Energy Analysis of Upper Alazani Pilot Watershed Area (Akhmeta and Telavi Municipalities, Kakheti Region)

Republic of Georgia

Technical Report Number 23

Integrated Natural Resources Management in the Republic of Georgia Program

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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 analysis presented below was produced within the framework of the Integrated Natural Resources Management in Watersheds of Georgia (INRMW) Program. It deals with the upper Alazani pilot watershed –covering Akhmeta and Telavi municipalities, as selected by the INRMW project in 2011. This analysis is the second one from 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 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 tasks the DAP Center for producing a report on Energy Analysis of Upper Alazani Pilot Watershed Area.

More broadly SDAP Center activities call for undertaking this Watershed Energy Analysis in order to identify energy consumption, energy production, and energy resources in the two pilot watersheds. The study also is used to identify potential energy options, and to provide the necessary data for the subsequent preparation of watershed energy passports documenting energy inputs and outputs at a watershed level, which will be used by local government agencies and communities in planning for energy-related investments.[1]

The Watershed Energy Analysis goals are as follows:

- Assess local energy resources within 4 pilot watershed areas of 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.

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

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.[2]

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; 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 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 use. 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 the template created and tested during the upper Alazani pilot watershed assessment, although the process of the document development as well as the assessment proper differs in some aspects from the first report.

- *First,* unlike the case of Racha, working conditions in Kakheti allowed for more than one site visit by the SDAP field team.
- *Second,* the SDAP worked in close cooperation with CARE, which resulted in carrying out households’ survey within communities targeted by the latter for intervention.
- *Third,* two new components were added – the analysis of energy consumption by local government offices, as well as a description of the existing procedures of interaction between local governments and energy companies.

It is of importance to note that it was also possible to carry out some limited comparative analysis of household energy consumption practices between the two geographically distant and socio-economically different regions of Racha and Kakheti. This was especially helpful since both are situated in the upstream river basins.

During this study, the boundaries of the watershed for the first time came into did not align with the local municipal boundaries, within whose confines the energy sector is formally functioning and relevant data is provided. This important historical-geographic region in Georgia – Tusheti, which is

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

part of Akhmeta municipality -- is not only situated outside the Alazani River basin, but is also located outside the South Caucasus region as well. In this specific case, discrepancy had no impact on the assessment, since this area has a permanent population of only 112persons and more importantly for this analysis, has no energy supply or production infrastructure and therefore, was not included in the municipal data.[3]Such a boundary conflict will occasionally occur in attempts to fit socio-economic data (and relevant analysis), created and collected within the existing political administrative boundaries, into the natural watershed limits, 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 are similar in some respect to both the upper Rioni and upper Alazani watersheds. Due to the fact that there is no noticeable seasonal population movement in this part of Kakheti as there was in Racha, the electricity consumption patterns between the two watershed areas differ. On the other hand, just like in Racha, there is a heavy dependence on firewood for heating purposes, making fuelwood the single most important energy source for households in Kakheti.

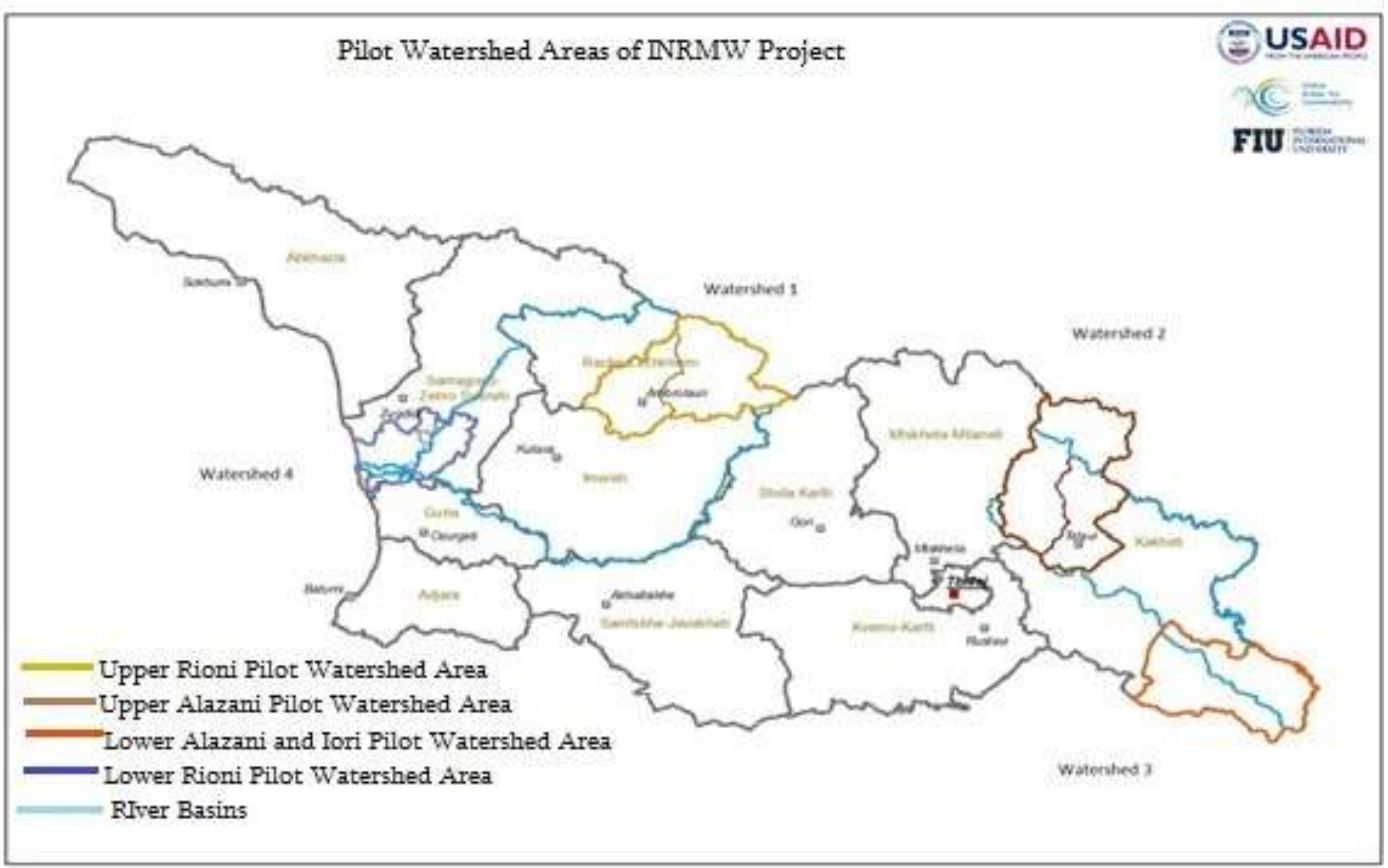
2. Socio-Economic Context

The Upper Alazani Pilot Watershed Area is located in the eastern part of Georgia, in the Kakheti region on the southern slopes of the Caucasus Mountain Range and adjoining lowlands along the Alazani River. While, as in the case of upper Rioni watershed, the watershed and administrative boundaries of Ambrolauri and Oni municipalities virtually coincide, upper Alazani watershed “fills up” (with little exception) the Telavi municipality, but occupies only about half of the Akhmeta municipality. The majority of Akhmeta, known as Tusheti is located not only outside the watershed proper, but also outside the Southern Caucasus as well.

The following figures are maps showing the boundaries of upper Alazani watershed.

[3]Population data is provided by Akhmeta municipality.

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 in Akhmeta is distributed among the town of Akhmeta proper (8,622 persons or 19.8% of total population) and 14 rural communities with 61 villages.[4] Of these villages, 28 have fewer than 100 inhabitants, and some are left with fewer than 50 people each. In Telavi, the municipality has 27.4% of the population concentrated in Telavi proper, with the rest distributed among 22 rural communities consisting of 24 villages, of which only 4 have less than 500 inhabitants. All the other villages have more than 1,000 inhabitants, making them rather large by Georgian standards. Telavi municipality is also rather unusual from the local communities' organizational point of view. Only one community here (Pshaveli) consists of two villages, while in all other cases the community consists of a single settlement. On the contrary, in Akhmeta there is only one case where the community and village are one and the same (Matani, with a population of 5,600). There are also three villages in Akhmeta community, where there are 1-3 persons per village.

In Akhmeta the population density is very low: 19.7 persons per km^2, if one considers the total municipality area including Tusheti. Without Tusheti the population density reaches approximately 41 persons per km^2, more than twice as much. In Telavi the population density is about 66 persons per km^2. The vast majority of the population is concentrated on the right bank of the Alazani River, (especially in Telavi, where only 7 villages are located on the left bank), clustered mainly around Telavi.

Much of this information comes from municipal development strategy documents, although these are not universally available. These were available for both Ambrolauri and Oni municipalities, but there is just one basic "Akhmeta municipality infrastructure development program" study, which was written in 2010. No such document is available for Telavi. Note that Telavi does not even have its own municipal web page.

Even when it is available, the data is rather dubious. For instance, there are three official but differing values of Akhmeta territory's actual area. One is given in the above Akhmeta development program, and two more are on the same Kakheti regional administration web site.[5]

Tusheti has had no permanent population since at least 1959, when the Soviet authorities gave up on providing locals with a sustainable livelihood and moved them over to the main part of Akhmeta. A primitive road leading there was constructed in 1981, but even today it is only passable by a 4WD vehicle with cross-country ability. Akhmeta municipality listed 76 permanent residents there in 2010 within the "Akhmeta municipality infrastructure development program," and 112 residents from information provided to SDAP in 2012. These people live in 6 villages with roughly 1.17 persons per household.[6] There are at least 32 settlements still present on the Tusheti map. Of course the population increases during the summer, when people staying elsewhere during the winter return, but there is no hard data on this. There is no electricity or natural gas supply for the area, which completely lacks an energy production or distribution infrastructure. As the director of the "Kakheti Energy Distribution "company indicated during the first INRMW field trip back in December 2010, there is no possibility of providing any permanent energy supply to this area in the foreseeable future based on the most elementary cost-benefit considerations.

[4]Akhmeta is itself center of rural community with 10 villages, in addition to being the municipality center. As in the previous report, population numbers are derived from data provided by the relevant municipalities.

[5]Akhmeta development program – 2641 km^2, page- http://www.kakheti.gov.ge/index.php?cat=77&par=6 as 2583 km^2, page http://www.kakheti.gov.ge/index.php?cat=6&par=6 – 2248 km^2.

[6]There are 2.6 persons per household in Akhmeta total.

Both municipalities, unlike Racha, demonstrate a positive population growth trend, with relatively stable population numbers since the year 2000; although the population decreased by 9% between 1989and 2000.

Throughout recent history Kakheti has always been considered to be one of the leading regions of Georgia, as the center of the country's viticulture and winemaking industry. Unfortunately, this specialization did not help to the region develop successfully during the post-Soviet period. Specifically, it was hurt after first losing the Soviet and then the Russian (after 2006) markets, for which this industry was originally oriented. Kakheti does not demonstrate any optimistic economic 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. But of these four, Racha and Guria have always been regarded as economically depressed, while Mtskheta-Mtianeti and Samtskhe-Javakheti are regarded in the same grouping as with Kakheti by this index.[7]

For centuries, the Kakheti region has always played a major role in the political and economic life of Georgia. However, the situation is different now. Despite representing 9.12% of the Georgian population, Kakheti only generates 5.4% of the country's GDP. Thus, its GDP per capita represents only 59.25% of the average Georgian per capita income. The economic density for Kakheti is one of the lowest in the country and in 2010 was GEL 85,530/km^2, as compared toGEL475,472/km^{2}in Adjara and GEL 11.7 mln/km^2 in Tbilisi.[8]

Out of 406,000 people inhabiting Kakheti in 2011, only about 12,500 were employed in the private sector (including self-employment), which is fewer than there were in2010.[9]There is no relevant information available for Telavi, but according to the "Akhmeta municipality infrastructure development program" study (p. 18), there were just 6 industrial enterprises registered in Akhmeta in 2010 with 225 people employed and GEL 2,200,000 in production. Virtually all of these enterprises were represented by wineries, which are unable to employ a large number of people throughout the year.

The "Kakheti Regional Development Strategy 2009-2014" developed by the UNDP Kakheti Regional Development Project No. 00045135,reiterates the same conclusion.[10] Heavily dependent on wine production, which is not a reliable source of income today, the region continues to lag behind other parts of Georgia in economic growth. More than 80% of the economically active population is formally employed in agriculture, which is dominated by a subsistence economy. Although even formal unemployment was rather high at the time of the development of this strategy (19%), it is actually much higher. As explained in the previous SDAP report, anyone who lives in the countryside and owns at least 1 ha of agricultural land is considered to be fully "employed." As the household survey conducted by SDAP Center shows, many people do not consider agricultural employment to be a full-time income generating activity.

There is a clear understanding by the Georgian leadership of the importance of Kakheti's regional development, which is considered a strategic development priority for the country. Still, the overall

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

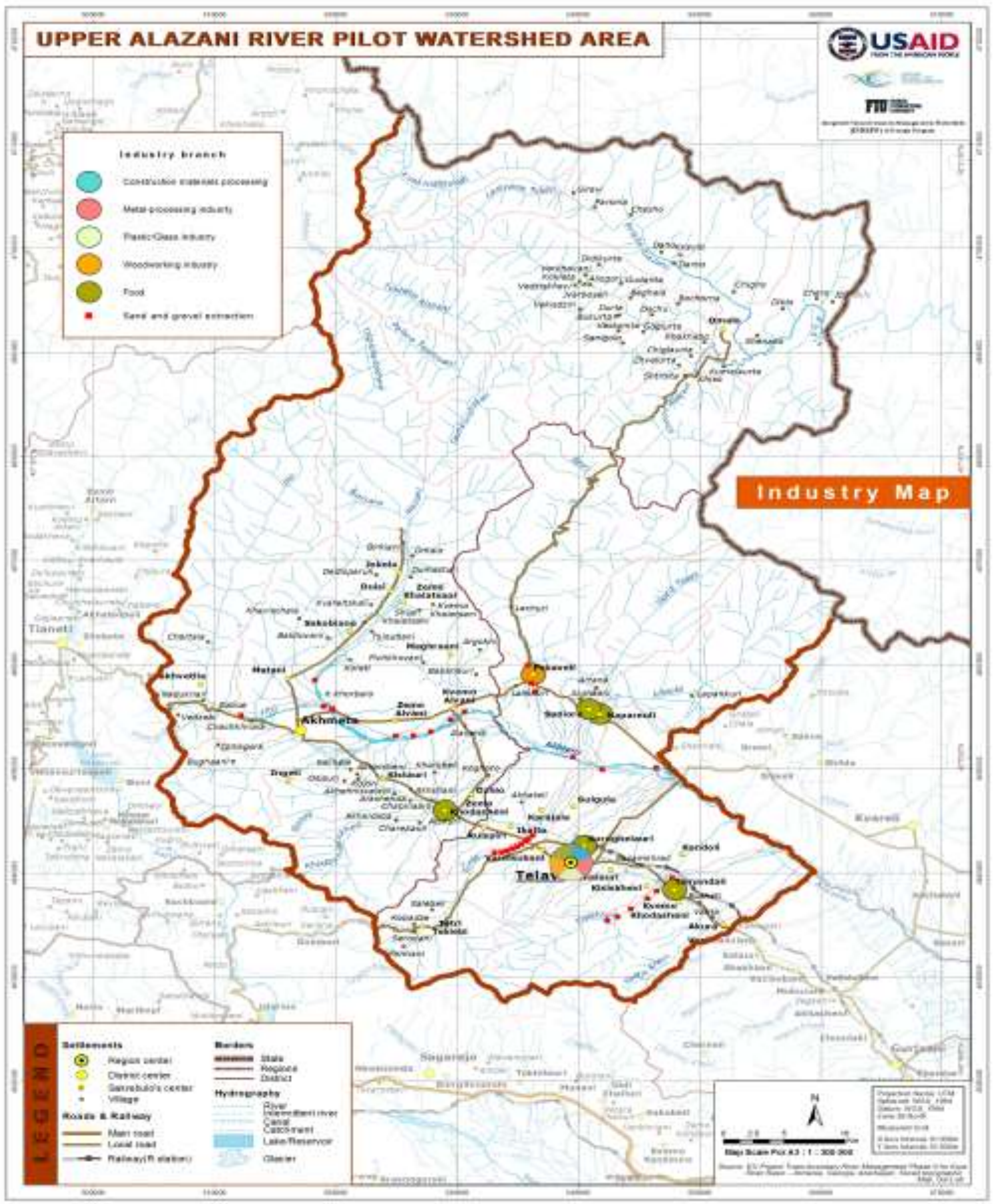
strategy is biased toward tourism development in the region. A number of widely publicized ventures were already implemented, although these have not impacted the watershed under consideration. In addition, the Ministry of Regional Development and Infrastructure of Georgia presented $ 75 million to the Kakheti Development project to be implemented through the Municipal Development Fund of Georgia. The project envisions “urban development, rehabilitation of tourist and community infrastructure throughout the region.” Within the framework of the project, a complete rehabilitation of the Telavi and Kvareli historic central part is planned, including a number of historic monuments.[11]

On May 1, 2012 in Kvareli (Kakheti) a presentation on the future development plans was made by the Strategic Development Agency, which was created by Presidential Decree #316 on April 19, 2012 as a public law entity, to coordinate and monitor various tourism and investment projects. As a first stage, the Agency prioritizes the Kakheti and Imereti regions for tourist development.[12] There is not any significant emphasis on employment growth and agricultural development anywhere in the region, which are key elements for overcoming the current economic crisis in the Kakheti region. For both regions there is hardly any concern or proposals for upper Alazani watershed, save for the rehabilitation of some parts of Telavi buildings.

