Energy Analysis of Upper Rioni Pilot Watershed Area (Ambrolauri and Oni Municipalities, Racha-Lechkhumi and Kvemo Svaneti Region)

Republic of Georgia

Technical Report Number 24

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	WinrockInternational
SDAP	Sustainable Development and Policy Center
EE	EnergyEfficiency
HH	HouseHold
EU	EuropeanUnion
HPP	HydroPowerPlant
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 Upper Rioni Pilot Watershed analysis was produced within the framework of the Integrated Natural Resources Management in Watersheds of Georgia (INRMW) Program. It provides energy analysis for Upper Rioni Pilot Watershed Area, covering the Ambrolauri and Oni municipalities, as selected by the INRMW programin 2011. This analysis is the first one of a series of four, dealing with an upstream and downstream watershed ares for both the Rioni and Alazani rivers.

The Sustainable Development and Policy (SDAP) Center conducted this analysis under the contract signed with 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.

The goal of the energy component of the GLOWS INRMW program is to empower the local government officials with the management opportunities for improving the watershed energy consumption, distribution and resource extraction in a sustainable manner. To fulfill this task the first stage of the project's energy component required basic energy statistics and detailed energy analysis of the pilot watersheds. For this reason a comprehensive background energy analysis was conducted for four pilot watersheds based on results of energy data collected from surveys.

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.

The "Energy Passport" software program proposed will incorporate an overall energy balance – the comprehensive system for presenting and analyzing country level energy system related data. This approach is endorsed and used by a variety of global and regional organizations, as well as national governments as a universal planning tool. Due to its format it is well fitted to serve as a platform for software development. It will be modified as needed in order to accommodate additional analytical and decision-making features to satisfy the future development needs of small territorial units like municipalities and/or regions of Georgia.[1]

It is expected that the Energy Passport will serve several purposes: as a database, that will provide a comprehensive system for maintaining energy information; as a forecasting tool, it will enable the user to make projections of energy supply and demand over a long-term planning; 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 report was created based on data and documents collected from the following information sources:

- Central government agencies, mainly the Ministry of Energy and Natural Resources and National Statistics Office of Georgia as well as other agencies where appropriate;
- Local municipality authorities (collected during a field trip to Racha working directly with representatives of the local administration);
- Utility companies; and,
- Internet.

Household energy use patterns were identified based on a survey of households living in typical residential buildings.

The authors especially appreciate the kind assistance provided by the Ministry of Energy and Natural Resources of Georgia, which extended its helping hand to deal with various state agencies and businesses.

As experience gained during developing this report shows, there is no system in place for regular data collection relevant to the energy sector both the local and federal levels in Georgia. Existing data is scattered throughout numerous government organizations and businesses and obtaining it mostly depends on the good will of the representatives of such state or private bodies. In the end, SDAP relied on the direct involvement of MENRP to obtain missing data.

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

The below assessment is organized by the following template: Chapter 1 is devoted to a short socio-economic analysis of municipalities within the Upper Rioni Pilot Watershed Area, Chapter 2 deals with energy resources and their utilization; in Chapter 3 energy supply and utilization come under scrutiny, while Chapter 4 provides detailed analysis of a sample household survey. Conclusions and recommendations complete this report. Additional information, including research methodology, household survey questionnaire template as well as watershed energy balance is provided in annexes.

1. Socio-Economic Context

For the case of less developed countries, local energy problems are usually considered as stemming from an inadequate energy supply, more often than not neglecting the fact that an absence/shortage of energy solvent demand may cause distortions of the energy balance even when there is abundant energy available. Analysis shows that the Racha region may provide a typical example of energy balance distortions in the case of an adequate energy supply.

Racha proper – as an historic region of Georgia is presented as Ambrolauri and Oni municipalities, i.e. what is considered as Upper Rioni Pilot Watershed Area under the INRMW program. Both of these belong to the smallest municipalities in Georgia in terms of population. Oni, with 8,400 people in 2011 was the second smallest, while Ambrolauri (14,300) – is the fourth smallest municipality of Georgia. [2] Racha-Lechkhumi and Kvemo Svaneti regions, which these municipalities are part of, is also the smallest region of Georgia, with 2.3 times less population than the second smallest Mtskheta-Mtianeti region. Although these numbers should be applied cautiously since many people are only formally affiliated with Racha (registered there) but live permanently elsewhere, visiting the region occasionally, mostly during the harvest season – August-September.

Below are the maps of Ambrolauri and Oni municipalities.

[2] Population by municipalities for the beginning of the year (in thousands)http://www.geostat.ge/index.php?action=page&p_id=473&lang=eng

<u>Figure1.1</u> 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

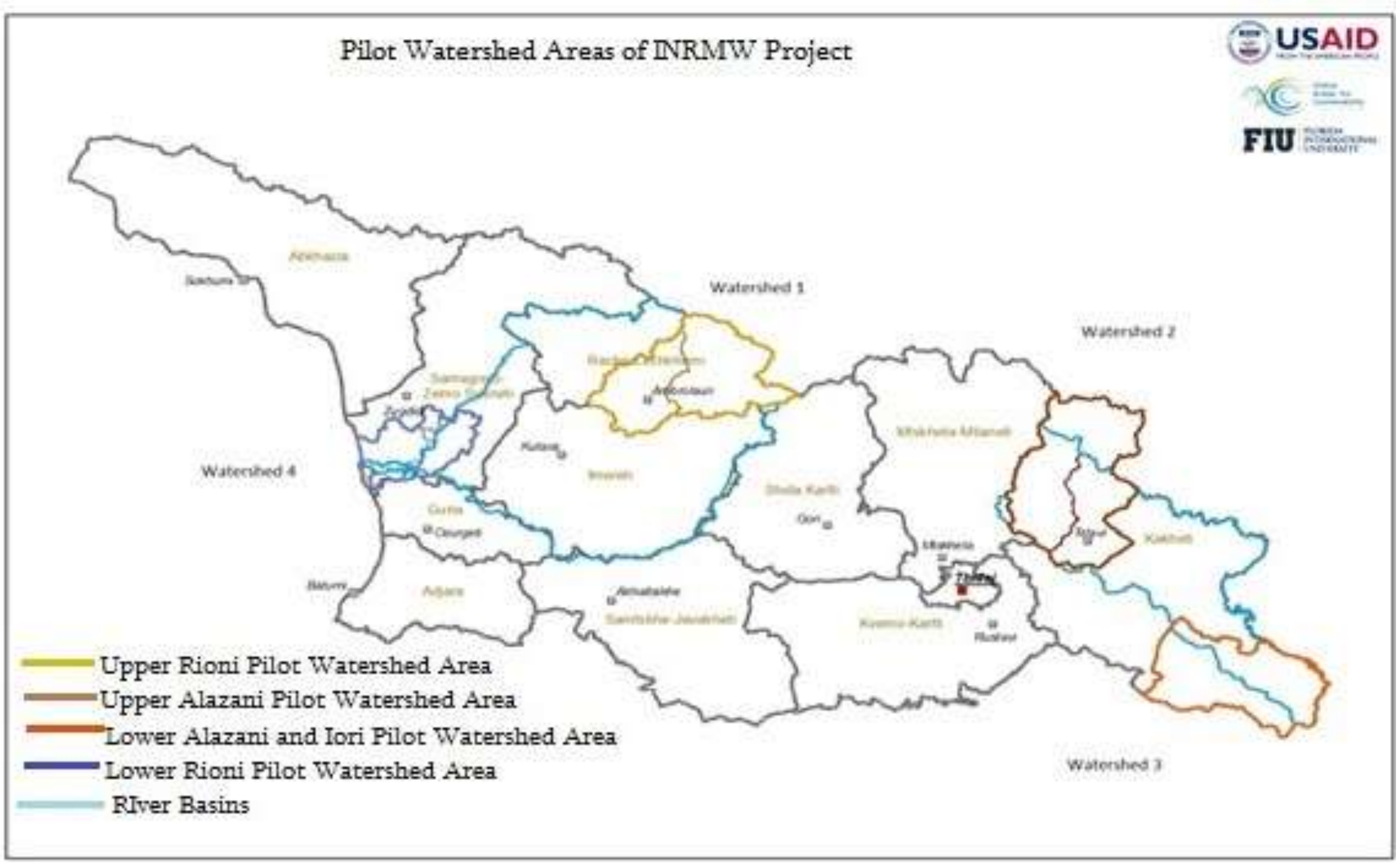
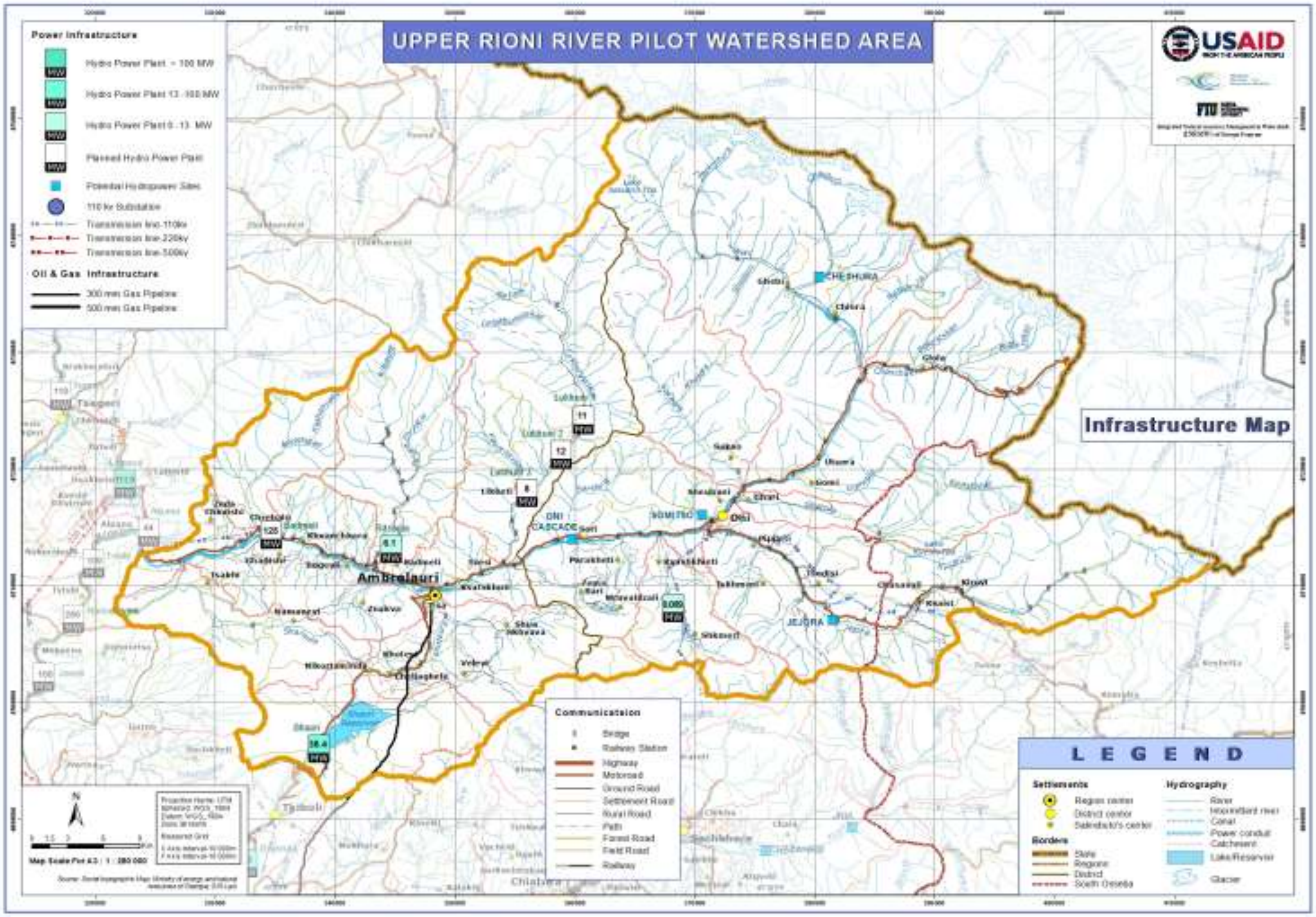
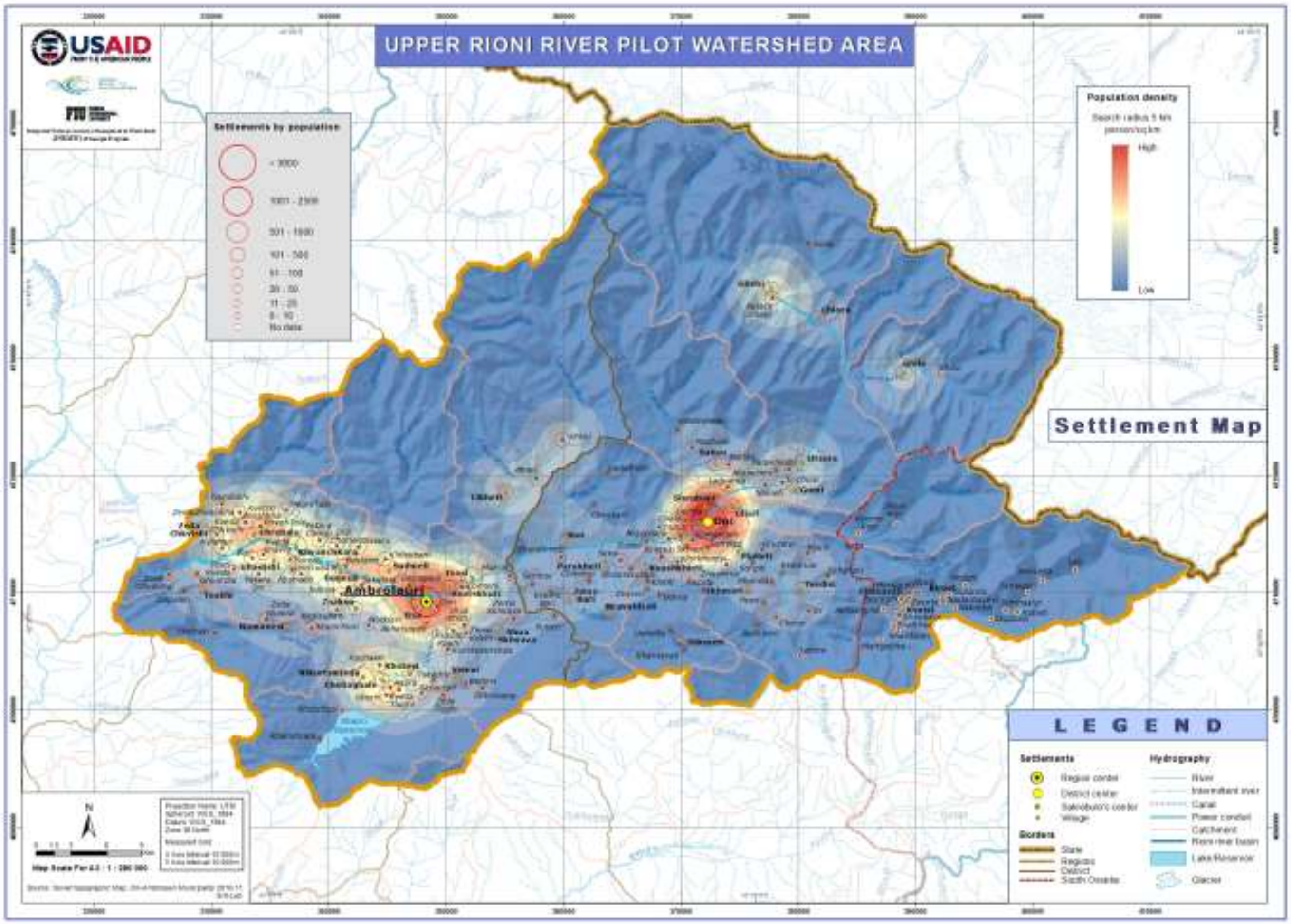


