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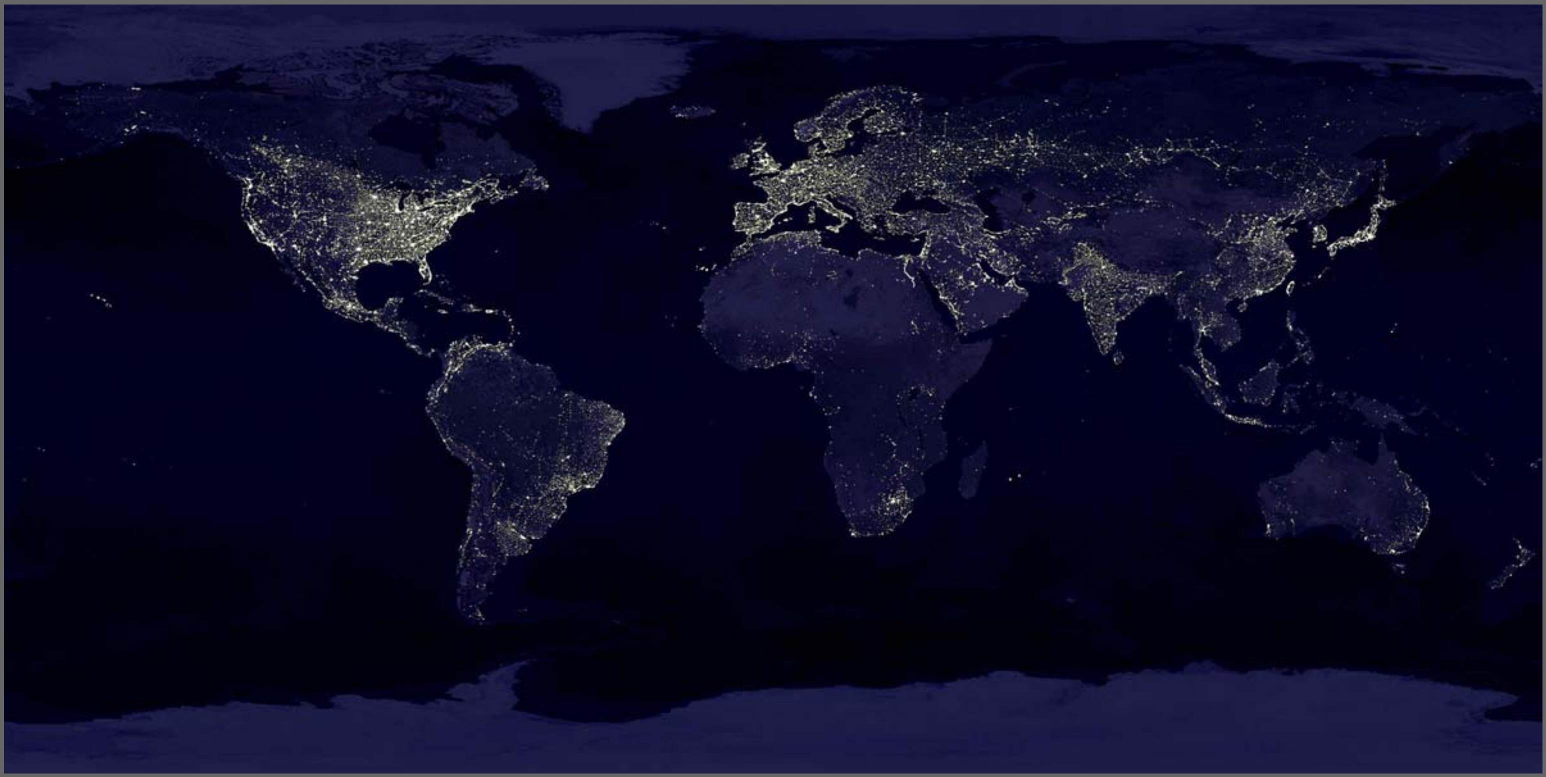
Energy Efficient Potential in Georgia and Policy Options for Its Utilization



Prepared by World Experience for Georgia for Winrock International under Sub Agreement 5708-07-04
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Energy Efficient Potential in Georgia and Policy Options for Its Utilization

Prepared for: USAID/Caucasus
25 Atoneli Street
0105, Tbilisi, Georgia

Prepared by: Rural Energy Program
26 Dzmebi Kakabadzeebi Street, Tbilisi
0105, Georgia
Tel: +995 32 50 63 43
Fax: +995 32 93 53 52

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and
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P.Tsintsadze has led on institutional issues related with energy conservation in Georgia
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K.Melikidze has prepared a section on World Experience in Energy Efficiency and advised on the efficiency of buildings.
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WEG – World Experience for Georgia
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Table of Contents

Chapter 4 - Energy Balances in Georgia

Chapter 5 - Energy Efficiency Potential in Residential and Nonresidential Sector of Georgia

Chapter 6 - Assessment of Energy Efficiency Measures

Chapter 7 -Conclusions and Recommendations

Introduction

The Energy Policy of Georgia states a goal of forming the legal and institutional framework for improved energy efficiency in the residential and industrial sector of Georgia. In compliance with this provision of Energy Policy the Ministry of Energy has requested Winrock International to assist with drafting of Energy Efficiency and Renewable Energy laws. The current study has been conducted by the foundation “World Experience for Georgia” for Winrock International. This study is a first step in developing the policy recommendations for Energy Efficiency Strategy and Policy options for use in drafting the Law on Energy Efficiency.

The study is mostly concerned with efficiency of energy consumption. Efficiency in energy production, transformation and supply is not the subject of this work and these issues are only briefly commented on. We also do not consider oil products and their use for transport, as well as use of natural gas as a feedstock for industry.

The report has been prepared in a short period of three months and thus does not cover all the issues related to energy efficiency. The time limitations and quality of data did not allow WEG to make accurate statistical analysis and data reconciliation. In some cases we had to make ad hoc adjustments to data where we felt it was incorrect. We preferred to devote more time and space to methods that can be applied in further studies and policy analyses and tried to keep our main conclusions and recommendations safe from potential inaccuracies and gaps in data.

For the sake of clarity throughout this document we will stick to the following definitions:

Energy Efficiency* – *will denote using less energy to provide the same level of energy service, related to more efficient technology and equipment.
***Energy Saving* -** *will denote using less energy to provide less energy service and this is mostly related to the human factor of energy use habits and regimes of operation.*
Energy Conservation *will unite these two concepts and mean using less energy because of both of these reasons.*

Chapter 1
Executive Summary

Recent increases in energy prices, the desire to reduce the risks of dependence on external energy supplies, and improvements in energy distribution collection levels have created prerequisites for active development of energy efficiency in Georgia. Further, Georgia's chosen path towards European Union ascension has encouraged the government, particularly the Ministry of Energy, to advance initiatives in the field of energy efficiency and renewable resources. The Ministry has requested Winrock International, which is implementing the USAID Rural Energy Program, to assist in drafting the new energy efficiency and renewable energy laws. This request complements Georgia's present energy policy that stipulates establishing the legal and institutional framework for improving energy efficiency and harmonization with European Union ascension targets. There are a myriad of benefits that result form pursuing these objectives.

1. Efficiency, including energy efficiency, is a feature of developed society and is positively correlated with many different societal improvements, including:
   - better organization of government structures,
   - enhanced interaction between government and business entities,
   - development of a high-skilled banking sector, and
   - better interaction amongst government, business and civil society.

2. Energy efficiency is incorporated into European Union ascension targets and has a significant potential to enhance Georgia's economic, environmental and social standing by:
   - reducing energy imports and thus increasing the country's energy security,
   - positively impacting energy tariffs,
   - positively impacting the country's external trade balance,
   - positively impacting economic and social development, and
   - reducing environmental impacts from energy consumption and trade.

This study is a preliminary step towards developing Georgia's energy efficiency strategy and priorities, to be reflected in the prospective Energy Efficiency Law. The study gives the first rough estimate of energy efficiency potential in different areas of energy consumption and lays the foundation for further studies and policy development in this very important field for Georgia. Due to time constraints, there was no possibility to sufficiently explore several interesting research topics and this task remains for future studies.

1.1 Summary of Energy Efficiency Measures and Policies for Georgia

Presented below are the highest priority energy efficiency measures identified in this study; they are:

1. Improvements in energy distribution,
2. Replacing incandescent light bulbs with fluorescent bulbs,
3. Promotion of efficient wood stoves, and
4. Reform of the construction code to include energy efficiency requirements.

1. Improvements in energy distribution

Improvements in the energy distribution sector remain the most important energy efficiency measure to be implemented in the Georgian energy sector. Distribution systems are owned by private companies and are still subject to high levels of loss; these losses can be reduced significantly through cost effective measures.

Improvements in the distribution sector can save approximately 500 million kilowatt-hours (kWh) of electricity and approximately 180 million cubic meters of gas for the Georgian economy. This is approximately 7% of total electricity consumption and approximately 10% of gas consumption in Georgia in 2006. This amount of electricity would be enough to power Tbilisi in the months of December and January while saved gas could satisfy the needs of the city for half a year.

2. Replacement of incandescent light bulbs with fluorescent bulbs

Efficient lighting has been identified as the highest priority measure for addressing economic and supply security issues at a very low cost. Replacement of incandescent bulbs with fluorescent bulbs has been identified as the most profitable and easy to implement energy efficiency measure, on a large scale. This measure provides a high return on investment to energy consumers, as can be seen from Figure 1.1 below.

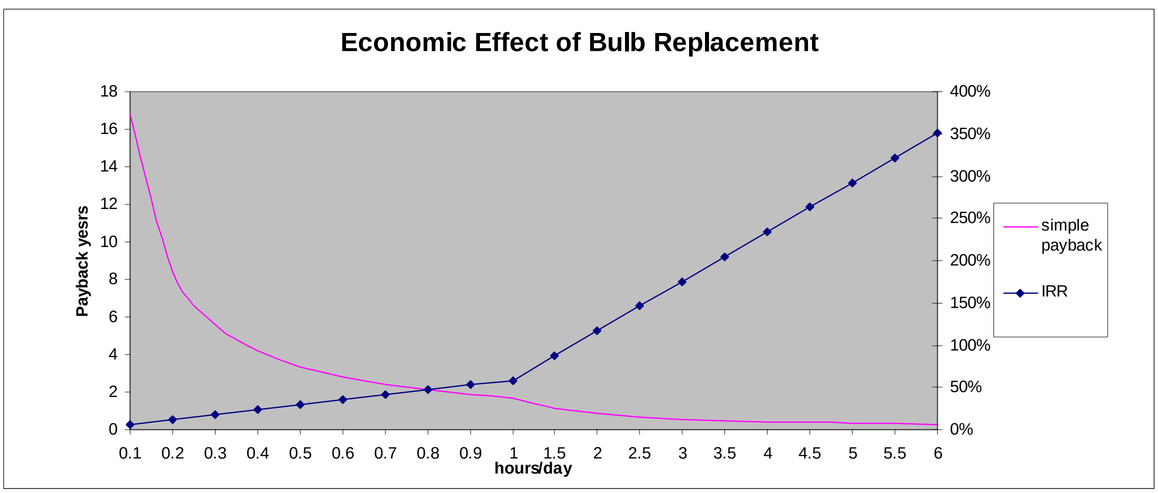

Figure 1.1. Simple payback and Internal Rate of Return (IRR), indicators of the financial merits of fluorescent bulb replacement

As Figure 1.1 shows, a person who leaves a light on for four hours a day, recoups his or her fluorescent bulb investment in less than five months using a Simple Payback calculation, and will have an IRR of 234%; a person who leaves a light on for approximately 50 minutes a day has an IRR of 23%. While residents of Georgia have much to gain from switching to fluorescent lighting, at the macro level, the state receives substantial benefits from bulb replacement. These benefits primarily come from the fact that:

1 kWh of energy saving is equivalent to 1.19 kWh of generation, because of transmission losses associated with delivery of that 1 kWh to the customer.

In addition to saving energy and enhancing Georgia's energy security, the widespread adoption of fluorescent lighting also yields serious economic benefits for Georgia.

- **Efficient lighting has the potential to yield energy tariff reductions.** Effective tariff reductions vary from 0.009 tetri per kilowatt hour (t/kWh) in the summer to as much as 0.48 t/kWh in winter months.

  The cost of a saved kilowatt hour for bulb replacement is 0.8 tetri/kWh.[1] For comparison, the cost of generating energy in Georgia through hydropower is estimated to be between 7-9 tetri/kWh. **Thus the cost of saving energy through light bulb replacement is about 10 times less than the cost of generating that same amount of energy.**

- **Replacing six million bulbs positively contributes 85.6 million United States Dollars (USD) to Georgia's external trade balance over a 5 year period**, with a discounted present value of 54.3 million USD.

- **Full implementation of efficient lighting has the potential to reduce the need for budget subsidization in the energy sector by $26 million every year.**

3. Promotion of efficient wood stoves

According to simple estimates, the widespread introduction of energy efficient stoves can save as mush as 30-40% of firewood currently used; this is equivalent to about 700,000 cubic meters of fuel wood. A reduction in wood consumption of this magnitude would significantly reduce the environmental impact from wood felling and would also reduce Georgia's greenhouse gas emissions.

[1] This is a levelized cost of switching to a fluorescent bulb divided by number of kWh-s saved during the bulb's lifetime.

4. Introduction of energy saving requirements in the construction code

About 80-90% of gas consumed in Georgia's residential sector is used for space heating. This fact emphasizes the importance of building efficiency improvements. Currently there are no effective mandatory or indicative standards in construction and even old Soviet standards are not being observed. As a result, the burgeoning housing stock that is presently being built in Georgia is becoming a source of excessive energy loss, now and in the future. Energy-inefficient buildings are going to aggravate Georgia's energy situation. Table 1.1 illustrates how a variety of energy efficiency measures in the construction and residential sector can yield substantial energy savings for Georgia.

Energy Efficiency Measure	**Energy Saved**	
	Electricity (Gigawatt hours)	**Natural gas (millions of cubic meters)**
Improvement in energy distribution	500	180
Installation of Efficient Lighting	350	-
Weatherization	80	25-30
Energy Savings from instilling energy efficient behavior in society	150	20-30
Energy Savings in the Non-residential Sector	450 GWh	
Efficient wood burning	700 thousand cubic meters of wood	

Table 1.1. Estimates of energy savings accrued from employing different energy efficiency measures.

If the construction code would require installation of more efficient fluorescent bulbs (rather than incandescent ones), this measure would have the potential of replacing the need for construction of a large hydro power plant; this is certainly a cheaper and faster measure for contributing to Georgia's energy security.

This analysis avoids the complex task of demand forecasting. For simplicity, all energy efficiency measures are compared to the 2007 model energy balance rather then exploring the dynamic development of consumption and supply over a number of years.

1.2 Methods and Analytical Tools Used for this Study

In the current study, we have developed a number of analytical tools for analyzing the consumption structure of different energy carriers. A set of models has been developed to examine the residential electricity consumption and to separate electricity consumption for different end uses, taking the seasonality of energy consumption into account.

An attempt has been made to advance the analysis of energy efficiency measures to include additional economic justification at both the micro and macro level. The project has developed a number of analytical tools for analyzing the effects of energy efficiency programs:

1. A parameter of country energy dependence has been introduced in order to enable the comparison of the effects of different energy efficiency and energy supply options in reducing the country's dependence on external energy sources. Figure 1.2 depicts the parameter showing seasonal dependence on external energy supplies for electricity end use (EDSIE).

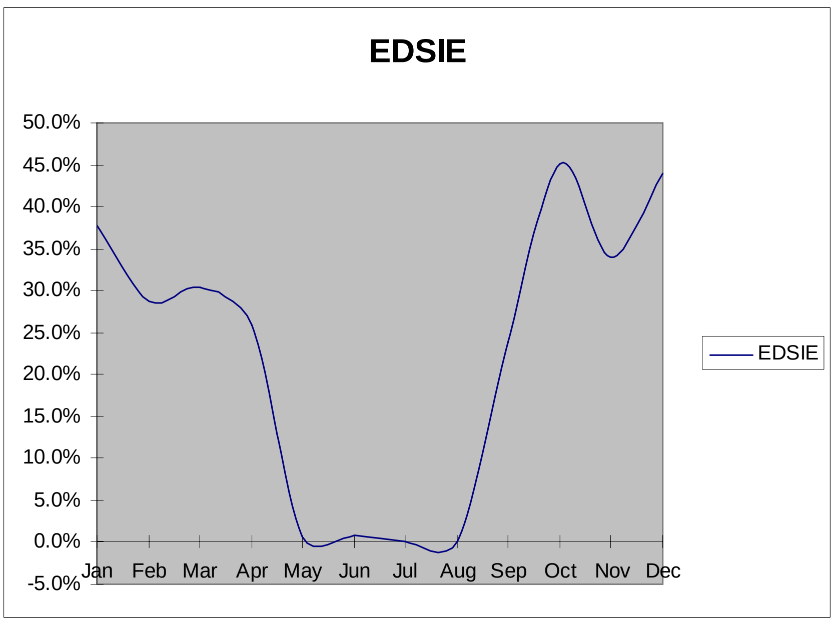

Figure 1.2 Electricity Dependence Seasonal Index (EDSIE)

This seasonal dependence curve, above, shows the percentage of electricity coming from external energy sources in each month. It can be used to compare different energy saving and generation options measures by their contribution to reducing the country's external energy dependence.

2. A model has been developed to evaluate the seasonal variation of the lighting load in the residential sector. Figure 1.3 shows the result of the model, derived with the account of seasonal variations of daytime duration, ambient luminance due to sun elevation, weather conditions and seasonal migration of the population for holiday seasons.

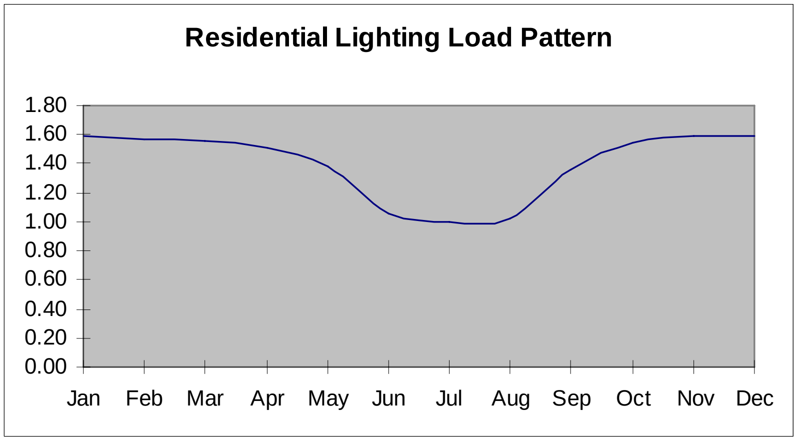

Figure 1.3. Seasonal dependence of residential lighting energy consumption

2. A model has also been developed for evaluating the effects of public information campaigns on consumer behavior. Figure 1.4 compares energy consumption based on the "energy conservation awareness" of the consumer; the graph contrasts energy consumption of informed consumers who have chosen to install fluorescent lighting versus the energy consumption of consumers in the absence of an energy efficiency public information campaign.

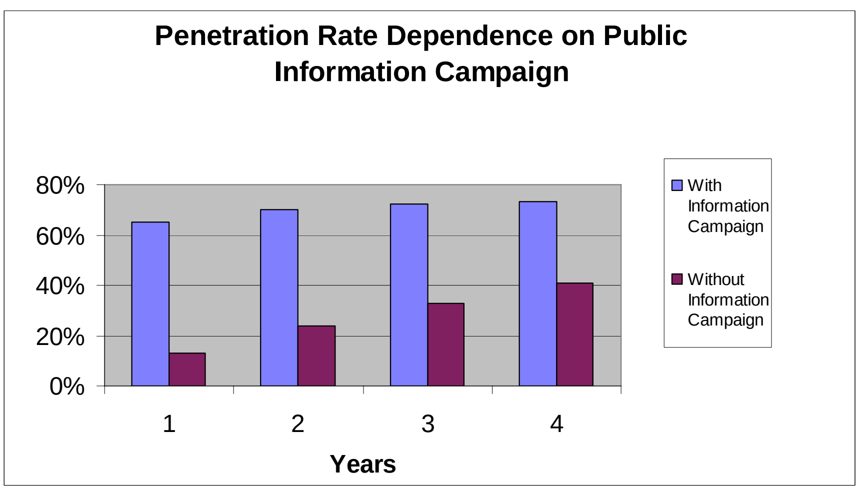

Figure 1.4. Rate of bulb replacement in the presence and absence of an information campaign

1.3 Policy Measures for Utilization of Energy Efficiency Potential

The following measures should be taken by the country in order to create the appropriate conditions for realizing the above energy efficiency potential.

- Develop and approve the Law on Energy Efficiency, with or without inclusion of renewable energy).
- Create a special designated authority to lead in the matters of energy efficiency, within an existing government structure or a new one.
- Develop an Energy Efficiency Strategy for the country, with clearly formulated targets and related economic development plans.
- Develop long- and short-term energy efficiency plans.
- Expand and strengthen the activities of specialized energy efficiency organizations like the Energy Efficiency Center and the Georgian Association of Energy Engineers.
- Encourage and support the practical application of Clean Development Mechanism for energy efficiency and renewable energy projects.
- Support research and development in the field of energy efficiency in order to support this sector with sound information and a strong analytical base.
- Develop the planning functionality to incorporate economic and technical factors in the country's development strategy.
- Develop energy efficiency educational programs and information campaigns.

Immediate Actions

There are a number of low-cost, highly-effective measures that can be undertaken in the short term without significant organizational measures and based on existing donor support and existing structures. These include:

- an information campaign for the support and promotion of simple measures like fluorescent bulb replacement.
- an energy efficiency program conducted in all government-owned buildings; this would include transitioning from incandescent to fluorescent bulbs.

Further Research

There are a number of issues partially addressed in this study and/or outside of the study's scope, which require further research; such study could reveal significant, additional efficiency potential for the benefit of the Georgian economy. This would include potential savings from electricity generation and supply, efficient tariff setting, regional cooperation, and other avenues. It is highly desirable to conduct research in these and other directions in order to create a sound basis for further policy decisions.

Chapter 2
Institutional Issues of Energy efficiency in Georgia: Barriers and Opportunities

2.1. International Aspects of Energy Conservation in Georgia

In today's world, energy efficiency and energy savings have acquired greater prominence in the public and private sector. Developed countries, as well as international financial institutions, are increasingly prioritizing energy efficiency in their operations. With support and encouragement from these countries and institutions, developing countries and countries in transition, such as Georgia, have also begun to embrace energy efficiency.

There are several main factors that have driven energy efficiency and energy conservation into the forefront; they are:

- Decrease of fossil fuel reserves
- Strong and irreversible growth of energy prices
- Growth in demand for energy
- Negative environmental impact of the production and consumption of almost all energy types.

Energy efficiency and energy-saving related infrastructure are not sufficiently developed in Georgia. Georgia took its first serious steps towards energy efficiency in 1994-1995, with the assistance of the European Union's "Technical Aid for the Commonwealth of Independent States" Program. Though technical aid was given to develop a Georgian Energy Policy, this support did not result in any marked improvements in energy efficiency or energy conservation; Georgia's ineffective energy distribution systems could not support payment collections and hampered implementation of energy policy reforms.

In 1996-1997, several small scale energy-savings programs were implemented and in 1998, the Energy Efficiency Center began operations as a not-for-profit organization; this center continues its successful operation today. Later, with the support of USAID, local charter of the Association of Energy Engineers and the Georgian Association of Energy Engineers were established. Members of these associations have worked as the core staff on various donor-funded energy efficiency projects in Georgia. There are several other energy efficiency organizations that operate primarily on an ad hoc basis with support from minor grants or short term programs.

Attention to energy efficiency has recently been revived in Georgia. Infrastructure rehabilitation projects and financial reform have increased the reliability of Georgia's energy supply and now more attention is being directed to energy conservation measures. Certainly the price increases on imported natural gas, increases in electricity and gas tariffs, higher collection rates in distribution companies, and concerns of energy security and security of supply are new realities that create incentives for energy conservation.

However, **macro-level energy efficiency requires the higher organization of society**; Georgia is approaching a state of development where it is able to undertake and implement policy reform such that energy efficiency and energy saving measures are broadly adopted.

There are a number of international, multilateral and bilateral agreements that require concrete energy efficiency and conservation actions from Georgia; these are:

- Energy Charter Treaty and Energy Charter Protocol on Energy Efficiency and Related Environmental Aspects (PEEREA)[1]
- Framework Convention on Climate Change and the Kyoto Protocol[2]
- Clean Development Mechanism (CDM) under the Kyoto Protocol
- European Neighborhood Policy[3]
- European Commission “Green Paper,” [4] and the
- Memorandum of Understanding signed with Denmark in 2004 (Appendix 1.).

These agreements can serve as roadmaps for Georgia to chart its short- and long-term development incorporating energy efficiency into the country’s future.

The Energy Charter Protocol on Energy Efficiency and Related Environmental Aspects (PEEREA) is a legally binding instrument that was signed together with the Energy Charter Treaty in December 1994, by the same fifty-one states that signed the Treaty itself (including Georgia). It requires signatories to formulate energy efficiency strategies and policy aims that establish appropriate regulatory frameworks; moreover, signatories must develop specific programs for the promotion of efficient energy usage and the reduction of harmful environmental practices in the energy sector.

The Energy Charter Secretariat has conducted an in-depth review of energy efficiency policies and programs in Georgia. The Secretariat’s report,[5] published in 2006, presents a number of observations, recommendations, and an analysis of Georgia’s institutional framework. This information can guide Georgia in formulating priorities and analyzing the barriers that need to be overcome to develop successful energy conservation strategies and policies. A good comparison of Georgian and European legislation and policy objectives can be found in “Georgian Economic Trends” of June 2006.[6]

In May 2007 Georgia applied for an observer’s status in the Energy Community Treaty and has received an observer status in December 2007 .[7] This will be another step towards integration into European structures, improving energy security and the harmonization of legislation with Europe.

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[1] http://www.encharter.org/
[2] http://unfccc.int/
[3] http://ec.europa.eu/world/enp/documents_en.htm
[4] http://ec.europa.eu/energy/green-paper-energy/index_en.htm
[5] In-Depth Review Of Energy Efficiency Policies And Programmes. Energy Charter Secretariat. 2006.
[6] http://geplac.org/files/english-june.pdf
[7] http://www.energy-community.org/

2.2. The Clean Development Mechanism

In addition to providing technical assistance and guidance, several of these international energy agreements offer financial incentives and project financing for Georgia to undertake energy sector reforms. **The Clean Development Mechanism of the Kyoto Protocol is an important instrument to be fully utilized in developing energy efficiency and renewable energy activities in Georgia**. This is a project-based mechanism designed to promote investment in projects that reduce or sequester emissions of greenhouse gases in developing countries, including Georgia.

The Kyoto Protocol has created a significant opportunity for countries that are not members of the Organization for Economic Cooperation and Development (OECD), such as Georgia, to leverage investments in clean technologies and energy efficiency through the sale of carbon dioxide (CO_2) emission reductions. To meet commitments under the Kyoto Protocol by 2012, OECD countries have a demand for approximately 3 billion tons of emission reductions, with a market value estimated to be between U.S. $ 20 - 25 billion.[8]

Georgia meets the eligibility requirements to sell emission reductions from projects at the international carbon market under the Clean Development Mechanism (CDM). According to the "Resolution of the Government of Georgia #2," passed on 20 January 2005, the Ministry of Environment Protection and Natural Resources has been appointed as the Designated National Authority for executing the CDM. By the "Resolution #172," passed on 29 September 2005, a Coordination Board for the implementation of the CDM was created. This board is chaired by the Minister of Environment and comprised of representatives of the Ministries of Finance, Energy and Economy, among other stakeholders. Subsequently, a "Procedure of the Activities of the Coordination Board" has been approved.

Georgia has considerable potential to develop many CDM projects, especially in the renewable energy and energy efficiency sectors. Georgia will have the possibility to generate tens of millions of dollars in carbon revenue over the next few years by leveraging investments in the energy, waste, forestry and agricultural sectors. A programmatic approach currently being developed under the CDM, will present prospects to undertake large-scale programs like the replacement of incandescent bulbs; these programmatic initiatives would be eligible for additional CDM funding.

Opportunities can also be realized by implementing projects that reduce greenhouse gas emissions or enhance sequestration. In Georgia about 90% of greenhouse gas emissions are generated in the energy and transport sectors.[9] Carbon reduction revenue is potentially available for projects in Georgia that:

- increase the efficiency of power generation—this includes rehabilitation and modernization of existing hydro power plants
- make use of renewable energy technologies

[8] State And Trends Of The Carbon Market 2007 , Karan Capoor, Philippe Ambrosi, World Bank Institute - 2007
[9] Georgia's Initial National Communication Under The United Nations Framework Convention On Climate Change, Tbilisi - 1999

- minimize emissions associated with gas transportation and distribution
- decrease losses in power transmission and distribution, and
- increase energy efficiency in the residential sector.

Georgia may also capitalize on financial incentives for projects that:

- improve waste management and the capture of methane from landfills and wastewater
- increase removals by biological sequestration of greenhouse gases from the atmosphere, e.g., by planting trees or managing forests, reforesting degraded/deforested lands, and
- generate biogas from various types of biomass.

For Georgia, a reduction in the generation of 1.0 Megawatt-hour will typically reduce CO_2 emissions by 0.379 ton[10]. The value of 1 ton of CO_2 reduced under CDM projects, which is now under negotiations in Georgia, is reported to be currently in the range of 10 USD.

While carbon transactions do not address the underlying financing needs of a project, future cash flows from carbon financing enhance the viability of a project. Since carbon revenues are typically payable in strong currencies by buyers with high credit ratings, these revenues can be used to increase a financiers' confidence in a project and to leverage additional capital from international finance institutions and others.

Timing is critical for CDM projects as the window of opportunity is rapidly closing due to uncertainty in the carbon market at the end of 2012; the first commitment period under the Kyoto Protocol. The bulk of project-based transactions are targeted at meeting OECD compliance needs through 2012, emphasizing the need for quick action given the long lead time between project preparation and the "first yield" of emission reductions.

International finance institutions, donors and several industrialized countries have programs targeted to support Georgia and other developing countries in institutional and technical capacity building to implement CDM projects. Some of these organizations have special carbon funds to buy emission credits. Through its experience in the market, they bring to the table the ability to mobilize in-house and external expertise, links to sources of funding and technical support for carbon project development and supervision. In November 2004, a Memorandum of Understanding on cooperation on CDM projects was signed by the Government of Georgia (Ministry of Environment) and the Government of Denmark (Ministry of Environment), c.f. Appendix 1.

After several rounds of discussions, the Executive Board of the CDM agreed on the basic rules for a Program of Activities to qualify for earning carbon credits under the CDM in June 2007.[11] This is a major achievement and will open the way for a new class of CDM activities, such as a distributed program replacing lighting bulbs.

[10] http://www.climatechange.telenet.ge/CDM-baseline.htm

[11] http://www.carbon-financeonline.com/index.cfm?section=features&action=view&id=10675

At the moment several CDM projects are being developed in Georgia; they are at different stages of development. The most important projects are: a waste disposal gas utilization project near Tbilisi, with the participation of a Japanese company; Enguri hydro power station renewal project, together with EBRD; small hydro power station rehabilitation projects, where the World Bank will purchase waste; and the North-South Gas Pipeline Rehabilitation Project, where the Georgian Oil and Gas Corporation is working with a private investor.

On the 31st of August 2007, the Emission Reductions Purchase Agreement (ERPA)was signed, with participation from the International Bank for Reconstruction and Development (IBRD of the World Bank), the Community Development Carbon Fund, and the Energy Efficiency Centre of Georgia.

This is the first Kyoto Protocol Clean Development Mechanism agreement in Georgia. The agreement will come into force after procedures are finalized between the United Nations Framework Convention on Climate Change and the Ministry of Environment and Natural Resources of Georgia

The Energy Efficiency Centre of Georgia acts as a bundling agency for this ERPA and shall bundle Verified Emission Reductions of nine Small Hydro Power Stations rehabilitated in the frame of the USAID-funded Rural Energy Development Program.

2.3. The Legal and Institutional Environment

While the Kyoto Protocol's Clean Development Mechanism can bring financing to energy efficiency and energy saving projects, Georgia must create a legal and institutional framework to support project implementation. The following analysis identifies promising projects, as well as the preconditions necessary for the Georgian government, private sector, non-profit-sector and the public to embrace these energy-efficiency initiatives.

2.3.1 Building Energy Efficiency in Georgia Requires a Strong Legal Framework

The Energy Policy of Georgia states a goal of developing the legal and institutional framework for improving energy efficiency in residential and industrial sectors; however, this goal remains largely unattained. **The legal and regulatory base of energy efficiency and energy savings has yet to be developed in Georgia.** Its absence impedes success in implementing energy efficiency programs. In the law "On Energy and Natural Gas", the basic legal act in the field of energy, efficiency is seldom mentioned. Only in Paragraph 3 of Article 1, "to promote improvement of effectiveness of energy generation, transmission, dispatching, distribution, import, export and consumption, also, natural gas delivery, import, export, transportation, distribution and consumption" is energy efficiency discussed.[12] Further, energy saving is not mentioned at all. There are no other legislative documents regulating the activities related to energy efficiency in Georgia.

[12] Law of Georgia "On Energy and Natural Gas", 2006

Development and management of energy efficiency and energy savings requires a complex approach. Given that there are many different organizations and commercial agents whose activities need to be coordinated, **Georgia needs a comprehensive framework of unified programs and plans to facilitate that coordination.** The role of the State is well poised to undertake this task.

Developed countries have been very successful in facilitating a coordinated framework to embrace energy efficiency and energy savings, whereby the State develops a legal base, including liberal tax and customs codes, to give economic incentives to all categories of consumers. The State also invests in energy-efficient and energy-saving facilities and technologies, involving the banking sector in this process. With incentives in place to elicit consumer participation, banks will find energy-efficiency projects and programs favorable.

In parallel with liberalization and economic levers, State control should be imposed on energy efficiency and energy savings as expressed in state polices. The first place to begin would be through the development of construction and energy saving construction codes. All new constructions should be strictly monitored so that energy efficient and energy saving materials, technologies, facilities, equipment, etc. are used during construction. While this would make construction more expensive, consumers would ultimately win with this investment by reaping continual returns from lower energy expenditures.

At the moment in the country there is no special State entity that manages energy efficiency and energy saving policy, develops corresponding programs and plans, and coordinates their implementation. The Ministry of Energy and its Department of Energy Policy and International Relations are responsible for the development of energy efficiency policies and legislation; however, up to now their main focus has been to increase energy supply. There is a need to establish a special dedicated structure that would advance energy efficiency issues and coordinate with state bodies, commercial and not-for profit entities, as well as energy consumers. Such a structure can be independent or established within the Ministries of Energy or Economic Development. In spring, 2007, a similar structure was established in the Ministry of Economic Development (at the departmental level), but its activities are basically oriented on promotion of renewable and non-traditional energy sources usage in the regions. Of course, this new entity is quite beneficial for Georgia's development, but it is not enough to ensure that Georgia has a successful energy efficiency framework.

2.3.2. Enacting Laws and Creating Incentives for Energy Conservation

Georgia's energy and gas tariffs are only partially oriented towards stimulation of energy efficiency and energy saving. Electricity and gas retail tariffs are being set by the regulatory commission and are designed to fully reflect the costs of energy service. However the costs of energy supply differ significantly in winter and summer months and this is not reflected in consumer tariffs. The significant step towards stimulation of energy saving was made starting on June 1, 2006 by the introduction of block tariffs (also known as stepped tariffs) for the general population; these tariffs are subsidized for low levels of consumption and become increasingly more expensive as consumption increases[13] According to data from the energy distribution companies JSC Telasi and Energo-Pro Georgia, consumption of energy has been reduced by 5-10% for consumers with individual meters. Additional analysis is needed before final conclusions are drawn attributing the observed energy consumption reduction to the stepped tariffs. Other factors may be at play, such as intensive gasification or a consumer shift to gas for heating, cooking or hot water supply, as natural gas is currently less expensive than electric energy.

In the Gldani-Mukhiani district of Tbilisi, during the first seven months of 2006, monthly gas consumption equaled to 1.46 million cubic meters; during that same period in 2007 the population consumed 3.365 million cubic meters, while the number of consumers, 7,530, remained constant. This shows increased gas supply due to installation of more gas appliances and is probably accompanied by reduced electricity consumption.

It is worth mentioning that a reduction of energy consumption through energy efficiency measures should not adversely affect people's living conditions; in fact, energy efficiency measures generally improve living conditions and people's level of comfort.

Introducing block tariffs for gas consumers does not seem appropriate at this time. Gas distribution companies would need a refined billing system, an established commercial cycle and good control of the network for theft prevention for such tariffs to be introduced. Gas distribution systems in Tbilisi and the regions are vulnerable to high levels of theft and probably can not support such a tariff structure.

Nevertheless, there is still a possibility to make Georgia's tariffs more reflective of the real economic structure of electricity supply; introducing seasonal tariffs (winter-summer) should be seriously considered. As it is known, the energy system of Georgia incurs deficits in the winter and depends on imports. In summer Georgia has a surplus of about 600-800 million kilowatt-hours (kWh), and in some cases the energy can not be used (water is non-productively spilled). Further, as energy generally is generated at hydro power stations in summer, the tariffs are almost twice cheaper than the average weighted tariffs of energy in winter (Cf. Chapter 4). Unequal loading of the energy system during the day could also be addressed. In winter, the evening peak load exceeds the night trough by a factor of four; whereas in the summer, the peak exceeds the night trough by only a factor of two.

Equalization or maximal leveling of peak loads between the day and night is important for energy system stability and reliability. This equalization can also be reached through differentiation of day and night tariffs (for enterprises at the first stage and for the public during the second stage). Pricing an energy night tariff lower than the day tariff will give incentives for enterprises to work during the night hours (e.g., wood processing enterprises). This is not only favorable for the electric energy sector, but for consumers as well.

2.3.3 Building Energy Security with a new Building Code for Georgia

[13] GNERC's Resolution # 18, dated May 15, 2006

In Georgia, there are no national norms and standards for construction. A Construction Code would oblige construction entities to build with the materials and norms that maximally save energy on lighting, heating and air conditioning in buildings. It is well known that approximately 40% of total consumed energy is being needlessly lost due to inadequate insulation;[14] thus, achieving energy efficiency and energy saving in the construction sector is very important. The majority of buildings built in Georgia have a thermal resistance that fluctuates between R = 0.62-0.78 ($m^{2\cdot}\ {}^{0}C\ {}^{\cdot}W^{-1}$); the higher the R-value is, the greater the insulation power is. If Georgia increased the R value to 2.1, it would eliminate half of the thermal losses of buildings.

