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ASSESSMENT OF BENEFITS COMMERCIAL CUSTOMERS CAN RECEIVE FROM THEIR DEMAND FLEXIBILITY IN THE POWER MARKET OF GEORGIA

Abstract:

The purpose of our study is twofold: the first is to demonstrate that power-intensive commercial entities (with 1,0 MW or more network connection capacities) can benefit from participation in Demand Response (DR) programme(s) by selling excess power generated by them to the balancing market of Georgia if they are permitted to have an access to the electrical grid. The additional benefits come from the avoidance of network charges; and the second is to show that for relatively small power-intensive commercial entities (with 100 kW or less network connection capacities) participation in Demand Response (DR) programme(s) is not equally beneficial but still reasonable. To meet research objectives 4 (four) case studies have been conducted. Study participants were the Hotel (with 1,0 MW network connection capacity) and the private University (with 0,04 MW network connection capacity). Their names cannot be divulged due to the confidentiality requirements. Each of them was offered two DR programme(s) with different schemes for participation. These schemes were approved by DSR participants and adapted to the current needs of National Grid of Georgia. Finally, the cost of each DR programme as well as the expected annual revenues for participants have been calculated based on selected schemes -(a) availability requirement, (b) response time, (c) maximum duration of activation, and (d) estimated number of activations/yr, and on the basis of ESCO's annual reports reflecting the companies' power consumptions in the year of 2017.
Under the study two hypotheses have been tested. The first research hypothesis is following: "Power-intensive commercial entities (with 1,0 MW or more network connection capacities) can benefit from participation in Demand Response (DR) programme(s) if they are permitted to do so. For these entities more beneficial will be the investments in CCHP (Combined Coolong, Heat, and Power) plant than in PV panels". The second research hypothesis is following: "For relatively small power-intensive commercial entities (with 100 kW or less network connection capacities) participation in Demand Response (DR) programme(s) is less profitable but still reasonable. For them it is better to use the generated power for their own purposes than just to sell it to the Balancing Market and make money".
The results of the case studies are presented in the article.

Keywords:

Demand Side Response (DSR), DR programme(s), responsive behavior, demand flexibility, energy efficiency, load management.

JEL Classification: D22, M31, Q41

INTRODUCTION

For already of the past decade, Georgian Government (GoG) has been trying to introduce Market Based Instruments (MBI) such as energy efficiency obligations and auctions, to bring increased competition to the business of electricity generation, sales, and service delivery. Among other key objectives, GoG is trying to achieve, are the establishment of a legal framework and commercial conditions necessary for the development of transparent and non-discriminatory electricity market. To assist GoG to make the minimum modification to the current Georgian power market design and enable Georgian HPPs to sell their electricity output into the Turkish power market (and, eventually, other regional markets), with a trading mechanism that properly allocates risks among market players and provides dependable cross-border transmission capacity rights, USAID/Caucasus Office of Energy and Environment in collaboration with Deloitte Consulting, LLP and Pierce Atwood Attorneys have developed Georgian Electricity Market Model (GEMM 2015) and Electricity Trading Mechanism (ETM) harmonized with both EU competitive market principles and the Turkish power market rules and procedures under the Hydropower Investment Promotion Project (HIPP)(USAID, 2013)

The support provided under the HIPP project was also addressed the Ministry of Energy and Natural Resources' (MENR) priorities to become a regional leader in clean energy generation for domestic consumption and export with assumption that retail electricity customers of Georgia should not be negatively impacted by any change in the power market design (USAID, 2013) but with no intention to enable them to manage their electricity consumption and be paid in return from their demand flexibility. Thus, in broad terms, initial legislative and regulatory efforts to promote competition have focused on the supply side of the market: creating trading floors for energy and capacity sales, removing barriers to independent generators and marketers, and promoting open and non-discriminatory access to the transmission grid. It was assumed by developers of GEMM 2015 that competition among a variety of suppliers would be sufficient to ensure reasonable electricity rates and service options to customers without efficient integration of Demand Response (DR) resources[1] in power portfolios and distribution system.

Principal lessons learned from the experience of New England's, French, Germany, Austria and other power systems and markets is that competition among electricity suppliers alone without an active Demand Response (DR) is not enough to create efficiently competitive electricity markets. Since electric service is central to economic and social wellbeing, electricity rates are of a paramount interest of the society as a whole.