Figure 1.2 Upper Rioni Pilot Watershed Area. Developed by: Nutsa Megvinetukhutsesi, GIS expert hired under INRMW program



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



The population of Ambrolauri is distributed among the town of Ambrolauri proper (2,333 persons or 14.5% of the total population) and 18 rural communities with 70 villages. Of these villages, 28 have less than 100 inhabitants, and some are left with less than 50 people. In contrast, in Oni municipality, 40.4% of the population is concentrated in Oni proper, with the rest distributed among 17 rural communities consisting of 63 villages; of which 44 have less than 100 inhabitants including 34 with less than 50 inhabitants. In some villages there are less than 10 residents. The population density is also very low at 12.3 persons per km^2 in Ambrolauri, and 6.2 persons per km^2 in Oni; although the vast majority of the population is concentrated along the Rioni River and the lower reaches of its tributaries.

This region is often omitted from the formal statistical data provided by the National Statistics Office of Georgia, especially when it comes to the presentation of economic indices. The situation is ameliorated to some extent by the existence of Ambrolauri and Oni municipal development strategy documents, although these are not regularly updated and the most recent data they supply (2009) is already somewhat obsolete.[3]

Throughout recent history Racha was considered as a depressed region with a stagnating economy and high out-migration rates. It also showed the poorest economic development results among all Georgian regions since 1999. While in Georgia total production value grew more than 6 times during 1999-2010, and in some regions 8-9 times, in Racha-Lechkhumi and Kvemo Svaneti it grew only 2.5 times.

Today this has resulted in a negative growth rate and a grossly distorted population age structure. According to the latest available statistical data, Racha-Lechkhumi and Kvemo Svaneti were the only regions in Georgia with a population decrease. Deaths outnumbered live births by 1.9 times (916 versus 490).[4] In accordance with the National Statistics Office from 2002-2011, Ambrolauri municipality lost 11 percent of its total population, while Oni municipality lost 9.7 percent.[5]

Although Ambrolauri and Oni Municipal Development Strategy documents are developed via a similar methodology, the population age structures differ substantially by age groups. As a result it is difficult to compare these data, although it is clear that the population of retired people (age 65 and older) comprise 39% of Ambrolauri's, and 30% of Oni's population. This is an unfavorable demographic situation making it difficult to generate income within these municipalities, where the working age population is less than half of the total.

At the same time the official unemployment level in 2009 reached 24% in Ambrolauri and 20% in Oni. In both municipalities each employee had to provide for two dependents on average, and this included self-employed persons. For official Georgian statistical purposes, any person who owns at least 1 ha of agricultural land is formally considered as employed, whether there is any significant monetary income generation or not (in the majority of cases for regions like Racha it is not). In Oni such "self-employed" outnumber people employed in both state and private sectors by 1.5 times, in Ambrolauri – by 1.1 times.

[3] http://www.georgia-racha.ge/photos/7277-ONI%20municipality%20Strategy.pdf; http://www.georgia-racha.ge/photos/3339-Ambrolauri%20Municipal%20development%20Strategy.pdf

[4] National Statistics Office of Georgia.Main Demographic indicators for 2010 year.Table.2 Summary vital statistics by region in 2010 year.

[5] op.cit. http://www.geostat.ge/index.php?action=page&p_id=473&lang=eng

In both municipalities only persons employed by the state and some (rather limited number) successful private enterprises may count on more or less a stable monetary income. There are few employment-generating enterprises in these municipalities. One of the most successful local enterprises "Racha Springs", which produces bottled spring water, provides employment to only 33 persons.[6] According to #44 Ambrolauri district Majoritarian MP Gocha Enukidze, all industrial enterprises operating in the municipality only provided employment to 206 persons in total (14 enterprises).[7]

For other people, including almost all employed in agriculture (i.e., the vast majority of the population) both have little income or barter[8]. About 98% of all people engaged in agricultural production in Oni (there is no data available for Ambrolauri, although the situation should be the same there) produce it for their personal use (subsistence).

Most people with a guaranteed monetary income here are older retirees, who receive government monthly pensions (males over 65, females over 60 years of age). This pension, as of September 2011, amounts to GEL 100 (app. USD 60) per month, which is substantially less than the subsistence minimum[9] for the average consumer as defined by the National Statistics Office of Georgia in December 2011 – GEL 139 (USD 83). On the other hand, in a region with a predominantly subsistence economy, such pensions are the only source of monetary income for many households.

In the case of the pilot watershed area under consideration, there is a typical demand-side problem in the energy sector. Regardless of whether there is enough available energy in the market, the majority of the population has insufficient financial resources to purchase it. Those who are able to purchase it allocate the lion share of their household spending on energy, which reduces their ability to purchase other goods and/or services. This was one of the major findings of household survey conducted by the SDAP field team in Ambrolauri and Oni municipalities. More specifically, about 90% of respondents interviewed answered that they allocate at least 50% their household spending on energy.

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

[6] http://www.georgia-racha.ge/ge/main.php?id=1307269491
[7] http://ambrolauri.majoritarian.ge/index.php?id=23&lang=geo
[8]A system of exchange by which or services are directly exchanged for other goods or services without using a medium of exchange, such as money.It is usually bilateral, but may be multilateral, and usually exists parallel to monetary systems in most developed countries, though to a very limited extent. Barter usually replaces money as the method of exchange in times of monetary crisis, such as when the currency may be either unstable (e.g., hyperinflation or deflationary spiral) or simply unavailable for conducting commerce
[9]Socially recognized **minimum** level of **income** to avoid material poverty

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 Rioni Pilot Watershed Area (and in all other pilot watershed areas under investigation within the INRMW program), it is important to take into consideration the fact that the term “resource” *per se*as 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 a 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 Rioni Pilot Watershed Area, mineral energy resources (including thermal water) appear absent altogether. But there are other 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.

Wind energy. According to the *Wind Power Atlas of Georgia*, as well as comments on the area from MENRP (http://www.menr.gov.ge/4501), the territory of Upper Rioni Pilot Watershed Area does not appear to possess adequate wind power potential for commercial wind power plants, although it may be used for smaller-scale generation (up to 50 kW) on an individual level. Additional wind power evaluations may be warranted.

Solar energy potential for the region is estimated at about 1,059 kWh per m^2 of horizontal surface per annum for Ambrolauri and 1,113 for Oni.[10] Given the normal system conversion efficiencies, this is equivalent for a square meter to about 130 kWh of electricity (PV) or 820 kWh of thermal energy (hot water) annually for Ambrolauri and 136kWh(PV) and 862 kWh, respectively for Oni. This is less than the Georgian average but still enough to substantially contribute to the reduction of commercial energy dependence by heating water throughout the year at the household level.[11]

Biogas, which is produced from animal waste, is a viable alternative to commercial fuel, although a bio-digester needs four heads of cattle minimum to produce enough gas to justify the equipment investment. In Racha nowadays there are less than two heads of cattle per household engaged in agriculture, but this does not mean that biogas cannot be utilized as a source of alternative energy for families with more cattle, especially if local government and community organizations promote and provide guidance on available technologies.

The most common renewable energy resources in Racha are hydro and biomass (fuel wood) resources.

Hydropower: Both municipalities are situated within the Rioni river basin and its tributaries and sub-basins and therefore possess huge, mainly untapped hydro resource potential (see figures 3.1 and 3.2). The estimated potential installed capacity (P) for the rivers situated within these municipalities is 202.6 MW, with an annual electricity generation (E) of - 1130.7 m kWh. All this potential is currently utilized by only a few small micro-hydro power (MHP) plants. The largest one is Ritseula- run-of-the-river MHP (Ambrolauri municipality), situated on the river Ritseula over a distance of 6 km from the nearest settlement. It belongs to “Ritseulahesi” LTD (purchased in 2009 by the Georgian International Energy Corporation (GIEC), a member of the Georgian Industrial Group (GIG) holding – owners of 88.5% of company capital). It is licensed as a small run-of-the-river MHP with an installed capacity of 6.1 MW. It was placed into operation in 1937, and currently utilizes about 55% of its installed capacity. It is currently undergoing reconstruction in order to increase its installed capacity to 14-17 MW by the fall of 2012. It provides employment to 32 persons.

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

[11] The average for Georgia is 1,550 kWh of solar energy, equivalent to 190 kWh of electricity and 1,200 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

Figure2.1. Ritseula HPP dam

There is also the Zvareti run-of-the-river HPP (Oni municipality) with 0.26 MW installed capacity, belonging to Orba 2008 LLC[12]. In 2011 Ritseula MHP sold to the Georgian energy market 16.646 MW/h electric energy, while Zvareti sold 0.915 MW/h. In 2010, with UNDP assistance, another plant was put into operation with a 70kW capacity at Chiora MHP (off grid), which exclusively serves that village.

The State Program "Renewable Energy 2008" - (Georgian Government Decree #107 April 18, 2008) established a new rule to facilitate the construction of renewable energy sources in Georgia –"is aimed at facilitating the construction of renewable energy sources by means of attracting the investments". [13]

Since the adoption of this program, the Government of Georgia and the Ministry of Energy and Natural Resources, must in particular pay special attention to the utilization of renewable resources, especially hydro resources.

In order to attract foreign investors the GoG proposes to work with them on the Build-Own-Operate (BOB) principle, which means that:

- All new power plants are totally deregulated[14]
- No generation license is needed for HPP under13 MW of capacity

[12] http://www.esco.ge/index.php?article_id=18&clang=0
[13] http://www.esco.ge/files/decree_107_final.pdf
[14] Hydropower plants less than 13 MW can contract to sell power in both the wholesale market as well as to any retail consumer. Hydropower plants greater than 13 MW built after August 1, 2008, have been fully deregulated and are entitled to trade electric power at deregulated tariffs to qualified consumers, ESCO and for export. Construction Permit is the legal basis for implementation of construction of hydropower plant, absence of which any work is deemed illegal. HPP's with capacity of 2MW and more requires Environmental Impact Assessment (EIA) permit. Construction permit and environmental permit are combined.

- No tariff is set for newly built HPPs so investors are free to choose the market and price
- There is no special fee for the connection to the grid
- There is free third-party access to the grid
- No license is required to export and no tariff is set
- During the 10 years of the power plant operation, in the winter season of each year during three months, the electricity produced by the power plant shall be realized only to ensure domestic consumption by free (deregulated) tariff and/or by means of the guaranteed purchase agreement agreed upon in advance with an ESCO in which the tariff is determined according to the legislation in force.[15]

One of the most useful outcomes of implementation of the program was the development of a "Hydro Energy Technical Potential Cadastre of Rivers of Georgia", which taps into and illustrates small (non-traditional) technical hydropower potential of the 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 determined the small hydropower technical potential of the country. The results of this study for rivers within the Upper Rioni Pilot Watershed Area are presented in Table 3.1 and Figures 3.2 and 3.3. This table provides summarized data on Ambrolauri and Oni municipalities' rivers' potential installed capacity (P) in MW-s, as well as annual electricity generation (E) in m kWh is provided in Table 3.1. The Roman numerals in the table denote potential hydro-power generators. Rivers are denominated in accordance with their definition from the schematic maps in Figures 3.2 and 3.3

<u>Table 2.1</u> Hydro Power Potential for Selected Georgian Rivers

Municipality	River	Installed Capacity - P MW	Annual electricity generation – E million kWh
Ambrolauri	V.1.1 Lukhuni		
	I	0.8	4.7
	II	3.5	19.7
	III	7.5	41.4
	IV	17.3	96.1
	∑	29.1	161.9
	V.1.2 Qajiani		
	I	1	5.7
	II	4.5	25.6
	∑	5.5	31.3
	V.1.3 Veleula		
	I	0.9	5.2
	II	1	6.1
	III	3.3	19.1
	∑	5.2	30.4

[15] http://www.menr.gov.ge/en/4494, Energy Sector of Georgia, February 2010, Energy_sector_Geo.pdf

