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# EMPOWERING RESIDENTIAL CUSTOMERS TO BENEFIT FROM NET METERING IN THE POWER MARKET OF GEORGIA

## Abstract:

We continue the series of investigations of the benefits from Demand Side Response (DSR) programme(s) and at present We will concentrate on Net Metering (NEM), as marketing tool, in replacing uneconomic investments in costly power generation and, thus, achieving efficiency goals, with case studies from three residential customers involved in retail-rate NEM.

The purpose of our study is twofold: the first is to demonstrate that residential customers in Georgia can save money on their utility bills every year by making excess electricity with their rooftop solar panel systems and sending it back to the grid if they are involved in retail-rate net energy metering program; and the second is to demonstrate that demand flexibility is the most promising and intuitively workable new frontier maximizing the use of renewable approaches. For Georgia, solar is often a solution suitable for the geographical needs of remote communities. While some claim that net metering represents an unfair burden on non-solar electricity customers, Our net metering cost-benefit studies have found the opposite to be true.

To meet research objectives 3 (three) case studies have been conducted. Study participants were three residential customers using NEM to export generated excess electricity to the Distribution System Operator (DSO) JSC “Telasi” that interconnects 358,14kW of the new solar capacity in its service territory (Tbilisi, capital of Georgia) and contributes 49% of total solar capacity (739,75kW) generated by NEM. Their names cannot be divulged due to the confidentiality requirements. To conduct the cost-benefit analyses, We specifically requested the utility to submit data in alternative current (ac) to track the actual solar capacity received by the grid from the study participants between January 31 and December 31, 2018. For the purposes of analyses, We have supplemented survey data with additional information including Georgian National Energy and Water Supply Regulatory Commission (GNERC) resolutions, and the bidding materials obtained from the private company Electroni, Ltd.

Under the study the following research hypothesis has been tested: “Residential customers can benefit from retail-rate net energy metering if they choose to participate in this residential demand response (RDR) program but yet the benefits are not substantial due to the net metering compensation structure and the market barriers to entry." Our cost-benefit analyses revealed that net metering can save residential customers hundreds of dollars on their utility bills every year, so it's a good reason to make the money-saving choice.

## Keywords:

Residential Demand Response (RDR), Net Metering (NEM), Distributed Energy Resources (DERs), Demand Side Response (DSR), Energy efficiency (EE)

**JEL Classification:** D19, M31, Q21

## INTRODUCTION

For more than a century, Georgian retail-rate customer's only choice was buying power from a local Distribution System Operators (DSOs) at a price determined by regulator. Currently, the situation has been somehow changed when Residential Demand Response (RDR) program in the form of Net Metering (NEM) tapped into the power market of Georgia thus allowing retail-rate customers to export excess electricity generated by their rooftop panels to the grid and in this way reduce their energy bills.

As a variety of distributed energy resources (DERs), including customer-sited solar, electric vehicles, and battery storage are added to the grid, they put power in customers' hands. But, because they also put power out of utilities' control, DERs are seen as a threat by some to utilities' safety and reliability standards.

For this and some other reasons, the integration of distributed energy resources into the national grid is hindered in Georgia. As a result, the opportunity to more actively engage with customers and benefit from utility-customer relationship is lost. It happens because Georgia's power supply market is highly concentrated. According to the annual report of Georgian National Energy and Water Supply Regulatory Commission (GNERC), $HHI_{2018}$ = 5,543.43. Currently there are only two DSOs that own, maintain and operate the electricity distribution system of Georgia - JSC "Energo-Pro Georgia" and JSC "Telasi", each with the market share 66,48% and 33,52%, respectively. Up to the year 2016, these utilities experienced only one-way relationship with their customers by sending them energy bills and informing about load curtailment. Since the prices are set so as to give DSOs a reasonable opportunity to receive allowed revenues to recover costs actually incurred in operating network, including a fair return on capital invested, there is no incentive for them to cultivate two-way relationships with their customers and enable renewable resources to participate in the energy market of Georgia. But from the year 2016 the situation has been somehow changed. Under the regulatory pressure they are now obliged to connect customers having their own energy capacities (photovoltaic rooftop or ground-mounted solar panels with the capacity not more than 100 kilowatt) and willing to participate in net energy metering, with the grid and in this way supporting Georgia's power sector to harmonize Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the "Promotion of the Use of Energy from Renewable Sources" and Directive 2012/27/EC on "Energy Efficiency" with national energetic legislation.

As many DERs will be added to the national grid, utilities will increasingly take advantage of that supply to balance load at the same time achieving their environmental targets. Net Metering (NEM) is just the first step in reaping benefits from residential demand response (DR) as a resource of more efficiently matching supply with load.

Even though NEM has only three years history in Georgia, it already attracts public interest *as a money-saving choice* and therefore, We wanted to investigate whether retail-rate customers involved in net metering can get a credit to hedge against the electricity they use from the grid when it is not sunny or at nighttime.

