POLICY PAPER

Policy Schemes for Supporting Small Scale Solar Power Generation in Georgia

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List of Abbreviations

ADB – Asia Development Bank

AYPEG – Association of Young Professionals in Energy of Georgia

BNEF – Bloomberg New Energy Finance

CDM – Clean Development Mechanism

CER – Carbon Emission Reduction

CIT – Corporate Income Tax

DHI – Diffuse Horizontal Irradiance

DNI – Direct Normal Irradiance

EBRD – European Bank for Reconstruction and Development

EIA – Energy Information Administration

FIT – Feed-in Tariff

GHI – Global Horizontal Irradiance

GNERC – Georgian National Energy and Water Supply Regulatory Commission

IEA – International Energy Agency

IFC – International Finance Corporation

IRENA – International Renewable Energy Agency

LCOE – Levelized Cost of Electricity

MoE – Ministry of Energy of Georgia

O&M – Operation and Maintenance

PIT	– Personal Income Tax
PPP	– Private-Public Partnership
PV	– Photovoltaic
REC	– Renewable Energy Certificate
RPS	– Renewable Portfolio Standards
TSO	– Transmission System Operator
TYDP	– Ten Year Network Development Plan 2015-2025
VAT	– Value Added Tax

Introduction

Solar power is one of the fastest growing renewable energy technologies becoming competitive with traditional sources of electricity generation. Its main characteristics are: high initial investment costs, free fuel during the operations period and environmentally friendly nature. All this makes solar one of the best power solutions for all three sectors of economy: households, business and government. With high importance of energy security around the world solar brings individual solutions to agents in need of more secure power supply.

Through its decreasing costs over the years solar can become one of the driving forces for efficiency and competitiveness for developing economies. Georgia with its geographic location has around 250-280 sunny days annually, with total sunshine varying from 1,900 to 2,200 hours. Global horizontal irradiance around the country is in range of 1,000-1,600 kWh/m^2 annually, with most of territory receiving between 1,200kWh/m^2 and 1,400kWh/m^2. Although, Georgia's solar potential has not been studied fruitfully, total annual potential of the country is estimated to be around MW 108 (MoE, TYDP 2015-2025). All this creates suitable conditions for households and businesses to integrate solar power in their everyday electricity usage. In addition, Georgia has around 20 villages, with total 471 households without electricity supply and connection to the grid (MoE). For most of these households, solar is only viable opportunity for getting electricity and consequently major components of civilized life.

Solar can also play an important role in solving some of the most important energy challenges of the country. Currently, around 56% (96% in rural and 26% in urban areas) of Georgian households use firewood for space heating, while only 9% (0.2% in rural and 17% in urban) use electricity (AYPEG). Such a high share of firewood in energy usage causes deforestation and other environmental problems. Supporting independent solar power generation can both provide reliable electricity to households and businesses, as well as contribute role in solving some of the major environmental challenges of the country.

Development of small scale solar photovoltaic (PV) systems is beneficial for Georgia in many ways. Supply security is one of the major challenges for the country's electricity sector with around 25-35% of annual generation coming from thermal power working on imported natural gas. Solar power addresses this challenge through providing micro level solution to households and businesses. With its renewable, carbon free nature small scale PV systems can partially substitute need for thermal power generation. Unlike hydro installation of solar systems takes much less time, is relatively straightforward and needs less engineering expertise. Additionally, fast development of battery storage technologies makes solar 24/7 electricity source. Small scale solar PVs are good for electricity market as well. Connection of many small scale electricity generators to the grid can support improvements in the market structure towards more competition. Finally, being at the border of Europe and Middle East – that has one of the largest solar potential in the world - Georgia can become a suitable country for manufacturing of photovoltaic panels and related technologies. Solar manufacturing industry is one of the fastest growing in the world, however development of local market can be vital for bringing world's technological race into Georgia.

At this stage Georgia does not have renewable energy development strategy or any policy supporting solar power generation at households and businesses. Only recent document is a Ten Year Network Development Plan (TYNDP) of Georgian State Electricity System – government owned transmission system operator (TSO). Report overviews opportunities for different power sources including solar. One of its arguments is that due to high volatility in power generation integration of solar and wind power plants in transmission system is unreasonable prior to 2025 (TYNDP 2015-2025). However, TYNDP does not review prospects of developing small scale power systems.

As for electricity market regulatory framework, it has few points on integration of small scale power plants (<100 kW installed capacity) into the grid. This can be summarized in following two provisions: (i) consumer can connect its small scale power plant free of charge to the grid[1], (ii) Excess electricity of the consumer can be supplied to the grid for price equal to the consumer's price minus distribution tariff (GNERC). Otherwise, regulatory framework does not include any other incentives for small scale solar power solutions. On the other hand, government does not have any subsidies, or other fiscal initiatives in its budget and tax. At this stage there are only several households/businesses in Georgia taking advantage of supplying their excess electricity from small scale power plants to the system, however none of them are solar PV systems.

In Georgia solar photovoltaic technologies are generally seen as an expensive power source, that is primarily used in remote areas were installation of grid is significantly more expensive, creating space for solar. Furthermore, due to low public interest most of such projects are financed with grants from international donors, or government organizations interesting in creating opportunities in remote areas. Best example of such support program for renewable energy and energy efficiency is **"Energy Credit"** – low interest loans for households and businesses from EBRD with partnership of Georgian commercial banks. This project with its drawbacks is discussed in Section 4 and is one of the most realistic incentives for development of small scale solar power systems in Georgia.

[1]All the equipment costs for connecting the small scale plant to the grid are taken by the consumer.

There are two factors that limit usage of independent small scale solar power in households and businesses. First and the most is low electricity prices that make solar more expensive than purchases from the grid, thus making investment – or at least creating illusion – that solar will not scale. Second, awareness about solar power is very low in society – not only in general public, but also in professional circles in energy sector. As for the awareness in energy sector most of stakeholders see large unutilized potential of hydropower, making them more interested to harvest large scale cheaper electricity generation opportunities. Currently with undeveloped industrial sector Georgia is already running annual electricity deficit that will grow with economic development. Furthermore, electricity consumption per capita is quarter of that in industrialized countries. Thus, on the one hand power consumption is increasing in the country faster than generation capacity and on the other hand solar power creates an opportunity for creating capacity relatively faster for at least some of the residential and commercial consumers.

