermal and heat pumps.		√
16	Eliminate customs duties on electrical cars.		√

Annex 1 – Consolidated Time-Bound Action Plan

		ACTION PLAN RE ARMENIA				
▼	*Milestone*					
	Time period					
NO	**OBJECTIVE /** INTERVENTION	**ACTION**	**OUTPUT**		**RESPONSIBLE**	**POTENTIAL FUNDING**
	Near term - next 2 years: Establishing parliamentary foundation and policy documents					
1	**Legally binding RE targets**				**Ministry of Energy**	**Public**
1.1		Government draft on Armenian Energy Vision	Draft			
1.2		Stakeholder debate	Stakeholder comments			
1.3		Revision of Energy Vision	Revised and final Vision	▼		
1.4		Government draft on RE Strategy with quantified targets	Draft			
1.5		Parliament debate	Revised draft			
1.6		Passing of RE Strategy	Binding RE targets	▼		
2	**Government RE Action Plan**				**Ministry of Energy**	**Public**
2.1		Institutional capacity evaluation	Evaluation			
2.2		Evaluate funding options	Evaluation			
2.3		RE Action plan with specified interventions	Government Action plan	▼		

Mid-term - up to 2015: Implementation begins						

					Ministry of Energy	Public
5.6		RE Action plan with specified interventions	Binding RE targets	▼		
5.5		Passing of RE Strategy	Government Action plan			Public
				▼	Ministry of Energy	
					Ministry of Energy	
			Revised draft			Public

6	**Legislation - Regulatory interventions**				**Ministry of Energy**	Public
6.1	No 8 and 9	Drafting changes to SHPP ownership law and land lease clauses	Draft amendments		Ministry of Energy	Public
6.2		Parliamentary process of amendments	Revised amendments		Ministry of Energy	Public
6.3		Final amendments to regulation	Legally binding amendments		Ministry of Energy	Public
6.4		Operationalise amendments	Strategy		Ministry of Energy	Public
6.5		Implementation plan	Plan		Ministry of Energy	Public
6.6		Implementation period			Ministry of Energy	Public
6.8	No 10	Draft law on mandatory bio-fuel blending	Draft law		Ministry of Energy	Public
6.9		Parliamentary process	Revised law		Ministry of Energy	Public
6.10		Final law	Mandatory bio-fuel blending		Ministry of Energy	Public
6.11		Operationalisation strategy	Strategy		Ministry of Energy	Public
6.12		Implementation and monitoring plan	Plan		Ministry of Energy	Public
6.13		Implementation period			Ministry of Energy	Public
6.14		Monitoring of compliance with amendments	Monitoring report	▼	Ministry of Energy/R2E2	Private
7	**Legislation - Tax incentives**				**Ministry of Energy**	
7.1	No 12 and 15	Draft law on SHPP, solar thermal and heat pumps components receive VAT exemption	Draft law		Ministry of Energy	Public
7.2		Parliamentary process	Revised law		Ministry of Energy	Public
7.3		Final law	VAT exemption		Ministry of Energy	Public
7.4		Operationalisation strategy	Strategy		Ministry of Energy	Public
7.5		Implementation and monitoring plan	Plan		Ministry of Energy	Public
7.6		Implementation period			Ministry of Energy	Public
7.7		Monitoring of compliance with amendments	Monitoring report	▼	Ministry of Energy/R2E2	Private
7.8	No 13	Draft amendments on wind VAT holiday with extended payback period	Draft law		Ministry of Energy	Public
7.9		Parliamentary process of amendments	Revised amendments		Ministry of Energy	Public
7.10		Final amendments to regulation	Legally binding amendments			

Annex 2 – Regulations of Neighbouring Countries

Georgia

Over 85 percent of Georgian electricity is produced by hydroelectric plants and the rest of the electricity is produced by thermal power plants. As of early 2011, Georgia had no special legislative acts to regulate the use of renewable energy sources. Electricity sector legislation partly addressed the grid-connected electricity from hydropower and wind power, while other types of renewable energy are not covered by corresponding legislative acts. There is even no established clear and consistent definition of renewable energy sources to be used uniformly across Georgia's legislation. Moreover, there is no designated authority charged exclusively with developing RE in Georgia.