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[1]DR resources include all intentional modifications to the electric consumption patterns of end-use customers that are intended to modify the quantity of customer demand on the power system in total or at specific time periods.

The purpose of our study is twofold: the first is to demonstrate that power-intensive commercial entities (with 1,0 MW or more network connection capacities) can benefit from participation in Demand Response (DR) programme(s) by selling excess power generated by them to the balancing market of Georgia thus assuring the balance between demand and supply over sustained period of time. In this regards, commercial entities must have an access to the power grid to support National Grid in the time of need and, must be adequately paid for their responsive behavior by adjusting their energy use per their commitment with the National Grid. Their participation in the power market of Georgia can be accomplished through application of Demand Side Response (DSR)[2]. According to Mr. Wayne Davies (Solutions Engineer, DSR), Demand Side Response (DSR) is an opportunity for large energy consumers to simultaneously earn revenue and reduce costs by adjusting electricity use when the national grid needs it most. (Vayne, 2017) The additional benefits come from the avoidance of the network charges.

Review of Literature

Our assumption is based on the analysis commissioned by Regulatory Assistance Project (RAP) to more fully understand the potential benefits of customers managing their electricity consumption. This analysis demonstrates that all power customers benefit from increased consumer market participation and that, while varying from year to year, the potential benefits are considerable. (Baker, Benefiting Customers while Compensating Suppliers: Getting Supplier Compensation Right, 2016) Even modest reductions in demand can avoid the need to run high-marginal-cost generation or other more costly measures, reducing market clearing prices. This allows suppliers to make significant savings when buying energy for their customers, and one would expect that most of these savings will make their way to customers through competitive or, where necessary, regulatory pressure. (Baker, http://www.raponline.org/blog/proposed-electricity-directive-step-right-direction-customers-demand-response/, 2017)

Even though efficiency is central to meet energy security goals, while also fostering economic and social development, many market failures are holding back the realization of the full potential that energy efficiency offers. For these reason, at the Kitakyushu Energy Ministerial Meeting in 2016, G7 countries[3] recognised energy efficiency as the “first fuel” and asked the International Energy Agency (IEA) to undertake research into market based instruments (MBIs), such as energy efficiency obligations and auctions. In response to that request, IEA prepared report that provides the first global overview of the

[2]DSR is a scheme where large energy users are paid for their ability to be flexible in times of grid need.

[3]The Group of Seven (G7) countries are: Canada, France, Germany, Italy, Japan, the United Kingdom and the United States.

growth in the use of MBIs; their impact; and the key policy design issues associated with their successful implementation. (IEA, 2017)

Beyond RAP analysis and International Energy Agency (IEA) report, our research is based on the public sector case studies prepared by Mr. Wayne Davies (Solutions Engineer, DSR) (Vayne, 2017), on the reports and recommendations of the New England Demand Response Initiative (Cowart, 2004), Bloomberg New Energy Finance, Federal Energy Regulatory Commission (FERC), USAID/Caucasus Office of Energy and Environment, Georgia's Electricity System Commercial Operator (ESCO), and on the reports and resolutions of GNERC and MENR.

Methodology

There are many opportunities for customer-based DR to add value to power systems and markets, and many types of DR resources to call upon. In our study we will concentrate on Demand Response (DR) Programme(s) that are accomplished through: (a) an increase in on-site generation (investments in Combined Cooling, Heat, and Power (CCHP) Plant); and (b) application of micro-power plants[4] (investments in solar panels). As proved, DR programme(s) have a potential to attract a sufficient base of demand-side resources and provide value both electric system and markets.

On the basis of the exploratory research 2(two) hypotheses have been generated:

Hypothesis 1:"Power-intensive commercial entities (with 1,0 MW or more network connection capacities) can benefit from participation in Demand Response (DR) programme(s) if they are permitted to do so. For these entities more beneficial will be the investments in CCHP (Combined Coolong, Heat, and Power) plant than in PV panels".

Hypothesis 2: "For relatively small power-intensive commercial entities (with 100 kW or less network connection capacities) participation in Demand Response (DR) programme(s) is less profitable but still reasonable. For them it is better to use the generated power for their own purposes than just to sell it to the Balancing Market and make money". In both cases the amount of the expected annual revenues depends on the type of the programme they choose to participate in and on the selected scheme for participation within a certain period of time.