Speaking in more general terms, the purpose of our study is twofold: the first is to find out *whether NEM is a good reason to make the money-saving choice* and go solar sooner rather than later, and the second is to prove that for Georgia, *solar is often a solution suitable for the geographical needs of remote communities*.

In addition, our study expected to be the additional prove to the viewpoint that competition among a variety of suppliers is not 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 of Georgia. (Maglakelidze, Veshaguri, Gegeshidze, & N., 2018)

The answers to these questions are embodied in our study findings.

[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.

## Review of Literature

Our study assumptions are based on the various reports prepared by energy sector consultants, associates, alliances and etc. Especially notable among them is the annual solar market surveys carried out by Smart Electric Power Alliance (SEPA). SEPA began surveying electric utilities from the year 2007 to track the capacity of solar power they interconnected to the grid each year. The annual survey and subsequent Snapshot reports continue to provide critical insights into the U.S. solar market in general, with a particular focus on utility-scale development. The service territories of these companies cover an estimated 92% of all solar capacity in the nation and the participating utilities represent slightly more than 110 million customer accounts, or approximately 75% of all customers accounts throughout the U.S. (SEPA, 2018)

The second Smart Electric Power Alliance' (SEPA) research that captures our interest is "Financing Community-Based Solar Projects". This research is about how to support innovative and replicable community-based solar business models and programs that bring solar energy to underserved communities, including low- and moderate- income (LMI) customers, state, local, and tribal governments, and nonprofit organizations. (SEPA, 2018)

Another notable source is the Regulatory Assistance Project (RAP) paper "Beneficial Electrification: Ensuring Electrification in the Public Interest" that explores policy and regulatory decisions that need to be made to accommodate innovations across the power sector. The paper makes the case for what RAP calls beneficial Electrification—in other words, electrification in the public interest. The authors offer six principles that will help policymakers and regulators formulate and evaluate their electrification strategies to broadly secure the benefits. (Farnsworth, Shipley, Lazar, & N., 2018)

Our cost-benefit analyses are based on the net metering records obtained from distribution system operator (DSO) JSC "Telasi" that represents 27 retail net metering customer accounts, or approximately 40% of all retail net metering customer accounts throughout Georgia, and on the bidding materials obtained from the private company "Electroni,Ltd". Beyond the mentioned reports and papers, our study findings are based on Georgian National Energy and Water Supply Regulatory Commission (GNERC) annual reports and resolutions, reports of the Energy Policy Department at the Ministry of Economy and Sustainable Development of Georgia, Bloomberg New Energy Finance, Federal Energy Regulatory Commission (FERC), USAID/Caucasus Office of Energy and Environment and etc.

## Methodology

Our research has two objectives: the first is to demonstrate that residential customers in Georgia can save money on their utility bills every year by making excess electricity with their rooftop solar panel systems and sending it back to the grid if they are involved in retail-rate net energy metering program; and the second is to demonstrate that demand flexibility is the most promising and intuitively workable new frontier maximizing the use of renewable approaches. For Georgia, solar is often a solution suitable for the geographical needs of remote communities.

On the basis of the exploratory research conducted at the outset of study, the following hypothesis has been generated:

Hypothesis: “Residential customers can benefit from retail-rate net energy metering if they choose to participate in this residential demand response (RDR) program but yet the benefits are not substantial due to the net metering compensation structure and the market barriers to entry.”

For the purpose of testing hypothesis, case studies from three retail-rate residential customers involved in net energy metering (NEM) and served by the local Distribution System Operator (DSO) JSC “Telasi” operating in the terrain of Tbilisi (capital of Georgia), were applied. Their names cannot be divulged due to the confidentiality requirements. According to the Georgian National Energy and Water Supply Regulatory Commission (GNERC) report for the year 2018, JSC “Telasi” represents 27 customer accounts, or approximately 40% of all solar customer accounts throughout Georgia. JSC “Telasi” interconnects 358,14kW of the new solar capacity in its service territory (Tbilisi, capital of Georgia) that contributes 49% of total solar capacity (739,75kW) generated by NEM. (GNERC, 2018) Thus for purposes of analyses, net metering data have been obtained. We specifically requested the utility to submit data in alternative current (ac) to track the actual solar capacity received by the grid from study participants between January 31 and December 31, 2018.

Besides, in order to illustrate that solar is often a solution suitable for the geographical needs of remote communities of Georgia, We have examined the bidding materials obtained from the private company Electroni,Ltd. On the basis of these materials We estimated the money savings of Mtkheta Municipality that announced the bidding on supply and installation of solar microgrid with the capacity of 1,59 kW for illumination of the outer architecture of St. Nino church.

See the study findings in the next part of the article.

