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Energy Analysis of Lower Alazani-lori Pilot Watershed Area (Dedoplistskaro Municipality, Kakheti Region)

Republic of Georgia

Technical Report Number 21

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Integrated Natural Resources Management in the Republic of Georgia Program

Technical Report Number 21

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List of Acronyms

USAID	United States Agency for International Development
INRMW Program	Integrated Natural Resources Management in Watersheds of Georgia Program
WI	Winrock International
SDAP	Sustainable Development and Policy Center
EE	Energy Efficiency
HH	House Hold
EU	European Union
HPP	Hydro Power Plant
MW	Megawatts
MWh	Megawatt/hours
NG	Natural Gas
PV	Photovoltaic
RE/EE	Renewable Energy/Energy Efficiency
RE	Renewable Energy
SHP	Small Hydropower
kW	Kilowatts
kWh	Kilowatt/hours
PPA	Power Purchase Agreement
NGO	Non-Governmental Organization
GoG	Government of Georgia
MENRP	Ministry of Energy and Natural Resources Protection

Introduction

The following analysis was produced within the framework of the Integrated Natural Resources Management in Watersheds of Georgia (INRMW) Program. It deals with the Lower Alazani-Iori Pilot Watershed Area (including Iori downstream) covering Dedoplistskaro municipality, as selected by the INRMW project in 2011. This analysis is the third in a series of four, dealing with two upstream and two downstream watersheds of the Rioni and Alazani rivers, respectively.

The Sustainable Development and Policy (SDAP) Center conducted this analysis under a contract signed with the Winrock International Institute for Agricultural Development (Prime Contract # AID-114-LA-10-00004 INRMW, subcontract # 6331-11-01) within Activity 2: Detailed Assessments and Community Stakeholder Engagement. This subcontract defines the SDAP Center task producing draft report on Energy Analysis of the Lower Alazani-Iori Pilot Watershed Area.

More broadly SDAP Center activities call for undertaking this Watershed Energy Analysis in order to identify the energy consumption, energy production, and energy resources in the four pilot watersheds. The study also is used to identify potential energy options, and to provide the necessary data for subsequent preparation of watershed energy passports documenting energy inputs and outputs at a watershed level. These will be used by local government agencies and communities in planning for energy-related investments.

The Watershed Energy Analysis goals are as follows:

- Assess local energy resources within 4 pilot watershed areas of the Alazani and Rioni River Basins (with a special emphasis on renewable resources - RE);
- Determine current energy consumption and production patterns;
- Identify opportunities to reduce energy consumption through the adoption of energy-efficiency (EE) investments and practices.

The outputs of the Watershed Energy Analysis will form the basis for Energy Passports of municipalities within the Watersheds (detailed description of energy passports and the methodology to develop them are given in Annex 1). Although such an analytical document as presented here may be used independently, it will provide an instantaneous snapshot of the current energy situation. The Energy Passport can be systematically updated with new data inputs in the future.

Energy planning for a geographical area provides an opportunity for reorganizing the energy consumption and distribution trends so that they can be managed more efficiently in the future.

To reach this goal it was envisioned to develop a software energy planning tool that is not a model of any particular energy system, but rather an instrument that can be used to create models of different energy systems, called in this project “Energy Passports”, where each requires its own unique data structures. It is expected that energy planning software tool will be used for forecasting energy balances and development of the energy action plans for each watershed.

The “Energy Passport” software program proposed will incorporate an overall energy balance – the comprehensive system for presenting and analyzing country level energy system related data. This

approach is endorsed and used by a variety of global and regional organizations, as well as national governments as a universal planning tool. Due to its format it is well fitted to serve as a platform for software development. It will be modified as needed in order to accommodate additional analytical and decision-making features to satisfy the future development needs of small territorial units like municipalities and/or regions of Georgia.[1]

It is expected that the Energy Passport will serve several purposes: as a database, that will provide a comprehensive system for maintaining energy information; as a forecasting tool, it will enable the user to make projections of energy supply and demand over a long-term planning; and as a policy analysis tool, it can assess the effects - physical, economic, and environmental - of alternative energy programs, investments, and actions. An "Energy Passport" provides a comprehensive view of the energy system as a whole. It is thus the necessary instrument for understanding energy as part of a larger situation; a present situation, a future "business as usual "situation, and as an alternative energy scenario, oriented towards sustainability.

At the community level, there will be a strong focus on alternative fuel sources and energy efficient technologies that reduce the need for heating and other energy uses. The program will assess selected energy-related natural resources from the standpoint of their sustainable use, identifying threats to such use, and developing options for optimizing their use in the framework of long-term conservation and broader economic growth. Illustrative subjects for watershed productivity and energy efficiency studies include: hydropower productivity; fuel wood use (and regeneration/silviculture practices); and local alternatives that reduce/substitute fuel wood demand and others.

This analytical document was developed based on a template created and tested during work on the Upper Rioni and the Alazani Watershed Assessments, However, the process of the document development as well as the assessment differs in some aspects from the former assessments.

It was possible to carry out some limited comparative analysis of household energy consumption practices between the upstream and downstream watersheds of the same river. This was especially helpful since both are situated in the same region of Georgia.

During this study, the boundaries of the watershed did not align with the local municipal boundaries, within whose confines the energy sector is formally functioning and the relevant data is provided. Dedoplistskaro municipality includes not only part of Alazani downstream watershed, but also the Lori downstream watershed as well. Still this overlap makes little to no impact on the energy sector analysis, since virtually the entire population and the relevant energy infrastructure are located within the Alazani watershed.

Such a boundary conflict can occasionally occur in attempts to fit socio-economic data (and relevant analysis) that is created and collected within the existing political administrative boundaries and forced into the natural watershed boundaries, which may or may not coincide with the actual administrative boundaries.

As a whole, the results of this analytical paper clearly show that despite some important differences in socio-economic development trends and levels, the energy consumption patterns of households

[1] For detailed presentation of energy balance see Annex 1.

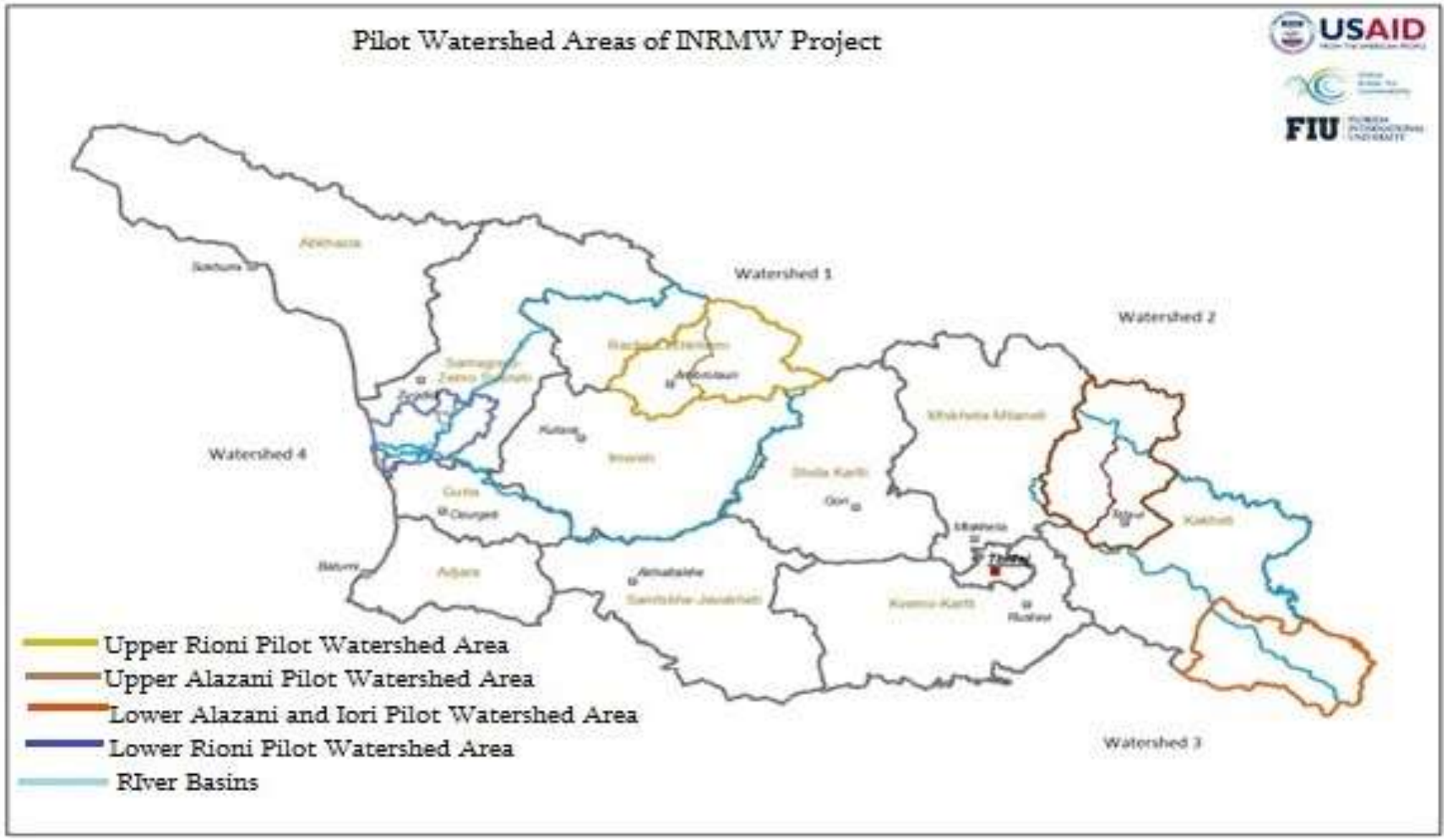
are similar in some respect to those in upper Rioni and Alazani watersheds. The most important aspect is that just like Racha and Telavi-Akhmeta, there is a heavy dependence on firewood for heating purposes, making it again the single most important energy source for households. On the other hand, the Lower Alazani-Iori Pilot Watershed Area is almost devoid of fuel wood resources and is undergoing desertification, which makes solving the fuel wood dependence problem much more pressing than elsewhere.[2]

1. Socio-Economic Context

The Lower Alazani-Iori Pilot Watershed Area is located in the eastern part of Georgia, in the Kakheti region. Out of 2,592 km^2 of total Dedoplistskaro territory, the Alazani watershed occupies approximately 1,163 km^2 or 45%, with the remaining area belonging to Lori. The following maps show the boundaries of pilot watershed areas.

[2]For methodology please refer to: Energy Analysis of Upper Rioni Pilot Watershed Area(Ambrolauri and Oni Municipalities, Racha-Lechkhumi and Kvemo Svaneti region).

Figure1.1 Map of the relative location of pilot watershed areas of Rioni and Alazani river basins within the territory of Georgia
Developed by: Nutsa Megvinetukhutsesi, GIS expert hired under INRMW program



The population of Dedoplistskaro municipality was 32,847 persons in 2011, according to the local municipality data. Of this the town of Dedoplistskaro has 7,392 persons, or 22.5% of the total population. There are 13 rural communities with 15 villages. Of these villages, only two have fewer than 200 inhabitants, and three have less than 1,000, while all the other villages have more than 1,000 inhabitants, making them rather large by Georgian village standards. Only two communities consist of two villages, while in all other cases the community consists of a single settlement.

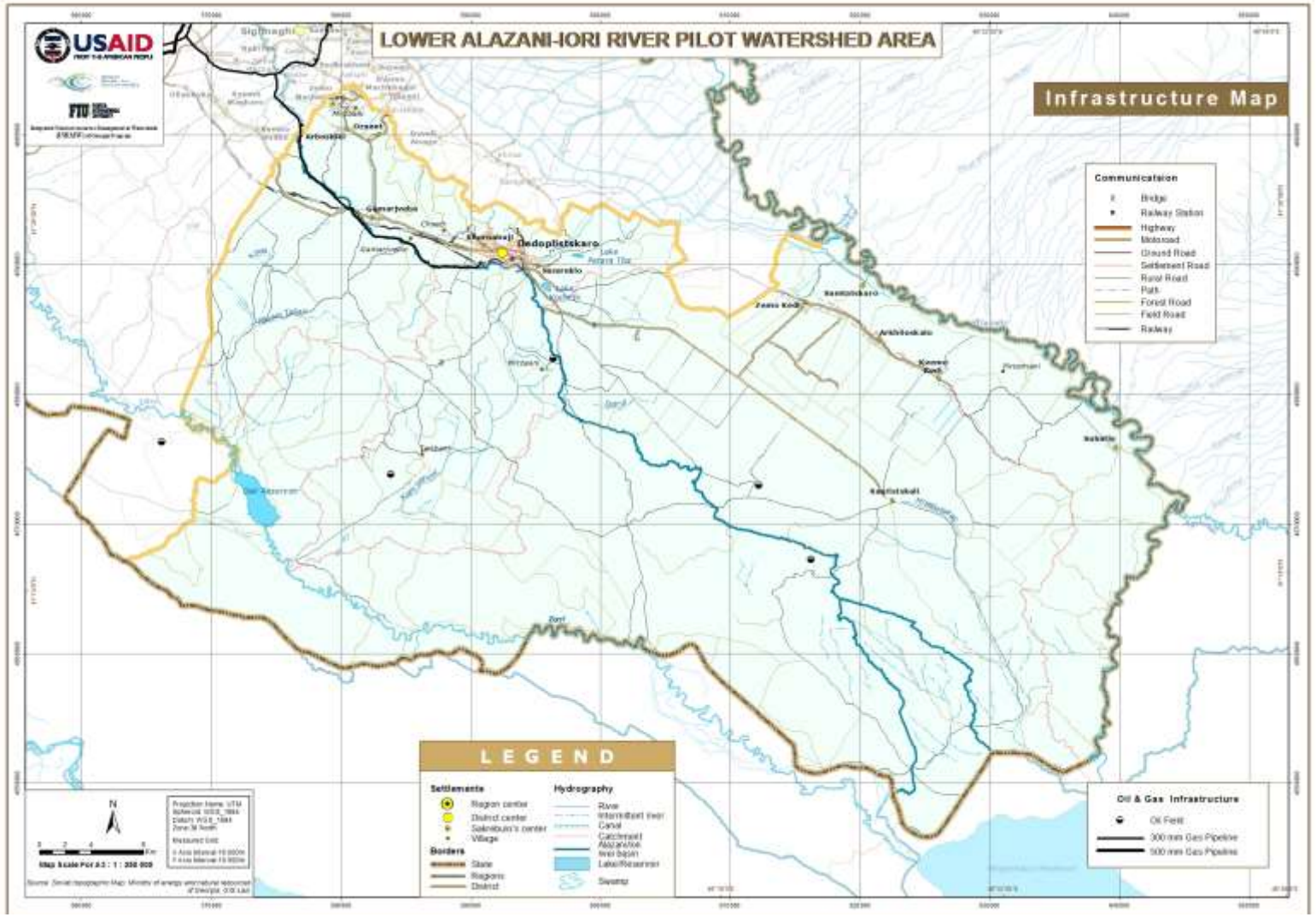
The population density is very low at 12.6 persons per km^2. The population is concentrated in two clusters, adjacent to the north-east administrative border and distinctively separate from each other (see Figures 2.2 and 2.3). The larger one, which is located westwards, consists of 10 settlements (including the town of Dedoplistskaro), with approximately 68% of the total population, while the smaller one, eastwards, consists of 6 villages with the remainder of the population.[3]