	V.1.4 Ritseula		
	I	0.7	3.9
	II	2.5	13.5
	III	2	11.5
	IV	4.1	22.8
	∑	9.3	51.7
	V.1.5 Askistskali		
	I	1	5.6
	II	3.3	18.6
	III	5.1	29
	∑	9.4	53.2
	Total Ambrolauri[16]	58.5	328.5
Oni	V.3.1 Rioni		
	I	0.6	3.5
	II	4	22
	III	6.8	37.8
	∑	11.4	63.3
	V.3.2 Zophkhitura		
	I	0.4	2.5
	II	2	11
	III	3.1	17.2
	∑	5.5	30.7
	V.3.3 Djandjakhi		
	I	1.8	9.8
	II	2.9	15.6
	III	4.2	23.4
	IV	4	22.4
	V	10.5	58.7
	∑	23.4	129.9
	V.3.4 Sontarula		
	I	0.3	1.8
	II	1	5.6
	III	1.2	6.9
	∑	2.5	14.3
	V.3.5 Kheva		
	I	0.9	5.2
	II	2.4	13.6
	III	4.3	23.6
	∑	7.6	42.4
	V.3.6 Cheshura		

[16]For reasons unknown there is no data available for Rioni potential within Ambrolauri municipality

	I	1.1	6.5
	II	3.1	17.2
	III	5	27.9
	∑	9.2	51.6
	V.3.7 Sakaura		
	I	1.5	7.9
	II	2	11.6
	III	5.3	28.9
	IV	8.6	48.1
	V	8	44.8
	VI	8.3	46.2
	∑	33.7	187.5
	V.3.8 Gharula		
	I	1.9	9.8
	II	2	11.2
	III	1.3	7.7
	IV	2.9	16.2
	V	3.8	21.4
	VI	4.9	27.1
	∑	16.8	93.4
	V.3.9 Jejora		
	I	3.9	20.9
	II	7.4	41.5
	III	3	17.2
	IV	4.8	26.4
	V	8.2	45.8
	VI	6.7	37.3
	∑	34	189.1
	Total Oni	144.1	802.2
	Total Ambrolauri and Oni	202.6	1130.7

Within the framework of the "Renewable Energy 2008" State Program, a number of HPP construction projects within the Upper Rioni Pilot Watershed Area have been planned and implemented. Among these projects is the Luknuni small run-of-the-river HPP cascade construction project, currently in an early stage of implementation. It consists of three HPP's situated on Lukhuni River in Ambrolauri municipality (see Table 3.2). This is an important project, especially from a local development point of view, but it has little impact on employment in the region since it needs a maximum of 140-150 qualified personnel per HPP in the construction phase, and 12-15 during operation.[17]

[17]Scientific Research Firm "Gamma", Lukhuni HPP ESIA, p. 66.

Table 2.2 Lukhuni River Hydropower Projects

HPP	Owner Company	Installed Capacity MW	Annual Generation GWh	Estimated Investment USD thousand	Start of Construction	Projected Completion of Construction	Commencement of Operations
Lukhuni 1	Rusmetal LLC	10.8	66.07	18 178	2015 May 1	2019 December 1	2020 January 1
Lukhuni 2	Rusmetal LLC	12.0	73.58	20 198	2010 August 1	2014 December 1	2015 January 1
Lukhuni 3	Rusmetal LLC	7.5	46.03	12 624	2020 May 1	2024 December 1	2025 January 1

Source: *Ongoing Investment Projects, http://www.menr.gov.ge/en/4494*

There are also three potential HPP projects under consideration:

1. Cheshura, situated on the Cheshura River (Oni municipality), installed capacity 7.5 MW, regulation type – run of the river, average annual output 32.4GWh;

2. Somitso, the Jejora River (Oni municipality), installed capacity 24.3 MW, regulation type – reservoir, annual generation - 144.28 GWh;

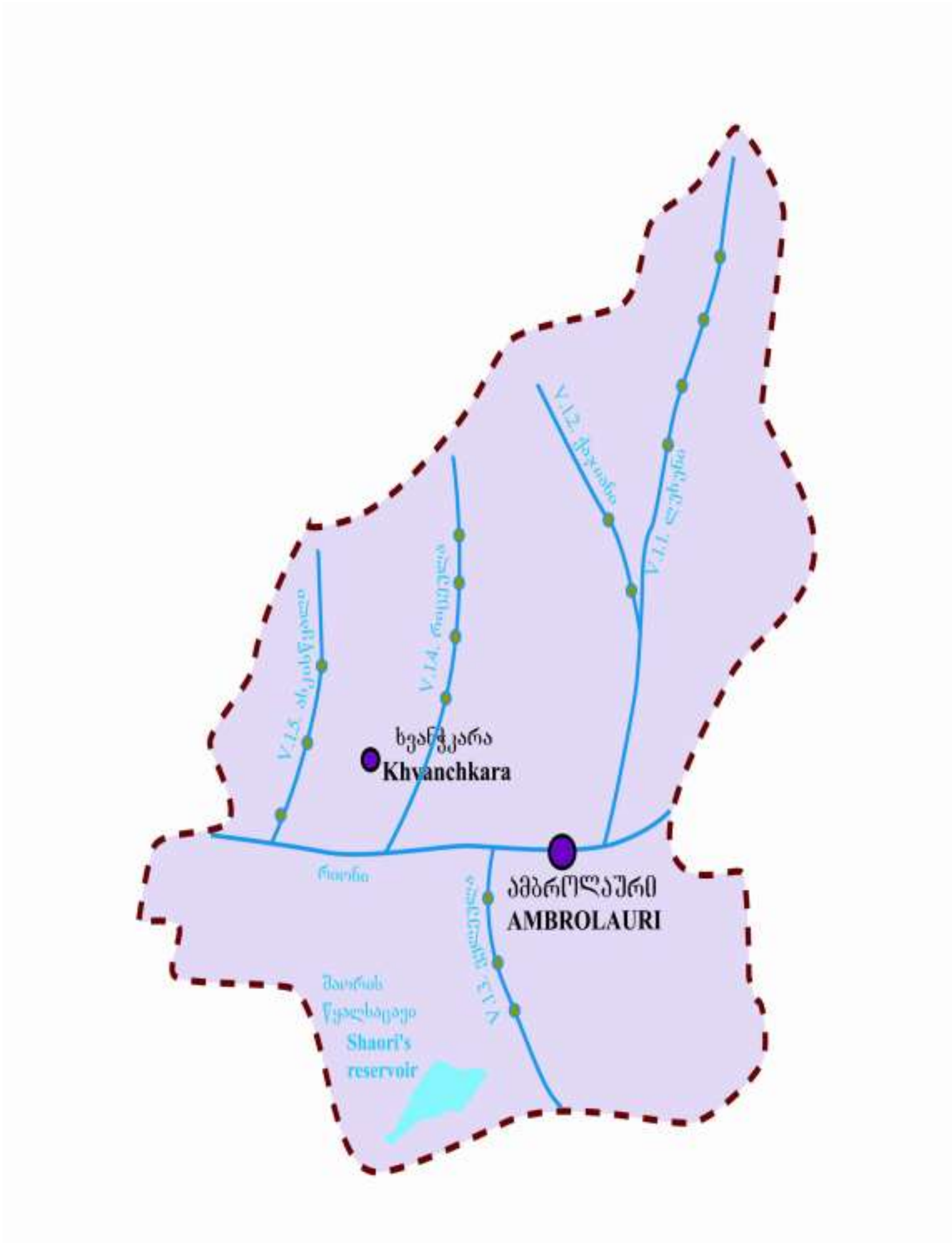
3. Jejora HPP, the Jejor River (Oni municipality), installed capacity 15.8 MW, regulation type – reservoir, annual generation - 86.58 GWh.[18]

After implementation of these ongoing and potential projects, the total installed capacity of all HPP in the region should reach 843 MW or 41.6% of potential installed capacity; accordingly annual generation may become 485 GWH or 42.9% of potential generation. From the mid- to long-term perspective this is impressive, although it is also obvious that Racha as it is today cannot fully utilize this opportunity.

The largest HHP project proposed to be implemented in the Upper Rioni Pilot Watershed Area so far is the Oni cascade. Initially it was publicized as a reservoir type with 276/282 MW installed capacity and 1530 GWh annual generation. MENR even announced tender for project implementation, although with a rather downsized installed capacity of 190 MW; however at present this project has been shelved.

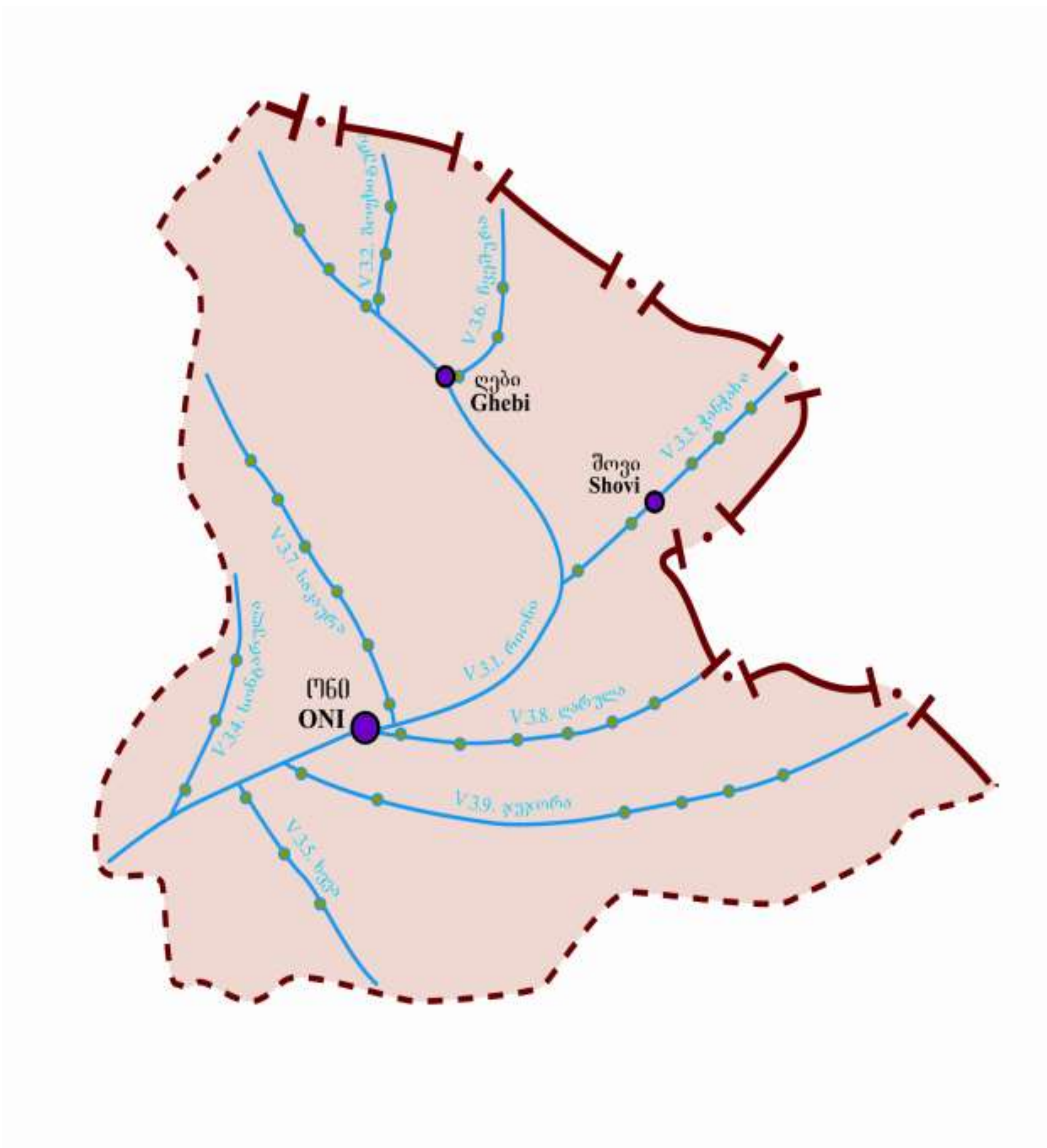
[18] http://hpp.minenergy.gov.ge/index.php?lang=eng

<u>Figure 2.2</u> Schematic of the Ambrolauri Municipality River System



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

<u>Figure3.3:</u> Schematic of the Oni Municipality River System



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

Fuel wood is formally defined as trees that will yield logs suitable in size and quality for the production of firewood logs or other wood fuel, the logs of such trees.[19]Other wood fuels include woodchips, wood pellets, and wood briquettes, bark, sawdust and shavings. In Georgia only firewood is formally recognized, inventoried, and provided permission for logging.

There is only one recognized document, which deals with problems of the forestry sector in Georgia, mainly fuel wood, which can be relied upon as a reliable source of data and analysis. This is "Wood Energy Resources of Georgia and Their Efficient Utilization" produced by the Energy Capacity Initiative Project in 2010 (Contract No. ECI-GA-20).[20]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.[21]According to this report Racha-Kvemo Svaneti region occupies the second position in Georgia by part of the total territory covered by forest – 57% or 265.63 thousand ha, althought his is characterized only for the Svaneti part of the region, while in Ambrolauri and Oni municipalities forest covers about 35-50% of the territory. By this indicator they do not belong to the most forested parts of Georgia. Ambrolauri municipality claims that forests occupy 69,000 ha of municipality area, while Oni municipality defines this area as 72,000 ha. This is 60% and 53% of their respective territories, which appear at odds with the reports.

This assessment accurately characterizes the situation existing in the sector, which is considered as one of the least organized and transparent in Georgia, as well as an object of constant controversy. In this case it means that any information cited may be controversial. In such cases it is preferred to rely on information provided by official sources, like municipalities and the Forestry Department – Legal Entity of Public Law under the Ministry of Environment Protection of Georgia.