## Analysis and Findings

For more than a century policymakers managed energy supply to meet demand but today, for the first time, they can do the opposite and manage demand to meet supply. Among the wide-ranging changes taking place on the customer side of the power sector, one of the most striking is the opportunity for beneficial electrification. Beneficial Electrification (BE) is the *electrification in the public interest*. According to the Regulatory Assistance Project (RAP), electrification to be considered beneficial, or in the public interest, it must meet one or more of the following conditions, without adversely affecting the other two: save consumers money over the long-run, enable batter grid management, and reduce negative environmental impact. (Farnsworth, 2018)

However, to fully realize the benefits BE promises to deliver to consumers as well as grid managers and the environment, it is critical for policymakers and regulators to put "Efficiency First" that means *to prioritize investments in customer-side resources* including end-use energy efficiency and demand response, whenever they cost less or deliver more value than investing in costly energy infrastructures, fuel, or supply alone. As long as energy efficiency is the lowest-cost choice among resources, it should be the first choice in policymaking, planning, and utility acquisition.

When the European Commission's "Clean Energy for All Europeans" package of legislation put "Efficiency First," this principle evoked fear in the renewable energy sector representatives whether "Efficiency First" would pose a threat to the explosive deployment of renewable energy in recent years. In response to this fear J.Rosenow and A. Jahn noted that "in order to completely decarbonise energy production, we need more investment in renewables, not less. Just as the energy system cannot be decarbonised through energy efficiency alone, a system with 100 percent renewables cannot be achieved without extensive energy efficiency. (Rosenow & Jahn, 2017)

Thus, European Commission's initiative to put "Efficiency First" does not mean that renewable energy "takes the back seat". Just the opposite, it means that energy efficiency (EE) must be realized through design and implementation of Demand Response (DR) Programme(s) that are accomplished through an increase in *on-site generation* (e.g., investments in solar, wind, biomass and etc.). While energy efficiency (EE) programs of the past were primarily used to reduce baseload in a central-station paradigm, the demand-side management (DSM) programs of the future with energy savings will serve as an economic proxy for the avoided investment in new capacity.

Even though there are many opportunities in Europe for customer-based DR to add value to power systems and markets, and many types of DR resources[2] to call upon, in Georgia, up to the year 2016 they were restricted to the deployment of efficient household appliances and did not go beyond of it.

But from the year 2016 the situation has been somehow changed. Under the regulatory pressure Distribution System Operators (DSOs) are obliged to connect customers having their own energy capacities (photovoltaic rooftop or ground-mounted solar panels with the capacity not more than 100 kilowatt) and willing to participate in net energy metering (NEM), with the grid and in this way supporting Georgia's power sector to harmonize Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the "Promotion of the Use of Energy from Renewable Sources" and Directive 2012/27/EC on "Energy Efficiency" with national energetic legislation.

To permit Demand Side Response (DSR) and, respectively, renewable energy to participate in the half-regulated power market of Georgia, Georgian National Energy and Water Supply Regulatory Commission (GNERC) took the step forward by introducing micro-capacity power plants' development project ("Net Metering") that allows customers to export their excess electricity (capacity) to the grid at a fixed rate approved by the regulator. But there are some restrictions for Georgian customers willing to export their valuable resource to DSOs 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"[3], 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.

Based on the information provided by GNERC, by the end of 2018, 67 residential customers with the total solar capacity of 739,75 kW are involved in Net Energy Metering. They are served by the two Distribution System Operators - JSC "Telasi" and JSC "Energo-Pro Georgia". JSC "Telasi" interconnects 358,14kW of the new solar capacity in its service territory (Tbilisi, capital of Georgia) and serves 27 residential customers, and JSC "Energo-Pro Georgia" interconnects 381,61kW of the new solar capacity and serves 40 residential customers. Compared to 2017 year, the number of customers has been increased by 2,4 times, and connected capacity – by 2,7 times. (GNERC, 2018)

[2] Some DR resources can be *scheduled* as load curtailments by system operators in day-ahead and real-time markets, additional DR resources arise as a result of *customer response to price* signals (e.g., Time of Use (TOU) rates and etc.)
[3] Resolution #20, September 18, 2008

Thus, proliferated practice of “Net Metering” is already established in Georgia and is growing year after year. By allowing micro-power plants working on solar PV to participate in the power market of Georgia, GNERC expects: (a) to reduce financial expenditures necessary for construction of transmission and distribution network; (b) to reduce electricity loses in transmission and distribution network; (c) to give additional opportunity to net metered customers to tap into DSR potential; (e) to support the Energy Policy Department at the Ministry of Economy and Sustainable Development of Georgia to meet decarbonisation goals. (Maglakelidze, Veshaguri, Gegeshidze, & N., 2018)

In our study we will concentrate on Demand Response (DR) Programme(s) that are accomplished through an increase in *on-site generation* (*e.g., investments in solar PV panels)*, particularly on Net Metering (NEM)[4].

In order to meet our first research objective and to demonstrate that net metered residential customers in Georgia can save money on their utility bills every year by making excess electricity with their rooftop solar panel systems and sending it back to the grid, three case studies from three retail-rate residential customers involved in net energy metering were applied. Their names cannot be divulged due to the confidentiality requirements. Let’s call them Customer 1, Customer 2, and Customer 3.