Increasing solar power generation is one of the primary goals of the energy policy agenda in most of developed economies such as United States, Germany, Spain, Japan and China. Over last decade this initiatives facilitated decrease of prices (per kWh) of electricity generated by photovoltaic (PV) three times. In many countries electricity prices of Solar PV went below the retail price that guarantees stable growth of installations both in households and businesses. Google, Apple, Walmart, IKEA, Kohl's, Facebook and many large corporations use solar power for increasing their competitiveness. Policies used for reaching this results can be grouped in three clusters: (i) solar Rebates – payments per watt installed, (ii) tax credits – production or investment based tax incentives and (iii) feed-in tariffs (FIT) – set price (typically above the retail price) from utilities for the electricity provided to the grid (EIA). Solar rebates and tax credits are actively used in different states of U.S., while FIT has been associated with the German model of motivating solar power generation. With FIT government obligates utilities to enter into long-term contracts to pay small scale solar power generators higher than retail price for electricity supplied to the grid. German model also actively uses different schemes of subsidies to increase electricity produced by solar photovoltaic. All policies in above three clusters have their success stories and bottlenecks. In many cases success of the policy is primarily defined by the country context, however analyzing results of above policies in different countries will facilitate suggestion of policy initiatives in literate manner.

This policy paper analyzes current regulatory framework on the Georgian electricity market, to find space and opportunities for integrating needs of solar generation growth. It studies different components of electricity market regulatory framework to find the ways of improvements under current vertically integrated electricity market. Although, there is lack of data Levelised Cost of Electricity Generation (LCOE) is calculated, as an important cost indicator of solar photovoltaic for households and businesses (IRENA). Through reviewing international case studies this paper suggests different policy initiatives from above three clusters. It also reviews Georgia's tax code (including customs provision) for finding space to integrate needs of solar power development in government's fiscal policy.

This policy paper is organized in the following manner: Section 2 defines methodology of calculating LCOE and provides major assumptions. Section 3 provides results of LCOE calculations for six different scenarios and compares them to current electricity tariffs in the country. Section 4 reviews international experience, opportunity to integrate it in Georgia, defines costs for different policy interventions and makes recommendations on the best options. Section 5 concludes the policy paper and summarizes main results.

I. Methodology

To provide feasible policy recommendations it is essential to have benchmark cost that will help to compare scales of different policy interventions, tax relief, or feed-in tariff. Such benchmark cost value is Levelised Cost of Electricity that shows cost per kWh of electricity over lifetime of system. To avoid any misconceptions it should be noted that LCOE gives an insight only about electricity generation costs. This method is not suitable to determine how cost efficient is a specific power plant. For that one should make needed financial calculations, estimate all revenues and expenditures to be undertaken based on a cash-flow model. Having electricity cost calculated for household and business scale solar power systems will support choosing right incentive schemes and proper capacity of government intervention. Following specification of the LCOE is used:

$$LCOE = \frac{I_0 + \sum_{t=1}^{n} \frac{M_t}{(1+r)^t}}{\sum_{t=1}^{n} \frac{E_t}{(1+r)^t}} \quad (1)$$

Where,

- $LCOE$ – average lifetime levelized cost of electricity generation,
- I_0 – Initial investment in solar power system
- M_t – Operation and maintenance costs of the system$t$
- E_t – annual electricity generation in year t
- r – discount rate
- t – lifetime of PV system

Initial investment in solar power system – this variable is calculated based on international prices for currently available PV solutions around the world. Initial investment variable takes into account all investment costs needed to make PV system operational. This includes: price for panels, as well as balance of system components, approximate planning, engineering services and costs for installation.

Operation and Maintenance (O&M) costs of the PV system includes all costs that are needed for proper functioning of solar power system over its lifetime. As this policy paper calculates LCOE for the general system of different capacities, 0.5% of initial investment cost is assumed to represent a realistic level of O&M costs annually (ADB, IRENA).

Annual Electricity Generation – approximation of annual power generation is made based on maps of global horizontal irradiance levels for Georgia based on following formula (ADB 2014):

$$E = C_R \times GHI \times D \quad (2)$$

Where,

- E – annual electricity generation
- C_R – total installed capacity
- GHI – global horizontal irradiance
- D – derate factor represents an efficiency measure of PV system and typically ranging between 0.6 and 0.8. In this policy paper two options of 0.6 and 0.75 of derate factor are used for calculating generation of PV system.

Discount rate – discount rate will be based on average annual interest rate available on long term loans of commercial banks in Georgia.

Lifetime of the PV system – as PV technology loses efficiency after certain period we assume that lifetime of the system is 20 years that is a typical efficiency warranty period of solar manufacturers and is recommended in the literature (ADB).

Levelized Cost of Electricity is good benchmark value for several reasons: (i) it includes generation of the system over its lifetime, thus analyzing long term benefits of the system; (ii) it directly includes total investment cost of the system, as well as operations cost, therefore it compares all benefits and all costs of the system; (iii) result is a simple intuitive and easy to understand value, that unites long term cost of generating electricity. Bottleneck associated with such cost value is defining systems lifetime. Although, solar systems may have specific lifetime, they do not deplete totally after this period. Such lifetime is generally associated with highest efficiency of power generation, therefore LCOE might not capture all the benefits that solar PV system may provide.

In most cases LCOE is not a suitable measure to calculate level of feed-in tariffs and other measures, as legislative framework on solar PVs makes it a hard task. However in case of Georgia, this is possible as there is no legislative framework or special tariff schemes for supporting PV system. In addition, main bottleneck of this measure is the fact that it does not take into account significance of electricity generated at a given hour of the year. Thus, in case of peak load in the system electricity might be more expensive for the household or business to buy/sell depending on personal consumption. In many such cases PV system owner might benefit from extra high electricity prices. This is especially interesting for the case of countries with annual electricity supply deficit, such as Georgia. However, this drawback of the measure does not apply in this case considering country's electricity market structure and regulatory framework. Specifically, in Georgia small scale PV system owner (< 100 kWp installed capacity) can buy/sell electricity for the fixed tariff at any point during the year. Therefore, unless power exchange market is developed in Georgia, this limitation of LCOE measure does not apply either. Levelized cost of electricity calculated above captures most costs and benefits that PV system can give the owner under current regulatory framework in Georgian electricity market.

Lastly, one of the most challenging parts of calculating LCOE in Georgia is data availability. As it is typically based on data from already installed systems, in Georgian case cost value have to be approximated based on international experience and different reports, about developments in PV market.

II. Calculation of LCOE for Solar PV

Georgia with its location on southern Caucasus range has favorable conditions with 250-280 sunny days annually (MoE) and 4,383 hours of daylight annually. According to Solar GiS data collected between 1994-2010 average global horizontal irradiance (GHI) varies between 1,000-1,600 kWh/m^2 (Figure 1. – SolarGIS). With its solar irradiance levels Georgia is similar to Southern Germany, Southern France, Northern Italy and Northern Spain, thus policy measures used in this countries can be at least partially applicable for Georgia and its Solar power potential.