Much of this information comes from the municipal development strategy documents, although these are not universally available. But there is just one basic "Dedoplistaskaro municipality infrastructure development program" study, written in 2010.

The municipality was one of the worst hit by the post-Soviet population decline, even though it is located far from areas of local conflicts and had no large ethnic non-religious minority groups, who mainly emigrated in the 1990's from other parts of Georgia. During the period between the two population censuses of 1989 and 2002, the total population here dropped by 17%, although it has remained stable since them. The urban population (i.e., in the town of Dedoplistskaro proper) declined by 24% during the same period and has been reduced further by 5% since then. It is worth mentioning that Dedoplistskaro was awarded the status of an urban settlement in 1963 after being designated as a Municipal Center of the same name. It has few urban functions except as a formal municipal administrator and does not provide its population with any of the advantages of an urban lifestyle. Quite on the contrary, given the current economic realities, living in proto-urban settlements of this kind may put its population at a greater disadvantage as compared to the rural population, who at least has access to agricultural land for income generating activities.

[3]There is one feature which differentiates Dedoplistskaro municipality from all the other municipalities of Georgia. Since this municipality provides winter pastures for cattle (sheep mainly) from Akhmeta, there is the village Kasristskali, which is located here, serving as a base for pasture operation, but formally belonging to Akhmeta municipality. Unfortunately we were not able to obtain any information about this village to be included in this report.

Figure 1.2 Map of the Lower Alazani-Iori Pilot Watershed Area
Developed by: Nutsa Megvinetukhutsesi, GIS expert hired under INRMW program



Throughout recent history Kakheti was always considered to be one of the leading regions of Georgia and the center of the country's viticulture and winemaking industry. Unfortunately, this specialization has not helped it to develop successfully during the post-Soviet period. After first losing the Soviet market, and then after 2006 the Russian market (for which this viticulture industry was originally oriented), Kakheti does not show any optimistic growth trends. Out of 11 Georgian regions Kakheti as a whole is characterized by rather low production values, with only 4 regions (Racha, Guria, Mtskheta-Mtianeti and Samtskhe-Javakheti) lagging behind it nationally. But of these four, Racha and Guria have always been regarded as economically depressed, while Mtskheta-Mtianeti and Samtskhe-Javakheti are regarded by this index in the same grouping as with Kakheti.[4]

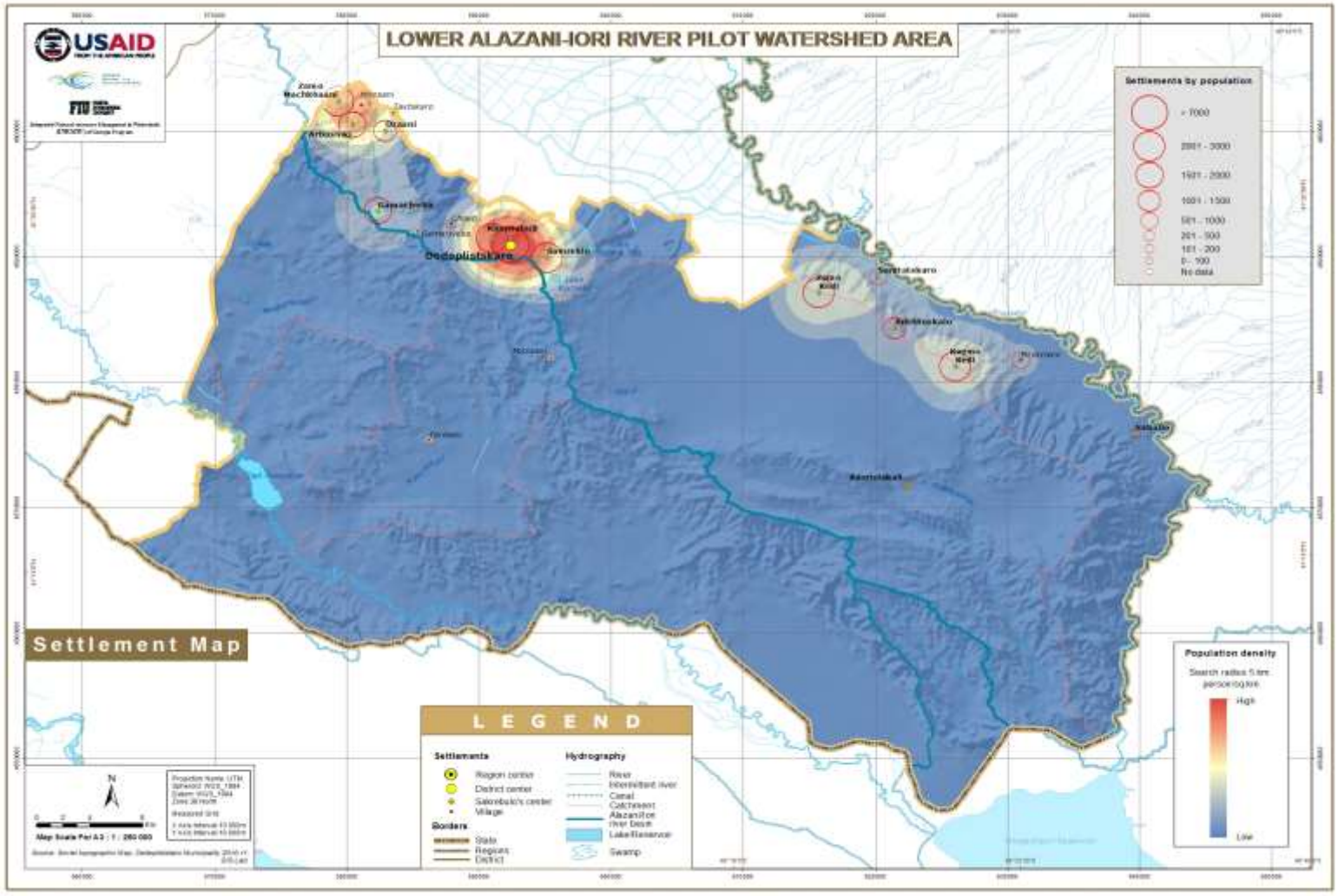
For centuries, the Kakheti region has always played a major role in the political and economic life of Georgia. However, the situation is very different now. Despite representing 9.1% of the Georgian population, Kakheti only generates 5.4% of the country's GDP. Thus, its GDP per capita represents only 59.3% of the average Georgian per capita income. The economic density for Kakheti is one of the lowest in the country and in 2010 was GEL85,530/km^2, as compared to GEL475,472/km^{2}in Adjara and GEL11.7 million/km^2 in Tbilisi.[5]

Out of 406,000 people inhabiting Kakheti in 2011, only about 12,500 were employed by the business sector (including self-employed), which is fewer as compared to 2010.[6] According to the "Dedoplistskaro municipality infrastructure development program" study (p. 11), there were 38 industrial enterprises registered in 2010 with 485 employees and GEL8,320,000 in production. All in all Dedoplistskaro is not the "typical" Kakheti district, which is usually associated with viticulture. It is predominantly agricultural (more than 70% of production originates in this sector), as with the rest of this region, but the agriculture here is mainly represented by grain crops, sunflowers, and livestock.

Dedoplistskaroalso differs from the rest of Kakhetisince the type of agricultural economy represented here does fit well into a regional development strategy. The "Kakheti Regional Development Strategy 2009-2014" developed by the UNDP Kakheti Regional Development Project No. 00045135, defines only viticulture and tourism as development priorities.[7]The Kakheti Development project to be implemented through the Municipal Development Fund of Georgia is also strongly biased towards tourism development, where Dedoplistskaro has no such plan. The only attempt to modernize this part of Kakheti was made in the 1990's, when Georgia tried to implement an ambitious plan of becoming self-sufficient in grain supply. Unfortunately this failed due to poor management and corruption. Thus far, there is not even a short or medium term perspective strategy for economic development of Dedoplistskaro, although (as with everywhere else in Georgia) a great deal is done with regards to local infrastructure modernization and development.

[4]see: http://www.geostat.ge/index.php?action=page&p_id=211&lang=geo
[5]Source: Kakheti Regional Development Project, Cost-Benefit Analysis, 2nd DRAFT, p.
[6]See: http://www.geostat.ge/index.php?action=page&p_id=211&lang=geo
[7]http://www.undp.org.ge/files/24_742_488455_kakheti-strategy-eng.pdf

<u>Figure 1.3</u> Lower Alazani-Iori Pilot Watershed Area – Population map and settlements
Developed by: Nutsa Megvinetukhutsesi, GIS expert hired under INRMW program



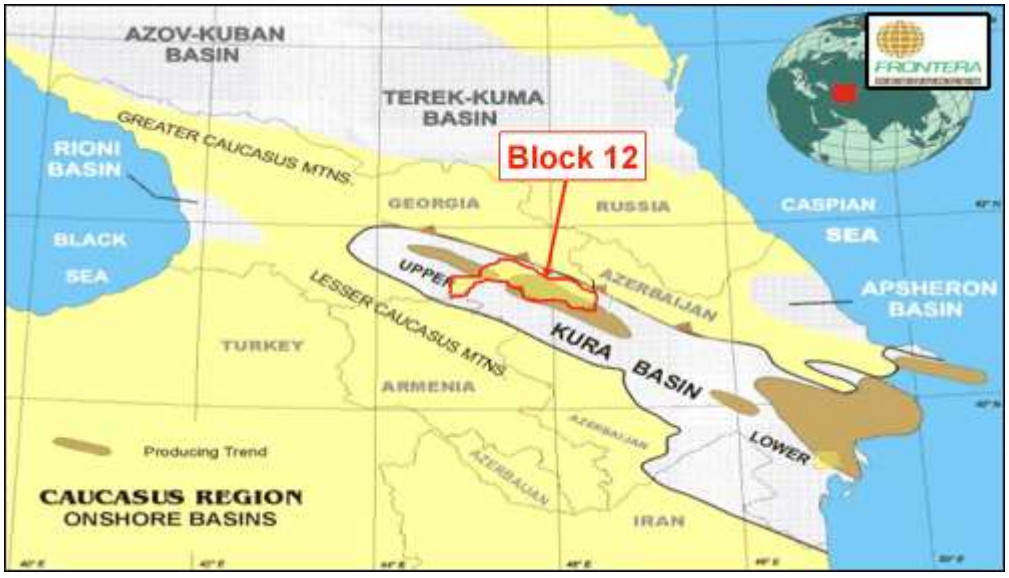
2.Energy Resources

General considerations about factors influencing the utilization of energy resources as well as their applicability in Georgia were covered in the first report, thus this report will not repeat them here.

The Lower Alazani-Iori Pilot Watershed Area is the only one of the four where valuable mineral energy resources have been discovered, such as petroleum.