To track the actual solar capacity exported to the grid by the study participants between January 31 and December 31, 2018, We specifically requested the utility (JSC “Telasi) to submit data in alternative current (ac).

Our study findings are summarized in the tables below.

Case Study 1 revealed that the Customer 1 is connected to the JSC “Telasi” distribution grid and owns solar microgrid with the installed capacity 6,5kW. The Customer 1 had the negative balance in four months (January, February, November, and December) of the billing Year (2018) but in the last two-month (November and December) the negative balance was cancelled out by the credits accumulated during the previous months. The total annual consumption of Customer 1 was 4268,4 kW.h and respectively, the annual cost of consumed power amounted to USD 388,01 (4268,4kW.h X$0,0909[5]=$388,01). Instead of this amount, Customer 1 was billed at total USD 13,56 ($11,09+$2.48=$13.56) during the billing period because of the negative balance of January and February.

[4] NEM is a utility billing mechanism enabling residential customers who are making excess electricity with solar panel systems, to get a credit to hedge against the electricity they use from the grid when it’s not sunny or at nighttime.

[5] Since the average monthly consumption of Customer 1 is more than 301kW.h, he/she is charged for consumed per kW.h $ .0909.

Table 1.

The Cost-Benefit Analysis Based on the Case Study 1

| **Customer** | 1 | | | | | | |
|---|---|---|---|---|---|---|---|
| **Installed Capacity** | 6.5 kW | | | | | | |
| **Date** | **Power Received from the Grid (kW.h)** | **Total Accumulated Power Received from the grid (kW.h)** | **Exported Power to the Grid (kW.h)** | **Total Accumulated Power Exported to the Grid (kW.h)** | **Difference (D-B) (kW.h)** | **Accrued Benefit (kW.h)** | **Cost/Benefit (USD)** |
| **A** | **B** | **C** | **D** | **E** | **F** | **G** | **H** |
| 31.01.2018 | 319.27 | 0 | 167.83 | | 151.44 | 0 | $ 11.09 |
| 28.02.2018 | 307.57 | 626.84 | 264.41 | 432.24 | 43.16 | 0 | $ 2.48 |
| 31.03.2018 | 285.61 | 912.45 | 360.6 | 792.84 | -74.99 | -74.99 | 0.00 |
| 30.04.2018 | 199.57 | 1112.02 | 719.85 | 1512.69 | -520.28 | -595.27 | 0.00 |
| 31.05.2018 | 183.41 | 1295.43 | 659.88 | 2172.57 | -476.47 | -1071.74 | 0.00 |
| 30.06.2018 | 167.73 | 1463.16 | 773.48 | 2946.05 | -605.75 | -1677.49 | 0.00 |
| 31.07.2018 | 189.44 | 1652.6 | 824.55 | 3770.6 | -635.11 | -2312.6 | 0.00 |
| 31.08.2018 | 168.6 | 1821.2 | 675.5 | 4446.1 | -506.9 | -2819.5 | 0.00 |
| 30.09.2018 | 150.3 | 1971.5 | 712.6 | 5158.7 | -562.3 | -3381.8 | 0.00 |
| 31.10.2018 | 367.1 | 2338.6 | 505.5 | 5664.2 | -138.4 | -3520.2 | 0.00 |
| 30.11.2018 | 1059.1 | 3397.7 | 156 | 5820.2 | 903.1 | -2617.1 | 0.00 |
| 31.12.2018 | 870.7 | 4268.4 | 69.6 | 5889.8 | 801.1 | -1816 | 0.00 |
| 23.01.2019 | Credits Received from Exported to DSO Power* | | | | | 1816 | $ 83.08 |
| Total Annual Consumption for the Year 2018 (KW.h) ** | 4268.4 | | | | | | $ 388.01 |
| Average Monthly Consumption KW.h | 355.7 | | | | | | |
| Money Paid to DSO for the Actually Consumed Power for the Year 2018 ($) | | | | | | | $ 13.56 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Total Customer Savings for the Year 2018 ($) | | | | | | | $ 457.53 |
| * Average weighed price paid to net metered customers for exported to the grid power is $0.046. | | | | | | | |
| ** Residential electricity rate from 301 kW.h and over including the VAT, is $ .0909. | | | | | | | |
| Note: Average 1USD for the year 2018 is $2.535. | | | | | | | |

*Source: Research materials*

It means that Customer 1 saved USD 374,45 ($388,01-$13.56=$374.45) by the end of the billing period. In addition, Customer 1 got the credit ($ 83,08) for exported to the grid power by the end of the billing period and therefore, the total customer savings for the year 2018 amounted to USD 457,53 ($374,45+$83,08=$457,53). (see the Table 1).

If considering that the cost of solar installations with the rated capacity 1kW in Georgia is roughly $750, Customer 1 invested somewhere around $4875 ($750X6,5 kW=$4875) in his/her solar microgrid. Thus the number of payback years is 11 ($4875/$457,53=11).