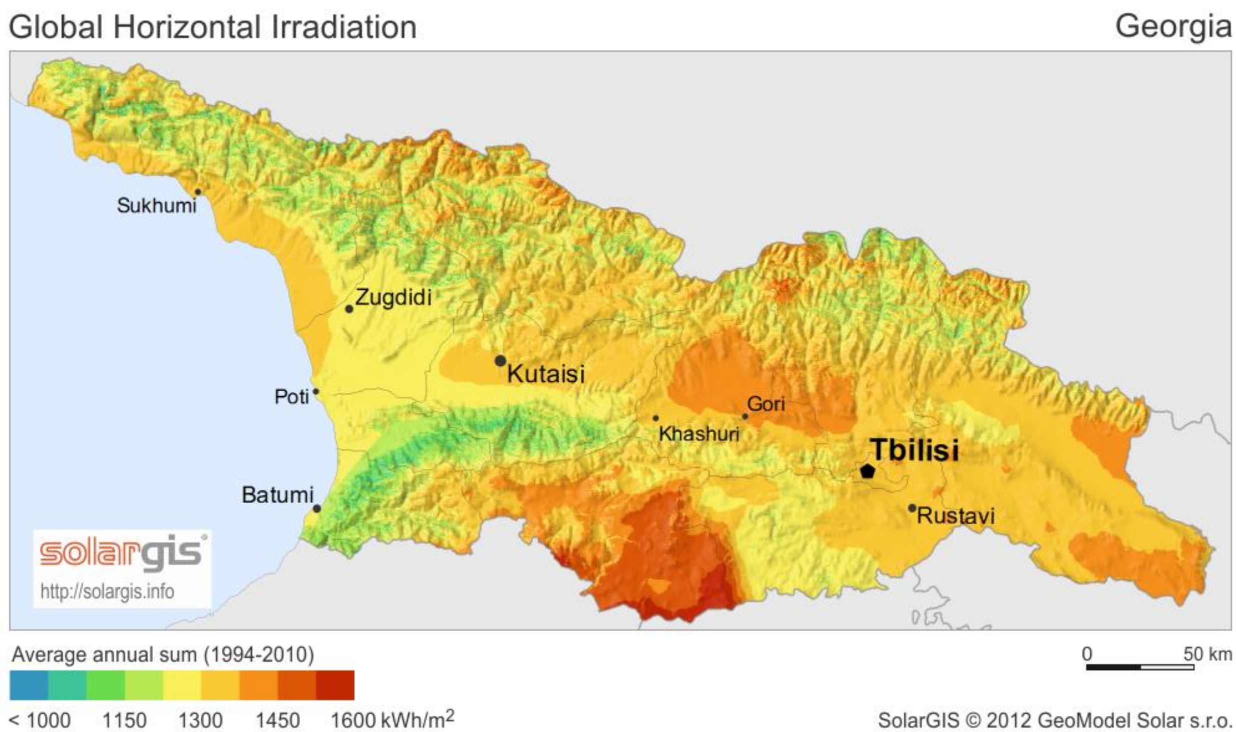


Figure 1. SolarGIS – GHI map Georgia

Figure 1. shows that on most of country's territory GHI is in range between 1,150 kWh/m^2 and 1,450 kWh/m^2. Considering locations of major towns in the country, this policy paper calculates solar PV electricity generation for three scenarios of GHI: (i) 1,150 kWh/m^2- Batumi, Zugdidi, Poti; 1,300 kWh/m^2- Tbilisi, Telavi, Kutaisi, Sokhumi; 1,450 kWh/m^2 Gori, Rustavi, Akhaltsikhe, Akhalkalaki.

Unfortunately, Georgian meteorology agency does not have a long term time-series covering recent periods of direct normal irradiance (DNI) and diffuse horizontal irradiance (DHI). This information is essential to make more accurate calculations of electricity generation. Except for different support schemes, one of the basic steps for developing solar power is to provide transparent data on solar radiation. Therefore, installing pyranometers[2] in major locations of the country is essential for success of the sector and making more literate decisions while investing in solar power generation.

For calculation of levelized cost of electricity following assumptions are made in this paper:

- System's operation period is 20 years that corresponds to current minimum performance warranty of module manufacturers;
- For each of three possible GHI levels 1,150-1,300-1,450 kWh/m^2, policy paper uses two scenarios of derate factor 0.6 and 0.75. This way both whole country and effect of efficient use of PV on LCOE is captured;
- Discount rate used in LCOE calculation is average annual interest rate for long-term loans in 2014 i.e. 13.1%. Rational for using interest rate on loans as a discount rate has following argument: (i) this rate is the "price" for investing in PV installation or any other long-term investment in the country, (ii) it captures all risks associated with any investment

[2] It should be noted that one pyranometer is installed in Gori by Georgian Energy Development Fund, however it is not sufficient to make judgments about the country in general.

in the country, (iii) it gives a chance to find what is the interest rate on the market that will correspond to possible low-interest loan program;

- Operation and maintenance is fixed to 0.5% of total investment cost that is considered to be sufficient as, target installations are small scale plants needing minimum O&M.

Based on above developed methodology electricity generation of conventional 1 kWp PV system is calculated with three different options of GHI and two different options of derate factor. Thus we have six different scenarios of annual power generation of PV system presented in Table 1.

Table 1. *Electricity Generation of conventional 1 kWp power solar power system* $C_R = 1$

Global Horizontal Irradiance(GHI)	**Derate Factor**(D)	**Electricity Generation (kWh/year)**(E)
1150	0.6	690
	0.75	862.5
1300	0.6	780
	0.75	975
1450	0.6	870
	0.75	1087.5