Primary responsibility for energy policy lies with the Ministry of Fuel and Energy (MOFE). The Electricity Law of July 1997 established the National Electricity Regulatory Commission (NERC) and separated policy-making from regulation, operation, and ownership. The Electricity Law outlines the tariff-setting principles to be used by NERC. One principle is that tariffs should allow for a return on invested capital sufficiently attractive for investment into rehabilitation and further development of the energy sector. Another provision prohibits cross-subsidization from one category of consumers to another.

The document of Main Directions on State Policy in the Energy Sector stipulates Georgia's goal of RE development and contains concrete development milestones for SHPPs and wind power plants through 2015. However, the policy measures for implementation of these goals proved to be insufficient and the projected numbers remain largely unrealistic. According to the law, the small hydro plants can sell all their output to Electricity System Commercial Operator (ESCO) at average tariff.

Iran

Renewable energy production in Iran is negligible. With 9% of the world's oil reserves and 17% of its natural gas reserves, Iran has an abundant supply of fossil fuel resources, which tends to discourage the pursuit of alternative renewable energy sources.

Renewable Energy Organization of Iran (SUNA) is responsible for evaluating the potentials renewable energy resources, regulating the industry, and promoting of various renewable energy projects. An applicant for a power generation from RE must perform the required feasibility studies and submit the report to SUNA for review and approval. Iranian Water Resources Management Organization is responsible for confirming the compliance of feasibility studies for the small hydroelectric power plants.

SUNA is also responsible for signing the long-term contract for purchase of electricity in accordance with issued establishment license. Typically, a contract commences from its effective date and ends at the end of the "Commercial utilization period" of the power plant. Producer is responsible to inform SUNA about the quantity of renewable electricity that has been sent to electricity grid along with receipt confirmation of Grid Management through monthly statements.

In accordance to the law, Ministry of Energy is obligated to purchase produced electricity energy produced by private and governmental sectors at guaranteed prices. This amount is changed each year and are is in accordance to the following equation:

$$\text{Escalating coefficient of mentioned rates in long-term contracts} = \left(\frac{\text{Retail Price index CPI at the beginning of payment year}}{\text{Retail price index CPI at the beginning year of signing the contract}}\right)^{a} \times \left(\frac{\text{Average exchange rate (Euro) in 1 month prior than payment date}}{\text{Average exchange rate (Euro) in 1 year prior than payment date}}\right)^{1-a} \div (1.02)^{b}$$

Where: *a* varies between 0.25 and 0.75 and its value is specified in the contract.
b is the difference of the year of signing of the contract and the year that the payments began.

Once feed-in tariff rate is established, it will be fixed for the duration of the contact. However, a developer may be able to negotiate higher rates than the ones established at a given year.

Azerbaijan

Azerbaijan has large reserves of oil and gas. This acts as a disincentive for the promotion and development of the potentially significant renewable energy resources. Law of the Azerbaijan Republic on Utilization of Energy Resources establishes policy related to the energy resources utilization and regulates the relations between the state and physical and legal entities.

Typically, policies are put into effect by presidential decrees. The State Program on Use of Alternative and Renewable Energy Sources in Azerbaijan Republic (2005 to 2013) was approved with Presidential Decree. The objective of the program is to promote power generation from renewable and environmentally sound sources to utilize more efficiently hydrocarbon energy sources. The Ministry of Energy has also established the Coordinating Council for realization of this program.

The new Azerbaijan State Agency for Alternate and Renewable Energy Sources is the only governmental body responsible for development of renewable energy sector. This agency will regulate, organize, and carry out state control over relevant activities. In particular, the agency is charged with making the proposals for promotion and financing for engineering, construction, and operation of relevant sites, including production of necessary equipment.

Asian Development Bank completed the preparation of a study entitled the Concept of Alternate and Renewable Energy for Azerbaijan. The study recommended establishing tariffs based on the avoided costs of the buyer, or a published tariff based on the costs of the producer (“feed-in” tariffs). As of early 2011 there were no set procedures to establish tariffs for the electricity developed from RE.