Achieving an R value of 2.1 can be done, for example, by adding a four centimeter layer of urethane foam, but at this stage of development in Georgia, this would most likely lead to technical and financial difficulties. According to expert estimations, however, increasing Georgian buildings' thermal resistance up to an average of R=1.62 [$m^2\ {}^{0}C\ W^{-1}$] is absolutely enough to significantly reduce thermal losses.

With such dramatic energy efficiency gains to be made by just improving a building's insulation, it is no wonder that the global construction sector pays significant attention to this feature of energy saving. For guidance, there are the well developed International Construction Code and International Code of Energy Saving. Georgia is just beginning to consider incorporating the principles of these codes into its laws; as Georgia develops a construction code, it is very important the country utilize the participation of energy and construction specialists such that the thermal properties of buildings be fully accounted for any new code.

2.3.4 Bringing the Benefits of Energy Efficiency to the Public

The culture of energy consumption is an important factor affecting a country's savings. In the Soviet era, the price of energy did not reflect its real cost; as a result, citizens, organizations and businesses consumed energy with virtually no thought to the amount consumed. To a great extent this pattern remains, notwithstanding the high tariffs. Broad groups of society are not adequately informed on the benefits and importance of saving energy. Energy efficiency and energy saving requires society to have high organization, establishment of new habits and traditions, and community-economic instruments; Georgian society has not achieved this level yet. Certainly, the establishment of metering and payment systems for energy and water service, together with adequate tariff structures, have improved the situation significantly. However targeted information campaigns for consumers and business are very much needed.

Informing consumers of the benefits from energy efficiency and how to go about reaping those benefits should be a first priority. The majority of the population does not know this information. Energy-saving household appliances, such as light bulbs, TVs, refrigerators, etc., have already appeared at the Georgian market. These appliances are more expensive than common appliances; however, by reducing energy consumption over the appliances' lifetimes, consumers actually benefit from their initial investments.

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[14] Energy Efficiency, Energy Security, Renewable Energy: Taking Forward The Gleneagles Dialogue And The G8 St Petersburg Conclusions- Roger Williamson- 2006

In Europe, the European Commission has created mandatory energy labels for several household appliances. There are two basic types of labels, the energy comparison label and the endorsement labels. As the name suggests, the former allows consumers to compare the energy consumed relative to similar products. The latter simply notes the appliance is extremely energy effective. In addition to the European Union countries, Canada, Norway, Mexico, South Korea and the United States obligate companies to post energy labels on certain appliances to be sold. While the methods might differ, all these programs work to inform the consumer that he or she can reap benefits in the long-term by making an energy efficient investment in the short-term.

Municipal and community programs are a great way to bring energy efficiency to the public. These programs are of special consequence for mountainous regions such as Mtskheta-Tianeti, Adjara, Racha and Svaneti, where delivery of electric energy, natural gas and other energy carriers is technically complicated and expensive. In these regions using renewable energy sources and utilizing the energy with maximum efficiency is often the only way energy demand can be satisfied. With the exception of a few community-led initiatives, it is the donor community primarily implementing renewable energy and energy efficiency projects, as there are no municipal energy programs. It should be mentioned here that donor projects are being implemented together with the Energy Efficiency Centre with grants from the governments of Holland and Norway and the World Bank in the framework of United Nations Develop Program.[15] Additionally, financial assistance from USAID enabled PA Consulting[16] and Winrock International to implement energy programs; among them, is a project implemented by the latter called "Rural Energy Program in Villages." As the donor community demonstrated, there is a lot of potential for developing municipal and community-based renewable energy projects.

2.3.5 Engaging the Banking Sector

As sources of capital for energy efficiency projects and as energy consumers, the banking sector also needs to be engaged. **Currently, the banking sector is not sufficiently involved in energy efficiency and energy saving projects and programs in Georgia.** This reality is born more out of a dearth of projects and programs than indifference.

The Banking Sector can help incentivize energy efficiency adoption by providing credit at lower interest for projects or consumer purchases that are energy efficient. Of course this will only happen when there is a legal framework and the government has lent its support to energy efficiency projects and programs. In the countries where the government has highly prioritized energy efficiency and energy savings, the banking sector is also actively involved and, generally, this proves quite profitable for the sector, as evidenced by United Nations Environment Program data.[17]

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[15] Annex 1 (the materials of Energy Efficiency Centre)
[16] The USAID/PA Consulting Energy Efficiency and Renewable Energy Program in Georgia
[17] Global Trends in Sustainable Energy investment, UNEP, 2007

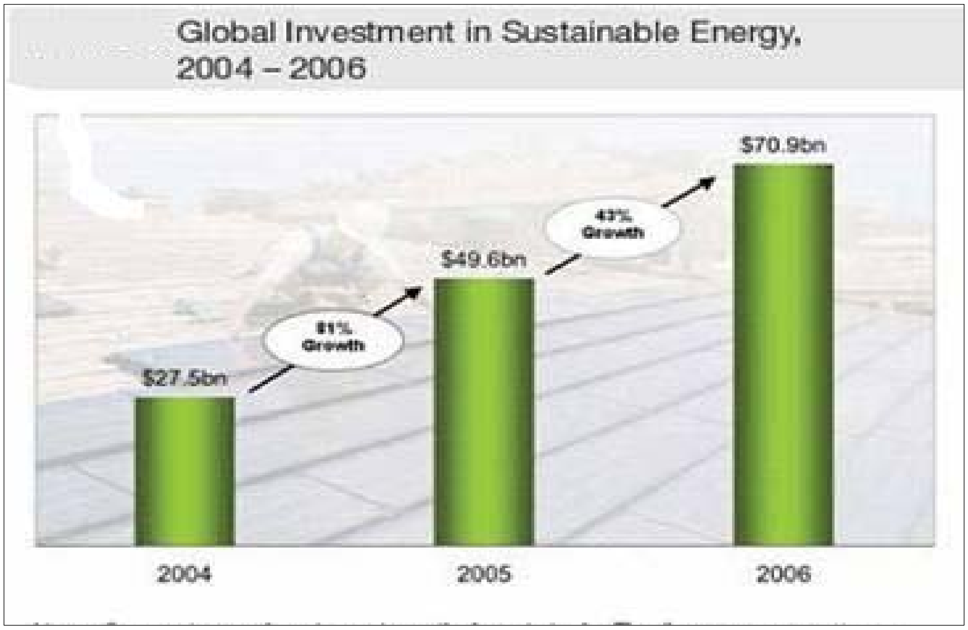


Figure 2.1. Global sustainable energy investments 2004 – 2006. Source: United Nations Environment Program

As shown in the graphic above, the amounts invested in energy efficiency and renewable energies grew from 27 billion USD in 2004 to 70 billion USD in 2006. It should be mentioned that European Bank for Reconstruction and Development plans to allocate a preferential credit line in the amount of 35 million USD for Georgia; the monies will be completely directed to energy efficiency and renewable energies projects.

2.3.6 Reducing Commercial Losses in Distribution companies

The most effective incentive for efficient energy use is the payment for its cost. In this respect there is still significant room for improvements in Georgia.

Precise metering and high collection rates provide strong economic signals for consumers to reduce consumption and/or to invest in energy efficient technologies; these signals are obstructed when meters are not installed or are not functioning, or if consumers can secure artificially low rates through corruption with the distribution companies.

During these last two years, Georgia has made significant progress in reducing electric energy consumption and increasing cost collection. In the electric energy sector, large industrial consumers almost fully pay the costs of consumed energy.

Among energy distribution companies JSC Telasi has the best collection rates; Telasi represents about 25% of the entire sector's consumption. In Tbilisi individual meters are installed for 95% of the population (approximately 420,000). Before the end of 2007 the whole city will be metered. In the month of June 2007, Commercial losses constituted only 6%; this should be considered a great achievement by all measures.

United Energy Distribution Company/ Energo-Pro Georgia represents about 35% of the market; their losses have come down by approximately 10% over the last two years. The company has made these gains through the installation of communal meters.

Besides installation of meters, the company caused reduction of peak load from 650 MW to 480 MW in winter peaks.

Significant improvements in collection have not been seen by Kakheti Distribution Company, though its market share is so low (3%) that it has a negligible impact on the general picture.

In the total energy system of the country, winter peak load has decreased from 1600 megawatts in 2005 to 1200 megawatts in 2007, since metering was implemented. This is an important step forward.

Despite these marked improvements, a high level of commercial losses and theft remains in the sector, even for Telasi and UEDC/Energo-Pro. Thus, further distribution system improvements are needed. Not only would improvements bring a great benefit to the distribution companies, but it would benefit the whole sector. Given the significant investment required to improve the distribution system, great care must be taken to ensure the upgrades are implemented cost effectively.

World Experience for Georgia estimates that average commercial losses can be cost-effectively reduced down to 6% of the total annual power purchase for Telasi and down to 10% of annual power purchase for Energo-Pro. This estimate is based on past experience of development in Telasi and UEDC and takes into account the differences in the network of Telasi, which is urban and Energo-Pro, which is rural to a greater extent. Table 2.1 summarizes the potential energy savings due to a reduction in commercial losses.

	Power Purchase	Technical Losses	Billing	Comm. losses	Comm. losses %	Target Comm. losses	Estimated saving
Telasi	**1,955.4**	**242.5**	**1,398.8**	**314.1**	**16.1%**	**6.0%**	**197**
Energo-Pro	**2,394.0**	**358.4**	**1,468.1**	**567.5**	**23.7%**	**10.0%**	**328**
Total Saving							**525**

Table 2.1. Potential for Loss Recovery in Distribution Companies (GWhs)

Commercial losses are even higher for gas distribution companies. According to information from Kaztransgas-Tbilisi the level of loss in this company approaches 42% of its total gas purchase. By reducing commercial losses down to 10%, Kaztransgas-Tbilisi would recover 120 million cubic meters of natural gas per year and this is equivalent to roughly $21 million at the average gas price of $175 per thousand cubic meter.

The level of losses in regional distribution companies owned by Itera-Georgia has not been reported. However, with the assumption that this company suffers the same proportion of commercial losses, the total amount of natural gas that could be recovered through improvements in the distribution system would be at least 60 million cubic meters.

Thus improvements in distribution companies can save approximately 500 million kilowatt hours of electricity and about 180 million cubic meters of gas for the Georgian economy.

Distribution improvements remain a top energy efficiency measure to be implemented in Georgia; however, improvements require significant capital investment. Moreover, improvements in distribution companies' operations may take several years to implement. Meanwhile less capital intensive and more profitable energy efficiency measures should be implemented in the places safe from energy theft.

The success of metering has clearly demonstrated that energy savings can be achieved from consumers' price sensitivity. **Taxes and customs benefits can provide significant incentives for implementation of energy efficiency and energy saving programs**. The loss of budgetary revenue will finance the gain of energy security and independence. For example, if the government provides a temporary tax exemption for business investments that establish greater energy efficiency, the government will lose some budgetary revenue, but there will be less energy demand. Decreased demand during Georgia's autumn and winter increases Georgia's energy security, and may decrease the costs of peak energy. This, in turn, would reduce the budgetary subsidies allocated for poor families.

There are a number of policy measures and technologies that can be successfully used to reduce energy consumption in Georgia. In the next chapter we present some examples from the world's experience in energy conservation.

Chapter 3
World Experience in Energy Efficiency and Energy Saving

3.1 Energy Efficiency – A Problem of Definitions

The definition of "energy efficiency" seems to be philosophical in nature. An engineer may define energy efficiency in a very restrictive equipment sense, whereas an environmentalist may have a more broad view of energy efficiency. An economist, politician, sociologist, etc., may each have a different concept of energy efficiency".[1]

Definitions of energy efficiency as well as efficiency-based policies differ strongly depending on who, where, when and to what ends the person is applying these definitions. Thus in order to analyze energy policies one has first of all to form a clear understanding of how energy efficiency is defined in this particular context as well as how this definition is incorporated into the particular policy setting. Moreover it is important to define, how these policies may be interpreted bearing in mind the policy setting in which the analyst is operating. This also means that designing any energy efficiency policy measures needs first of all a clear definition of terms for *energy efficiency* and *energy efficiency policy* proceeding from the concrete social and economic environment within which such policy should be designed and implemented. To avoid misunderstanding in this paper we'll apply the term "energy efficiency" - for technology and "energy savings" for the human factor to be united under an umbrella of "Energy conservation."

One of the common definitions of sustainable energy defines it as 'energy that can be produced economically and safely for all time without impacting the environment and well-being of future generations.' This means a reduction of greenhouse emissions and stabilization of the climate change process by limiting our use of non-renewable sources of energy, including the chemical energy in fossil fuels, and using more renewable sources. From a policy perspective, sustainable energy brings two related topics together under one heading, which are: energy efficiency and renewable energy.

3.2. Policy and Institutional Measures

For implementation of sustainable energy policy it is important to use a systemic approach, which includes adoption of a whole range of environmental/energy policy instruments:

- Economic instruments such as taxes, fees, grants, and subsidies;
- Persuasive and information efforts, e.g. education , training and labeling;
- Regulatory / legislative;
- Planning, i.e. energy security.

[1] http://www.eia.doe.gov/emeu/efficiency/ee

3.2.1 Economic instruments

The economic efficiency and environmental effectiveness of these instruments is linked to their ability to influence the entire electricity market. Economic instruments are subdivided into: *energy pricing system* and *subsidies*. As a general rule, the economic instrument will be more efficient and effective if it signals to multiple agents in the electricity market.

3.2.2 Energy Pricing

Adequate energy pricing is a necessary condition for promoting energy efficiency. The first step in energy efficiency policy should be to adapt energy prices so as to give the correct market signals to consumers. Many countries have started to implement energy efficiency programs without first adjusting energy prices - the results have been disappointing because there was no incentive for consumers to change their behavior or to acquire energy efficient equipment and technology.

Adequate pricing means establishing consumer prices for energy products that reflect the cost of energy supply, i.e. the long-term marginal cost for electricity, the long-term price of on international markets for fossil fuels. Although most energy planners agree with such objectives, they often face reluctance and opposition from decision-makers outside the energy sector, who fear public opposition and the impact of energy price corrections on the Consumer Price Index. The price level to *household customers* varies in a wide range in OECD countries. Japan, Germany, Spain and Denmark are at the top (around 15-20 US cents per kilowatt-hour (kWh) at 1995 PPP[2]); North American countries (Canada, Mexico and the USA) and Norway stand at the bottom (5-10 US cents/kWh).

In some countries, such as Norway and the United States, the electricity price consists of fixed network charge and the variable price for energy use. However many experts have criticized traditional electricity pricing systems, based on a fixed charge and a consumption charge, for not providing incentives energy efficiency. Indeed, where the fixed charge is a high proportion of the price, this limits the incentive to use for energy efficient equipment and techniques.

The price driver

Viewed historically, interest in energy efficiency has largely followed oil and other primary energy price fluctuations: the higher the price of oil, the stronger the interest in energy efficiency. Following a period of low oil prices at the end of the 20th century when little attention was paid to energy efficiency; higher energy prices have again propelled energy efficiency to the top of political and public agendas. It is therefore vital that final price signals reach consumers through cost-reflective pricing.

For final energy prices to drive high levels of efficiency, they should ideally reflect all long run costs, meaning that subsidies that may have helped a technology penetrate the market eventually need to be removed and identified externalities need to be included. The prices of energy and energy products often reflect only a part of the overall costs, the part tied to the immediate cost of primary supplies or electricity generation. Rarely do they include longer term environmental

[2] PPP stands for purchasing power parity, a criterion for an appropriate exchange rate between currencies. It is a rate such that a representative basket of goods in country A costs the same as in country B if the currencies are exchanged at that rate; taken from: http://economics.about.com/od/economicsglossary/g/ppp.htm

costs or the long run marginal development costs. To achieve cost effective market prices, governments have to introduce sound legislation and stable investor-friendly regulations.

If final energy prices do not reflect true costs, decisions made by consumers when purchasing equipment or making an energy efficient investment, such as retrofitting a house, more often will not reinforce the drive towards economic optimization. There will be a gap between the actual achievements in energy efficiency and what could result if an accurate price system accounting for all costs involved was required by government policy and supported by clear regulations.

If price signals are to be felt, then full payment for energy services must be made. Metering and a workable energy payments system are therefore critical to the promotion of greater energy efficiency.

At the same time, it is a practical political reality that abrupt and total withdrawal of subsidies may not be possible, particularly for poor remote rural populations and for the increasing numbers of poor people who are crowding into the urban and peri-urban areas of developing countries. Where tax credits or subsidies are maintained, however, they should be transparent, targeted and time-bound. Significant quantities of electricity in developing countries are stolen at this time through illegal connections – this is the worst "subsidy design" possible and experience shows that even very poor people are willing to pay something and will use electricity more carefully as a result.

Similarly, where political realities include energy taxation (for example, to cover the costs of externalities in end use prices), the principle of transparency regarding objectives and the level of taxation should be applied. Energy taxes themselves are often a source of serious distortion in the ways energy is used.

Energy efficiency policies that use direct or indirect price mechanisms (e.g. removing subsidies, incorporating externalities through market based mechanisms) are the most effective in lowering energy consumption trends. However, even without changing the overall price environment, energy efficiency policies should be pursued to correct market imperfections such as the lack of information for small consumers about household improvements or about the full operating costs of appliances, the building owner-tenant interest in thermal performance, and access to funding for technology improvements. Here again, legal standards, labels and information dissemination, along with an adequate payments system for energy are central to energy efficiency goals.

3.2.3 Economic and Fiscal Incentives

Among other financial instruments that can stimulate investments in energy efficiency are economic and fiscal incentives. These incentives are aimed to encourage investments in energy efficient equipment and processes by reducing the investment cost, but they employ different mechanisms to induce change. They are:

- **Economic incentives** are any financial instrument that can stimulate investments in energy efficiency. They fall into two broad categories: investment subsidies, and soft loans.

- ***Investment subsidies***

The objective of investment subsidies is to provide funds to consumers to stimulate energy efficiency investments in existing buildings and equipment, or the adoption of energy efficient techniques. In principle, these incentives apply to actions that are cost effective from the collective point of view, but which would not otherwise be undertaken by consumers. Economic incentives may also be given to the producers of equipment, to encourage the development and marketing of energy efficient equipment.

- ***Soft loans***

Soft loans are loans offered at subsidized interest rates, i.e. at rates lower than the market rate, to consumers who invest in energy efficient techniques and equipment. Soft loans have the advantage that they can be easily implemented by banking institutions. Due to the current high level of interest rates, such measures can be attractive to different categories of consumers.

European Bank for Reconstruction and Development in Bulgaria.

Lack of capital and other investment restrictions are among the main barriers to the realization of energy efficiency projects in Bulgaria. The lack of financial resources and interest on the part of private investors is due to the high risk and low awareness. The main approaches to overcoming these barriers could be: state guarantees or international financial support, together with commercial loans. In July 2005 the EBRD lended €20.1 million to three Bulgarian banks – United Bulgaria Bank, Postbank and RZB Bulgaria – to help finance private individuals' efforts to promote energy efficiency projects. These loans were provided under a framework that has been developed in conjunction with the Kozloduy International Decommissioning Support Fund and the Ministry of Energy and Energy Resources trough the Energy Efficiency Agency of Bulgaria. Funds from this framework will also be available to other participating banks. With KIDSF participation, the EBRD has designed the Energy Efficiency Credit Line Facility to overcome market imperfections which hamper the energy conservation market in Bulgaria.

- **Fiscal incentives** include measures to reduce the tax paid by consumers who invest in energy efficiency. They comprise tax reductions on energy efficient equipment, accelerated depreciation, tax credits and tax deductions. These measures normally require specific provision in the relevant legislation.

Tax credits, tax reductions and accelerated depreciation are fiscal incentives that reduce the tax paid by consumers who invest in energy efficiency. Fiscal incentives are usually preferred to economic incentives, as they are less costly from the government point of view. They can work well if the tax collection rate is sufficiently high. Such measures usually have a poor performance in an economy in recession or in transition.

- ***Financing of Incentives***

Financial and economic incentives are funded in a variety of ways. Some countries have created special funds supplied from different sources, such as Thailand, and other countries are offering guarantees for such investments, such as France's credit system FOGIME and FIDEM; for these systems utilities, governments, non-governmental organizations, banks and international organizations are all participating in the design and administration.

Utility-run programs are financed by the utility's customers (ratepayers), and are implemented by the utility or by sub-contractors such as energy service companies (ESCOs) or NGOs. A new method of financing is "wire charges", where all electricity consumers pay a surcharge and the money is placed in a fund to finance energy efficiency programs. The fund is then administered by the utilities, government agencies or NGOs.

Taxpayers finance government energy efficiency programs. The programs are created, organized, funded and administered by governments, with the general aim of increasing the rate at which new technologies enter the market. They are implemented by government agencies, contractors, NGOs and/or Energy Service Companies (ESCOs). ESCOs provide energy efficiency improvements and energy management services to companies and other customers, and get paid out of the savings realized from the improvements. Banks are becoming an important source of lending to ESCOs, using the expected energy savings from projects as collateral for loans. Charitable foundations may also provide funding.

3.2.4 Energy Service Companies (ESCOs)

The most dynamic factor in the creation of a special energy efficiency market niche is the emergence of ESCO activity in different economies. ESCOs are companies that provide technical expertise and financing for energy efficiency investments, with a guarantee of reductions in energy costs. This mode of financing is an example of third party financing. The ESCO makes the investment and receives a portion of the savings (around 50%) as its compensation. A soundly-based ESCO industry can operate in the private sector with limited government support, resulting in significant energy savings.

Economic and fiscal incentives can establish the environment necessary to ensure profitable business schemes by ESCOs. To be effective, ESCOs need to operate in a market economy with no subsidy on energy prices and with a sound legal framework. ESCOs invest primarily in CHP (combined heat and power technologies), in industry, in fuel substitution, and in small hydropower. One concern with ESCOs is that, since the savings are being shared, only the most cost-effective measures will be pursued, and the overall extent of energy saving measures may not be as great as if the energy-consuming firms operated independently. ESCOs might also be reluctant to propose investments in advanced but risky technologies. At the same time, if the ESCO industry did not exist, many firms would not even consider energy efficiency investments. The allocation of benefits and/or risks between the ESCO and the beneficiary company is an important issue.

3.2.5 The role of governments

The role of governments in energy conservation is crucial in launching initiatives and establishing legal frameworks. Results obtained from China's efficient technologies replacement program and from Brazil's PROCEL program serve as a good example. Nationwide initiatives providing tax incentives for energy conservation are considered a basic element of the energy policy formulated in the USA. Government initiatives to create new incentives to invest in energy efficiency, including tax breaks and easier access to capital markets (bank loans and stock markets), are crucial. The challenge for policymakers in practice is two-fold: to find the appropriate balance between reliance on the market and intervention to address social and environmental policy goals, and to find workable mechanisms that ensure that stated policy goals are met. Governments have a responsibility to intervene to protect air quality by regulating emissions since individual polluters would otherwise not pay for the environmental damage. This damage is a cost that is external to the market place, and is thus called an externality. Levying charges on polluting activities is one way of effectively internalizing these externalities. Subsidizing less or non-polluting activities can achieve similar end-results.

3.2.6 Persuasive and information instruments

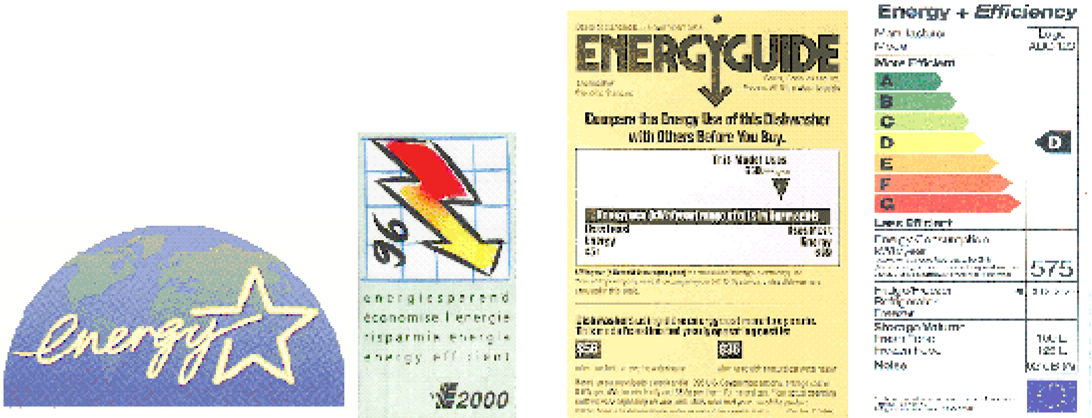
Many countries have introduced energy efficiency programs. Among the different energy efficient instruments are persuasive/information and regulatory instruments. Labeling programs and minimum energy performance standards (MEPS) have proved to be very effective. Most countries first focused applying those standards on refrigerators, along with air conditioners in certain countries, since they account for a large part of household electricity consumption (in Europe, 20-30% depending on the country). It is difficult to measure the impacts of these programs themselves in terms of energy savings, as other factors may intervene at the same time, as explained above. What can be observed is a reduction in the average consumption of the electrical appliances that are targeted by the programs.

Labeling

The fact that energy efficiency measures remain within the purview of the more developed countries, thus far, is well illustrated by the case of energy labeling. Providing information to consumers on the energy efficiency performance of new appliances is a well-known and widespread energy efficiency measure. Labeling programs aim at drawing the attention of consumers to the energy consumption of their appliances. Indeed, a lack of information is generally considered to be one of the main barriers to improving energy efficiency.

Labeling programs may differ from one country to the other, although two general approaches exist: "comparison labels" and "endorsement labels" for end-use, energy-efficiency appliances. Comparison labels enable consumers to compare the energy efficiency of all the appliances on sale (e.g. European Label, or Energy Guide in the USA). Endorsement labels simply identify appliances which are particularly energy efficient (e.g. Energy Star in the USA). Comparison labels are usually mandatory, which implies regulation. Indeed, it is only meaningful if all manufacturers provide the information, and if the information is expressed in a similar way; manufacturers usually implement endorsement labels on a voluntary basis.

Endorsement labels ***Comparison labels*** **.**



Energy Star (USA) E 2000 (CH) USA EU

Figure 3.1. Examples of endorsement and comparison labels

Mandatory labeling for several electrical appliances exists in all European Union (EU) countries based on the same regulations (EU directives). The EU regulation is mandatory and replaces the existing national regulation. The EU labels give each appliance a grade between A and G (with A most efficient), a corresponding easy-to-read color code (green for A, red for G), and the average specific consumption in kWh/year For the first year, the regulation only concerned refrigerators and freezers; it was later extended to other appliances (washing machines, dish washers and lamps). Such labeling is relatively cheap and easy to implement. Out of 193 formally recognized countries of the world, energy labeling is so far introduced in the EU, Switzerland, Norway, the US, Canada, Japan, Australia, New Zealand, Korea, Turkey, Mexico.

Comparison labels are more effective than endorsement labels

By helping consumers identify the most energy efficient products and choose more efficient models, comparison and endorsement labels encourage manufacturers to focus on improving energy efficiency. Although these two types of labels can be complementary (e.g. in Brazil for refrigerators), comparison labels are considered to be the most effective since they enable comparison of all the appliances on the market rather than simply identifying the most efficient ones. That is why comparison labeling is generally mandatory. Nevertheless, voluntary comparison labeling programs also exist, and some have proved their effectiveness (i.e. Thailand).

Energy bus- example of information instrument

Bus and train mounted propaganda displays were widely used in many places. For instance such buses were used in 1990s in California by both the state environmental agencies as well as the green NGOs. Beyond Petroleum (BP) has adapted this instrument for use in Azerbaijan in the form of the Energy Bus. The Caspian Energy Bus delivers awareness and guidance on environmental protection, safety and alternative energy directly to the communities along BP's pipelines in Azerbaijan. At the same time, it serves as an effective tool for communicating BP's in-country experience in energy projects, community investment and alternative energy technology through on-board multi-media interactive displays.

The Caspian Energy Bus is a specially designed tractor trailer that travels the pipeline route, stopping in villages along the way. As a walk-through energy resource center with displays and models, the EB trailer shows visitors ways to be more energy efficient, safer and environmentally friendly in their own communities. In addition to raising awareness on these issues, the EB offers "how to" brochures, gives consultations on applying energy saving strategies such as insulating windows and doors, conducts safety presentations in schools and explains the costs of poor environmental stewardship.




Figure 3.2 Illustration of energy bus. Source:"Umid" Humanitarian & Social Support Center[3]

3.2.7 Regulatory instruments

Standards

Performance standards for electrical appliances, usually known as minimum energy performance standards (MEPS), impose a minimum energy efficiency rating or a maximum consumption for all the products on the market. In some countries, they aim at a sales-weighted average energy efficiency ("target values" in Switzerland, or the "Top Runner Program" in Japan). Some programs rely on the voluntary participation of manufacturers (e.g. washing machines in Europe, Iran, Brazil). Efficiency standards levels may be set in a number of different ways. In Europe, a statistical approach is used - the energy efficiency of appliances already on the market is used as a basis and the standard is drawn up so as to obtain an improvement of 10-15% in the average energy efficiency of new appliances. In other countries, regulations are based on a cost-benefit evaluation (e.g. in the USA, to raise the energy efficiency of appliances to a level which corresponds to a return on the investment in 3 years).

In Europe, several countries introduced voluntary agreements in the 1980s and 1990s (Germany in the 1980s, Nordic countries in the 1990s, Switzerland in 1995). Since 1999, an EU directive has defined mandatory energy efficiency standards for refrigerators and freezers in EU countries. Japan chose a different approach, that consists of defining a voluntary target for energy efficiency improvement by a given year. Minimum efficiency standards are planned in the near future for refrigerators and air conditioners in several additional countries: for refrigerators in Korea, Indonesia, Slovakia, Turkey, Lithuania and India; and for air conditioners in Korea, Indonesia and India.

Labeling and efficiency standards are complementary

Labeling programs cannot completely transform markets; they need to be complemented by minimum performance standards. Standards are necessary to remove inefficient but cheap products from the market, which labeling programs alone cannot do. They are also needed in markets where the selection criteria of consumers totally exclude energy efficiency, as is the case with televisions, or when the economic options for the consumer are very limited.

3.2.8. Planning instruments

As for strategic studies on energy-efficiency trends, energy planning instruments should address the fundamental goals associated with the cost and reliability of energy supply. To adjust a country's energy demand, supply-side energy efficiency and energy conservation should become an important goal of society. For these purposes, strategic planning instruments should include investments in energy efficiency or conservation. Energy efficiency has proved to be a cost-effective strategy for sustainable development without necessarily growing energy consumption or negatively impacting the environment. Energy efficiency planning can offset the need for additional generation. Should energy efficiency measures be considered, planners need to take into consideration the effects of such measures when demand forecasting, and as a potential

[3] umid.office@azerin.com

measure with associated costs and volumes of energy saving to be compared with generation options.[4]

3.3. Global Energy Conservation Trends

The energy-efficiency performance of countries varies widely. The EU and Japan are for instance three to four times more energy-efficient in terms of energy intensity than the countries of the former Soviet Union or the Middle East. Energy intensity is a measure of the energy efficiency of a nation's economy; it is calculated as energy use per unit of GDP. High energy intensities indicate a high price or cost of converting energy into Gross Domestic Product (GDP). Low energy intensity indicates a lower price or cost of converting energy into GDP. Energy efficiency already forms the basis of a portion of the EU's international cooperation activities, including activities with industrial partners such as the United States, countries in transition such as Russia, and developing countries such as China and India. Furthermore, energy-efficiency projects, albeit limited in size, are part of the lending portfolio of international and European financing institutions; there is great potential to achieve synergies if more countries coordinated efforts.

The principal reasons for strengthening energy efficiency cooperation are closely linked to the geopolitical and strategic interests of the EU and the business opportunities arising from the EU's leading role in this area. In particular, Europe could be actively engaged in establishing and adopting standards on energy efficiency that can be internationally compatible. A further reason is the contribution energy efficiency can make to economic and social development. The recent increase in oil prices highlighted the impact of increased energy demand resulting from rapid growth in energy consumption in a number of countries, including China. Given the scarcity of energy resources and the limited spare production capacity, especially for hydrocarbons, it is obvious that energy importing countries increasingly become competitors for the same energy resources, for example in Russia, the Middle East and the Caspian region. Therefore, energy efficiency is an issue in the interest of all energy importing countries, including the Union, and should be integrated into their global strategy for security of energy supply. Figure 3.3 illustrates energy demand in EU partly covered by adoption of energy efficiency policies. we need to explain what is negajoules.   The word “negajoules” shown on the top of Figure 3.3 indicates the energy being saved by efficiency measures, based on 1971 energy usage.

4 Integrated Resource Planning –UNEP 1997

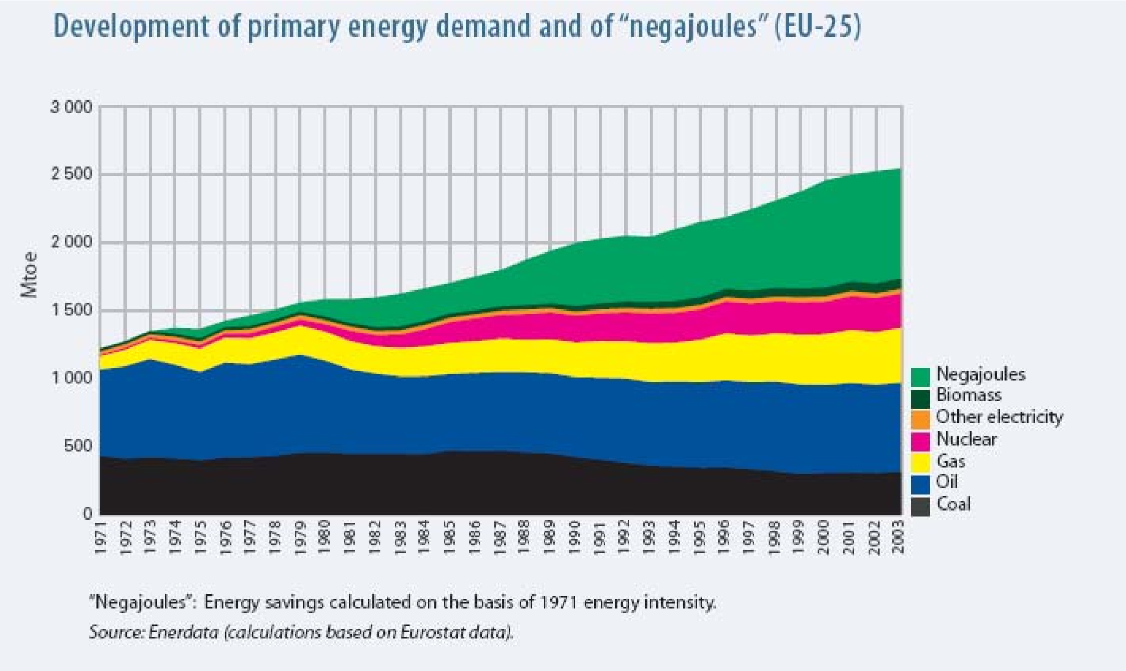


Figure 3.3. Energy demand in the EU. Source: The Green Paper on Energy Efficiency [5]

3.3.1. European Union Energy Policy Overview

The European Community, together with its Member States, is working to improve energy efficiency in all sectors whilst at the same time increasing the use of renewable energies. Early in 2007 the European Union (EU) proposed a new energy policy as a first resolute step towards becoming a low-energy economy, making the energy consumption more secure, competitive and sustainable. On March 8-9, 2007, the EU Prime ministers agreed upon an Energy Policy for Europe (for EU-27) including a firm commitment to increase renewable energy to 20% of primary energy supply in 2020 for the 27 EU-countries combined, increase energy efficiency with 20% by 2020 and increase biofuel in transport fuels in sustainable ways to 10% by 2020. They also agreed on a 30% reduction of greenhouse gas (GHG) emissions 1990 - 2020 on the condition that other countries also commit to reductions, and with a view to reduce GHG emissions 60-80% by 2050. If an international agreement is not possible, they agreed that the EU countries should reduce GHG emissions at least 20% for the period 1990 - 2020. Further they agreed to strengthen cooperation on four high-priority Trans-European networks, enhance functioning of internal energy markets with better separation of production and transmission companies, and increase international cooperation to secure energy supplies and to cooperate with other energy importing countries on energy efficiency and renewable energy.

A common policy is the most effective way to tackle today's energy challenges, which are shared by all Member States. The aims of the policy are supported by market-based tools (mainly taxes, subsidies and the CO2 emissions trading scheme), by developing energy technologies (especially technologies for energy efficiency and low-carbon energy) and by Community financial instruments.

[5] http://ec.europa.eu/energy/efficiency/index_en.htm

The Energy Package presented by the European Commission is part of the movement begun by the Green Paper on a European Strategy for Sustainable, Competitive and Secure Energy in March 2006 and once again places energy at the heart of European activities. The Commission asks the Member States to do everything in their power to implement a European energy policy built on three core objectives:

1. **sustainability** - to actively combat climate change by promoting renewable energy sources and energy efficiency;
2. **competitiveness** - to improve the efficiency of the European energy grid by creating a truly competitive internal energy market;
3. **security of supply** - to better coordinate the EU's supply of and demand for energy within an international context.

Energy Efficiency Action Plan

Seven months later, the EU Commission launched a **new** Energy Efficiency Action Plan with ten proposals for action. The action plan follows after consultation of the White Paper on Energy Efficiency Paper 2005 and is made to be a cornerstone in EU's policy for energy efficiency.

In October 2006 the European energy ministers approved a continuation of the Intelligent Energy for Europe (IEE) program, for support of sustainable energy for the period 2007-2013. The previous round of IEE energy program was launched for period 2003-2006. Intelligent Energy for Europe is a EU program to create a new direction and focus for energy policy in Europe that helps to promote respectively energy efficiency and renewable energy. For period 2007-2013 it includes the old SAVE program for non-technical support for energy efficiency and is itself part of the new large “Competitiveness and Innovation Framework” program. The annual budget for the new IEE program is in average 91 million euros for the each of the seven years that it will run. This is substantially more than the 50 million euros/year that the previous IEE program had for 2003-2006. It is important to underline that project SAVE—"Multiplying success in buildings," had goal to catalyze the implementation of the buildings-directive for energy efficiency, and promotion of best practice in energy efficient building.

The new IEE program will support more rational, efficient, and sustainable patterns in energy use by identifying and removing administrative, communications, and other non-technological barriers. As a part of the global Competitiveness and Innovation Framework program, the IEE also targets sustainable economic growth with job creation, greater social cohesion and higher quality of life. The promotion of the EU Parliament eco-innovation will also be supported, along with these projects:

- Strategic studies on energy trends for the preparation of future legislative measures as well as the development of standards, labeling and certification systems;

- Creation, enlargement or reorganization of structures and instruments for sustainable energy development. This includes local and regional energy management, and the development of adequate financial products and market instruments;

- Promotion of sustainable energy systems and equipment in order to accelerate their penetration of the market and to stimulate investment. Awareness campaigns and the creation of institutional capabilities should also be supported;

- Development of information, education and training structures;

- Promotion of know-how and best practices through operational transnational networks.