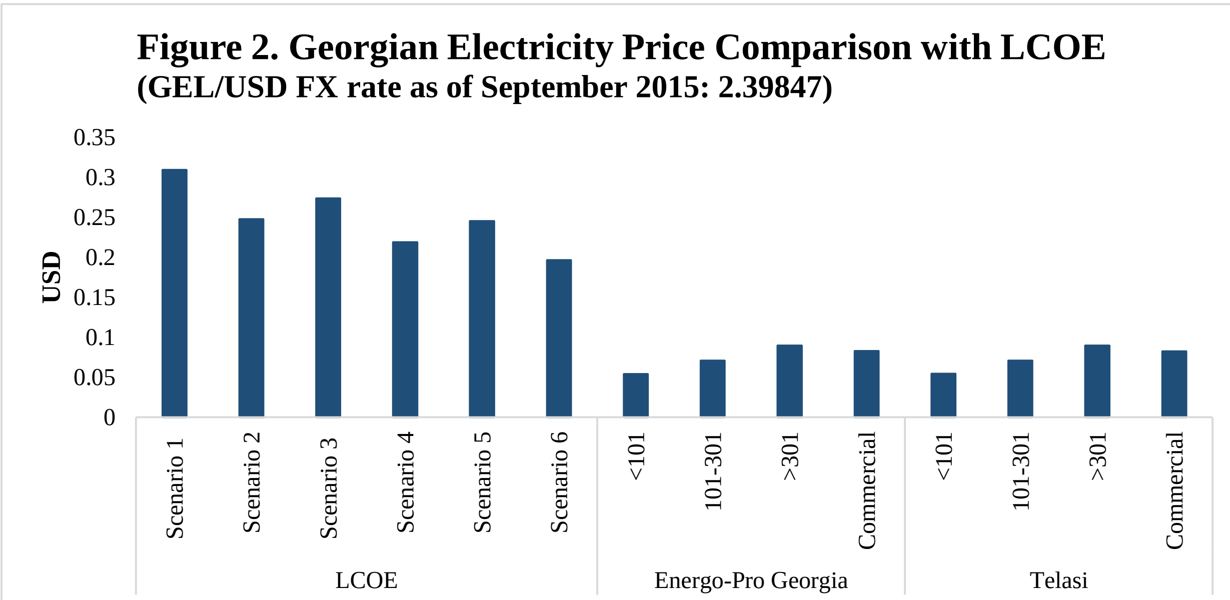
Considering the data limitation on price of PV systems per Wp price for installed capacity from credible international reports is used. One of such sources is Bloomberg New Energy Finance (BNEF) and its report prepared for International Energy Agency (IEA). Based on BNEF forecast system price in

2015 will be USD 1.44 per Wp. This data is used for calculation of initial investment in conventional 1 kWp solar power system. Based on above assumptions Table 2. shows calculation of initial investment O&M costs and different levels of LCOE based on above six scenarios:

Table 2. *LCOE for conventional solar power system in Georgia*

Initial Investment (I_0) (USD)	**O&M Costs (M_t) (USD)**	**Lifetime of the system (t) (years)**	**Discount Factor**	**Discounted O&M Cost**
1440	7.2	20	$(1.31)^t$	50.28
Generation Scenarios	**Electricity Generation**	**Discounted Electricity Generation**	**LCOE (USD per kWh)**	
Scenario 1	690	4818.1	0.31	
Scenario 2	862.5	6022.6	0.25	
Scenario 3	780	5446.5	0.28	
Scenario 4	975	6808.2	0.22	
Scenario 5	870	6075.0	0.25	
Scenario 6	1087.5	7593.7	0.20	

This level of LCOE is very high for seeing solar power generation as a viable alternative to utility electricity. Specifically, even with recent adjustment in electricity prices LCOE is more than twice of current utility tariff for highest consumers in the country. Current electricity tariffs in Tbilisi (electricity utility – Telasi) and other regions covered by Energo-pro Georgia are following:



Results in Figure 2 show why independent PV system is not the cost efficient power supply option for households and businesses. Estimates of LCOE for shows that even under most optimistic scenario utility electricity prices are twice cheaper. Although, few things have to be noted. Estimation of LCOE is calculated based on PV system price, not taking into account any subsidy or support program. Thus, under current tariffs of highly regulated electricity market in Georgia, solar photovoltaic technologies do not scale in areas were connection to the grid is available. Although, with deregulation of Georgian electricity market current low electricity price will definitely increase. In addition, introduction of power exchange might also be helpful especially for businesses owning PV systems. With deregulated market businesses and households will be able to consume cheaper electricity during the peak load, or benefit from selling it for the high price to the grid. Under the deregulated market LCOE will not be the comprehensive measure to evaluate benefits of

PV system and derive supporting policy schemes. Lastly, it should be noted that above calculations are made for conventional PV system, therefore making a specific project for solar power installation can result in lower LCOE.

One of the key components in LCOE calculations is discount rate. Current high interest rates on long-term loans in Georgian economy plays a vital role in making LCOE very high for solar PVs. In general investing in small scale solar PV does not have a very high return on investment (ROI), thus with very high interest rates in the country small PV systems do not scale. However, with increase in installed capacity of PV higher cost efficiency can be achieved. This clearly signals that low-interest loan programs for solar installations might be an important incentive both for households and businesses.

In addition, efficiency in design, operation and maintenance of PV system is vital for bringing LCOE down. For this reason efficiency of system's design should be one of the basic requirements for eligibility to receive any type of support scheme. One of the drawbacks of LCOE as a measure is that it does not take into account generation after 20 year period. In this case this discounting period is taken based on international experience and the fact that most solar manufacturers give a warranty of 20 years of high efficiency operations. However, solar system is not totally depleted after warranty period and is just generating electricity below 90% of its initial efficiency. LCOE is not capturing this fact, therefore underestimating lifetime generation from PV system. Although, its effect on final result of LCOE is insignificant. Making above calculations for the lifetime of 25 years gives only 1¢ difference in LCOE.

Finally major contributor in PV system cost is initial investment in installed capacity. This variable is very rapidly decreasing over the past 10 years around the world. Unfortunately, Georgia is not the part of the race for improving solar power technology, however it can easily import already available technologies. Number of fiscal and legislative initiatives can decrease the price for PV systems. Such policies include changes in tax code on import of solar panels, as well solar rebates per installed capacity. Although, incentives such as rebates can create motivation for installing solar panels and decrease LCOE for PV system owners, under such a large difference with the tariff payment can become a burden for the state budget.

III. Policy Alternatives

There is a large number of different fiscal policy incentives for renewable energy developers around the world. Both national governments and international inter-state agreements create basis for developing incentive schemes for technologies such as solar PV. Such incentive schemes are: renewable portfolio standards, renewable energy certificates, clean development mechanism, grants and rebates, low-interest loan programs, tax incentives, feed-in tariffs and market premium. From this alternatives paper discusses three groups of incentive schemes: (i) Low interest loans, rebates and grants; (ii) tax incentives; (iii) feed-in tariffs. Other policy schemes mentioned are either not applicable, or will be ineffective in Georgian reality. Primary criteria for an alternative to be chosen in this policy paper is that it should be effective given the current framework of Georgian electricity market and affordable for the government.

Specifically, renewable portfolio standard (RPS) is an obligation, or a quota system required to certain entities typically utilities and large electricity consumers to consume certain percentage of electricity from renewable energy sources. This policy initiative is problematic as most of Georgia’s electricity comes from hydro (roughly 80% of total electricity generation in 2014). Thus entities obliged to follow the renewable portfolio standards will be able to easily answer even very tough requirement. Another option is to set the RPS specifically for solar, however in this case policy will be directed not towards incentive, but towards making an entity pay higher price for power consumption. Finally, Georgia is a developing country striving to attract as many investors in the country as possible. Adding additional regulation on source of power consumed is not an investor friendly decision.