According to the official data provided by the Regional Forestry Department of Racha and Kvemo Svaneti, the total amount of wood intended for energy purposes (i.e., firewood) makes up about 70,115 m^3, of which 42,028 m^3 are represented by lighter woods –such as fir, with a density of 410-500 kg perm^3—and 23,865 m^3 are represented by heavier woods – such as beech, with a density of 710-800 kg per m^3.[22] This latter case belongs to the category of very good trees according to their usefulness for heating purposes. Presented in caloric terms this means that the formally available amount of wood for energy purposes amounts to 126,207,000 kWh.[23]Assuming that the average local household needs 8-10 m^3 of firewood per year, all local households combined may need approximately 79,560-94,450 m^3, i.e. even officially supplied data shows that the available fuel wood resources are not enough to satisfy the current, and perhaps rather unsustainable local demand.[24]

[19]http://www.websters-online-dictionary.org/definitions/FUELWOOD
[20]Unfortunately this report exists only in Georgian.
[21]"Wood Energy Resources of Georgia and Their Efficient Utilization", p. 20.
[22]4222 m^3 were not categorized by species.
[23]We arrived at this number by multiplying the total amount of fuel wood in m^3 by 1800 kWh, which is a rather approximate calorific value for beech and fir, which more or less coincide. Of course such calculation is rather approximate, but it serves the purpose of this report, since it defines the general trends. More reliable data needs special research, which has never been implemented in this country and it is not planned, as far as we know.
[24]See Chapter 4 for more details

3.Energy Sector

4.1 Consumption

4.1.1 Electricity

Electricity in Racha is supplied by JSC ENERGO-PRO Georgia, which is owned by the ENERGO-PRO a.s., a Czech based company. This company serves two-thirds of Georgian electricity customers, including residential users, as well as commercial and state organizations.

In Ambrolauri, the municipality company serves 10,292 residential customers, of which 3,625 are metered (35.2%). About 313 are commercial and budget organizations (all of these have individual meters). In Oni there are 6,037 residential customers, of which 2,910 (48.2%) are metered. There are 209 commercial and budget consumers, all of whom have individual meters. It is important to stress that the absence of individual metering among the population usually leads to confusion and often to conflicts, since the exact amount of consumption by each household is unclear. This is especially true in such cases where small businesses are not registered as commercial customers, and obviously passing along the rebated cost of their electricity consumption to other customers.

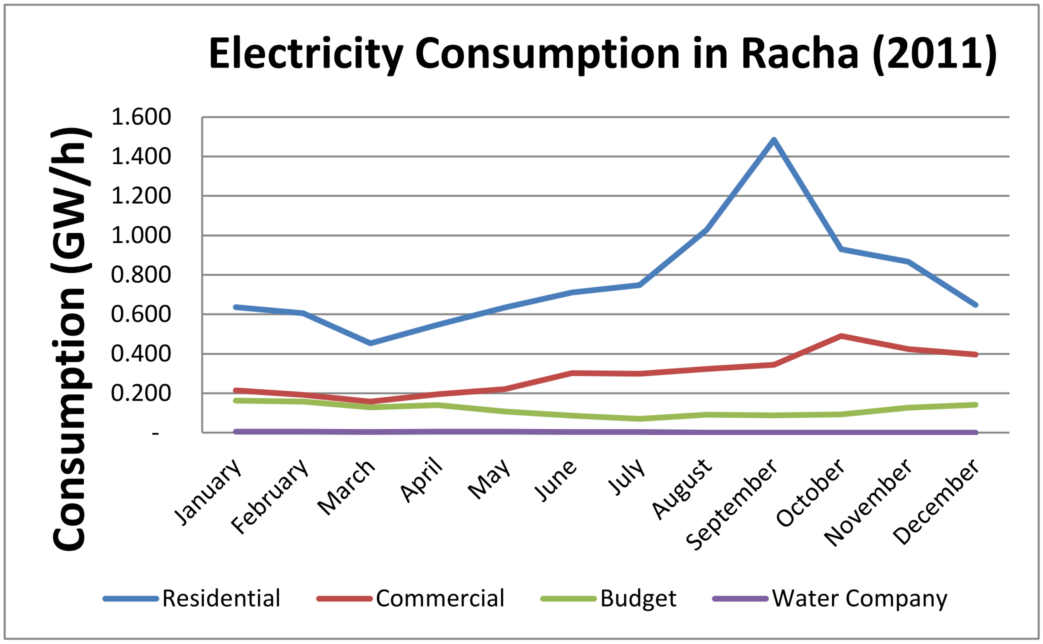
Electricity tariff for population is ~ GEL 0.13 per KWh (USD 0.08), while for commercial consumers it is GEL 0.16 (USD 0.096).

On average, the population accounts for about 2/3 of all electricity consumed in both municipalities. The network losses are between 5.2-6%.

The company receives 1.3-1.5 GWh electricity in summer and 0.6-0.7 GWh during the winter.

There are two important findings that can be drawn from the data provided from the charts below including a comparative analysis of population and Energo-Pro residential customer data. First- there are approximately 9,400 households (circa 22,700 people) in Racha, in which electricity is supplied to 16,392 residential (individual) customers. Thus, there are about 75% more residential customers than households. Second – every year starting from 2007, annual residential electricity consumption increases sharply in August, then peaks in September, before it again recedes to approximate August levels in October and continues to recede until its absolute minimum in March-April. This trend has also maintained in the commercial sector, although it is not as sharply pronounced. The residential sector energy consumption maximum is almost 3 times higher than the minimum. While in the commercial sector this difference is not that sharp –consumption here approximately doubles, more so in Oni, than in Ambrolauri.

<u>Figure 3.1:</u> Electricity consumption in Racha in 2011



<u>Source</u>: JSC ENERGO-PRO Georgia

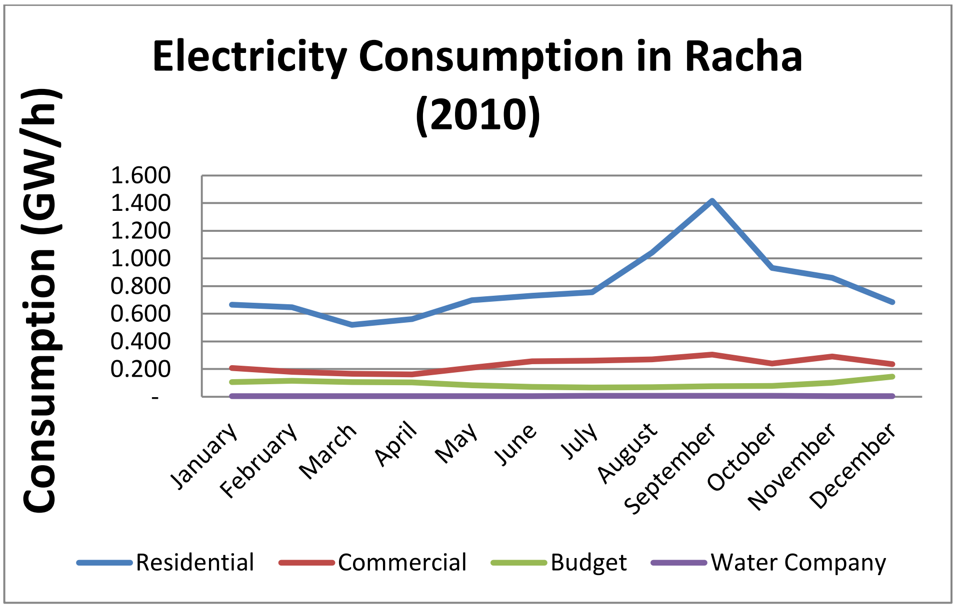
There can be two reasons for such a distribution of energy consumption:

a) There are plenty of people (about 7,000 households based on the data provided above), who do not reside permanently in Racha, but have housing there. Naturally the vast majority of such people are migrants from the region, who do not want to sever ties with Racha and use it as a convenient place to spend the summer holidays, or even more so to receive some additional (mostly non-monetary) income from the land they own.

b) Racha is turning into a popular tourist destination, which also adds to increasing energy consumption. Nevertheless, this is not as important a factor as the previous one since consumption peaks in September, the first month after the active tourist season. It also does not affect the commercial sector as much as it affects the residential sector. This implies that there are fewer people who do not have roots in Racha, than those who do. This thesis is supported by the electricity consumption trends by municipalities – in Oni, where there are some established resorts, the summer peak in commercial energy consumption is much more pronounced than in Ambrolauri.

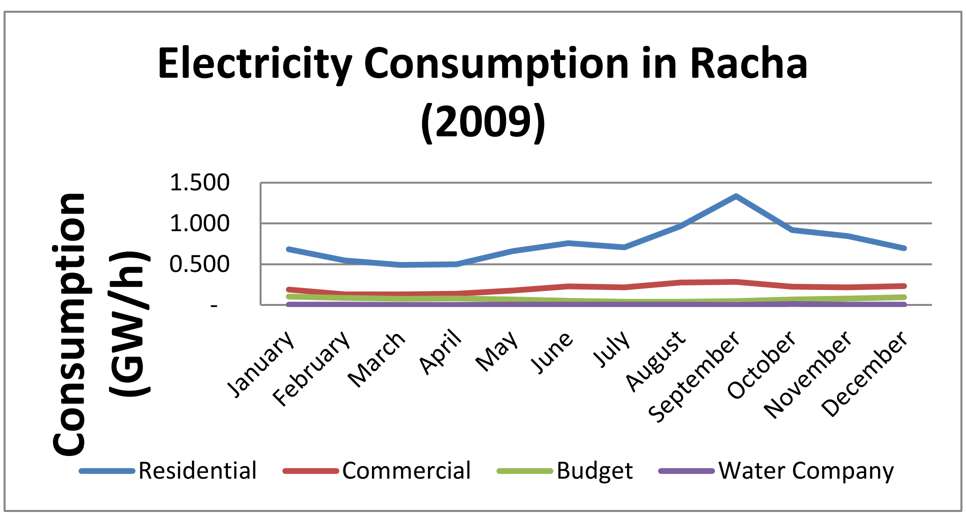
Analysis of electric annual energy consumption trends makes clear one more peculiarity of local consumer behavior. Contrary to generally observed trends, electricity consumption does not increase in winter with its shorter days and drops to its minimum in March-April. This trend is observed both in the residential as well as the commercial sectors. During these months consumption in the residential sector is almost 40% less than the average month throughout the year. This may lead one to the conclusion that not only does the population increase by about 75% during the summer months against the nominal registered amount of approximately 9,400, but it also drops by some 40% during the winter and early spring season. This means that here in Racha we may have to deal with a dramatic seasonal fluctuation in population numbers. Such fluctuation may change local household numbers from some six thousand during the "low tide" in winter to some 16,000 during the "high tide" in September. Although this is only a presumption based on the analysis of electricity consumption data and needs additional research for final verification. Still it is important from an energy sector development point of view, since it makes more difficult policy planning and implementation regardless of the reason. Again, such fluctuations are not unusual for single industry economies and regions based on tourism and recreation, but Racha does not belong to such, and the observed trend could be the result of poverty, increased summertime power demand, and other developmental issues.

Figure 3.2: Electricity consumption in Racha in 2010



***Source:* JSC ENERGO-PRO Georgia**

Figure 3.3: Electricity consumption in Racha in 2009

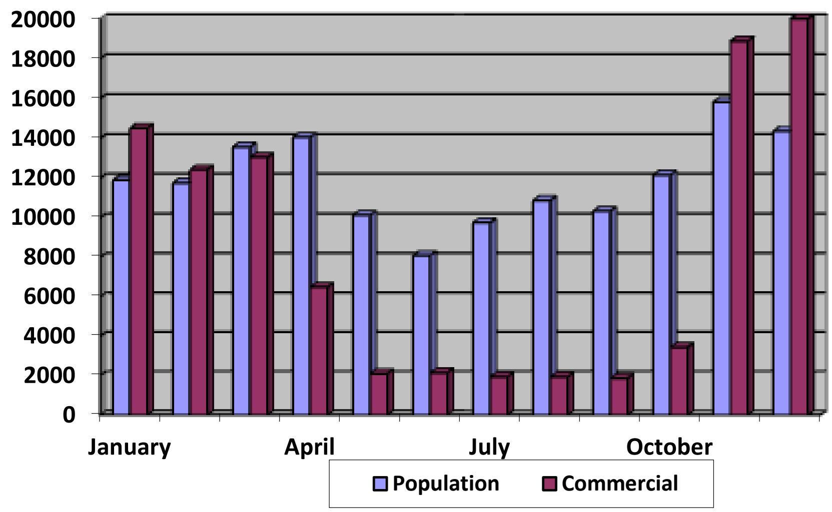


***Source:* JSC ENERGO-PRO Georgia**

3.1.2 Natural Gas

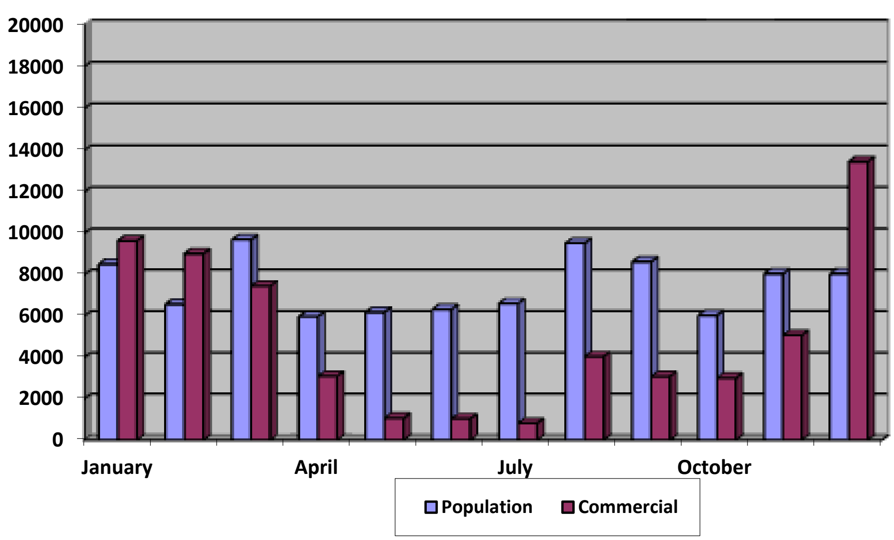
Since 2007, natural gas has been supplied only to part of the town of Ambrolauri by JSC Ambrolauri Gas, which belongs to the Iberia Business Group – trade and industrial holding. The number of customers grew from 224 in 2007 to 570 in 2011, of which 28 are commercial customers. Gas supply was reinstated in Ambrolauri after a long interruption and now is provided to 69% of its former customers.