***Petroleum*.** Petroleum is presented in the Shallow Fields Production Unit located in Block 12. It is operated by Frontera Resources Corporation (of Houston, Texas, USA) under a 25-year mineral extraction license relating to Block 12, granted to Frontera Eastern Georgia Limited, effective as of August 22, 1997. Assessment of the gross (100 percent) contingent and prospective resources for this field was carried out in 2010 by Netherland, Sewell and Associates, Inc.[8]

Figure 2.1 Shallow Fields Production Unit located in Block 12



***Source:* http://www.fronteraresources.com/operations/introduction/**

Partial results of the assessment are presented below in Table2.1

Table 2.1 Oil resources operated by Frontera Eastern Georgia Limited

Field	Gross (100 percent) Oil Volumes (Million Tons)[9]	
	OOIP[10]	Contingent Oil Resources[11]
	Best Estimate	Best Estimate
Mirzaani	37.0	2.44
Mtsarekhevi	1.36	0.19
Nazarlebi	5.97	0.57

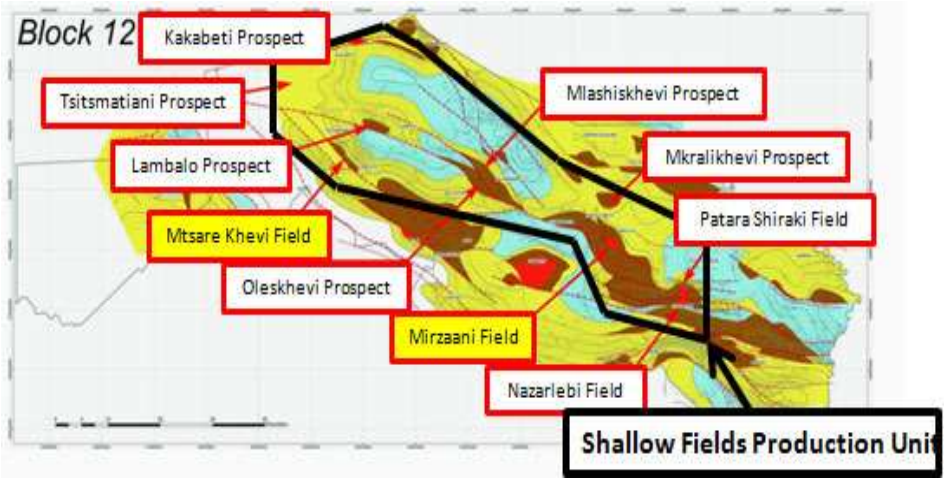
[8]Frontera_SFPU_Resources_Report.pdf
[9]In the original text oil volumes are in Million Barrels. Conversion was based on 1 barrel = 0.1364 ton.
[10]Oil in Place
[11]Contingent resources are those quantities of petroleum estimated, as of a given date, to be potentially recoverable from *known* accumulations, but the applied project(s) are not yet considered mature enough for commercial development due to one or more contingencies.

PataraShiraki	3.52	0,27
Total	47.85	3.47

***Source:* Frontera_SFPU_Resources_Report.pdf**

Oil in these fields can be classified as light crude, with an approximate energy content of 11,717 kWh/ton. This means that the cumulative energy content of 47.85 million tons OOIP is equal to 560,642GWh.[12]

Figure 2.2 Shallow Fields Production Unit Oil Fields



***Source:* http://www.fronteraresources.com/operations/block-12-operations-focus/shallow-fields-production-unit/**

Figure 2.3 Drilling and logging operations at the Mirzaani #1 well in November 2009

***Source:* http://www.fronteraresources.com/media/operations-photo-galleries/mirzaani-field-gallery/shallow-fields-production-unit-mirzaani-field-photo-gallery-february-2009-january-2010/**

[12]This number is only for illustrative purposes.

According to the Georgian Oil and Gas Corporation, currently Frontera extracts oil from the following fields listed below:

Mirzaani – 108 wells;

Nazarlebi – 2 wells;

Barda – 2 wells;

PataraShiraki – 24 wells;

MtsareKhevi – 17 wells;

Taribana – 5 wells.

Cumulative oil production from these wells in 2010 amounted to 12 thousand tons, and in 2011 it was 10.7 thousand tons.

Such renewable energy resources as hydro and biomass fuel wood abound in Watersheds 1 and 2, but are barely represented here.

***Hydropower*.** The "Hydro Energy Technical Potential Cadastre of Rivers of Georgia" report identifies the small (non-traditional) realistic hydropower potential of Georgian rivers. All separate sections of each river where the plants with a capacity not exceeding 10 MW could be built were investigated individually. By summing them up the overall small hydro power potential of the country was estimated. This study does not include sections of rivers whose total hydro power potential is less than 1 MW. No river or river section inside the Lower Alazani-Iori Pilot Watershed Area were identified with a hydro power potential of this small a size. There are also no HPP's in Dedoplistskaro. This does not mean that it is not possible to construct a small off-grid micro HPP, but so far there are no known plans or projects proposed of this kind.

Fuel wood is formally defined as - trees that will yield logs of suitable size and quality for the production of firewood logs or other wood fuel.[13] The other wood fuels include wood chips, wood pellets, wood briquettes, bark, sawdust and shavings. In Georgia, only firewood collection is formally recognized, inventoried, and provided permission for logging.

"Wood Energy Resources of Georgia and Their Efficient Utilization,"– this study, which is referenced in all of the watershed reports, is the most reliable source of information about the local forestry sector. It states on p. 33, that for municipalities where forests occupy less than 25% of the territory, the population needs additional heating fuel sources other than firewood.[14]In Dedoplistskaro forests cover just 12,788 ha, or 5% of the total area, 2,532 km^2.[15]Nevertheless, despite this poor resource situation and contrary to common sense, firewood is still allocated for logging here (see 3.1.4), and moreover is the largest single energy source available to the population, as well as to many offices and entities operating under the local government.

[13]http://www.websters-online-dictionary.org/definitions/FUELWOOD
[14]Unfortunately this report exists only in Georgian.
[15]See the letter # 08-05/246 of 30.01.2012 by Agency of Natural Resources, by Agency of Natural Resources, Ministry of Energy and Natural Resources of Georgia

There are other potential renewable energy resources such as wind, solar, biogas to consider as follows:

Wind Power. According to the *Wind Power Atlas* of Georgia, as well as information on the MENR website (http://www.menr.gov.ge/4501), the territory of the Lower Alazani-Iori Pilot Watershed Area has limited *wind power* potential for operation of commercial scale MW wind power plants (mainly less than 100 W/m^2 and up to 100-250 W/m^2 primarily in the Lori Valley), although the known resource is adequate to be used for small-scale generation (up to 50 kW) on an individual level.

The solar energy potential is approximately 1,387 kWh per m^2 of horizontal surface per annum.[16] This is equivalent to approximately 200 kWh of electricity or 1,000 kWh of thermal energy (hot water) annually per square meter. This is less than the Georgian average, but still enough to substantially reduce dependence on commercial fossil fuels by producing hot water throughout the year on a household, small business, or public building level.[17]

Biogas**,** which can be produced from animal waste, is a viable alternative to fossil fuels, although a biodigester needs at least 4 heads of cattle to produce enough gas to justify the capital investment in the equipment. Currently in the Lower Alazani-Iori Pilot Watershed Area there is not enough cattle on average per household engaged in agriculture to meet this minimum threshold (there were circa 2 heads of cattle per rural households (HH) on average). However, this does not mean that biogas cannot be utilized as a source of alternative energy for more well-to-do families, especially if there is appropriate guidance from local government and community organizations. As previous biogas utilization experience in Georgia shows, this type of energy generation is not popular and is unlikely to become so in the short term.

3. Energy Sector

3.1 Consumption

3.1.1 Electricity

"Kakheti Energy Distribution" is the sole provider of electric power to the Kakheti region including Dedoplistskaro municipality. [18]

The household survey conducted by the SDAP Center field team in the Dedoplistskaro municipality showed that all local respondents had individual electric meters, although the perception of the company's services differed considerably depending on location. Households in the town of Dedoplistskaro (18 HH) were partly (12 HH) or completely (4 HH) dissatisfied, with only 2 households being completely satisfied. On the contrary, of 9 consumers interviewed in Samreklo village, 8 were completely satisfied and 1 was partly satisfied. In Khornabuji village all 6 HH were

[16]Calculated from: samSeneblonormebi da wesebi, samSenebloklimatologia, snda w pn 01.05-06, oficialurigamocema, saqarTvelosekonomikuriganviTarebissaministro, Tbilisi, 2006, pp.11-12.

[17]The average solar resource for Georgia is 1,550 kWh/year of solar energy, equivalent to 190 kWh of electricity and 1,200 kWh of thermal energy, as presented in Renewable Energy Potential in Georgia and the Policy Options for its Utilization, Prepared by World Experience for Georgia for Winrock International under Sub Agreement 5708-07-04, February 2008, p.20 http://www.nateliproject.ge/files/02-re_prospects.pdf. All these numbers are very approximate and are used for general illustrative purposes only.

[18] It was described in detail in the previous report and is not repeated here.

partly satisfied. In all cases of partial satisfaction or dissatisfaction two reasons were cited – the poor state of power distribution networks and corresponding frequent power blackouts.[19] Based on the satisfaction data it appears that the state of the power supply network in Samreklo is somewhat better than in other localities.

Data on consumers and metering by "Kakheti Energy Distribution" is provided in Table 3.1 below.

Table 3.1 Number and type of consumers by kind of metering in Dedoplistskaro municipality at the beginning of 2012

Type of Consumers/metering	Number of Customers
Commercial Buildings	**630**
Group meters	1
Individual meters	629
Residential Buildings	**12,188**
Group meters	4,649
Individual meters	7,539
Public (Local Government) Buildings	**94**
Group meters	1
Individual meters	93
Communal Buildings	**461**
Group meters	-
Individual meters	461
Total Buildings	**13,373**
Group meters	4,651
Individual meters	8,722

***Source:* JSC Kakheti Energy Distribution**

The electricity tariff for consumers is GEL0.1298 ($ 0.08) per KWh. If the amount of electricity consumed is less than 100 kWh/month, the rate is GEL0.1652 ($ 0.10) for 101-300 kWh/month and GEL 0.1750 ($ 0.11) for 301 kWh or more/month.

On average households account for a staggering 91% of all electricity consumed in this municipality.[20]

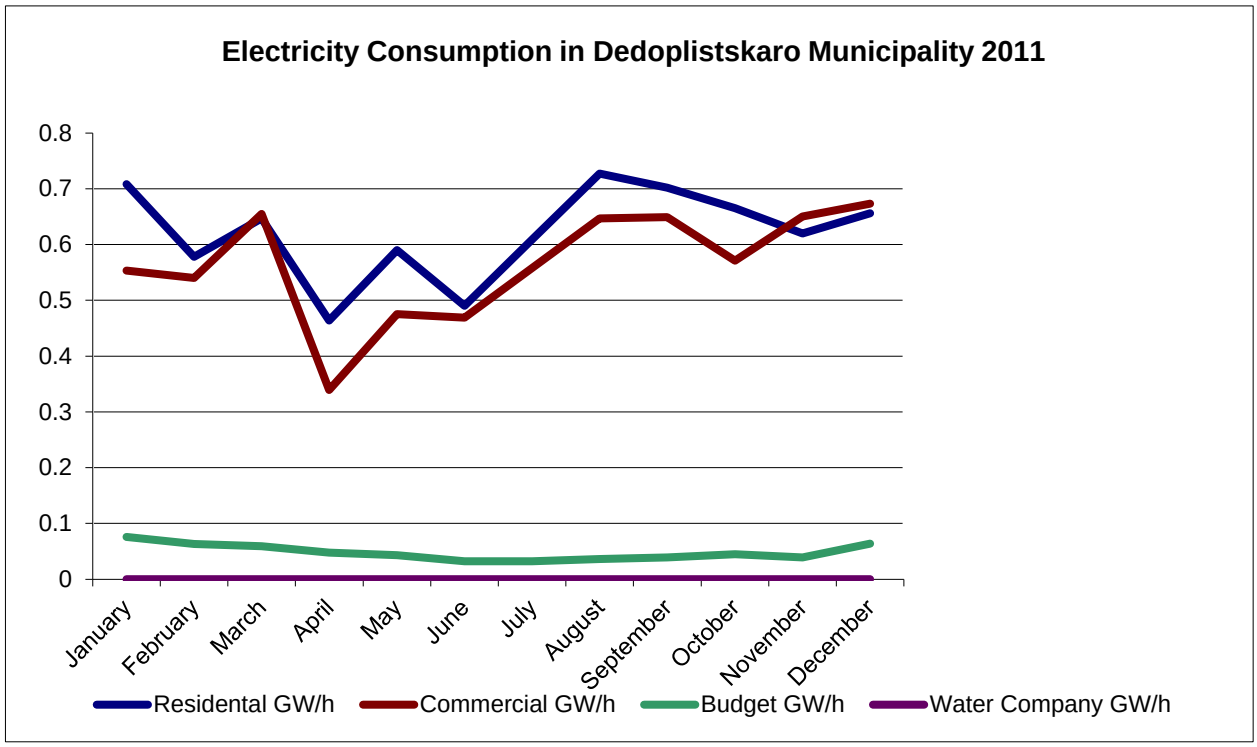
[19] The only difference between partial satisfaction and dissatisfaction, as one may conclude from results of household survey, is basically how respondents perceive the situation, since in both cases the same reasons are cited.

[20] This strongly differentiates the Lower Alazani-Iori Pilot Watershed Area from Upper Rioni and Alazani Pilot Watershed Areas, where population accounted for 2/3 and app. ½ of all electric energy consumed.

The company received 80.107 GWh electricity in 2011. Network losses are formally registered at 10.5%, which is about normal for an electric utility globally.