The Final EU Directive on Energy End-use Efficiency and Energy Services (2006/32) was adopted as directive 2006/32 on April 5, 2006. It entered into force May 17, 2006 and shall be implemented on May 17, 2008. It is mentioned that the energy efficiency targets are 1%/year, for the first 9-year period. The target is defined as the energy efficiency improvements resulting from energy efficiency measures. While this is a sensible way to measure it from a policy-maker's point of view, the list includes a number of measures that are - or can be - part of the normal "business as usual" development of increased energy efficiency of the societies. Thus, the policy may be open to "free riding" of countries that count energy efficiency improvements that are not an effect of active policies. The Directive also sets provisions to create conditions for the development and promotion of a market for energy services and for the delivery of other energy efficiency improvement measures for final consumers.

3.3.2. Energy Efficiency and Energy Conservation Policies in the United States

The U.S. Department of Energy categorizes national energy use in four broad sectors: transportation, residential, commercial, and industrial. Energy efficiency in the US is regulated both on the federal and states' levels through a number of legislative acts, including: the National Energy Conservation Policy Act of 1978; the Energy Tax Act passed by the U.S. Congress as part of the National Energy Act; and the National Appliance Energy Conservation Act (NIECE) of 1987 followed the earlier voluntary appliance efficiency targets of the Energy Policy and Conservation Act (EPACT) of 1975 and various State appliance-efficiency standards.

The most recent legislative act promoting energy conservation and energy efficiency in the US is the Energy Policy Act of 2005. The Act, described by proponents as an attempt to combat growing energy problems, provides tax incentives and loan guarantees for energy production of various types, as detailed below.

- Authorizes loan guarantees for "innovative technologies" that avoid greenhouse gases, which might include advanced nuclear reactor designs (such as PBMR) as well as clean coal and renewable energy.

- Increases the amount of biofuel (usually ethanol) that must be mixed with gasoline sold in the United States to triple the current requirement (7.5 billion gallons by 2012).

- Requires the U.S. Department of Energy to study and report on national benefits of demand response and make a recommendation on achieving specific levels of benefits. The Act also encourages time-based pricing and other forms of demand response as a policy decision.

- Provides tax breaks for those making energy conservation improvements to their homes; Sets federal reliability standards regulating the electrical grid (done in response to the Blackout of 2003).

The Energy Policy Act of 1995 also provides the following tax reductions:

- $1.3 billion for conservation and energy efficiency;

- $1.3 billion for alternative motor vehicles and fuels (ethanol, methane, liquefied natural gas, propane).

The Act also contains provisions for commercial buildings that make improvements to their energy systems. Energy improvements completed in 2006 and 2007 are eligible for tax deductions of as much as $1.80 per square foot ($ 19.38 per square meter). The incentives focus on improvements to lighting, HVAC (heating, ventilating, and air-conditioning) and building envelope. Improvements are compared to a baseline of the American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE 2001) standards. Many buildings are eligible for tax deductions for improvements completed or planned within the normal course of business, and can thus "free ride" for the new incentives. For municipal buildings, benefits are passed through to the primary designers/architects in an attempt to encourage innovative municipal design. These benefits emanate from the Department of Energy's desire to make all buildings "zero energy" within 20 years. The commercial building tax deductions can be used to improve the payback period of a prospective energy improvement investment.

Overall energy policies are managed by the United States Department of Energy (DOE) through the Office of Energy Efficiency and Renewable Energy, which currently supervises federal programs such as The Building Technologies Multi-Year Program, The US Weatherization and Intergovernmental Program, Federal Energy Management Program, and Energy Smart Schools.

Building Technologies Program (BTP) works in partnership with states, industry, and manufacturers to improve the energy efficiency of buildings. Through innovative new technologies and systems-engineered building practices it is transforming how Americans design, build, and operate the approximately 15 million new buildings projected to be constructed by 2015.

The Building Technologies Multi-Year Program outlines the technology portfolio and activities that are necessary to achieve the strategic goal of net-zero energy buildings (ZEB) at low incremental cost by 2025;[6] A ZEB is a residential or commercial building with greatly reduced needs for energy through efficiency gains, with the balance of energy supplied by renewables. Achieving long-term ZEB goals depends upon not only integrating and optimizing the best available technologies, but also depends on the development of new technologies and solutions. The Building Technologies Program research focuses on reducing the energy demand in buildings in a manner that will allow for the successful integration of renewable energy technologies. Much of the research conducted by Department of Energy's Building Technologies Program is funded through competitive solicitations. The building program selects research partners and projects based on factors such as energy saving potential, likelihood of success, and alignment with the recommendations of industry-developed technology roadmaps. Building program areas and initiatives include:

- **Appliances and Commercial Equipment Standards** aimed at developing test procedures and minimum efficiency standards for residential appliances and commercial equipment. This program covers 17 types of residential products and 11 types of commercial equipment. DOE currently is active in standards and test procedure development for the following residential products: battery chargers & external power

[6] http://www.eere.energy.gov/buildings/about/index.html

supplies, central air conditioners & heat pumps ,clothes dryers , clothes washers, cooking products, dehumidifiers, dishwashers, furnaces & boilers, fluorescent & incandescent lamps, fluorescent lamp ballasts, plumbing products, pool heaters, refrigerators & freezers, room air conditioners, small duct, high velocity air conditioners, and water heaters.

The Department of Energy currently is active in standards development for the following commercial products:

1. Clothes Washers
2. Distribution Transformers
3. Electric Motors
4. Furnaces & Boilers
5. High Intensity Discharge Lamps
6. Refrigerated Beverage Vending Machines
7. Refrigeration Equipment
8. Small Electric Motors
9. Unitary Air Conditioners & Heat Pumps
10. Water Heaters
11. ASHRAE Products: instantaneous thankless water heaters, commercial boilers, packaged terminal air-conditioners and packaged terminal heat pumps, three-phase air-conditioners and heat pumps < 19.06 kWt/hours (65 kbtu/hours), and single-package vertical air conditioners and single-package vertical heat pumps.

- **Building America** deals with support of research and development activities that produce *homes that use up to 70% less energy, with little or no increase in construction costs.* Building America homes incorporate energy- and material-saving technologies and building practices. Building America has five consortia, comprised of a total of more than 270 companies. Members of each consortium include architects, engineers, builders, equipment manufacturers, material suppliers, community planners, mortgage lenders, and contractor trades.

- **Building Energy Codes** supports development of more stringent and easier-to-understand building energy codes, develops downloadable compliance tools and materials, and provide technical and financial assistance to help states adopt, implement, and enforce building energy codes.

- **Emerging Technologies** supports research and development for the next generation of energy-efficient components, materials, and equipment.

- **Energy Star** develops technical requirements and qualifications defining ENERGY STAR status, and works with manufacturers, retailers, and utilities to promote the manufacture and use of ENERGY STAR products.

- **High Performance Buildings** works with architects, engineers, builders, contractors, owners, and occupants to optimize building performance, comfort, and savings through a whole-building approach to design and construction.

- **Rebuild America** is a network of hundreds of community-based partnerships across the nation that are saving energy, improving building performance, easing air pollution through reduced energy demand, and enhancing the quality of life through energy efficiency and renewable energy technologies.

- **Zero Energy Buildings of the Department of Energy** combines its partners' expertise in energy efficiency and renewable energy to perform research, design, and construct new buildings that produce, as well as consume energy.

The **International Residential Code (IRC)** is a comprehensive, stand-alone residential code that creates minimum regulations for one- and two-family dwellings of three stories or less. It brings together all building, plumbing, mechanical, fuel gas, energy and electrical provisions for one- and two-family residences. The IRC also provides a prescriptive approach (i.e., a set of measures) and a performance approach (i.e., energy modeling) for determining compliance.
The **International Energy Conservation Code** is a similar code which encourages energy conservation through efficiency in envelope design, mechanical systems, lighting systems and the use of new materials and techniques. The IECC is similar to the energy-related components of the IRC, and is referenced within the IRC, though the two are not always identical.

The US Weatherization and Intergovernmental Program facilitates the adoption of renewable energy and energy efficiency technologies in the United States and across the world.[7] To achieve this goal, the program provides technical assistance and analysis to help decision makers in state and local governments, Indian Tribes, and foreign nations examine which set of renewable energy and energy efficiency technologies is right for them. The Weatherization and Intergovernmental Program also manages the U.S. Department of Energy Office of Efficiency and Renewable Energy grant and incentive programs to states and Indian tribes, including the Weatherization Assistance Program, the State Energy Program and the Tribal Energy Program.

As the largest energy consumer in the United States, the federal government has both a tremendous opportunity and a clear responsibility to lead by example with smart energy management. By promoting energy efficiency and the use of renewable energy resources at federal sites, the ***Federal Energy Management Program*** helps agencies save energy, save taxpayer dollars, and demonstrate leadership with responsible, cleaner energy choices.

The Department of Energy also maintains ***Energy Savers Website***, which provides homeowners with tips for saving energy and money at home and on the road.[8] It provides the latest information on energy-saving, efficient technologies, gives tips for using clean, renewable energy to power homes, helps homeowners beat the high cost of fuel, with driving and car maintenance tips.

The US Office of Energy Efficiency and Renewable Energy also carries out the following programs related to energy efficiency policies:

- **Clean Cities** supporting public-private partnerships that deploy alternative fuel vehicles and build supporting infrastructure. To maximize their resources, community revitalization efforts often combine energy solutions for transportation and buildings.

[7] http://www.eere.energy.gov/wip/
[8] http://www1.eere.energy.gov/consumer/tips/index.html

- **EnergySmart Schools** working with school districts to introduce energy-saving design features and improvements to the physical school environment, and to promote and support energy education in schools.

3.3.3. Energy Efficiency and Energy Conservation Policies in Japan

Among the leading countries of the world Japan stands out for two major reasons:

1. It does not use term “energy efficiency” in its official documents and hardly in any research papers too, preferring “energy conservation” or “rational use of energy”:

2. Its energy conservation policies are strictly government regulated to the extent unseen both in the US and EU. The government generally prefers to enforce energy conservation measures both for industries and population, rather than using persuasion, financial and other incentives, although these are also widely used.

All energy conservation policies are run and controlled by the Agency for Natural Resources and Energy of the Ministry of International Trade and Industry. Japan's energy conservation policies are considered by an "Advisory Committee for Natural Resources and Energy". Important role in planning and implementation of energy conservation policies is played by the Energy Conservation Center, which contributes to promoting the efficient use of energy, protection of the global warming and sustainable development.[9] The Center formally employees 122 persons, but in 2005 the Center’s budget was 4,527 million yen.[10] Leaders from all the most important Japanese corporations serve on the Center’s board of directors.

Energy efficiency policy principles are formulated in the Fundamental Policies for Rational Use of Energy (adopted at the Cabinet Meeting on 6 July 1993, Ordinance No.361 of the Ministry of International Trade and Industry, on 15 July 1993). This document is based on the understanding of “the constant possibility of a global crisis in energy supply and demand”, as well as “global warming, which is mainly caused by energy use and resulting generation of carbon dioxide, is posing a grave problem that may have ill effects on the very basis of our survival”.[11] It addresses in detail: 1) Fundamental matters concerning the measures to be taken by energy users, etc. for the rational use of energy; 2) Fundamental matters concerning policies for promoting rational use of energy, measures to be taken by the central and local governments themselves as energy users. All energy efficiency measures are legally based on the Law concerning the Rational Use of Energy (usually referred to as "the Energy Conservation Law") adopted in June 1979 (enforced in October 1979), which was triggered by the two global oil crises and was aimed to promote the initiatives on energy conservation to reduce total energy demand.

The law was amended in 1983, 1993, 1998, 2002 and 2005. Compliance with the **Kyoto Protocol** in February 2004 and the consequent need to attain the Japan’s greenhouse gas emission reduction target committed at COP 3 [12] triggered an amendment. Among other things the amendment stipulated: strengthening energy conservation measures for residential buildings

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[9] http://www.eccj.or.jp
[10] 39523,3 US $
[11] http://www.eccj.or.jp/law/e-fndmnt.html

[12] The Kyoto Protocol has been issued as part of the COP 3 (Third Conference of the Parties to the UNFCCC-United Nations Convention on Climate Change).

and construction sector as well as obligation for energy suppliers and equipment retailers to make efforts to promote and disseminate energy-saving information**.**

The above law is supported and strengthened by the **Law for Energy Conservation and Recycling Support,** which is designed to support business operators who will voluntarily implement projects to promote the rationalization of the use of energy and natural resources. Currently the following energy conservation measures create the backbone of energy efficiency policy (concerning consumption) in Japan. Below is a smapling of a few of the Law's provisions.

- **Commercial sector:** Submission of energy-saving measure application reports is compulsory for newly constructed, expanded and remodeled buildings (non-residential). Submission of energy-saving measure application reports shall be compulsory for large-scale repair works. Submission of energy-saving measure application reports shall also be compulsory for large residential housing.

- **Residences and buildings:** The clients, those who will modify buildings and the owners of specified buildings shall be instructed or advised in connection with the design, construction, and maintenance of the buildings. The Ministry of Land, Infrastructure and Transport announces guidelines for the design and construction of residences. Buildings including residences having a total floor area of 2,000 m^2 or larger should submit notification of energy-saving measures to the competent authorities.

- **Promotion of the introduction of high-efficiency facilities (subsidies, tax systems, loans):** especially targets air conditioners and lighting apparatuses in the commercial sector when it was reviewed and extended in FY 2006; it also provides low-interest loans to businesses contributing to energy conservation, particularly for the introduction of Top Runner qualified equipment and energy-saving businesses.

Japan's Top Runner Standard

In Japan, as a key component of the energy conservation program for the residential, commercial, and transportation sectors is the Top Runner Standard, which was introduced to advance energy efficiency of machinery and equipment in 1999. The Top Runner System targets the product with the highest energy efficiency on the market at the time of the standard establishment process, and sets standard values by evaluating the potential to further reduce energy consumption. Naturally, target standard values are extremely high. The Energy Conservation Law has established a labeling system for Top Runner equipment so that buyers can obtain information about the energy consumption efficiency of machinery and equipment at the time of purchase. Although the prices of products that exceed standard values are inevitably higher than earlier products, the government is promoting (and people are accepting) that the life cycle costs of Top Runner equipment are significantly lower than that of older products.

The Energy Conservation Law has established a display program for Top Runner target machinery and equipment so that buyers can obtain information on the energy consumption efficiency of machinery and equipment at the time of purchase. Under the display program, manufacturers of Top Runner target machinery and equipment are required to display information about energy efficient products regulated under the "Notifications;" penalties will apply when a manufacturer does not comply to display requirements.

To further facilitate the popularization of energy-efficient equipment, the best labeling program (Energy Conservation Labeling Program) was established in Japan. Four items are to be shown on the label, including a symbol used to show the degree that energy conservation standards had been achieved, energy conservation standard achievement rate, energy consumption efficiency, and the target fiscal year. Following this the energy conservation labeling program was launched. The labeling program is a voluntary program, and displayed in product catalogues as well as on products themselves. Labels may be displayed on packaging, a product itself, tags, and the like besides catalogues.

The Energy Conservation Center, Japan established the "Energy Efficient Product Retailer Assessment Program," which manages and administers the program. Under this program, a public invitation is made to each home appliance retail shop, each shop that actively offers information and promotes sales is selected as an "Outlets that Excel at Promoting Energy-Efficient Products," and the results of the public invitation are announced. In addition, the Minister of Economy, Trade and Industry Award, the Minister of the Environment Award, the Director-General of the Agency for Natural Resources and Energy Award, and the Energy Conservation Center Chairman Award are given to particularly excellent shops. The results of the selection and awards are publicized to consumers through newspapers, magazines, journals of consumer organizations, NPOs,[13] the public relations magazines of local public agencies, and so on. Excellent shops that are selected and receive awards can use the "Outlets that Excel at Promoting Energy-Efficient Products" logo mark.

Energy Service Companies

Promotion of Energy Service Company (ESCO) Business

ESCOs are businesses that offer comprehensive services on energy conservation to clients, who in return will offer a part of their energy saving gains, such as savings on utility bills. The business has two forms: "Guaranteed savings agreement" where customers cover business costs and "Shared savings agreement" where the ESCO business covers business costs. These options enable service provision according to customer needs.

[13] The term NPO is used in recent years to encompass nonprofit organizations engaged in domestic as well as international activities. Most of the main political parties started drafting new NPO legislation that would effectively promote and support the activities of Japan’s nonprofit sector. The so-called NPO Law (officially the Law to Promote Specified Nonprofit Activities) finally passed the Diet in March 1998, providing a new impetus for better understanding among leaders and the public of the ways in which civil society could contribute to the public good.

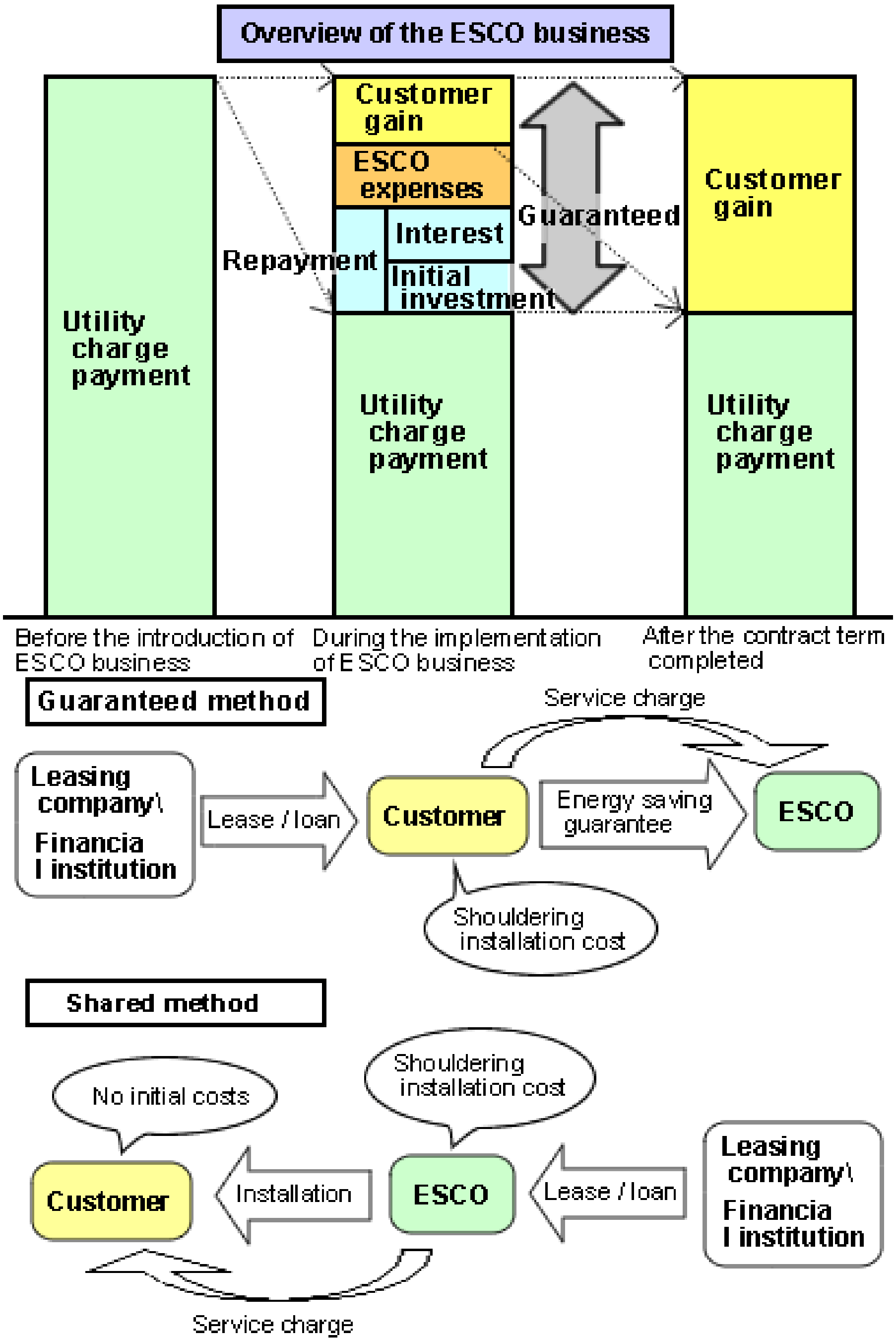


Figure 3.4. Promotion of ESCO Business ESCO-Related Market Scal***e;*** Source: http://www.eccj.or.jp/eng/e3209esco.html

ESCO-related markets have shown rapid growth in recent years with substantial room for market expansion (FY 2002 purchase orders: Approx. 51.5 billion yen). Research estimates its potential market size as 2,470 billion yen. Source: The ECCJ's ESCO Introduction Promotion Study Group Report; the market scale of the ESCO business in the US in 2000 is approx. US$ 2 billion.

[14] Ministry of Economy, Trade and Industry in Japan

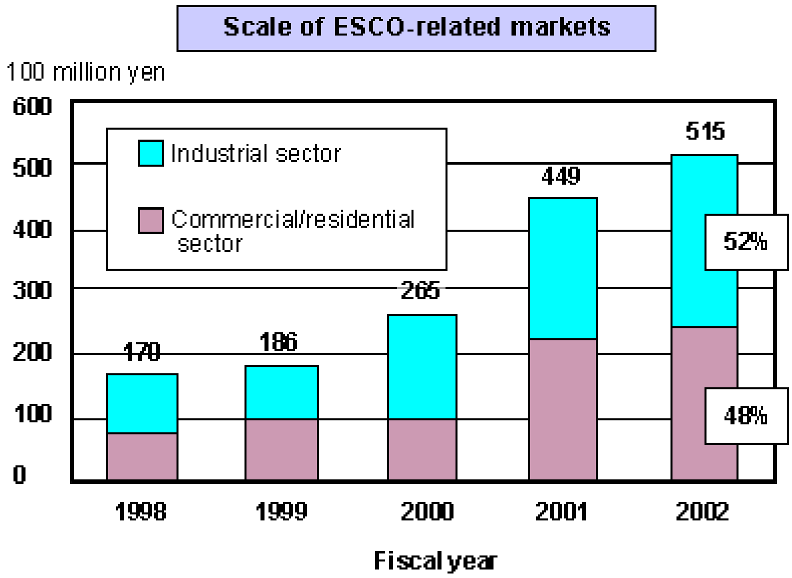


Figure 3.5. Development of ESCO Business in Japan,
Source: www.eccj.or.jp/eng/e3209esco.html

There are several ways countries can support the introduction of ESCO businesses, through partial subsidies for initial investments and low-interest loans for example, and this support could be extended to private enterprises and local governments implementing the ESCO business. A model ESCO project could be introduced also at a national facility, i.e., METI building from FY 2004 onwards.[14]

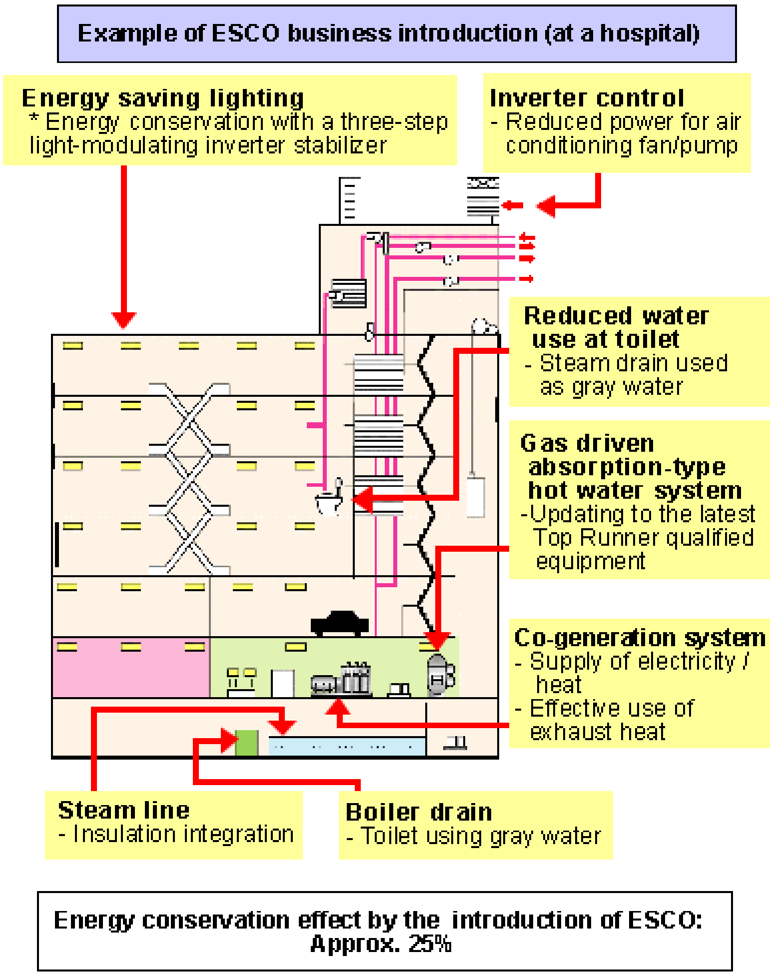


Figure 3.6. Example of ESCO Business Project at the Hospital.
Source: http://www.eccj.or.jp/eng/e3209esco.html

3.3.4. Energy Efficiency in Bulgaria

Bulgaria provides a good example for how countries from the former Soviet Union country can make significant steps towards developing the comprehensive legal framework for energy efficiency policy; one caveat with the Bulgaria example is that it remains to be seen whether the development and implementation of a coherent energy efficiency policy will occur. Still, it should be taken into consideration that this process here was stimulated, and to a large extent enforced by the EU; the EU included energy efficiency measures into the list of demands prospective members should meet before ascension. Thus planning and implementing such measures is much easier here than in other post-socialist or post-Soviet countries that are not on the EU "waiting list."

Energy efficiency measures in the country are regulated through the number of legal documents including The Energy Act, adopted on December 9, 2003, amended in 2004, 2005 (twice), 2006 (three times).[15] This Act regulates the social relations associated with the activities of generation, import and export, transmission, transit transmission, distribution of electricity, heat

[15] http://www.mi.government.bg/eng/norm/rdocs/mdoc.html?id=212967

and natural gas, transmission of crude oil and petroleum products through pipelines, trade in electricity, heat and natural gas, and utilization of renewable energy sources, as well as the powers of state bodies in formulating energy policy, regulation and control.

The principal purposes of this Act among other things are to create conditions for: energy development and the energy security of the country through efficient use of energy and energy resources; sustainable development in the utilization of renewable energy sources, including production of electricity from renewable energy sources in the interests of environmental protection; elaborate national long- and short-term programmers for the promotion of the utilization of renewable energy sources; to lay the said programs before the Council of Ministers for adoption; elaborate national indicative targets for promotion of the consumption of electricity produced from renewable energy sources; lay the said targets before the Council of Ministers for adoption; and prepare annual reports on the attainment of such targets, stating the degree of compliance of any measures taken with the obligations to prevent climate change.

The Energy Efficiency Act adopted in 2004, amended 2006 and 2007 regulates public relations with regard to the implementation of government policy for energy-efficiency promotion and for providing energy efficient services[16]. The objective of the law is to encourage energy efficiency through a system of measures and activities on national, industry, regional and municipal levels, as a major factor for enhancing the competitiveness of the economy, electric power supplies security and the protection of the environment.

The ministry responsible for energy policy is the Ministry of Economy and Energy. This ministry works on the development of Bulgaria's economic and energy policies. It aim is to increase the competitiveness of the national economy and the various institutions; encourage investments, innovations, entrepreneurship, exports, modernization of the industrial base; and stimulate measures on energy efficiency in the industry and the use of renewable energy resources.[17] The Ministry acts through the Energy Efficiency Agency - a juridical person, supported by the budget, with the statute of a ministerial executive agency.[18] The Agency develops programs and projects for improvement of energy efficiency and electric and heat power generation by renewable power sources. It monitors and coordinates energy efficiency programs and analyzes the results of projects related to the preparation of the National Energy Balance. The Energy Efficiency Agency's priorities include:

- Improving the energy efficiency;
- Public gas supply with natural gas;
- Legislative regulation of the "Energy efficiency" fund;
- Harmonization of the Bulgarian legislation with the European one, including in the field of the energy efficiency;
- Special accent on the energy efficiency development;
- Ensuring financial support for development of the energy efficiency in Bulgaria.
- The centerpiece of the agency activities is Program - Partnership for accession to the EU", envisaging:
- Preparation of Republic of Bulgaria for negotiations for accessions to the EU

[16] http://www.mi.government.bg/eng/norm/rdocs/mdoc.html?id=212967

[17] http://www.mi.government.bg/eng/

[18] http://www.seea.government.bg/index_en.php

- Implementation of the economical criteria from Copenhagen 1993
- European integration and sustainable development.

Interestingly, although Energy Efficiency Act has implemented a number of projects in the past, there is no current, ongoing project listed at its web page.

The Bulgarian Energy Efficiency Fund (BgEEF) was established through the Energy Efficiency Act adopted by the Bulgarian Parliament in February 2004. The initial capitalization of BgEEF is entirely with grant funds, its major donors being: the Global Environment Facility through the International Bank for Reconstruction and Development (the World Bank) - USD 10 million; the Government of Austria - Euro 1.5 million; the Government of Bulgaria - Euro 1.5 and several private Bulgarian companies.[19] BgEEF has the combined capacity of a lending institution, a credit guarantee facility and a consulting company. It provides technical assistance to Bulgarian enterprises, municipalities and private individuals in developing energy efficiency investment projects and then assists their financing, co-financing or plays the role of guarantor in front of other financing institutions.

The underlying principle of BgEEF's operations is a public-private partnership. The Fund pursues an agenda fully supported by the Government of Bulgaria, but it is structured as an independent legal entity, separate from any governmental, municipal and private agency or institution.

So far the fund has completed three projects in building sector, two including weatherization of buildings, one weatherization and installation of heating system. One similar project is ongoing. It also implemented two projects on improving street lighting and is running series of seminars on energy efficiency. All its projects are implemented through ESCOs.

3.4. Energy Efficient Methods and Technologies

3.4.1. Design and construction of energy efficient buildings

Perhaps the most important realization in the quest for energy efficient buildings has been that buildings, like people, function as a system. Building scientists and home performance specialists have measured and documented how all the different components in a home interact with and affect one another. When one part goes wrong, it will inevitably affect other parts that may seem on the surface to have no direct connection. We have come to know that the different parts of a house are as interdependent as the organs of a living being. Houses should therefore be designed and treated so that all the different parts of the system interact in a beneficial way. Many countries have developed their own standards of energy efficiency for buildings.

Green building is the practice of increasing the efficiency of buildings and their use of energy, water, and materials, and reducing building impacts on human health and the environment, through better siting, design, construction, operation, maintenance, and removal — the complete building life cycle.

[19] http://www.bgeef.com/display.aspx

Many design issues can be analyzed through the use of design tools. As used here, the term includes a diversity of tools, from those used to inform the process by indicating trends in energy use associated with strategic design decisions, to tools to predict the energetic performance of detailed architectural and engineering proposals. Even though there are many different design options of energy efficient house available, they all have several things in common to be considered as elements of an energy efficient house: a high thermal resistance R-value, tightly sealed thermal envelope; controlled ventilation; and lower than usual heating and cooling bills. Some designs are more expensive to build than others, but none of them need to be extremely expensive to construct. Recent technological improvements in building elements and construction techniques, and heating, ventilation, and cooling systems, allow most modern energy saving ideas to be seamlessly integrated into any type of house design without sacrificing comfort, health, or aesthetics. Listed below are some of the technologies that are used to build an energy efficient building, or zero energy home:

- Structural Insulated Panels
- Insulated Concrete Foundations
- Heat Recover Ventilation System
- Radiant Floor Heating
- Sealed Combustion Boilers
- Energy efficient windows
- Day-lighting
- Solar home design and orientation
- Trombe wall (passive solar heating)

Structural Insulated Panels (SIPs) are used to create an air tight building envelope. They are comprised of two skins of oriented strand board. With an inner core of solid foam insulation, bonded together. The result is an incredible strong panel. The panels come in 4' [20] x 24' panels (122-732 centimeters) that can be factory cut to meet the buildings design. The panels actually replace the buildings framed wall system. A typical Structural Insulated Panel wall consisting of 6-1/2"[21] (16.51 centimeters) thick panels have an R[22]-25 rating. Typical SIP roof panels are either 10-1/4"(26 centimeters) (R-40) or 12-1/4"(30.8 centimeters) (R-48). These are sized to accommodate conventional lumber at the panel connections. A SIP's envelope can reduce your buildings heating and cooling loads by as much as 50%.

Foundation walls and slabs should be at least as well insulated as the living space walls. Un-insulated foundations have a negative impact on home energy use and comfort, especially if the family uses the lower parts of the house as a living space.

Heat Recovery Ventilators or Energy Recovery Ventilators are growing in use for controlled ventilation in tight homes. These devices salvage about 80% of the energy from the stale exhaust air and then deliver that energy to the fresh entering air by way of a heat exchanger inside the device. They are generally attached to the central forced air system, but they may have their own duct system.

Houses that incorporate the above elements should require relatively small heating systems (typically less than 14,65 kWt/h even for very cold climates). Some have nothing more than

[20] '- foot= 30,48centimetres
[21] "-inch= 2,54 centimeters
[22] R- Value is the thermal resistance of material.

sunshine as the primary source of heat energy. Common choices for auxiliary heating include **radiant in-floor heating** from a standard gas-fired water heater, a small boiler, furnace, or electric heat pump. There are three types of radiant floor heat:

- radiant air floors (air is the heat-carrying medium);
- electric radiant floors;
- hot water (hydronic) radiant floors.

The water temperature in an under floor heating system can be a nominal 40 to 50 °C, considerably lower than conventional system. This means that under floor heating is ideal for use with alternative energy sources like ground temperature heat exchangers where heat can be recovered from the ground. Using heat exchangers or heat pumps this energy can be transformed in the higher temperature flow for use in heating.

Figure 3.7. In a modern under floor heating system pipes are laid into the floor, usually a solid screened floor.[23]

The Trombe wall was designed by Felix Trombe, a French inventor in the late 1950's and 1960's. The basic concept of the Trombe wall was to incorporate thermal mass into the wall. This creates a large storage capacity for heat. a masonry wall was built behind a wall of windows. The wall would slowly absorb the heat of the sun. At night when heating was needed, vents were opened to the top and bottom of the wall to circulate air around the wall. This was transferred into the house by convection air movement. It required no mechanical parts, and is capable of providing 20% of your homes heating needs. The wall takes many hours to heat up, the length of time depends on the size of the mass. A typical 10" concrete wall will take about 8-9 hrs. to heat to design temp. At night while the wall is cooling it transfers heat into the living space.

The original idea for a wall heating system was patented by Edward Morse in 1881. Many variations of this idea have been built, using different methods of thermal mass. Water is one that has been tried and has very good thermal storage properties. Another idea is to incorporate phase change materials into the wall. Phase change materials are materials that change from a solid to a liquid, or from a solid to another solid, when exposed to heat. In the process of phase change a large amount of heat is absorbed in the material. When the material cools and changes back to it's original form the energy stored is released. This is a very good way to reduce the amount of thermal mass needed, while increasing the amount of energy stored. Phase change materials are already being used in the electronics industry. These materials are used to keep electrical components from overheating, by absorbing heat away from the components.

[23] http://en.wikipedia.org/wiki/Underfloor_heating

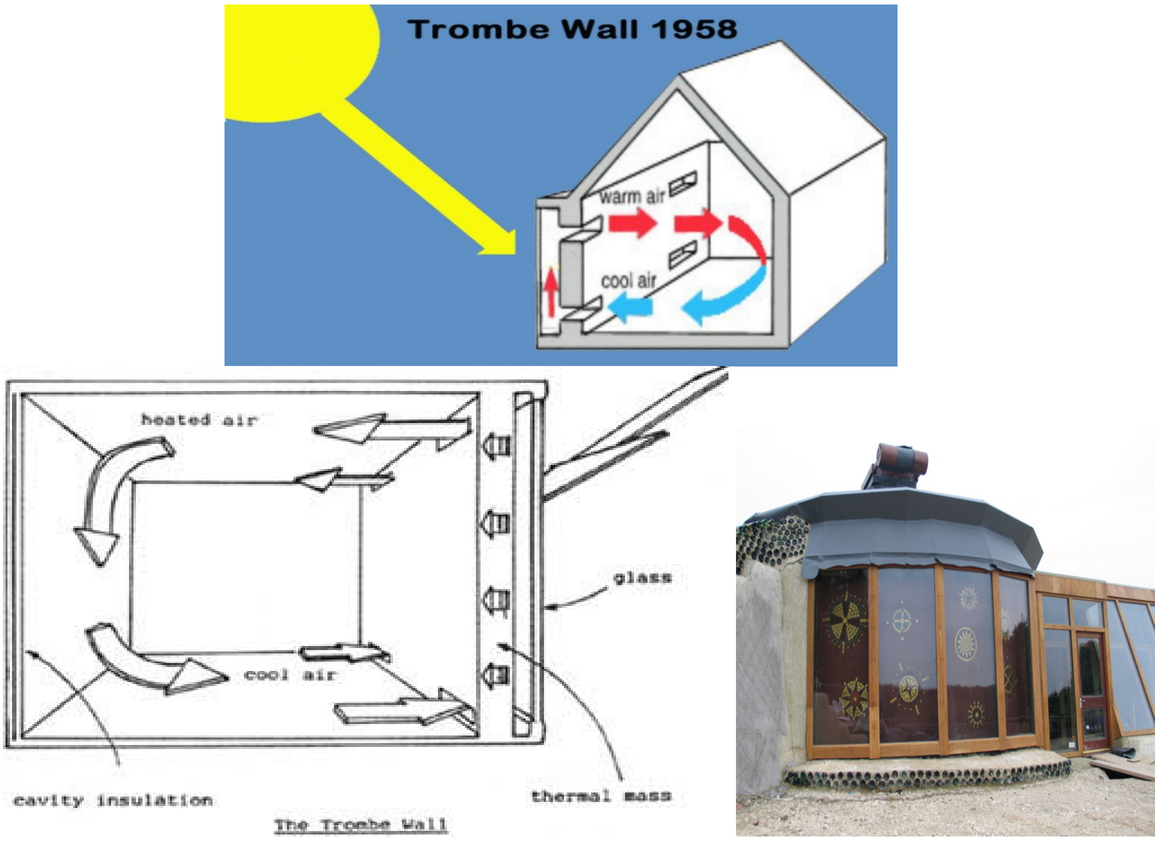


Figure 3.8. The Trombe Wall –passive solar heating (scheme and picture), Source:[24]; [25]

An average home may lose 30% of its heat or air-conditioning energy through its windows. **Energy-efficient windows** save money each and every month. There are even some cases where new windows can be net energy gainers. The payback period for selecting energy-efficient units ranges from two years to ten years. In new construction, their higher initial cost can be offset because you'll probably need a smaller, less expensive heating and cooling system. And more-durable windows may cost less in the long haul because of lowered maintenance and replacement costs. Plus, you'll be more comfortable the whole while you live with them.
Window choice has a real impact on heating and cooling costs. This chart is based on a computer model of heating costs for a 1,540-sq. ft. house with ceiling insulation and in the walls and floor. The window area is equal to 15% of the floor area.