Turkey

Turkey relies on thermal power plants for nearly 74 percent of its electricity needs. Hydropower does produce over a quarter of electricity, but renewables make up a mere 0.2 percent of electricity production. The Ministry of Energy and Natural Resources (MENR) is responsible for preparing and implementing energy policies, plans, and programs. The Energy Market Regulatory Authority was established as the independent regulatory authority.

Turkey regulations define renewable energy resources as installations using wind, solar, geothermal, wave, tide, biomass, hydrogen, and canal- and river-type hydropower as well as hydropower facilities with an installed capacity of less than or equal to 50 MW and a reservoir area less than 15 square km or a reservoir less than 100 million cubic meters.

The Renewable Energy Law promotes the use of renewables in a free energy market. The law introduces feed-in tariffs and provides a 10-year purchase agreement for all renewable energy certified producers that commerce their operation before 31 December 2011. Hydro and geothermal power producers should receive a fixed feed-in tariff of 15 percent above Turkish Electricity Wholesale and Trading Company’s (TETAS) wholesale electricity price. All other renewable energy producers will receive a tariff of 20 percent above the wholesale electricity price. The minimum of 5 Eurocents and a maximum of 6 Eurocents will be applied.

By setting up a floor price and guaranteed purchase agreement, the government provided financial incentives and reduced uncertainties of investment in renewable power. The Law also grants a 50 percent reduction on the fees for land use permission, and exemptions from regular license fees for renewable generators.

An Energy Efficiency Coordination Board was established to carry out energy efficiency studies within relevant organizations all over the country, monitor its results, and coordinate efforts. The Research, Planning, and Coordination Board (APK) of MENR co-ordinates the activities of the dependent and related institutions and executes national energy policy. It conducts long-term energy planning and develops different policy scenarios to support this work.

The General Directorate of Energy Affairs (EIGM) is the main policy-making body within the MENR. The EIGM is responsible for the co-ordination of the natural gas and electricity sector reform programs, including the consequences of past efforts to bring private investments to the electricity sector. It also carries out studies on general energy and environmental policies, renewable, and energy efficiency.

The Electrical Power Resources Survey and Development Administration (EIE) of MENR is assigned to identify the energy potential of water resources and to prepare dam and hydropower plant projects. The EIE carries out various activities in relation to energy efficiency and renewable energy resources.

Russia

Russia has the largest known natural gas reserves of any state on earth, along with the second largest coal reserves, and the eighth largest oil reserves. Renewable energy in Russia is largely undeveloped although there is considerable potential for renewable energy use. Geothermal energy, which is used for heating and electricity production in some regions of the Northern Caucasus and the Far East, is the most developed renewable energy source in Russia.

The energy policy of Russia is contained in an Energy Strategy document, which sets out policy for the period up to 2020. The Energy Strategy document outlines several main priorities: an increase in energy efficiency, reducing impact on the environment, sustainable development, energy development and technological development, as well as improved effectiveness and competitiveness.

The Federal Law on Energy Saving and Energy Efficiency Increase and Amending Certain Legislative Acts of the Russian Federation outlines the general principles of Russian policy in the field of energy efficiency (EE) and energy saving (ES). Several government decrees where then issued base on this law to address specific issues, such as EE requirements for goods, including electric bulbs, EE requirements for buildings and construction, EE classes of goods and apartment buildings, EE requirements for public procurements, etc. According to this Law, goods produced on the territory of the Russian Federation and imported to Russia must contain information on their EE classes. A Government Decree establishes seven classes for various goods, from “A” being the maximum efficiency to “G” being the minimum efficiency. Failure to comply with these requirements will result in fines and/or confiscation of the goods.

Moreover, this law has prohibited the circulation and sale of incandescent lamps with power exceeding 100 W starting 1 January 2011. According to the EE rules, buildings and structures must comply with obligatory requirements fixed by the Ministry of Regional Development in concurrence with the Ministry of Energy. This is one of the most important requirements which will require that the indication of the EE classes of apartment buildings to be posted on their facades. The Law also requires that every building be provided with an energy accounting meters (“energy gauges”) and fixes deadlines for the installation of such equipment. Failure to comply with EE requirements in designing, construction, reconstruction, and major remodelling, as well as failure to comply with gauge fitting requirements could result in stiff fines. Furthermore, in order to draw the attention of the public to EE and ES matters, the Law provides for a wide range of measures aimed at informing people and raising their awareness.