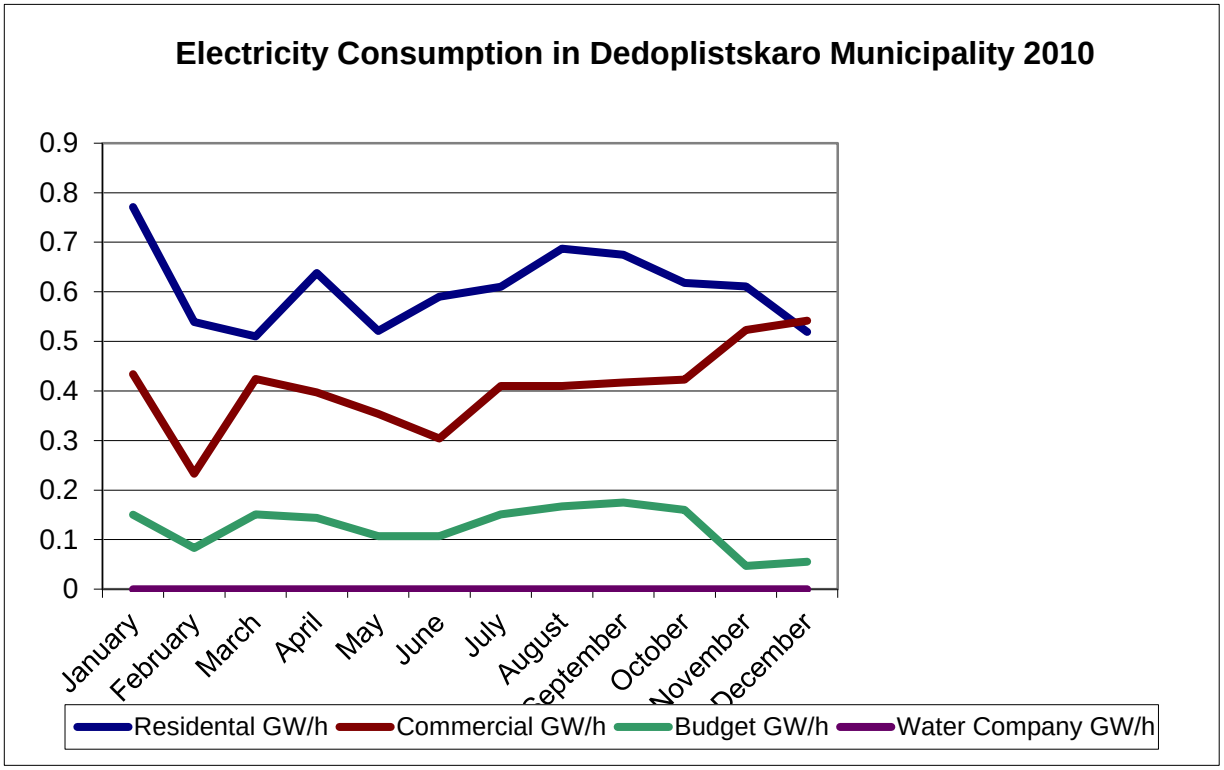
Unlike Upper Alazani Pilot Watershed Area, there is an identifiable trend in electricity consumption for the year 2011, unlike in previous years when it was hard to find any coherent monthly energy consumption patterns. An almost flat power consumption curve is observed for municipal buildings, which operate with little seasonal fluctuations and a minimum power draw during the summer months. Consumption in the business sector and population peaks August-September, which is logical for this region with a predominantly agricultural economy. The emergence of this trend coincided with a sharp reduction of reported consumption of electricity by the budget sector (by about 2.6 times in 2011 as compared with 2010), with a corresponding increase in commercial sector consumption during the same period (by 40%). The monthly basis drop in budget sector consumption took place starting March 2011, while the increase of commercial consumption trends started in May of the same year. Prior to 2011, the budget sector consumed an average of about 30% of commercial sector consumption, and in 2011 this dropped to just 12%. The main reason for this decline may be the introduction of an individual metering system for the municipality, resulted in a decoupling of businesses from local municipal building meters.

Figure 3.1Electricity consumption in the Lower Alazani-Iori Pilot Watershed Area in 2011



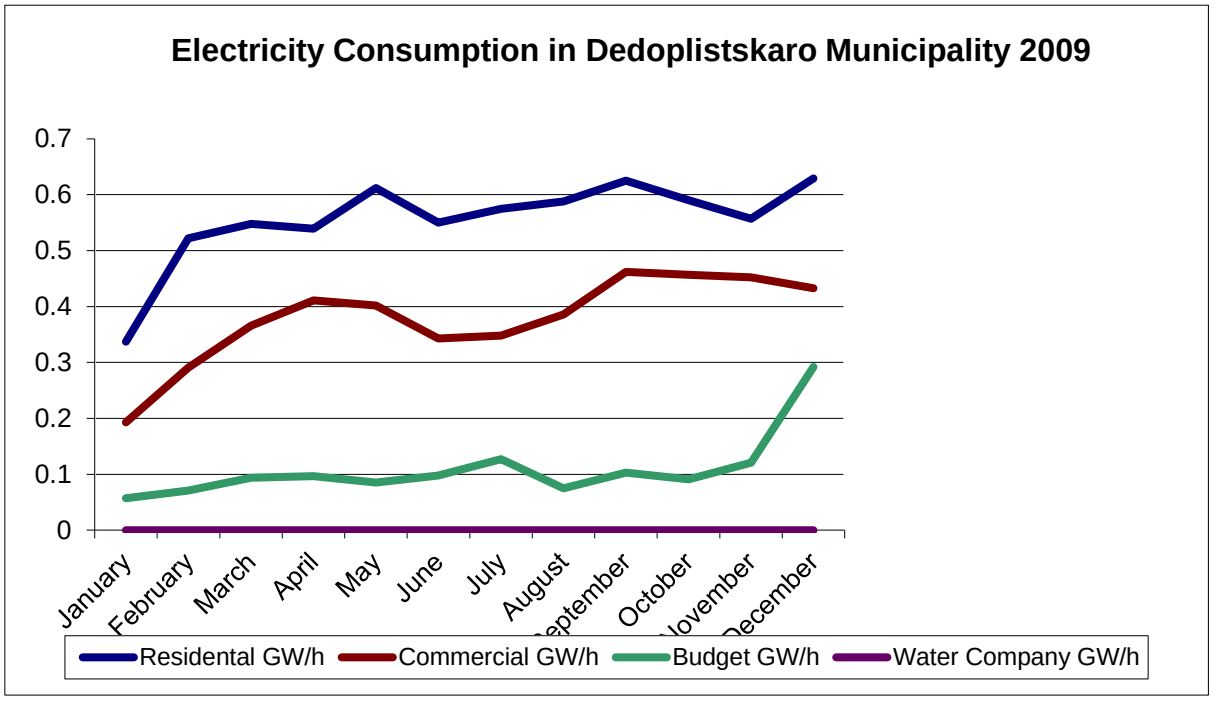
***Source:* JSC Kakheti Energy Distribution**

Figure 3.2 Electricity consumption in the Lower Alazani-Iori Pilot Watershed Area in 2010



Source: ***JSC Kakheti Energy Distribution***

Figure 3.3 Electricity consumption in the Lower Alazani-Iori Pilot Watershed Area in 2009

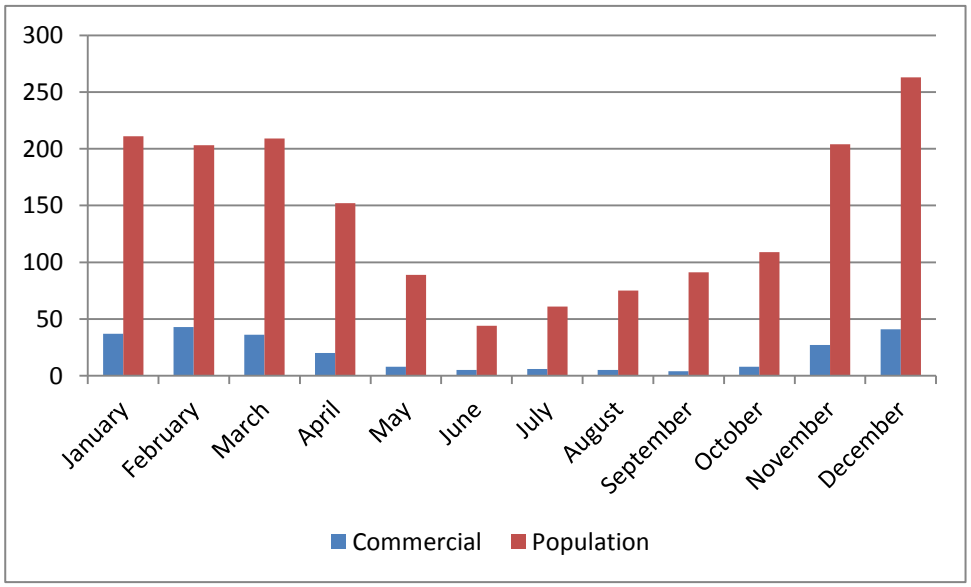


Source: ***JSC Kakheti Energy Distribution***

4.1.2 Natural Gas

Unlike the Upper Alazani Pilot Watershed Area, natural gas in the Lower Alazani-Iori Pilot Watershed Area is supplied only by SOCAR Georgia GasLtd – which is the daughter company of SOCAR Energy Georgia, Ltd (which was established by the State Oil Company of Azerbaijan Republic).It was founded in 2007 and won a tender from the Ministry of Economic Development of Georgia for the privatization of gas distribution companies, which were the property of the state before (Presidential decree № 306 of May 13, 2008). It is now in charge of distribution of natural gas and developing an appropriate infrastructure in Kakheti, Mtskheta-Mtianeti, Shida and KvemoKartli, Adjara, Guria, Imereti, Samegrelo, i.e., virtually the entire country except for Tbilisi, Racha, and part of Kakheti and Samegrelo.

Figure 3.4 Natural gas supply to Dedoplistskaro residential and commercial consumers in 2011 (thousands m^3)



***Source:* SOCAR Georgia gas Kakheti LTD**

There are 110 commercial natural gas consumers in the municipality (i.e., private and public sector) and 3,049 residential consumers (HH) out of 3,159 total connections. The Dedoplistskaro population is clustered into two settlement groups - the main part of the population is concentrated into 10 communities (including the town of Dedoplistskaro) in the western part of the municipality, which are all supplied by natural gas. The rest of the population resides in 6 communities, creating a separate cluster in the eastern part of the district which has no natural gas supply. Judging by the total number of households in the first cluster and the number of individual consumers as provided by Socar, it is possible to estimate that about 40% of HH are provided with natural gas, which is the highest share among all three watersheds analyzed so far. As for individual settlements in this cluster – in the town of Dedoplistskaro along with the villages of Samreklo and Khorhabuji, natural gas is provided to 3,033 residential customers of 4,420 households, or 69% of the total.[21] This is the highest share of households supplied with natural gas among all observed localities so far.

[21]Dedoplistaskaro and these two villages are provided with natural gas by the single distribution system and it is impossible to separate them.

In Gamarjveba village there are 19 residential customers per 620 HH, or just 3% of the total. The villages of ZemoMachkhaani, Ozaani and Abroshiki together are supplied with natural gas from Gurjaani municipality. There are 1,097 residential customers per 2,651 HHs, or 41% of all households. This is also the highest share of rural HH with natural gas supply among watersheds observed.

Analysis of Figure 3.4 above also shows that the commercial sector on average consumes just about 14% of the total gas consumed. When consumption by the local government organizations is subtracted from this number, it is further reduced to only 12%. The commercial sector also includes such organizations as police, the courts, private schools, churches, residences, etc., thus driving down the actual share of services for the industry even lower. This shows that the private commercial sector is severely underdeveloped. In comparison, the Akhmeta share of the commercial sector is about 40% of the power consumption, while in Telavi is approximately 60%. Even after subtracting all possible non-industrial/commercial consumers, the difference is still significant, especially taking into account that the other two mentioned municipalities do not even belong to the most developed parts of Georgia.

4.1.3 Liquid Fuels

Liquefied propane gas (LPG) is sold by two outlets in the town of Dedoplistskaro. Both are operated by individual entrepreneurs. At one, represented by the owner Besik Popiashvili, the sales volume in 2011 was about 1,200 kg per month during summer, and 800 kg in winter at the price of $1.50 per kilogram. The entrepreneur Tengiz Gonashvili sold in 2011 approximately 1,500 kg per month in summer, and 600 kg in winter at a price of about$ 1.80 per kg. Thus, LPG here is much cheaper than in upper Alazani watershed. Interestingly there are no more LPG sales outlets in the municipality itself, even in communities where there is no competing natural gas supply.

4.1.4 Fuel wood

Formal procedures for legally logging firewood population in Georgia were described in detail in the report on the Upper Rioni Pilot Watershed Area, so these similar details are not reported here.[22] Still the Lower Alazani Pilot Watershed Area differs from Upper Pilot Watershed Areas in that there are almost no commercial wood resources. Fuel wood for logging has been allocated for this municipality only since 2009, and only for a very small amount (2,867 m^3 in 2011, which is just 1/14 of the fuel wood allocated for Telavi for instance). There are no commercial licensees for wood harvesting here (see Table 3.1 below).

Table 3.1 Allocated and procured fuel wood in Dedoplistskaro municipality, years 2009-2011

Year	Wood (m^3)	
2011	Allocated	2,867
	Procured	2,867
2010	Allocated	5,624
	Procured	5,403
2009	Allocated	2,550
	Procured	2,303

[22] Energy Analysis of Pilot upper Rioni watershed, (Ambrolauri and OniMunicipalities, Racha-Lechkhumi and KvemoSvanetiregion), p. 29.

Source: Ministry of Energy and Natural Resources of Georgia, Agency of Natural Resources

4. Household Energy Consumption Analysis

During a field visit to Dedoplistskaro, the SDAP Center representatives conducted a household sample survey in order to investigate typical energy consumption patterns on the household level. In order to select households which are representative of a larger population SDAP team used the representative sampling method. For this survey a total of 34 households were surveyed, including 19 in two villages near Dedoplistskaro (9 in Samreklo village and 6 in Khornabuji), as well as 19 in the town of Dedoplistskaro.[23] 34 typical residential buildings were randomly selected for survey. The sampling results were extrapolated to make generalization about upper Alazani watershed area. The above mentioned methodology allowed estimating typical energy consumption patterns without assessing every single household in target watershed area.