Figure 3.4: Natural Gas Supply to Ambrolauri Population and Commercial Consumers in 2011 (m^3)



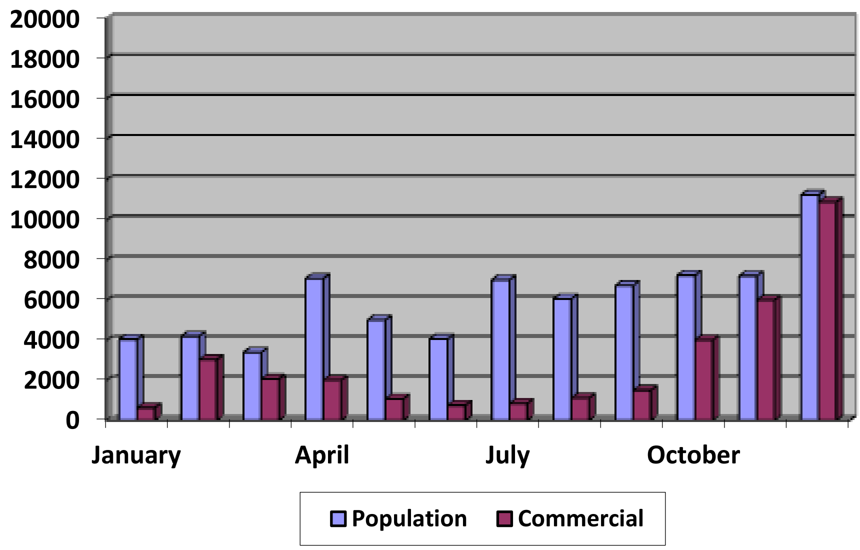
***Source:* Ambrolauri Gas JSC**

Figure 3.5: Natural Gas Supply to Ambrolauri Population and Commercial Consumers in 2010 (m^3)



***Source:** Ambrolauri Gas JSC*

Figure 3.6 Natural Gas Supply to Ambrolauri Population and Commercial Consumers in 2009 (m^3)



***Source:** Ambrolauri Gas JSC*

Ambrolauri Gas planned to increase the number of consumers to 600 in January 2012, although this means that just about 6.4% of Racha households would be provided with natural gas. Expansion outside Ambrolauri proper is also planned, although not to Oni municipality. Danger of landslides is cited as a reason. The average household consumed a minimum of 15 and a maximum of 26 m^3 of natural gas during 2011, which corresponds well with data obtained during the household sample surveys. All other factors considered, natural gas, whenever it is supplied remains the single most reliable and cheapest energy source for cooking, hot water supply and heating in Georgia. Note that both Ambrolauri Gas data and the household survey show that it is not used for heating.

3.1.3 Liquid Fuels

Liquefied propane gas is sold by two outlets in Ambrolauri. One is represented by an individual entrepreneur, Tengiz Tsagareishvili (outlet name – Blue Flame), and till October 2011 was the sole supplier of LPG in the region. Sales volume in 2011 was approximately 70,000 m^3 (~20 tons) at a price of USD 1.98 per kilogram, or approximately 95 kg daily. Sales volume decreased by half from the previous year, mainly due to a sharp increase in wholesale pricing. According to Mr. Tsagareisvili, he was able to pay approximately USD 400 per ton before the oil price hike, and now has to pay USD 1,300-1,500 per ton.

The company Socar Energy Georgia opened its first petrol filling station in Ambrolauri during the fall of 2011, which also sells LPG. The price per kilogram is approximately USD 2.03 and daily sales are about 30-35 kg. [25]

<u>Figure 3.1:</u> LPG outlet in Ambrolauri

3.1.4 Fuel Wood

On August 20, 2010 the GOG issued decree #242 “On Approval of Forest Use Procedures”, which defined how people are able to use forest resources for their own use, which includes firewood as well?[26] After a site for logging is defined and entered into a computer data-base (registered), a person goes to the bank and is required to acquire two receipts - a) payment to a value of GEL 3.00 (~USD 1.80) for use of natural resource; b) payment for services rendered - of GEL 3.00 (~USD 1.80). This person defines the kind of wood and forest lot area to be utilized, and receives a logging ticket. Then this ticket is presented to a forest ranger that issues an acceptance certificate, where the individual numbered trees are indicated. This document states that the person “has a reasonable period to log trees”, whatever that may be. After logging, the ranger inspects the logs and issues a certificate of origin, which is valid for 24 hours, during which time the wood should be transported to the place of destination.

On paper such a procedure looks pretty simple and straightforward, although in practice it is difficult to implement. The main reasons are that the majority of such lots are very hard to access (far from settlements, roads, situated on steep slopes, etc.), plus it is very difficult to remove logs and transport them. Although wood acquired in this manner is much cheaper than purchased on

[25]Speaking about LPG both MrTsagareishvili, employees of Socar as well as respondents of the household survey (see 5. Household Energy Consumption Analysis) were using various dimensions to characterize the product simultaneously – m^3, liter and kilogram. Thus it was decided to use kilograms as a common denominator

[26]The translation is ours, since we could not find an English version of this document

the market (see chapter 4. Household Energy Consumption Analysis), essentially few people use this method to obtain fuel wood in Racha individually or at a household level. As a result, many of the trees set aside for firewood logging are left untouched. On the other hand there are plenty of indications of illegal logging, which may amount to a considerable part of firewood used in Georgia. Members of the SDAP Center field team witnessed in Racha in December 2011 how numerous heavy trucks were parked loaded with logs along the main highway connecting Ambrolauri with the Imereti region, which were harvested quite openly and without any interruption on the slopes immediately adjacent to the road. Such a process under the existing Georgian law should not take place in principle, but it nevertheless happens in reality.

Table 3.1: Allocated and Procured Fuel wood in Ambrolauri and Oni Municipalities, Years 2007-2011

Year	Wood (m^3)	Ambrolauri	Oni
2011	Allocated	30,360	11,420
	Procured	10,591	5,233
2010	Allocated	37,595	26,145
	Procured	13,638	6,647
2009	Allocated	33,145	23,047
	Procured	15,067	7,074
2008	Allocated	33,783	19,558
	Procured	15,639	8,490
2007	Allocated	26,950	16,728
	Procured	13,278	9,986

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

These results mainly coincide with an analogous table provided for all Georgian municipalities as already mentioned in "Wood Energy Resources of Georgia and Their Efficient Utilization" (table 4.1, p38). Still these numbers cast some doubt since they are not easily verifiable. There are about 9,400 households in both Ambrolauri and Oni municipalities. According to the results of the SDAP Center household survey, each household consumes 8-10 m^3 of wood per year (see Table 3.1). This gives us app. 80-90,000 m^3 of total annual firewood consumption. Even if these calculations are wrong, the "Wood Energy Resources of Georgia and Their Efficient Utilization" states that the average household in Georgia consumes 6 m^3 of hardwood firewood annually, which means that even in such a case the population of Racha should consume firewood on the order of 57,000 m^3per years. Even if it is assumed that a large part of the Racha population moves elsewhere during a long winter (by about 40% as we suggest in 4.1.1) the discrepancy between volumes formally stated in Table 3.1 is glaring.

4. Household Energy Consumption Analysis

During a field visit to Racha, the SDAP Center representatives conducted a household sample survey in order to investigate the typical energy consumption patterns on the household level. In order to select households which are representative of a larger population SDAP team used the representative sampling method. In this survey a total of 25 households, living in typical residential buildings were surveyed in order to define energy use trends, practices, and expenditures. These including 6 from Ambrolauri proper, 7 from villages near Ambrolauri (4 in Tsesi village and 3 in Sadmeli), and 5 from Oni and 7 from Oni municipality villages (3 in village Chala and 4 in Lachta).[27] 25 typical residential buildings were randomly selected for survey. The sampling results were extrapolated to make generalization about upper Rioni 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 a questionnaire developed specifically for this purpose (see Annex 1). This questionnaire used on a household level consisted of 6 sections:

1. Demographic information (8 questions)
2. Energy sources used (20 questions)
3. Occupied building information (5 questions)
4. Building structure (22 questions)
5. Heating/air conditioning systems (21 questions)
6. Energy expenditures (10 questions)

The main finding of the sample survey is that the type of energy consumption and impact on the household is mainly defined by the household income and is similar for both urban and rural settlements.

Of all households surveyed in Ambrolauri, 3 defined themselves as being of middle income and 3 as poor; in Tsesi – 3 poor and 1middle income, Sadmeli – 2 poor, 1middle income. In Oni municipality – Oni proper – 3 poor, 2 middle income, Chala – 2 poor, 1 middle income, Lachta – 2 poor and 2 middle income. No household defined themselves as having a high income.

Of those households considered middle income, every household but one had at least one member employed in the government sector (for this region government employment guaranteed a relatively high income by local standards).[28] The only exception from the rule was a household where the head of the family was employed at the Ritseula HPP. Almost all poor families represented were employed in agriculture (which under local conditions provides little or no monetary income), or were unemployed.

All households were provided with an intermittent electricity supply, save for Sadmeli; all had individual meters. The level of satisfaction was high, with some exceptional complaints about the quality of electricity, which often fluctuates during inclement weather (torrential rain, heavy snow, etc.). Households mainly consume 100-200 kWh of electricity per month, although more affluent families use up to 250 kWh/month and the poorest use less than 100 kWh/month. Household spending on electricity supply is mainly in the range of USD 90-120 annually, although there are exceptions (in the case of the higher income or large poor families), when this runs higher than 180 USD, in 2 cases it was as high as USD 270.

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[27]The selection of geographical area for the survey was to a large extent determined by the fact that the field trip took place in December, in snowy conditions, when traveling through the region (and to the region as well) was a difficult, and sometimes a dangerous undertaking. Although villages as well as residential buildings were selected after consulting representatives of local authorities, who confirmed them as typical for the area.

[28]Although monetary evaluation of household income was not the aim of this survey, one family, which was the most affluent among all, in an off the record conversation stated its annual income in the range of USD 9,000.

Natural gas is supplied only to part of the town of Ambrolauri. The level of satisfaction with the gas supply company services is high. Households with a gas supply use it sparingly, just 20-30 m^3 per month. Only in one case did the consumption reach 80 m^3 per month. Annually this costs approximately USD 70-270.[29]

Outside Ambrolauri (and partly in Ambrolauri) people mainly rely on liquefied gas (LPG) for cooking.[30] Such gas is readily available locally, although it is not as cheap for local customers at USD 2.00 on average per kilogram. Annual expenditures were ranged from USD 15-30 to 84-180, distributed evenly by the number of households.

<u>Figure 4.1</u> Electricity consumption was determined based on Energo Pro bills

Virtually in all surveyed households firewood was the main source of energy and the largest single energy expense. 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.

Compared to all other energy sources, firewood costs these households much more than all other energy sources combined. Nine households opted for logging their own firewood as proposed by the government. It reduced the price of wood 2.5-3 times compared to commercial market retail rates, but all respondents complained that the lots where they could log the wood were extremely difficult to access, thus making the harvesting process very difficult and inconvenient.

[29] Price per 1 m^3 of natural gas for population is app. USD 0.30
[30] 3 households of 24 did not use even such fuel.

<u>Figure 4.2:</u> Firewood stored for winter

Households spent in the range of at least USD 300 per season, and almost half of respondents spent USD 600 per season for firewood (the lowest range was USD 120 per season). All respondents, both poor and affluent, characterized firewood as very expensive and difficult to access.

Interestingly, the introduction of natural gas to Ambrolauri did not substantially change energy use patterns. All households with a natural gas supply heated their own homes with firewood, and in only one case was a wood stove heating supplemented with a homemade (and dangerous to use) gas heater.

<u>Figure 4.3:</u> Homemade Gas Heater

<u>Note:</u> *This unit is illegal and dangerous for health.*

All households follow the common home heating patterns observed throughout Georgia (outside large cities as well as for poor households within large cities) – in winter people vacate all rooms in the house, save for one or two (rarely more) where a wood stove is installed.[31] They live there, often cook, and sometimes (depending on the size and composition of the family) they retire to unheated rooms during the night.[32] This was the pattern stated by all respondents in Racha, irrespective of their income and social status. All households use heating only during the daytime.

Questionnaire –*Does your existing heating system create comfortable conditions?* 16 respondents cautiously answered – from time to time. The rest were either totally satisfied (6 households), or totally dissatisfied (3 households). Total or partial heating system dissatisfaction was primarily ascribed to either poor insulation of buildings or inefficient wood stoves, or both.

Questionnaire - *Are heating expenses justified from the household budget expenditures point of view?*
Just one household said no, while all households of middle income 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.

<u>Figure 4.4</u>: Typical Arrangement. Families are usually living "around the stove" in winter.

The same approach may be observed with regards to lighting. Only one household intentionally replaced all incandescent lamps with the modern fluorescent ones for energy efficiency. In all other cases people live under self-enforced energy saving operational conditions. To save money, they simply switch off lighting throughout the house except for a single room, where they use older style incandescent bulbs.

No household had an air conditioner. Only 3 had various models of electric water tank heaters (for bathrooms).

[31]In one case a middle income family heated four rooms by wood stove and electric radiators, but there were 3 children under 15 (two girls and 1 boy).
[32]Sometimes people simply live in kitchens in winter.

Questionnaire - *What part of the household annual budget do they spend on energy?* 15 respondents answered about 50%, two – 10%, one 15%, and the rest - more than 60%. Even middle-income households spent half of the budget on energy if there were 5 or more family members. People employed in agriculture invariably spent most of their money on energy, mostly for heating. The reason is not only the high cost of firewood, but also that they have little cash income.