Renewable energy certificates (REC) are the specific market mechanism, typically used with RPS. REC is a property right on electricity generated, that renewable power producer can sell the entity obliged to meet the renewable energy target. Acquiring a certificate is normally associated with a certain costs and number of verification steps. Typically utility scale renewable power plants, or businesses having their large scale solar installation attain such certificates. As Georgia does not have an RPS, or developed large polluting industries applying REC will not be possible. Although, there is an option for cross-border sale of RECs for now even newly built hydropower plants frequently do not apply to receive them. Thus REC cannot be a powerful incentive for the possible owners of PV systems.

Clean Development Mechanism (CDM) is a type of carbon credit developed under the Kyoto Protocol that represents an agreement between countries to meet a certain target of carbon emissions. CDM makes a basis for creation of carbon emission reduction credit (CER) that operates as a tradable instrument between the countries. There is a simplified procedure for the small rooftop PV project to acquire CER: (i) PV project should result in reduction of measurable amount of carbon emissions, (ii) project must demonstrate its contribution in country’s environmental and economic development goals (ADB 2014). CER can be applied for small scale PV installation in households and businesses in Georgia. As CER is an incentive that is managed by international organization, there is definitely a role for local representative office of UN and the government to increase awareness, about CER and its benefits. Selling the CERs to developed countries can be an additional benefit for Georgian PV owners from their system. However current international prices for carbon emission are very low, thus a benefit from this policy will be very limited.

3.1 International Experience

Most of developed countries see a solar power as a micro level solution to a bigger problem of power generation from fossil fuels. A smart policy initiatives and incentive mechanisms led race for advancement of PV technologies over the last decade, resulting in drastic decrease of its price. Some of the most experienced in designing incentive mechanisms for solar power are European countries whose examples can be applicable for Georgian case, especially in places with similar conditions. Specifically, experience of Germany as one of the leading countries in solar power development is useful. Furthermore, policies schemes from countries like Italy, France and United States is also interesting.

Germany is a country with extremely rich experience in creating policy mechanisms for solar power development. It recently updated incentive schemes set out in Act on Granting Priority to Renewable Energy Sources (EEG 2014). Specifically, renewable energy act provides three main support schemes: Feed-in Tariffs, market premium and low interest loans (RES Legal). **Both building and ground mounted systems with installed capacity up to 500 kW are eligible for the feed-in tariffs**. For the amount of feed-in tariff Germany does not differentiate between residential and commercial installers. Its level is derived based on generation site and the installed capacity. The amount of FIT for the building mounted systems varies between €ct 13.5 and 11.49 per kWh minus €ct 0.4 per kWh. As for other type of systems it is €ct 9.23 minus €ct 0.4 per kWh (EEG 2014). From 1st December 2014 Following FITs are in Force in Germany:

Furthermore, plants with a capacity exceeding 500 kW are eligible for the market premium. With this incentive plant operator has to sell electricity directly to the consumer with a supply agreement and claim the so called market premium from the grid operator who is obliged to take any electricity

Table 4. *FTIs in Germany*

Installed Capacity	FIT
< 10 kWh	12.59 €ct/kWh
< 40 kWh	12.25 €ct/kWh
< 500 kWh	10.95 €ct/kWh
< 10 MW	8.72 €ct/kWh

produced by solar power plant. The market premium is calculated each month.

More interesting incentive scheme for the purposes of this policy paper is low interest loans under the KfW Renewable Energy Program for investments in installations of renewable energy technologies. This loans are long-term low-interest period loans with a fixed interest period of 5 or 10 years and repayment-free start-up period. Annual effective interest rate varies between 1.31-7.56% depending on repayment-free start-up period and duration of fixed interest rate. Projects are eligible to get financing of up to 100% of investment, however for the costs not more than € 25 million.

From the German experience Georgia can use several incentive mechanisms. First of all, similar renewable energy development act has to be initiated that will include the policy framework, including responsible government bodies for setting and financing feed-in tariffs. A low-interest loans can be a successful support incentive that can be financed both by Georgian government with support of international donor organizations.

Italy is another interesting example for Georgia considering similarities of GHI between Georgia and Northern Italy. Support mechanisms in Italy are: **feed-in tariffs, net-metering and tax reduction schemes (RES Legal)**. PV technologies **of installed capacity up to 100kW are eligible for the feed-in tariff** that decreases with an increase of electricity output from the system. Furthermore, Italy offers **net metering** to PV system owners with installed capacity between 20 kW and 200 kW. Italian model is slightly different from traditional net-metering. In this case, PV system operator pays supplier for amount of electricity consumed, while state agency for development of renewables (Gestore Servizi Energetici) buys fed-in electricity and gives a credit to solar plant operator. Once a year balance is calculated and if electricity fed-into the grid is more than consumed, PV system operator is eligible for compensation. With this method of net-metering, owner of PV system is eligible to receive as much electricity for free as they produce. **Tax reduction mechanism** in Italy is especially interesting with its simplicity and straightforward approach. As Georgia has relatively simple and straightforward tax systems this example might be interesting to implement. Italy has value added and real estate tax reduction schemes for owners of small scale solar power plants. Deliveries and services related to installation of PV system and investment in development of grid distributing this system are eligible to reduction in value-added tax from 20% to 10%. Furthermore, national government gives municipalities an opportunity to reduce real estate tax below 0.4% up to 5 years period. It should be noted that real estate tax system in Italy is similar to its counterpart property tax in Georgia.