Windows lose and gain heat by conduction, convection, radiation and air leakage. This heat transfer is expressed with U-values, or U-factors. U-values are the mathematical inverse of R-values. So an R-value of 2 equals a U-value of 1/2, or 0.5. Unlike R-values, lower U-value indicates higher insulating value.

Conduction is the movement of heat through a solid material. Touch a hot skillet, and you feel heat conducted from the stove through the pan. Heat flows through a window much the same way. With a less conductive material, you impede heat flow. Multiple-glazed windows trap low-conductance gas such as argon between panes of glass. Thermally resistant edge spacers and window frames reduce conduction, too.

[24] http://www.energyefficientbuildingtechnologies.com/Trombe_wall_2.jpg
[25] http://www.energyefficientbuildingtechnologies.com/trombe_wall_3.jpg

Windows lose heat in four ways. The rate at which a window loses heat through the combination of the four is called its U-value. It is the inverse of the R-value, so the lower the U-value, the greater the insulative value of the window.
Energy-efficient glazing on windows reduces winter condensation. When low glass temperatures cause inside air to reach its dew point, water condenses on the window. The chart indicates the points where indoor humidity and outdoor temperature combine to cause condensation on various types of glazing. This chart is based on center-of-the-glass temperatures, but the edges are always colder, and condensation usually begins there.

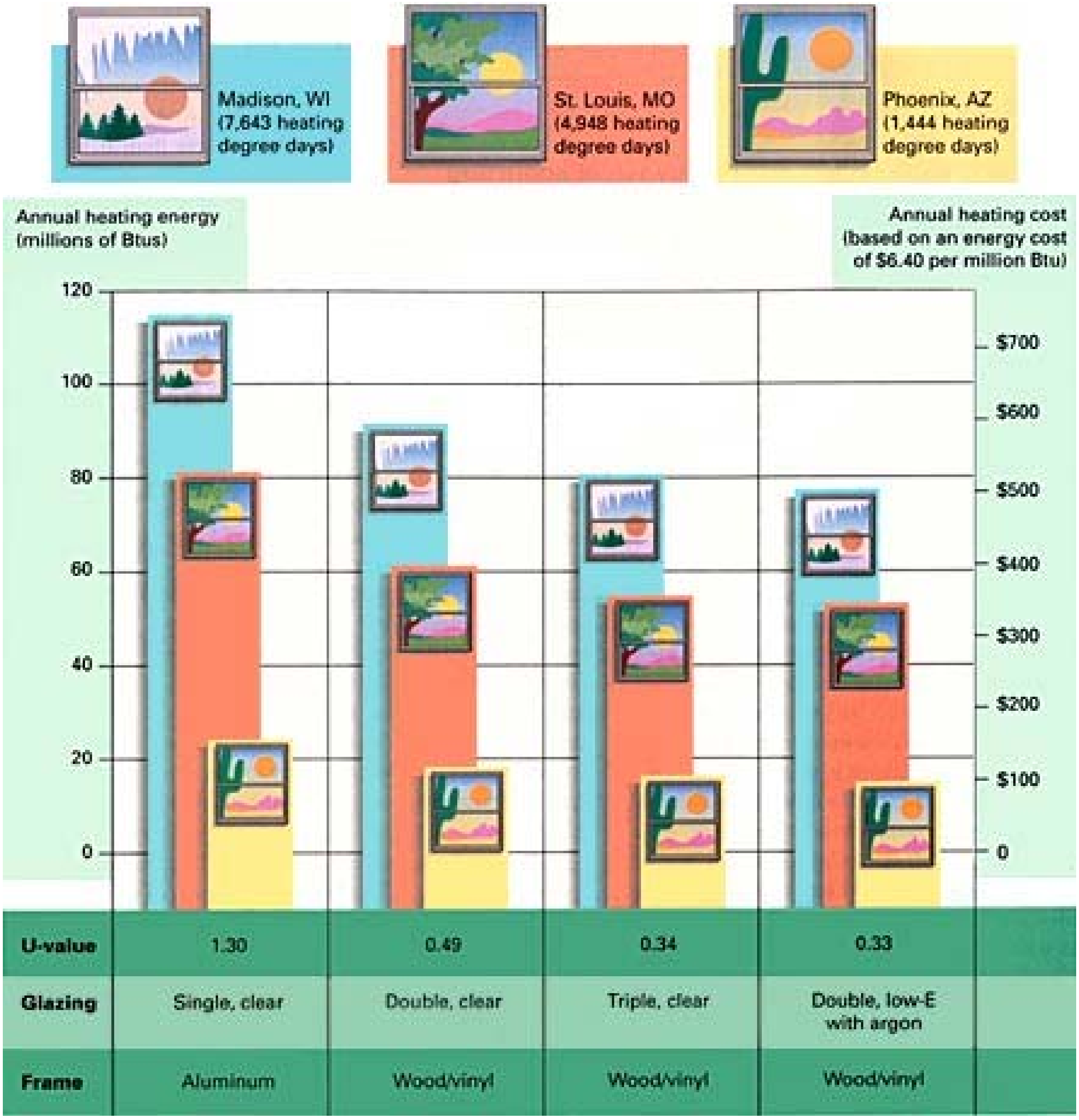


Figure 3.9. Window choice has a real impact on heating and cooling costs. Source: Understanding Energy Efficient Windows [26]

Frame materials also affect energy performance. There is a great difference in the insulative value of common frame materials. Here are some typical U-values for common frame materials:

[26] http://www.taunton.com/finehomebuilding/how-to/articles/understanding-energy-efficient-windows.aspx

Frame material	U-value
Aluminum (no thermal break)	1.9-2.2
Aluminum (with thermal break)	1.0
Aluminum-clad wood/reinforced vinyl	0.4-0.6
Wood and vinyl	0.3 - 0.5
Insulated vinyl/insulated fiberglass	0.2 - 0.3

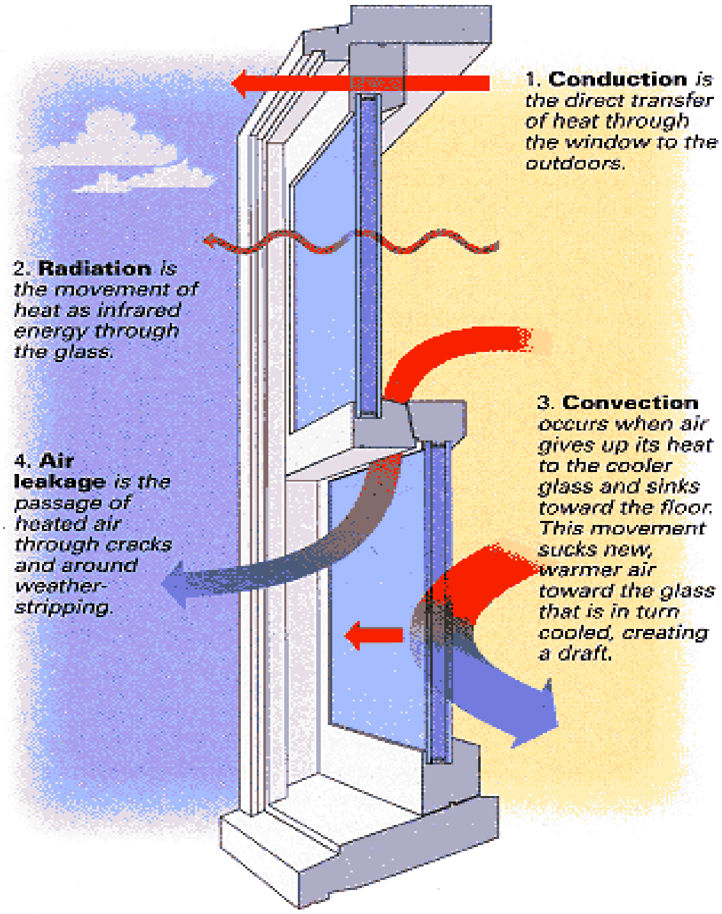


Figure 3.10. The scheme of heat losses through the window.[27]

[27] http://www.taunton.com/finehomebuilding/how-to/articles/understanding-energy-efficient-windows.aspx

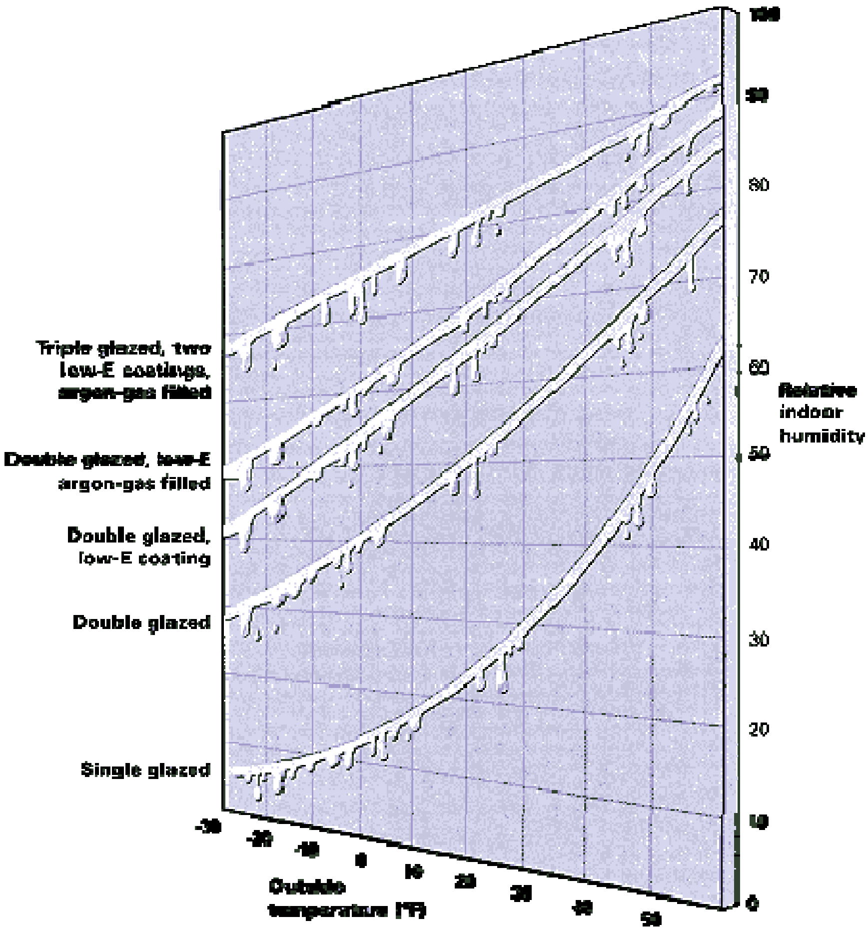


Figure 3.11. Energy efficient glazing.[28]

3.4.2. Energy efficient technologies

There are several other technologies and techniques that can save Georgia's residential and business consumers money and energy.

- Energy efficient lighting
- Energy efficient Appliances
- Efficient water heating
- Control Systems
- Management Systems
- Adjustable Speed Motor Drives
- Efficient Wood Stoves

Electric lighting burns up to 25% of the average home energy budget; however, **energy efficient lighting** can dramatically reduce electricity bills. Compact fluorescent lights (CFL) and light emitting diode (LED) bulbs have revolutionized energy-efficient lighting. Compact fluorescent light bulbs combine the efficiency of fluorescent lighting with the convenience and popularity of incandescent fixtures. CFLs can replace incandescents that are roughly 3 to 4 times their

[28] http://www.taunton.com/finehomebuilding/how-to/articles/understanding-energy-efficient-windows.aspx

wattage, saving up to 75% of the initial lighting energy. Although CFLs cost from 10 to 20 times more than comparable incandescent bulbs, they last 10 to 15 times as long (Figure 3.12). Amory Lovins of the Rocky Mountain Institute calculated that replacing a 75 watt incandescent light bulb with an 18 watt compact fluorescent (that gives the same amount of light) would, over the lifespan of the new bulb, prevent the emission of about 1 ton of carbon dioxide and 8 kilograms of sulphur dioxide into the atmosphere, plus a huge savings on electricity cost. And, the compact fluorescent will last over 10 times as long.

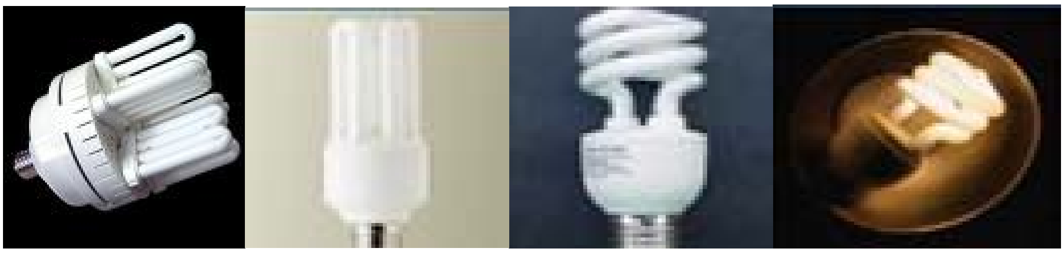


Figure 3.12. Various Compact Fluorescent Lights

LEDs (Light Emitting Diodes) shown below in Figure 3.13 are small, solid light bulbs which are extremely energy-efficient. Recent improvements in manufacture have lowered the cost of LEDs, which has expanded their application. They are an excellent, efficient replacement for the terribly inefficient small incandescent bulbs found in task lights, nightlights, pathway lighting, exit signs, and especially flashlights. As the amount of light needed gets larger (lighting an entire room, for instance) LEDs are only marginally more efficient than a 100 watt incandescent—but a nightlight made with white LEDs is almost three times as efficient as the incandescent it replaces. Also, if run at recommended current levels, LED lights should last tens of thousands of hours, a huge improvement over other lighting technologies. They are also very shock- and cold-resistant, perfect for portable and outdoor applications. Groups of 3-9 white LEDs are effective as reading lamps. Three of our white LEDs running together use only 0.22 watts! Single white LEDs make great pathway lights, and can be left on all the time. Flashlights can be easily converted to use LED bulbs; this is probably the best application for them.

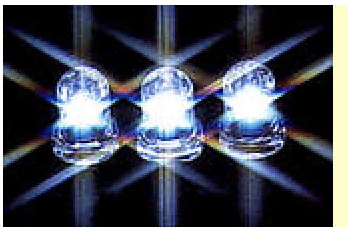


Figure 3.13. Light Emitting Diodes

Appliances account for about 20 percent of a typical household's energy use. When shopping for new appliances, it is necessary to think of two price tags. The first one is the purchase price. The second price tag is the cost of operating the appliance during its lifetime. You'll be paying that second price tag on your utility bill every month for the next 10 to 20 years, depending on the appliance. Many **energy efficient appliances** cost more to buy, but save money in lower energy costs**.**

If the people were to equip their homes only with products that have the EnergyStar® label, he/she would cut his/her energy bills, as well as greenhouse gas emissions, by about 30 percent.

Another way to compare appliances is by using Energy Guide labels, which provide information about efficiency of appliances in terms of how much energy uses each model compared with the most efficient model.

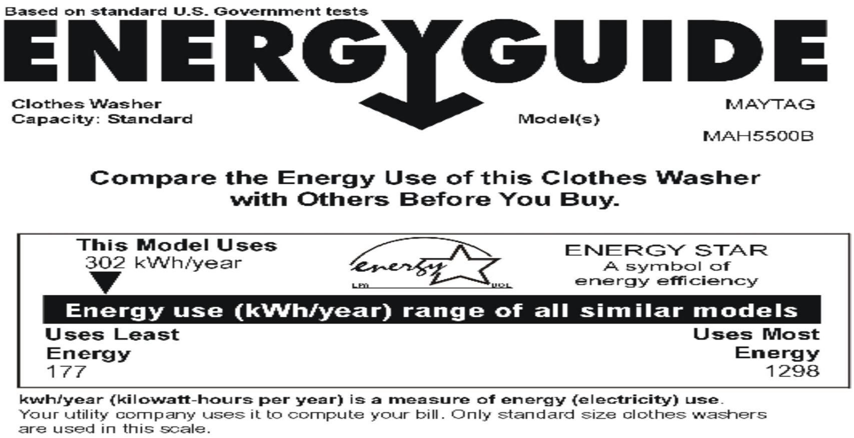


Figure 3.14. Energy guide label. [29]

Water heating is the third largest energy expense in the average home in developed countries. It typically accounts for about 14 percent of the utility bill. There are four ways to cut water heating bills—use less hot water, turn down the thermostat on water heater, insulate water heater and pipes, and buy a new, more efficient water heater.

Proper in-house management can save about 30% of energy**.** First level, in-house management of energy efficiency through maintenance and housekeeping measures:

- Establishment of in-house energy management committees or groups;
- Designation of energy managers;
- Data collection;
- Safety issues;
- Review of operational efficiency**.**

A **Control system** is a device or set of devices to manage, command, direct or regulate the behavior of other devices or systems. In modern buildings control systems command and regulate indoor air parameters, and are integrated with HAV [30]systems. The invention of these components in HVAC[31] systems goes hand-in-hand with the industrial innovation, and new methods of modernization, higher efficiency, and system control are constantly introduced by companies and inventors all over the world. Approximately 20% of energy can be saved with the proper use of HVAC, where humidity and temperature must all be closely regulated.

Most motors turn at nearly constant speed. However much of the time the devices they drive may operate at less than maximum design speed. This speed reduction can be accommodated by an **Adjustable Speed Motor Drive**[32] that varies the shaft speed to the driven load. Slowing a

[29] 3955551images.lowes.com/product/050946/050946947891.pdf
[30] HAV-heating and ventilation system
[31] HVAC-heating ventilation and air conditioning . Is referred to as "climate control", because the three functions of heating, ventilation, and air-conditioning are closely interrelated. HVAC systems can provide ventilation, reduce air infiltration, and maintain pressure relationships between spaces.
[32] http://www.energy.wsu.edu/documents/engineering/motors/MotorDrvs.pdf

pump or fan in this manner reduces energy consumption much more effectively than allowing the motor to run at constant speed and then restricting or bypassing the flow with a valve or damper.

The most common applications of ASDs are for pumps and fans—to balance flows and meet changing system needs. For example, ASDs can be very cost-effective in retrofit or new construction of HVAC systems and water supply systems. Speed reduction provides high energy savings.

Average wood stoves used in Georgia have the typical efficiency of 35-40%. This means that 60-65% of the energy obtained by burning the wood gets lost in the atmosphere. Making the stoves efficient means to make a better use of this energy and leave more heat of exhaust gases either in the stove itself or with the heated object e.g. the saucer. **Efficient stoves** typically can have an efficiency of up to 70-80%. There are many designs of efficient stoves used over the world. Below we show some of the stoves manufactured in Georgia.

Figure 3.15. Stoves manufactured in Georgia; Source: Bioenergy Ltd.

The above does not complete the list of technologies and policy options that might be considered for implementation in Georgia. However it is clear that there is a vast area of international experience accumulated in the field of energy efficiency where Georgia benefit from. The final choice of preferred policy and technology options should be done based on thorough analysis of Georgia's internal economic, political and market conditions, development perspectives and goals.

Chapter 4

Energy Balances in Georgia

This chapter covers the information necessary for evaluating the potential effects of energy efficiency and renewable energy development on Georgia's total energy supply and consumption. Along with the aggregate energy balance, the electricity and natural gas balances are broken out separately. Available information about energy use by different consumer categories is presented and the issues of energy security are discussed in relation to electricity, natural gas and aggregate energy balances.

4. 1. Aggregate Energy Balance of Georgia in 2006

The discussion of energy balances and energy consumption patterns has twofold importance for the current study. One of the objectives is to quantify and evaluate Georgia's dependence on imported energy and to analyze the seasonal character of this dependence from the point of view of the country's energy security. Another main objective is to analyze energy consumption for different types of energy, breaking the analysis out for various end uses and into different consumer categories, in order to identify and evaluate the potential energy savings.

The Statistics Department of Georgia currently does not prepare energy balances, so the relevant data should be collected from different sources and compiled into an aggregate balance. The aggregate Energy Balance of Georgia for 2006 is given in Table 4.1, and is based on annual reports of relevant agencies (e.g., Saknakhshiri, Saknavtobi, Association of Oil Product Producers & Importers) and preliminary data to be published by Statistics Department of Georgia in annual report for 2006.

Energy Balance of Georgia 2006 (kilotons of oil equivalent—KTOE)

#		Coal	Crude Oil	Oil Prod-ucts	Natural Gas	Hyd-raulic Energy	Renew-able	Fire-wood and waste	Elec-tricity	Thermal Energy	Total
10	Production	4	64		17	457	14	385			**941**
11	Import	3		792	1517				65		**2377**
12	Export		-53	-3					-12		**-68**
13	Stock Build Up	-1	2	4	-3						**2**
15	Primary Production 15=10+11-12±13	6	13	793	1531	457	14	385	53	0	***3252***
20	Electricity plants, Boilers			-6	-508	-457			638	32	**-301**
21	Oil refineries		-13	12							**-1**
22	Other transfor-mations and losses			-14	-346				-91		**-451**
30	Energy Supply 30=15±20±21-22	6	0	785	677		14	385	600	32	***2499***
40	Industrial Sector 40=41+42+43+44	2	0	92	167	0	0	0	116	12	**389**
41	Metallurgy			3	5				43	3	**54**
42	Chemical production & Petrochemistry			17	27				36	3	**83**
43	Nonmetallic materials			15	18				13	2	**48**
44	Other production	2		57	117				24	4	**204**
50	Transportation 50=51+52+53	3		512	24				52	0	**591**
51	Aviation, marine			24	4				4		**32**
52	Railway and automobile transport	3		448	14				36		**501**
53	Unspecified transport			40	6				12		**58**
60	Other sectors 60=61+62+63+64	1		181	293		14	385	432	20	**1326**
61	Agriculture			64	58		0	20	14	4	**160**
62	Services	1		16	28		6	24	16	16	**107**
63	Households			75	201		8	329	396	0	**1009**
64	Unspecified			26	6		0	12	6	0	**50**
70	Non-energy consumption			0	193			0			**193**

Table 4.1. Aggregate energy balance 2006.

Year 2006 was not a typical year for the Georgian Energy Balance; Georgia experienced disruptions in gas supply from Russia in the beginning of the year and disruptions from additional rehabilitation of Enguri Hydropower Plant (HPP) in the spring and summer of 2006, a major source of electric energy in Georgia.

The annual 2006 structure of energy supply in Georgia is given in Figure 4.1.

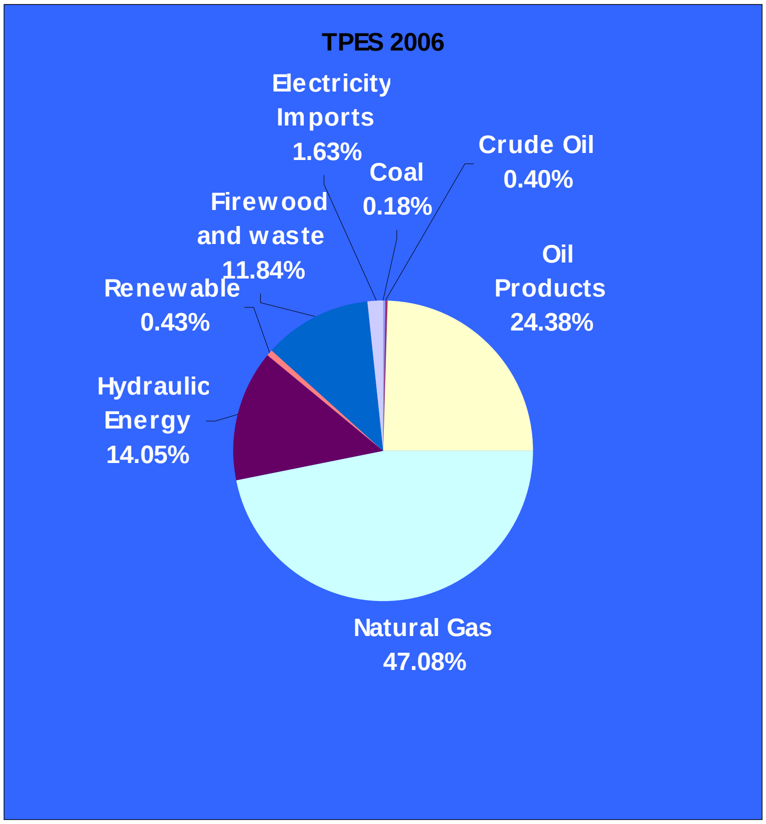


Figure 4.1 Structure of Total Primary Energy Supply (TPES) in Georgia, 2006.

The energy balance of 2006 shows the following features of energy supply and consumption:

- Out of the total primary energy supply in the country, about 71% (47% natural gas and 24% oil products) was imported;
- Out of the total imported energy the major share (64%) comes as natural gas and about 33% as oil products;
- The contribution of firewood to indigenous energy supply is comparable to that of hydraulic energy;
- The share of renewable energy sources, other then small hydro, in the energy balance is negligible, less then 0.5%.

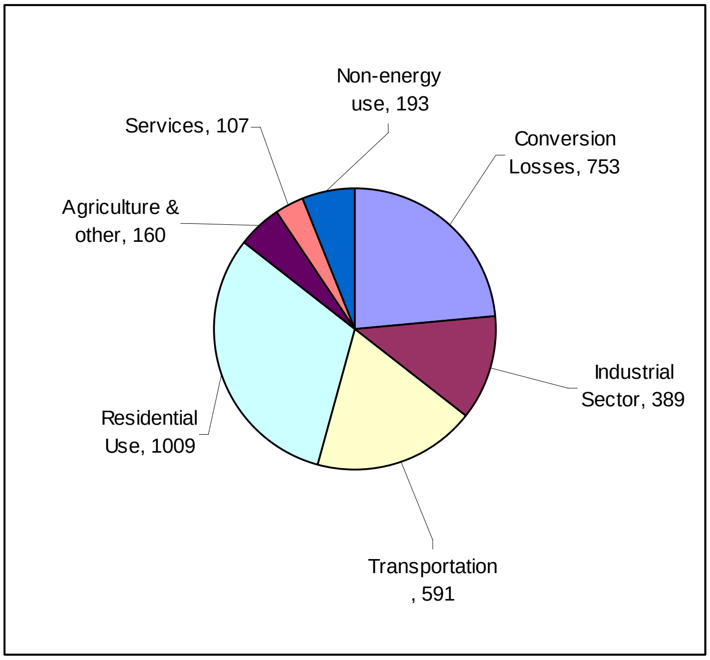


Figure 4.2 Total energy consumption in Georgia (kilotons of oil equivalent).

The structure of energy end use is shown in Figure 4.3. The analysis reveals that:

- Energy use of households (including personal transport) is about 53% of the total in-country energy consumption. It exceeds 3 times the energy use of industry and 8-10 times the consumption of the agriculture and services sector;
- There is a significant share of gas conversion losses. A great deal of it is (301 kilotons of oil equivalent—KTOE) can be cut in half by more efficient thermal generation technologies. A detailed analysis taking into account the potential demand and generation regimes together with economic analysis could provide more insight into the economic feasibility of addressing this issue through more efficient cogeneration and combined cycle technologies.

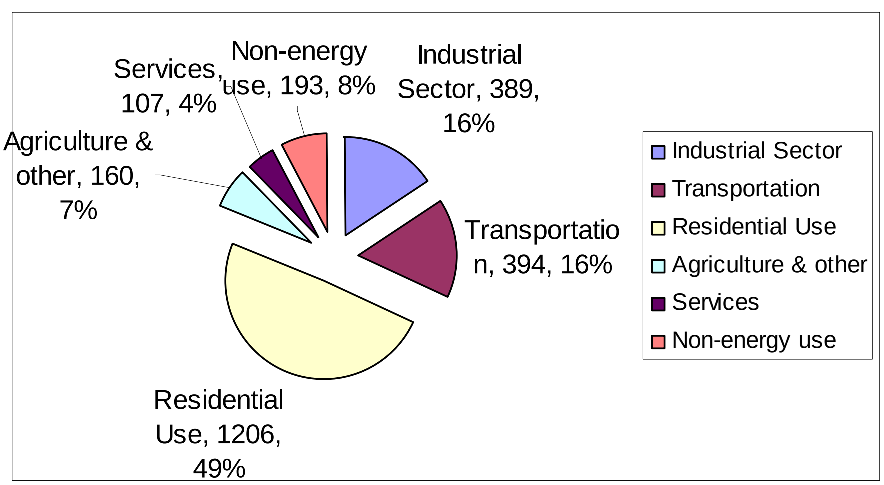


Figure 4.3. Structure of Useful Energy Consumption in Georgia (kilotons of oil equivalent).

Per capita energy supply in Georgia in kilograms of oil equivalent (kgoe) is summarized below in table 4.2:

	KgOE/person	Units
Total Energy Supply (TPES)	738	N/A
Natural Gas Supply	348	427 normal m^3/year
Oil Products	178	-
Electricity	160	1863 kWh/year

Table 4.2 Per capita energy supply; kilograms of oil equivalent.

Table 4.2 shows that energy consumption is much lower in Georgia than in developed countries, and countries of the former Soviet Union; these consumption figures can be compared with the parameters of previous years and similar parameters of other countries.[1] Relatively low per capita energy consumption reflects the structure of economy and the climatic conditions, but it does not change the main conclusion of this analysis— there is a significant energy saving potential in Georgia.

4.2. Electricity Balances

4.2.1. The 2006 Electricity Balance

Electricity supply was essentially unrestricted in 2006. Thus demand was not curtailed by a supply limitation and the 2006 electricity balance correctly represents the existing structure and seasonal patterns of electricity demand. There was a tariff increase in the middle of the year (June 1, 2006), that may have changed the behavior of different consumer groups; however, more in-depth analysis and detailed data is needed to make well justified conclusions on this matter.

The details of the 2006 electricity supply and consumption balance are given in Appendix 2. The dynamics of electricity demand over the year is shown in Figure 4.4 on the next page.

[1] http://earthtrends.wri.org/text/energy-resources/variable-351.html

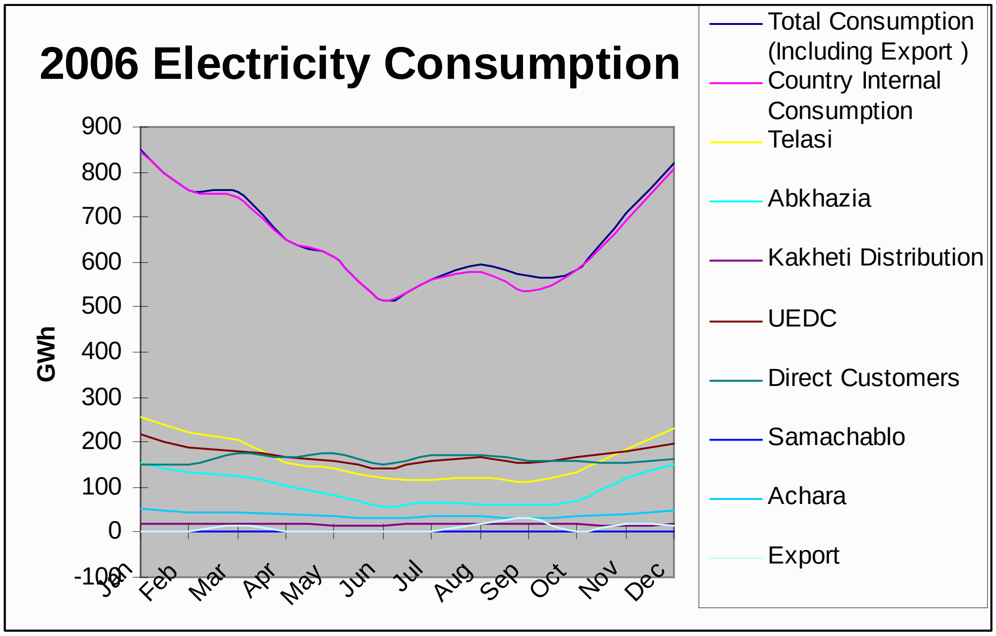


Figure 4.4. Seasonal variation of electricity consumption in 2006.

While the electricity demand pattern may have been typical, the supply of electricity in 2006 was not. Due to the shutdown of Enguri HPP for major rehabilitation in the spring and summer months, the year was marked with higher levels of electricity imports and the operation of thermal power plants in summer months; this is unusual for the Georgian power sector in recent years. Seasonal dynamics of electricity supply in 2006 is shown in Figure 4.5.

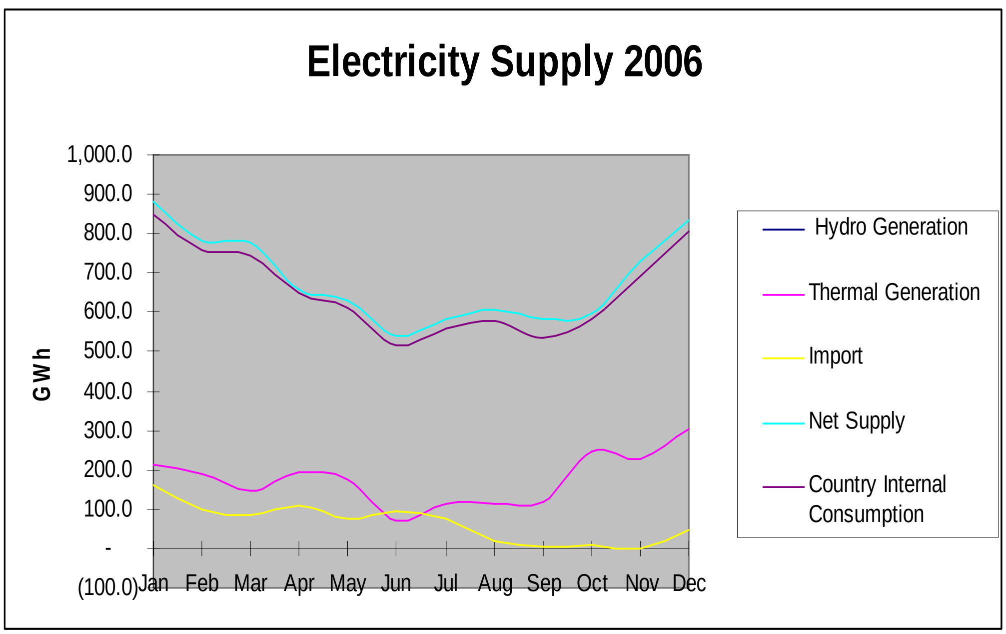


Figure 4.5. 2006 electricity supply patterns.

Year 2006 was fairly anomalous; Georgia experienced reduced hydropower generation in the summer months combined with an increase in imports and thermal generation. Starting in

August, the import was minimized and from September onward the power system started getting back to its normal mode of operation.

Electricity imports were relatively high in 2006 due to the rehabilitation of Enrguri HPP; however, a more recent trend in Georgia's energy sector has been to reduce electricity imports and replace them with gas imports, for local thermal generation of electricity.

The structure of supply in 2006 is shown in Figure 4.6.

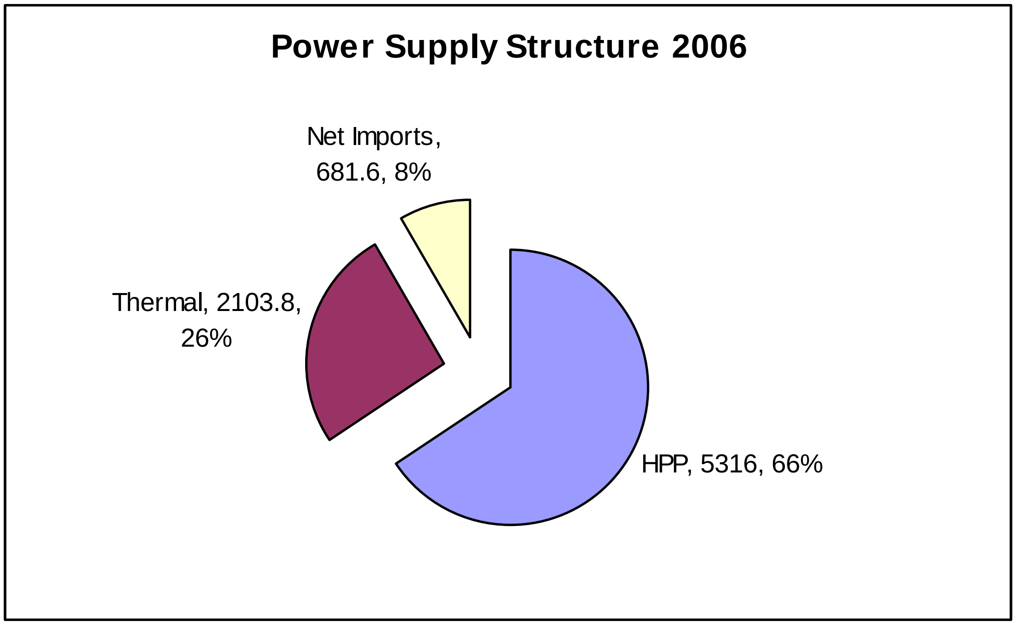


Figure 4.6. Electricity Supply Structure 2006 (GWh).

Total electricity supply and consumption in 2006 was 98% compared to that of the previous year. The history of electricity supply and demand over recent years does not show significant growth of demand.

	2000	2001	2002	2003	2004	2005	2006
Total Production	7446.0	6942.0	7256.0	7163.0	6706.0	7100.0	7419.9
HPP	5905.6	5571.5	6742.9	6527.9	5892.9	6070.0	5316.0
Thermal	1540.4	1370.5	513.5	635.1	813.2	1030.6	2103.8
Imports	611.5	877.6	713.2	844.2	1210.0	1399.0	777.6
Exports	210.5	523.3	244.5	109.3	-	120.0	96.0
Consumption	7847.0	7296.3	7724.7	7898.0	7916.0	8379.0	8197.4
Net Imports	401.0	354.3	468.7	735.0	1210.0	1279.0	681.6

Table 4.3. Dynamics of Electricity Supply and Demand over 2000-2006 (GWh).

The stability of demand may be caused by two different reasons: 1) the increase in collection rates of distribution companies has resulted in less consumption by those who were previously getting electricity for free; 2) tariff increases may have influenced the level of consumption of different customer categories, customers who tend to reduce their electricity bills to affordable levels.