There were 6 households, who claimed to spend about 4/5 of their budget on energy. In one such household (Oni municipality, village Chala) there were 5 members, 2 less than 15 years old, 2 – 16-64 and 1 older than 65. Only one was employed in agriculture, with no guaranteed monetary income. Only one household member – the retiree, had a guaranteed monetary income as an old age pension, circa USD 720 per year. They claimed to spend annually about USD 750 on energy, which is more than the money they are formally entitled to. They do not use any LPG for cooking, have no natural gas supply, and have only 4 traditional incandescent bulbs at home. They just spend 360 kWh of electricity annually. 4 more households were also unemployed, or there was just one person in household employed in agriculture.[33]

It's no wonder that only three households rated their energy expenditures as not a problem, 5 rated them as medium difficulty, while the rest characterized energy expenses as either very difficult or even unendurable.

Figure 4.5: Bathroom with an Electric Hot Water Boiler.

There are two key conclusions – the first is that for economically depressed regions like Racha, the majority of people do not have sufficient income to provide themselves a satisfactory energy supply. The second is that for the few that do have adequate income, they feel rather comfortable as shown by the survey. Amelioration of the existing situation is clearly beyond the scope and

[33]Only in one case did the household claim they spent 80% of their budget on energy looked doubtful. This one consisted of 2 retirees, meaning that their guaranteed annual budget should be about USD 1,440, which is a large sum for Racha, while they spent about USD 680 on energy.

budget of the INRWM project. But many of the observed problems come from the inability to manage the available energy resources properly, and this can be ameliorated (at least to some extent) through simple information dissemination and implementation of pilot projects that demonstrate the low-cost of energy efficiency and viability of renewable energy under various donor programs, including INRMW program.

For instance, as it was observed, even in Ambrolauri, where people have a reliable natural gas supply, they still use firewood for heating instead, despite it being very expensive, hard to access, and inefficient. At the same time on the Georgian market there are readily available various models of modern natural gas space heaters, which provide much more comfortable conditions, heat larger spaces, and are safer and less expensive to use than wood stoves. Depending on the size, their payback period may be as short as one or two years; however, homeowners are reluctant to make the initial capital cost payment to install a more efficient and cheaper system to run a gas stove. Some HH probably are reluctant to switch over to gas since they are not sure that gas will be supplied reliably, based on past experience, when it was suspended without any warning for 14 years.

Outside Ambrolauri efficient modern wood stoves can be demonstrated and recommended. Such efficient stoves consume 1.5-2 times less firewood than conventional woodstoves leading both to considerable savings for consumers as well as to an appropriate reduction of wood use from local forests. Demonstration and recommendation of simple weatherization measures is also a viable option regarding all local households.[34] There are opportunities to develop new commercial programs for paying for new energy efficient hardware on an installment (credit) basis, such as more efficient wood or gas stoves.

Figure 4.6: Energo Pro Company Branch Office in Ambrolauri. The facility is also heated with a wood stove.

The survey results confirmed again the earlier observations that the energy balance in Upper Rioni Pilot Watershed Area is primarily defined by demand, rather than by supply. There is abundant

[34] Due to time and resource limitations SDAP was not able to research energy consumption practices in the government and business sectors. But while visiting various organizations and business offices for data collection during the field trips showed that they usually tended to follow the same practices as the local population. They use wood stoves for heating (even Energo Pro electricity company office in Ambrolauri), or even manage to function (somehow) without any heating at all.

energy available on the market, but there is a reduced demand from both business and the population in general. As a result, the potential energy benefits for the population are not realized in most cases due to limited financial and other resources for energy. People simply have inadequate finances to provide themselves a satisfactory return in terms of creating comfortable living (and working) conditions.

The type and state of housing that these households occupy also play an important role from an energy consumption point of view. As mentioned above, heating is the main consumer of energy for any given household, and its efficiency is to a large extent reduced due to nonexistent or poor building envelope insulation.

Most houses are typically built from common cement blocks or stone, which are characterized by heavy heat losses and are able to provide comfortable conditions only through constant heating.[35] By heating premises only during the day time, users simply create a situation of expensive discomfort. In 10 out of 24 cases families heated only 2 rooms with an average area of 30-50 m^2; in two cases there were 3 heated rooms (but the total area in one case was still 50 m^2); and in one case the family heated all 4 rooms with 150 m^2 of area. In all other cases families were restricted to heating just one room with an area of 20-25 m^2.

<u>Figure 4.7:</u> Typical Un-insulated Cement Block House with Poor Thermal Characteristics.

In addition, only in two cases were there metal-plastic framed windows installed, and in only one house were they double-glazed. In all other cases window frames were made of wood, with single glazing and were not weatherized. The average design heating temperature for Ambrolauri is -9^o C and -10^o C for Oni. Even the old Soviet building codes defined mandatory double-glazed windows for buildings in these climatic conditions to support minimal comfort.

[35]Parts of houses (in one case the whole house) have sometimes external wood walls. In case of Georgia this means that these walls are constructed from relatively thick boards without any additional insulation. To heat properly such premise is hardly possible.

Leaky single glazed windows with wooden frames can support more or less comfortable conditions inside houses only through constant heating. The same considerations can be applied to the uninsulated doors used, which are not much better than the windows, with only sturdier frames. Roofs are also usually constructed from various kinds of metal, also with heavy heat losses and without any adequate insulation.

Essentially homes in this region are virtually "leaking" the heat out during the heating season, putting their inhabitants at a huge disadvantage in terms of comfort and expenses. They have to pay a rather high price for firewood compounded by inefficient wood stoves and even more poorly insulated building envelopes for their houses. In the end they may have some kind of mediocre comfort for a relatively short time at an exorbitant price. As was mentioned above, the majority of surveyed households spend about USD 600 for firewood during the heating season (up to six months).[36] As experience shows for the same sum one may provide a very high degree of comfort (including hot water and cooking) for more than 100 m^2 of heated area, provided that there are modern double-glazed metal-plastic windows, efficient natural gas boiler, and external walls with relatively good thermal properties.

Figure 4.8: Typical Single Glazed Windows with Non-Weatherized Frames

In any case it looks like Racha population emerges from this situation as net losers, to say nothing about over-exploitation of local forests as a fuel wood resource.

[36]Households paid a maximum of GEL 80-100 per m^3 of firewood (USD 48-60), which is obviously very expensive *per se,* but rather cheap compared to other regions of Georgia. In Goriminicipality in winter 2011-2012 m^3 of firewood according to local officials costed GEL 200 on average (USD 120).

Figure 4.9: **Typical Uninsulated Wooden House**

Below is a summary for a typical household energy budget based on survey results:

On average, households consume:

~1,344 kWh electric energy per year.

~352 kWh of liquefied gas (LPG) or 5,200 kWh of natural gas (where it is available) per year.

~19,358 kWh of firewood per year.

Thus, a total of about 21,054 kWh of energy is consumed annually on average for each household without a natural gas supply, and 25,902 kWh with a natural gas supply.

This data was arrived at through the following calculations:
Electric energy – measured in kWh by metering;
LPG – 1 kg of LPG – 12.87 kWh; 1 m^3 LPG=2 kg;[37]
The firewood caloric value was calculated for beech firewood, which is the most widespread in Racha. 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.[38] This average was used since the moisture content of air dried beech logs is not available.

It can be easily calculated that the typical household spends more than 9/10 of all consumed energy for very inefficient winter heating. In monetary terms this does not look so bad (see Table 5.1), since fuel wood is by far the cheapest fuel per kWh, but still it outnumbers the cost of electricity and liquefied gas used by far, especially if it is purchased on the retail market.

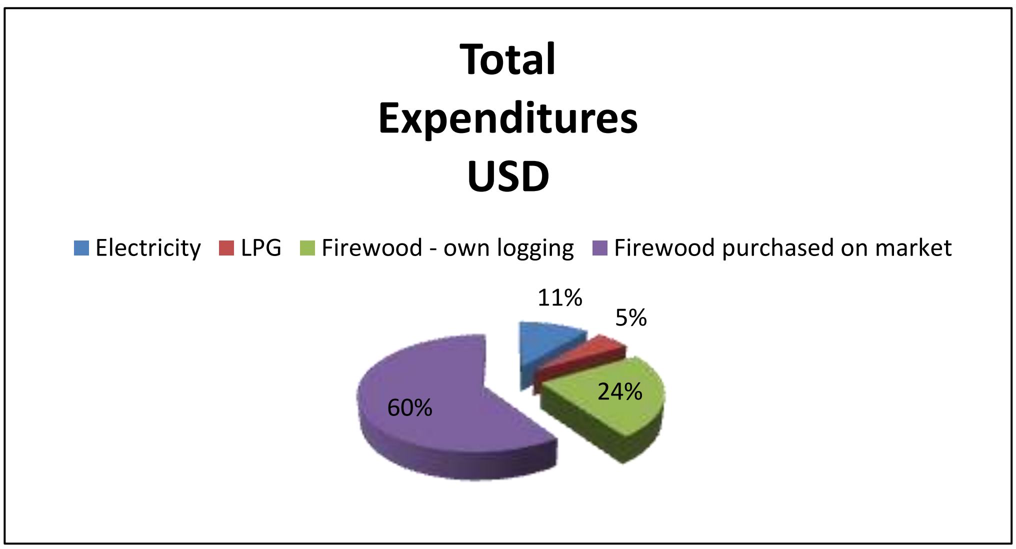
[37] http://www.volker-quaschning.de/datserv/faktoren/index_e.php
[38] http://nuke.biomasstradecentres.eu/Portals/0/D2.1.1%20-%20WOOD%20FUELS%20HANDBOOK_BTC_EN.pdf

Table 4.1: Annual Household Energy Expenses

Energy Type	Total kWh Consumed per year	Price per kWh USD	Total Expenditures USD
Electricity[39]	1344	0.08	108
LPG	352	0.15	53
Firewood - own logging	19358	0.012	232
Firewood – purchased on market		0.03	581
All energy	21054	-	393/742

The Oni Investment Passport developed in 2010 states (p.8) that the average annual income per person in Oni municipality was approximately USD 600, thus justifying claims low-income households that they spend circa 4/5 of their monetary income on energy.[40]

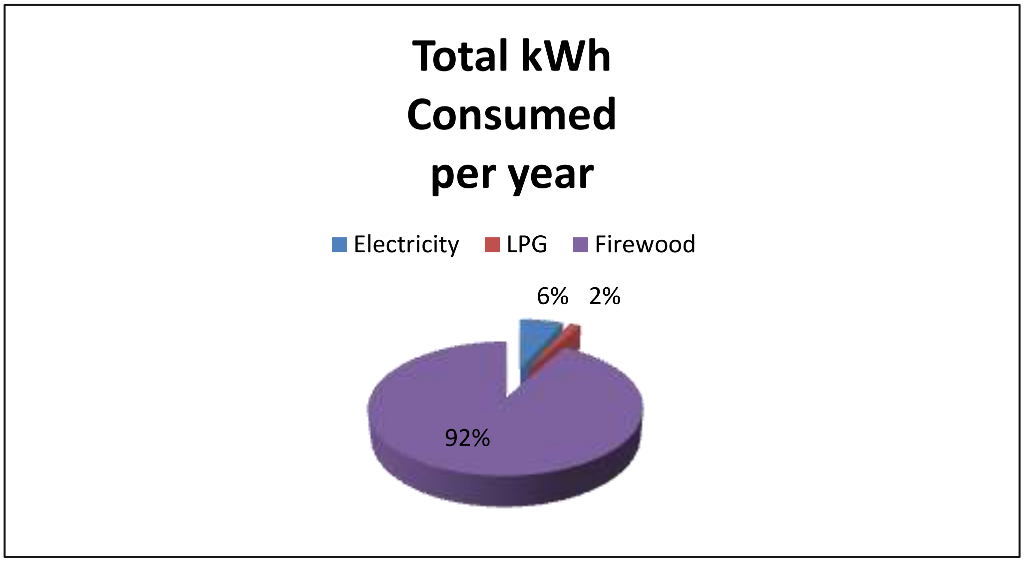
Figure 4.10: Total Expenditures USD



[39]Official data by JSC Energo-Rro Georgia suggests about 614 kWh of electricity consumed by one residential consumer (i.e. household) per year. We do not use this number in the report, since it obviously refers to all registered consumers, even if they are absent from Racha for most of the year. For the survey we interviewed persons permanently residing there. On the other hand, if we analyze electricity consumption per household in August of any given year since 2007, when this consumption (and population, as it looks like) reach their maximum, metered and surveyed monthly consumption figures come very close, to about 100-110 kWh/month.

[40]Oni Minicipality Investment Passport.Ministry of Infrastructure and Regional Development of Georgia, 2010 (in Georgian), 9399-pasporti.oni.pdf. It is also worth noting that the same Investment Passport claims that the vast majority of the population in Oni derives a major part of their income from plots of land, they own, but app. 97% of all produce is consumed within the households and only about 3% is sold, which again shows that households where people are only employed in agriculture receive little to no monetary income. (op.cit. p.7)

<u>Figure 4.11:</u> Total kWh Consumed Per Year



4. Conclusions and Recommendations

Based on a preliminary analysis of documents and data on municipalities within the upper Rioni pilot watershed (Ambrolauri and Oni), the SDAP Center decided to concentrate on the state of the local population with regards to the energy sector. This approach was implemented via a household sample survey, which concentrated on energy use trends, practices, and expenditures on an individual household level. This decision was undertaken because Racha as such emerges as an economically depressed region with a grossly distorted population structure due to migration, with little economic activity to speak of and consequently very limited opportunities for the population to derive monetary income locally from their activities. This clearly creates demand side problems in the energy sector, based on relatively limited demand from both undeveloped businesses as well as transient population.

This approach proved to be justifiable, since it helped to unveil a number of suspected issues that never before have been properly measured and documented. These issues mainly are related to the state of the local population, which in the absence of proper employment and monetary income has to heavily overpay for inefficient heating during a half-year long heating season. Such situation is hardly tolerable since households with such limited means have to spend a high percentage of their income on inefficient heating (but no hot water for instance other than stove top heating for bathing).This is due to inefficient heating systems, poor insulation of houses, and expensive heating fuel (firewood). Thus, a relatively poor HH generally has to spend about the same amount of funds (but a higher percentage of total income), as a more affluent household to meet basic energy needs such as heating, hot water, and cooking. A final concern, but certainly not the least, is that the population is generally uninformed on matters regarding energy savings and energy efficiency even in their most elementary forms.