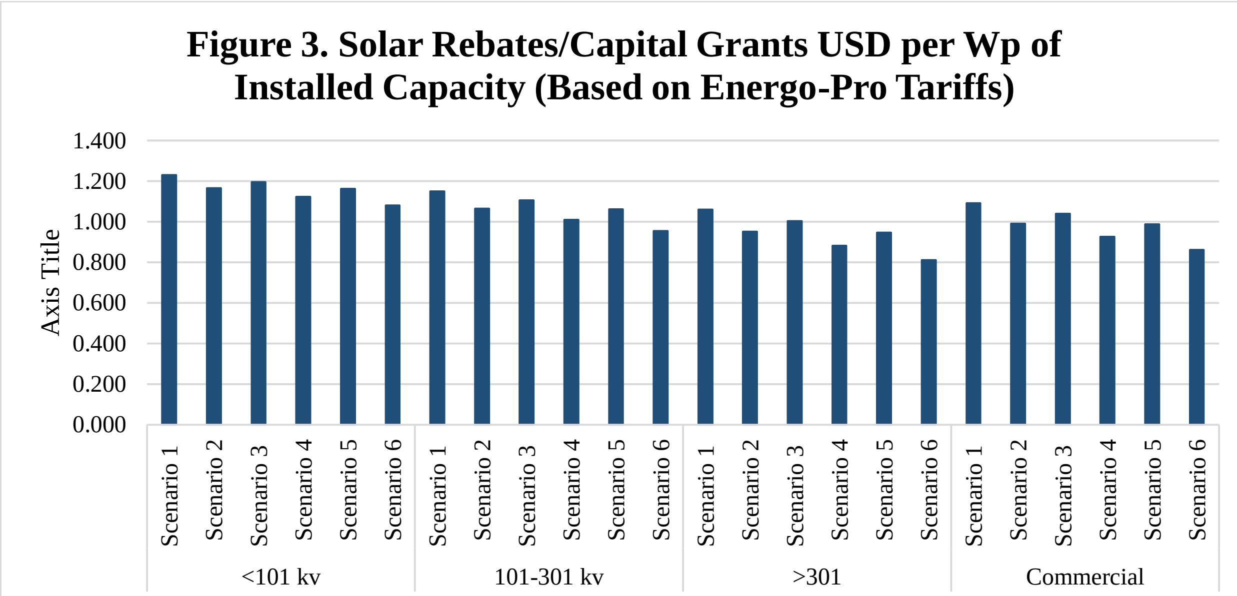
France with similar solar conditions to Georgia, has interesting support mechanisms for solar PV owners. Independent solar power installations are eligible for **feed-in tariffs and tax credits (RES Legal)**. Electricity suppliers and grid operators are obliged to sign an agreement with PV system owner for purchase and payment for electricity for the fixed price. FIT is limited to solar PV installations below 12 MW capacity. Furthermore, amount of feed-in tariff depends on type and total capacity of installation, not taking into account use of the building. FITs are decreased every quarter with maximum annual reduction of 20%. Another incentive is value added tax reduction that applies to PV installation if it covers the needs of a building and is up to 3 kW capacity or does not cover more than $30m^2$. The reduced VAT is 5.5% for the mainland of France and Corsica. Before 1 January 2014 French PV owners were also eligible to the income tax credit. An individual was able to deduce a certain percentage of investment in PV system up to € 3,200 per installed kWp. Persons installing solar PV systems on their residential building were able to deduce 11% of net hardware costs from their income tax, however capacity of the plant should not have exceeded 3 kWp.

From different policy alternatives used international, Georgia can definitely benefit from German type low-interest long-term loan program. This is clearly shown in LCOE calculations, where discount rate plays a very important role in reducing electricity cost. Feed-in tariffs are also interesting in all three cases, especially in Italian case where they can be used together with specific net-metering scheme. Finally, tax incentives such as VAT and property tax reduction can be used in Georgia, as it has relatively simple and straightforward tax code. It should be noted that with its simplicity Italian approach to tax reductions can be better integrated in Georgian system, while French income tax deduction policy can be configured as well. Finally, it should be noted that in general French incentive schemes are very limited, while German and Italian approaches create better opportunities to explicitly, or implicitly make solar power profitable for prospective owners.

3.2 Solar Rebates, capital grants and low-interest loan programs.

Solar rebates and capital grants are the policies that can be analyzed jointly, as these are cash payments for financing part of the PV system installation costs. Difference between solar rebates and capital grants is that one is given after successful installation, or connection to the grid, while the letter is given upfront. A solar rebate has an important benefit of evaluating already finished project and giving the payment afterwards, thus having a full control over the result. This is especially important considering that efficiency of the system can have a vital role in its final profitability. Giving a solar rebate after successful installation creates an opportunity to control over inventory procurement, quality of installation and ensure effective spending of state support funds – therefore keeping derate factor high and minimizing risks of deviating from an initial feasibility study.

However drawback of this incentive is that individuals, or businesses without initial funds to invest in the project will not be able to participate. Therefore, number of individuals, or businesses with a good potential and capability to implement a solar power project will be outcast. In the contrary capital grants capture all available projects, while baring a risk that implemented solar power system will not match initial conditions set in the feasibility study. Bottleneck of realizing any of this policies is that none of them create any motivation for further technological development, nor do they create the basis for long-term efficiency of the PV systems. In addition, imposing a state solar rebate, or capital grant will be very costly for the government. Taking into account LCOE of PV systems for Georgian case solar rebate/capital grant should cover between USD 1.21 and USD 0.77 per Wp of installed capacity, depending on a development scenario and annual consumption of system's owner. Figure 3 shows calculations of solar rebates/capital grants for the PV systems in Georgia:



Calculations in Figure 3 are made based on tariff that is covering most of locations mentioned in Section 3 i.e. residential and commercial tariff of Energo-Pro Georgia. Some other assumptions are: (i) solar rebate/capital grants aim to make consumers indifferent between producing electricity themselves and buying it from the grid, (ii) amount of rebates do not include any VAT tax exemptions, (iii) scenarios are optimistic considering that they are calculated for the highest electricity tariff, thus covering only part of the country. In addition, current tendency on Georgian market is increase in electricity prices, due both economic fluctuations and growing power deficit.

Even under optimistic scenario set out in above table giving such a large subsidy for solar power installation will be extremely costly and inefficient for the government. With this policy government will have to cover between 53% and 84% of total investment cost for the solar power system. It should be also taken into account that such cost is taken just in order to keep electricity priced at the same level for the consumers as in case of no intervention. Furthermore, considering economic situation in the country solar rebates might not cover a significant amount of target audience for developing household scale solar systems, thus capital grants will have to be chosen. The last does not create a guarantee for efficiency, therefore might be counter-productive. Summing up all above arguments, subsidy policy is not to be recommended under the scope of this policy paper.