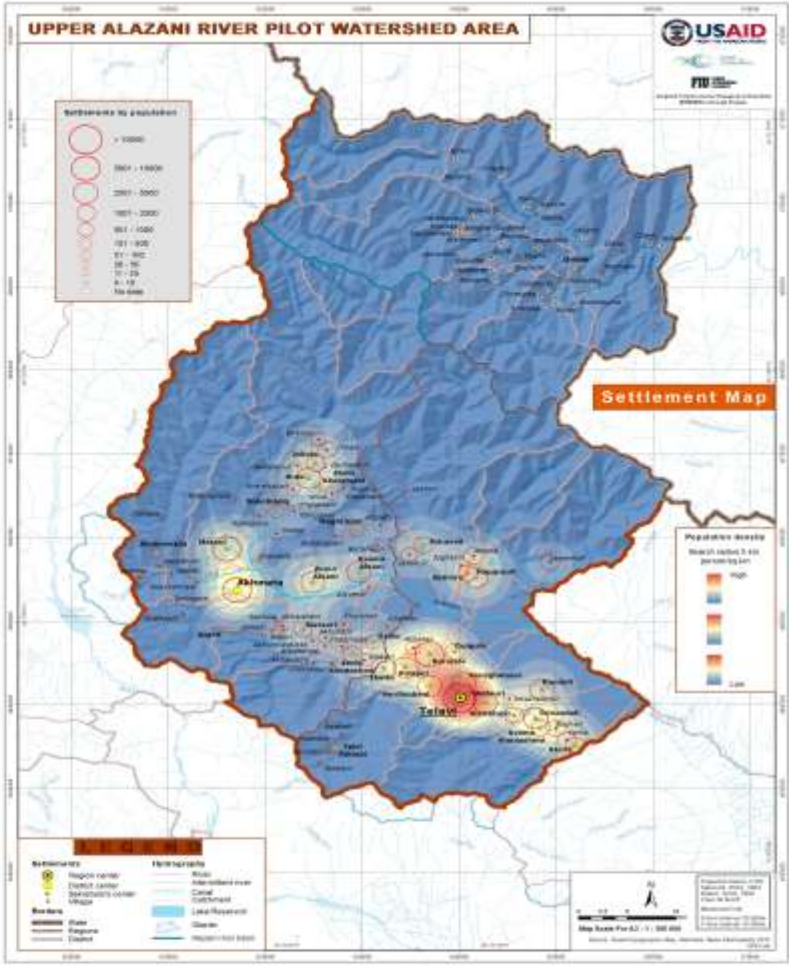
As was previously determined in the first report on the Upper Rioni Pilot Watershed Area, an absence/shortage of demand may create distortions in the energy balance even when there is abundant energy available. The analysis shows that the Kakheti region (as Racha before) may provide a typical example of energy balance distortions in regards to an adequate energy supply.

[11] http://www.mrdi.gov.ge/index.php?option=com_igallery&view=igcategory&id=15&Itemid=6&lang=en
[12]See for instance: http://www.internet.ge/?l=GE&m=5&sm=0&ID=2207, or http://www.rustavi2.com/news/news_textg.php?id_news=45338&pg=1&im=main

<u>Figure 1.2</u> Map of the Upper Alazani Pilot Watershed Area. *Developed by: Nutsa Megvinetukhutsesi, GIS expert hired under INRMW program*



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



This means that for the watershed under consideration, there are typical demand-side problems in the energy sector – even if there is enough energy available on the market, the majority of the population has insufficient financial resources to purchase this energy; this was also the same determination as in the report for the Upper Rioni Pilot Watershed Area. The only difference is that the population in Kakheti in general is not as impoverished as in Racha, and that the energy provision presents a lesser burden on household budgets (see chapter 4). But the general trends are the same – the population is the largest consumer of all types of energy. Fuel wood still plays some overwhelming role for household energy consumption. Other kinds of energy are also consumed to an extent, but are secondary as compared to household heating in winter.

As noted from the Energy Analyses Report on Upper Rioni Pilot Watershed Area – "Such a unique situation has a considerable impact on the subsequent analysis, since it is obvious that the emphasis should not be so much on increasing energy supply/availability *per se,* but rather on finding more affordable energy options for individual households. Thus, the focus should be made on the kind of energy generation, which after initial investment can provide fuel/power almost free of charge at the individual household level. Such a conclusion also stems from numerous interviews with people in various parts of Georgia conducted by the SDAP Center (not restricted to INRMW program), where respondents invariably opted for obtaining some kind of stand-alone energy generation opportunities (solar panels, biogas generators, off-grid micro HPP serving their particular village, etc.), which will serve any given individual household, or group of households, but is not part of a larger infrastructure.

This is the key task, which is clearly outside the sphere of responsibility of central authorities, but calls for local initiatives and public participation.

2.Energy Resources

While judging the availability of natural energy resources in Upper Alazani Pilot Watershed Area, it is important to take into consideration the fact that the term "resource" *per se*as it is defined by economics is not somehow complete, unchangeable or irreversible. There are many factors that separately or in combination may define some part of nature as a resource for some interested party but not for the other, or make a particular resource available at some given stage of societal development, while neglecting it for other stages. Such factors include:

- economic factors
- technological factors
- environmental factors
- market factors
- legal factors
- governmental factors
- social factors

There may be other factors as well depending on time, location, interested parties, etc. Whether some part of nature is an economic commodity and can be considered an asset upon which loans and equity can be drawn, generally to pay for its utilization at a level to attain profit - usually plays a decisive role. But there are also cases when other considerations, rather than just economics, may prevail. This is often the case when social welfare considerations outweigh the profit factor, as often is the case in the developing world. Sometimes (and in some places – often) it is necessary to utilize resources, which are not interesting/profitable from a private investors' or the central authority's point of view, in order to maintain security and provide minimum social standards for poorer communities and/or individuals.

In the case of Upper Alazani Pilot Watershed Area there are resources that may not be feasible to use from commercial investors or a central government point of view, but definitely should be considered by local governments and community based organizations in order to "fill in" the gaps in energy systems, which some larger players (e.g. Businesses, central government, etc.) cannot or do not want to do, or do not understand. These are commercial wind power, centralized solar energy, and larger scale biogas.

An important remark: currently in Georgia there is only one kind of energy which is not readily available, this is natural gas that needs larger investments for infrastructure development. All other kinds of energy are supplied throughout the country. The issue is not the energy as it is (although it was the case a few years ago), but rather a shortage of demand, since a large portion of the local population is still poor and in the countryside – cash strapped. That's why there is a need for energy, which may be utilized at the individual and/or small community level almost free of charge, with minimum maintenance after initial investment. This is where local governments and/or programs like INRMW (CARE component) should come into play, since the intervention of central authorities in such cases is obviously inefficient and unnecessary, distracting their attention from larger development projects of national-level importance. One of the main functions of the Energy Passport electronic program should be assistance in *drawing division lines* between central and local authorities in such cases.

In the case of upper Alazani pilot watershed (like upper Rioni pilot watershed) mineral energy resources (including thermal water) have not been discovered. But there is potential for other renewable energy resources such as wind, solar, biogas, hydro resources, and biomass. The only energy resources that currently abound in upper Alazani watershed are hydro resources and fuel wood.

Wind energy. 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 upper Alazani watershed does not have any verified *wind power* potential for the feasible operation of commercial wind power plants (less than 100 W/m^2), 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 1,448 kWh per m^2 of horizontal surface per annum for Akhmeta, and 1,437 kWh per m^2 for Telavi.[13] This is equivalent to 178 kWh of electricity or 1,120 kWh of thermal energy (hot water) annually for Akhmeta, and 176 kWh and 1,113 kWh respectively for Telavi. 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.[14]

[13] Calculated from: ᲡᲐᲛᲨᲔᲜᲔᲑᲚᲝᲜᲝᲠᲛᲔᲑᲘ ᲓᲐ ᲬᲔᲡᲔᲑᲘ, ᲡᲐᲛᲨᲔᲜᲔᲑᲚᲝᲙᲚᲘᲛᲐᲢᲝᲚᲝᲒᲘᲐ, ᲡᲜᲓᲐ Წ პნ 01.05-06, ᲝᲤᲘᲪᲘᲐᲚᲣᲠᲘᲒᲐᲛᲝᲪᲔᲛᲐ, საქართველოსეკონომიკურიგანვითარებისსამინისტრო, თბილისი, 2006, pp.11-12.

[14] The average solar resource for Georgia is 1,550 kWh/year of solar energy, equivalent to 190 kWh of electricity and 1200 kWh of thermal energy, as presented in Rural 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.

Biogas which can be produced from animal waste, is a viable alternative to commercial 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 upper Alazani watershed there is not enough cattle per household engaged in agriculture to meet this minimum threshold in Telavi, although there may be in Akhmeta. 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 the local government and community organizations. As previous biogas utilization experience in Georgia has shown, this type of energy generation is not popular and is unlikely to become so in the short term.

Hydropower. Both municipalities are mainly situated within the Alazani River basin and its tributaries' sub-basins. They possess a considerable and mostly untapped hydro resource potential (see Figures3.1 and 3.2). The potential installed capacity (P) of the rivers situated within these Akhmeta (without Tusheti) municipality is 80.6 MW with an annual electricity generation potential (E) of416.2 million kWh per year; for Telavi municipality a potential of 98.8 MW with 571.8 million kWhper year. The total for both municipalities within upper Alazani watershed is 179.4 MW hydro potential with 988.0 million kWh per year of energy generation.

Part of Akhmeta municipality with1,139 sq.km. area is isolated from the main region and creates the Tusheti region on the Northern slopes of the Caucasus range. Seven rivers located in Tusheti have a potential installed capacity (P) of 63.2 MW-s as well as an annual electricity generation (E) of 362.3 million kWh.

All this potential is currently utilized by only a few small and micro hydro power plants. The largest one is Khadorhesi, which is a run-of-the-river HHP located in Akhmeta municipality at the confluence of the Alazani and Samkuristskali rivers. It is owned by Ltd "Eastern Energy Corporation "and funded primarily with Chinese capital. It started operations in 2004 and has a rated capacity of 24 MW. It belongs to a rather small number of qualified enterprises (a total of 20). The generation license is issued by the Georgian National Energy and Water Supply Regulatory Commission (license #059 11 of 12 November 2004).[15] It is the 15th largest licensed HPP in Georgia. It generated 95 GWh in 2008, 138 GWh in 2009, 142GWh in 2010 and 123 GWh in 2011. This is approximately twice as much as was consumed in upper Alazani watershed in the same year, about 61GWh.[16]

Ltd "Eastern Energy Corporation" also owns amini HPP Khadori 1 with a rated capacity of 0.65MW, located nearby, which is the 8th smallest HPP of this type in Georgia (out of 34).[17]In September 2012 Khadorhesi-2 HHP with rated capacity of 5.4 MW and potential annual generation of 35 GWh, owned by Ltd "Feri" started operation. Ministry of Energy and Natural Resources publicizes it as "the only Hydropower Plant that has been constructed since 2000".[18]

[15]http://www.gnerc.org/uploads/el._licenziatta_sia_2012.pdf, http://www.esco.ge/index.php?article_id=17&clang=1
[16]Kakheti Energy Distribution
[17]http://www.esco.ge/index.php?article_id=18&clang=1
[18]http://www.menr.gov.ge/en/News/2012/2528

Figure 2.1 **Khadori HPP monthly generation in 2011, in GWh**

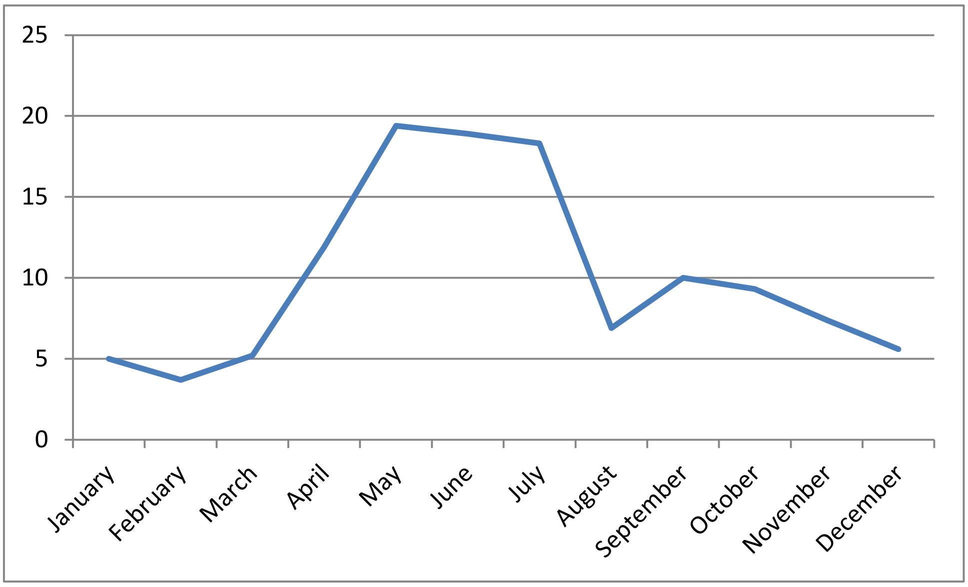


Figure2.2.Khadori 24 MW HPP

There is also a Boldoda run-of-the-river HPP (Telavi municipality) with a 0.26 MW installed capacity, belonging to Energia 1 LLC, situated on the Alazani River in Napareuli village in Telavi municipality[19]. In 2011 Boldoda generated over 3 MW/h of electricity.

[19] http://www.esco.ge/index.php?article_id=18&clang=0

<u>Figure 2.3.</u> Boldoda 0.26 MW HPP, generator

All that these HPPs generate annually utilize only about 1/8 of the electricity generation potential of the main rivers located in upper Alazani watershed (excluding Tusheti).