The survey was conducted using the same questionnaire developed specifically for this purpose, which was used during the survey of the Upper Rioni Pilot Watershed Area (See Annex 1).

This questionnaire consists of 6 parts:

1. Household demographics (8 questions);
2. Energy sources used by household (20 questions);
3. Building characteristics occupied by the household (5 questions);
4. Building envelope structure (22 questions);
5. Heating/air conditioning systems (21 questions);
6. Energy expenditures (10 questions).

The Dedoplistskaro household energy consumption patterns are similar to or closely resemble those observed in the Upper Rioni and Alazani Pilot Watershed Areas. This is to some extent defined by the fact that all five municipalities are located in the same building-climatic zones.[24] That means that there are rather similar demands with regards to energy consumption (especially for heating), but also due to mainly similar cultural traditions and lack of relatively affordable efficient heaters, as well as the general low income levels. People continue to heat with traditional and inefficient energy-consuming wood stoves, despite the fact that the Lower Alazani-Iori Pilot Watershed Area has very little wood resources. As a result, the amount of energy provided by burning wood virtually outranks all other kinds of energy used, creating rather similar energy consumption patterns for all the watersheds. Still there are some observed differences, stemming mainly from the fact that here there are more households which have access to natural gas. There are even a few poor households that shifted to natural gas heating, abandoning more expensive fire wood altogether.

[23]This report uses the same template as in Reports 1 and 2 (and will continue to do this in the remaining report) in order to make it easier to make comparisons between the different watersheds.

[24]See samSeneblonormebi da wesebi, samSenebloklimatologia, snda w pn 01.05-06, oficialurigamocema, saqarTvelosekonomikuriganviTarebissaministro, Tbilisi, 2006, pp. 9-10. Climatic zone is III-B.

Figure 4.1 A rather unusual uninsulated house (Dedoplistskaro town)

A difference from the previous surveys is that this analysis was conducted separately for both urban and rural households in order to define similarities and/or differences in household energy consumption patterns more precisely.

Of all the households surveyed in the municipality, 13 defined themselves as being of middle income and 21 as poor, as follows: urban 12 poor and 7 of middle income; rural 9 poor, and 6 as middle income. In both cases approximately 3/5 of all respondents see themselves as poor. No household ranked themselves as having a high income.

Unlike the Upper Rioni and Upper Alazani Pilot Watershed Areas, there are many households with no permanently employed HH members among the urban population. There are 8 such out of 19 in Dedoplistskaro proper, although only 3 outside it. Of course, there are a couple of households where persons are retired, thus entitled to a pension, i.e., they have a permanent guaranteed monetary income source, but there are also households where there are no pensioners and no one is employed, or with just 1 pensioner per 5 to 6 household members.

The main spheres of employment are in the government sector, private industry and services, as well as agriculture. Here, unlike in the Upper Rioni and Upper Alazani Pilot Watershed Areas, public sector employment does not provide a household middle income status, since for instance a school teacher's monthly salary often does not exceed an old age pension. Interestingly, among the 15 rural households, agriculture employees were reported in only 9 cases, of which only in 3 HHs listed agriculture as their only income source.

Figure 4.2 Private school in the city of Dedoplistskaro. These are typical inefficient traditional wood stoves invariably used both by private households and various organizations.

All households were provided with an intermittent electricity supply and all had individual meters. The level of consumer satisfaction was not as high as in other parts of Kakheti. Out of 19 respondents in the town of Dedoplistskaro, only 2 were completely satisfied; 12 were partly satisfied, and 4 were not satisfied. The poor state of the power supply lines and ensuing frequent power outages were named as reasons for partial satisfaction or complete dissatisfaction. On the contrary, in the rural area, 7 of 15 respondents were completely satisfied, while 8 were partly satisfied.

Urban households consume approximately 110 kWh of electricity per month, although more affluent families use up to 300 kWh/month. 10 out of 18 households consumed less than 100 kWh/month. Households' spending on electric power is about $180 annually, although there are exceptions (in the case of the higher income families), when this may run higher than $ 250 year. One household did not have any electricity supply, which was discontinued by the provider due to accumulated arrears. In rural areas the average household consumed about 75 kWh of electricity per month, with spending of about $ 90 per year.[25]

Unlike in the Upper Rioni and Alazani Pilot Watershed Areas in Dedoplistskaro, natural gas was supplied to 13 out of 19 urban HH (2/3 of all households) and 13 of 15 rural households. The level of monthly consumption was also relatively higher, at about 45 m^3 on average, with corresponding higher annual expenses of $ 165 per household, versus $ 100 in upper Alazani watershed.

[25]The huge difference in payments, which is inconsistent with consumption is caused by the progressive electricity tariff.

Unlike the Upper Rioni and Alazani Pilot Watershed Areas, only 3 urban and 1 rural households were using liquefied gas (LPG) for cooking. Liquid gas costs about $ 1.60 on average per kilogram, which is cheaper than in the other watersheds. Urban households consumed roughly 3 kg LPG per month each, with corresponding annual expenses of $ 55, while the rural household reported spending 8 kg/ month with substantial annual expenses of $ 145. Two urban and one rural household did not use either natural gas or LPG, meaning that they relied on firewood for both cooking and heating.[26]

For the vast majority of all surveyed households, firewood was the main source of energy, and the largest single household expense was related to energy. It is mainly used for heating during the winter period, for at least 6 months per year. Often heating is combined with cooking and in the poorest households it is used for this purpose year round.

Again, as different from the Upper Rioni and Alazani Pilot Watershed Areas there was one urban household, which had a natural gas fired central heating and hot water supply system installed in the whole house; 1 urban and 3 rural households used wall mounted natural gas space heaters; 2 urban and 1 rural household used homemade natural gas heaters, 2 more urban and 1 rural household used electric space heaters as supplementary; 6 urban and 3 rural households had natural gas water heaters; and 1 rural household had an electric water heater in the bathroom. One rural household simultaneously used a wall mounted gas heater, electric space heater, wood stove for heating, plus an electric water boiler in the bathroom.

Still 17 urban households used firewood as well as 14 rural households.[27] On the other hand there were three households (2 urban, one rural), which did not use firewood at all, which is different from the other previously studied watersheds.[28]

Urban households spent about$ 230 per year for firewood, while rural households spent $ 280 on average. For both urban and rural households the cost of firewood was about $ 30 per m^3, which is considerably cheaper than in the Upper Rioni and Alazani Pilot Watershed Areas. Rural households reported using 10 m^3 on average per heating season, while urban households used 8 m^3 per year on average.

All respondents, both poor and affluent, characterized firewood as very expensive and difficult to access. Still these difficulties were different from those of Racha and other parts of Kakheti. Unlike these areas, Dedoplistskaro produces close to none of its own firewood. During the height of the heating season (January), the price for 1 m^3 may reach $ 50-60, which is well beyond the reach of most households. As a result, almost without exception, respondents said that they start ”hunting” for firewood at the end of the heating season, when plenty of people try to get rid of any leftover wood (this is often caused by a desperate need for cash, which is in short supply during the springtime for families with predominantly agricultural employment). At the end of the heating season wood can be bought cheaply.

[26]One of these did not have electricity supply as well.
[27]Three households managed to obtain firewood through their own logging, which is pretty unusual for this municipality, which is mainly devoid of forest.
[28]One of the urban households had a natural gas space heating and hot water supply system installed shortly before the SDAP team interviewed them, thus they reported as having a firewood stove as well.

All three households using homemade gas heaters consider themselves poor, which is plausible considering their size and composition. Of these, two had 6 members each and there were 5 people in the remaining HH. There were 2 children under 16 in each of these households, and just one permanently employed resident per household. There was 1 retired person (i.e., with some permanent guaranteed monetary income of about $ 60 per month) in two households. As for the employed persons, they were represented by a cook, farmer, and self-employed physician. Their share of energy related HH expenses was as high as in the other poor households, which was in the range of 60-70% of total expenses. Thus the upside of using natural gas for heating for poorer households was that they did not have to spend time and energy on purchasing firewood, nor did they have to pay a substantial sum of money up front. The downside of this situation is that homemade heaters are dangerous, and not all are more efficient than firewood heaters, although the gas heaters do not need constant supervising.

Here as well as almost anywhere in Georgia, during winter people vacate all rooms in the house, save one or two heated rooms (rarely more), in which a wood stove is used (or some instances here a gas heater). They live in this heated area, often cook, and sometimes (depending on the size and composition of a family) they retire to other unheated rooms during the night under heavy blankets, or sometimes not.[29] This was as stated by the majority of respondents in Kakheti (Dedoplistskaro included), irrespective of their income and social status. All households use heating only during the daytime (natural gas heating included). This is also the same as was found in Racha and other parts of Kakheti.

Questionnaire- *Do existing heating systems create comfortable conditions?* Just 3 urban respondents answered – Yes, Always; 7 said that it creates comfortable conditions from time to time; and 9 (i.e. almost half) said that they are dissatisfied. Contrary to this, 7 rural respondents (i.e. almost half) answered that heating always created comfortable conditions, 5 answered from time to time, and 3 were dissatisfied.

Total or partial dissatisfaction from heating was primarily ascribed either to poor insulation of buildings or inefficient heating implements, or both. Considering that almost all households use the same kind of heating and live in similar houses, the above answers, which mirror each other in the urban and rural population, can be mostly ascribed to a subjective perception of the situation, rather than to the actual differences between urban and rural areas.

Questionnaire- *Are heating expenses justified from a household budget expenditures point of view?* Only 2 urban households said no, and 4 said yes. For the remaining 13 these expenditures were only partly justified mainly because they were able to heat only rather restricted parts of their homes. Among rural respondents 6 consider such expenses justified and for the remaining 9 – partly justified.

Only two households intentionally replaced some of their incandescent lamps with modern fluorescent ones and thus were interested in energy efficiency. In all other cases people live under self-enforced energy saving conditions. They simply switch off lights throughout the house, save for a single room, where they use old incandescent bulbs. No household had an air conditioner. Unlike upper Alazani watershed, where 20 households had various models of electric water heaters in

[29]Sometimes people simply live in their kitchens in the winter.

their bathrooms, there was only one such unit in Dedoplistskaro, probably because more households use a natural gas supply.

Questionnaire- *What part of the household annual budget do you spend on energy?* Among 19 urban households, 4 answered 40% or less; 5 answered 50%; 4 answered 60%; and 6 answered 70% or more. Among 15 rural households, 3 answered that they spend 40% or less, 2 answered 50%, 4 answered 60%, and 6 answered 70% or more. When a household reports that more than 70% of their annual budget is spent on energy (especially when they report spending 90% of their budget on energy) this may be exaggerated, although there are cases when such reporting could be justified. For instance in the town of Dedoplistskaro there is a household consisting of 2 unemployed persons, spending approximately $400 on heating, or 90% of their budget, which might be plausible for subsistence economy, where in-kind production and consumption is simply not quantified. A rural household consisting of 6 persons, with just one permanently employed in agriculture (no pensioners) claims to have spent approximately 90% (as reported) of their *monetary income* on energy.

However, in many cases such high numbers are definitely exaggerated, especially when there is a retired person in the household with a guaranteed annual monetary income of $ 700. According to simple calculations, they spend about 50-60% of this sum on energy. All in all both urban and rural households in this watershed may spend on average 50 to 60% of their annual *monetary income* on energy, which appears to be at an unsustainably high level.

In the Upper Alazani Pilot Watershed Area almost half of respondents (24 of 49) answered, that they spend 40% and less, 13 respondents answered – 50%, and 13 more than 50%: four answered 60%, nine 70% and more. I n Racha, of the total 25 households, 15 respondents answered about 50%; two as 10%; one as 15%; as and the rest (7) as more than 60%.

Of 19 urban households, only 1 household rated energy expenditures as not a problem; 5 respondents described energy expenses as medium difficulty; 6 HH rated them as very difficult, and 6 HH as unendurable. Among the rural households again there was just one that rated energy expenditures as posing no problem; 4 considered them as medium difficulty; 3 as difficult; and 7 as unendurable. Again here twice as many people considered such expenses 'difficult to unendurable' than those for whom such expenses posed 'no to medium' problems.

In the Upper Alazani Pilot Watershed Area only nine households rated energy expenditures as not a problem; 18 respondents described energy expenses as medium difficulty; 15 HH rated as very difficult; and 8 HH as unendurable.

The type and state of housing, which these people occupy also plays an important role from an energy consumption point of view. As was demonstrated above, heating is the main consumer of energy for any given household, and its efficiency was to a large extent reduced due to poor home insulation.

By heating premises only during the day-time, homeowners simply create a situation of expensive discomfort. In the town of Dedoplistskaro, in 14 cases out of 19 families used heating for only 1 or 2 rooms with an average area of 35-60 m^2; in three cases there were 3 heated rooms; and in 1 case the family heated 4 rooms with a total area of 80 m^2. In 14 other cases families were restricted to

less than 40 m^2 area, of which in 6 homes they heated less than 20 m^2. In rural areas out of 15 HH 12 heated 1-2 rooms with an average area of 40 m^2 and less (in 6 cases 20 m^2 and less). In one case 4 rooms were heated and in 2 cases – 5 rooms. In all cases when more than 3 rooms were heated, it was provided by a combination of a gas heater with an electric space heater and wood stove as well (although the latter was definitely not often used judging by the amount of wood consumed).