The share of useful (legal) consumption has increased since 2000 when electricity consumption was aggravated by unpaid and wasteful consumption of uncontrolled consumers. Since then the collection rates have dramatically improved and the same amount of electricity that was essentially wasted in 2000 is now a part of economic turnover. Although this is a significant achievement, the collection levels of distribution companies need to be improved further; this will be a significant contribution to efficient energy use.

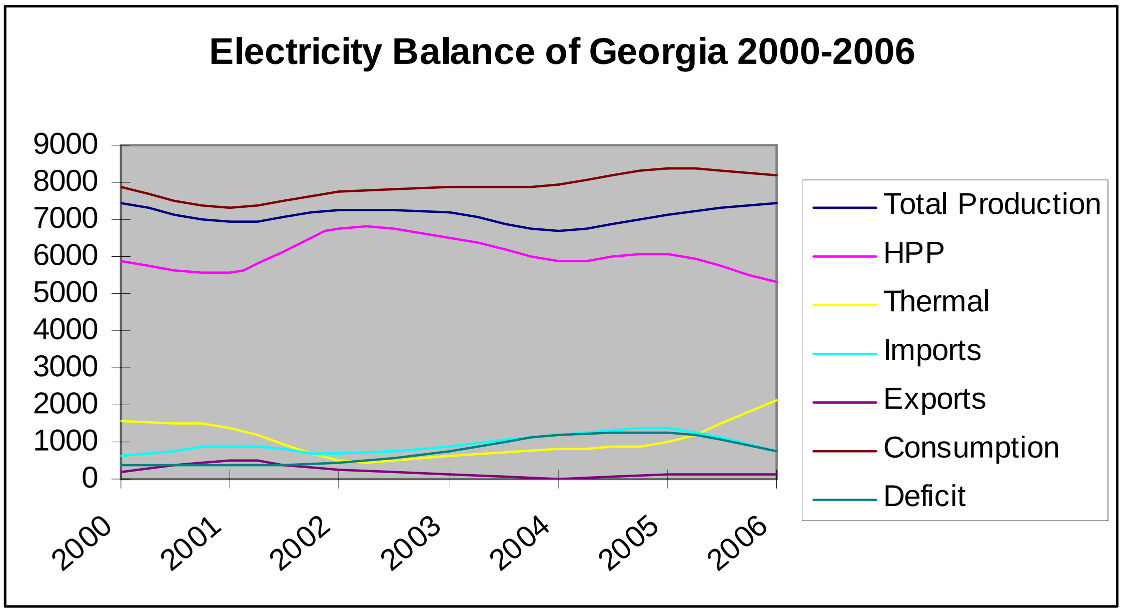


Figure 4.7. Dynamics of energy balance in Georgia (GWh).

The chart shows that there is a trend towards increasing local generation and reducing imports in 2006, in spite of the reduction in hydro generation during that time. This was achieved through higher total generation for thermal power plants.

4.2.2 Model 2007 Electricity Balance

As a reference electricity balance for our study we constructed the "2007 Model Electricity Balance" which is based on actual 2007 January-August data and 2006 September – December data.[2] We convert this data into the model January-December balance by simply rearranging the months and thus September-December 2006 data is used as substitute for September-December of 2007. The details of the 2007 Model Electricity Balance electricity supply and consumption balance are given in Appendix 3.

[2] The data for July- August 2007 will be included by the end of the study when actual data will become available. Meanwhile we use dummy data for these two months.

Our assumption is that consumption patterns between 2006 and 2007 do not differ significantly, and the desire is to have as recent and as representational of a supply picture as possible. Indeed, As can be seen from Figure 4.5, the consumption pattern of 2007 closely follows that of 2006. The supply picture of 2006 was specific due to Enguri HPP rehabilitation; however we assume that from September onward, generation returned to a typical operational regime. The benefit of such an approach is that it reflects the current electricity consumption pattern and also represents the supply-side corresponding to ordinary operating conditions of the Georgian Power Sector.[3]

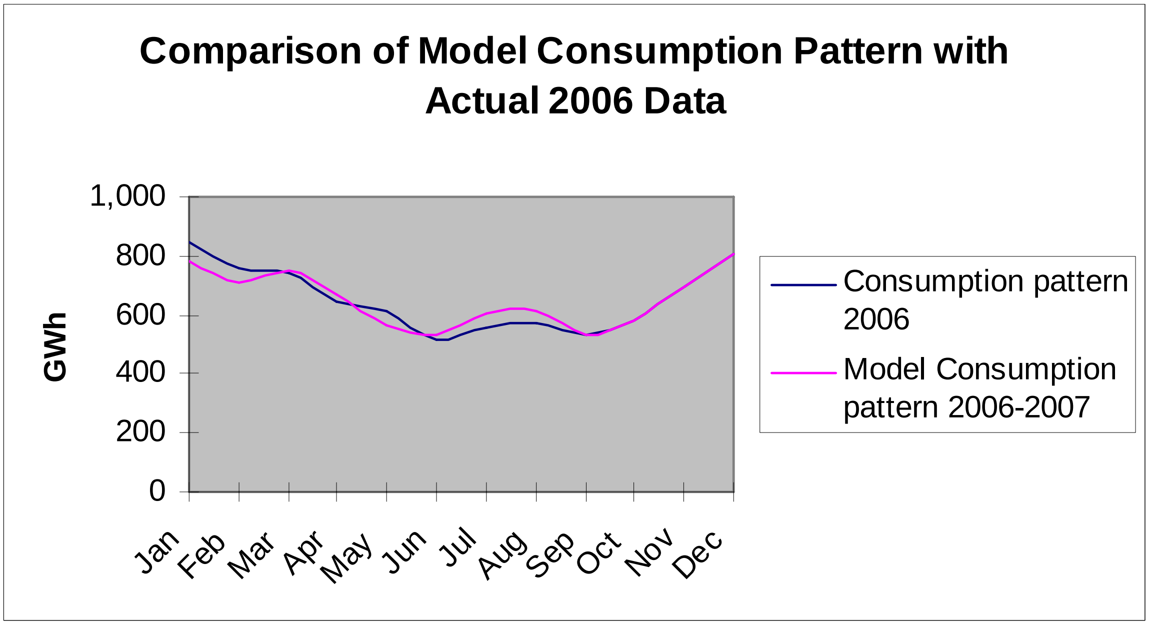


Figure 4.8. Consumption patterns 2006 and Model 2007.

[3] There is some deficiency in such an approach since we can not properly account for the electricity to be imported in winter in return for the summer export of 2006. However we are aware of this problem and take this into consideration when formulating main conclusions.

The 2007 model electricity supply diagram is given in Figure 4.9.

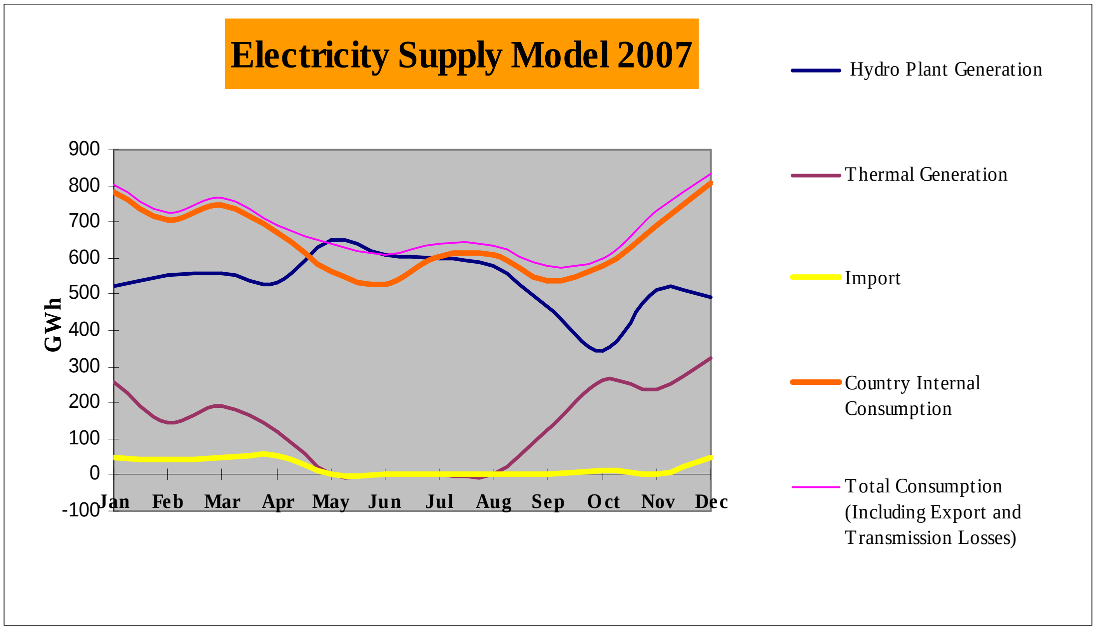


Figure 4.9. Electricity supply dynamics 2007.

The chart above clearly shows the seasonal features of electricity generation in Georgia:

- Hydropower generation dominates the supply and increases in the summer months.
- Thermal power plants are operating only in winter months and are used to make up for the lack of hydro generation.
- Electricity imports can be used in winter season to back up and supplement local thermal generation.

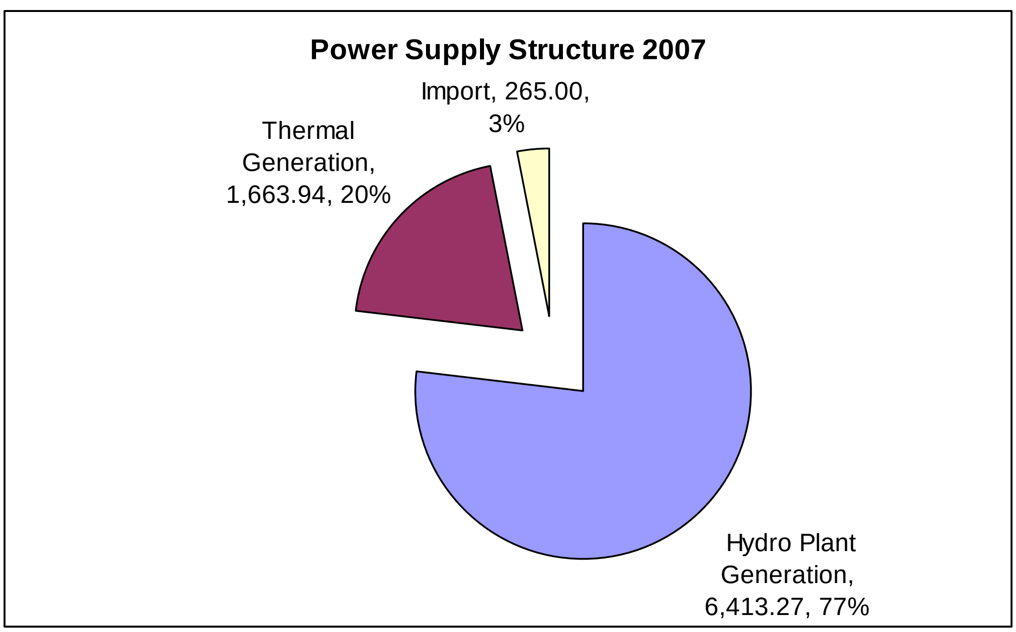


Figure 4.10. Structure of power supply 2007.

Remarkably, an export potential has been successfully used in 2007 to arrange the seasonal energy swap with neighboring countries. This kind of swap can benefit all parties involved. According to the recent information from ESCO a total of 614.4 GWh-s has been exported, by September 1, in 2007. This is a significant success and this energy exchange with neighboring countries should be properly reflected in the present analysis after the exchange transaction will be finalized.

Seasonal Variation of Energy Cost

Considerable seasonal variation of generation sources results in the seasonal variation of energy supply costs. In particular, the higher share of thermal power and imports used in the winter season contributes to higher supply cost. In order to evaluate the cost of supplying the power in different months we have constructed a chart of effective monthly generation tariffs. Tariffs approved by Georgian National Energy Regulatory Commission (GNERC) have been applied.[4] Although, according to the Market Rules and GNERC resolutions, the generators can sell for less than the GNERC-approved tariff caps; we are not aware of such facts at the time of writing this report.

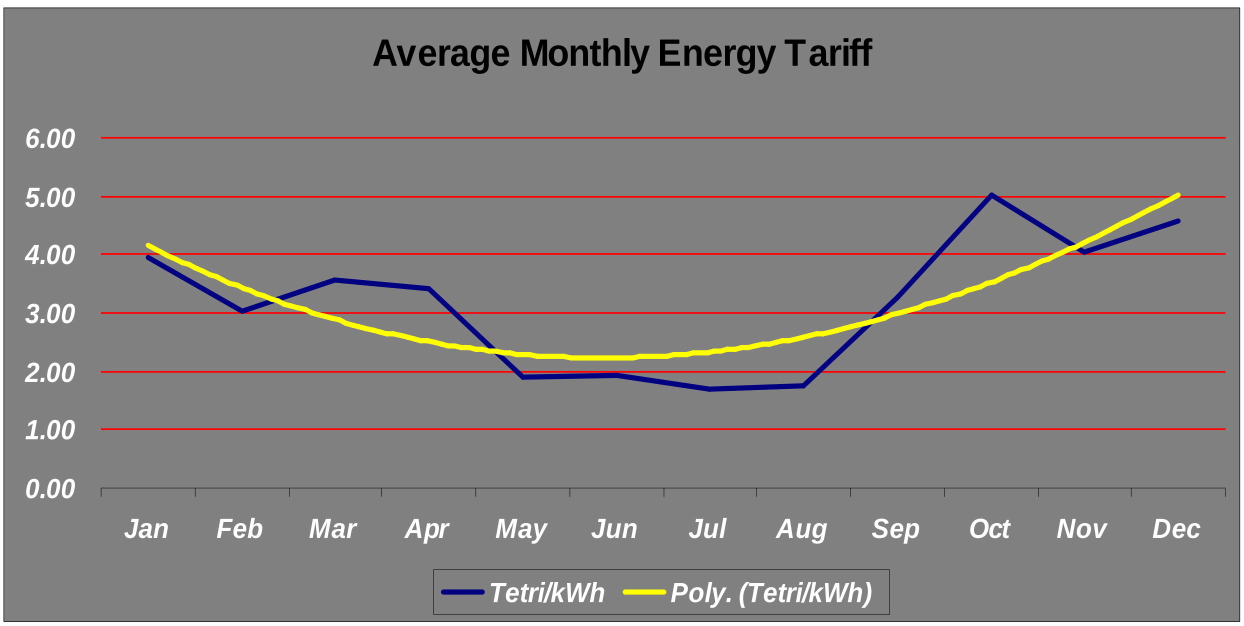


Figure 4.11. Seasonal variation of effective electricity tariff.

The graph shows that the cost of supplying electricity more than doubles in winter months compared to the summer period where hydropower is sufficient to cover in-country needs. The details of calculation can be found in Appendix 4.

[4] GNERC resolution #18 of May 15, 2006 and subsequent resolutions.

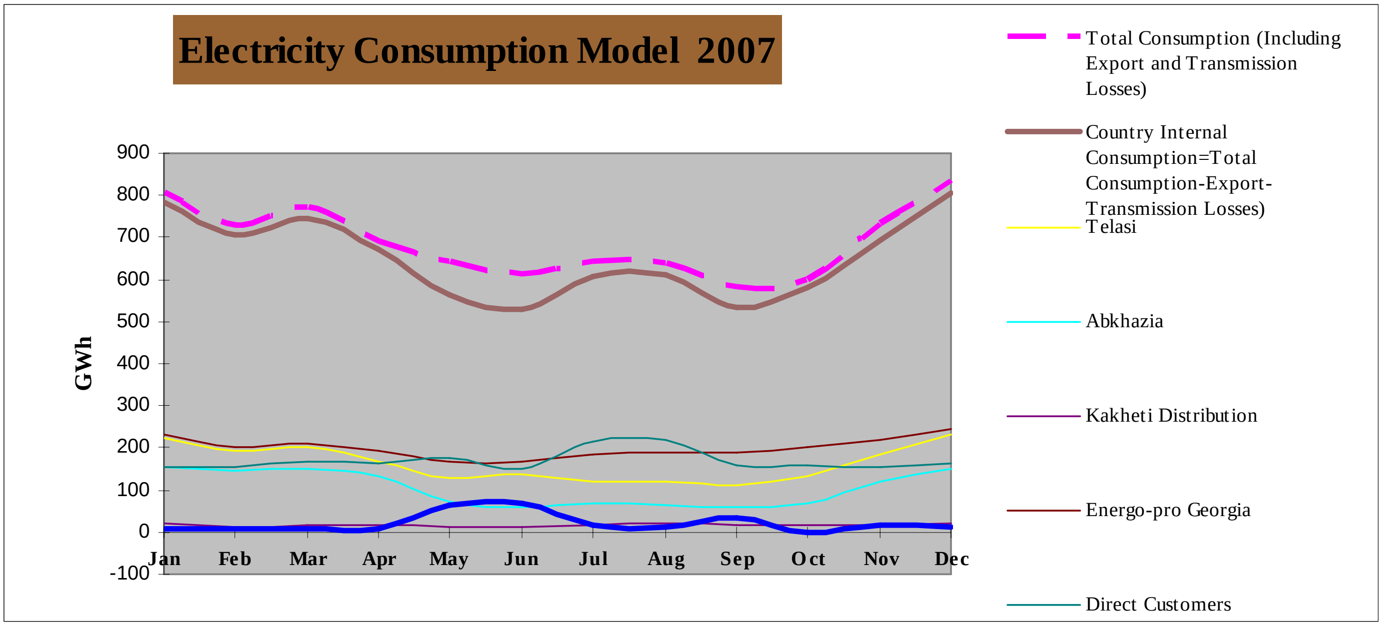


Figure 4.12. Seasonal structure of electricity consumption model.

The chart shows that:

- Seasonal variation of electricity consumption is mainly caused by distribution companies.[5]
- Big industrial consumers (direct customers) show reversed seasonal pattern of consumption – their consumption slightly increases in summer.
- In summer there is a surplus of electricity allowing the Georgian power system to export the energy.
- There is no import of electricity in this model even in winter months, since the recent tendency is to increase in country thermal generation and reduce electricity imports. This feature can be corrected later when the volume of actual import will be known.

[5] A more detailed analysis shows that this in turn is mainly caused by increase of residential consumption in winter months.

The annual structure of electricity consumption is shown in Figure 4.13.

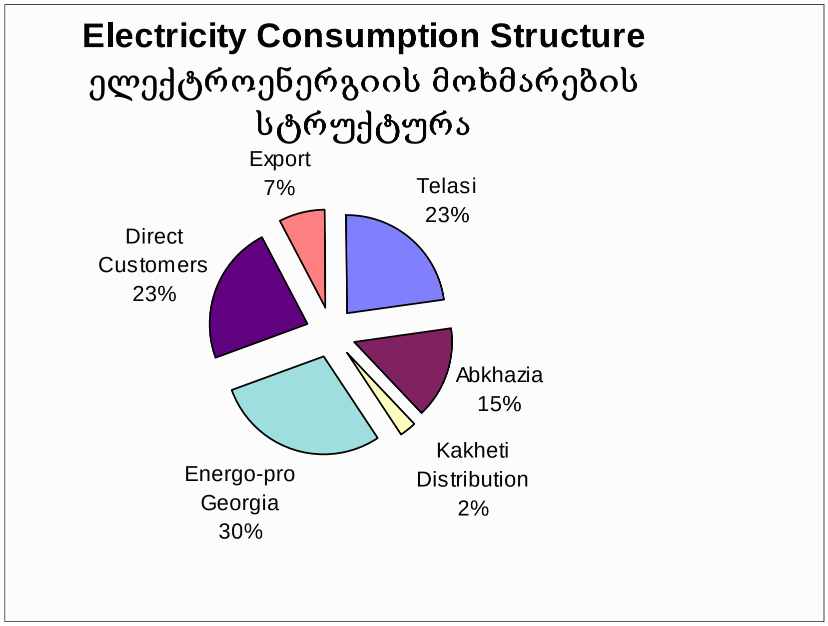


Figure 4.13. Electricity consumption by wholesale consumers.

Figure 4.13 shows that the biggest wholesale consumer is Energo-Pro Georgia (30%), followed by Telasi (23%) and the aggregate consumption of Georgia's large industries, referred to above as Direct Customers (23%).

A breakdown of direct consumers by their consumption is given in Figure 4.14.

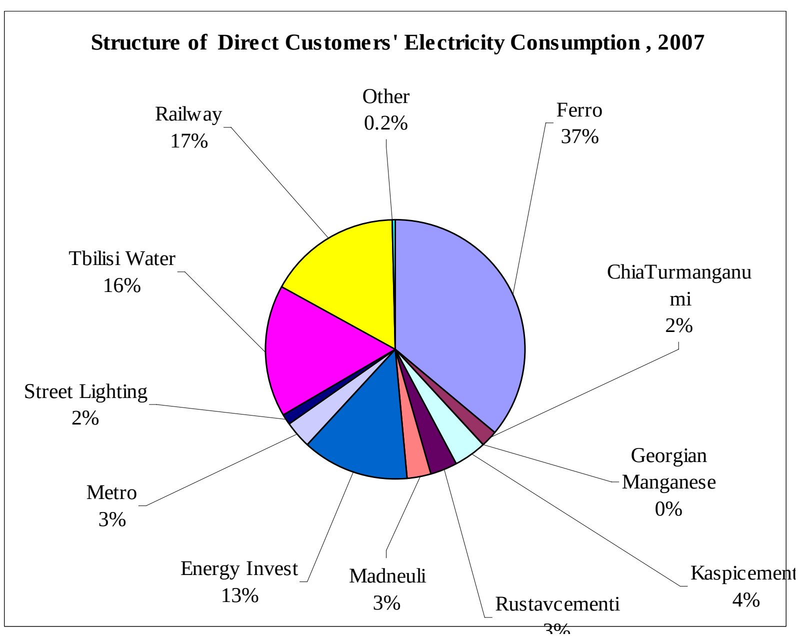


Figure 4.14. Consumption by Direct customers.

Zestaphoni Ferric Alloy plant is the biggest direct consumer followed by Railway and Tbilisi Water. A detailed energy audit in these enterprises could reveal a savings potential that can be material for the whole country energy balance.

4.2.3. Excess of Hydroelectric Resources

According to the statistics from previous years and the estimates of various experts, there is a significant excessive hydraulic energy resource in the Georgian power system that needs to be duly utilized. The failure in using this resource can lead to unproductive waste of water.

There are two different reasons that can result in unproductive water waste at hydropower plants:

1. Water pouring or "waste of water" can be caused by malfunctioning of a hydropower plant or technical difficulties at hydro-technical structures. For instance, in 2001, due to the lack of maintenance on power plants and hydro-technical structures for the flooding period, the high filtering of water, and erroneous regimes of operation, there was a waste of water equivalent to 1.5 billion kWh of electricity. Of which 0.6 billion kWh was lost due to the damage of Enguri dam's spillway hole. During five months of 2002, the water, equivalent to 312 million kWh of electricity, was wasted unproductively because of the lack of maintenance at Georgia's hydropower plants, excluding Enguri HP. In the same period, the damage of Enguri dam's spillway hole caused loss of water equivalent to 250 million kWh of electricity. In total there has been a waste of water equivalent to 562 million kWh in five months.[6] However, the maintenance works completed in 2004-2006, have significantly reduced unproductive waste of water caused by technical malfunctioning.

2. The second possible reason for water waste is the surplus of hydraulic energy compared to system demand during the months of May-July. In this period, the water discharge in rivers strongly increases, and electricity usage considerably decreases. As a results an unproductive discharge of water in hydro plants may happen. Specialists estimate the amount of excessive energy at approximately 700-800 million kWh annually, or about 10% of in-country electricity generation, of the value of approximately 30 million GEL by today's tariffs. In 2007 a great deal of this resource has been successfully utilized for export.

The problem of seasonal imbalance is not new for Georgian energy system. It has continued for years, caused by one main reason – Georgian power plants were planned and constructed based on the needs of united energy system of Soviet Union. After the breakdown of the Soviet Union, and isolation of the Georgian energy system, some of the capacity remained unloaded in the summer. The strategy of new generation development has to take into account this in country seasonal energy imbalance.

[6] Energogeneratsia 2001 annual report

In spite of the fact that Georgia has excess hydropower production capacity, it does not directly contribute to country's energy independence and requires additional measures like energy swaps with neighboring countries to bring the benefit to Georgia.

Georgia's seasonal hydropower imbalance needs to be more closely studied to be effectively resolved. Some of potential solutions to this problem are:

1. Introduce seasonal tariffs in summer – this will stimulate economic sectors to exploit the resources proficiently;
2. Develop the stable regional mechanisms of seasonal energy exchange including a regional electricity market;
3. Develop the strategy of new generation development that takes into account these seasonal energy imbalance issues.

4.3. Natural Gas Balances

Like electricity balance, the natural gas balance in 2006 was also atypical due to excess gas imports for electricity generation.

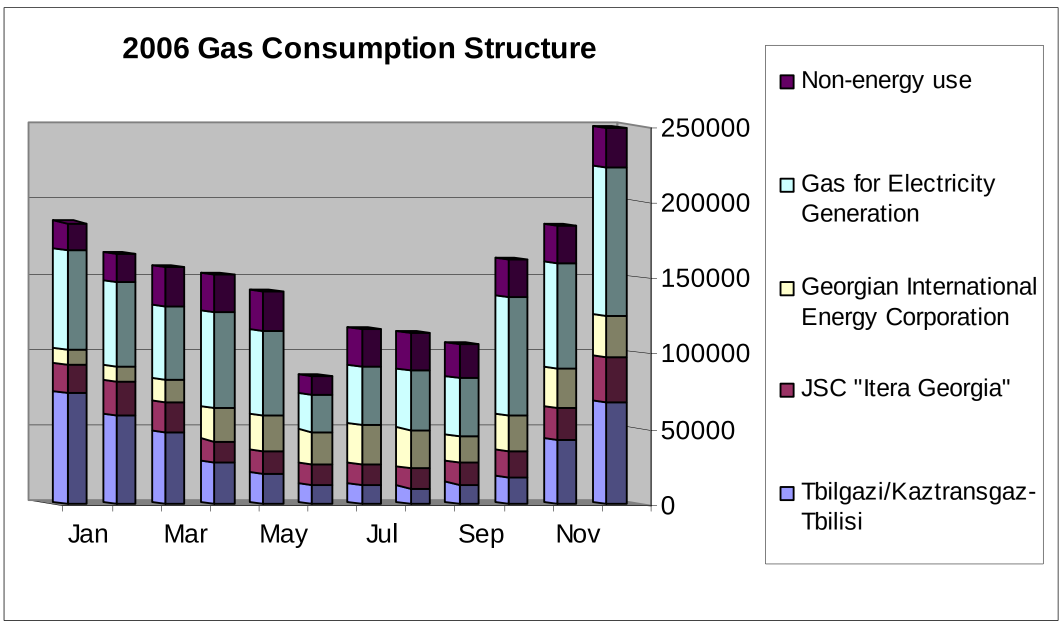


Figure 4.15. Monthly Gas Consumption Structure in Georgia 2006.

As can be seen from Figure 4.15, gas use for electricity generation occurred throughout the year. The seasonal variation of gas consumption is much more pronounced in Tbilisi (Kaztransgas-Tbilisi) then in other regions of Georgia (Itera Georgia), indicating that gas use for heating is more intensive in Tbilisi than in other places (Cf. Appendix 5.)

The chart in Figure 4.13 shows the gas consumption by different wholesale consumers.

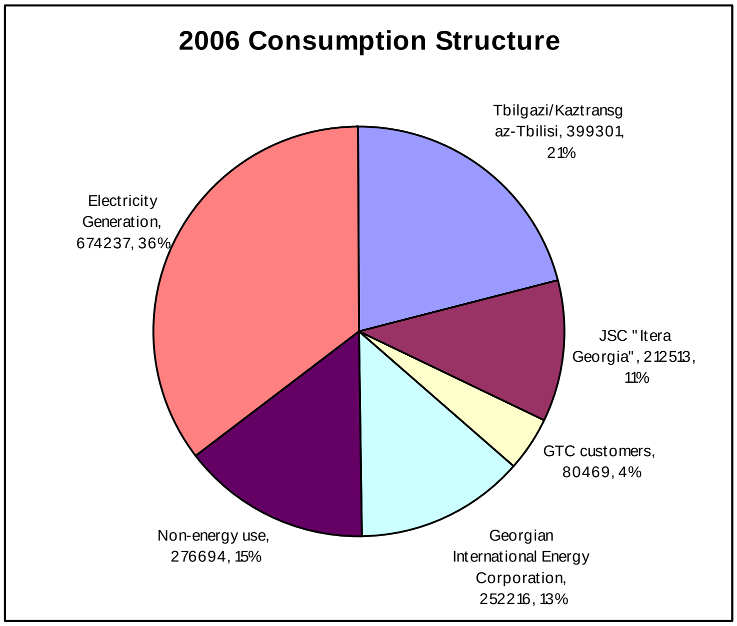


Figure 4.16. Georgia's annual 2006 gas consumption structure in thousand cubic meters.

As can be seen from the chart the biggest share of gas (36%) was used for electricity generation and the biggest wholesale consumer is Kaztransgaz-Tbilisi (21%).

In order to develop a more typical model gas balance that would reflect the recent situation, in analogy with model 2007 electricity balance, we have reconstructed a model gas balance for 2007. This is based on actual 2007 January-June, and actual 2006 September-December data. (July-August data are forecast) (Cf. Appendix 5).

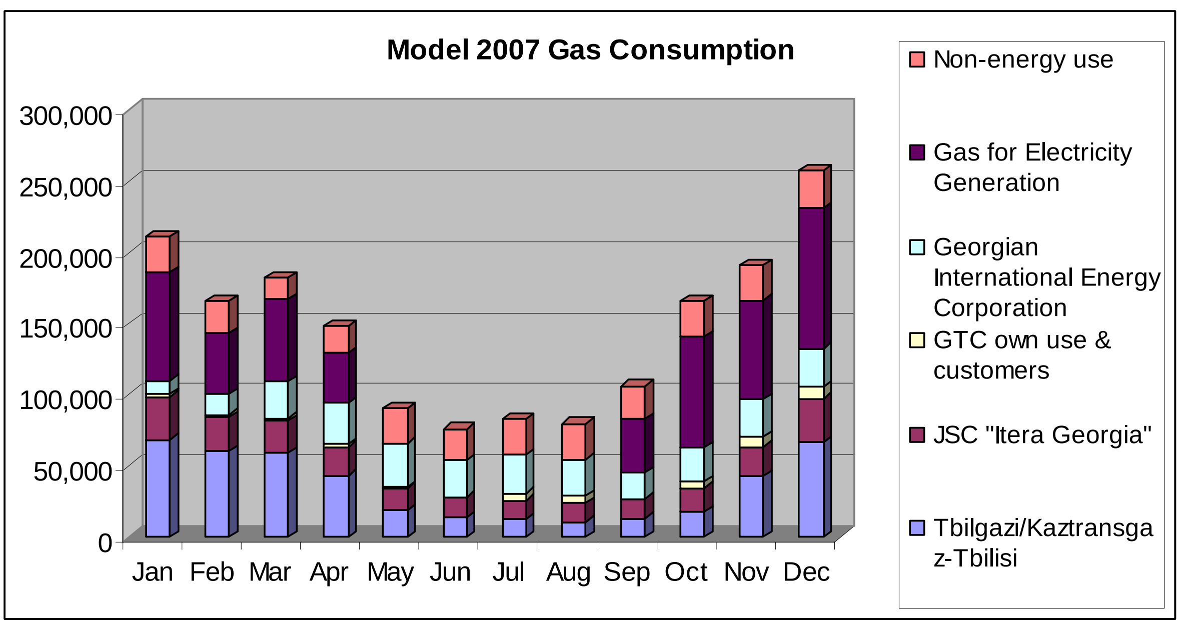


Figure 4.17. Monthly gas consumption model.

In the 2007 gas consumption model, Kaztransgas-Tbilisi preserves its seasonal consumption pattern. Thermal power plants are not generating energy in summer months and accordingly there is no gas use for electricity generation in summer; the share of gas used for electricity generation is reduced, compared to that of 2006 (Figure 4.18.).

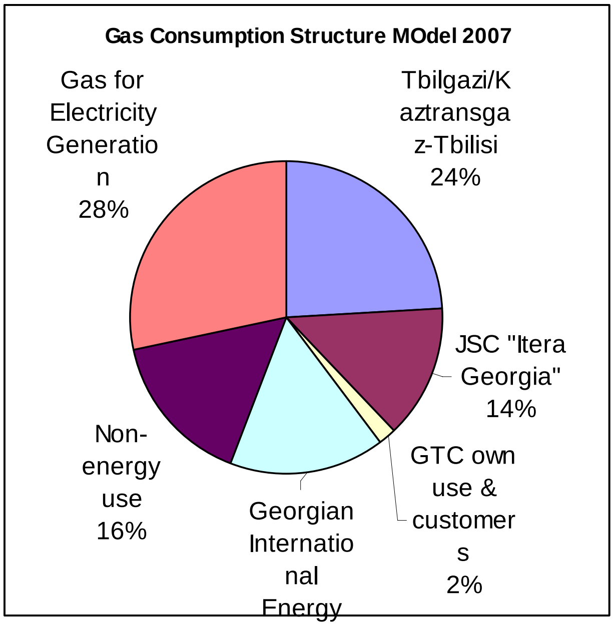


Figure 4.18. Annual Model Gas Consumption.

The gas consumption model can be used to evaluate the gas usage for heating with good accuracy. (Cf. Appendix 6). For this purpose we subtract from the annual gas usage curve the gas used for electricity generation and another component (mainly cooking and hot water supply) that remains constant over the whole year (assumed to be equal to June consumption) the remaining variable seasonal component is attributed to gas usage for heating (c.f. Figure 4.19.).

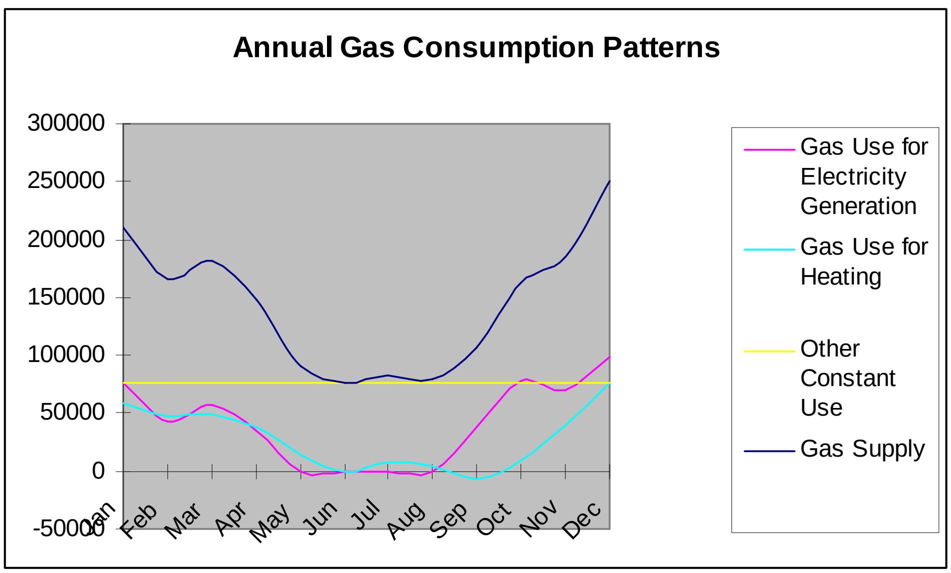


Figure 4.19. Seasonal patterns of gas consumption

With such assumptions we can estimate that gas consumption for heating in all sectors of economy is 334 million cubic meters (area under the light blue curve). Accordingly the rough picture of gas end-use is depicted in Figure 4.20.

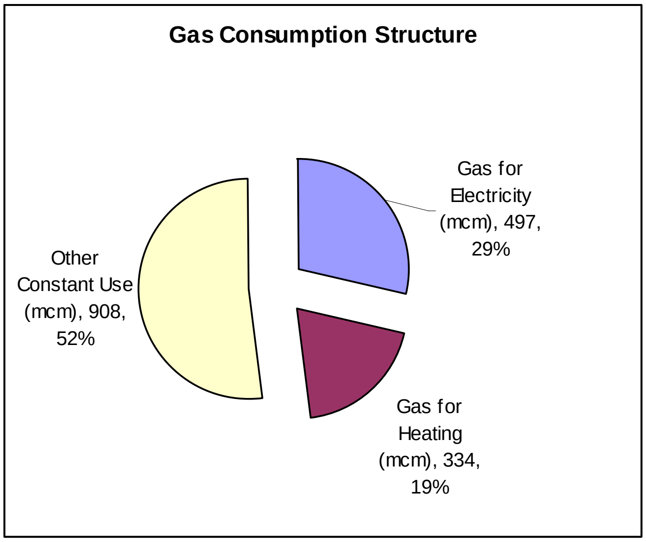


Figure 4.20. Annual gas consumption by end use.

Because of significant uncertainty related to different gas suppliers and their prices it is not currently feasible to make any meaningful forecast of the gas supply structure and potential prices. At the time of writing this report it has been announced that the gas price from the Azeri gas supply will increase to the international market level.

4.4. Energy Dependence of Georgia and Model Aggregate Energy Balance

Energy Security can be defined as a short term and long term reliability of energy supply at affordable prices. Such a definition can be applied at the level of individual consumers, consumer groups or at the level of a whole country. Absolute measure of energy security at the country level requires analysis of different long term and short term risks related to technical, market and political factors of external energy supply to the country. These factors of Energy Security are specific to countries and their concrete regional conditions. Rigorous analysis of energy security involving all these factors is a complex task that goes beyond the scope of this study. Instead, we will simply assume that reduction in the amount of imported energy of a particular type correspondingly reduces the energy dependence of the country, and thus by reducing the risks related to that supply, increases energy security.

4.4.1. Model Aggregate Energy Balance

Energy balance is the main instrument for analyzing a country's dependence on external energy imports. In case of Georgia the main factor of energy security is its dependence on fossil fuel imports from neighboring countries (71% of total primary energy supply). Another critical factor of country's energy dependence is the pronounced seasonality of its energy consumption and supply patterns.