The State Program "Renewable Energy 2008" - (Georgian Government Decree #107 April 18, 2008)enables the construction of new renewable energy sources in Georgia –"aimed at facilitating the construction of renewable energy sources by means of attracting investments". [20]

Besides, "Hydro Energy Technical Potential Cadastre of Rivers of Georgia", taps and illustrates the small (non-traditional) technical 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, and by summing them up the overall small hydropower technical potential of the country was determined. The results of this study of rivers within the Upper Alazani Pilot Watershed Areas are presented in Table 3.1 and Figures3.2 and 3.3. This table provides summarized data on Akhmeta and Telavi municipalities' rivers' potential installed capacity (P) in MW-s. The annual electricity generation (E) in millions of kWh is provided in Table 3.1. The Roman numerals in the table denote potential hydropower generators. Rivers are denominated in accordance with their definition from the schematic maps in Figures 3.2 and 3.3

[20] http://www.esco.ge/files/decree_107_final.pdf

<u>Table 2.1</u> Small Hydro Power Potential of the Upper Alazani Pilot Watershed Area

	River	Installed Capacity - P MW	Annual electricity generation – E million kWh
Akhmeta	VII.1.6 Alazani		
	I	2.2	13
	II	4.4	24.9
	III	6.2	36.2
	IV	5.7	33.6
	∑	18.5	107.7
	VII.1.8 Samkuristskali		
	I	1.1	6.5
	II	2.0	11.8
	III	8.8	51.3
	∑	11.9	69.6
	VII.1.10 Khevisdjala		
	I	0.5	3.1
	II	1.2	6.6
	III	1.4	8.1
	∑	3.1	17.8
	VII.1.11 Samkuriskhevi		
	I	1.8	9.7
	II	3.1	17.7
	∑	4.9	27.4
	VII.1.12Ilto		
	I	0.8	4.8
	II	2.0	11.8
	III	1.3	7.5
	IV	2.4	13.9
	V	4.0	23.4
	VI	4.4	25.6
	VII	3.9	22.6
	VIII	3.3	19.2
	∑	22.1	128.8
	VII.1.13 Orvili		
	I	0.7	3.9
	II	1.5	8.5
	III	2.9	16.1
	∑	5.1	28.5
	VII.1.14 Khevgrdzeli		
	I	0.5	2.8
	II	1.6	8.9
	∑	2.1	11.7

	VII.1.15 Khodasheniskhevi		
	I	0.6	3.5
	II	1.7	10.0
	III	3.1	17.9
	IV	3.3	19.2
	V	4.2	24.7
	∑	12.9	24.7
	TotalAkhmeta	80.6	416.2
Telavi	VII.2.1Stori		
	I	2.0	11.8
	II	2.8	16.3
	III	3.4	19.7
	IV	7.1	41.6
	V	7.8	45.6
	VI	10.2	58.9
	∑	33.3	193.9
	VII.2.2 Chakhuriskhevi		
	I	0.7	4.2
	II	2.1	12.5
	III	2.5	14.1
	IV	3.4	19.3
	V	5.3	30.2
	VI	6.1	35.5
	∑	20.1	115.8
	VII.2.3 Lopota		
	I	1.6	9.3
	II	2.5	14.6
	III	3.9	22.5
	∑	8.0	46.4
	VII.2.4 Usakhelo		
	I	1.0	5.6
	II	2.9	17.2
	III	4.0	23.4
	∑	7.9	46.2
	VII.2.5 Didkhevi		
	I	0.8	4.4
	II	1.8	10.6
	III	6.2	35.3
	∑	8.8	50.3
	VII.2.6 Turdo		
	I	0.7	4.2

	II	1.9	10.4
	III	1.9	11.0
	IV	2.2	12.6
	V	2.2	12.8
	VI	2.8	16.2
	∑	11.7	67.2
	VII.2.7 Kisiskhevi		
	I	1.1	6.6
	II	1.3	7.2
	III	1.4	7.9
	IV	1.6	9.0
	∑	5.4	30.7
	VII.2.8 Tsivi		
	I	0.9	5.4
	II	2.7	15.9
	∑	3.6	21.3
	Total Telavi	98.8	571.8
	Total Akhmeta and Telavi	179.4	988.0

Within the framework of the "Renewable Energy 2008" State Program, a number of HPP construction projects within upper Alazani watershed are under consideration as follows:

1. Samkuristskali 1, situated on the Samkuristskali River (Akhmeta municipality), installed capacity 4.9 MW, regulation type – run of the river, average annual output 25.7 GWh;

2. Samkuristskali 2, situated on the Samkuristskali River (Akhmeta municipality), installed capacity 22.6 MW, regulation type – run of the river, average annual output 117.4 GWh;

3.Stori, situated on the Stori River (Telavi Municipality), installed capacity 11.8 MW, regulation type – run of the river, average annual output 56.8 GWh;

4.Stori 1, situated on the Stori River (Telavi Municipality), installed capacity 14.0 MW, regulation type – run of the river, average annual output 69.4 GWh;

5. Stori 2, situated on the Stori River (Telavi Municipality), installed capacity 11.4 MW, regulation type – run of the river, average annual output 50.5 GWh;

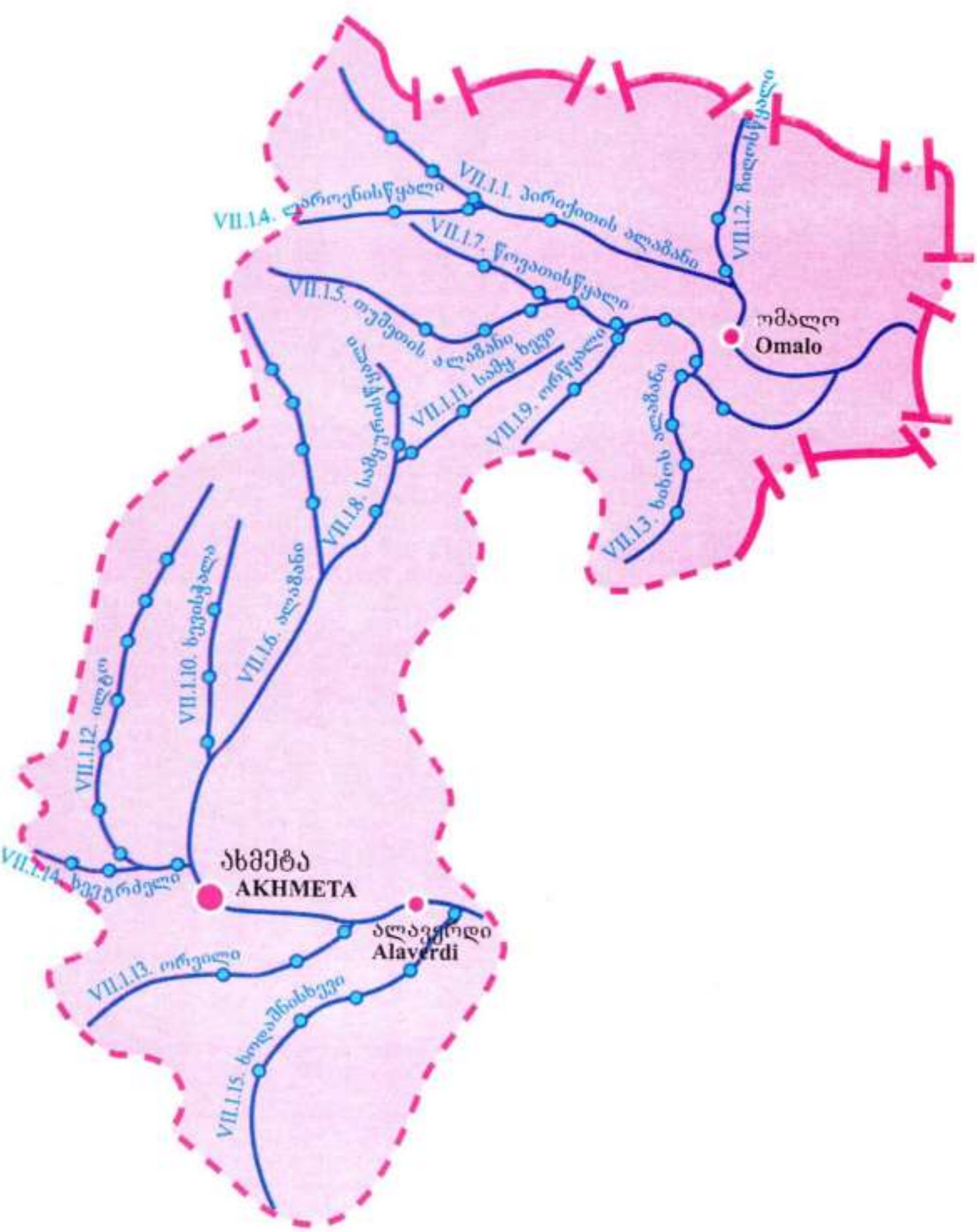
6.Stori 3, situated on the Stori River (Telavi Municipality), installed capacity 13.7 MW, regulation type – run of the river, average annual output 60.6 GWh; [21]

After the implementation of these ongoing and potential projects, the total installed capacity of all HPP in the region could reach 98 MW, or 54% of the potential installed capacity; accordingly the annual generation is estimated at 481 GWh, or 49% of potential generation. This is much less than

[21] http://hpp.minenergy.gov.ge/index.php?lang=eng

for upper Rioni watershed, but Western Georgia has much higher hydro energy potential. The potential Eastern generation may exceed the current in upper Alazani watershed by about 8 times.

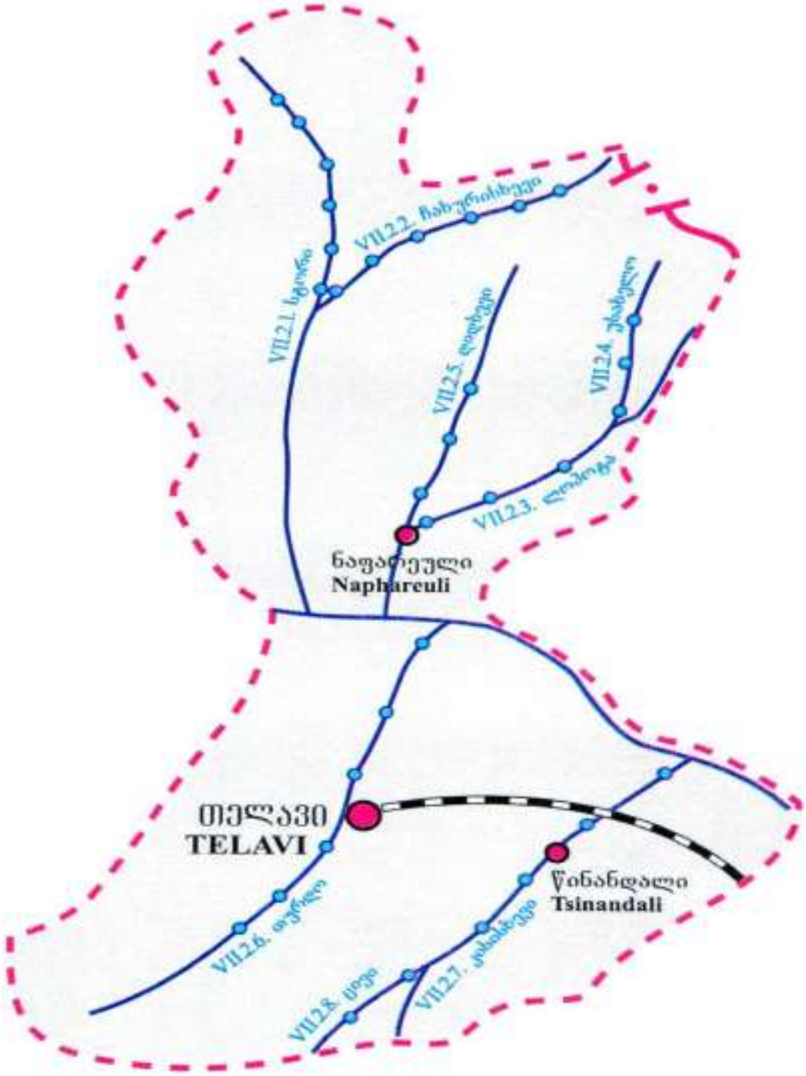
<u>Figure 2.4</u> Schematic of the Akhmeta Municipality River System



Rivers VII.1.1, VII.1.2, VII.1.3, VII.1.4, VII.1.5, VII.1.7, VII.1.9do not belong to upper Alazani watershed

<u>Source:</u> Ministry of Environment and Natural Recourses of Georgia

<u>Figure 2.5</u> Schematic of the Telavi Municipality River System



<u>Source:</u> Ministry of Environment and Natural Recourses of Georgia

Fuelwood **i**s formally defined as - trees that will yield logs of suitable size and quality for the production of firewood logs or other wood fuel.[22] The other wood fuels include wood chips, wood pellets, wood briquettes, bark, sawdust and shavings. In Georgia, only firewood is formally recognized, inventoried, and given permission for logging.

[22]http://www.websters-online-dictionary.org/definitions/FUELWOOD

Firewood has covered almost 50% of the population's energy demand during the last 15 years and this has created significant problems. Georgian forestry, the main firewood source, can sustainably satisfy just 15% of Georgia's energy demand. Therefore the present use of forestry at such a wasteful pace can result in environmental catastrophe such as landslides, desertification, and sedimentation of rivers. (Rural 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, p.109)

There is only one recognized document that can be relied upon as a reliable source of data and analysis on problems with the Georgia forestry sector, mainly fuel woods. This study is entitled "Wood Energy Resources of Georgia and Their Efficient Utilization," and was produced within the Energy Capacity Initiative Project in 2010 (Contract No. ECI-GA-20).[23] According to this analysis there is no reliable data on forest resources in Georgia, meaning that any information about fuelwood should be carefully scrutinized before its application.[24] The Kakheti region occupies the second highest ranked position in Georgia in terms of the total territory covered by forest – 30.6 % or 347.7 thousand ha; while in Akhmeta and Telavi municipalities the forest covers about 35-50% of the territory (the same parameters as in Watershed 1). By this indicator they do not comprise the most heavily forested parts of Georgia. According to Decree #299 of August 4, 2011, the forest fund of Akhmeta municipality was defined as 64,988 ha, while for Telavi it was defined as 57,227 ha. This is 30% and 55% of their respective territories.

This characterizes the situation existing for the fuelwood sector, which is considered to be one of the least organized and transparent in Georgia, and is an object of constant controversy. The information presented here is the least controversial. As such, this relies on information provided from official sources, like municipalities and the Forestry Department – Legal Entity of Public Law under the Ministry of Environmental Protection of Georgia.

Unfortunately, since the Regional Forestry Department of Kakheti was not as cooperative as in Racha, it was not possible to determine the total amount of wood intended for energy purposes (i.e. firewood) in the region.

3. Energy Sector

3.1 Consumption

3.1.1 Electricity

Just three companies are responsible for the distribution of electric power in Georgia: "Energy- Pro Georgia", "Telavi" and "Kakheti Energy Distribution." The latter is the sole provider of electric power to the Kakheti region and the most troubled entity of the three. It was established on the base of a Joint-Stock Company "Sinatle" on April 15, 2003. From 2005 to 2008 it operated under bankruptcy re-organization. After a number of futile attempts to find a new owner, it was finally

[23] Unfortunately this report exists only in Georgian.
[24] "Wood Energy Resources of Georgia and Their Efficient Utilization", p. 20.

sold to "Concerns Achemos Grupe" of Lithuania for 9.15 million GEL at auction.[25]Achemos undertook the responsibility to invest GEL 15 million into "Kakheti Energy Distribution" during 2009-2013, as well as to complete the installation of individual meters by 2014.

In reality the new owner completely failed to fulfill its contractual obligations. It generated huge debts for electricity purchased and supplied to customers (app. 4.4 m GEL[26]) and did not provide individual metering in acceptable numbers. Thus, legal procedures began at the Tbilisi City Court in August 2011 and the company again fell under bankruptcy protection in September of the same year.

All in all the company is an object of numerous complaints mainly regarding the mistreatment of customers who do not have individual meters, sometimes resulting in the cutting of supply to whole neighborhoods if one of the customers failed to pay, frequently during state holidays (which is punishable by Georgian law), etc. Interestingly, during household surveys conducted by the SDAP Center field team in Akhmeta and Telavi municipalities, there were a rather restricted number of complaints regarding the electricity supply, probably because all surveyed households have individual meters. Out of 50 households surveyed, 9 were "partly satisfied" with the company's services and only 7 were "dissatisfied." In all cases the complaints were in regards to the quality of electricity supplied and the state of the supply network. All complaints were restricted to Telavi municipality; there were none in Akhmeta.

In response to our quest from the Ministry of Energy and Natural Resources of Georgia "Kakheti Energy Distribution" provided information regarding its current activities in Kakheti (Watersheds 2 and 3).[27]Data on consumers and metering is provided in Table 4.1 below.