For the purpose to meet the research objectives and to test hypotheses generated at the outset of the study, case studies from two commercial entities (the Hotel and the private University) were applied. Two different DR programme(s), with two different schemes for

[4] Under 100kW of installed capacity

participation, were offered to the survey participants - the Hotel and the Private University. These schemes were roughly defined according to the requirements of DSR participants and adapted to the current needs of National Grid of Georgia[5]. Finally, the cost of each DR programme as well as the expected annual revenues for participants have been calculated based on selected schemes - (a) availability requirement, (b) response time, (c) maximum duration of activation, and (d) estimated number of activations/yr, and on the basis of ESCO's annual report reflecting the companies' power consumptions in the year of 2017. (see Appendix 1.) The results of the case studies are shown in the summary tables below.

Analysis and Findings

Based on foreign experience, DSR participants can benefit from their demand flexibility by adjusting their energy use per their commitment with the National Grid. Thus, we want to prove that the benefits received by power-intensive commercial entities (with 1,0 MW or more network connection capacities) will be large enough to facilitate investments in DR programme(s). Furthermore, we want to demonstrate that the application of DR programme(s) can also be reasonable for relatively small power-intensive commercial entities (with 100 kW or less network connection capacities), if they choose to participate in, even though they will be paid less for their demand flexibility.

In this respect, DSR participants have to be given nondiscriminatory access to the electrical grid of Georgia to be able to sell excess electricity (capacity) to the Electricity System Commercial Operator (ESCO)[6] at a fixed price approved by Georgian National Energy Regulatory Commission (GNERC)[7], at least on the first stage of implementation of GEMM 2015 and the Electricity Trading Mechanism (ETM), before establishment of Market Clearing House (MCH)[8] obligated to determine margins that each electricity buyer and seller, trading in the market, will be required to provide.

Both study participants (the Hotel and the Private University) were offered TRIAD (combined Coolong, Heat, and Power (CCHP*) Plant) Case and Solar Panel Case for consideration.

Initially, the Hotel (with the network connection capacity 1,0 MW) was offered TRIAD (combined Coolong, Heat, and Power (CCHP*) Plant) case for consideration. According

[5]In future, DSR schemes will be the subject of negotiations between DSR participants and balancing Market Operator (MO)

[6]Under the GEMM, the successor entity to ESCO will be a Market Operator that will be licensed by GNEWRC as the MO. MO will operate the hourly balancing market of Georgia

[7] After implementation of GEMM, DSR participants will be paid a market clearing price

[8]an agency or separate corporation of electricity market power exchange responsible for settling trading accounts, clearing trades, collecting and maintaining margin monies, regulating delivery and reporting trading data

to our calculations, the cost of DR programme is considerable (USD 2,8 million per MW) but if considering the expected total annual revenues (USD 477 304,04) the Hotel can receive from selling excess electricity (capacity) (2 674,26 MW/h) to ESCO at a fixed rate $44 per MW/h that amounts to USD 117 667,35 (2 674,26 MW/h X $44 = USD 117 667,35) plus the avoided network charges (USD 359 636,69[9]), the cost of the programme can easily be covered in 5,87 years. (see Table 1.)

The Solar panel case proved to be totally unreasonable for the Hotel. It costs approximately USD 2,0 million to receive 1,0 MW power by Solar Panel. If considering the number of annual working hours of solar panel (~ 1500), it was impossible for the Hotel even to cover its own annual consumption (5 325,74MW/h) let alone the generation of excess power (see Table 1.). Beyond this, for installation of 1,0 kW solar panel 7 m^2 area is needed. Requirement in free space is also the critical issue for Hotels located in city centers.

Thus, the research Hypothesis 1 that "Power-intensive commercial entities (with 1,0 MW or more network connection capacities) can benefit from participation in Demand Response (DR) programme(s) if they are permitted to do so. For these entities more beneficial will be the investments in CCHP (Combined Coolong, Heat, and Power) plant than in PV panels", is accepted.

The Private University (with the network connection capacity 0,04 MW) was also offered Solar Panel case for consideration. According to our calculations, the cost of the programme is USD 80000. If considering that the expected total annual revenue (USD 4 954,72) the University can receive from selling excess electricity (capacity) (3,92 MW/h) to ESCO at a fixed rate $44 per MW/h that amounts to USD 172,52 (3,92 MW/h X $ 44= USD 172,52) plus the avoided network charges (USD 4 782,19), the cost of programme will be covered in 16,15 years. Even though the benefits from DR programme are though obvious but they are jeopardized by the number of payback years (see Table 2.).