Russian authorities have adopted support procedures to stimulate the use of renewable energy sources in Russia. It aims to ensure the financial viability of investments in renewable energy by adding a ‘premium’ (or ‘increment’) to the wholesale electricity price. Moreover, it requires consumers to purchase a certain amount of their electricity needs from renewable energy installations. It also specifies that producers will be compensated by the state for the connection costs of renewable energy installations with an installed capacity of not more than 25 MW.

United States

In the U.S., several regulations and programs deal with the production, distribution, and use and conservation of energy, and the development of alternative sources of energy. The U.S. Department of Energy ("DOE") is a government department concerned with policies of the U.S. relating to energy and safety. The Federal Energy Regulatory Commission (FERC) is an independent regulatory agency that oversees and regulates the sale of the natural gas, oil, and electricity markets in the U.S. The FERC also provides licenses for hydroelectric plants and reacts to environmental matters.

The Solar America Initiative (SAI) is a part of the Federal Advanced Energy Initiative to accelerate the development of advanced photovoltaic materials with the goal of making it cost-competitive with other forms of renewable electricity by 2015. The Environmental Protection Agency (EPA) has published a "State and Local Guide to Action" that outlines a strategy for developing energy efficiency and renewable energy through planning and policy implementation and provides lessons learned for 16 commonly used policies.

Most of the renewable energy development incentives are established by individual states. Increasing numbers of U.S. states and territories are implementing policy measures and dedicating funding to encourage the deployment of renewable energy technologies. The design and implementation of these incentives is varied – and so are the development trends. Feed-in tariffs, rebates, and net metering are three of the most widely used incentives for promoting RE.

The ethanol industry is one of the most significant success stories in use of renewable energy in U.S. over the past quarter-century. Largely, increased use of ethanol in conventional gasoline has resulted from government policies. At the Federal level, there have been Federal tax incentives and strict environmental standards. In addition, states currently employ numerous tax exemption, producer incentives, and mandates for ethanol.

EU

EU has taken various measures aimed at promoting renewable energy, be it in the shape of technology programs or specific policy initiatives. Policy measures have been adopted in the form of targets, either in a political context such as renewables target, or under sector-specific legislation, such as the bio-fuels and renewable electricity Directives, which also provide a set of measures aimed at facilitating the achievement of the targets set.

Directive 2009/28/EC of the European Parliament and of the Council related to the promotion of the use of energy from renewable sources is the main document governing future development of RE in EU Member State. This Directive requires each Member State to adopt a National Renewable Energy Action Plan (NREAP) and present to the European Commission. These plans are to set out Member States' national targets for the share of energy from renewable sources consumed in transport, electricity, and heating and cooling in 2020.

Communication from the Commission to the Council and the European Parliament, entitled "Renewable Energy Road Map Renewable energies in the 21st century: building a more sustainable future" is another document related to RE in Europe. With this Roadmap the Commission sets out an important part of its strategic vision for the energy future of Europe. It seeks to accelerate significantly the growth in renewable energy, and proposes that the EU achieve a contribution of 20% of its energy mix from renewable energy sources by 2020.

EU has adopted the bio-fuels directive (2003/30/EC), with the objective of boosting both the production and consumption of bio-fuels in the EU. Directive 2004/8/EC is on the promotion of cogeneration. The Energy Performance of Buildings Directive 2002/91/EC, promotes efficient heating. However, renewable energy use in heating has grown only slowly.

During the first EU Summit on Energy on 4 February 2011, the decision was taken to strengthen energy networks in a move that gives fresh impetus to the renewable energy industry and will help curb Europe's growing reliance on fossil fuels. It was also acknowledged that further green growth requires a high-tech power grid to carry wind power from the north and solar power from the Mediterranean to central cities.