Table 3.1 Number and type of consumers by kind of metering in Akhmeta and Telavi municipalities at the beginning of 2012

Akhmeta		Telavi	
Type of Consumers/metering	**Amount**	**Type of Consumers/metering**	**Amount**
Commercial Buildings	**794**	**Commercial**	**1,619**
Group meters	13	Group	19
Individual meters	781	Individual	1,600
Residential Buildings	**15,054**	**Population**	**27,049**
Group meters	5,917	Group	12,061
Individual meters	9,137	Individual	14,998

[25]Before it was sold to Energo Pro-Georgia in 2008, although the Ministry of Economic Development annulled the agreement almost immediately, citing mistakes in documentation, namely a wrong number of transformers reported as well as missing data on land owned by the company.
[26]http://www.humanrights.ge/index.php?a=text&pid=13800&lang=eng
[27]See letter #122 of February 9, 2012. SDAP Center again uses this opportunity to express the gratitude for the support rendered by the MNERG, without which a large part of formal data would not have been available for review and analysis.

Public (local government) Buildings	**198**	**Budget**	**296**
Group meters	5	Group	7
Individual meters	193	Individual	289
Communal	**282**	**Communal**	**79**
Group meters	1	Group	5
Individual meters	281	Individual	74
Total Buildings	**16,328**	**Total**	**29,043**
Group meters	5,936	Group	12,092
Individual meters	10,392	Individual	16,951

***Source:* "Kakheti Energy Distribution"**

In Telavi there are 25,430 households. Assuming that each household is provided with electricity (we have no information to the contrary), only about 36% of these have individual meters. In Akhmeta there are 16,332 households (excluding Tusheti), of which about 56% are metered. The downside of this situation is that it allows for the manipulation of the electricity supply as well money collection, and has created conflicts and confusion. All other groups of consumers are much better metered, with a minimum of group meters.

The electricity tariff for the population is GEL 0.1298 ($ 0.08) per KWh, if the amount of electricity consumed is less than 100 kWh/month, GEL 0.1652 ($ 0.1) for 101-300 kWh/month and GEL 0.1750 ($ 0.11) for 301 kWh or more/month.

On average, residential buildings or households account for about 51% of all electricity consumed in both municipalities.[28]

The company received 80.107 GWh of electricity in 2011. The network losses are formally registered at 10.5%.

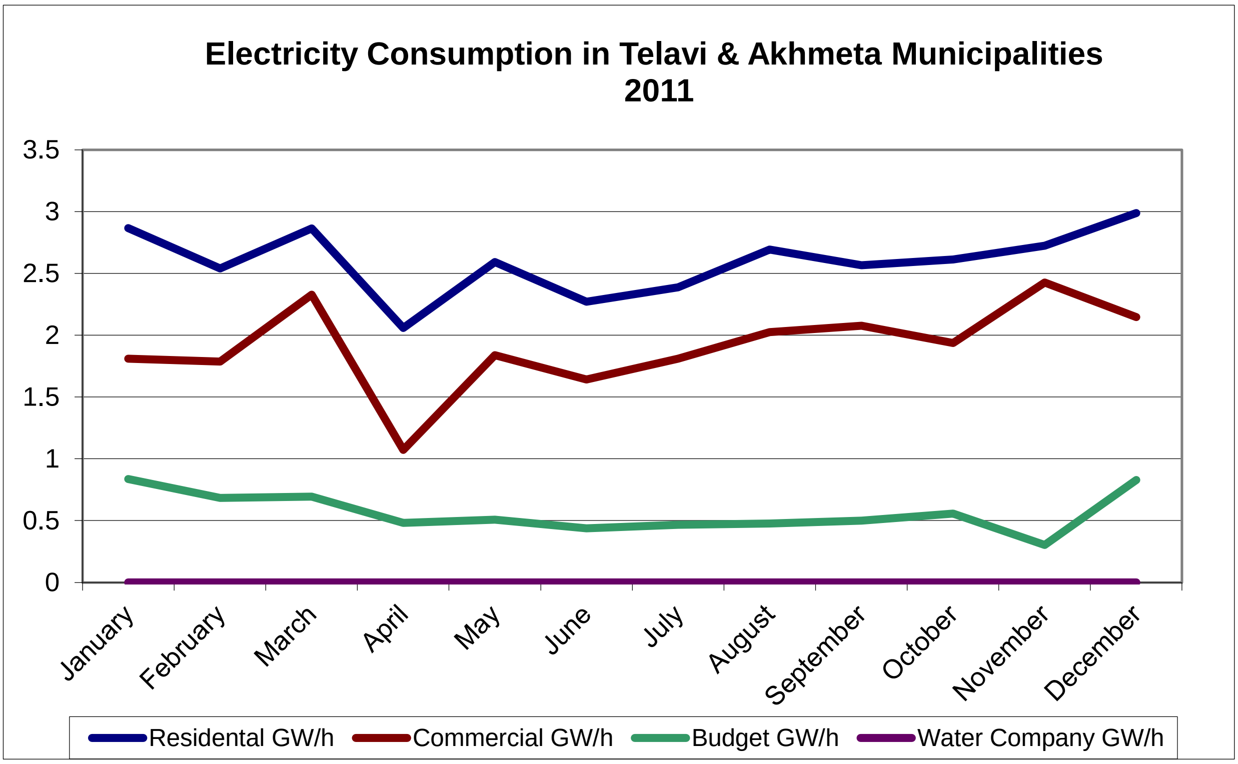
It is hard to find any coherent monthly energy consumption trends (especially with regards to population) based on data provided by JSC Kakheti Energy Distribution. There was a trend in Racha electricity consumption, somewhat atypical, but nevertheless a trend.[29] There are clearly visible trends in natural gas consumption data provided independently by two different supply companies for Telavi and Akhmeta districts separately (see Figures 4.4, 4.5 and 4.6 below). Analyzing this data

[28]This strongly differentiates Upper Alazani Pilot Watershed Area from Upper Rioni Pilot Watershed Area, where the population accounted for 2/3 of all electric energy consumed.

[29]See Energy Analysis of Upper Rioni Pilot watershed Area. (Ambrolauri and Oni Municipalities, Racha-Lechkhumi and Kvemo Svaneti region), pp. 25-26, charts 4.1, 4.2, 4.3

leaves a lingering suspicion that the peculiarities of the Kakheti Energy Distribution data collecting and reporting play as important a role in its formation as the actual consumption trends. It seems that in such cases formally presented consumption trends are mainly defined either by flawed data collecting and/or reporting practices existing at Kakheti Energy Distribution, or both.

Figure 3.1:Electricity consumption in the Upper Alazani Pilot Watershed Area in 2011



Source: JSC Kakheti Energy Distribution

Figure 3.2: **Electricity consumption Upper Alazani Pilot Watershed Area in 2010**
Source: ***JSC Kakheti Energy Distribution***

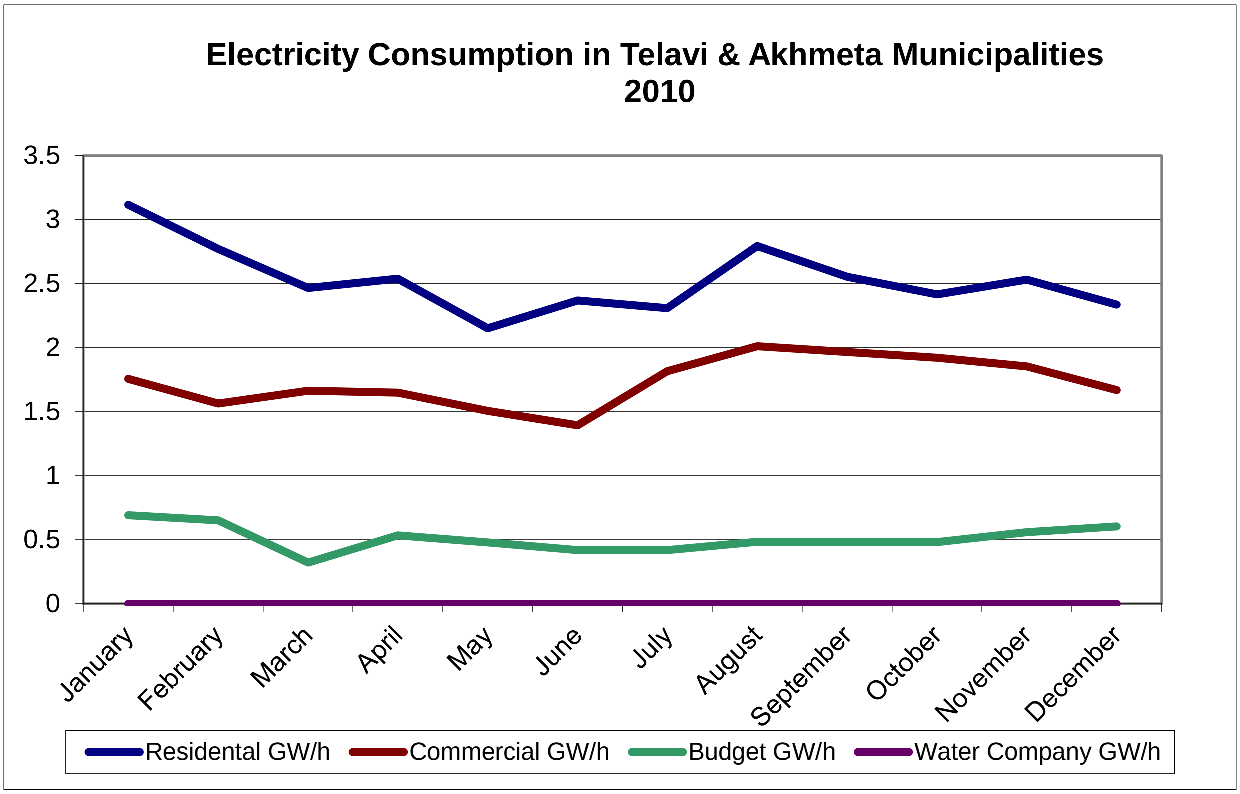
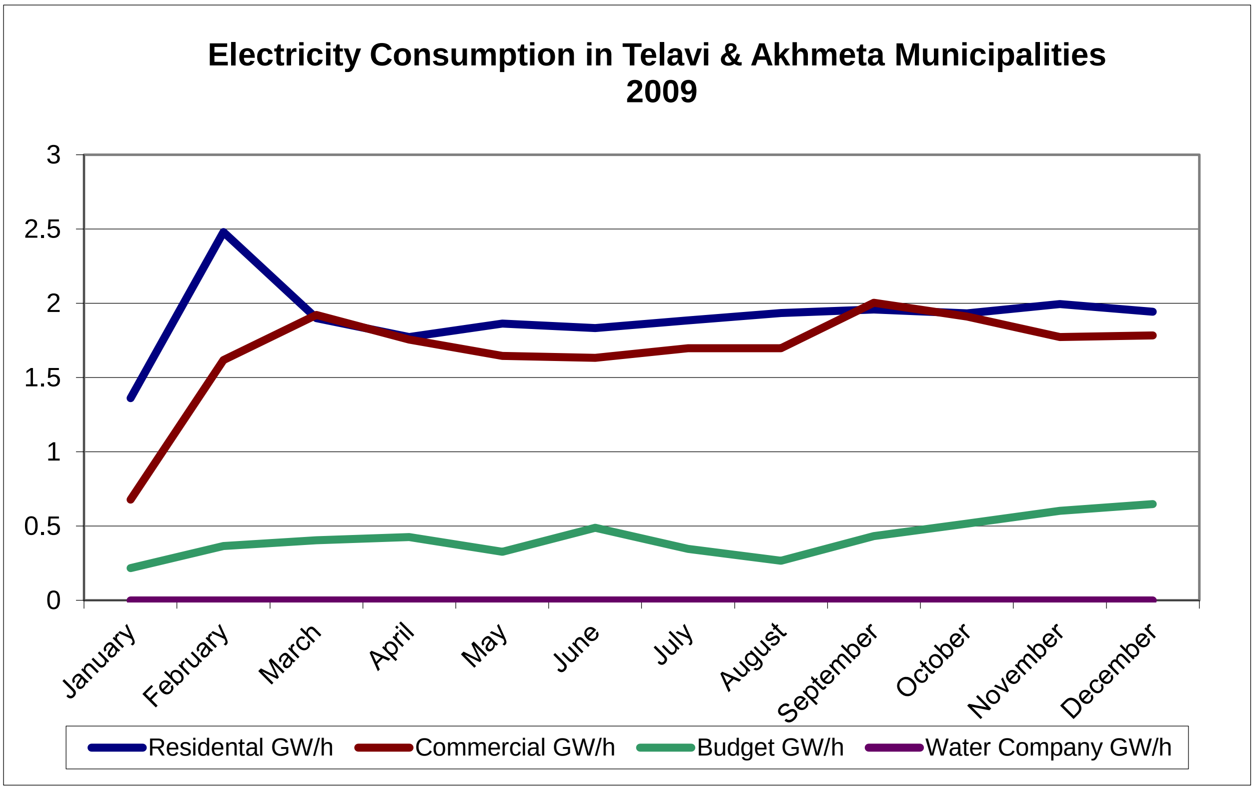
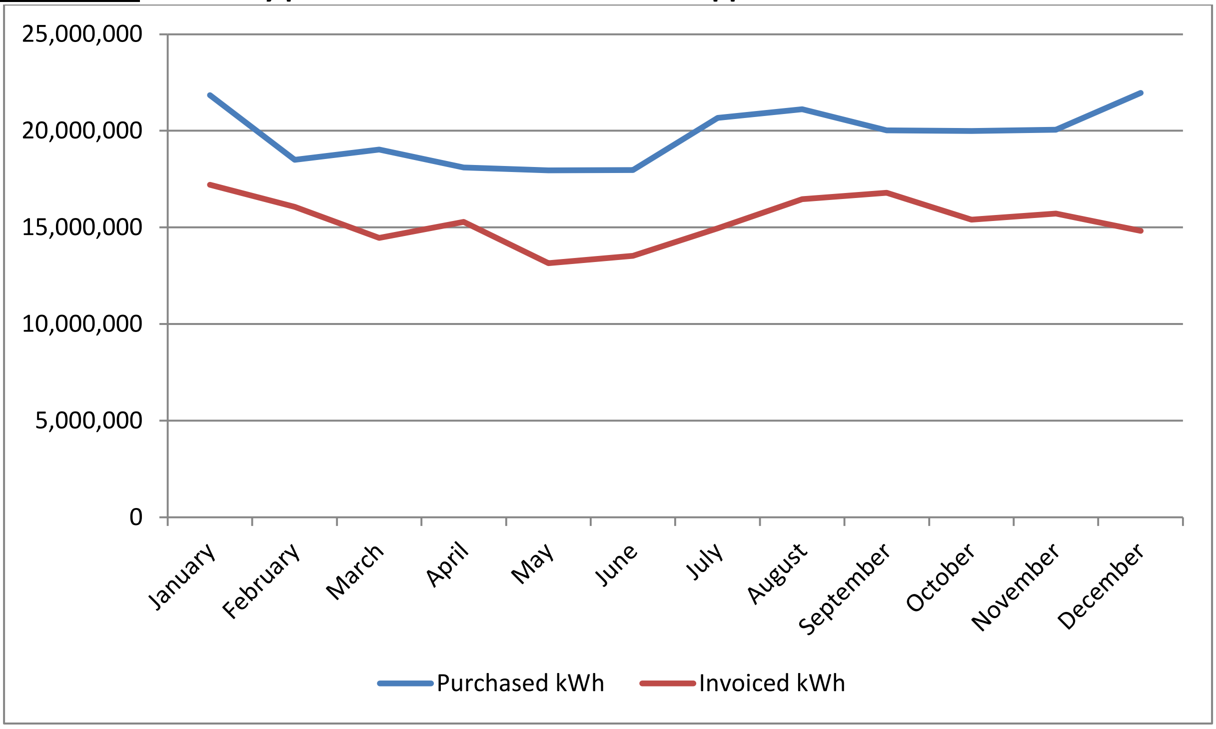


Figure 3.3: **Electricity consumption in the Upper Alazani Pilot Watershed Area in 2009**



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

Figure 3.4: Electricity purchased and invoiced in the Upper Alazani Pilot Watershed Area in 2010[30]