Most houses are built from common cement blocks or stone, which are characterized by heavy heat losses. It is very difficult to provide comfortable conditions in such housing, especially using inefficient traditional wood stoves as illustrated in Figure 5.2. In addition, only in two cases were metal-plastic framed windows installed (not throughout the house, but only in parts of it). In other cases, window frames were made of wood with single glazing, again extremely inefficient and characterized by large heat losses. Uninsulated doors are not much better than the windows, only with sturdier frames. Roofs, generally without adequate insulation, are also characterized by heavy heat losses.

A summary of the typical household (HH) survey results is as follows:

An average urban household, which uses firewood, consumes about
~1,301 kWh electric energy per year;
~463 kWh of liquefied gas (LPG) or 3,943 kWh of natural gas (where it is available); and
~14,240 kWh of firewood annually.

Thus, an average total of about 16,004 kWh of energy is consumed annually for a typical household without a natural gas supply, and 19,484 kWh for a HH with a natural gas supply.

Table 4.1 Annual Urban Household Average Energy Expenses

Energy Type	Total kWh Consumed per year	Price per kWh $	Total Expenditures $
Electricity	1,132	0.098[30]	127
Natural Gas - metered[31]	3,943	0.033	130
LPG	463	0.12	56
Firewood – purchased on market[32]	14,240	0.017	242
All energy-			
Households with Natural Gas	19,484	-	499
Households with LPG	16,004	-	425

[30]Weighted average price
[31]Natural gas-observed -3340 kWh or 110 US$ per year. In this case metered and observed results are similar.
[32]There was just one household that logged its own fuelwood.

Figure 4.3 Annual Urban Household Average Energy Consumption (HH with natural gas)

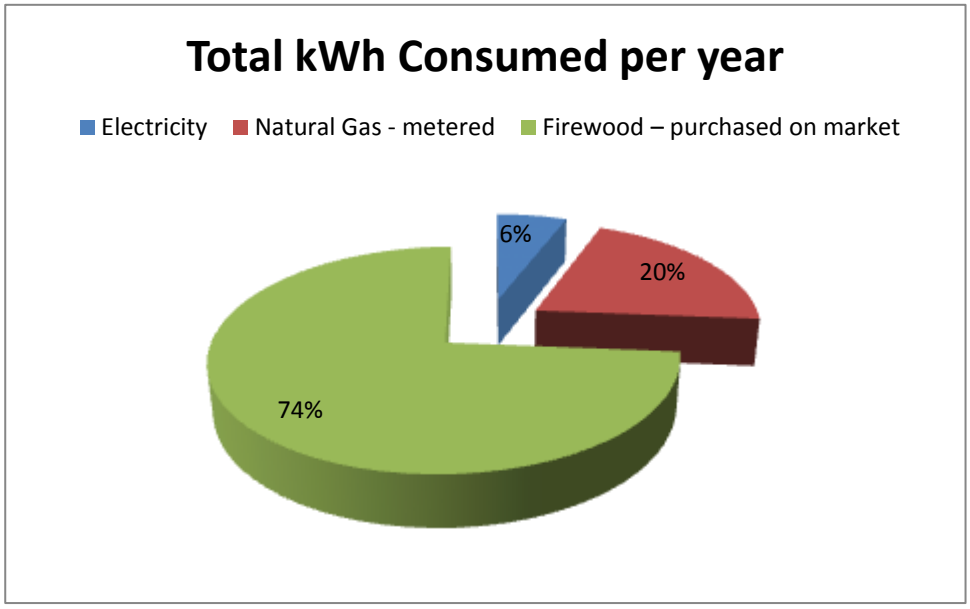
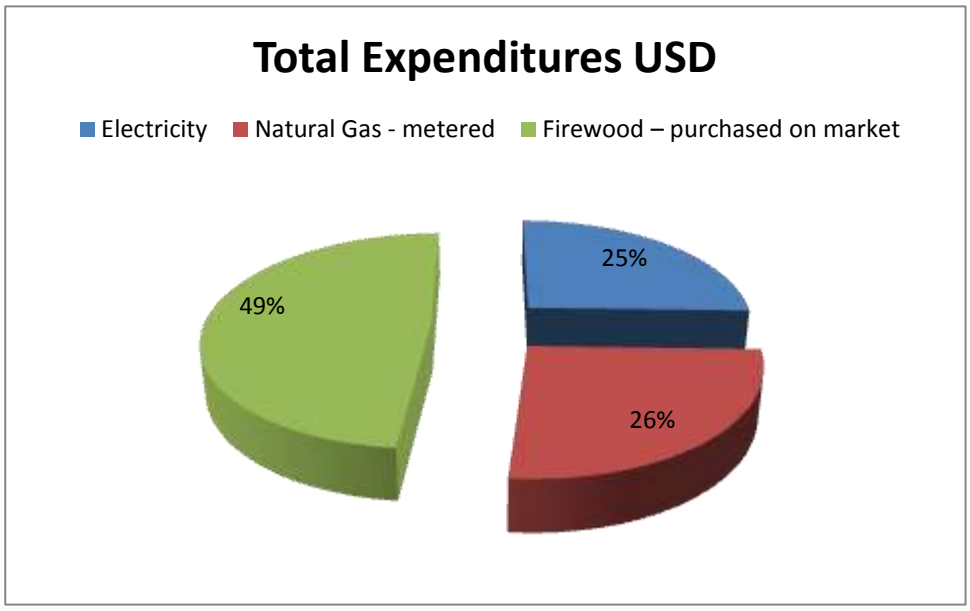


Figure 4.4 Annual Urban Household Average Energy Expenses (HH with natural gas)



We arrived at this data through the following calculations, similar to those used for upper Rioni watershed:

Electric energy – measured in kWh by metering as provided by the local electric energy supply company;

1 m^3 of natural gas supplied to Georgia has about 9.36 kWh on average;

LPG – 1 kg of LPG has12.87 kWh;[33]

The firewood caloric value was calculated for beech firewood, which is the most widespread. Depending on moisture content it varies between 1,672 and 1,888 kWh for m^3 of stacked logs, or 1,780 kWh on average.[34] We used this average since the moisture content of air dried beech logs is not available.

An average rural household consumes about

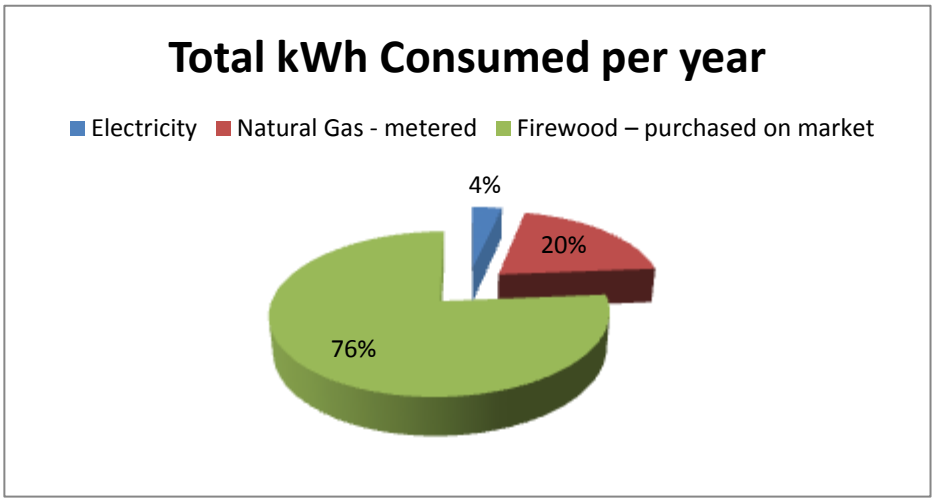
~811 kWh electric energy per year;
~1,235 kWh of liquefied gas (LPG) or 4,711 kWh of natural gas (where it is available);
~17,800 kWh of firewood.

Thus, an average total of about 19,846 kWh of energy is consumed annually for a typical household without a natural gas supply, and 23,322kWh for a HH with a natural gas supply.

Table 4.2 Annual Rural Household Average Energy Consumption and Expenses

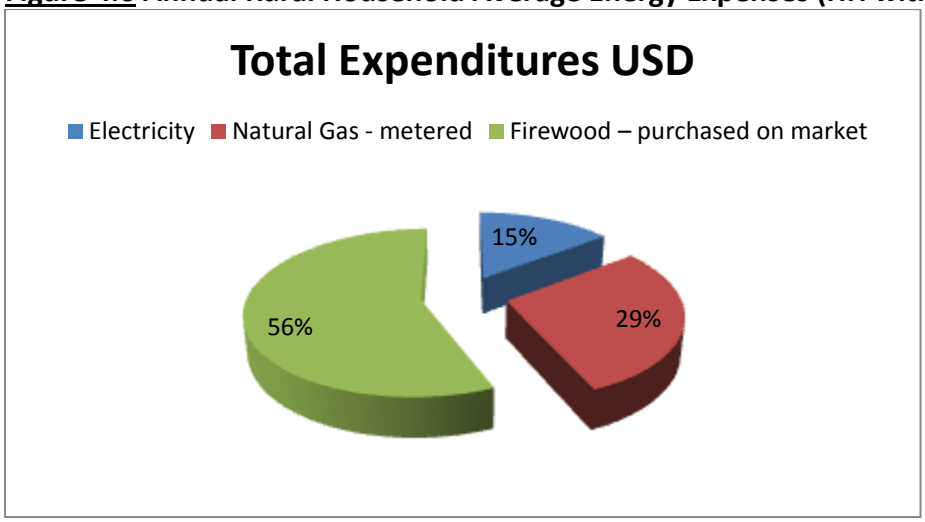
Energy Type	Total kWh Consumed per year	Price per kWh $	Total Expenditures $
Electricity	811	0.098[35]	79
Natural Gas - metered	4,711	0.033	155
LPG	1,235	0.12	148
Firewood – purchased on market[36]	17,800	0.017	303
All energy-			
Households with Natural Gas	23,322	-	537
Household with LPG[37]	19,846	-	530

Figure4.5 Annual Rural Household Average Energy Consumption (HH with natural gas)



[33] http://www.volker-quaschning.de/datserv/faktoren/index_e.php
[34] http://nuke.biomasstradecentres.eu/Portals/0/D2.1.1%20-%20WOOD%20FUELS%20HANDBOOK_BTC_EN.pdf
[35] Weighted average price
[36] There was just one household that logged its ownfuelwood.
[37] There is just one rural HH using LPG.

Figure 4.6 Annual Rural Household Average Energy Expenses (HH with natural gas)



A comparison of urban and rural households' energy consumption shows that while an average rural household consumes just 62% of electricity as consumed by the average urban household, it also consumes 20% more natural gas and 25% more firewood.

Annual average energy expenses were also separately calculated for households, which do not use firewood, but rely only on natural gas for cooking and heating. There were 3 such households with an average annual electricity consumption of 1,733 kWh and natural gas consumption of 11,606 kWh. Thus, an average total of about 13,340 kWh was consumed by such a household, which is considerably less than for households which use firewood. This is 68% of typical urban households with natural gas and firewood, and 57% of typical rural households. On the other hand, such a household spends $ 610 on average on energy per year (minimum $ 350 and maximum – $ 700), which is considerably higher than for other households.

This again highlights the issue of changing from firewood to natural gas for heating purposes. It is obvious that such a move makes no sense if HH uses homemade gas heaters – illegal, inefficient, and hazardous. Such heaters cannot provide any better indoor comfort conditions while being more expensive to use. On the other hand, vented wall mounted gas heaters are able to provide good indoor comfort conditions, need a relatively short time to heat up to a 40-50 m^2 of floor area, are safe and easy to use, and do not need constant supervision. Still such an approach cannot be recommended for poorer HHs, which heat relatively small areas (often less than 20 m^2) and use up to 6 m^3 of firewood during a heating season.

It looks like that for middle income households not changing over to natural gas heating is more of a case of lingering traditions, rather than predominantly financial problem. Such heaters are financially competitive for heating about 40-50 m^2. Using more than one of these appliances is unjustifiably expensive. Using a natural gas wall mounted heater seems to become competitive at about $300-350 annual natural gas related expenses (which includes heating for at least 6 months plus all the year round cooking expenses), which is at least comparable to the average heating expenses in the municipality. Or they might be recommended in a majority of cases for households with a natural gas supply, which are able to spend at least $ 250 per heating season to heat 1-2 rooms.

The average price of such heaters as advertised by the leading Georgian household appliances trade chain "ElitElectonics" is in the range of $ 120-180 depending on capacity (120-150 m^3 of heated space) and the manufacturer.[38] These appliances could also be purchased at a 0% interest rate credit offered for instance by Liberty Bank at the time of writing this report.[39]

Table 4.3 Annual Urban Household Average Energy Expenses

Energy Type	Total kWh Consumed per year	Price per kWh US$	Total Expenditures US$
Electricity	1,132	0.098[40]	111
Natural Gas - metered[41]	5,181	0.033	170
LPG	875	0.12	148
Firewood – purchased on market[42]	16,020	0.017	303
All energy-			
Households with Natural Gas	22,333	-	584
Household with LPG[43]	18,027	-	562

In general terms, household energy consumption in the Lower Alazani-Iori Pilot Watershed Area is to a large extent similar to consumption in the Upper Rioni and Alazani Pilot Watershed Areas, despite the noticeable natural-geographical and socio-economic differences. Here again, the lion's share of energy consumption is for firewood, used primarily for heating. Unlike the former watersheds, the share of households with a natural gas supply is rather high (about 3/4 of surveyed households). People predominantly use firewood for heating, despite the fact that it cannot provide comfortable conditions due to inefficient woodstoves and a lack of home insulation. The typical household with natural gas still spends 73% of all consumed energy on firewood, while in households with LPG this share increases to nearly 9/10 of all energy (89%). If using an excessive amount of firewood for heating in other watersheds is justifiable by the fact that these regions have abundant wood resources, observing the same pattern in Watershed 3, where such firewood is much more scarce, does not seem judicious.