The same conclusion can be made with the application of TRIAD for participation in DR Programme for the private University. Based on the approved scheme for participation, the expected total annual revenue (USD 8 904,16) the University can receive from selling excess electricity (capacity) (93,68 MW/h) to ESCO at a fixed rate $44 per MW/h that amounts to USD 4 121,96 (93,68 MW/h X $ 44=USD 4 121,96) plus the avoided network charges (USD 4 782,19), the cost of programme will be covered in 12,58 years. Even though the TRIAD case is more lucrative (the expected total annual revenue is about 1,8 times as more than in the case of Solar Panel) for the private University, these benefits are again jeopardized by the number of payback years (12,58) (see Table 2.).

[9]In the estimated year

Table 1: The Assessment of Benefits from DR Programme(s) on the Basis of Case Studies for the Hotel

DR Programme	1. Creation of own capacity and selling excess electricity (capacity) to ESCO.Investmentin TRIAD - Combined Coolong, Heat, and Power (CCHP*) Plant.	2. Creation of own capacity and selling excess electricity (capacity) to ESCO. Investment in micro-capacity electrical plants working on solar energy.
Commercial entity	The Hotel	The Hotel
How revenue is earned	Avoidance of network charges and payments from ESCO for the excessive electricity (capacity) sold to it ($/MW)	Avoidance of network charges and payments from ESCO for the excessive electricity (capacity) sold to it ($/MW)
Availability requirement	During Spring, Autumn, Winter, and Summer Seasons	Solar energy: 1500-1600 hours
Response time	24/7hours	24/7 hours
Max duration of activation	60 minutes	5 minutes
Estimated number of activations per year	1 to10	290-365
Cost of DR programme ($) (Investment per MW)	2 800 000	80 000
The number of annual working hours	8 000	1 500
Network connection capacity, MW	1,0	1,0
Annual generation, MW/h	8 000	1500
Annual consumption of power, MW/h	5 325, 74	5 325,74
Excess generation, MW/h	2 674,26	(3 825,74)
The rate of ESCO, MW	44,0	
The annual revenue received from selling excess electricity (capacity) to ESCO, ($)	117 667,35	
The annual expenditures on consumed electricity (capacity) bought from ESCO (the avoided network charges), $	359 636,69	
Expected total annual revenues (the avoided network charges +the cost of excess electricity (capacity) sold to ESCO), $	477 304,04	
Payback period (Year)	5,87	

Source: Research Materials

Table 2: The Assessment of Benefits from DR Programme(s) on the Basis of Case Studies for the Private University

DR Programme	2. Creation of own capacity and selling excess electricity (capacity) to ESCO. Investment in micro-capacity electrical plants working on solar energy.	. Creation of own capacity and selling excess electricity (capacity) to ESCO. Investment in TRIAD - Combined Coolong, Heat, and Power (CCHP*) Plant.
Commercial entity	Private University	Private University
How revenue is earned	Avoidance of network charges and payments from ESCO for the excessive electricity (capacity) sold to it ($/MW)	Avoidance of network charges and payments from ESCO for the excessive electricity (capacity) sold to it ($/MW)
Availability requirement	Solar energy: 1500-1600 hours	During Winter and Summer weekdays, late afternoon
Response time	24/7 hours	6 hours
Max duration of activation	5 minutes	30 minutes
Estimated number of activations per year	290-365	10 to 20
Cost of DR programme ($) (Investment per MW)	80 000	112 000
The number of annual working hours	1 500	3744
Network connection capacity, MW	0,04	0,04
Annual generation, MW/h	60	149,76
Annual consumption, MW/h	56,079	56,079
Excess generation, MW/h	3,92	93,68
The rate of ESCO, MW	44	44
The annual revenue received from selling excess electricity (capacity) to ESCO, ($)	172,52	4 121,96
The annual expenditures on consumed electricity (capacity) bought from ESCO (the avoided network charges),$	4 782,19	4 782,19
Expected total annual revenues (the avoided network charges + the cost of excess electricity (capacity) sold to ESCO), $	4 954,72	8,904,16
Payback period (Year)	16,15	12,58

Source: Research Materials

Despite this fact it is still reasonable for the private University to invest in DR programme for the purpose to avoid network charges and to sell excess power to ESCO. Forcible argument supporting our opinion is following: the small power-intensive commercial sector (with the network connection capacity less than 100 kW) can buy the electricity (capacity) from ESCO at the rate 0,084 cent per kW that almost twice exceeds the rate at which ESCO buys electricity (capacity) from commercial sector (0,044 cent per kW). According to the current legislation, if the small power-intensive commercial sector chooses to invest in alternative power sources (CCHP plants, PV panels, wind power plants and etc.), they can be involved in the programme of “Net Metering” and deduct generated and consumed power to ESCO in monthly profile and save considerable money from the rate differences. Furthermore, commercial entities have the opportunity to be paid for the excess power sold to ESCO by the end of the estimated year (0,044 cent per kW).