Source: JSC Kakheti Energy Distribution

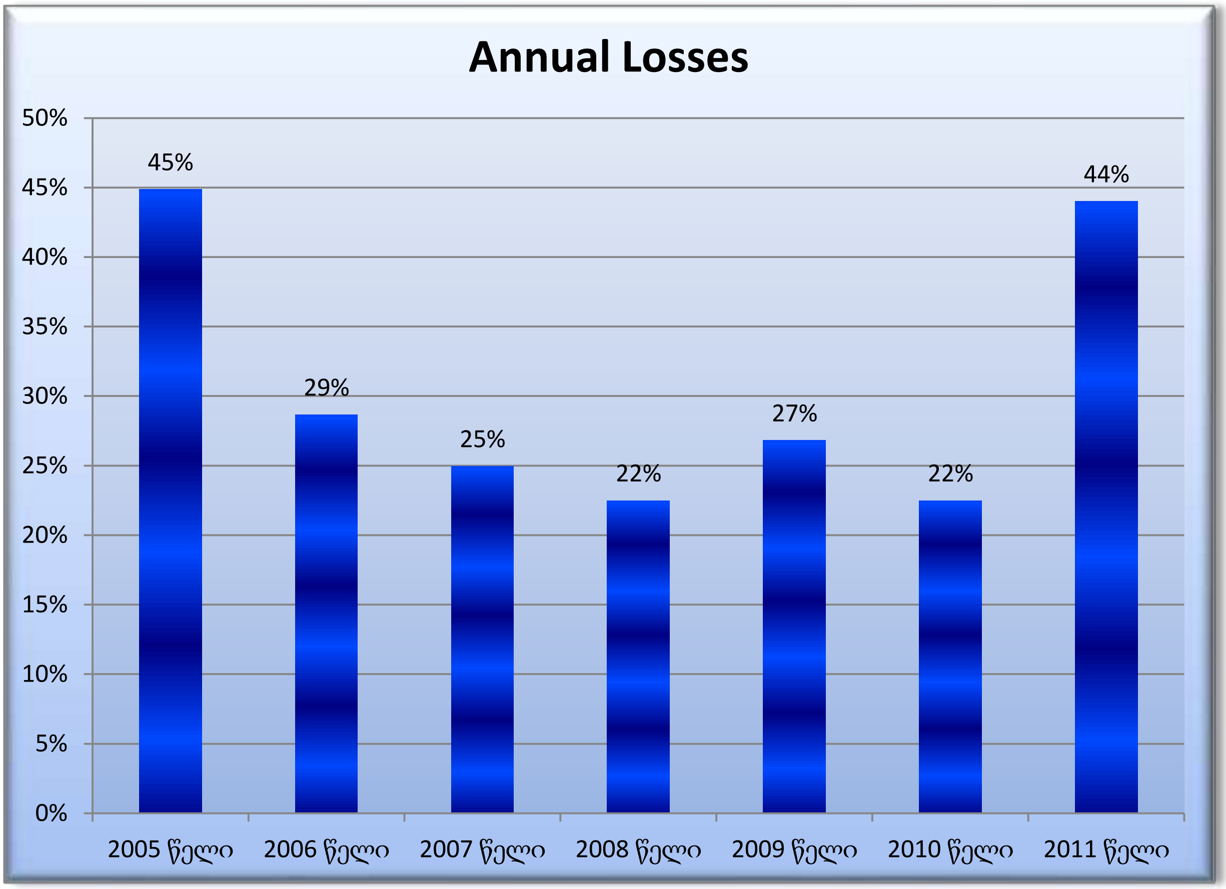
Figure 3.4 above supports the argument that the Kakheti Energy electricity consumption data do not reflect the actual trends. Shown here is the obvious discrepancy between formally delivered and invoiced electricity. Invoicing lags behind the delivery, does not reflect it accurately, and sometimes even shows opposite trends. Although the company reports network losses of about 10%, in the same document it provides data shown in the chart below, which is directly borrowed from JSC Kakheti Energy Distribution, which developed it. Some of the data in this chart is inaccurate and exaggerate the actual losses in the system. For example, the company had information of invoiced electricity and corresponding losses for just 9 months of 2011. In the absence of complete invoicing information, the company allocated 100% losses for the last three months of 2011, which averages to 44% losses in the year, even though the actual rate must have been less. In addition, the losses, which range between 45% in April and 10% in September, originated from the company's inability to properly invoice and collect money for electricity delivered.

It is possible that the rest of the data provided by Kakheti Distribution was developed along the same lines, making it rather difficult to draw reliable conclusions.[31]

[30]At the time of providing this information there was no complete invoicing data for 2011.

[31]SDAP field team found mistakes in the calculation of electricity supply data to Dedoplistskaro (Watershed 3) and requested their correction, which was done, although it took rather a long time. There is no guarantee that we simply could not trace the same kind of irregularities in other data.

Figure 3.5: **Annual electricity losses as presented by JSC Kakheti Energy Distribution**



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

3.1.2 Natural Gas

Unlike the electric power distribution system, natural gas in upper Alazani watershed is supplied by two independent private companies - SOCAR Georgia Gas and Wissol Gas Distribution. The latter is a branch of Wissol Group CSR, one of the largest business groups in Georgia, with interests not only in the energy sector, but also in construction, advertising, and supermarket chain development, which is represented on the local market by 11 sub-brands, Wissol gas being one of these. It has supplied natural gas to Telavi municipality since 2008 after 14 years of interruption of supply to most consumers.

Under the agreement with the Georgian government, the company is obliged to build/reconstruct the gas supply network to Telavi settlements with its own funds.[32] On its webpage the company reports that it has already completed the gas supply to 12 villages,[33] though in practice this does not mean that some specific households are supplied with gas. The installation of a gas meter with an accompanying connection to the supply pipeline costs at least GEL 280 ($ 171) but this is an ideal case, when the main supply line runs virtually into the household back yard. In practice, Wissol (as

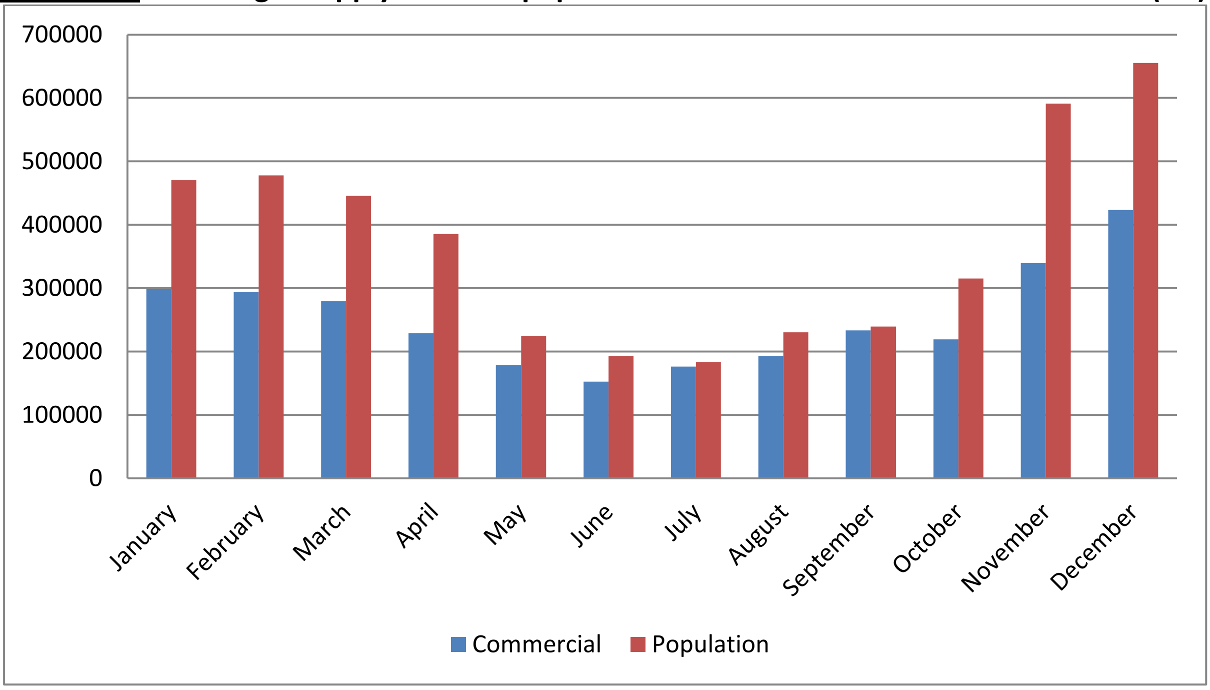
[32]It is important to note that natural gas is supplied only to settlements located on the right bank of Alazani River. As for the remaining settlements on the opposite banks, SDAP has no information on whether providing gas to them in the foreseeable future is even an object of consideration.
[33]http://www.wissol.ge/index.php?eng&cat=44&type=1

any other gas supply company operating on the Georgian market) develops a specific price-list for every given case, with prices often running into the thousands of GEL. As a result, in some villages reported as supplied by Wissol natural gas, the gap between the number of customers and the number of served households is large. For instance, in the village of Akura up to 81 out of 850 households received service in 2011, ; in Ikhalto villageup to 7out of 1,015 , received service; in Vardisubani up to 146 out of 1,171 received service; and in Ruispiri up to267 out of 1,144 received service. Of course, there are villages where it the majority of households are supplied with natural gas. For instance, in Tsinandali there are 1,317 households with 850 customers. It was impossible to obtain customers' data from Wissol disaggregated by types of customers (residential versus non-residential), thus this data includes organizations and businesses as well, further reducing the actual number of residential customers. There are 25 settlements in Telavi (including the town of Telavi proper) with 25,430 households, but natural gas is formally supplied to 17 settlements and 11,480 consumers of all types. In 2012 Wissol is planning to add 2,000 new customers.

The real problem is that supplying natural gas to the population mainly depends on the solvency of the former, rather than on the proper functioning of the distribution companies. Since such solvency is rather low, a major part of the population remains without a natural gas supply even if there are gas pipelines running along the main streets of their villages. Such households still use LPG for cooking, although the price difference between the natural gas and LPG is significant (see Chapter 5).

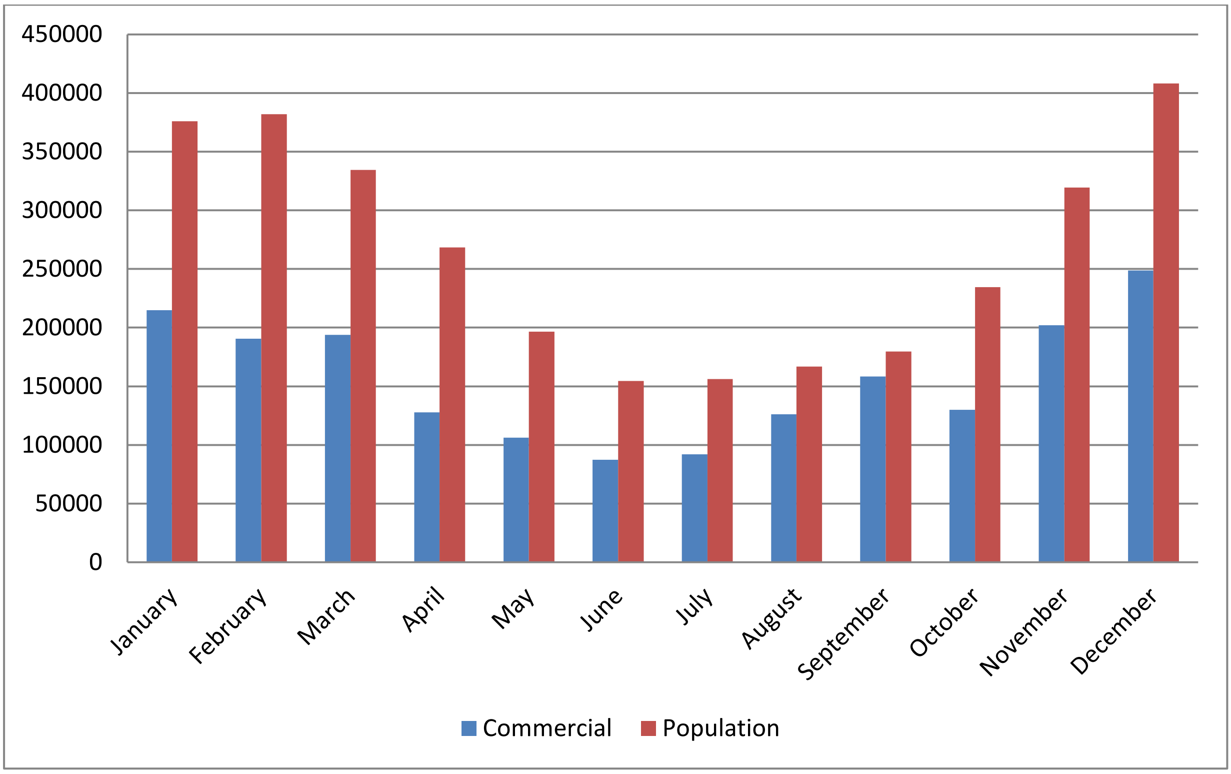
Some better organized village councils try to lobby the central government to obtain funds for supplying gas to individual households, and depending on some particular contacts and pull by the latter, such lobbying can actually work. For instance, if one may believe Georgian TV, the village of Akura has been promised support by the government in installing the gas supply to every household.

<u>Figure 3.6:</u> Natural gas supply to Telavi population and commercial consumers in 2011 (m^3)



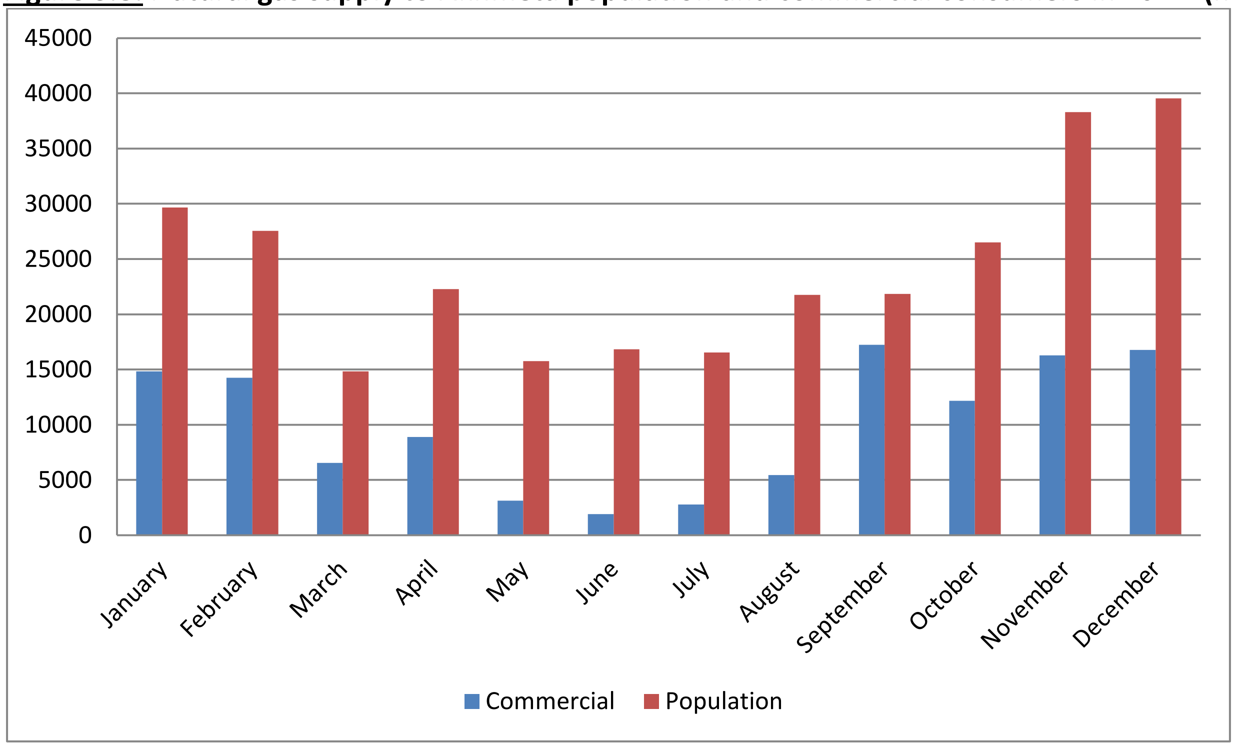
<u>Source:</u> Telavi Service Center of Wissol Gas Distribution

Figure 3.7: Natural gas supply to Telavi population and commercial consumers in 2010 (m^3)



Source: *Telavi Service Center of Wissol Gas Distribution*

Figure 3.8: Natural gas supply to Akhmeta population and commercial consumers in 2011 (m^3)



Source: *SOCAR Georgia gas Kakheti LTD*

Akhmeta municipality is provided with natural gas by SOCAR Georgia Gas, Ltd –which is the daughter company of SOCAR Energy Georgia, Ltd (established by the State Oil Company of Azerbaijan Republic). It was founded in 2007 and won the tender from the Ministry of Economic Development of Georgia for the privatization of gas distribution companies, which were the property of the state before the presidential decree № 306 of May 13, 2008.SOCAR is now in charge of the distribution of natural gas and developing an appropriate infrastructure in Kakheti, Mtskheta-Mtianeti, Shida and KvemoKartli, Adjara, Guria, Imereti, Samegrelo, i.e. virtually the whole country except for Tbilisi, Racha, and parts of Kakheti and Samegrelo.