Due to the huge price differential, households with natural gas consume approximately 7 times more energy provided by this fuel as compared to those with LPG, and still spend just 1.15 times more money than the latter. Here again, as in the Upper Rioni and Alazani Pilot Watershed Areas, it is a clearly observed pattern of HH behavior – heating is of the highest priority and lighting and other amenities provided by electricity are obviously sacrificed in order to provide some measure of indoor comfort through heating.

[38] See: http://www.ee.ge/index.php?m=268&cat_id=1194
[39] http://ee.ge/uploads/bank/liberty.pdf
[40] Weighted average price
[41] Natural gas-observed -3340 kWh or 110 US$ per year. In this case metered and observed results are similar.
[42] There was just one household that logged its ownfuelwood.
[43] There is just one rural HH using LPG.

Table 4.4 Comparative household energy consumption in the Upper Alazani and Lower Alazani-Iori Pilot Watershed Areas

Energy Type	Upper Alazani Watershed		Lower Alazani Watershed	
	Total kWh Consumed per year	Total Expenditures $	Total kWh Consumed per year	Total Expenditures $
Electricity	1,513	142	1,132	111
Natural Gas - metered	3,511	116	5,181	170
LPG	888	151	875	148
Firewood – purchased on market[44]	17,444	366	16,020	303
All energy				
Households with Natural Gas	22,297	618	22,333	584
Households with LPG	19,845	659	18,027	562

[44]There was just one household that logged its own fuelwood, but still reported that it cost them as much as the firewood purchased on the market. These people are so poor that they do not even use LPG for cooking. As a result firewood accounts for up to 95% of their energy consumption, the rest is provided by electricity.

Figure 4.7 Side by side comparison of typical household consumption by type of energy consumed in Upper Alazani and Lower Alazani-Iori Pilot Watershed Areas (for households with natural gas)

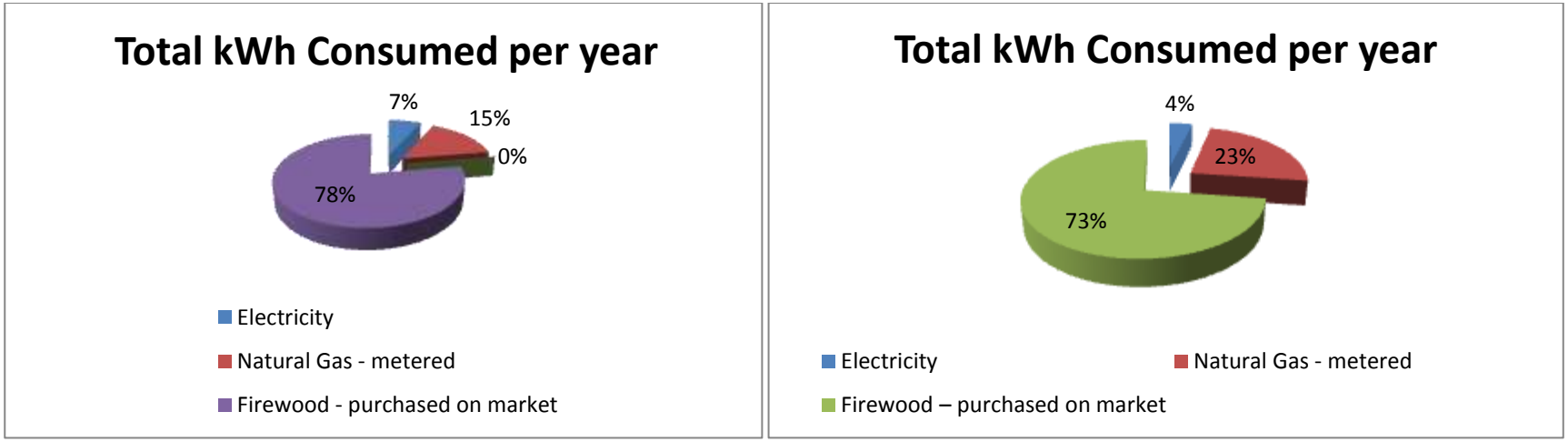


Figure 4.8 Side by side comparison of typical household expenditures by type of energy consumed in Upper Alazani and Lower Alazani-Iori Pilot Watershed Areas (for households with natural gas)

5. Local Government and the Energy Sector

As was mentioned in the previous report on the upper Alazani watershed, there is no apparent legal framework for cooperation between local governments and the energy sector. Since the Dedoplistskaro municipality is part of the same Kakheti region as Telavi and Akhmeta, it operates on the same template as these latter municipalities. The single most important item of cooperation between the municipal governments with the energy service companies is energy (primarily electricity), which is provided to the various municipal bodies and organizations.

As was already mentioned this watershed differs from others with the presence of petroleum resources on its territory. This brings about an interesting question, whether to consider these resources and extracted petroleum as part of the Lower Alazani-Iori Pilot Watershed Area energy balance? Although Frontera Georgia, operating here hires some local staff, in all other respects it enjoys territorial independence and has no direct or other contacts with the local administration. The municipality does not even have a contact phone number of any Frontera representative. Moreover, Frontera and petroleum resources are not mentioned in the Dedoplistskaro municipality infrastructure development program. Based on the Law of Local Self-Government (2304-rs 2005-12-16), each municipality benefits from private business through the introduction of local taxes, dues, and fees. Still it cannot tax the exploitation of natural resources, which is administered by the Ministry of Energy and Natural Resources (see law on dues and fees, სსმ, 41, 30/12/2004).

In this report, as in the previous one, it was attempted to follow the energy consumption patterns by municipal facilities. There were 29 facilities by the end of 2011 (municipal administration and village communities' administration buildings as well as other facilities) as reported by the local authorities. All of these were supplied by electricity (but 18 did not have individual meters). Only a Municipal administration and army recruiting center and emergency service (fire brigade and emergency medical care) buildings had natural gas supply, obviously used only for heating, since there is no consumption reported in summer. Of these the municipality administration was the largest consumer, accounting for up to 70% of all natural gas consumed.[45]

Village community administrations consumed very little electricity, sometimes less than 20 to even less than 10 kWh/month (at least as formally reported). Some did not even report any electricity use during the summer with long days. Three of these do not even use fuel wood, meaning that they are not heated at all, raising the question – how do they function in winter?[46]

The Dedoplistaskaro Culture and Sports Center pulls together 20 cultural facilities (centers of culture, libraries, museums) and a sports hall. Of these, 15 did not have individual electricity meters. Only the Culture Center in Dedoplistskaro and Sports Hall had a natural gas supply, but the latter has been discontinued since April 2011. Seventeen museums, libraries and local cultural centers were invariably heated with firewood, provided by 1.6 m^3 of firewood each per year, which appears to be the universal standard for Dedoplistskaro municipality. Considering that the average household consumes about 9 m^3 of firewood per year; this amount is hardly

[45]It is not possible to define its share in electricity consumption since many facilities do not have individual meters.
[46]Although judging by the amount of electricity consumed they can hardly function except during daylight in warm weather.

enough to provide any kind of comfortable conditions for these facilities, both for visitors and personnel.

There were also 16 kindergartens as well as an educational center and a youth house united under the umbrella of a separate legal entity, as found elsewhere in Georgia, although they belong to the municipality. Of these, 15 did not have individual electric meters. Of the remaining 3, there were 2 kindergartens, of which one is reported to consume 60-70 kWh per month on average. All kindergartens used firewood for heating and cooking, although all of them consumed less than 10 m^3 annually. Just two kindergartens were supplied by natural gas, but one of these reportedly consumed just 5 to 17 m^3 per month.

Judging by the above numbers, almost no local municipal facility (with the exception of the municipal building and military and emergency services) is able to provide adequate comfort and working conditions both for their personnel and visitors (which is especially important in the case of kindergartens).

Conclusions and Recommendations

Not surprisingly, basic conclusions derived from the two previous reports on the Upper Rioni and Upper Alazani Pilot Watershed Areas may be applied without much alteration to the Lower Alazani-IoriPilot Watershed Area as well. This is what in the previous reports defined as a *demand side problem* of the energy sector. The most important is that despite the obvious differences between Watersheds (geographical, socio-economic, etc.), the structure and volume of the households' energy consumption, as well as population behavior and preferences, are identical.

In all three cases the baseline of energy consumption is determined by *climatic factors*, which define the length of the heating season, as well as the amount of energy necessary for heating depending on the severity of any particular winter.

The main problem, which emerges for all three watersheds considered thus far, is that people heavily overpay for incessant heating during a half-year long heating season due to poor efficiency wood stoves and a lack of home insulation.

The Lower Alazani-Iori Pilot Watershed Area still considerably differs from the Upper Rioni and Alazani Pilot Watershed Areas since as it does not possess any significant wood resources. The allocation of logging quotas for the Dedoplistskaro municipality may be considered as an administrative anomaly, rather than as a result of balanced decision-making. Moreover, the territory of the Lower Alazani-Iori Pilot Watershed Area is well known as a hotbed for modern desertification in for the region. This process is entirely man-made, thus raising further questions about the feasibility of any kind of exploitation of wood resources in this area.

In addition, almost all firewood available on the local market is of a rather doubtful origin (as elsewhere in Georgia), casting further doubts on the feasibility of its application to heating (and sometimes cooking) purposes in this Watershed.

Recommendations developed for the Upper Alazani and Rioni Pilot Watershed Areas are applicable to the Lower Alazani-Iori Pilot Watershed Area as well. These are:

- First, organize an **educational campaign** aimed at familiarizing the local population with the most elementary energy saving and energy efficiency measures, which almost every household can implement independently, including trainings for local population on building energy efficiency issues;
- Second, develop "simple"/low cost energy efficient **weatherization measures** for low income rural population;
- Third develop a **weatherization service center** unit for implementation of the above measures in housing;
- Fourth, set up small **woodstove fabrication workshops** in the region for making energy efficient wood stoves to be sold to the local population. Such efficient wood stoves reduce firewood needs by 1.5-2 times and would create local cash paying jobs. The additional positive effect of the implementation of this measure will be a reduction of fuel logging with associated environmental benefits. This measure also will contribute to safety issues as well as to the improvement of the indoor comfort conditions.
- Fifth carry out **woodstove testing** procedures of the energy efficient wood stoves aimed at establishing wood stove certification unit as a strategic goal.
- Sixth, undertake an **inventory of public buildings** within each pilot watershed with corresponding energy audits of select public buildings
- Seventh, **organize trainings** for the municipality staff in order to raise awareness on the energy efficiency issues for proper decision making.

The following can be suggestions are in addition to the above recommendations in order to further improve the present situation:

First – for relatively well-to-do HH with natural gas supply (i.e., for people who are able to pay some $ 350 and more for all natural gas use related expenses per year) – to shift to wall mounted gas heaters.[47] Local administration and INRMW can work hand-in-hand to select households that may be advised to make a shift from firewood to natural gas heating. The administration then may apply to one of the leading local dealers in household appliances for the development of a special credit line for such households (including free of charge installations), organize purchases and installation of heaters.

Second – the same consideration may be applied to households which have to use firewood in the absence of natural gas supply. Continuing the use of existing extremely inefficient woodstoves is hardly tolerable based both on economic and ecological considerations. On the other hand, efficient wood stoves are not as readily available for sale in the local market, as gas heaters. Nor are there any credit schemes available for customers. Nevertheless, INRMW and municipal administration may organize at least one demonstration project involving the following:

- Select qualified (i.e., financially solvent) households for the project;

[47] In the absence of central heating, such heaters, with ventilation outlets leading outside the heated area, are the best heating implements for use in Georgia.

- Purchase a batch of efficient wood stoves from a reliable supplier at prices comparable with wall mounted gas heaters; and

- Establish a special **credit line for the purchase** of such woodstoves at local banks, which offer credit support for customers purchasing gas heaters.

The downside o**f this proposal is that it ca**n be applied only to a HH with a guaranteed permanent monetary income. Such income is relatively restricted in this predominantly agricultural region, where pensioners (as elsewhere in Georgia) often are the only persons with such an income in large households. Besides it cannot be applied to poorer households.

Third- to develop a weatherization service center unit for implementation of the above measures in housing for follow up by the local government;

Of course, it is assumed that all of the above should go hand-in-hand with simple weatherization measures; otherwise the effect of installing more efficient heating equipment will be considerably reduced.

As to off grid alternative energy solutions, recommending construction of off-grid HHPs, is definitely not applicable to Dedoplistskaro considering that it does not possess enough hydro resources. Other kinds of renewable energy, namely solar, biogas and wood pellets may be considered, when appropriate.

Wood pellets. Such pellets are relatively more efficient as a fuel source than the log wood (stacked-air dry), which is universally used in Georgia. 1 m^3 of such pellets contains 3,100 kWh of energy,[48] while we operate with energy density by volume of 1,780 kWh on average for watersheds under consideration. I.e. formally the use of wood pellets is 1.74 times more efficient than the use of conventional firewood in Georgia. The problem is that pellets are not by definition an independent product, but rather the byproduct of the woodworking industry. Only in the case of large scale production may such pellets become competitive with conventional firewood. A relatively developed woodworking industry is altogether absent in Georgia, thus there is no appropriate economically viable pellet production as well. Small scale pellet production turns out to be very expensive produced at a price of approximately $ 120 per m^3. This transfers into $ 0.039 per 1 kWh, while on average in all 4 pilot watersheds price of 1 kWh of firewood is $ 0,016 - or 2.4 times less. Accordingly replacement of firewood by wood pallets under the current Georgian conditions can hardly be recommended based on the most elementary cost-benefit considerations. Besides pellets require specialized stoves of a different kind, which are very expensive by Georgian standards (and not supplied in this country). The US consumer guides or specialized shops' advertisements for instance, put retail prices of such stoves at $ 1,100 minimum, and $ 1,400-3,000 on average.[49]On the other hand, we may recommend for consideration of briquetting hazelnut shells, which are produced in eastern Georgia as a waste product. This may represent a viable alternative to wood pellets, at least in hazelnut producing areas.