More impactful policy measure to support financing of PV systems is **long-term low-interest loan program.** In this case prospective owner of solar power system applies for the loan with interest below market rate – thus decreasing LCOE for the specific system through decreasing discount rate. Effectiveness of low-interest rate programs is evident from example of many countries including Germany and U.S. Such program bears two type of motivations for system owners: (i) through decrease in LCOE, low interest loan makes PV system a profitable investment in the long-run, especially in countries with high interest rates, such as Georgia; (ii) loan as a liability creates an additional motivation for system's efficiency. Therefore, long-term low-interest loan programs impact two variables of LCOE: discount rate and derate factor. However, discount rate can be seen only as a proxy for prospective interest rate, as it assumes 20 years maturity period that is rather unrealistic term for loans for solar power project. Figure 4. shows LCOE in case of different discount rates:

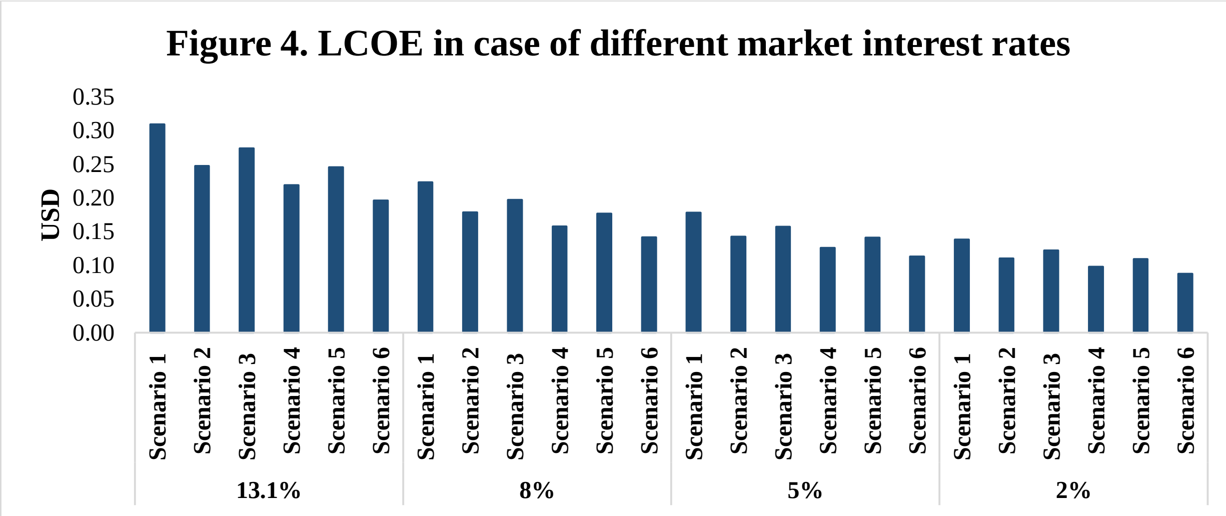


Figure 4 demonstrates that LCOE decreases below current utility tariffs for 2% discount rate, therefore to achieve profitability low-interest loan program should target rates below this level. In this case, similar assumptions apply for household and business scale solar power solution, however commitment to support the program will be lower for government or donor organization in case of business loans.

European Bank for Reconstruction and Development (EBRD) has already started similar program in Georgia. **Energocredit** is a 10 to 15 percent loan subsidy program for individuals and companies to purchase energy efficient equipment. However, only heliosystems are included in the list of technologies to be financed and PV systems are not taken into account. Although, the program envisages technical assistance it was widely criticized in professional circles. Major problem with the program is lack of competence on energy efficiency in credit departments of commercial banks that frequently causes funding of technologies that do not qualify efficiency standards. With its successes and shortcomings the program is definitely a good start, on which low-interest loan program for PV systems can be built. Above mentioned support scheme is exactly the one that can decrease LCOE for the solar PV owners, as well as drive higher efficiency through technical assistance.

Reformed version of “Energocredit” can be a good start-up incentive for prospective solar installers.

In order to make low-interest long-term program successful in developing country such as Georgia, involvement of different international donors is vital. Participation of international donors such as: EBRD, ADB and IFC can be vital for this incentive scheme, however national government has to strongly support such initiatives. Loan programs can be one of the driving forces for developing independent solar power generation in Georgia, as well as to provide some good examples of private-public-partnership (PPP).

3.3 Tax Incentives

Georgia with its relatively simple tax system can create easy to administer support schemes for solar power development, both for households and businesses. Support mechanisms can impact owners of solar PV systems explicitly through reducing taxes levied on solar PV systems, such as VAT and other customs duties and implicitly by reducing personal income tax (PIT), corporate income tax (CIT), or property tax.

In Georgia PV technologies are taxed same way as any other imported goods with the 18% **VAT** (if price of the good is above GEL 300) on the customs. Other customs service fees apply to the import of solar PVs as well. Exempting PV technologies from the VAT will reduce their price for installers and support development of new industry in the country. Currently government revenue from VAT levied on PV technologies is minimal, however development of new industry will bring revenues through other taxes. It should be also noted that there are two type of exemption mechanism from the VAT: with the right to deduct and without. This policy paper proposes exemption from the VAT without the right to deduct, however exemption should be given to all types of equipment related to installation of PV systems i.e. balance of system components, net meters etc. It should be also noted that this exemption implies PV installers will not pay VAT on any stage of operations from import to installation.

Similar to Italy, municipalities in Georgia are responsible to set level of **property tax** up to 1% of property's value. In order to promote installation government can issue a decree to propose to municipalities the tax exemption of properties equipped with the solar power systems. It should be noted, that in order to get maximum effect of this policy minimum level of installed capacity, or minimum level of solar power consumption should be set. Otherwise, an exemption can be given to a property that does not consume significant amount of solar power. A better alternative in this case is to give an exemption to a property that uses more than 60% of solar power in a total consumption of electricity. Such tax exemption can be administered using net meters, as well as create an incentive for more power generation.

Personal income tax reduction can be an important incentive for the **households** to install PV system. Currently PIT is 20% on any income from Georgian source. Reduction of PIT to 15% for one person per house equipped with solar system will create additional funds for PV owners on annual basis. Specifically, a person with gross annual income over GEL 40,000 will benefit from more than GEL 2,000 a year, while a person with annual income more than GEL 100,000 will get benefit of more than GEL 5,000 for owning solar system. To maximize effect of the policy minimum level of annual consumption of the house should be set as well i.e. 60% of PV electricity in a year. It should be noted that in order to get the benefit from such policy a person must have a contract with an employer setting the gross salary. The PIT benefit will make investment in solar power more profitable for households with highest consumption. Unfortunately, it is hard to estimate exact loss in government revenues due to PIT reduction, however similar provision has already been in

Georgian tax code. A provision that would gradually reduce PIT to 15% for 1 January 2015 had been recalled by the parliament in 2013.

Corporate income tax reduction is a similar policy for companies as PIT reduction is for households. Under current Georgian tax legislature CIT is 15% of annual corporate profits. Reduction of CIT to 10% can create an incentive for businesses to invest in solar power. However same as in case of households there is a certain threat that reduction will be given to the business for a very small amount of electricity consumption. Therefore, a certain level of consumption has to be set for entitlement to the tax reduction.