To analyze the issues related to country's energy independence we needed an energy balance that would reflect the typical expected consumption patterns in the nearest time. For this purpose we have constructed a model aggregate energy balance of 2007. As input we have used the actual 2006 energy balance, Model 2007 Electricity Balance and Model 2007 Gas Balance and assumed that supply and consumption of other types of energy (except electricity and gas) will remain essentially the same as in 2006. We expect that such an energy balance better reflects the typical expected energy situation in Georgia in the nearest future. A summary of the model balance is presented in the Table 4.4:

Model Energy Balance of Georgia (**kilotons of oil equivalent KTOE**)

#		**Coal**	**Crude Oil**	**Oil Products**	**Natural Gas**	**Hydraulic Energy**	**Renewable**	**Firewood and waste**	**Electricity**	**Thermal Energy**	**Total**
10	Production	4	64		17	574	14	385			**1058**
11	Import	3		792	1462				23		**2280**
12	Export		-53	-3					**-32**		**-88**
13	Stock Build Up	-1	2	4	-3						**2**
15	Primary Production 15=10+11-12±13	6	13	793	1476	574	14	385	-9.21	0	3252
20	Electricity plants, Boilers			-6	-401	-574			708	32	**-241**
21	Oil refineries		-13	12							**-1**
22	Other transformations and losses			-14	**-346**				-91		**-451**
30	Energy Supply 30=15±20±21-22	6	0	785	677		14	385	600	32	***2499***
40	Industrial Sector 40=41+42+43+44	2	0	92	167	0	0	0	116	12	**389**
41	Metallurgy			3	5				43	3	**54**
42	Chemical production & Petrochemistry			17	27				36	3	**83**
43	Nonmetallic materials			15	18				13	2	**48**
44	Other production	2		57	117				24	4	**204**
50	Transportation 50=51+52+53	3		512	24				52	0	**591**
51	Aviation, marine			24	4				4		**32**
52	Railway and automobile transport	3		448	14				36		**501**
53	Unspecified transport			40	6				12		**58**
60	Other sectors 60=61+62+63+64	1		181	293		14	385	432	20	**1326**
61	Agriculture			64	58		0	20	14	4	**160**
62	Services	1		16	28		6	24	16	16	**107**
63	Households			75	201		8	329	396	0	**1009**
64	Unspecified			26	6		0	12	6	0	**50**
70	Non-energy consumption			0	193			0			**193**

Table 4.4. Model 2007 Energy Balance of Georgia.
In the 2007 model balance we are using, the same heating value of 8070 kCal/m^3 is used for deriving the 2006 energy balance. However due to the higher share of Azeri gas in 2007 and its higher heating value, the average heating value of gas may need to be reconsidered. The amendment can be made after the exact mix of Azeri and Russian gas becomes known.

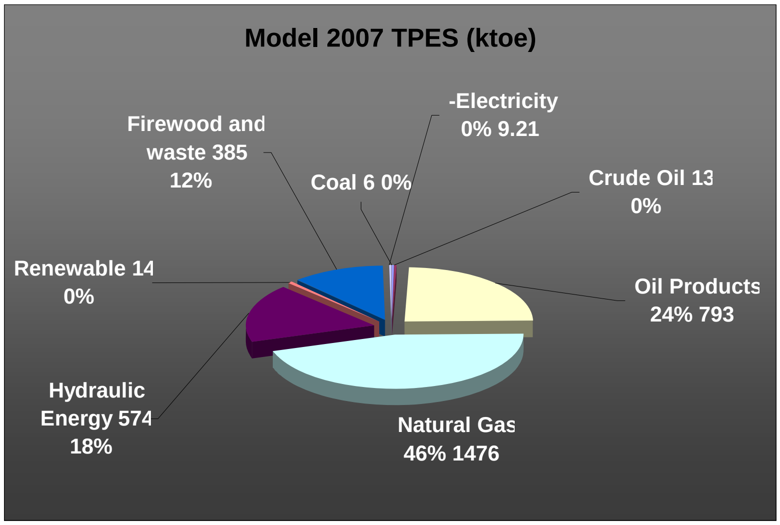


Figure 4.21. Structure of energy supply.

The main conclusions from the model Aggregate Energy Balance are almost the same as in case of 2006 balance:

- 69% of the total primary energy supply in country comes from imported resources
- 46% of imported energy is natural gas and 25% oil products
- The biggest indigenous energy resource is hydro energy (18%), followed by firewood (12%)

If we exclude oil products and gas used as feedstock for industry from consideration, the structure of energy supply in Georgia looks as shown in Figure 4.22.

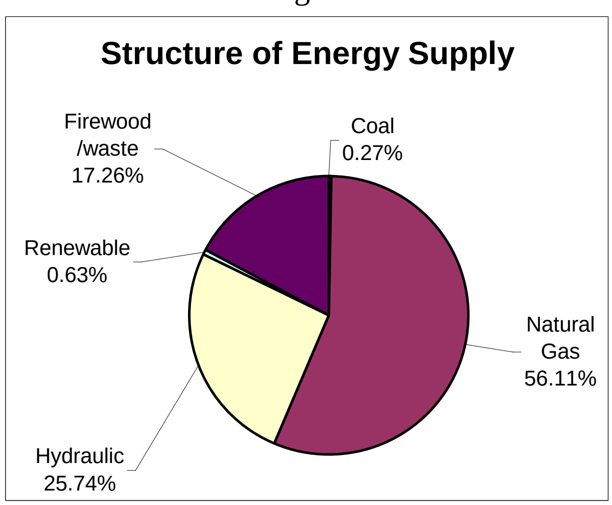


Figure 4.22. Structure of energy supply for energy use in Georgia.

It can be seen that 57% of energy needs of households and economy (ex. transportation) is covered by imported natural gas.

4.4.2. Parameters of Energy Dependence

A country's dependence on imported energy resources can be measured by the share of these external resources in total primary energy supply. As can be seen from the aggregate energy balance this parameter for Georgia is about 70%. If we exclude oil products from our consideration and focus only on energy use then 56.7% of energy needs are covered by imported natural gas and the rest by indigenous hydro resources and fire-wood

Energy dependence of Georgia is sharply seasonal decreasing in summer and increasing in the winter season. This increased dependence is aggravated by the fact that in winter months the capacity of suppliers as well as transportation capacities are much more loaded, thus it becomes harder to make up for the interruption of supply from some particular source[7].

Seasonal pattern of energy use in Georgia is given in Figure 4.23. Here we have neglected the energy carriers other than hydro-energy, gas and fire-wood. Indeed, other energy sources currently contribute only a few percents to the total energy use in Georgia.

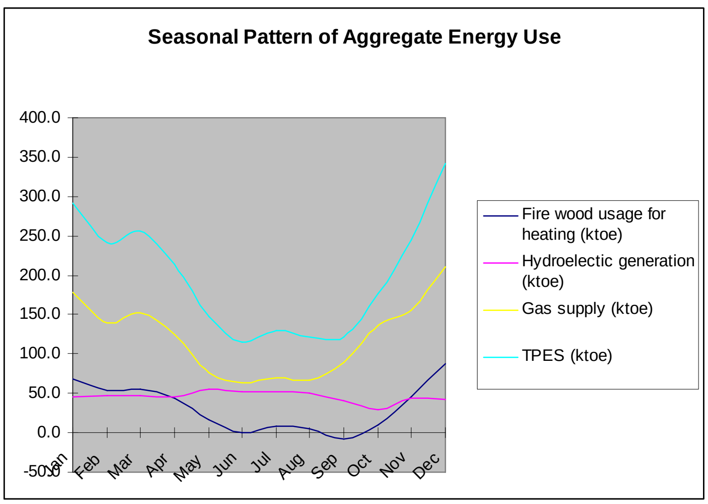


Figure 4.23. Seasonal structure of aggregate energy use.

Georgia is energy deficient over the whole year. Although there is a surplus of hydraulic energy in summer months, it still can not replace the gas imported in the same period of year even if fully utilized.

[7] In this study we do not consider the issues of system stability and the short term deficit that can be experienced by the power system. This is a task for separate study incorporating loss of load probabilities and other system stability parameters.

While analyzing the energy security and external dependence issues one needs to take into consideration this seasonality (Cf. Appendix 7). Indeed, interruption of external energy supply will have much more damaging results in winter, when the share of imports is higher, than in summer, when local hydropower generation has more potential. To account for this seasonality, we introduce the Energy Dependence Seasonal Index (EDSI) equal to the amount of imported energy in each particular month divided by total energy import in the year. While considering any measure for increasing the energy supply or reducing consumption, we have to weigh it with EDSI in order to determine its relative importance compared with other possible measures and the potential input in energy security. The chart for EDSI derived from the above pattern looks as follows:

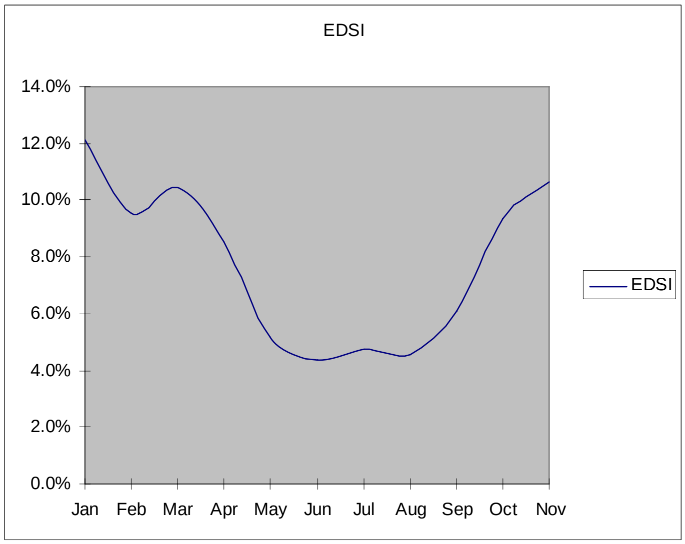


Figure 4.24. Energy dependence seasonal index.

One can notice that EDSI shows increased dependence on imports in winter months.

As the carriers of energy, electricity and gas can replace each other in many applications. At the same time, the limitations of existing distribution networks and energy appliances do not allow the use of these energy carriers interchangeably in many cases. Interchangeability would require substantial time and investment. Thus while analyzing the energy security issues we should focus on both these carriers and consider both the electricity and gas balances.

Since there is no significant production of fossil fuels in Georgia, the thermal plants can not directly contribute to the country's energy independence and energy security. What is being achieved by construction of new thermal plants is more capacity in converting the energy of imported fossil fuels into electricity. Operation of thermal plants can add to diversity of supply by allowing import of gas instead of electricity. Thermal plants are necessary for the stability of the power system and in optimizing the production of hydro-plants, however their contribution to energy security is of secondary importance.

For this reason we introduce a separate parameter to characterize the dependence of electricity supply on external imports.

The analog of Energy Dependence Seasonal Index for electricity is ESDIE. ESDIE measures the seasonal dependence on external energy supply for electricity usage and demonstrates a profound seasonal behavior (cf. Figure 4.22).

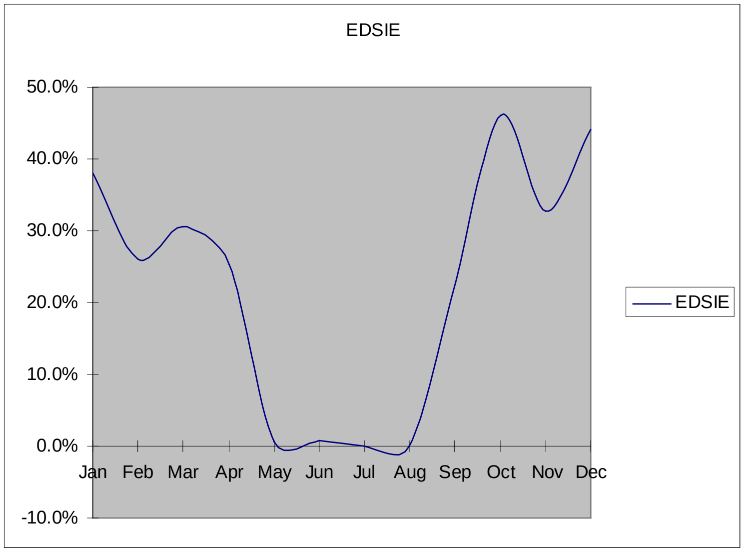


Figure 4.25. Electricity dependence seasonal index.

This graph demonstrates the high importance of electricity supply increase or consumption reduction measures in winter months and it also shows that if some measure can give a positive contribution to electricity balance in summer months, its contribution to energy independence will still be zero, unless some additional measures will be taken (e.g., energy swap arrangements or some sort of energy storage) to shift the effect to the period when the country is strongly dependent on external energy supply.

4.5. Consumption by Consumer Categories

Estimate of energy efficiency and Energy saving potential requires detailed information about consumption of various types of energy by different consumer categories. The quality and availability of data in distribution companies does not always allow us to make sufficiently detailed analysis. So in some cases we had to supplement the factual data by expert estimates and our own surveys.

UEDC/Energo-Pro has a more detailed breakdown of consumption by customer categories than Telasi. Consumers are classified into activity categories and their total consumption can be analyzed. However the data are not always reliable and some consumer categories show questionable seasonal behavior. A detailed breakdown of consumption patterns by Energo-Pro consumer categories can be found in Appendix 8. Here we present only the aggregate data at the distribution company level.

4.5. 1. Telasi

Telasi classifies its customers into four main categories: Residential, Commercial, Budget and Central Customers. Monthly consumption patterns by these consumer categories is given in Figure 4.26.

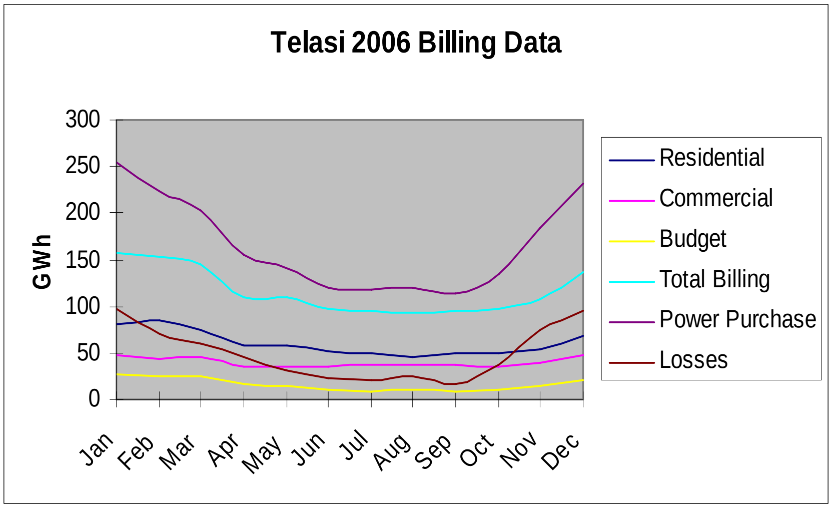


Figure 4.26 Telasi power supply and consumption patterns.

Residential consumers represent the biggest consumer class with 37% share in total Telasi annual power purchase (Figure 26) and 53% in billing. The share of losses is still high at 30% and exceeds the allowable annual technical losses (12.4%) by 17.6%. The seasonal pattern of losses follows that of total consumption and approaches its maximum in winter months, when Georgia is most dependent on power imports.

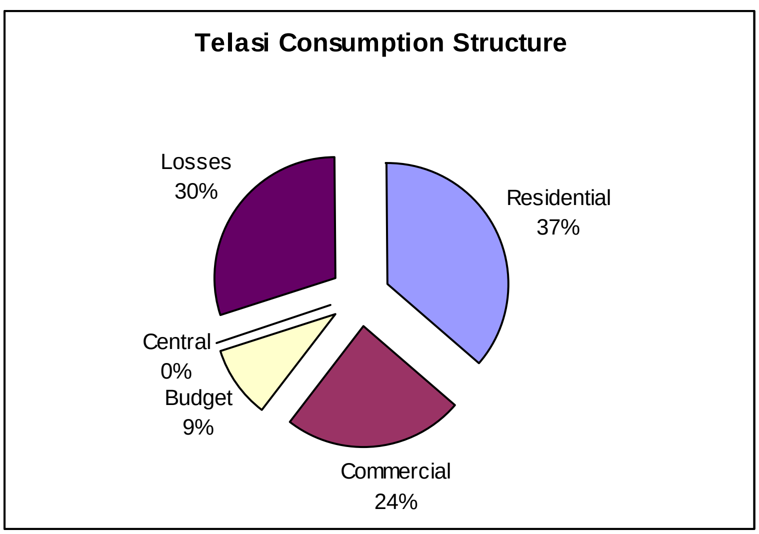


Figure 4.27. Telasi annual consumption structure.

The consumption of residential consumers is seasonal and indicates electricity use for heating. More detailed monthly power purchase and consumption patterns of Telasi can be found in Appendix 9.

4.5.2. UEDC/Energo-Pro

The Assets of UEDC – United Electricity Distribution Company of Georgia and Achara Distribution Company of Georgia were acquired by Energo-Pro in June 2007. So the data on 2006 and the beginning of 2007 were acquired from billing systems of these separate distribution companies, while subsequent analysis and forecasts relate to Energo-Pro data (cf. Appendix 8.). The Consumption structure of UEDC/Energo-Pro can be seen in Figure 4.28, below.

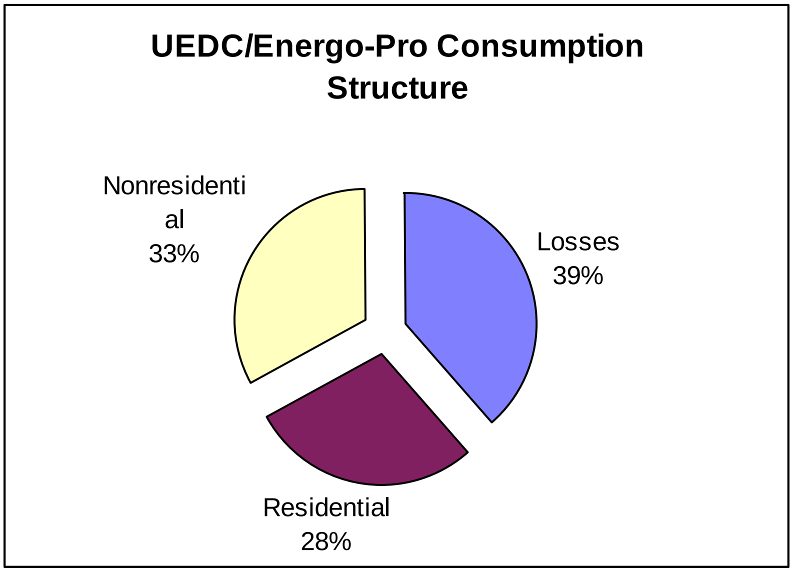


Figure 4.28. Energo-Pro annual consumption structure.

Residential consumption in UEDC/Energo-Pro has a smaller share compared to that of Telasi, while the percentage of losses is higher. The higher total losses can be attributed to both higher technical and commercial losses in the Energo-Pro network.

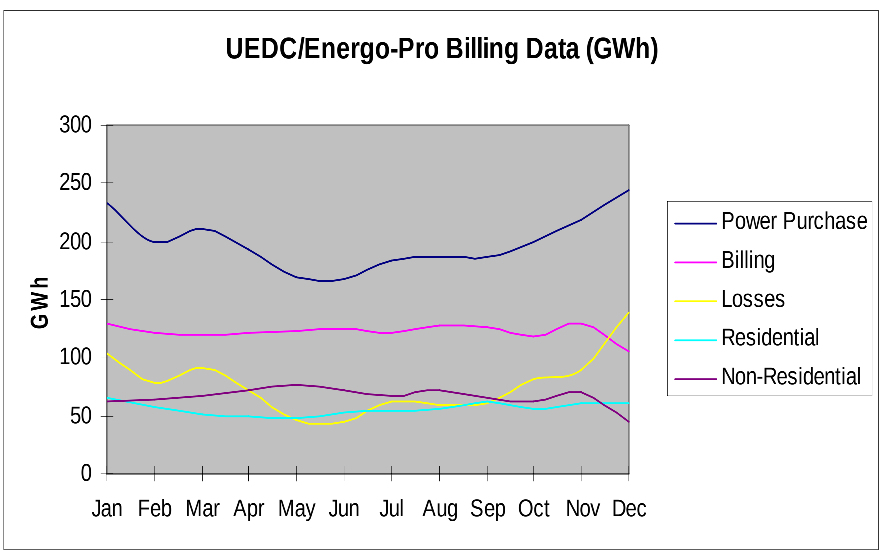


Figure 4.29. Energo-Pro power supply and consumption patterns.

UEDC power purchase has a less pronounced seasonal pattern that can be attributed to a lower share of residential consumption, and also is indicative of less use of electricity for heating purposes.

4.5.3. Achara

Achara's billing data was obtained from Energo-Pro Georgia and represents the period before Energo-Pro purchased the Achara distribution company's assets.

Figure 4.30 below shows the seasonal variation of billing in total and by customer categories. The irregularities of the consumption pattern can be attributed to the quality of data obtained from the Achara billing data base (Appendix 10).

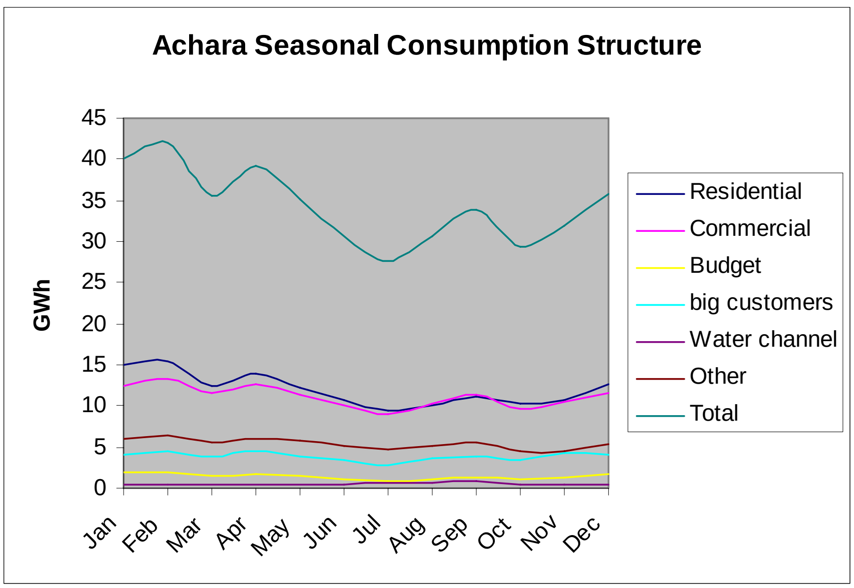


Figure 4.30. Achara power supply and consumption patterns.

The chart in Figure 4.28 shows the annual consumption structure of Achara Distribution Company by customer categories.

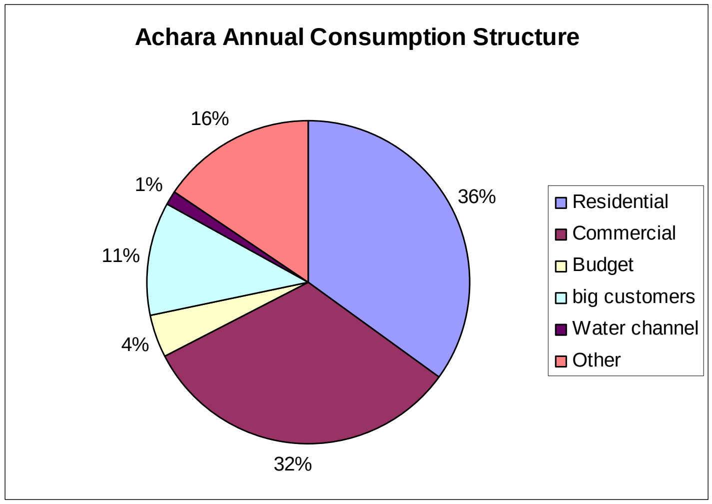


Figure 4.31. Achara annual electricity consumption structure.

4.5.4. Kakheti

Kakheti represents a small percentage of consumption compared with other distribution companies.

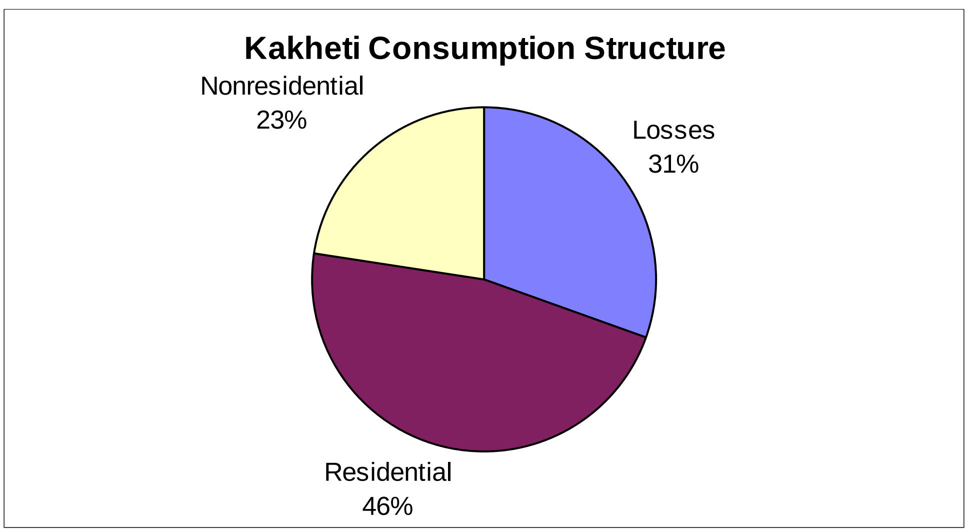


Figure 4.32. Kakheti annual electricity consumption structure.

At the time of writing this report the data from Kakheti distribution company had not been obtained. So we have reconstructed the seasonal behavior based on UEDC consumption patterns and used Kakheti information on the May 2006 consumption structure (Appendix 11.)

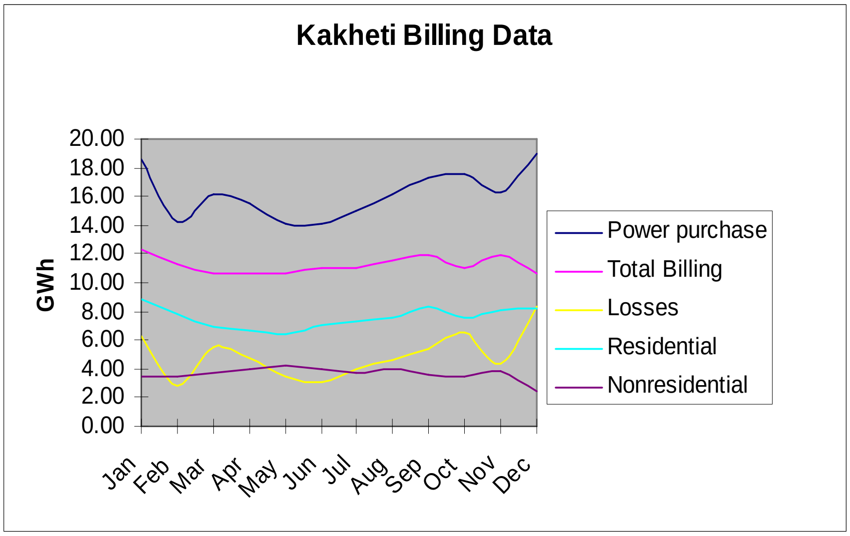


Figure 4.33. Kakheti power supply and consumption patterns (reconstruction).

The consumption of residential consumers is less seasonal than in the case of Telasi and indicates reduced use of electricity for heating.

4.5.5. Commercial Losses in Electricity Distribution Companies

Table 4.5 summarizes the level of technical and commercial losses in electricity distribution companies.

	Power Purchase	Technical Losses	Billing	Comm. losses	Comm. losses %
Telasi	1,955.4	242.5	1,398.8	314.1	16.1%
Energo-Pro	2,394.0	358.4	1,468.1	567.5	23.7%

Table 4.5. Commercial losses in distribution companies (GWh).

The figures for commercial losses (electricity theft) have been derived by subtracting the official allowances for technical losses approved by GNERC from the power purchase.[8] The remaining figures of losses, the level of theft in these distribution companies with fair accuracy. The figures also represent the potential for savings by reducing this theft. According to expert estimates, these losses could be cut into half within two years, using cost-effective measures.

4.5.6. Gas Consumption in Tbilisi

Tbilisi gas consumption information was obtained from "Kaztransgas-Tbilisi" (Cf. Appendix 12). The data shows a great share of losses, up to 42%, which is almost equal to the total billing of

[8] GNERC Resolution #17, of May 11 2006.

residential customers. Billing of nonresidential customers amounts to only 14% of total gas supply to Tbilisi.

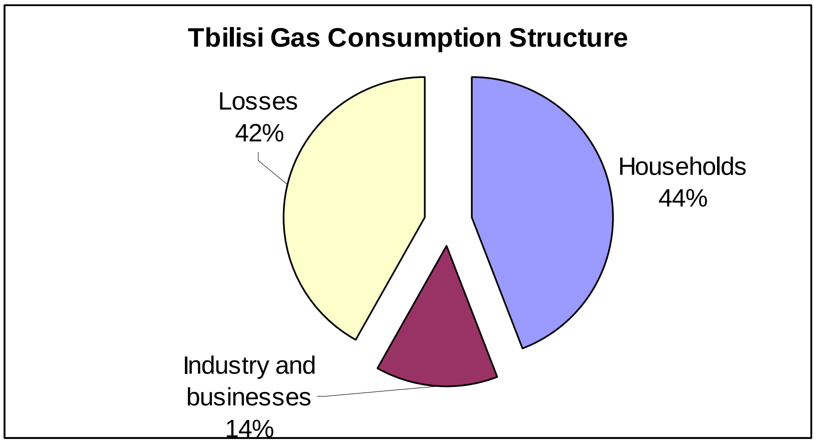


Figure 4.34. Kaztransgas-Tbilisi annual consumption structure.

The annual gas consumption chart shows a sharp seasonal variation of consumption. Maximum gas consumption in December differs from the August minimum by almost 7 times. The high percentage of losses can be attributed mostly to commercial loss (theft) of gas and indicates a significant potential for saving, since usually non-paid consumption exceeds paid demand several times.

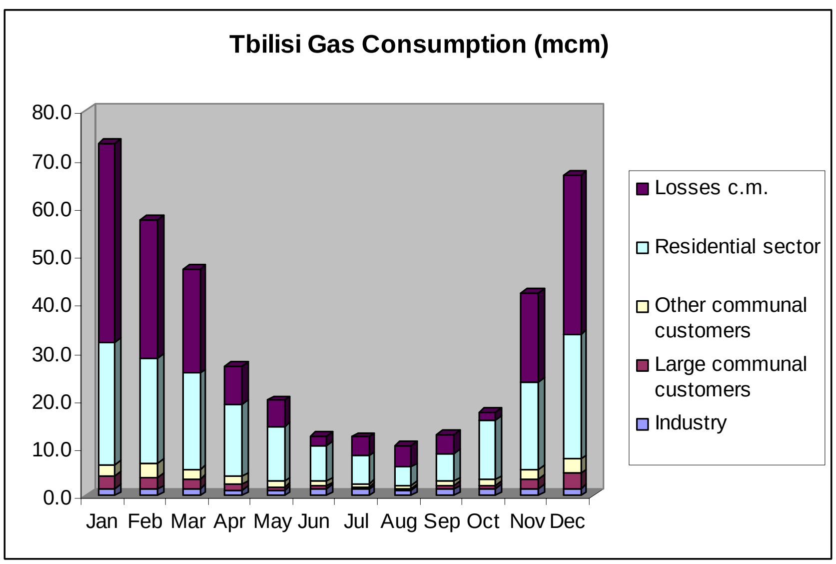


Figure 4.35. Kaztransgas-Tbilisi gas supply and consumption pattern (million m^3).

The seasonal difference in gas supply and consumption is much sharper than that in electricity. This reflects the use of a great portion of gas for heating and indicates the need of a closer study of the possibilities of gas saving by reducing the heating load.

Other Gas Distribution Companies

There are a great number of gas distribution companies in the cities and regions of Georgia, mostly owned by Itera-Georgia. It was not possible to get information about consumption by customer categories from all these small distribution companies. So because of this shortage of information we will assume the same structure of consumption as in Tbilisi.

Chapter 5
Energy Efficiency Potential in Residential and Nonresidential Sector of Georgia

5.1. Electricity Saving Potential in the Residential Sector of Georgia

5.1.1. Electricity Consumption Peculiarities in the Residential Sector of Georgia

Facilitating energy savings in Georgia's residential sector has the potential to produce substantial benefits, as Georgia's households consume approximately 30-35% of Georgia's total energy consumption. Figure 5.1 shows the population's share in energy consumption from the data of major energy distribution companies.

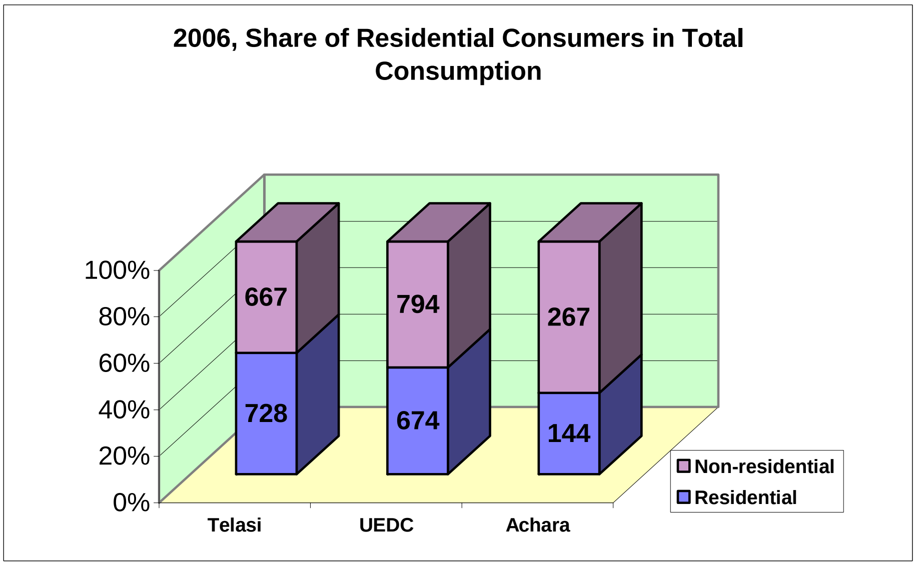


Figure 5.1. Residential and nonresidential billing in electricity distribution companies

The energy supply of the population is characterized by sharp seasonal variation. The ratio of Georgia's domestic consumption minimum in summer to its maximum in winter (seasonality coefficient) is about 55% - (Cf. Figure 5.2 -Telasi data). Consumption seasonal variation is especially high in large cities, where a great number of consumers use electric heaters in winter periods and in summer they leave their permanent dwelling places for extended periods to take holidays. Monthly energy consumption in villages and regions is more than in towns. There the population consumes energy for lighting and natural gas; wood is being used for heating and hot water supply. As for air conditioning, the initial research shows that its share in total energy consumption is insignificant and does not have any serious impact on Georgia's seasonal character of energy consumption.

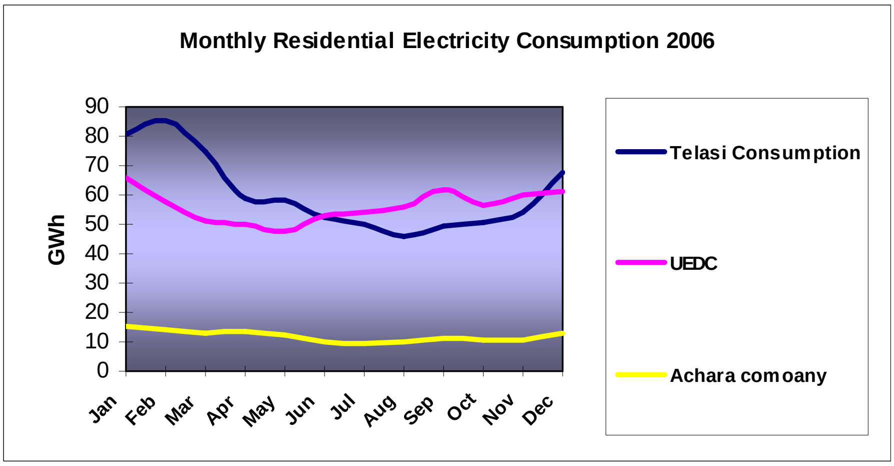


Figure 5.2. The Pattern of Monthly Energy Consumption of the Population of Georgia; data supplied by Georgia's major energy providers.

5.1.2. Natural Gas Consumption Peculiarities in the Residential Sector of Georgia

Natural gas is used by more than 470 thousand customers in Georgia. The population uses it for cooking, heating and hot water supply. Annual indicators of gas consumption for major regions of Georgia given in the table below, and Figure 5.3 shows the dynamics of monthly consumption of natural gas according to regions.

	No. of Cust--omers	Total Consumption mcm/year	Cooking mcm/year	Heating & hot-water mcm/year	Hot water supply mcm/year	Heating mcm/year
Tbilisi	304,500	183.5	72	112	22.3	89.2
Ajara	5,000	1.3	0.5	0.8	0.2	0.7
Mtskheta	4,000	1.7	0.7	1.0	0.2	0.8
Kartli	23,120	8.8	3.4	5.3	1.1	4.3
Kvemo Kartli	47,790	12.2	4.8	7.4	1.5	6.0
Kakheti	20,200	5.2	2.1	3.2	0.6	2.6
Imereti	65,700	12.9	5.0	7.8	1.6	6.2
Guria	370	0.1	0.0	0.1	0.01	0.04
Sum	470,680	225.7	98.1	127.6	25.5	102.1

Table 5.1. Annual Indicators of Natural Gas Consumption for the Population of Major Regions of Georgia, million cubic meters.