Since 2009, the number of customers in Akhmeta municipality more than tripled, from 443 to 1,456; of these, 1,426 were households. Still, natural gas is supplied only to 4 settlements–the town of Akhmetacovering 1162 households out of 3510, Matani covering 110 out of 2241, Zemo Alvani covering 154 out of 1,650, and Kvemo Alvani covering 30 out of 1,392. There are just 30 commercial gas customers in the whole municipality. There are 56 settlements and 16,349 households in this municipality (excluding Tusheti), so in reality natural gas is only available to about 9% of all households. This is a pretty low number, which means that people continue to depend on LPG for cooking and fuel wood for heating, both of which are rather expensive and inefficient. In 2012 it is planned to supply gas to an additional 500-600 customers.

3.1.3 Liquid Fuels

Liquefied propane gas (LPG) is sold by two outlets in Telavi municipality. One is represented by an individual entrepreneur Vakhtang Tsertsvadze, and the other by Socargas. At the former, the sales volume in 2011 was about 1,000 kg per month during the summer, and 250 kg in the winter at a price of $ 2.14 per kilogram, i.e., LPG here is more expensive than in Racha. The Wissol LPG filling station manager, after obtaining all possible personal data from SDAP field team members (including their car license number) was uncooperative and refused to provide any information about its activities (as well as his name), thus we cannot estimate with any accuracy the amount of LPG sold in upper Alazani watershed. One more Socargas outlet is located in Akhmeta. It sells on average about 40,000 kgs of LPG per year at a price of about $ 1.6 per kg, which is much cheaper than the same LPG supplied by individual entrepreneurs.

At least 4 out of every 5 households in Telavi and Akhmeta (save for the poorest, which rely on fuel wood only) depend on LPG. This fuel is pretty expensive compared to both natural gas and fuel wood (see Table 4.1), but still people have no other more convenient options; linking-up to the natural gas supply calls for an initial investment well beyond the means of the majority of households.[34]

3.1.4 Fuel Wood

Formal procedures for logging fuel wood by population in Georgia were described in detail in the previous report on the Upper Rioni Pilot Watershed Area, so we will not repeat details here.[35] In many instances fuel wood production in the upper Alazani watershed mirrors that of upper Rioni

[34]It looks like that there was one more individually operated LPG outlet in Telavi, but it was not functioning. At the same time one more Socar LPG otlet was under construction in downtown Telavi in spring 2012.
[35]Energy Analysis of Pilot Watershed 1, (Ambrolauri and Oni Municipalities, Racha-Lechkhumi and Kvemo Svaneti region), p. 29.

watershed, with the only difference being that out of 50 households surveyed by SDAP Center, only one logged its own fuel wood instead of buying it on the market. During off-the-record talks, people say that there is no sense in logging trees themselves, since this is very difficult andrisky.Thus in the end they hire professionals, who do this for a price. In the end the price of such logged wood basically equals the market price. Some interviewees also suggest registering such people as firms and letting them serve the population legally.

Here again data on logging (the amount of fuel wood allocated for logging and actually cut) provided by the Ministry of Energy and Natural Resources of Georgia, Agency of Natural Resources, shows the same discrepancy as in Watershed 1 (see Table 4.1 below).

<u>Table 3.1:</u> Allocated and procured fuel wood in Akhmeta and Telavi municipalities, Years 2007-2011

Year	Wood (m^3)	Akhmeta	Telavi
2011	Allocated	20,236	47,080
	Procured	11,221	36,488
2010	Allocated	30,801	51,607
	Procured	22,993	47,617
2009	Allocated	34,834	49,258
	Procured	27,228	35,445
2008	Allocated	43,920	62,571
	Procured	27,785	50,719
2007	Allocated	32,589	52,051
	Procured	17,513	35,236

<u>Source:</u> Ministry of Energy and Natural Resources of Georgia, Agency of Natural Resources

Forboth Akhmeta and Telavi (especially in Akhmeta), the amount of wood procured is much less than formally allocated for logging. But whatever is reported as logged is much less than is actually consumed. A comprehensive report on "Wood Energy Resources of Georgia and Their Efficient Utilization" states rather conservatively that the average household in Georgia consumes 6 m^3 of hardwood firewood annually. The SDAP household survey clearly states that almost universally people use fuel wood for heating (with the exception of some very rich HH or the few multistory houses in Telavi). In Akhmeta for instance, there are 16,332 households, meaning that they need at least 97,992m^3 of fuel wood annually. Formally they logged 11,221 m^3 in 2011.[36] Unlike Racha there is no observed or calculated population out-migration in winter, thus again (as in Racha), where does the rest of the fuel wood come from?

4. Household Energy Consumption Analysis

During the field visit Kakheti, the SDAP Center representatives conducted a household sample survey in order to investigate typical energy consumption patterns on a household level. In order to select households which are representative of a larger population SDAP team used the

[36]SDAP Center survey suggests that in a majority of the cases people consume at least 8 m^3 of fuel wood per household.

representative sampling method. In this survey, a total of 50 households living in typical residential buildings were surveyed in order to define energy use trends, practices, and expenditures, including 25 in villages near Telavi (9 in Ikalto village, 8 in Gulgula and 8 in Ruispiri), 10 in the town of Akhmeta, and 15 in Akhmeta municipality villages (7 in Kistaurivillage and 8 in Kvemo Alvani).[37]50 typical residential buildings were randomly selected for survey. The sampling results were extrapolated to make generalization about upper Alazani watershed area. Above method allowed studying a typical energy consumption patterns without assessing every single household in target watershed area.

The survey was conducted using the questionnaire developed specifically for this purpose. (See Annex 1).

The 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 main finding of the sample survey is similar to the one conducted in the Upper Rioni Pilot Watershed Area–the type of energy consumption and impact on the household is mainly defined by household income and is similar for both urban and rural settlements. Moreover, energy consumption patterns are similar for both Upper Alazani and Upper Rioni Pilot Watershed Areas. This is to some extent defined by the fact that all four municipalities are located in the same building-climatic zones.[38] That means that there are rather similar demands with regards to energy consumption (especially heating), but it is also due mainly to similar cultural traditions, a lack of relatively affordable efficient heating implements, and the general low level of income. People heat with traditional and inefficient energy consuming wood stoves. As a result, the amount of energy provided by burning wood virtually outranks all other kinds of energy used (especially in poorer households), creating similar energy consumption patterns.

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[37]We deliberately stick to the same template as in Upper Rioni Watershed Energy Analyses Report (and will continue to do this in the remaining reports) in order to make it easier to make comparisons between different watersheds.

[38]See სამშენებლონორმები და წესები, სამშენებლოკლიმატოლოგია, სნდა წ პნ 01.05-06, ოფიციალურიგამოცემა, საქართველოსეკონომიკურიგანვითარებისსამინისტრო, თბილისი, 2006, pp. 9-10. Climatic zone is III-B. Building-climatic zones are defined according to the following parameters: average temperature of January, °C; average wind velocity of three winter months, m/sec; average temperature of July, °C; relative humidity of July, %.

Figure 4.1: Typical uninsulated house (Kistauri village, Akhmeta municipality)

Of all households surveyed in the Telavi municipality, 12 defined themselves as middle income and 13 as poor, as follows: Ikalto – 5 poor and 4 middle income; Gulgula – 5 poor and 3 middle income; Ruispiri – 3 poor and 5 middle income. In Akhmeta municipality, 14 defined themselves as middle income and 11 as poor. In Akhmeta proper – 5 poor and 5 middle income; Kistauri – 4 poor and 3 middle income; Kvemo Alvani – 2 poor and 6 middle income. No household in either municipality defined themselves as having a high income.

The main spheres of employment are in the government sector and agriculture. There are also several cases where people are employed in private business (mainly in Akhmeta – mini-markets and shops). Here, as in Racha, people of middle income are almost without exception employed in the public sector. On the other hand, almost all who identify themselves as poor are employed in agriculture, which generates little cash income. Some people do not even consider agriculture as permanent employment.

Figure 4.2: Typical uninsulated house (Ikhalto village, Telavi municipality)

All households were provided with a guaranteed electricity supply and all had individual meters. The level of consumer satisfaction was high, with a few complaints about the quality of electricity, except for Kvemo Alvani, where only 2 of 8 HH said that they are satisfied with the energy company service; 2 of them said they were dissatisfied and 4 of them said that they are partly satisfied. The main reason for dissatisfaction was the state of the electrical network and quality of electricity. Households on average consume 150-200 kWh of electricity per month, although more affluent families use up to 250 kWh/month and the poorest use less than 100 kWh/month. Households spending on electric power was typically in the range of $ 120-180 annually, although there are exceptions (in the case of the higher income or large poor families), when this may run higher than $ 250.

Natural gas is supplied to the largest part of Telavi municipality, to the town of Akhmeta and 3 nearby villages: Zemo Alvani, Kvemo Alvani, and Matani (Kvemo Alvani was part of this research). The level of satisfaction with the gas supply company services is high. Households with gas supply use it sparingly, just 20-30 m^3 per month. Annually this amounts to only about $100in expenditures.

Although in private conversations people noted that connections from a natural gas pipeline to the home are too expensive, it costs $700-1,000 (or more), and depending on how far the home is from the line. So, in many households people are using liquefied gas (LPG) for cooking. Liquid gas costs about $ 2.00 on average per kilogram. Annual expenditures were in the range of $ 130-200.

Only one household in Akhmeta used electric heaters in addition to a wood stove, with associated increases in electricity consumption (300 kWh/month) – the highest observed in both watersheds. This household also has the lowest observed energy expenses as a share of total household annual expenses (5%).

Virtually in all of the surveyed households firewood was the main source of energy (the single exception was one household in the town of Akhmeta), 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, although in some cases respondents claimed to heat their houses for up to 7 months. Often heating is combined with cooking and in the poorest households it is used for this purpose year round.

Households spent as little as$ 200-250 per year for firewood, but typically more than $300. All respondents, both poor and more affluent, characterized firewood as very expensive and difficult to access.

Interestingly, the introduction of natural gas did not change energy usage patterns. All households with a natural gas supply continued to heat their homes with firewood (except for one household in Akhmeta). In 2 cases, firewood was supplemented with natural gas heaters (1 wall mounted heater per house).

All households follow the general home heating patterns commonly observed throughout Georgia (outside large cities as well as for poor households in large cities) – in winter people vacate all rooms in the house, save for one or two (rarely more), in which a wood stove is installed. They live there, often cook there, and sometimes (depending on the size and composition of the family) retire to unheated rooms during the night, though not always.[39] This was as stated by all respondents in Kakheti, regardless of their income and social status. All households used heating only during the daytime. This is the same as occurs in Racha.

Figure 4.3: Fuel wood stored for winter.

Questionnaire- *Do existing heating systems create comfortable conditions?* Half of respondents answered – Yes, Always. 21 said that it creates comfortable conditions from time to time. And only 4 said that they are dissatisfied.

Total or partial dissatisfaction by heating was primarily ascribed either to poor insulation of buildings or inefficient wood stoves, or both.

Questionnaire - *Are heating expenses justified from household budget expenditures point of view?* Only four households said no; 23 said yes. For all others these expenditures were only partly justified mainly because they were able to heat only rather restricted parts of their homes.

The same approach may be observed with regards to electric lighting. Only one household intentionally replaced all incandescent bulbs with the modern fluorescent bulbs and was interested in energy efficiency. In all other cases people live under self-enforced saving conditions. They simply switch off lighting throughout the house save for a single room, where they use old incandescent bulbs.

No household had an air conditioning. Twenty had various models of electric water heaters in their bathrooms (9 in Telavi villages, 4 in Akhmeta proper and 7 in Akhmeta villages).

[39]Sometimes people simply live in kitchens in winter.

Questionnaire- *What part of the household annual budget do you spend on energy?* Almost half of respondents (24) answered that they spend less than 50%, four less than 10%, three 20%, three 25%, ten 30%, and four 40%. Thirteen respondents answered that they spend 50% and 13 answered that they spend more than 50%: four 60%, five 70%, three 80% and a one 90%.

The above clearly differentiates this part of Kakheti from Racha, where of the total 25 households 15 respondents answered about 50%,two 10%, one 15%, and the rest(7) more than 60%.

Only 9 households rated energy expenditures as not a problem; 18households described energy expenses as medium difficulty; 15 households rated it as very difficult; and 8 households rated it as unendurable.

The type and state of housing, which these households occupy also play an important role from an energy consumption point of view. As was demonstrated above, heating is the main consumer of energy in any given household and its efficiency was to a large extent reduced by the poor building envelope insulation.

Most houses are built from common cement blocks or stone, which are characterized by heavy heat losses and are only able to provide comfortable conditions through incessant heating. By heating the premises only during the daytime, homeowners simply create a situation of expensive discomfort. In 36 cases out of 50, families used heating in only 2 or 3 rooms with an average area of 35-60 m^2; in four cases heated 4 rooms; and in two cases the family heated the whole ground floor with a total area of 100-150 m^2. In all other cases (5 households), families were restricted to heating one room with an area of 20-25 m^2.

In addition, only in a few cases were there metal-plastic framed windows installed (not throughout the house, but only in parts of it). There was only one case with installed metal-plastic framed windows throughout the whole house. In other cases, window frames were made of wood with single glazing. Leaky single glazed windows with wooden frames have large heat losses and homeowners can maintain comfortable conditions inside their residences only through constant heating. The same considerations can be applied to uninsulated doors, which are not much better than the windows, only with sturdier frames. Roofs are also usually constructed from slate, or tile, or various kinds of metal, also with heavy heat losses and without adequate ceiling insulation.

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

An average household consumes about

~1,513 kWh electric energy per year
~888 kWh of liquefied gas (LPG) or 3,551 kWh of natural gas (where it is available)
~17,444 kWh of firewood

Thus, an average total of about 19,845 kWh of energy is consumed annually for a typical household without natural gas supply, and 22,297 kWh for a HH with natural gas supply.

This data was derived from the following calculations, similar to those used for upper Alazani watershed area:
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 – 12.87 kWh;[40]
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.[41]This average was used since the moisture content of air-dried beech logs varies.

Table 4.1: Annual Household Average Energy Expenses

Type of Energy	Total kWh Consumed per year	Price per kWh $	Total Expenditures $
Electricity	1,513	0.098[42]	142
Natural Gas - metered[43]	3,511	0.033	116
LPG	888	0.17	151
Firewood – purchased on market[44]	17,444	0.021	366
All energy			
Households with Natural Gas	22,297	-	618
Households with LPG	19,845	-	659

In general terms, household energy consumption in the Upper Alazani Pilot Watershed Area is similar to consumption in the Upper Rioni Pilot Watershed Area, despite the noticeable natural-geographical and socio-economic differences. Here again, the lion's share of energy consumption comes from firewood, used primarily for heating. Unlike Racha, the share of households with a natural gas supply is rather high (about 1/3 of surveyed households). People universally used firewood for heating, despite the fact that it cannot efficiently provide comfortable conditions due to inefficient wood stoves and a lack of home insulation. A typical household with natural gas still spends 78% of all consumed energy on firewood, while in households with LPG this share increases to nearly 88% of all energy consumed. Due to the huge price differential, households with natural gas consume approximately 4 times more energy provided by this fuel as compared to those with LPG, and still spend considerably less money than the latter.