Below are given the main findings of the report which demonstrate opportunities to improve the situation, and recommend direct interventions by the INRMW project as well as for the local governments in order to better rectify the situation. Thus, there are several avenues for future activities that can be considered as follows:

- 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;
- Third to develop a weatherization service center unit for implementation of the above measures in housing;
- Fourth, to set up small 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 testing procedures of the energy efficient wood stoves aimed at establishing a wood stove certification unit as a strategic goal.

As previously mentioned, local population obviously gives priority to such energy technologies, which can be run with minimum or even no maintenance and running expenses after installation (solar panels, biogas generators, off-grid micro HPP serving their particular village, etc.). 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 the 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 Rioni 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. Thus we 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,[41] 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 transfer into $ 0.039 per 1 kWh, while on average in all 4 pilot watersheds price of 1 kWh of firewood is $ 0,016 - or 2.4 times less. Accordingly replacement of firewood by wood pallets under the current Georgian conditions can hardly be recommended based on the most elementary cost-benefit considerations. Besides pellets require specialized stoves of a different kind, which are very expensive by Georgian standards (and not supplied in this country). The US consumer guides or specialized shops' advertisements for instance, put retail prices of such stoves at $ 1,100 minimum, and $ 1,400-3,000 on average.[42]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 app. USD 1000-1400, depending on producer and model of such panel. This is a solar vacuum collector that provides app. 2000 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 concrete consumer calls for specific calculations. Still the price is the problem, which definitely cannot be solved by the majority of local households without the outside assistance. Thus we prefer to recommend such panels mainly for use by kindergartens (sports schools as well), which definitely run into problems with providing the most elementary energy related services for the pupils. It is obviously easier to provide financing to a relatively small number of such institutions through the central government channels and/or some donor organizations.

Biogas. The price of a standard biodigester (mark BGD-6) on Georgian market is app. USD 2230 (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 efficient wood stoves, which cost less in the order of magnitude. Besides the operation of such biodigester needs at least 4 horned ungulates that is not a common occurrence. 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 money. Thus such biodigesters can be recommended but with reservations, provided that additional investigation is necessary in order to select HHs, which can use such installation (i.e. owning four and more ungulates), although there is the problem of financing installation of biodigester, which is clearly outside the reach of almost any household and calls for special financing schemes.

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

[42]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: Watershed Energy Analyses Methodology

Watershed Energy Analysis (WEA) Methodology

Prepared by the SDAP Center

October 2011

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1. Introduction

Georgia is country rich in natural resources, but the absence of appropriate environmental/energy policies takes away opportunity for sufficient natural resource governance and management, especially on the local level.

USAID/Georgia's Integrated Natural Resources Management in Watersheds (INRMW) Program aims to introduce innovative approaches and reach tangible results in the sustainable management of natural resources. Project envisages administrative improvement such as democratic decentralized decision-making for watershed management at the community level as well as behavior change of women and men in communities and authorities on the use of natural resources.

Energy analysis of pilot Watersheds present itself the indispensable part of (INRMW) Program framework aiming to assess accountability of the local energy sector, development of energy balances and verification of sustainable share of local energy resources as well as development of long range energy planning software tool - Energy Passport. This electronic program presents itself an integrated modeling tool that can be used to track energy consumption, production and resource extraction in the pilot watersheds.

1.1 Background on Watershed Energy Analysis (WEA) Context

The energy sector is one of the important components from the standpoint of general development for any country. Today the information creates the basis for the successful development of any socio-economic system. Without reliable, comprehensive upgradable data base such development is hardly possible.

In Georgia natural resource endowment, sufficient energy assessment and appropriate energy management within framework of INRMW program can improve conditions of small town and rural population in the country's regions providing them with affordable local energy resources contributing to small business activities as well as to the country's energy independence and energy security.

Energy research concept of the above project is based on the development of energy balances of pilot watersheds with the purpose to improve accountability of the Georgian energy sector on the local level aiming at identification of a sustainable share of local renewable energy resources and energy efficiency improvements. The conducted energy analysis will lay down the foundation for development of a long range energy planning software tool – i.e., the Energy Passport. 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 well as a policy analysis tool, that can assess the effects - physical, economic, and environmental - of alternative energy programs, investments, and actions.

Energy assessment of selected watersheds under INRMW program has its logical framework in which data collection, creation of database and development of energy balance constitutes its indispensable part helping to determine energy production, distribution and consumption trends as well as quantify input and output flows.

An assessment of an energy balance model of any given country or region that aims forecasting future trends needs access to reliable and concise energy statistics.

1.2 Main Data Sources

In selected watersheds within the framework of the INRMW program statistical energy data sources are used that cover electricity generation, transmission, distribution and supply. Energy data sources will also include other fuel sources for energy supply and consumption purposes. These data will be distinguished by fuel source and by end-use sector. The energy balance data for any pilot watershed will present annual energy production, conversion and consumption.

2. Methodology[43]

2.1 Definition of Energy Balances

The Department of Energy and Climate Change (DECC) of International Energy Agency - "An overall energy balance (referred to as "energy balance" in the rest of the chapter) is an accounting framework for the compilation and reconciliation of data on all energy entering, exiting and used within the national territory of a given country during a reference period. The energy balance expresses all forms of energy in a common accounting unit, and shows the relationship between the inputs to and the outputs from the energy transformation industries. In the energy balance all energy flows should be accounted for, and the balance is based on the first law of thermodynamics which states that the amount of energy within any closed system is fixed and can be neither increased nor diminished unless energy is brought into or sent out from that system. Energy balances show the commodity balances in a way that explains fuel conversion and the dependence of the supply of one fuel on one another. It presents the energy flow as the primary fuels are processed or used and as the consequent secondary fuels are produced and used.

The energy balance is a way of reporting energy data in a common unit and with products aggregated by category: coal, oil, petroleum products, gas, biomass, etc. It allows comparison of the shares of each source in the energy supply of a country or region and in each sector of economic activity. With an energy balance it is possible to analyze energy efficiency and the dependence on energy imports/exports can be determined. With the energy balance at hand it becomes possible to carry out quality control by checking inputs/outputs in the transformation sector as well as to solve discrepancies".

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2.2 Overview of Energy Balance Dimensions

Energy balance databases are based on three principal components: (1) products, (2) flows, and (3) time. *Products* represent various energy sources. These being natural gas, crude oil and petroleum

[43] This section is mainly based onhttp://www.iea.org/stats/docs/statistics_manual.pdf and http://www.energy.ca.gov/2005publications/CEC-500-2005-068/CEC-500-2005-068.PDF

products, coal, electricity, and some other energy sources like solar, wind, geothermal, or hydro. One should distinguish between primary electricity produced from renewable sources such as hydro, and secondary electricity produced from converted thermal energy. *Flows* represent supply, transformation, and consumption of energy. The transformation represents the energy used to extract and process energy resources as well as the energy inputs themselves that are transformed into secondary sources (for example the crude oil that is refined into petroleum products). The consumption phase defines all the end uses of energy throughout the economy. *Time* refers to the calendar year or years of the energy data available. An energy balance as it is consists of a balanced presentation of supply, transformation, and consumption data in a given year. Table 1 shows a simplified energy balance form. The positive sign (+) indicates where energy is produced or imported and the negative sign (-) indicates where energy is consumed or exported. Not all fuel types are used to produce each type of energy shown in the balance, and this is indicated by "N/A". An energy balance database allows a user to see a time series of flows for a given product (e.g., the supply, transformation, and consumption of natural gas over some range of years). But the complex methodology is necessitating by need to balance all flows, across all products, for a single year. In addition to the three principal components, there may be others also presented in such database.

Table 1 Example of the simplified energy balance form

Flows	Natural Gas	Crude Oil	OtherPetroleumProducts	Coal	Hydro	Other renewables	Wood Biomass	Electricity	Total
EnergySupply									
Production	+	+	N/A	+				+	N/A
Import	+	+	+	+				+	+
Export	-	-	-	-				-	-
BunkerFuels	N/A	N/A	-	N/A				N/A	N/A
NetStockWithdrawals	+/-	+/-	+/-	+/-				N/A	N/A
Transformation									
ElectricPlants	-	N/A	-	-				N/A	+
OilRefineries	-	-	+	N/A				N/A	-
End Use Consumption									
Industry	-	-	-	-				-	-
Transport	-	-	-	-				-	-
Residential Buildings	-	-	-	-				-	-
Commercial Buildings	-	-	-	-				-	-
ElectricityOutput (GWh)	+	+	+	+				+	+

Flows	Natural Gas	Crude Oil	OtherPetroleumProducts	Coal	Hydro	Other renewables	Wood Biomass	Electricity	Total
EnergySupply									
Production	+	+	N/A	+				+	N/A
Import	+	+	+	+				+	+
Export	-	-	-	-				-	-
BunkerFuels	N/A	N/A	-	N/A				N/A	N/A
NetStockWithdrawals	+/-	+/-	+/-	+/-				N/A	N/A
Transformation									
ElectricPlants	-	N/A	-	-				N/A	+
OilRefineries	-	-	+	N/A				N/A	-
EndUseConsumption									
Industry	-	-	-	-				-	-
Transport	-	-	-	-				-	-
ResidentialBuildings	-	-	-	-				-	-
CommercialBuildings	-	-	-	-				-	-
ElectricityOutput (GWh)	+	+	+	+				+	+

2.3 Energy Conversions

The International Energy Agency requires data for an energy balance to be displayed in a common energy unit to permit comparison and balancing between flows and products. However, data are first collected in physical units, such as volume and mass. Conversion from physical units to energy units is determined by the quality of a product and can vary. Depending upon what fuel is used conversion factor distinguish caloric values of fuels. Usually these energy units are displayed in tones of oil equivalent (toe), terajoules (TJ), British Thermal Units (Btu) or kWh.[44]

3. Energy balance flows

3. 1 Energy Supply

Flows of energy available to the country/region prior to transformation and consumption are reflected in the *energy supply* phase of an energy balance. The energy supply flow includes local energy production, imports, exports, international marine bunkers, and net stock withdrawals.

[44] The **tonne of oil equivalent** (**toe**) is a unit of energy: the amount of energy released by burning one tonne of crude oil, approximately 42 GJ. Joule is a derived unit of energy, work, or amount of heat in the International System of Units. the**terajoule** (TJ) is equal to one trillion (10^{12}) joules. One joule equals 2.7778×10^{-7} kilowatt-hours. A Btu is defined as amount of heat required to raise the temperature of one 1 pound (0.454 kg) of liquid water by 1 °F (0.556 °C) at a constant pressure of one atmosphere. One Btu equals 0.000293 kWh.

Local (indigenous) energy production means the primary energy produced within the country (state)/region. It reflects only primary forms of energy such as natural gas crude oil, coal, and production of primary electricity, but also the heat content of the energy released for production of electricity from nuclear, geothermal, biomass, municipal solid waste, and landfill gas.

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Imports of energy mean imported primary energy products, as well as secondary products such as refined petroleum products and electricity. These secondary products are not shown in the transformation sector, because the process of transforming the energy does not occur within state boundaries. *Exports*, likewise, include all energy sources shipped outside of targeted country/region borders.

International marine bunkers indicate deliveries of liquid fuels to ocean-going vessels for international destinations. In the IEA balances, only the fuel used for international m*arine* bunkers is deducted from domestic energy supply.

Net stock withdrawal shows the net quantities of fuels taken from or added to stock over the course of the year. A positive number shows that a net amount of fuel was withdrawn from stock and thus contributed to the year's supply. A negative number means that overall, fuel has been added to stock, reducing the quantity made available to the transformation or consumption flows. For natural gas, net stock withdrawal equals the natural gas withdrawn either from underground storage or liquefied natural gas (LNG) storage.

Since domestic production and imports are always shown as positive numbers, and exports and marine bunkers are shown as negative numbers, the sum of all the supply flows for any given product results in the total amount of energy from that source for that year.

3.2 Energy Transformation

According to the IEA the transformation phase of an energy balance accounts for two distinct aspects of energy provision: (1) energy inputs that are ultimately converted to secondary sources, and (2) the energy used for the extraction and processing of energy resources (e.g., coal mining, oil and gas extraction, process energy use at refineries).. Following the EIA classification data sets consist of: (1) utilities; (2) independent power producers (IPPs); (3) combined heat and power (CHP), electric power sector; (4) CHP, industrial sector; and (5) CHP, commercial sector. Combined heat and power facilities are required to report only the fuel used to generate electricity that is either consumed on site or sold. The quantity of fuel used to generate heat or steam for industrial/commercial purposes is not included, and is therefore shown as part of end use consumption (included either in manufacturing or services).

The consumption of energy needed to operate refineries or power plants is provided under the "Energy Sector: Own Use" category, as is the energy required to extract energy resources. This may consist of purchased electricity or natural gas or energy recovered on site. For example, a significant portion of the crude oil that enters a refinery is ultimately used for process energy. This category also includes the energy used for oil and natural gas extraction and energy used for coal mining. Electricity distribution losses occur in the transmission and distribution of electricity to consumers

3.3 Energy Consumption

Energy is consumed for many different purposes. Thus it may be advisable to track not only changes in the total country/region energy consumption, but also to observe trends in end-use consumption within various end-use sectors. Energy consumption data have been categorized into four principal end-use sectors: (1) industry, (2) transportation, (3) services, and (4) residences.