The data shows that up to 80-90% of natural gas consumed by the population is used for heating and hot water supply. **This fact points to the great importance of reducing heat losses in dwellings and promoting the rational use of hot water.**

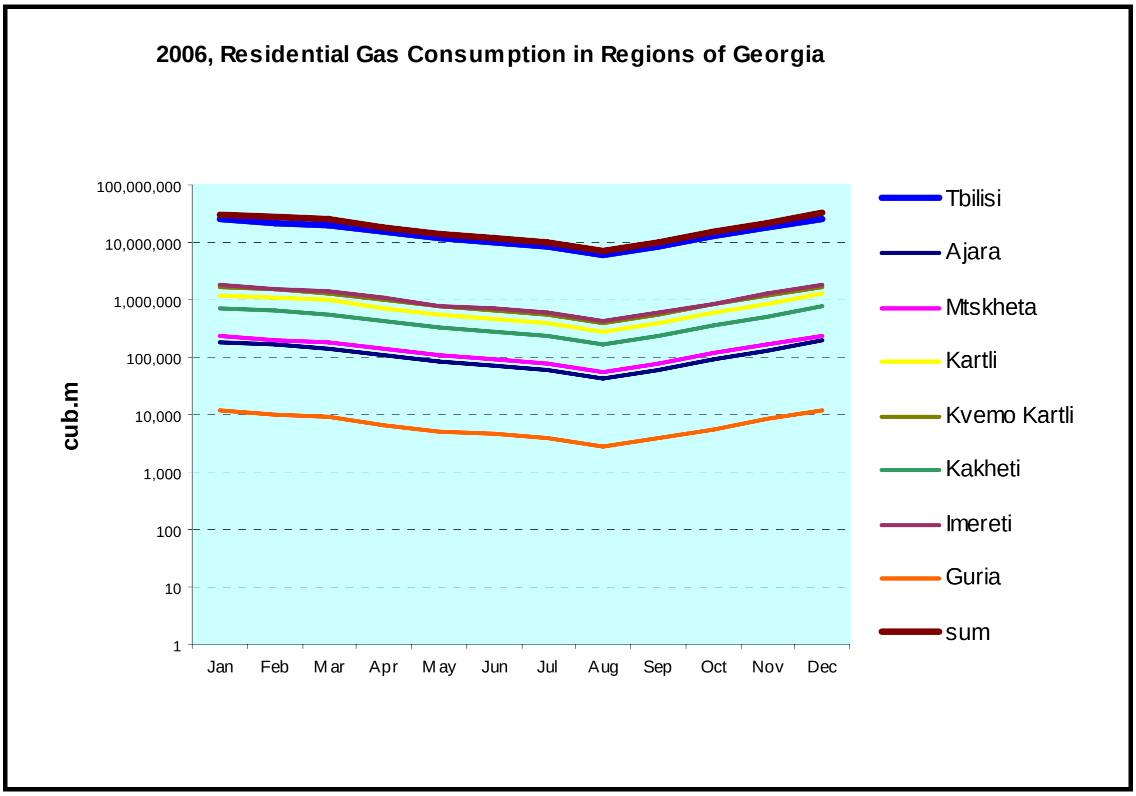


Figure 5.3. The Dynamics of Natural Gas Monthly Consumption for the Population of Regions of Georgia

5.1.3. Household Electrical Appliances and the parameters of their use

From the point of view of energy saving it is important to know the approximate parameters of consumption for electric appliances. This information helps consumers to make informed choices when purchasing new appliances.

Energy indicators of standard household appliances are displayed in Tables 5.2- 5.4. In Table 5.2, the characteristics of the appliances having comparatively great demand at local markets are presented. Their lifetime and energy consumption is obtained on the basis of evaluation. In Tables 5.3-4, the characteristics of electric appliances that are used less often are given.

Table 5.2. Typical Indicators of Basic Household Electric Appliances

Different Electric Appliances	Monthly Average Capacity, W	Average Lifetime	Energy Consumption, kWh/month	Energy Consumption, kWh/day	Energy Consumption, kWh/year
Refrigerators	80	24.0 hrs/day	58	2	701
TVs	90	6.0 hrs/day	16	1	197
Electric Irons	1 000	15 min/day	8	0	93
PCs	150	3.5 hrs/day	16	1	192
Washing Machines	750	30 min/day	11	0	137
Air Conditioners "Winter-Summer"	900	5.0 hrs/day	135	5	1 643
Electric Water Heaters	7 months in cold/medium season				
	1 500	3 hrs/day	135	5	1 643
	3 Months in Summer				
	1 500	4 hrs/day	180	6	2 190
Total			558	19	6 795

Table. 5.3. Typical Indicators of other Electric Household Appliances

Different Electrical Appliances	Requested/ Average Capacity, W	Average Lifetime	Energy Consumption, kWh/month	Energy Consumption kWh/day	Energy Consumption kWh/year
Dish washer	1 100	0.50 hrs/day	17	0.55	201
Toaster	550	10 min/day	3	0.09	33
Blender	180	10 min/day	1	0.03	11
Ventilator	50	5.00 hrs/day	8	0.25	91
Electric Grill	1 200	5 min/day	3	0.10	37
Electric Coffee-Grinder	300	5 min/day	1	0.03	9
Coffee maker, automatic	1 300	5 min/day	3	0.11	40
Kitchen Combine	650	5 min/day	2	0.05	20

Table. 5.4. Typical Indicators of other Electric Household Appliances (continuation)

Electric Bread Slicer	100	5 min/day	0	0.01	3
Electric Mincing Machine	250	5.0 min/day	1	0.02	8
Electric Squeezer	240	1.0 min/day	0	0.00	1
Hair Drier	1 200	5.0 min/day	3	0.10	37
Electric Bowl for Potato Chips	2 300	5.0 min/day	6	0.19	70
Electric Kettles	1 200	5.0 min/day	3	0.10	37
Floor Polisher	1 000	5.0 min/day	3	0.08	30
Microwave ovens	1 100	20.0 min/day	11	0.37	134
Total			63	2	761

5.1.4. Energy Consumption in the Residential Sector, a World Energy Georgia study

According to energy consumption the residential sector, Georgia may be divided into three categories of consumers. The first category covers consumers whose average daily consumption equals 5-100 kWh. The number of such customers in Tbilisi reaches 144,849 (36%). Consumers of the second category consume 100-300 kWh/month on average. Their number in Tbilisi equals to 40,059 (10%). There also exists passive consumers (closed flats) consuming less than 5 kWh/month of energy. Their number in Tbilisi is 59,639 (14%). The latter have not been the subject of our research.

In the framework of this investigation, we have defined annual dynamics of each category of consumers.

The Method of Analysis

The results of World Energy Georgia's energy audit were used as the basis of the analysis. The audit has been conducted for 50-70 consumers singled out from each category. During the audit, consumers completed questionnaires about their home energy use. An auditor then studied the electric appliances of customers and the appliances' working/loading regimes. The results of the study were generalized by means of statistical methods and then a typical picture of energy consumption was created for each category of consumers.

Annex 2 shows the dynamics of monthly energy consumption for different consumers. The results are obtained through studying payment receipts.

The Study Results

Detailed below are the study's results conducted for each category of consumers. The patterns and structure of typical energy consumers from each consumer category are presented in Figures 5.4 – 5.10.

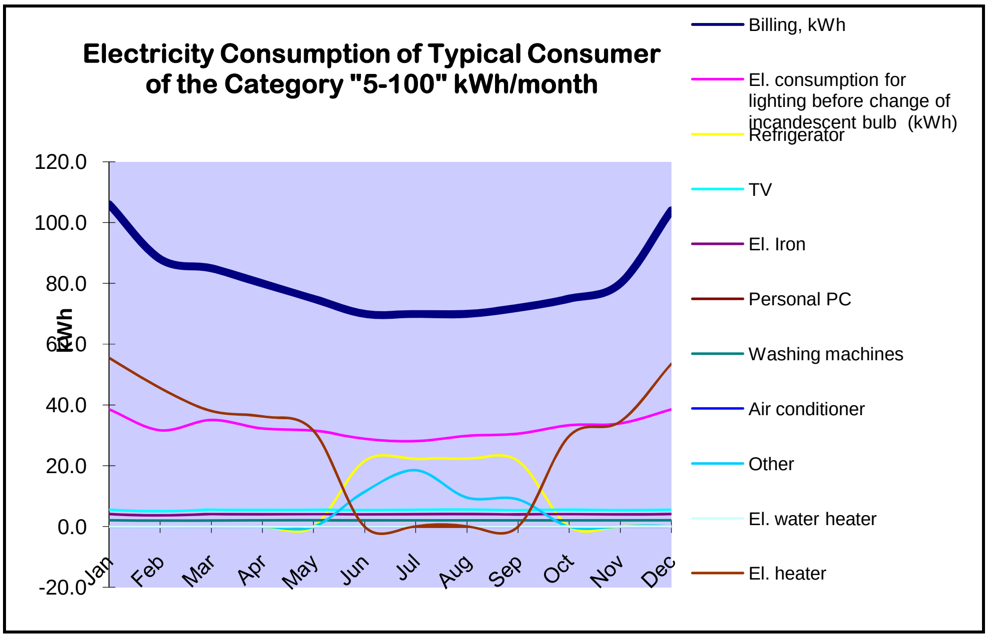


Figure 5.4. Consumption of a typical consumer of "5-100 kWh/month" category

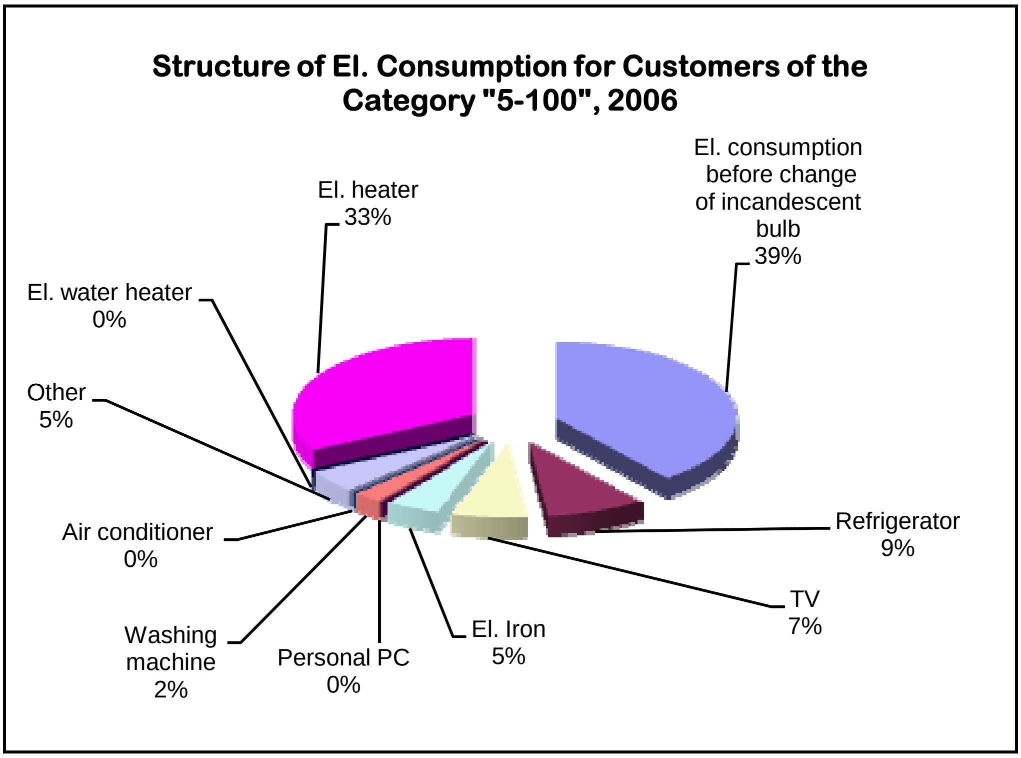


Figure 5.5. Structure of electricity consumption of consumers of "5-100 kWh/month" category

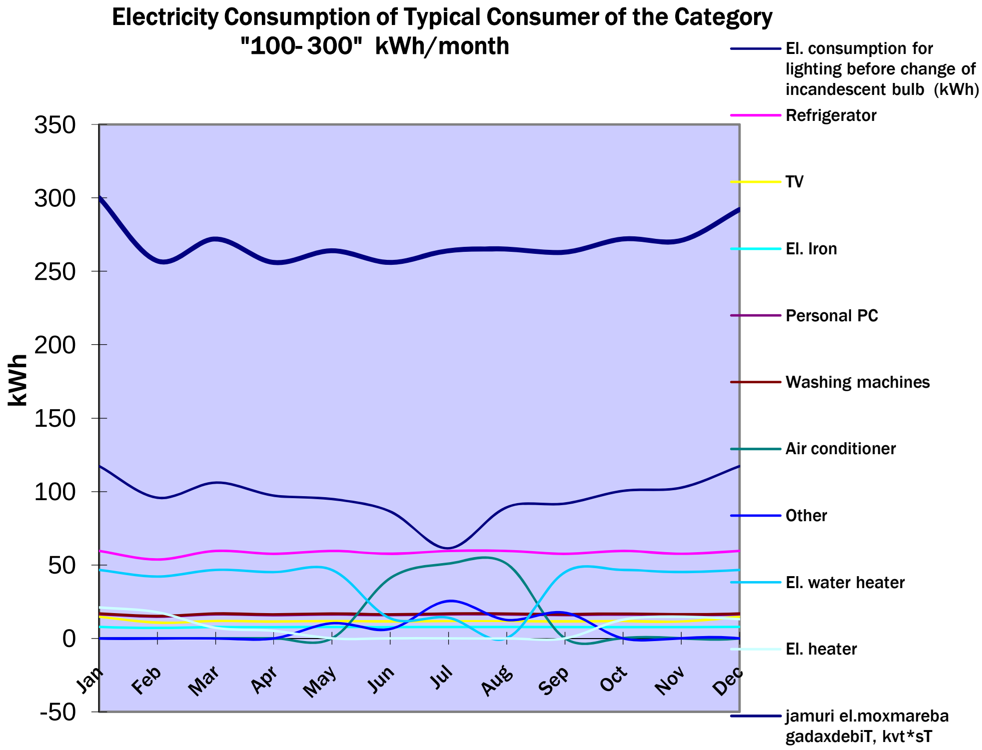


Figure 5.6. Electricity consumption of a typical consumer of “100-300 kWh/month” category

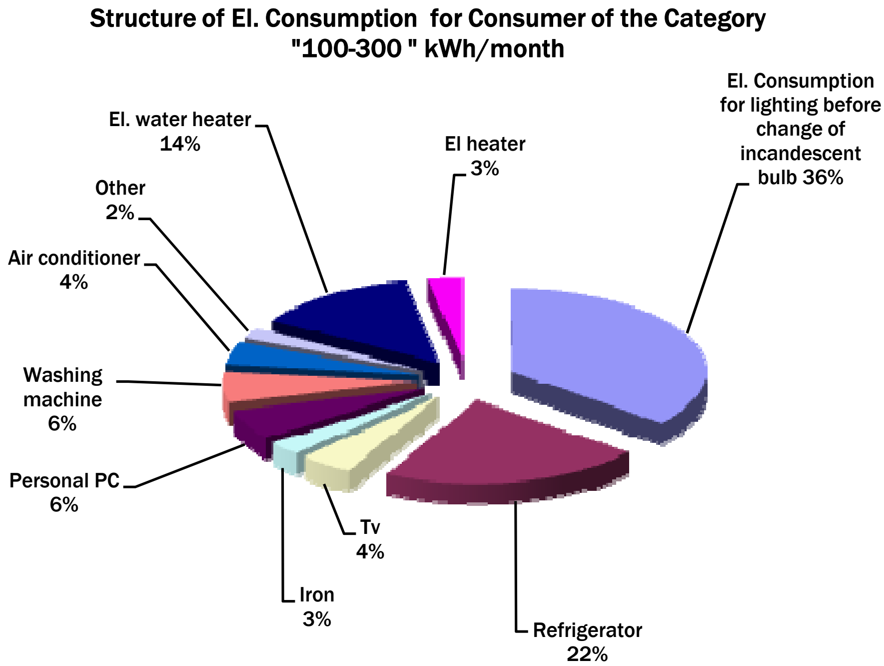


Figure 5.7. Structure of electricity consumption of consumers of "100-300 kWh/month" category

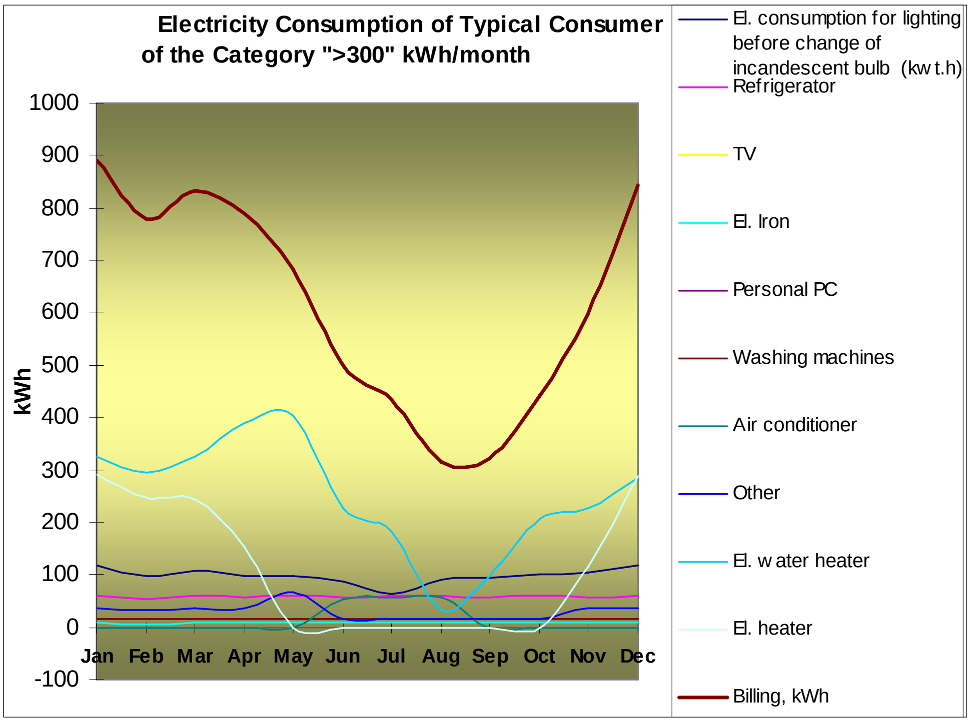


Figure 5.8. Electricity consumption of a typical consumer of ">300 kWh/month" category

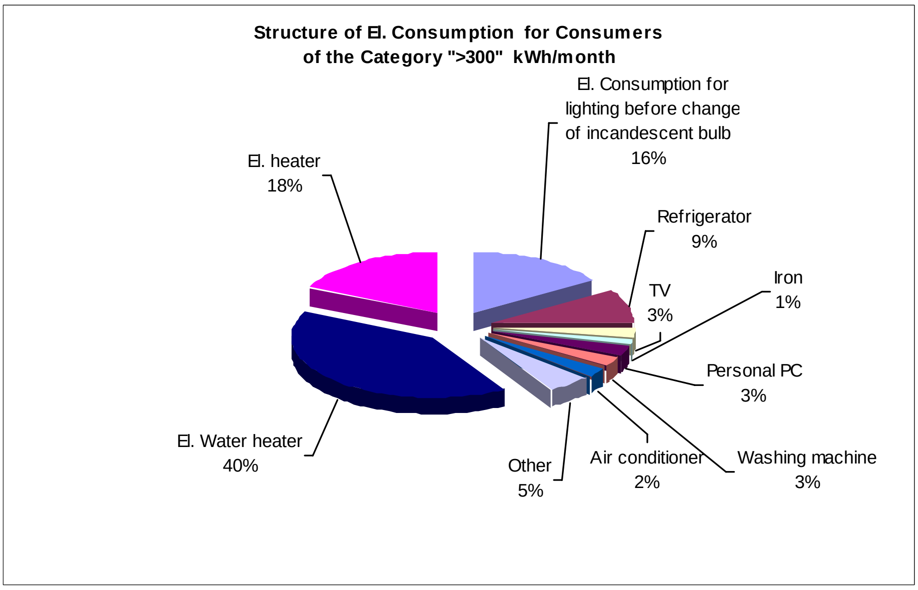


Figure 5.9. Structure of electricity consumption of consumers of “>300 kWh/month” category

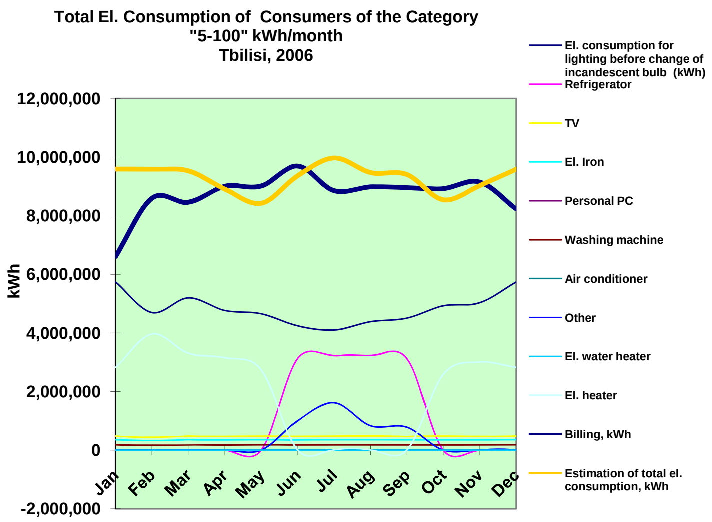


Figure 5.10. Dynamics of total electricity consumption of consumers of “5-100 kWh/month” category

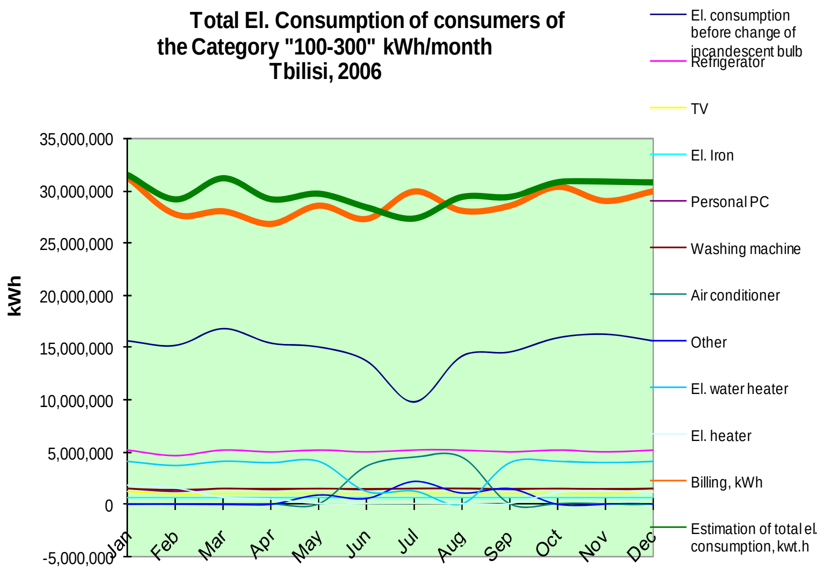


Figure 5.11. Dynamics of total consumption of consumers of “100-300 kWh/month” category

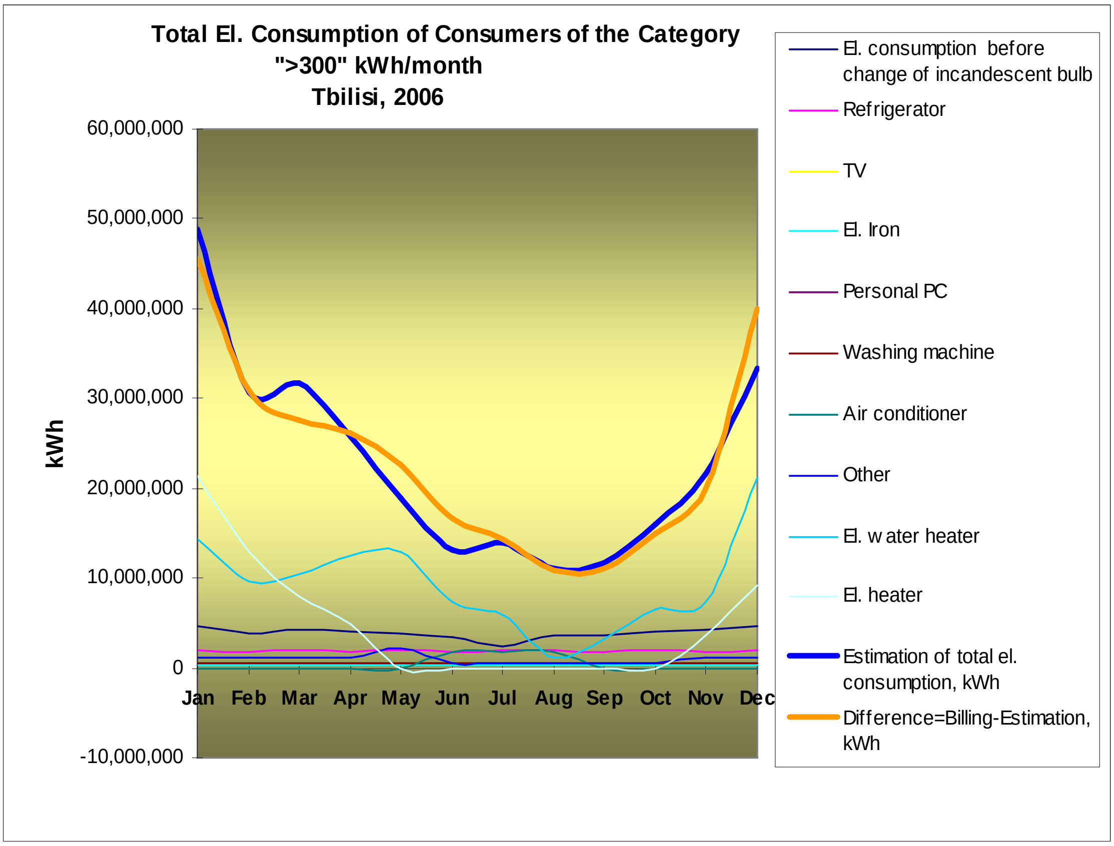
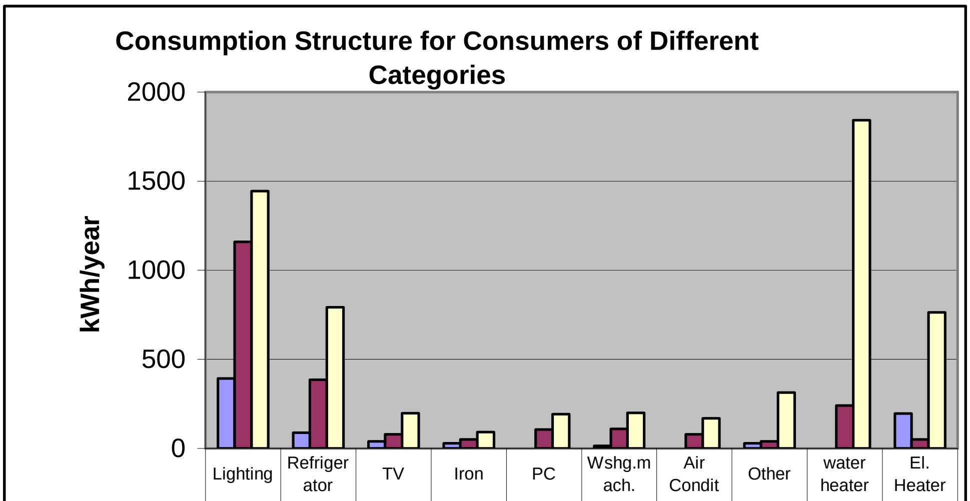


Figure 5.12. Dynamics of total consumption of consumers of “>300 kWh/month” category

The difference between the consumption values obtained by estimation and payment receipts does not exceed 30%. The report's authors think such error is acceptable for statistical research.

For comparison, on Figure 5.13 there is given an annual consumption structure for the consumers of different categories. The figure shows that consumption of lighting, refrigerators, electric appliances and heating is especially high. All other kinds of consumption are significantly low.



	Lighting	Refriger ator	TV	Iron	PC	Wshg.m ach.	Air Condit	Other	water heater	El. Heater
"5-100 kWh/month"	393	88	39	29	0	15	0	29	0	195
"100-300 kWh/month"	1160	385	80	50	105	110	78	40	240	51
">300 kWh/month"	1444	792	197	91	192	200	168	314	1842	764

Figure 5.13. Annual Electricity consumption by appliances for consumers of different categories

In the category "5-100 kWh/month" the majority of energy consumption lies in lighting (40%) and electrical heating (30%). Consumers of this category use natural gas for heating and hot water supply. The gas heaters are located in one of the rooms. Electric energy is used only as additional source of heating for the rest of the rooms in extremely cold months. The daily duration of electric heating (co-heating) in such periods does not exceed 1-1.5 hours. Consumers mainly use small, low capacity refrigerators. Very often refrigerators (especially old types) are used only in summer months.

In the category "100-300 kWh/month" the basic share of electric consumption lies in lighting (35%), refrigerators (20%) and electric heating (15%). Consumers of this type use natural gas for heating purposes. Mainly small 2-5 kW capacity (so called "Karma" type) heaters are used for heating. Additional electric heating is rarely used. A small part of these consumers has central heating using individual boilers. For hot water supply, most people use electric water heater tanks (Ariston, Thermex, etc.) or heaters directly operated by means of current (Atmors).

In the category ">300 kWh/month" the largest part of electric consumption lies in water electric heaters (30%), lighting (25%) and electric heating (15%). Consumers basically use natural gas for heating. Electric energy is used only as additional heating source in cold months (heating for 2.5-3 hours per day). Some consumers have central heating – hot water supply on the basis of individual boilers. Though, most just use electric water heating tanks and heaters directly working on current for hot water supply.

Study results show that there is significant energy saving potential in lighting, constituting 25-40% of general consumption. That is why special attention was paid to studying energy saving potential in lighting.

5.1.5. Lighting

The study of energy saving potential was preceded by studying the current status of lighting in the general population. This lighting study encountered certain difficulties: it was necessary to collect and generalize voluminous statistical materials on types of bulbs existing within population, their number, peculiarities of usage, and lighting regimes, etc. It was also necessary to study the market of energy efficiency bulbs existing in Georgia. The task was divided into two parts – technical and economical. The technical side of the issue is discussed first.

The types of lighting appliances, peculiarities of their use and indicators of consumption currently used in Georgian households were conducted by studying Tbilisi and generalizing the results. The study derived data from energy audits, previously mentioned (Appendix 6.2). The results of the study were processed in spreadsheet models, which, together with the parameters of bulbs, included the indicators of consumption of other electric appliances. In the model, by means of test calculation method, the values of lighting and other types of electric consumption were separated from each other. As the background condition, the seasonal dynamics of natural ambient lighting in Georgia was used. The latter was determined in the framework of another specially developed model that considers corresponding assumptions and photometric parameters accepted for Georgia's climatic zone; 75 W was accepted as average capacity of the incandescent bulbs.

The study showed that the numbers and types of the bulbs in Tbilisi, significantly differ for different categories of consumers. The share of energy efficient (fluorescent) bulbs installed in homes of the "100-300 kWh/month" category of consumers constitutes ~ 25-30%; in ">300 kWh/month" category of consumers ~ 15-20%. According to lighting regimes, the bulbs are divided into those that are dependent on natural external lighting and independent ones (e.g., independent bulbs in "dark" parts of apartments – the hall, bathroom, and cellar, etc.). According to this loading (duration of lighting), bulbs are divided into three groups: bulbs lit for longer periods of time or loaded bulbs—these are bulbs in the rooms where people are constantly gathering such as the kitchen; bulbs used for shorter periods of lighting or non-loaded bulbs—these bulbs operate in rooms where people do not stay for extended periods. Both of these bulb use categories assume that these rooms are partially lit by sunlight during daytime uuse. Finally, the study differentiates bulb use for lighting regimes that are short in use and whose use does not depend upon daylight access, such as bathrooms, laundry rooms, and certain hallways. The estimated amounts, consumption indicators and saving potential of each group are given in Table 5.6. The study estimates saving potential (technical) by supposing that all existing incandescent bulbs would be replaced with fluorescent bulbs, which consume a quarter of the electricity the incandescent bulbs consume.

The assessment revealed that the share of savings attainable in general electricity consumption reaches 40-15%, for the consumers of "5-100 kWh/month" and ">300 kWh/month" categories correspondingly. This is from the point of view of spreading the substantial results of savings over different regions of Georgia.

Bulb numbers, indicators of consumption and saving potential				
For a typical consumer	Consumer of "5-100" consumers	Consumer of "100-300" consumers	">300" consumers	Average capacity
Total number of bulbs	8 units	18 units	25 units	
Energy efficient bulbs	0 units	5 units	4 units	20 W
Incandescent bulbs	8 units	13 units	21 units	75 W
The bulbs independent from external natural lighting				
Energy effective bulbs of long lighting	0 units	5 units	4 units	
Incandescent bulbs of long lighting	3 units	6 units	5 units	
Duration of long lighting	1 241 hrs/year	1 824 hrs/year	2 242 hrs/year	
Incandescent bulbs of short lighting	3 units	4 units	12 units	
Duration of short lighting	310 hrs/year	304 hrs/year	374 hrs/year	
The bulbs independent from external natural lighting :				
Incandescent bulbs of short equal lighting	2 units	3 units	4 units	
Duration of short equal lighting	292 hrs/year	292 hrs/year	292 hrs/year	
For Tbilisi Population				***Total***
Total number of bulbs, unit	1 158 792	2 850 768	1 001 475	5 011 035
Loaded incandescent bulbs, unit	434 547	950 256	200 295	1 585 098
Non-loaded incandescent bulbs, unit	434 547	633 504	480 708	1 548 759
Incandescent bulbs of short equal lighting, unit	289 698	475 128	160 236	925 062
Loaded effective bulbs, unit	0	791 880	160 236	952 116
Electric usage of lighting by evaluation, kWh/year	56 893 066	183 731 998	57 843 173	298 468 237
Saving by means of efficient bulbs instead of incandescent ones, kWh/year	42 507 357	140 486 492	41 288 295	**224 282 143**

Table 5.5. Number of bulbs, indicators of consumption and saving potential

2006, Population of Georgia, Energy Saving Potential in Lighting	Savings in Lighting GWh/year	Number of Consumers	Saving per consumer kWh/year
Tbilisi	145	396000	375
United Distribution Company (Energy-Pro)	200	757000	264
Ajara	25	93000	267
Total	**370**	**1 246 000**	

Table 5.6. Energy saving potential in lighting

5.1.6. Heating

The population of Georgia uses natural gas, electricity and fuel wood for heating and hot water supply. Fuel wood is mostly being used in rural areas and the places where there is no gas distribution network. We are unsatisfied with the accuracy of information regarding fuel wood consumption in Georgia. Currently official information differs significantly from expert evaluations. Insufficient information about wood felling and the absence of a united data base on wood consumption does not allow us to make concrete calculations. Therefore we make only rough estimates on efficiency potential in wood consumption. We believe this issue requires serious attention.

An estimate has been made of gas and electricity use for heating purposes. We were using the data of large energy distribution companies- Telasi, UEDC/Energo-Pro, Kaztransgaz-Tbilisi, Achara Natural Gas, Mtskheta Gas and other regional distribution companies. At the same time we studied individual gas consumption histories of 20 Kaztransgaz-Tbilisi customers in order to single out and estimate gas consumption for cooking. According to the available data we conclude that monthly gas consumption for cooking for an average family varies in the range of 0.55 -1.1 cubic meters a day. In order to distinguish between gas use for hot water supply and for heating we have inferred from houses with central heating, where the heat load in summer (non-heating season) constituted about 15-20% of the heat load in winter (heating season). For the calorific content of gas we have used 8070 CCal/m^3. The efficiency of gas heaters was estimated at 75% (average efficiency of the Karma type of natural gas heater).

	Number of Customers	Total Consumption GWh/year	For Cooking GWh/year	Heating and Hot water supply GWh/year	Hot water supply GWh/year	Heating GWh/year
Tbilisi	304 500	183.5	72	112	22.3	89.2
Achara Gas	5 000	1.3	0.5	0.8	0.2	0.7
Mtskheta Gas~	4 000	1.7	0.7	1.0	0.2	0.8
Kartli	23 120	8.8	3.4	5.3	1.1	4.3
Qvemo Kartli	47 790	12.2	4.8	7.4	1.5	6.0
Kakheti	20 200	5.2	2.1	3.2	0.6	2.6
Imereti	65 700	12.9	5.0	7.8	1.6	6.2
Guria	370	0.1	0.0	0.1	0.01	0.04
Total	470 680	225.7	98.1	127.6	25.5	102.1

The Table 5.7. The estimate of natural gas used for heating, cooking and hot water supply in various regions in Georgia

5.1.7. Weatherization

The most apartment houses were built in Georgia in accordance with old Soviet standards. There were unconformities to standards because of following reasons: improper design and assembly, substandard housing, and unjustified acceleration of construction, etc. Consequently, the buildings had poor quality. Standardizations are in progress now in Georgia, which gives hope that this sector may have standardized, regulated development in the nearest future.

All recent research in energy efficiency carried out in Georgia shows that Georgia's buildings have high energy losses. The quickest way to mitigate energy losses of buildings, post-construction, is weatherization of external windows and doors; this saves about 20-30% of estimated heating energy.

To define potential energy saving in the residential sector only apartment houses were considered. Administrative settings and offices were not analyzed since the majority of them have been renovated since 2005. For the study, we assume that the insulation condition of those buildings is acceptable.

Only the major residential sector was analyzed in the project— that is, where gas and electricity is used for heating. According to the data from the Institute of Demography and Sociology (unfortunately there is only old data available) about 60-65% of dwelling houses are block of flats in Tbilisi, 20-25% are individual houses, and the rest are a mixed kind of flat, the latter is not taken into account. In other cities, 40-45% are as a block apartments and about 40% are an individual houses.

According to our survey about 85% of windows and doors in the block buildings in Tbilisi are of the old, wooden construction and have to be insulated (weatherized). Only 30% of this amount is being annually insulated by inhabitants. Therefore, about 50% could be additionally insulated. This means that at least 10% [50% x 20%=10%] of total energy consumption for heating can be saved. The cost of weatherization for Tbilisi and other cities approximately on this scale is: 900 000 GEL for block buildings and 1 300 000 GEL for individual houses. Table 5.8 shows the Saving Potential in weatherization for several large regions of Georgia.

	gas heating,	heating by electricity,	sum of heating,	saving in heating by weatherization,
Tbilisi	628	67	694	69
Ajara	5	0	5	1
Mtskheta	6	1	6	1
Kartli	30	3	33	3
Kvemo Kartli	42	4	46	5
Kakheti	18	2	20	2
Imereti	44	5	49	5
Guria	0	0	0	0
sum	718	77	795	79

Table 5.8. Saving Potential in weatherization for several large regions of Georgia, millions of kilowatt-hours.

By applying the same logic and estimates illustrated above to the whole country, we can roughly estimate the total potential of energy saving through weatherization in Georgia. According to estimates in Chapter 4 and Appendix 6., the total annual amount of gas used for heating in Georgia is around 300 million cubic meters. Thus about 10% or 30 million cubic meters of natural gas; **this is equivalent to 280 kWh of energy that can be saved through the simplest of weatherization measures.**

Electricity saving through heating is harder to estimate. Autumn-winter excess over summer consumption of electricity is about 1-1.6 TWh annually. However this excess is due to increased lighting as well as heating. Assuming that half of this energy goes for heating and that 10% of that heating energy can be saved through weatherization measures, we arrive at 50-80 GWh of energy, in rough agreement with the result in Table 5.8.