[40]http://www.volker-quaschning.de/datserv/faktoren/index_e.php
[41]http://nuke.biomasstradecentres.eu/Portals/0/D2.1.1%20-%20WOOD%20FUELS%20HANDBOOK_BTC_EN.pdf
[42]Weighted average price
[43]Natural gas-observed -3340 kWh or 110 US$ per year. In this case metered and observed results are similar.
[44]There was just one household that logged its own fuel wood, 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.

Table 4.2: Comparative household energy consumption in Upper Rioni and Alazani Pilot Watershed Areas (households with LPG)

Type of Energy	Upper Rioni Watershed		Upper Alazani Watershed	
	Total kWh Consumed per year	Total Expenditures $	Total kWh Consumed per year	Total Expenditures $
Electricity	1,344	108	1,513	142
LPG	352	53	888	151
Firewood – purchased on market	19,358	581	17,444	366
All energy	21,054	742	19,845	659

Figure 4.4: Distribution of typical household expenditures by type of energy consumed (for households with natural gas supply)

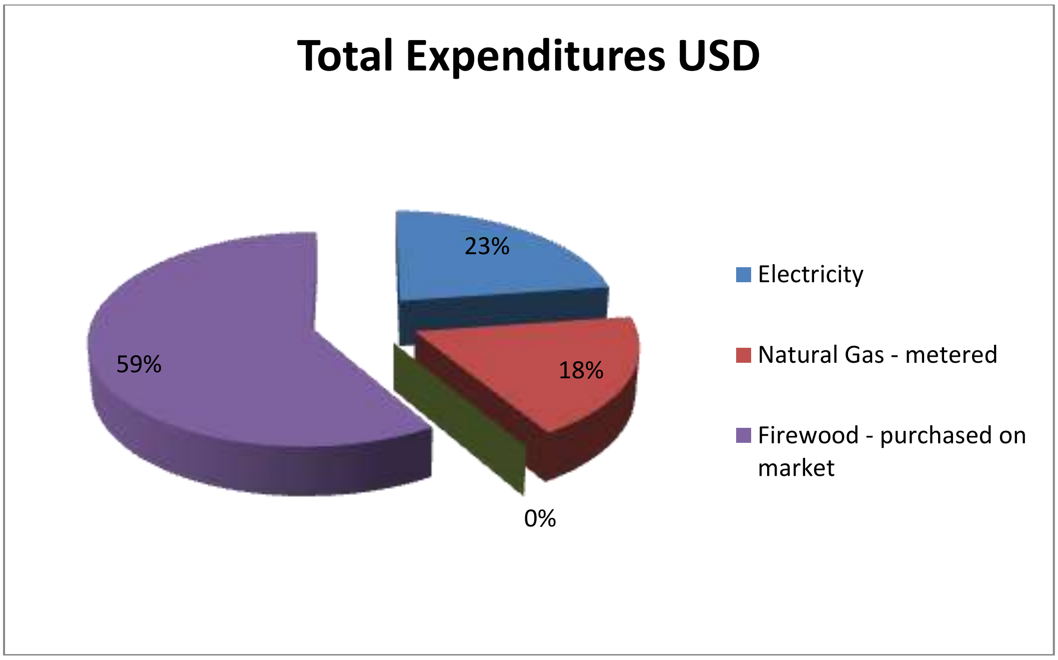
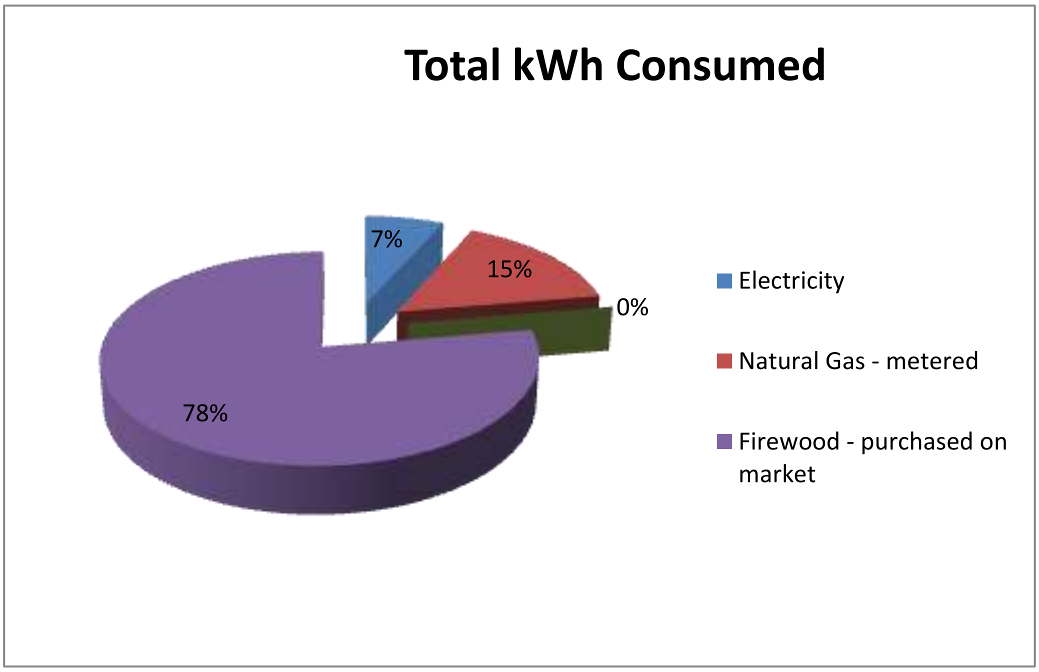
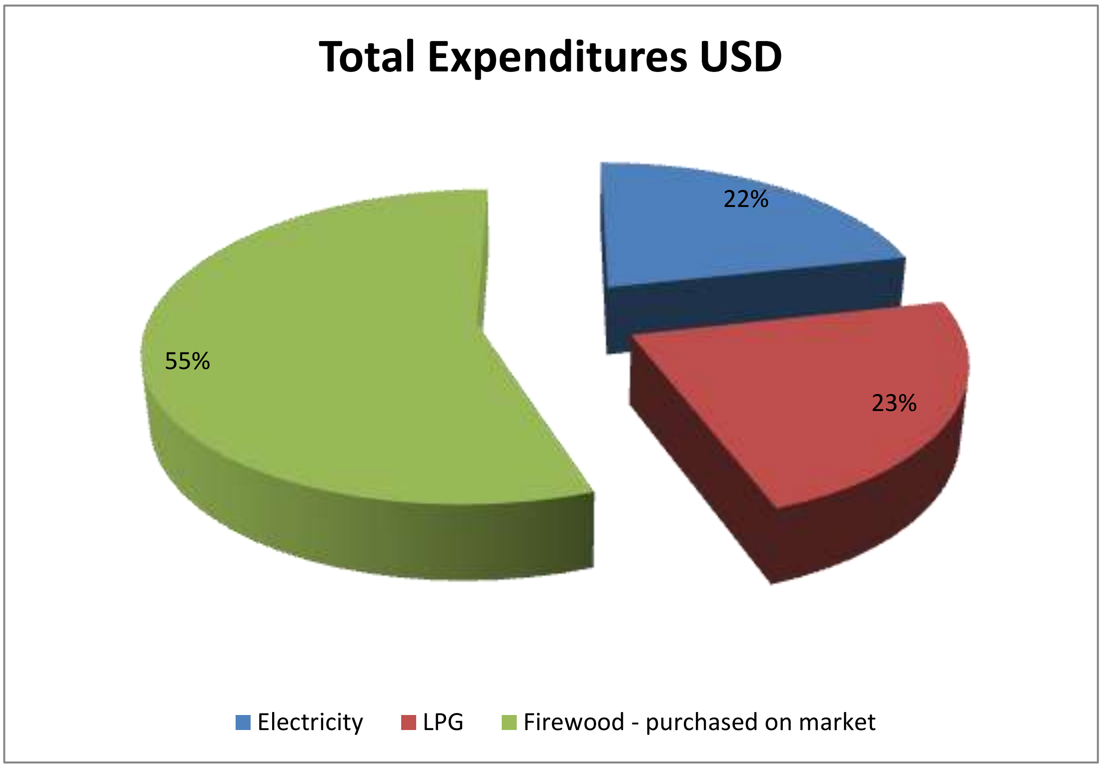


Figure 4.5:Typical household energy consumption by types of energy (for households with natural gas supply)



<u>Figure4.6</u>: Distribution of typical household expenditures by type of energy consumed (for households with LPG)



<u>Figure 4.7:</u> Typical household energy consumption by types of energy (for households with LPG)

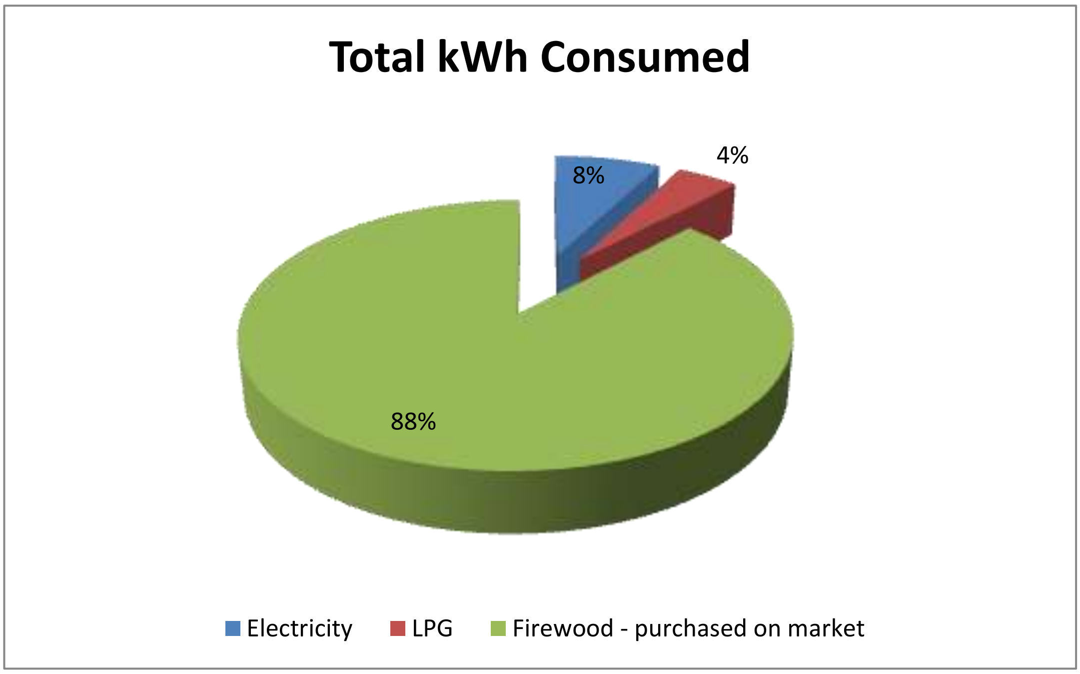


Figure 4.7: Side by side comparison of typical household expenditures by type of energy consumed in Upper Rioni and Alazani Pilot Watershed Areas (for households with LPG)

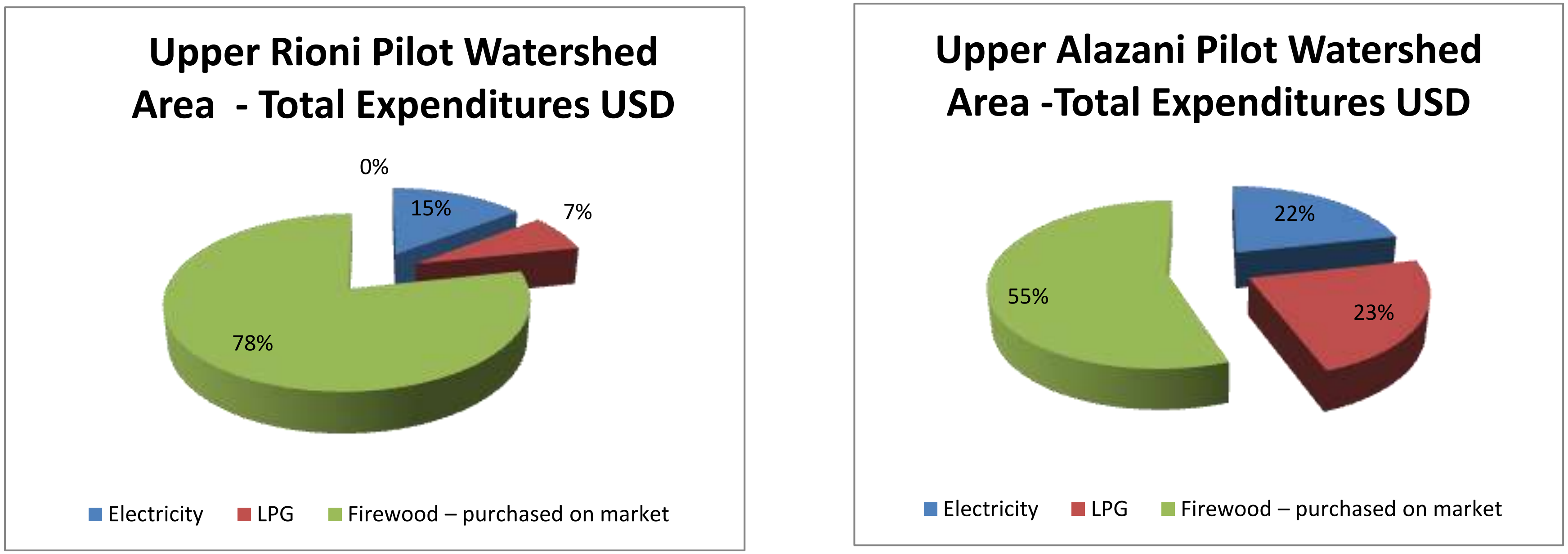
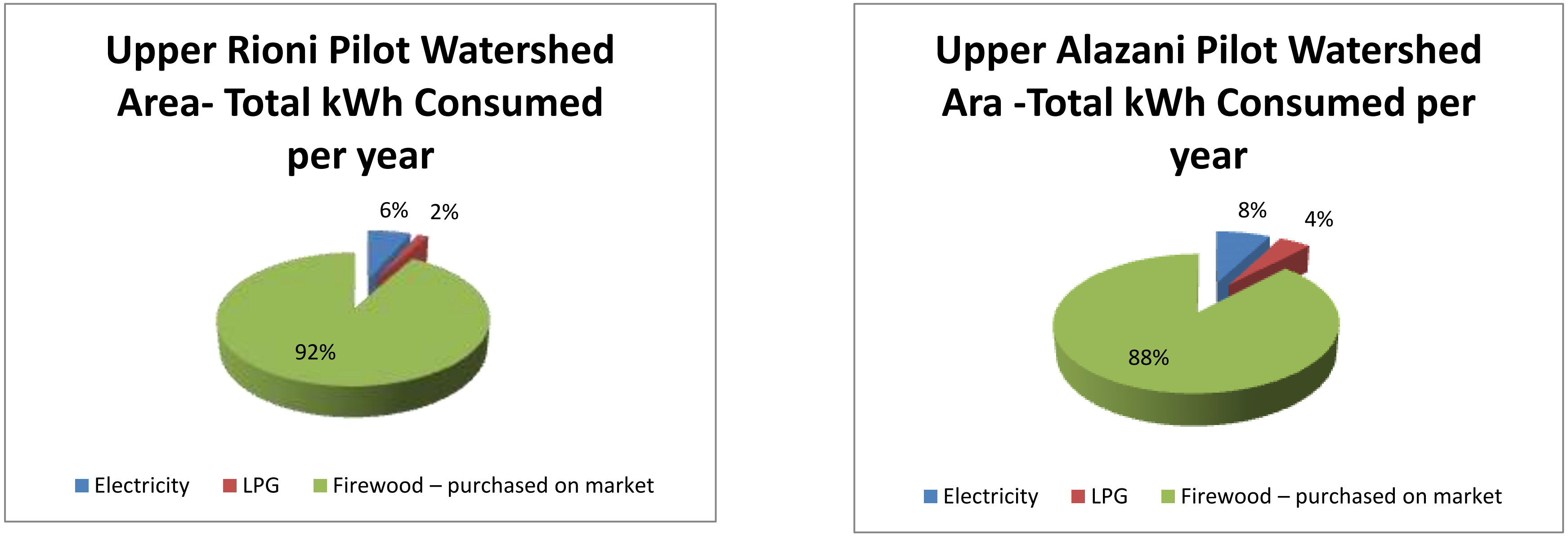


Figure4.8: Comparison of typical household energy consumption by types of energy for Upper Rioni and Alazani Pilot Watershed Areas (for households with LPG)



5.Local Government and Energy Sector

There is no apparent legal framework for cooperation between local governments and the energy sector. The Akhmeta and Telavi municipality representatives could not identify any links.[45]According to the Law of Local Self-Government (2304-rs2005-12-16), each municipality benefits from the private sector energy business through the introduction of local taxes, dues, and fees. But in practice for the upper Alazani watershed such taxes and fees have not been applied to the energy sector. Evidently, the municipality has never considered the energy sector a subject for formal review and discussion. On the other hand, during the first INRMW field trip in December 2010, it was clearly visible that the manager of JSC Kakheti Energy Distribution had a good working relationship with the regional administration and was regarded as an insider. It appears that there is again the issue of scale – energy sector companies are too large to deal directly with any local government below the regional level.