Below are present examples of the most typical actual energy balance. This is the simplified variety of such balances, since the full versions of such, even for a relatively small country like Ireland, for instance includes at least 2 200 variables.[45]

[45] http://www.seai.ie/Publications/Statistics_Publications/Energy_Balance/

2009 Energy Balance for Georgia

in thousand tons of oil equivalent (ktoe) on a net calorific value basis

SUPPLY and CONSUMPTION	CoalandPeat	Crude Oil	Oil Products	Natural Gas	Nuclear	Hydro	Geothermal, Solar, etc.	Biofuels and Waste	Electricity	Heat	Total*
Production	137	51	0	6	0	637	44	382	0	0	1258
Imports	83	5	903	1080	0	0	0	0	22	0	2092
Exports	-16	-41	0	0	0	0	0	0	-64	0	-121
International MarineBunkers**	0	0	0	0	0	0	0	0	0	0	0
International AviationBunkers**	0	0	-41	0	0	0	0	0	0	0	-41
StockChanges	0	0	0	0	0	0	0	0	0	0	0
TPES	**205**	**15**	**861**	**1086**	**0**	**637**	**44**	**382**	**-42**	**0**	**3189**
Transfers	0	0	0	0	0	0	0	0	0	0	0
Statistical Differences	0	0	-5	0	0	0	0	0	-6	3	-7
ElectricityPlants	0	0	-67	-262	0	-637	0	0	730	0	-237
CHP Plants	0	0	0	-148	0	0	0	0	6	43	-99
HeatPlants	0	0	0	0	0	0	0	0	0	0	0
GasWorks	0	0	0	0	0	0	0	0	0	0	0
OilRefineries	0	-15	12	0	0	0	0	0	0	0	-3
CoalTransformation	0	0	0	0	0	0	0	0	0	0	0
LiquefactionPlants	0	0	0	0	0	0	0	0	0	0	0
OtherTransformation	0	0	0	0	0	0	0	0	0	0	0
Energy Industry Own Use	0	0	0	-77	0	0	0	0	-92	-4	-173

Losses	0	0	0	-58	0	0	0	0	-93	-2	-153
TFC	**205**	**0**	**802**	**541**	**0**	**0**	**44**	**382**	**504**	**40**	**2517**
Industry	**45**	**0**	**29**	**181**	**0**	**0**	**0**	**0**	**113**	**21**	**388**
Transport	**36**	**0**	**677**	**21**	**0**	**0**	**0**	**0**	**57**	**0**	**791**
Other	**123**	**0**	**89**	**266**	**0**	**0**	**44**	**382**	**334**	**19**	**1257**
Residential	18	0	89	201	0	0	38	330	251	10	936
Commercial and Public Services	55	0	0	16	0	0	6	38	66	2	183
Agriculture / Forestry	16	0	0	37	0	0	0	0	18	7	78
Fishing	0	0	0	0	0	0	0	0	0	0	0
Non-Specified	34	0	0	13	0	0	0	14	0	0	60
Non-EnergyUse	**0**	**0**	**7**	**73**	**0**	**0**	**0**	**0**	**0**	**0**	**81**
- ofwhich PetrochemicalFeedstocks	*0*	*0*	*0*	*73*	*0*	*0*	*0*	*0*	*0*	*0*	*73*

* Totals may not add up due to rounding.
** International marine and aviation bunkers are included in transport for world totals.
Source: http://www.iea.org/stats/balancetable.asp?COUNTRY_CODE=GE

It is important to take into account that developing energy balances for pilot watersheds is not the aim of the assessment. Such balance is to be used as a stepping stone, a kind of foundation, to build onto the additional components, which are not included as such, but are necessary for the development of watershed energy passport. Besides energy balance as such is more of an accounting document, rather than a tool for comprehensive analysis and decision making purposes. At this stage of the program development energy balance is used also to define sources of energy data, kinds of data necessary to evaluate state of energy systems at municipal level, to compare and evaluate such data, to define its reliability, to compare data from various sources across municipalities included into four Pilot Watersheds.

By definition, the scope of energy balance does not include:
• Passive energy such as heat gain of the building and solar energy falling on the land to grow crops, etc.
• Energy resources and reserves.

It also does not differentiate for instance between the natural gas supplied by pipeline and liquefied gas, which is rather important for decision making purposes on the level of relatively small territorial units. Energy balance also does not identify energy saving and energy efficiency issues. And the most important – energy balance is the tool for establishing an energy information database on the country level. It is rarely used for inta-country territorial units, usually in case of complex, large ones, like the states of the USA or sometimes provinces of EU countries.

If we use the energy balance approach at all, is because it is based on a well developed, comprehensive methodology for collection, processing, comparison and presentation of data, which is internationally acknowledged and adopted. Besides format of energy balance provides good opportunity for development of software program based on it.

In our case, the standard approach should be modified in order to accommodate additional features, stemming from necessity to satisfy needs of developing comprehensive analytical and decision making tool to be used on the level of small territorial units – municipalities and/or regions of Georgia.

As a result there are a number of parameters, which are not included in the traditional energy balance, but should be used in energy assessment and development of energy passports in the watersheds and/or regions of Georgia.

The list presented below is not the final and can be revised in the process of developing the energy assessment(s) and energy passports. Some items, presented here, may not be attainable at the local level or in the concrete Georgian context. The same applies to the standard energy balance items and definitions. For instance it is relatively easy to trace energy flows across national boundaries, since any more or less functioning country is a semi - closed system in terms of reducing to a minimum of smuggling. At the level of the municipality and/or region, tracing accurately the movement of energy, which is not supplied through centralized systems (electricity, natural gas, etc.), it a daunting task. For instance one may usually fuel a car at filling station, which is located outside the municipality where he/she lives, since such filling station is more conveniently located, or the fuel is cheaper, etc. The same applies to liquefied gas. Depending on the circumstances such transfer may account to a considerable part of fuel consumption on municipality level, the situation which is impossible in the case of country. The another problem of the similar mien stems from the fact that on the country level data on energy flows is gathered and supplied by specialized statistical agencies, while on municipality level one has to deal with individual private companies, which according to the Georgian law have right to refuse to supply any information regarding their activities.

Besides on the country level government monitors and controls all production and flows of energy within its boundaries by default. On the municipality level, energy production (except for off-grid) is clearly outside the control and monitoring of local governments as well as parts of energy flows. Larger energy consumers (especially industrial as well as property of central government) are also outside the local government jurisdiction. Thus the task of properly defining energy consumers that can be monitored, evaluated and dealt with at the municipality level is also very important.

It is also important to preserve all standard items of energy balance disregarding the fact that in case of Georgian municipalities/ regions some items will be definitely missing.

The list of additional items to be added to the standard energy balance in the case of Georgia

Natural energy resources:

Reserves of traditional energy resources as provided in energy balance in accordance to IEA classification - occurrence, quality, quantity, availability, economic value, type of ownership (state, private, mixed, etc.), and owners.

Renewable energy sources (wind, solar, water, firewood, etc.) - occurrence, availability, economic value (type of ownership, owners – whenever appropriate).

Energy production and consumption:

Energy producing enterprises – type, capacity, type of ownership, owners, operational characteristics, output, location, market value (if available), major consumers and/or markets.

Energy distributors - type, capacity, type of ownership, owners, operational characteristics, output, location, market value (if available), major consumers and/or markets, distribution networks.

Energy consumers – type (population, industry, commercial, services, etc.), type of energy supplied, distribution networks and/or points, supply chains, the amount of energy distributed by consumers, prices, in case of stationary supply networks (electricity, natural gas) – metering and geographical coverage. The largest consumers should be reviewed separately if possible. Utilization of existing supply systems, overproduction, supply deficit.

Production and consumption of various types of energy per capita and per unit of local produce.

Energy management:

Energy management systems – organization, chains of command, rights and responsibilities, regulatory documents.

Energy efficiency:

This item is not utilized in any territory related energy sector analysis known to us and distinguishes the given approach from others. In this concrete case it is mainly related to the building sector, of which housing has the top priority, with thermal engineering properties of the most typical residential buildings with appropriate recommendations for improvement of these properties. Types, location and number of such buildings are decided during field trips. Application of energy efficiency approach to industry, commerce, etc. is beyond the capacity of this program.

Population behavior, traditions and stereotypes regarding use of various kinds of energy for household needs. Comprehensive analysis and recommendations aimed at achieving energy efficiency through the altered behavior and application of efficient technologies (within the means of typical households), as well energy saving.

This calls for the organization of a survey among the most typical households. Numbers of respondents as well as types of households are selected during field trips.

All data, mentioned above, are to be presented in the form the extended energy balance table, supplemented with maps, schemes and graphs, whenever necessary. These will be attached to analytical text, complete with recommendations and results of household survey and energy audits.

All data in energy balance tables as well as in final energy consumption analysis in watershed assessments are to be presented in kWh, as the most widely accepted and understood unit of energy (especially that this is a billing unit for energy delivered to consumers by electric utilities).

Under the normal circumstances this kind of work is organized along the following stages:

1. Formulation of survey plan. Collection and processing data from various sources available outside the objects of analysis. Correction of the plan based on the collected data;
2. Introductory field trip. Acquaintance with the situation on site, meeting with key stakeholders. Organization of future trips (amount, duration, purpose);
3. Trips to collect data and conduct auditing and household survey.
4. Data processing, writing a report, presentation.

Due to time limitations imposed on SDAP first three stages are to be carried out simultaneously.

Annex 2: 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, do not have answer)
- Do they have a car? Yes/No
- If they have one, 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 energy company service? – Satisfied, Partly satisfied, Not satisfied
- Reason of dissatisfaction – power cuts, quality of electricity, service of company personnel, other reason (indicate) ---
- Natural Gas Yes/No
- If yes, is there a gas supply meter? Yes/No
- How much natural gas do they use per month? (cubic meters) --
- Are they satisfied by 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)----------------------
----
- What kind of building systems' blueprints can be found? (heating systems and etc.) ----------
----
- Which system's technical description and documentation can be found? -----------------------------
-

4. Dataonbuildingstructure

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

4.1. External walls

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

4.2. Windows

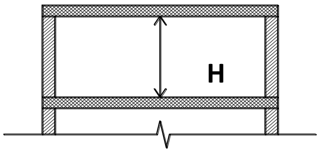
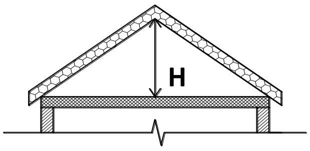
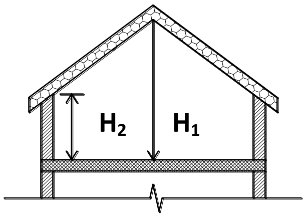
1. General condition of windows - Bad, Acceptable, Good
2. The total area of windows (m^2) --
3. Window material – Wood, Aluminum, Metal-Plastic, Other (indicate) -----------------------------------
4. Type of window frame – Single frame, Double frame, Other (indicate) -----------------------------------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

4.3. Doors

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

4.4. Roof

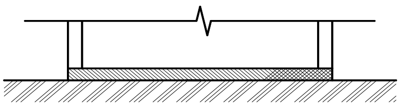
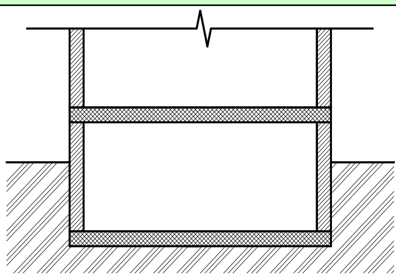
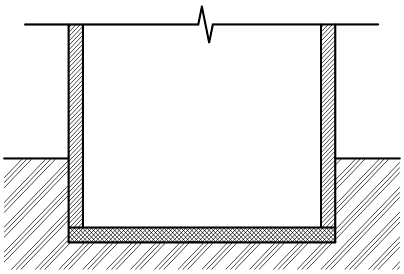
- General condition of roof - Bad, Acceptable, Good
- Total area of roof (m^2) ....

<table>
<tr><td>Roof type RF1</td><td>Attic, Roof Type 2 RF2</td><td>Attic, Roof Type RF3</td><td colspan="4">Attic, Roof Type RF4</td></tr>
<tr><td>Roof on a top of heated area</td><td></td><td></td><td colspan="4"></td></tr>
<tr><td>Attic height m</td><td></td><td></td><td>H_1</td><td></td><td>H_2</td><td></td></tr>
</table>

- Roof material ....

4.5. Floor

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

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

5. Heating/Air Conditioning Systems

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

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

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

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

5.5. How long the building is heated during year? (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 heat 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 the household budget expenditures point of view? Yes, No, Partly

5.11. If 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, than 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 for lighting during the 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, what method do they use? (Indicate) --

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

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

----

6. Energy expenditures

1. How much electricity do they use, how much do they spend on electricity during 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? --
6. How much other fuel do they use, how much do they spend on other fuel during the year? --
7. What part of the household annual budget do they spend on energy? ------------------------------------
   ----
8. Do these expenditures create financial problems for them? – Yes/No
9. If the answer is yes, please describe this problem as - Unimportant, Medium Difficulty, Very Difficult, Unendurable
10. What do they believe to be the reason of these problems? – Expensive energy, Non-effective service, Discrepancy between price and quality of service, Low income, Other (describe) ---

Annex 3: Standard Simplified Energy Balance

This is an approximate, draft version of a standard simplified Energy Balance downsized to the level of a Georgian municipality. It is drawn primarily to check what can and should be done as a basis for forming an Energy Passport. This is the first known attempt of this kind.

Energy Resources:

Mineral Fuels – None discovered

Hydro resources – 202 MW potential installed capacity; 1,130.7 GWh potential annual electricity generation

Wind – unknown, no data available

Solar – 2 721,9mWh annually (total surface area)[46]

Biogas – no data

Fuel wood – 126. 2 GWh

Energy supply:

Local production:

Mineral Fuel – none

Hydro – 36 m kWh app.

Wind – none

Solar – unknown, no data

Biogas – unknown, no data

Fuel wood – 43.2 m kWh app.

Import:

Electricity – no data

Natural gas/LPG – 233 000 m^3 ; 2 180.1 m kWh app.[47]

Export – no

End use consumption:

Residential buildings: electricity – n/a; natural gas/LPG – 1 582.9 m kWh app.; fuel wood – 43.2 m kWh app.

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[46]Considering this surface as horizontal

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

Industry and Commercial buildings – electricity – n/a; natural gas/LPG – 597.2 thousand kWh app.; fuel wood – n/a, liquid fuel – n/a

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