Case Study 2 revealed that the Customer 2 is connected to the JSC "Telasi" distribution grid and owns solar microgrid with the installed capacity 9,72kW. Because of the high capacity solar microgrid that generates far more power than it is needed (the average monthly consumption of Customer 2 is only 127,68kW.h), Customer 2 experienced the positive balance throughout the billing year (2018). The total annual consumption of Customer 2 is 1532,2 kW.h and respectively, the annual cost of consumed power amounted to USD 112,18 (1532,2kW.h X $0,07321[6]=$112,18). Since Customer 2 incurred absolutely no charges during the billing period, he/she saved USD 112,18 during the year 2018. In addition, Customer 2 got the credit ($ 345,21) for the exported to the grid power by the end of the billing period and therefore, the total customer savings for the year 2018 amounted to USD 457,39 ($112,18+$345,21=$457,39). (see the Table 2)

If compare the total annual savings of Customer 1 and Customer 2, We can immediately notice that they managed to save almost the same amounts during the year 2018, USD 457,53 and USD 457,39 respectively, even though the Customer 2 invested 1,5 times more – USD 7290 ($750X9,72kW=$7290) – in his/her solar microgrid than the Customer 1 (USD 4875) that results in around 16 Years ($7290/$457,39=16) payback period for Customer 2 as opposed to 11 years as in the case of Customer 1.

[6] Since the average monthly consumption of Customer 2 is between 101kW.h - 301kW.h, he/she is charged for consumed per kW.h $ .07321.

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Table 2.

The Cost-Benefit Analysis Based on the Case Study 2

| **Customer** | 2 | | | | | | |
|---|---|---|---|---|---|---|---|
| **Installed Capacity** | 9.72kW | | | | | | |
| **Date** | **Power Received from the Grid (kW.h)** | **Total Accumulated Power Received from the grid (kW.h)** | **Exported Power to the Grid (kW.h)** | **Total Accumulated Power Exported to the Grid (kW.h)** | **Difference (D-B) (kW.h)** | **Accrued Benefit (kW.h)** | **Cost/ Benefit (USD)** |
| **A** | **B** | **C** | **D** | **E** | **F** | **G** | **H** |
| 28.02.2018 | 239.2 | 0.00 | 253 | 0.00 | -13.80 | -13.80 | 0.00 |
| 31.03.2018 | 163.8 | 403 | 632.9 | 885.9 | -469.10 | -482.90 | 0.00 |
| 30.04.2018 | 119.1 | 522.1 | 1086.1 | 1972 | -967.00 | -1449.90 | 0.00 |
| 31.05.2018 | 110.4 | 632.5 | 1138.7 | 3110.7 | -1028.3 | -2478.2 | 0.00 |
| 30.06.2018 | 108.1 | 740.6 | 1343.6 | 4454.3 | -1235.5 | -3713.7 | 0.00 |
| 31.07.2018 | 153.8 | 894.4 | 1298.5 | 5752.8 | -1144.7 | -4858.4 | 0.00 |
| 31.08.2018 | 50.6 | 945 | 1090.5 | 6843.3 | -1039.9 | -5898.3 | 0.00 |
| 30.09.2018 | 110.9 | 1055.9 | 1005.6 | 7848.9 | -894.7 | -6793 | 0.00 |
| 31.10.2018 | 123.3 | 1179.2 | 663 | 8511.9 | -539.7 | -7332.7 | 0.00 |
| 30.11.2018 | 153.7 | 1332.9 | 357.8 | 8869.7 | -204.1 | -7536.8 | 0.00 |
| 31.12.2018 | 199.3 | 1532.2 | 208.5 | 9078.2 | -9.2 | -7546 | 0.00 |
| | | | | | | | |
| 23.01.2019 | Credits Received from Exported to DSO Power* | | | | | 7546 | $ 345.21 |
| Total Annual Consumption for the Year 2018 (KW.h) ** | 1532.2 | | | | | | $ 112.18 |
| Average Monthly Consumption KW.h | 127.68 | | | | | | |
| Money Paid to DSO for the Actually Consumed Power for the Year 2018 ($) | | | | | | | $0.00 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Total Customer Savings for the Year 2018 ($) | | | | | | | $ 457.39 |
| * Average weighed price paid to net metered customers for exported to the grid power is $ .046. | | | | | | | |
| ** Residential electricity rate from 101kW.h to 301 kW.h including the VAT, is $.07321. | | | | | | | |
| Note: Average 1USD for the year 2018 is $2.535. | | | | | | | |

*Source: Research materials*

Thus, Case Study 2 is the clear demonstration why it is not reasonable to install solar microgrid with more capacity than the average monthly consumption is because installed capacities that don't align with average monthly consumptions have adverse impact on net metered customers' savings as well as on the payback period. It is because the *retail rate* offered to net metered customers for the electricity exported to the grid is much more less ($0,046) than the rates[7] charged by DSOs for consumed from the grid power (see Appendix 1). Therefore, when calculating the installed capacities one should plan on his/her average monthly consumption to avoid over-expenditures.