Thus, the research hypothesis 2 that “For relatively small power-intensive commercial entities (with 100 kW or less network connection capacities) participation in Demand Response (DR) programme(s) is less profitable but still reasonable. For them it is better to use the generated power for their own purposes than just to sell it to the Balancing Market and make money”, is also accepted.

If lying deep down the history of investments in global clean energy and capacity installations, we will soon find out that the world experienced the same situation in 2004. If You wanted more capacity, You had to spend more. According to the research done by Bloomberg New Energy Finance, when spending USD 62 billion in capacity installations in 2004, one could get 20 GW, and when spending USD276 billion in 2010, one could get 88 GW. Since the year 2010 the situation has been changed drastically. By spending the same amounts, one can get about double capacity – 160 GW (Liebreich, 2017). It means that investment in renewable energy and the energy efficiency grown and grew from very early days from USD 60 billion per year up to a third of a trillion dollars (USD 300 billion) in 2017. (Liebreich, 2017). It is a good signal for our entrepreneurs to track where the money is accelerating.

According to Mr. Michael Liebreich, Chairman of the advisory board at Bloomberg New Energy Finance, the prices of key technologies (solar PV and onshore wind) have dropped by over half since 2015. (see Appendix 2) Michael Liebreich also pointed out that “prices are falling so quickly that “if you are not planning for two-cent solar, you are not on the money.” (Shipley, 2017)

This brief information about the key trends shaping the power sector is to provide convincing illustration of the rapid decline in renewable unsubsidized energy costs and thus incentivise commercial customers to monetise their energy flexibility through

Demand Side Response (DSR) and benefit from allowing renewable resources to participate in the balancing market of Georgia.

Member States currently take only limited account of demand-side participation when assessing resource adequacy. A recent study by Sia Partners suggests that demand response in many Member States could amount to 6 to 14 percent of peak demand and total 52 GW for the European Union.(Sia Partners, 2014) It is also estimated that demand response could economically displace approximately 9.2 percent of forecast U.S. national peak demand, i.e. around 72 GW. (FERC, Assessment of Demand Responce & Advanced Metering, 2014) Furthermore, in 2009 the Federal Energy Regulatory Commission (FERC) estimated that by 2020 the U.S. could achieve 138 GW of demand response. (FERC, National Assessment of Demand Response Potenatial, 2009).

To permit Demand Side Response (DSR) and, respectively, renewable energy to participate in the half-regulated power market of Georgia, GNERC took the step forward by introducing micro-capacity power plants' development project ("Net Metering") that allows customers to sell their excess electricity (capacity) at a fixed rate approved by the regulator to the Balancing Market. But there are some restrictions for customers willing to sell their valuable services to ESCO impeding the participation of renewables in the power market of Georgia. According to the current regulations, it is forbidden for customers to own the micro-capacity power plant that uses other than renewable energy and has more capacity than their demanded network capacity is. Moreover, according to the changes made to the "Electricity (Capacity) Supply and Consumptions Rules"[10], renewable energy source is categorized as the micro-capacity power plant if it is owned by retail customer who is connected to the distribution network at the point of electricity consumption and which capacity does not exceed 100 kW.

According to the information provided by GNERC, "Net Metering" is already used by 11 customers with the total capacity 137 kW in the service area of JSC "Tealsi" and by 7 customers with the total capacity 51,7 kW - in the service area of JSC "Energo-Pro Georgia". Thus, We can say that proliferated practice of "Net Metering" is already established in Georgia. The benefits from allowing micro-power plants (working on solar PV, wind or biomass resources) to participate in the power market of Georgia are multi-faceted: (a) the reduction of financial expenditures necessary for construction of transmission and distribution networks; (b) the reduction of imported energy or the share of costly thermal energy in the energy portfolio; (c) the reduction of electricity loses in transmission and distribution networks; (d) additional opportunity for customers to tap into DSR potential and sell saved and/or excess power to the balancing market; (e)additional opportunity for MENR to meet decarbonisation goals and etc.