Solar energy: The price of a standard (2 m^2) solar panel on the Georgian market (installation included) is approximately$ 1,000-1,400, depending on the producer, size, and panel model.

[48] http://www.biomassenergycentre.org.uk/portal/page?_pageid=75,20041&_dad=portal&_schema=PORTAL

[49] see for example http://www.woodpelletstoves.net/buying.html, http://www.homedepot.com/webapp/catalog/servlet/ContentView?pn=KH_BG_HF_Wood_Pellet_Stoves, see chapter 4 of this report.

This is typically for a solar evacuated tube collector that provides about 2,000 kWh of energy per year under average Georgian conditions. This is more than enough to supply hot water to the majority of households in any watershed under consideration, although installation of such panels for any particular site calls for specific calculations depending on family size. Still the initial capital price is the main issue, which definitely cannot be afforded by a majority of local households without outside financing terms assistance. Thus we recommend such panels initially for public buildings such as kindergartens and sports schools, which have problems with providing basic energy services. It is easier to provide financing to a relatively small number of such institutions through the central government channels and/or some donor organizations than for private homes.

Biogas: The price of a standard biodigester (mark BGD-6) on the Georgian market is approximately $ 2,230 (including installation). It is even more expensive in areas with relatively cold winters where additional insulation is necessary to avoid freezing of digester contents. This is pretty expensive for the vast majority of people interviewed during the SDAP field visit. They cannot even afford the most readily available wall mounted gas heaters or efficient wood stoves, which are an order of magnitude less in cost. Such gas can only be used for cooking, but not for heating although the heating is universally the part of HH energy consumption, which requires the most energy and thus expense. Thus, such biodigesters can be recommended but only with reservations. There remains the issue of financing installation for biodigesters, which is clearly beyond the reach of almost any private household and calls for special financing schemes.

Annex 1: Household Energy Consumption Questionnaire

Household Energy Consumption Questionnaire

1. The basic information about household

- Settlement ----------
- Number of household members (residing permanently) ----------
- Age of household members (0-15, 16-64, 65 or older, gender) ----------
- Among them permanently employed ----------
- Sphere of employment ----------

  _____
- Income category (poor, medium income, high income, does not have answer)
- Do they have a car? Yes/No
- If they have, the amount of fuel used per month (liters) ----------

2. Basic information about sources of energy

Electricity, Yes/No

- If yes, is there an electricity supply meter? Yes/No
- If yes, what kind of meter is it? – Individual/Common
- How much electricity do they use per month? (kWh) ----------
- Are they satisfied with energy company service? – Satisfied, Partly satisfied, Not satisfied
- Reason of dissatisfaction – power cuts, quality of electricity, service of company personnel, other reason (indicate) ----------

  ----
- Natural Gas Yes/No
- If yes, is there a gas supply meter? Yes/No
- How much natural gas do they use per month? (cubic meters) ----------
- Are they satisfied by Natural Gas company service? – Satisfied, Partly satisfied, Not satisfied
- Reason of dissatisfaction – supply cuts, quality of natural gas, service of company personnel, other reason (indicate) ----------

  ----
- Firewood, Yes/No
- How much firewood do they use per month? (cubic meters) ----------

- What is the source of the firewood? – own logging, purchase on the market, other (indicate) ----------
- Is firewood easily accessible? – Easily accessible, Quite hard, Very hard
- Reason of dissatisfaction ----------
- Liquid Gas Yes/No
- How much liquid gas do they use per month? (cubic meters) ----------
- Other liquid fuels Yes/No
- How much liquid fuel do they use per month? (liters) ----------

3. Basic information about building

- Year of construction ----------
- Year of reconstruction/repair ----------
- What kind of building blueprints can be found? (facade, floors, cross-section)----------
- What kind of building systems' blueprints can be found? (Heating systems and etc.) ----------
- Which system's technical description and documentation can be found? ----------

4. Data on building structure

- Number of floors ----------
- Floor height (m) ----------
- The total floor area (m^2) ----------
- The total volume (m^3) ----------
- Perimeter of the floor (m) ----------

4.1. External walls

1. General condition of the walls - Bad, Acceptable, Good
2. The total area of external walls (m^2) ----------
3. Wall construction – Basement, Half-basement – Brick, Concrete, Cement Block, Stone, Wood, Other (indicate) ----------
4. Wall construction – Ground floor – Brick, Concrete, Cement Block, Stone, Wood, Other (indicate) ----------
5. Wall construction – Second floor – Brick, Concrete, Cement Block, Stone, Wood, Other (indicate) ----------
6. Facade wall orientation – North, North-East, East, South-East, South, South-West, West, North-West.

4.2. Windows

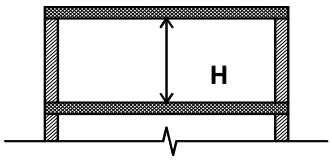
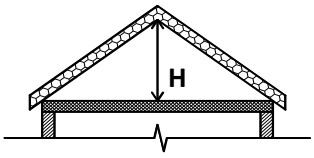
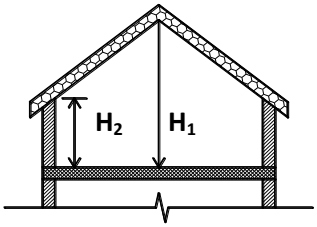
1. General condition of windows - Bad, Acceptable, Good
2. The total area of windows (m^2) ----------
3. Window material – Wood, Aluminum, Metal-Plastic, Other (indicate) ----------
   ----
4. Type of window frame – Single frame, Double frame, Other (indicate) ----------
   ----
5. Glazing type – Single, Double, Triple

4.3. Doors

1. General condition of doors - Bad, Acceptable, Good
2. Total area of doors (m^2) ----------
3. Door material – Wood, Aluminum, Metal-Plastic, Other (indicate) ----------
   ----
4. Type of doorframe – Single frame, Double frame, Other (indicate) ----------
   ----
5. Glazing type – Single, Double, Triple

4.4. Roof

- General condition of roof - Bad, Acceptable, Good
- Total area of roof (m^2) ----------

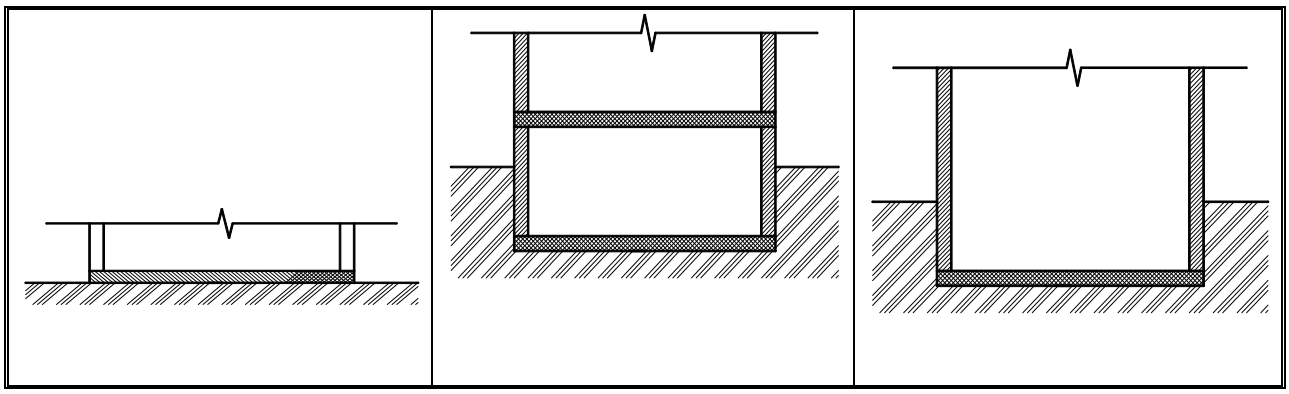
Roof type RF1	Attic, Roof Type 2 RF2	Attic, Roof Type RF3	Attic, Roof Type RF4
Roof on a top of heated area			
Attic height m			H_1 ____ H_2 ____

- Roof material ----------

4.5. Floor

1. General condition of floor – Bad, Acceptable, Good
2. The total area of floor (m^2) ----------
3. Floor material ----------

Floor type 1 Floor on ground	Floor type 2 Unheated basement	Floor type 3 Heated basement



5. Heating/Air Conditioning Systems

5.1. System Type – Water heating system, individual oven, electric heater, electric air conditioner, other (indicate) ----------

5.2. Energy sources – Natural gas, Electricity, Liquid gas, Other liquid fuel, Firewood, Coal, Other (indicate) ----------

5.3. Heat systems – Radiator (number), Wood oven (number), Gas oven (number, power output), Electric radiator (number, power output, kW), Electric conditioner (number, power output, kW), Other (indicate) ----------

5.4. What part of home is heated? – Number of rooms, area (m^2), floor, other (indicate) ----------

5.5. How long the building is heated during year? (Months or days) ----------

5.6. How often do they use heating – Every day, Several days per week, From time to time, Other (indicate) ----------

5.7. How do they use heating during the day – All day long, only daytime, several hours a day, other (indicate) ----------

5.8. Do existing heating systems create comfortable conditions? – Yes all the time, From time to time, No

5.9. If the answer is no, what you think is the reason of this? – Ineffectiveness of heating systems, Poor insulation of building, Expensive heating systems, Difficult access to fuel, other (indicate) ----------

5.10. Are heating expenses justified from the household budget expenditures point of view? Yes, No, Partly

5.11. If the answer is no, what is the reason? ----------

5.12. Air Conditioning systems – Yes/No

5.13. If the answer is yes, then what type of air conditioning systems are used? – Split system (number, power output, kW), window air conditioner (number, power output, kW), Electric ventilator (number, power output, kW), Other (indicate) ----------

5.14. Do they have hot water heaters? – Yes/No

5.15. If the answer is yes, then what kind of heaters do they have? – Connected to heating system, Natural gas boiler (number, power output), Electric boiler (tank, number, capacity, power), "Atmor" type (number, power), Liquid fuel boiler (type, number, power), Coal or wood fired boiler (number, power), Solar Collector (number, power), Other (indicate) ----------

5.16. Lighting system. Type of bulbs (Traditional incandescent bulbs, energy efficient) total quantity, power kW ----------

5.17. What part of home do they use lighting during evening – One room, Two rooms, Room and Storage and etc. (indicate) ----------

5.18. Do they purposely save electricity? Yes/No

5.19. If the answer is yes, then what method do they use? (Indicate) ----------

5.20. Do they know, what the term "Energy Efficiency" means? Yes/No

5.21. If the answer is yes, then what do they think it means? (Indicate) ----------

6. Energy expenditures

1. How much electricity do they use, how much do they spend on electricity during a year? (If there is an individual meter, please try to get answers from official energy company bills) ----------

2. How much natural gas do they use, how much do they spend on natural gas during a year? (If there is an individual meter, please try to get answers from official energy company bills) ----------

3. How much liquid gas do they use, how much do they spend on liquid gas during a year? ---

4. How much firewood do they use, how much do they spend on firewood during a year? ---

5. How much liquid fuel do they use, how much do they spend on liquid fuel during a year? ---

6. How much other fuel do they use, how much do they spend on other fuel during a year? ---

7. What part of the household annual budget do they spend on energy? ---

8. Do these expenditures create financial problems for them? – Yes/No

9. If the answer is yes, please describe this problems, as - Unimportant, Medium Difficulty, Very Difficult, Unendurable

10. How do you think, what is the reason of these problems? – Expensive energy, Non-effective service, Discrepancy between price and quality of service, Low income, Other (describe) ---

Annex 2: Simplified Energy Balance

This is an approximate draft version for a simplified Energy Balance downsized to the level of a Georgian municipality. It is drawn primarily to check what can and should be done as a basis for developing an Energy Passport. All data provided here refers to the Lower Alazani-Iori Pilot Watershed Area for the Dedoplistskaro municipality.

Energy Resources:

Mineral Fuel – Petroleum, OOIP equal 560,642GWh[50]

Hydro resources – not suitable for commercial small HHP development

Wind – unknown, no actual data available

Solar – >100 million GWh annually[51]

Biogas – no data

Fuel wood – no data available

Energy supply:

Local production:

Mineral Fuel – 10.7 thousand ton in 2011 or 125.4 GWh

Hydro – no

Wind – no

Solar – unknown, no data

Biogas – unknown, no data

Fuel wood – 4.1 GW/h app.

Import:

Electricity – no data

Natural gas – 7,839,420 m^3; 73. 377 m kWh app.[52]

Export – no

End use consumption:

Residential buildings: electricity 7.46 GW/h; natural gas/LPG – 16.0GWh app.; firewood – 730 GWh app.

Industry and Commercial buildings – electricity – 7.36 GW/h; natural gas/LPG – 2.2GWhapprox.; firewood – n/a, liquid fuel – n/a

[50]All data referring to oil energy content is very approximate.
[51]Considering this surface as horizontal
[52]Calorific value of 1000 m^3 of natural gas used in Georgia is assumed to be 9360 kWh

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