Case Study 2 also serves as an additional prove to the viewpoint that net energy metering (NEM) is more "*money-saving choice*" for residential net metered customers than "*money-making choice*". NEM is specially designed to help them to get credit to hedge against the electricity from the grid when it is not sunny or during at nighttime rather than to export excess electricity to the grid and make money.

Case Study 3 revealed that the Customer 3 is connected to the JSC "Telasi" distribution grid and owns solar microgrid with the installed capacity 2,6kW. The Customer 3 had the negative balance in three months (January, November, and December) of the billing Year (2018) but in the last two month (November and December) the negative balance was cancelled out by the credits accumulated during the previous months. The total annual consumption of Customer 3 was 1220,4 kW.h and respectively, the annual cost of consumed power amounted to USD 89,35 (1220,4kW.hX$0,07321[8]=$89,35). Instead of this amount, Customer 3 was billed at total USD4,59 during the billing period. It means that Customer 3 saved USD 84,76 ($89,35-$4,59=$84,76) during the year 2018. In addition, Customer 3 got the credit ($ 33,49) for exported to the grid power by the end of the billing period and therefore, the total customer savings for the year 2018 amounted to USD 118,25 ($84,76+$33,49=$118,25). (see the Table 3)

[7] rates paid by residential customers for the power received from the grid vary with amount of consumed KW.h power (see Appendix 1)

[8] Since the average monthly consumption of Customer 2 is between 101kW.h - 301kW.h, he/she is charged for consumed per kW.h $ .07321.

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Table 3.

The Cost-Benefit Analysis Based on the Case Study 3

| **Customer** | 3 | | | | | | |
|---|---|---|---|---|---|---|---|
| **Installed Capacity** | 2.6kW | | | | | | |
| **Date** | **Power Received from the Grid (kW.h)** | **Total Accumulated Power Received from the grid (kW.h)** | **Exported Power to the Grid (kW.h)** | **Total Accumulated Power Exported to the Grid (kW.h)** | **Difference (D-B) (kW.h)** | **Accrued Benefit (kW.h)** | **Cost/Benefit (USD)** |
| 31.01.2018 | 183 | 183.00 | 103 | 103.00 | 80.00 | 0.00 | $4.59 |
| 28.02.2018 | 39.4 | 222.40 | 57.4 | 160.40 | -18.00 | 62.00 | 0.00 |
| 31.03.2018 | 83 | 305.40 | 159 | 319.40 | -76.00 | -94.00 | 0.00 |
| 30.04.2018 | 80 | 385.40 | 283 | 602.40 | -203 | -297 | 0.00 |
| 31.05.2018 | 89 | 474.40 | 230 | 832.40 | -141 | -438 | 0.00 |
| 30.06.2018 | 99 | 573.40 | 232 | 1064.40 | -133 | -571 | 0.00 |
| 31.07.2018 | 103 | 676.40 | 157 | 1221.40 | -54 | -625 | 0.00 |
| 31.08.2018 | 89 | 765.40 | 183 | 1404.40 | -94 | -719 | 0.00 |
| 30.09.2018 | 84 | 849.40 | 170 | 1574.40 | -86 | -805 | 0.00 |
| 31.10.2018 | 98 | 947.40 | 165 | 1739.40 | -67 | -872 | 0.00 |
| 30.11.2018 | 138 | 1085.40 | 88 | 1827.40 | 50 | -822 | 0.00 |
| 31.12.2018 | 135 | 1220.40 | 45 | 1872.40 | 90 | -732 | 0.00 |
| 23.01.2019 | Credits Received from Exported to DSO Power* | | | | | 732 | $ 33.49 |
| Total Annual Consumption for the Year 2018 (KW.h) ** | 1220.4 | | | | | | $ 89.35 |
| Average Monthly Consumption KW.h | 101.70 | | | | | | |
| Money Paid to DSO for the Actually Consumed Power for the Year 2018 ($) | | | | | | | $4.59 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Total Customer Savings for the Year 2018 ($) | | | | | | | $ 118.25 |
| * Average weighed price paid to net metered customers for exported to the grid power is $ .046. | | | | | | | |
| ** Residential electricity rate from 101kW.h to 301 kW.h including the VAT, is $.07321. | | | | | | | |
| Note: Average 1USD for the year 2018 is $2.535. | | | | | | | |

*Source: Research materials*

Customer 3 invested somewhere around USD 1950 ($750X2,6kW=$1950) in his/her solar microgrid. If considering that the Customer 3 managed to save at total USD 118,25 during the year 2018, the number of payback years is around 16 ($1950/$118,25=16). In this particular case, installed capacity of solar microgrid is selected on the basis of average monthly consumption but the benefits of Customer 3 is jeopardized by the regulated (fixed) retail rate ($0,046) Customer 3 is paid for the exported to the grid 1 kW.h power that is much more less than the regulated (fixed) retail rate ($0,07321) charged by DSO for 1kW.h power received by the Customer 3 from the grid (see appendix 1). For customer-produced solar energy the fixed compensation (less than retail) is applied that has the negative impact on the savings of retail-rate net metered customers.