[10] Resolution #20, September 18, 2008

Conclusions

As a conclusion We can say that the new energy reality comes with new opportunities, but current plans fall short of tapping into the full potential of DR programme (s). Although there is opportunity in Georgia for commercial entities with the network connection capacity less than 100 kW to simultaneously earn revenue and reduce costs by adjusting electricity use when the national grid needs it most, significant market barriers to cost-effective load management are still on place. As mentioned above, power intensive commercial entities, with the network connection capacity more than 100 kW, are not permitted to participate in the programme of “Net Metering”. There are three main arguments serving as an explanation to this restriction:

1. There should be the meaningful differences between small HPPs (for which the production of electricity is the main activity) and customers using “Net Metering” for the ability to sell an excess electricity (capacity) to the electricity market in the case of surplus and to buy electricity (capacity) from the market in the case of need;
2. The maintenance of low capacity generators do not require additional personnel and supervision. It would be technically and financially difficult for power-intensive commercial entities (with the network connection capacity more than 100 kW) to maintain staff for proper maintenance, repair, and operation of their facilities;
3. Furthermore, officials are afraid that if the commercial entities, with the network connection capacity more than 100 kW, enter the market, it would have the negative impact on already established electricity rates.

The cautious economic outlook of GNERC officials is understandable because the power market of Georgia is still under regulation. But this argument will no longer work in the fully liberalized power market which will be open for everyone who will be willing to participate in it and where the electricity rates will be adjusted continually to bring supply and demand into balance. Once the market is in equilibrium, everyone benefits from it – suppliers can sell as much electricity (capacity) as they want and buyers can buy as much electricity (capacity) as they want at a fair price. Thus, market and policy reforms that will call for the economic demand responses – both short-term load curtailments and long-term reductions in consumption patterns – are needed.

Decentralise generation reduces uneconomic investments in costly power generation thus fostering economic development by increasing the local employment. GNERC should create appropriate conditions for commercial entities to invest in energy efficiency. According to the MENR, since 2016 year USD 708 617 204,2 has been invested in hydropower generation to receive 349,2 MW rated capacity. Even though Georgia has the big potential of hydropower resources[11], the good alternative for costly traditional generation is to promote investments in DR programme(s) offering various schemes for participation to commercial entities (especially if taking into account that Demand Response will be one of the building blocks of future wholesale and retail markets). Demand side flexibility helps to integrate the increasing amounts of intermittent renewable energy into the system and benefits consumers by giving them more control over their electricity consumption. Therefore utilities across the EU are keen to develop demand response on a commercial basis. (Ruby, 2017)

Since electric service is central to economic and social wellbeing, the balance between demand and supply of electricity is critical at all times, and this balance must be assured through active load management by customers and enhanced energy efficiency investments that could lower market clearing prices and improve reliability of power system over the long term. Thus, We strongly recommend to GNERC to enable DR programme(s) to replace uneconomic investment in costly power generation, and by doing so, promote energy efficiency.

APPENDIX 1.

The Power Consumption of the Hotel, Private University in the Year of 2017

	The Hotel	The Private University
January	447660	4890
February	466740	7560
March	477150	3960
April	450450	2880
May	456270	3060
June	492030	4590
July	609330	5070
August	678600	4200
September	687450	7560
October	220747	660
November	172007	4983
December	167308	6666
Average monthly consumption, kW	443812	4673
Annual Consumption, kW	5 325 742	56079

[11]The full theoretical hydro-energy potential of Georgia amounts to 135 billion kW.h

Average hourly consumption, kW	607,96	6.40
Network connection capacity, kW	1 000	40
Annual expenditures ($)	359 636,69	4782.2

Source: The calculations have been done on the basis of ESCO's reports

APPENDIX2.

Prices of Solar PV and Onshore-Wind in 2015-2017 Years, (cents/kWh)

	Solar PV	Onshore Wind
2015	5.8 cents/kWh	4.5 cents/kWh
2016	2.69 cents/kWh	3.0 cents/kWh
2017	1.79 cents/kWh	2.0 cents/kWh

Source: Reflections on 2017: Key Trends Shaping the Power Sector (Shipley, 2017)

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