It looks like every municipality works out its own template for dealing with the energy sector, although they should all look alike considering the restricted number of options and interests these governmental bodies have. The single most important item of cooperation between the municipal governments with energy service companies is energy (primarily electricity), which is provided to the various municipal bodies and organizations.[46] For instance, on a monthly basis an electricity distribution company presents a statement of energy expenses, which is then verified and checked by the municipalities and is used as a basis for electricity consumption and expense registration and tariff payments. On the village level the representative of the power company and the village head (rtsmunebuli) together check over the electricity meter readings. In the case of an issue (which is common when one deals with Kakheti Energy Distribution), the village head or citizen addressesthe municipality rather than the actual power company. The municipality then acts as an intermediary, petitioning the power company.[47] Such activity can hardly be described as proper, especially considering the relations between citizens and the power distribution company, since the company is required by law to have a working telephone line. These requirements are not met only in Kakheti, where the absence of such a line and the general abuse of legally binding responsibilities are characteristic operational features of Kakheti Energy Distribution.

Still, the municipality and Kakheti Energy Distribution work hand in hand for such specific cases as the distribution of electricity vouchers provided by the federal government to homeowners as a form of financial assistance. To this end, the municipalities provided information about (household) consumer energy usage based on their own data, rather than relying on the power company’s information, including corrected irregularities (for instance providing names and addresses of consumers missing from the power company database). Vouchers were also distributed by municipal employees.[48]

In the case of natural gas distribution companies, the municipal administration again acts as an intermediary and troubleshooter when the need arises. Although in the case of the Telavi

[45]In Telavi SDAP dealt with the deputy head of the municipality (gamgebeli), the head of the financial-budget department and the person in charge of public information, in Akhmeta with the head of administration and the head of public relations.
[46]Numerous bodies and organizations, one may say too numerous, if judging by Akhmeta and Telavi.
[47]The term *petitioning* was used by Telavi municipality representatives.
[48]It would be interesting to compare a list of consumers developed by municipalities with the list used by Kakheti Energy Distribution.

municipality, it is more complicated. While SOCAR Georgia gas Kakheti LTD is obligated under contract with the government to build and/or reconstruct natural gas supply pipelines to Akhmeta settlements with its own funds (although not to individual households), Wissol Gas Distribution is not required to do so; however, it will in some cases financially participate in projects initiated by others. For instance, within the Rural Aid Program sponsored by the Georgian government, villages are allocated some development funds. The village then decides how to spend this money. If, for instance, such money is earmarked for the development of a natural gas supply system, a special municipality body develops a supply line construction/reconstruction budget estimate. To do this accurately the municipality enlists the JSC "Design budgeting bureau of Telavi district" (100% state owned). This bureau develops a budget and depending on its complexity charges 1-2% of the budget funds as fee for its assistance. No tenders are stipulated by this program, thus Wissol Gas Distribution undertakes the work directly. If it finds the project interesting and financially attractive it may co-finance and enlarge it to allow for a broader supply system to be constructed. The amount of such co-financing is decided on a case-by-case basis. All such projects are overseen by the municipality inspection team, which issues reports used as a basis for acceptance of work and payment.

For instance for the year 2012, 8 villages out of 24 earmarked for Village Aid Program assistance, prioritized gas supply system development as their top priority. Of these 8,Wissol Gas Distribution co-financed 4 projects. In Kondoli village it added 70% to GEL 45,236 allocated through the Village Aid Program, in Gulgula 100% to GEL 27,782, in Vardisubani 50% to GEL49,134 and in Ikhalto 60% to GEL 48,503.[49]

Once again, due to the absence of any formal framework, the efficiency of interactions between the local government administration and energy companies depends primarily on the lobbying abilities of the former and the good will of the latter. Some village administrations are able to defend the rights of their people, while others are unable or disinterested to do so.

In this report it was attempted to follow the energy consumption patterns of municipal facilities directly. In Akhmeta municipality there were 19 facilities at the end of 2011 (municipal administration and village communities' administration buildings, water pumps and drill, as well as other facilities). All of these were supplied by electricity (but 3 of them did not have individual meters). Only the municipal administration and the local council buildings had a natural gas supply, obviously used only for heating since there was no consumption reported from June to November. Of these the municipality administration was the largest consumer, accounting for 40 to up to 75% of all electricity consumed, depending on the month of the year. Village community administrations consumed very little, sometimes less than 20 kWh/month , even less than 10 kWh/month (at least this was formally reported).

There were also 36 kindergartens, of which 12 did not have individual electricity meters.[50] Of the remaining 25, only 1 to 5 kindergartens (depending on the month) consumed more than 100 kWh/month. Fourteen kindergartens consumed less than 500 kWh in 2011. All kindergartens used firewood for heating and cooking, although the majority (20 kindergartens) consumed less than 10 m^3 annually. The reported fuel wood price (app. $ 35) is close to the price noted from the household survey ($ 37).

Akhmeta municipality also owns 4 music schools (which do not have individual electricity meters), a cultural center, a sports school, and a center of public health. All of these are heated

[49]SDAP was unable to ascertain why these particular projects were selected by Wissol.
[50]Kindergartens belong to municiupalities, but are managed by an independent legal entity.

by fuel wood to the extent comparable with a small household, 5-7 m^3 per facility. Only the sports school consumed 22 m^3, which considering the size of its main hall means that it probably is hardly heated at all. The same sports center reported just 392 kWh of electricity consumed in 2011 or about 33 kWh/month on average.

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

The town of Telavi is the center of regional administration and the largest urban settlement of the municipality, which is also located along one of the busiest highways in Georgia; thus, here street lighting emerges as the largest municipal consumer of electricity (approximately 70% of all electricity consumed).[51] Administrative buildings emerge as the smallest electricity consumers with water pumps being the second largest consumption. At least part of these buildings is supplied with natural gas, although use of fuel wood is also reported.

There are again 20 kindergartens, of which 7 had individual meters at the end of 2011 (versus 5 at the beginning of the same year). Just three of these kindergartens were supplied with natural gas, with the remaining 17 using LPG for cooking. All kindergartens used fuel wood for heating, even those supplied with natural gas. The amount of fuel wood purchased in November-December was just 4 m^3 for 8 kindergartens, 8 m^3 for 6kindergartens, 12 m^3 for 4 kindergartens, 16 and 20 $m^3$for each of remaining two. Overall the situation here looks somehow better than in Akhmeta, although considering that wood stoves used here are the same as in individual households the level of comfort for both children and teachers cannot be high, even without taking into account the associated danger of exposure of numerous small children to such “heating equipment”.

6. Conclusions and Recommendations

It should be emphasized that there is no ready-made or reliable system for collecting/generating relevant data related to the energy sector at the municipal level in Georgia. Information is scattered among various state and private organizations, and obtaining any data from any such organization, irrespective of its legal status is more of an exercise in diplomacy and good will, rather than the result of formal request procedures. Without the continued support of the Ministry of Energy and Natural Resources of Georgia, it would not be possible to obtain the majority of information used in these reports.

This may also be the single most serious limitation, since this is true for all levels of governance and the lack of reliable data may emerge as a hindrance for ongoing reforms. This also underscores the necessity for the development and introduction of an energy passport electronic program, which offers better information gathering and processing abilities.

In spite of a large number of successfully implemented reforms, by and large Georgia still remains a poor country with an underdeveloped economy. For both the Upper Rioni and Upper Alazani Pilot Watershed Areas this manifests itself in the predominance of household energy consumption within the overall energy consumption panorama. Considering that the majority of people outside the large urban centers are also poor (even those who position themselves as

[51]Akhmeta reported just one case of street lighting, in the square in front of the local cultural center, which also does not work all year round. Of course there is such lighting in the town of Akhmeta, but it obviously is not connected to individual meters.

middle class income), household energy consumption volume and structure are primarily determined by the minimal possible amount of energy usage necessary to satisfy the largest *indispensable* energy consumption item, i.e. heating. All additional household energy consumption is secondary.

This is what in the previous report was defined as d*emand-side problem* of the energy sector. Most importantly is that despite the obvious differences between upper Rioni and upper Alazani (geographical, socio-economical, etc.), the structure and volume of the household energy consumption, as well as population behavior and preferences, are identical. In both 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 the winter.

The main problem that emerges for both watersheds], 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 reverse of this is also true in that they:

a) Distort the energy supply structure by refusing themselves many conveniences (as can be provided by electricity, for instance, normal lighting in all rooms), as could be available in the case of more efficient heating;

b) Reduce the overall household energy consumption at the expense of economizing on the purchase of necessary goods and services, which they cannot afford due to high heating costs.

As was pointed out in the previous report - this to a large extent happens due to inefficient heating systems, poor or non-existent insulation of houses, and expensive heating fuels (firewood). The last, but not the least of which is that the local population is totally uninformed regarding the most elementary energy saving and modern energy efficiency approaches.[52]

This is the main finding of both reports, which indicates an opportunity and recommends direct intervention by the INRMW project, as well as by the local governments in order to improve the situation. This is where a number of fields of future possible activities can be considered.

It looks like the major analysis of all four reports will be similar since it appears that energy consumption patterns in all four watersheds are basically the same, based on similar demands and preferences as well as lingering cultural traditions, like using firewood for heating, even when natural gas is available. Only specific details will change between regions.

As a result of the similarities between the two areas, recommendations developed for Upper Rioni Pilot Watershed Area are applicable to Upper Alazani Pilot Watershed Area as well. These are:

- First, to 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, to develop "simple"/low cost energy efficient **weatherization measures** for low income rural population;

[52]Reducing energy consumption through retreating into the restricted part of homes in winter can not be considered as energy saving, since this is the enfroced behavior and not the result of conscious decision.

- Third to develop a **weatherization service center** unit for implementation of the above measures in housing;
- Forth, to 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 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 to carry out **woodstove testing** procedures of the energy efficient wood stoves aimed at the establishment of a wood stove certification unit as a strategic goal.

In addition, there should be considered Inventory of public buildings within each pilot watershed with corresponding energy audits of select public buildings, as well as trainings for the municipality staff, in order to raise awareness of energy efficiency issues for proper decision making.

As previously mentioned, the local population obviously gives priority to such energy technologies, which can be run with minimum or even no maintenance and running expenses after installation. Such preferences cast doubt on the feasibility of recommending construction of off-grid HHPs, especially taking into account that the Georgian government is firmly committed to maximization of hydro energy production in the country to the excess of covering all local electricity needs by such energy and a number of HPPs are either under or earmarked for construction in Upper Alazani Pilot Watershed Area. Besides, it's worth mentioning that, even though it is assumed that the small hydropower schemes are tend to have relatively modest environment impacts, some site specific effects arose from these schemes might be significant. Generally, unsustainable planning of hydropower can result in environmental impacts such as changes in flaw regime of the river, impact on downstream population, ecosystems and biodiversity. Environmental degradation associated from hydropower cascades (even small schemes) might be higher than that caused by large hydropower. Hence, Georgia should invest in research into potential environmental and social problems from hydropower and proceed with caution.

Above this study concentrated on carrying out some kind of feasibility assessment of other kinds of renewable energy, namely solar, biogas and wood pellets.

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,[53] 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 for 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. 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

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

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.[54] 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. 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 prefer to recommend such panels initially for use for public buildings such as kindergartens and sports schools, which have problems with providing the basic energy related services for the pupils. 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 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 SDAP field trip. 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.

[54] 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.

Annex 1: Household Energy Consumption Questionnaire

Household Energy Consumption Questionnaire

1. Basic information about the 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, 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 by the energy company service? – Satisfied, Partly satisfied, Not satisfied
- Reason of dissatisfaction – power cuts, quality of electricity, service of company personnel, other reason (indicate) ---

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- 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 the 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 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)-----------------------
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- What kind of building systems' blueprints can be found? (Heating systems and etc.) ---------
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- Which system's technical description and documentation can be found? -------------------------------
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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) ---
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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) -------------------------------------
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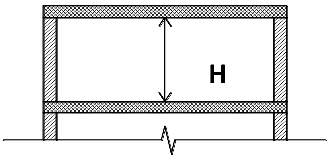
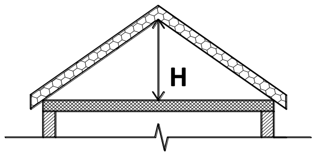
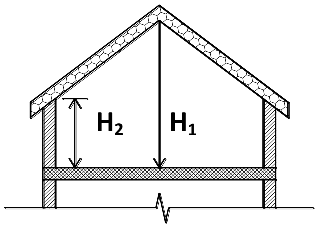
4. Type of window frame – Single frame, Double frame, Other (indicate) --
5. Glazing type – Single, Double, Triple

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

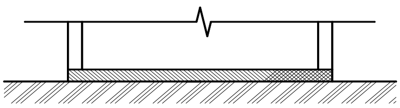
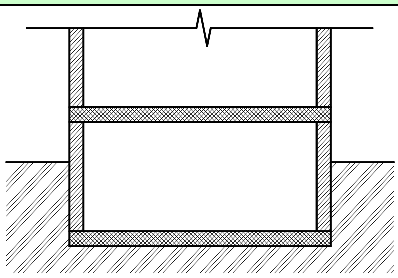
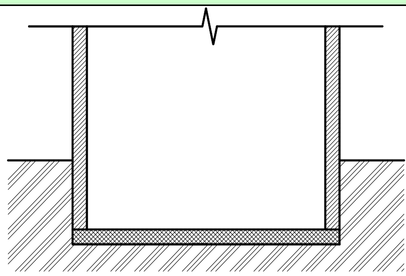
- General condition of roof - Bad, Acceptable, Good
- Total area of roof (m^2) --

Roof type RF1	Attic, Roof Type 2 RF2	Attic, Roof Type RF3	Attic, Roof Type RF4
Roof on 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 the home is heated? – Number of rooms, area (m^2), floor, other (indicate) --

5.5. How long is the building heated during the year? (Month or day) --

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 every 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 ahousehold 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 the home do they use lighting in 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 "EnergyEfficiency"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 the 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 the 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 the year? ---

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

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

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

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

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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) --

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Annex 2: Simplified Energy Balance

This is an approximate draft version for asimplified 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. It might be further modified, changed and improved on during further research for the two remaining watersheds. Again, this series of studies is the first known attempt of its kind for Georgia. All data provided here refers to upper Alazani watershed as consisting of Akhmeta and Telavimunucipalities.

Energy Resources:

Mineral Fuel – No known resources

Hydro resources – 179 MW potential installed capacity; 988GWh potential annual electricity generation

Wind – unknown, no actual data available

Solar – >100 millionGWhannually[55]

Biogas – no data

Fuel wood – no data available

Energy supply:

Local production:

Mineral Fuel – none

Hydro – 36 GWh app.

Wind – no

Solar – unknown, no data

Biogas – unknownno data

Fuelwood – 43.2 GW/h app.

Import:

Electricity – no data

Natural gas – 7839420 m^3; 73. 377 m kWh app.[56]

Export – no

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[55]Considering this surface as horizontal

[56]Calorific value of 1000 m^3 of natural gas used in Georgia is assumed to be 9360 kWh

End use consumption:

Residential buildings: electricity 31.199 GW/h; natural gas/LPG – 73.377 GWh app.; fuel wood – 730 GWh app.

Industry and Commercial buildings – electricity – 29.681 GW/h; natural gas/LPG – 29.360 GWh app.; fuel wood – n/a, liquid fuel – n/a

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