Furthermore, the significant market barriers for intermittent energy resources to participate in the retail electricity market of Georgia are still on place. As mentioned above, it is forbidden for residential customers to own the micro-capacity power plant that has more capacity than their demanded network capacity is. At the same time, solar projects are still very expansive for the residents of Georgia (1 kW installed solar capacity costs somewhere around $750) and because of the unfair compensation mechanism the payback period is so large that creates a real disincentive for making future investments in solar generation.

Thus, the research hypothesis that “Residential customers can benefit from retail-rate net energy metering if they choose to participate in this residential demand response (RDR) program but yet the benefits are not substantial due to the net metering compensation structure and the market barriers to entry”, is supported.

In order to meet the second research objective and to demonstrate that for Georgia, solar is often a solution suitable for the geographical needs of remote communities, We have studied the bidding materials regarding the acquisition of 1,59 kW capacity solar microgrid project for lighting the outside architectural part of St. Nino’s church located on the top of the mountain in the ancient city Mtskheta. The bidding was announced by the Mtskheta Municipality in 2018 and the private company Electroni,Ltd was rewarded by the contract regarding the supply of solar microgrid projects for lighting the outside architectural parts of six historical monuments including the St. Nino's church using the solar microgrids.

The estimated cost of the solar project under study amounted to USD 2778,5. The actual cost of the project amounted to USD 2889, including the materials. If the standard "wire" solution (arrangement of branching from the nearest 0,4kV network) were applied for lighting the outside architectural part of St. Nino's church, the cost of installation works would be USD 4939 that 1,7 times more than the cost of works in the case of "non-wires" solution (installation of solar microgrid). If taking into account that the outside architectural part of St. Nino's church needs to be lighted during the nighttime, the average annual cost of consumed power in the case of "wire" solution would be USD 590,08 (1,59 kW X 11,2 hour X 365 days=6499,9 kW.h; 6499kW.h X $0,0909=$590,08). If also considering that the service life of solar panel is approximately 20 years, the savings of St. Nino's church when choosing "non-wires" solution for lighting its outside architectural part is considerable (USD 11,801).

Even though for Georgia, solar is often a solution suitable for the geographical needs of remote communities, policymakers currently take only limited account of Distributed Energy Resources (DERs) when assessing resource adequacy. According to the publicly announced energy policy directions, "development of renewable resources is a key to tackling climate change and deploying cleaner sources of energy. (Energy Policy Department at the Miinistry of Economy and Sustainable Development of Georgia , 2018) Georgia is remarkably rich in hydro-power resources that take the first place among the natural riches of Georgia. Around 300 rivers are significant in terms of energy production. Their total annual potential capacity is 15GW but because of their distinct seasonality, these resources can be distributed only by building hydro power plants (HPPs) with regulating water reservoirs that is capital-intensive and have the adverse effect on nature. That's why the Government of Georgia has approved the State Program – "Renewable Energy 2008" that includes the list of greenfield projects and rules for construction of distributed energy sources. If taking into account that in most regions of the country annual duration of solar shining ranges from 250 up to 280 days amounting to approximately 1900-2200 hours, solar projects will become prevalent[9].

In the nearest future, the positive driver of the demand for solar projects will become the electrical vehicles (EV). Navigant worked with the Smart Electric Power Alliance (SEPA) and the Peak Load Management Alliance (PLMA) last year on the 2018 Utility Demand Response Market Snapshot. The report states, that the electric vehicle (EV) landscape is rapidly evolving, with forecasts predicting that EVs' annual energy

[9] The total solar energy potential of Georgia is 108 MW.

consumption will rise from a few terawatt-hours (TWh) a year in 2017 to over 100 TWh by 2030. (SEPA, 2018)

"Airgroup", the first industrial business group in Georgia working toward the ecological projects, announced that by the end of 2020 the first electro-mobiles will appear in the market of Georgia under the Georgian brand. By this time the planned production is 300 units of EVs, and according to the very optimistic forecast of "Airgroup", after seven years the number of EVs will reach 3000 and the half of them will remain in Georgia. This reality creates real challenge for policymakers and regulators to permit distributed energy resources (DERs) to step into the energy market of Georgia. Otherwise, EVs would add to system peaks and drive unnecessary investments in distribution infrastructure and, respectively costs to ratepayers.