In economic literature there are number of arguments in favor and against solar rebate and tax credit policies (van Benthem et. al), however tax incentives set out above are more feasible for Georgian reality. Tax reductions and exemptions benefits both installers and possible owners of systems. VAT exemption creates basis for more development of PV industry, while making import and purchase of solar systems cheaper. Furthermore, PIT, CIT and property tax reduction give owners additional indirect benefits to PV owners for installing solar power systems. All mentioned above is done without any subsidy scheme and costs from the government.

3.4 Feed-in Tariffs

Feed-in tariffs are one of the most widely used schemes to support electricity generation from renewable sources. Most of European countries as well as U.S. have feed-in tariffs both for small scale and large solar power generators. Georgia has feed-in tariff policy for small and medium hydropower plants, however no other support mechanism is available for other renewable sources of power generation. From economic perspective effect of feed-in tariffs is controversial, however in many cases it is essential for integration of solar in power market. There are number of challenges for Georgia to integrate feed-in tariffs into its system, as country has vertically integrated market creating entry barriers in many cases. In current market structures small scale solar PV system (i.e. up to 100 kW) can connect to the grid for free. Furthermore, for electricity it feeds into system PV system can receive difference between its consumption and grid tariff. Under current low electricity tariffs, paying grid tariff creates additional pressure on profitability of PV system. Thus exemption from the grid tariff for systems up to 100 kWp installed capacity can be a useful support scheme.

Taking into account the arguments provided in Section 3 of this policy paper LCOE calculated for Georgia can be used as a benchmark for feed-in tariffs. Considering that current LCOE is twice higher than consumption tariff on the market, using it as a feed-in tariff will be too expensive and inefficient for economy. Thus, exemption from grid tariff and using FIT after certain level of development when LCOE will decrease is sufficient.

IV. Conclusions and Recommendations

Development of solar photovoltaic systems is important for Georgian electricity system for several reasons. Solar provides households and businesses with micro level solution for electricity supply security. Through diversification of power supply sources and improvements in storage technologies solar contributes even more to increase of electricity supply security. Connection of many small scale solar PV systems to the grid will both contribute to grid, as well as market electricity market development. Renewable and carbon free nature of solar power will create at least a partial substitute to polluting thermal power generation.

This policy paper reviews different alternatives for creating schemes to develop independent solar power generation in households and businesses in Georgia. To acquire a benchmark cost value per kW/h LCOE is calculated, that represents unit cost of electricity generation over lifetime of the system. Calculations are made based on international market prices for PV systems and local conditions, both economic and of solar irradiance. LCOE helps to define minimum value for government intervention, thus helps to choose between policy alternatives. Common policy measures taken internationally and incentives in three European countries with similar GHI conditions are reviewed. Based on international experience, current market framework and legislature in Georgia, policy alternatives are set out.

Levelized cost of electricity came out to be twice higher than current grid tariff that is derived based on prices from relatively cheap hydro power and gas turbines. With very high LCOE solar rebate and capital grants seem to be too costly for the state budget. In addition capital grant policy makes it hard to ensure efficiency of solar installation. To avoid too high cost low-interest long-term loan program has been chosen as a policy alternative to provide prospective PV owners with needed funds for system's installation.

Cooperation between international donor organizations, government and private solar installers is essential for success of this policy.

Tax credit policy seems to be a good tool to promote installations around the country, as well as to develop currently embryonic PV industry. For this goal temporary exception of PV technologies and associated equipment from VAT is vital. Municipalities can motivate usage of solar as a power source through exemption from property tax. One of the major incentive for the households to receive indirect benefits for using solar power is reduction of personal income tax from 20 to 15 percent. This can be seen as an “indirect” subsidy to the solar PV owners. In contrast, businesses can make use of PIT reduction from 15 to 10 % for using solar power as source of electricity.

Finally, opportunities for setting feed-in tariff are also discussed. To receive maximum payment for electricity fed in the system. Considering that LCOE is very high in Georgia setting additional feed-in tariff is not to be recommended at initial stage of development.

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Appendix

Table 1. *Electricity Generation of conventional 1 kWp power solar power system* $C_R = 1$

Global Horizontal Irradiance$(\boldsymbol{GHI})$	**Derate Factor**$(\boldsymbol{D})$	**Electricity Generation (kWh/year)**$(\boldsymbol{E})$
1150	0.6	690
	0.75	862.5
1300	0.6	780
	0.75	975
1450	0.6	870
	0.75	1087.5

Table 2. *LCOE for conventional solar power system in Georgia*

Initial Investment (I_0) (USD)	O&M Costs (M_t) (USD)	Lifetime of the system (t) (years)	Discount Factor	Discounted O&M Cost
1440	7.2	20	$(1.31)^t$	50.28
Generation Scenarios	**Electricity Generation**	**Discounted Electricity Generation**	**LCOE (USD per kWh)**	
Scenario 1	690	4818.1	0.31	
Scenario 2	862.5	6022.6	0.25	
Scenario 3	780	5446.5	0.28	
Scenario 4	975	6808.2	0.22	
Scenario 5	870	6075.0	0.25	
Scenario 6	1087.5	7593.7	0.20	

Table 3. *Electricity prices in Georgia and their comparison with LCOE*

(USD/GEL FX rate as of July 2015: 2.2564)

Consumption (kWh)	Telasi ¢/kWh	Energo-Pro ¢/kWh	PV LCOE < Electricity Tariff
Household >101 kWh	5.41	5.40	N
Household 101-301 kWh	7.08	7.06	N
Household > 301 kWh	8.95	8.94	N
Commercial Consumers	8.24	8.28	N

Table 4. *FTIs in Germany*

Installed Capacity	FIT
< 10 kWh	12.59 €ct/kWh
< 40 kWh	12.25 €ct/kWh
< 500 kWh	10.95 €ct/kWh
< 10 MW	8.72 €ct/kWh

Table 5. *Solar rebate/capital grants USD per Wp of installed capacity based on Energo-Pro Tariffs*

Scenario / Consumption Level	< 101 kW	101-301 kW	> 301 kW	Commercial
Scenario 1	1.23	1.15	1.06	1.09
Scenario 2	1.16	1.07	0.95	0.99
Scenario 3	1.20	1.11	1.00	1.04
Scenario 4	1.12	1.01	0.88	0.93
Scenario 5	1.16	1.06	0.95	0.99

Table 6. *LCOE in case of different interest rate on Loans*

Scenario / Discount Factor	13%	8%	5%	3%
Scenario 1	0.31	0.22	0.18	0.14
Scenario 2	0.25	0.18	0.14	0.11
Scenario 3	0.27	0.20	0.16	0.12
Scenario 4	0.22	0.16	0.14	0.11
Scenario 5	0.25	0.18	0.14	0.11
Scenario 6	0.20	0.14	0.11	0.09