It's no secret that the energy sector is experiencing exponential change. Headlines tout transformative technologies, dynamic changes in costs and how consumers interact with the grid, and societal expectations for a cleaner environment. Three trends in particular are producing effects in the energy industry: the falling costs of variable renewable energy, the declining costs of energy technologies, and the increase in automation and our ability to control electricity demand. These trends are both challenges and opportunities for consumers, utilities, and the environment. (Farnsworth, 2018)

Falling costs of variable energy resources (VERs) such as wind and solar, have the positive effects throughout the industry. According to Bloomberg New Energy Finance (BNEF), projects that in 2015 were 5.8 cents per kilowatt-hour (kWh) for solar (in the United Arab Emirates) and 4.5 cents per kWh for wind (in the United States) were in 2017, 1.8 cents/kWh for solar (in Saudi Arabia) and 2 cents/kWh for wind (in India). (Farnsworth D. S., 2018)

Today the winning companies are helping lead clean energy development in many areas: an August 3 report by Bloomberg New Energy Finance found corporate purchases of renewable energy easily set a record this year. As of this summer, corporate purchasing had reached 7.2 GW of clean energy, surpassing the 5.4 GW purchased in 2017.

## Conclusions

Thus, the new energy reality comes with new opportunities, but current plans fall short of tapping into the full potential of Residential Demand Response (RDR). Demand side participation assumes increased involvement of consumers who choose to take part in it for a reward. As a consumer-driven and market-based mechanism successfully implemented in many other economic sectors in EU, demand response is an integral part of both wholesale and consumer-centric retail markets in the energy sector. It provides a fair reward to consumers for demand flexibility and relies on available technical solutions.

Demand response is increasingly viewed alongside energy efficiency and the coordination of distributed resources, in a concept known as integrated demand-side management. This is possible because efficiency has moved beyond the simple demand reductions often associated in Georgia with the use of energy efficiency home appliances and LED luminaires for lighting homes, and is increasingly focused on the timing and location of savings.

Based on Our cost-benefit analyses, We can conclude that the investments in solar microgrid projects are the real “*money saving choice*” for net metered residential customers of Georgia rather than the “*money-making choice*”. NEM is specially designed to help them to get credit to hedge against the electricity from the grid when it is not sunny or during at nighttime rather than to export excess electricity to the grid and make money because of fixed compensation structure (less than retail) applied to customer-produced solar energy.

Case Study 2 is the clear demonstration why it is not reasonable for Georgian net metered customers to install solar microgrid with more capacity than their average monthly consumption is. Installed capacities that don’t align with average monthly consumptions have the adverse impact on net metered customers’ savings as well as on the payback period.

Furthermore, the significant market barriers for intermittent energy resources to participate in the retail electricity market of Georgia are still on place. As mentioned above, it is forbidden for residential customers to own the micro-capacity power plant that has more capacity than their demanded network capacity is. At the same time, solar projects are still very expansive for Georgian residents (1 kW installed solar capacity costs somewhere around $750) and because of unfair compensation mechanism the payback period is so large that creates disincentive for future investments in solar generation.

## Problem Solution

In order to incentivize residential customers to invest in on-site solar generation, policymakers should introduce non-traditional net-metering rate structures for determining the export value of customer-generated solar. The value of customer-exported generation has to be calculated based on avoided cost, wholesale price, or marginal costs. In many states of the United States, policymakers are working to design price signals into rates that reward developers and customers for adding resources with useful time and location attributes.

Policymakers should also tire-down market barriers to entry for distributed energy resources (DERs) to connect consumers with more affordable and cleaner resources and in this way help utilities better manage the grid and reduce harm to the environment and public health. As many DERs will be added to the national grid, utilities will increasingly take advantage of that supply to balance load at the same time achieving their environmental targets. Net Energy Metering (NEM) is just the first step in reaping benefits from residential demand response (DR) as a resource of more efficiently matching supply with load.

In the nearest future, the positive driver of the demand for solar projects in Georgia will become the electrical vehicles (EV). EVs create real challenge for policymakers and regulators to permit distributed energy resources (DERs) to step into the energy market of Georgia. Otherwise, EVs would add to system peaks and drive unnecessary investments in distribution infrastructure and, respectively costs to ratepayers.

Beyond this, Our study is the additional prove to the viewpoint that for Georgia, *solar is often a solution suitable for the geographical needs of remote communities.* Thus, We strongly recommend the policymakers to enable Residential DR to replace uneconomic investment in costly power generation, and by doing so, promote energy efficiency. As noted in our previous study, competition among a variety of suppliers is not sufficient to ensure reasonable electricity rates and service options to customers without efficient integration of Demand Response (DR) resources[10] in power portfolios of Georgia. (Maglakelidze & Veshguri, I, 2017)

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[10]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.

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**APPENDIX 1.**

Residential Retail Rates, USD/kW.h

| Regulated Rate Ranges | Residential Rates without the VAT | Residential Rates Including the VAT |
|---|---|---|
| From 0 kW.h up to 101 kW.h | $ 0,0476 | $ 0,05738 |
| From 101kW.h up to 301 kW./h | $ 0,0609 | $ 0,07321 |
| 301 kW.h and Over | $ 0,0760 | $ 0,09090 |

| Average weighed price paid to net metered customers for exported to the grid power | |
|---|---|
| JSC “Telasi” | $ 0,046 |

| **Average 1USD - 2018** | **2.535** |
|---|---|

*Source:* Georgian National Energy and Water Supply Regulatory Commission (GNERC) resolution №20