5.2. Electric Energy Saving Potential in the Non-Residential Sector of Georgia

5.2.1 Introduction

A detailed study of energy efficiency potential, the introduction of efficient technologies, practical implementation of energy saving measures, and the effective use of local fuel-energy resources are among the basic preconditions of economic development and the guaranteed energy safety of the country. Particularly, the level of internal energy resources and effective application of the energy represented in the indicators of dynamics of energy efficiency, i.e. of generalized indicators of energy intensity of GDP, determine the competitiveness of the products produced in the country (at an internal as well as external market) and the competitive position of the country in the world.[1]

The improvement of energy use efficiency is especially important for Georgia, where, on the one hand, a major part of energy resources is imported for the needs of economy (the whole amount of natural gas consumed, most of the oil and oil products, and until recently a significant part of electricity) and, on the other hand, the efficiency of using these fuel-energy resources does not exceed even 45%. That is to say, we can not use even half of our imported energy resources.[2]

Therefore, rehabilitation of the existing resources, technical re-equipment of fixed assets and energy saving should be recognized as priority directions of the energy sector. Some concrete investigations show the following can be saved from the total amount of fuel and energy: in industry – about 70%, in transport – 15-18%, in agriculture – 10-14%, in utility service sector – 15-25%.[2]

The country's sustainable energy supply can be provided not only by enhancement of the generating capacity base in compliance with the increasing demand, but also by limiting the consumption growth on the basis of increased efficiency of the energy being used by consumers (enterprises, utility service tools and equipment, dwelling and community buildings, institutions of service sphere, etc.).

It should be mentioned, that the costs of on increasing energy production and supply exceed 3-5 times the amount necessary for decreasing the consumption demand for equivalent energy. That is why, development of energy consumer-demand management programs and their implementation should be useful not only for consumers, but for energy supply companies as well.

Up to now, the financial stability of energy supply companies relies only on increases in generation, supply and sales of energy and not on its saving. As a result, utilities will be reluctant to give up their positions unless proper incentives will be provided for them, to participate in energy efficiency and energy saving activities. But if we consider the experience of developed countries, where cooperation between energy supplier and energy consumers is reviewed as an independent business of high income, we shall understand that demand-management can create great profits for both parties.

A detailed understanding of energy efficiency potential, implementation of new efficient technologies, and practical applications of energy saving measures in energy generation as well as in transmission and consumption, is important from both economic and strategic points of view. Particularly, it will promote a solution of Georgia's energy problems and help the country increase its competitiveness of domestically-produced products through a reduction of its energy intensity. A comprehensive analysis of Georgia's energy efficiency potential will create better conditions for the country's energy safety and quicker economic development.

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[1] Kandelaki R., Jishkariani T., Miqiashvili T., Kiguradze D. The Practice and Outlooks of an Implementation of Energy Efficiency Technologies in Georgia. Scientific-technological journal „Energia". 2005. #1(33). pp.17-20.

[2] Chomakhidze D. Economic and Environmental Problems of Utilizing the Energy Potential of Georgia. "Tergi". Tbilisi. 2002. p. 275.

The same can be said about the industrial sector of energy consumption, with only the distinction that aforementioned benefits will be supplemented with a reduction in the prime cost of production and enterprise-specific energy usage, the creation of new jobs, and increasing energy independence. As for the residential sector, even here, a consumer can save significant energy resources through small financial costs.

5.2.2. Highlights of previous Energy Efficiency activities

Immediately after commencement of the reforms in the energy sector of Georgia, the issue of energy efficiency technology application and energy savings became relevant. Evaluation of the country's energy saving potential from this point of view was first conducted in the framework of the "Least Cost Plan for Energy Sector of Georgia" project[3].

The evaluation covered a package of energy saving and energy efficiency standard technologies [3,4,5,6,7,8,9]. For the industrial sector, this included: the application of variable-speed electric drives, optimization of transformers' capacities and performance regimes, decentralization of compressed air delivery and installation of small compressors instead of high capacity non-loaded compressors, the application of reactive capacity compensators and installations protecting engines from overloading, the application of energy-resources energy-consumption metering systems, energy saving lighting and energy-generation economic decentralized systems, and the creation of independent energy resources (e.g., construction of combined cycle gas-turbine units).

Later a special agency – the Energy Efficiency Centre – was created in Georgia that carried out important work in industrial enterprise energy audits and developed the methodology for conducting the energy audits.

The practical implementation of these first energy efficiency projects in Georgia started in 1998. The pioneers of this activity were so called Green Brigades, implementing energy saving pilot projects in different regions of Georgia.

Large-scale implementation of energy efficiency pilot projects in Georgia started in 2000, in the frameworks of a USAID program led by the company Hagler Bailly; later PA Consulting took charge of these projects. The management work was performed by the Georgian Association of Energy Engineers (GAEE) as a chief contractor. At the first stage, 42 demonstration projects on energy efficiency were conducted in different regions of the country, in the framework of this program. The projects were performed in households, and

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[3] Least Cost Plan for Energy Sector in Georgia. Final Report. Burns & Roe. 1998.

[4] Jishkariani T., Arabidze G., Chkhaidze B., Gogshelidze G., Laoshvili D., Mikiashvili T., Tavartkiladze L. Energy-Saving Activities in Some Regions of Georgia. International Conference, Sopron, Hungary. June 13-15, 2001.

[5] Kiguradze O., Jishkariani T. Energy Efficiency While Using of Thermal Pumps for Heating of Green-houses. Georgian Engineering News. 2001. #3. pp 90-93.

[6] Kiguradze O., Jishkariani T., Arabidze G. Energy Supply While Using of Thermal Pumps in Sphere of Wood Drying. Second International Energy Conference in Armenia, Yerevan, September 24-28. 2001, pp 62-64.

[7] Chkhaidze G., Kiguradze D. Demand Side Management Programs. „Energy". 2003. #4 (28), pp. 5-9.

[8] Jishkariani T., Miqiashvili T., Kiguradze D., Chkhaidze G. Energy Security of Georgia. National Report on Estimation of Sustainable Development. Tbilisi, 2002. p. 35.

[9] Jishkariani T., Miqiashvili T., Demand Side Management Programs. "24 hours", 2005. #102. p. 8.

were planned for educational, medical, commercial and industrial sectors; the projects envisaged implementation of following measures:

a) weatherization in order to reduce infiltration-exfiltration in buildings,
b) fuel switching—installation of heating systems with the heaters burning natural gas,
c) installation of heating systems with a boiler burning natural gas or liquid fuel with traditional water radiators,
d) replacement of the existing lighting systems with energy saving fluorescent bulbs,
e) repairing of roofing and insulation of ceilings,
f) optimization of electric engines and transformer performance regimes.

The second stage of the program was carried out in 2001-2003. During this period the USAID program implemented 34 energy efficiency pilot projects mostly in the industrial sector. The projects involved:

- optimization of transformer and water pumping stations working regimes,
- implementation of automatically-controlled lighting systems in the hotels,
- arrangement of energy provision complex systems in hospitals and clinics,
- construction of micro hydro power stations,
- manufacturing of biogas generators and their installation in farms,
- installation of sun collectors at guest service sites,
- implementation of energy saving measures in Tbilisi Metro,
- installation of steady and effective energy providing systems at food production plants, etc.

Object	Energy saving measure	Annual saving		Initial investment	Simple payback	*)d/i
		MWh/y	USD/y	USD	year	-
Oncology Centre (Tbilisi)	a, b, d	69	9612	31132	3	1.14
Youth House (Tbilisi)	a, b, d	39	3027	10089	3	1.3
Children's Clinic (Tbilisi)	a, b, d	37	5950	25688	4	0.9
Restaurant „Aragvi" (Dusheti)	a, b, d	65	2752	9183	3.3	1.2
Minimarket (Tbilisi)	a, b, d	7	1637	3496	2.1	1.86
Secondary School #56 (Tbilisi)	a, b, d, e	11	5506	22740	4.1	1.01
Azeri School (Bolnisi)	a	74	466	8425	18.1	0.2
Old people's home (Bolnisi)	a, b, d, e	46	2464	13377	4.0	1.1
Daycare school (Telavi)	a, b,	80	3472	18348	4.6	0.9
Water pump (Tbilisi)	v	514	16197	26624	2.0	2.5
Secondary School (Borjomi)	a, b,	24	3194	16867	5.0	0.8
Fashion House (Tbilisi)	a, b, d	7	1526	4220.5	2.8	1.45

*) the projects where SIR(d/i) is less than 1 are of humanitarian character.

Table 5.9. Economic efficiency indicators of the performed energy saving measures

The experience of previous projects has been used to estimate the Energy Efficiency potential of various non-residential consumers in Telasi and Energo-Pro. The data of UEDC/Energo-Pro contained more detailed information about consumer groups and their consumption seasonal profiles.

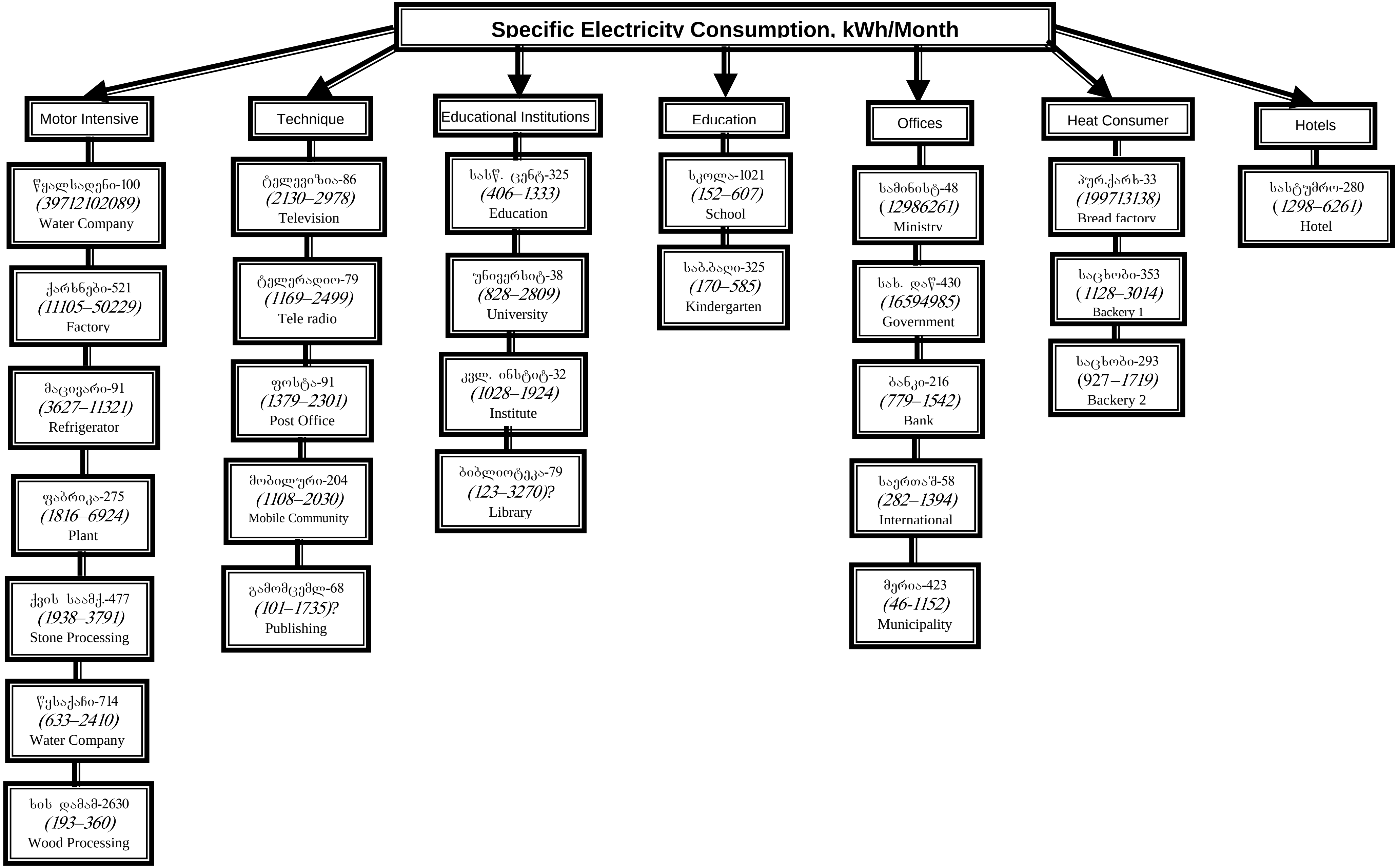
5.2.3. Evaluation of Energy Saving Potential

Methodology

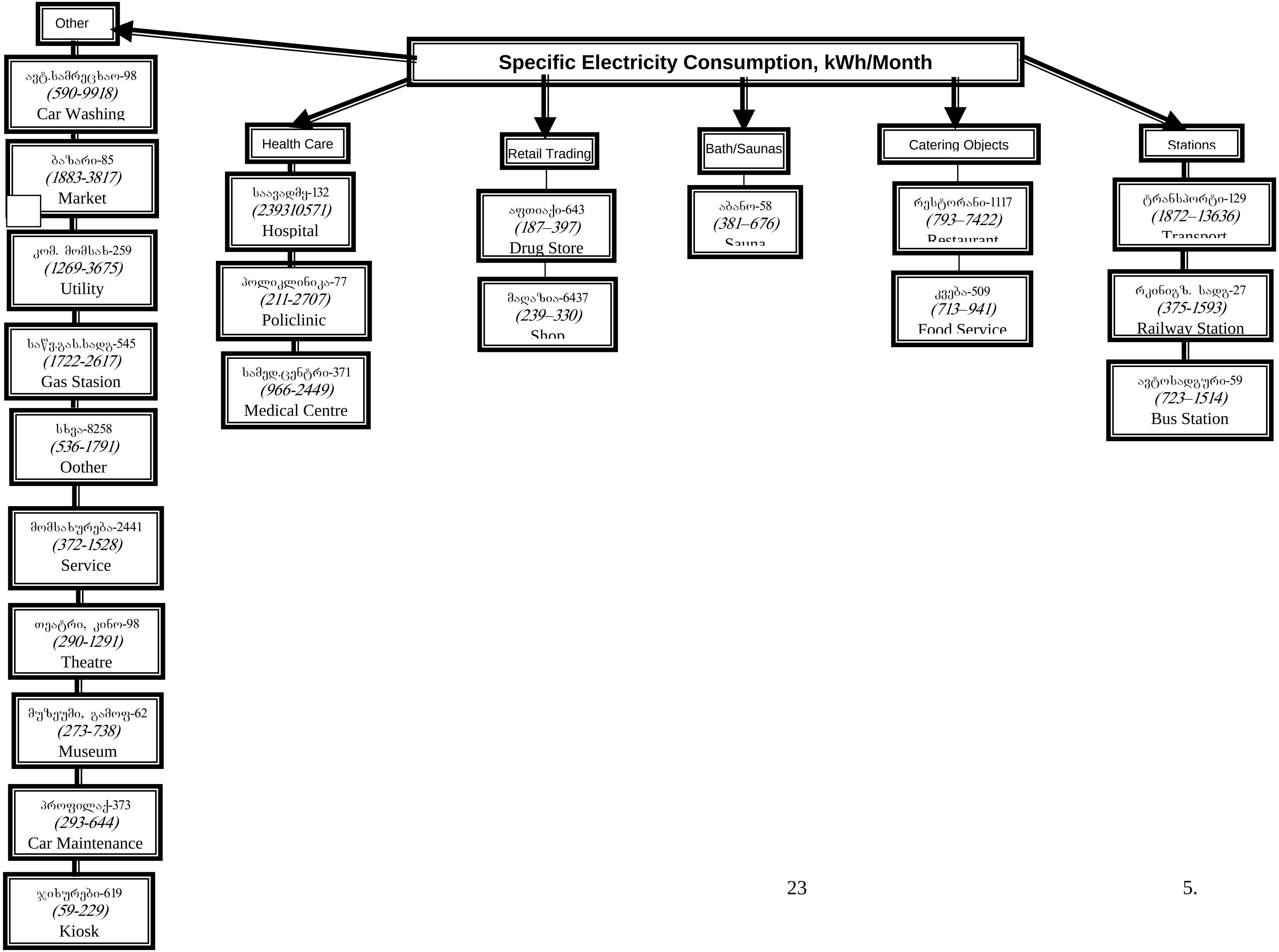
The official data on energy consumption of Telasi, Energy-Pro Georgia and Achara Energy companies has served as the basis of evaluation of energy saving potential, and can be found in the Appendices 4.7-4.10.

Electricity consumers have been grouped according to two main sectors – nonresidential and residential. Further, UEDC-EnergoPro data enabled us to divide the nonresidential into groups according to the types of electric equipment being used.

In total, the study reviews 13 consumer groups based on UEDC billing information, as depicted on the next two pages.

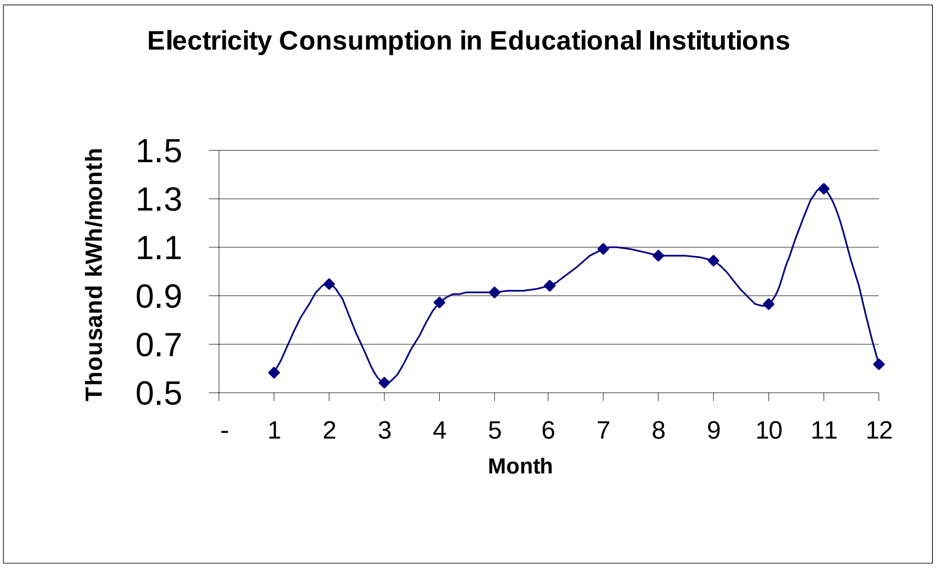

Specific Electricity Consumption, kWh/Month
Motor Intensive
Technique
Educational Institutions
Education
Offices
Heat Consumer
Hotels
წყალსადენი-100
(39712102089)
Water Company
ქარხნები-521
(11105–50229)
Factory
მაცივარი-91
(3627–11321)
Refrigerator
ფაბრიკა-275
(1816–6924)
Plant
ქვის სამქ.-477
(1938–3791)
Stone Processing
წყსაქაჩი-714
(633–2410)
Water Company
ხის დამამ-2630
(193–360)
Wood Processing
ტელევიზია-86
(2130–2978)
Television
ტელერადიო-79
(1169–2499)
Tele radio
ფოსტა-91
(1379–2301)
Post Office
მობილური-204
(1108–2030)
Mobile Community
გამომცემლ-68
(101–1735)?
Publishing
სასწ. ცენტ-325
(406–1333)
Education
უნივერსიტ-38
(828–2809)
University
კვლ. ინსტიტ-32
(1028–1924)
Institute
ბიბლიოთეკა-79
(123–3270)?
Library
სკოლა-1021
(152–607)
School
საბ.ბაღი-325
(170–585)
Kindergarten
სამინისტ-48
(12986261)
Ministry
სახ. დაწ-430
(16594985)
Government
ბანკი-216
(779–1542)
Bank
საერთაშ-58
(282–1394)
International
მერია-423
(46-1152)
Municipality
პურ.ქარხ-33
(199713138)
Bread factory
საცხობი-353
(1128–3014)
Backery 1
საცხობი-293
(927–1719)
Backery 2
სასტუმრო-280
(1298–6261)
Hotel

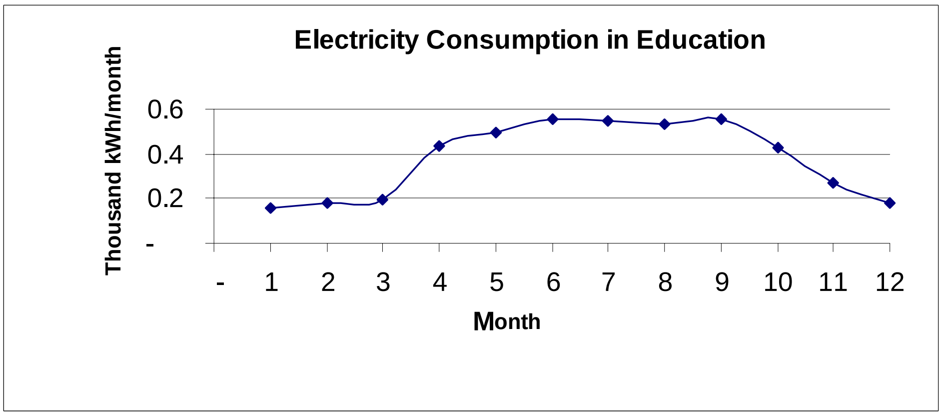
5.

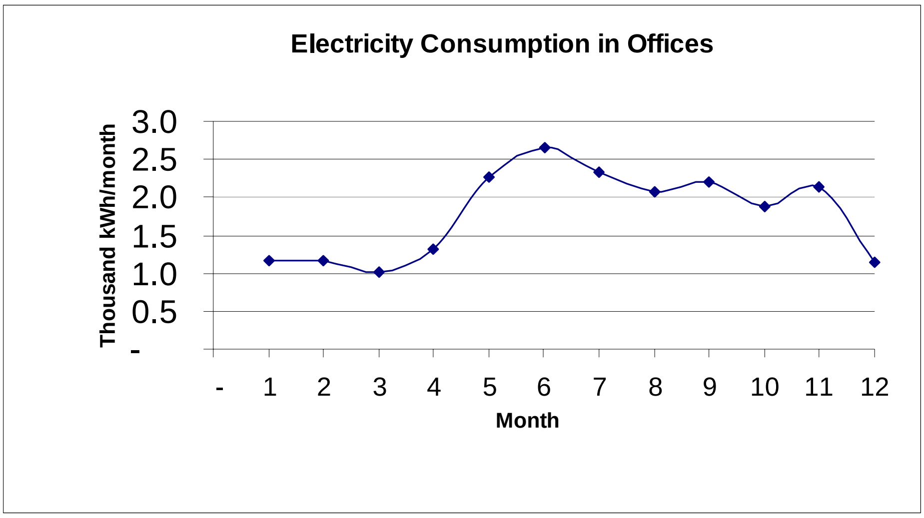

Specific Electricity Consumption, kWh/Month
Other
ავტ.სამრეცხაო-98 (590-9918) Car Washing
ბაზარი-85 (1883-3817) Market
კომ. მომსახ-259 (1269-3675) Utility
საწვ.გას.სადგ-545 (1722-2617) Gas Stasion
სხვა-8258 (536-1791) Oother
მომსახურება-2441 (372-1528) Service
თეატრი, კინო-98 (290-1291) Theatre
მუზეუმი, გამოფ-62 (273-738) Museum
პროფილაქ-373 (293-644) Car Maintenance
ჯიხურები-619 (59-229) Kiosk
Health Care
საავადმყ-132 (239310571) Hospital
პოლიკლინიკა-77 (211-2707) Policlinic
სამედ.ცენტრი-371 (966-2449) Medical Centre
Retail Trading
აფთიაქი-643 (187–397) Drug Store
მაღაზია-6437 (239–330) Shop
Bath/Saunas
აბანო-58 (381–676) Sauna
Catering Objects
რესტორანი-1117 (793–7422) Restaurant
კვება-509 (713–941) Food Service
Stations
ტრანსპორტი-129 (1872–13636) Transport
რკინიგზ. სადგ-27 (375-1593) Railway Station
ავტოსადგური-59 (723–1514) Bus Station

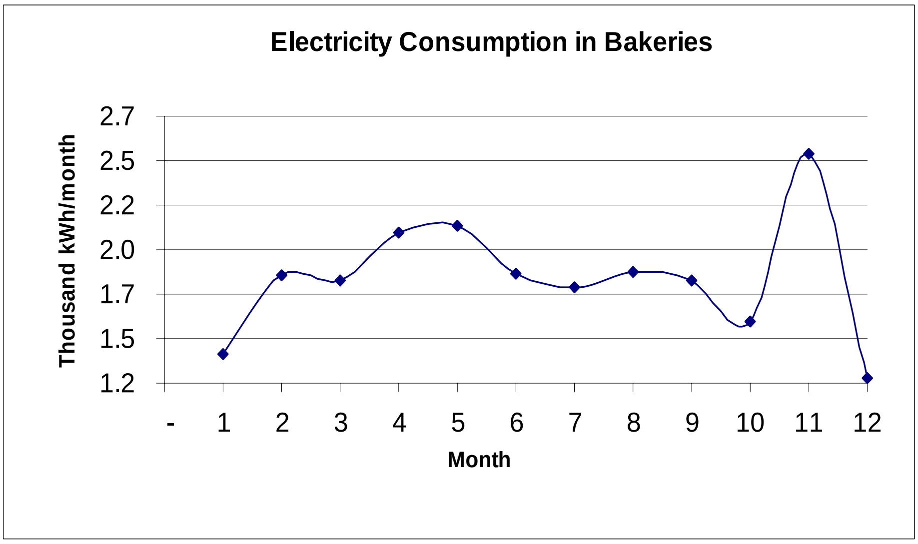
Unfortunately the accuracy of information was not always sufficient to draw sound conclusions. On the basis of above information the monthly electricity consumption graphs for typical objects representing each group have been developed for one year. The analysis has shown that existing information does not properly reflect the typical picture characterizing the seasons of a year. For example, the distribution of electricity consumption according to the months for schools clearly shows that maximum consumption is in summer period (during holidays). This can be related to repair works being conducted in the mentioned period or caused by some other reason, including data inaccuracy.

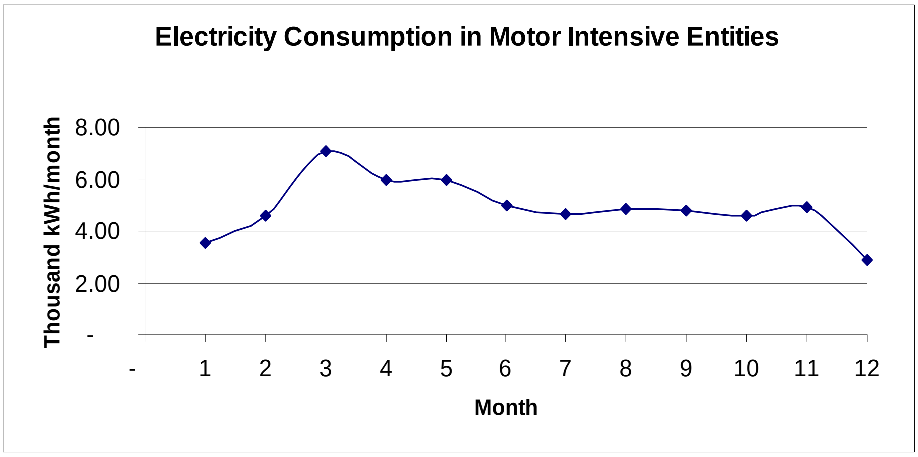
As the seasonal electricity consumption analyses could not give any result for individual consuming entities, the investigation has been conducted according to the average annual electricity consumption for the given groups, as depicted in the series of graphs lumped under Figure 5.14 below.

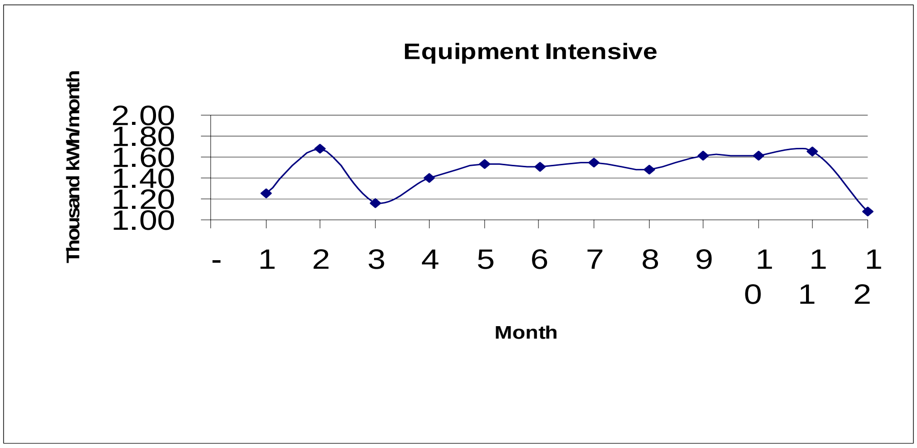


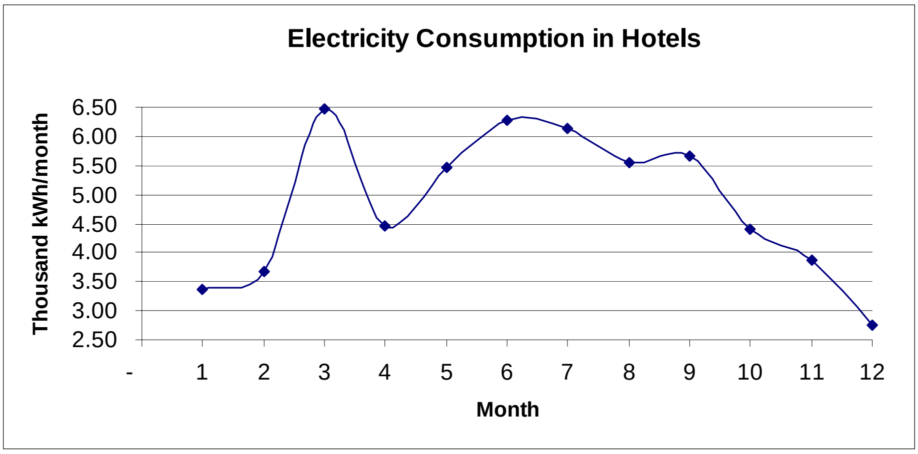


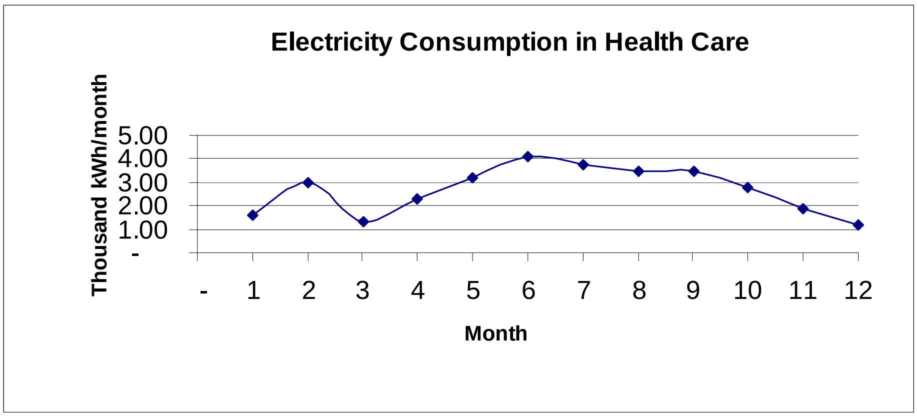

Electricity Consumption in Offices
Thousand kWh/month
3.0
2.5
2.0
1.5
1.0
0.5
-
- 1 2 3 4 5 6 7 8 9 10 11 12
Month

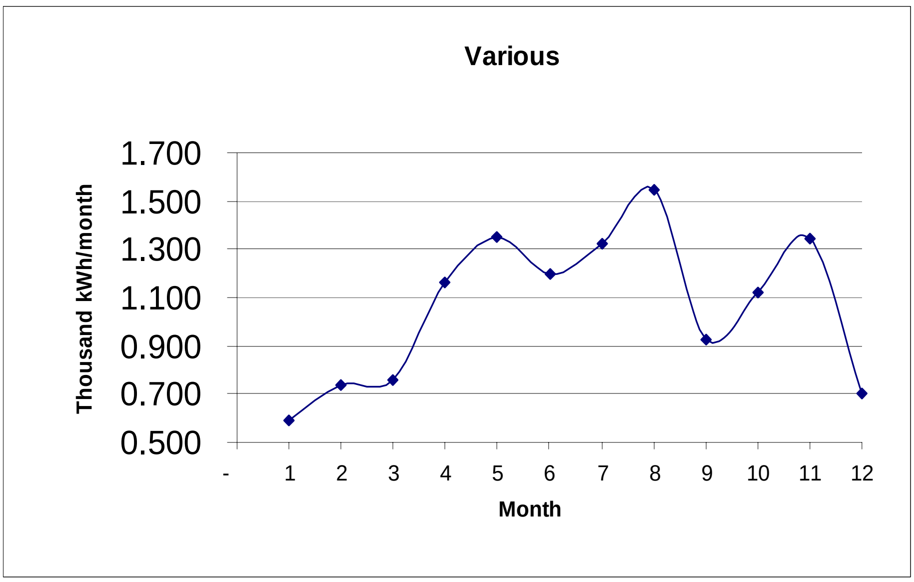

Electricity Consumption in Bakeries
Thousand kWh/month
2.7
2.5
2.2
2.0
1.7
1.5
1.2
- 1 2 3 4 5 6 7 8 9 10 11 12
Month

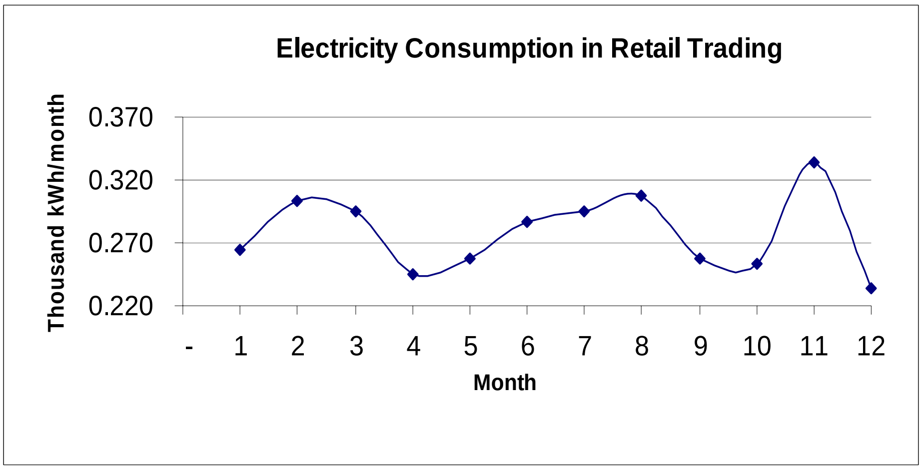

Electricity Consumption in Motor Intensive Entities
Thousand kWh/month
8.00
6.00
4.00
2.00
-
- 1 2 3 4 5 6 7 8 9 10 11 12
Month

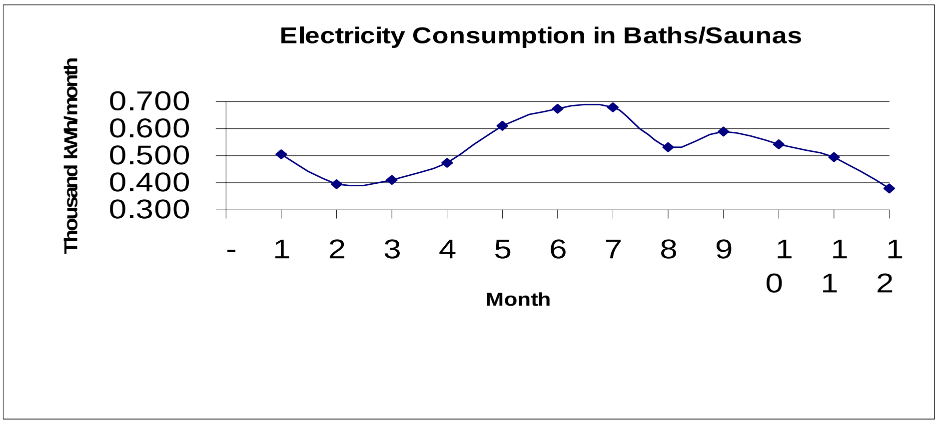

Equipment Intensive
Thousand kWh/month
2.00
1.80
1.60
1.40
1.20
1.00
-
1
2
3
4
5
6
7
8
9
10
11
12
Month

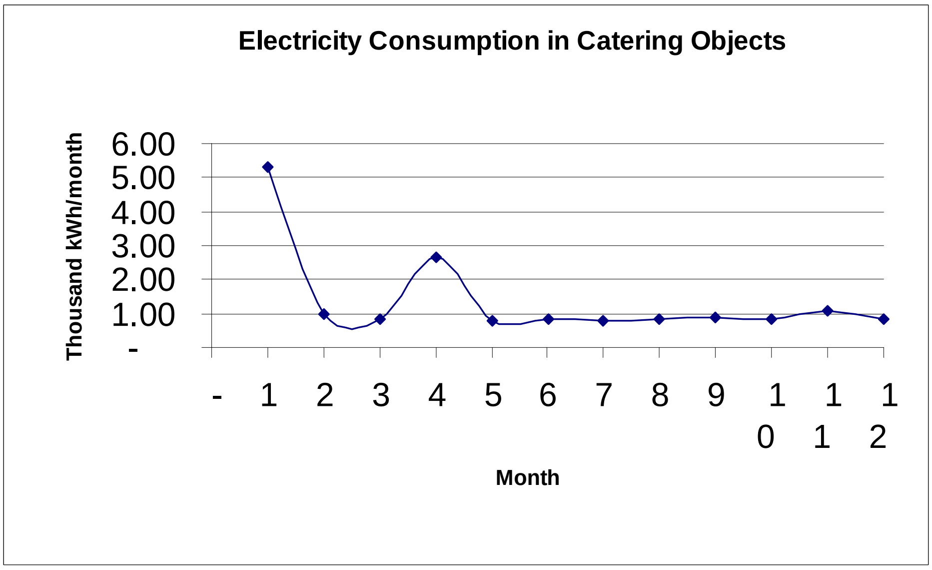

Electricity Consumption in Hotels
Thousand kWh/month
6.50
6.00
5.50
5.00
4.50
4.00
3.50
3.00
2.50
-
1
2
3
4
5
6
7
8
9
10
11
12
Month


Electricity Consumption in Health Care
Thousand kWh/month
5.00
4.00
3.00
2.00
1.00
-
-
1
2
3
4
5
6
7
8
9
10
11
12
Month


Various
Thousand kWh/month
1.700
1.500
1.300
1.100
0.900
0.700
0.500
-
1
2
3
4
5
6
7
8
9
10
11
12
Month


Electricity Consumption in Retail Trading
Thousand kWh/month
0.370
0.320
0.270
0.220
-
1
2
3
4
5
6
7
8
9
10
11
12
Month


Electricity Consumption in Baths/Saunas
Thousand kWh/month
0.700
0.600
0.500
0.400
0.300
-
1
2
3
4
5
6
7
8
9
10
11
12
Month


Electricity Consumption in Catering Objects
Thousand kWh/month
6.00
5.00
4.00
3.00
2.00
1.00
-
-
1
2
3
4
5
6
7
8
9
10
11
12
Month

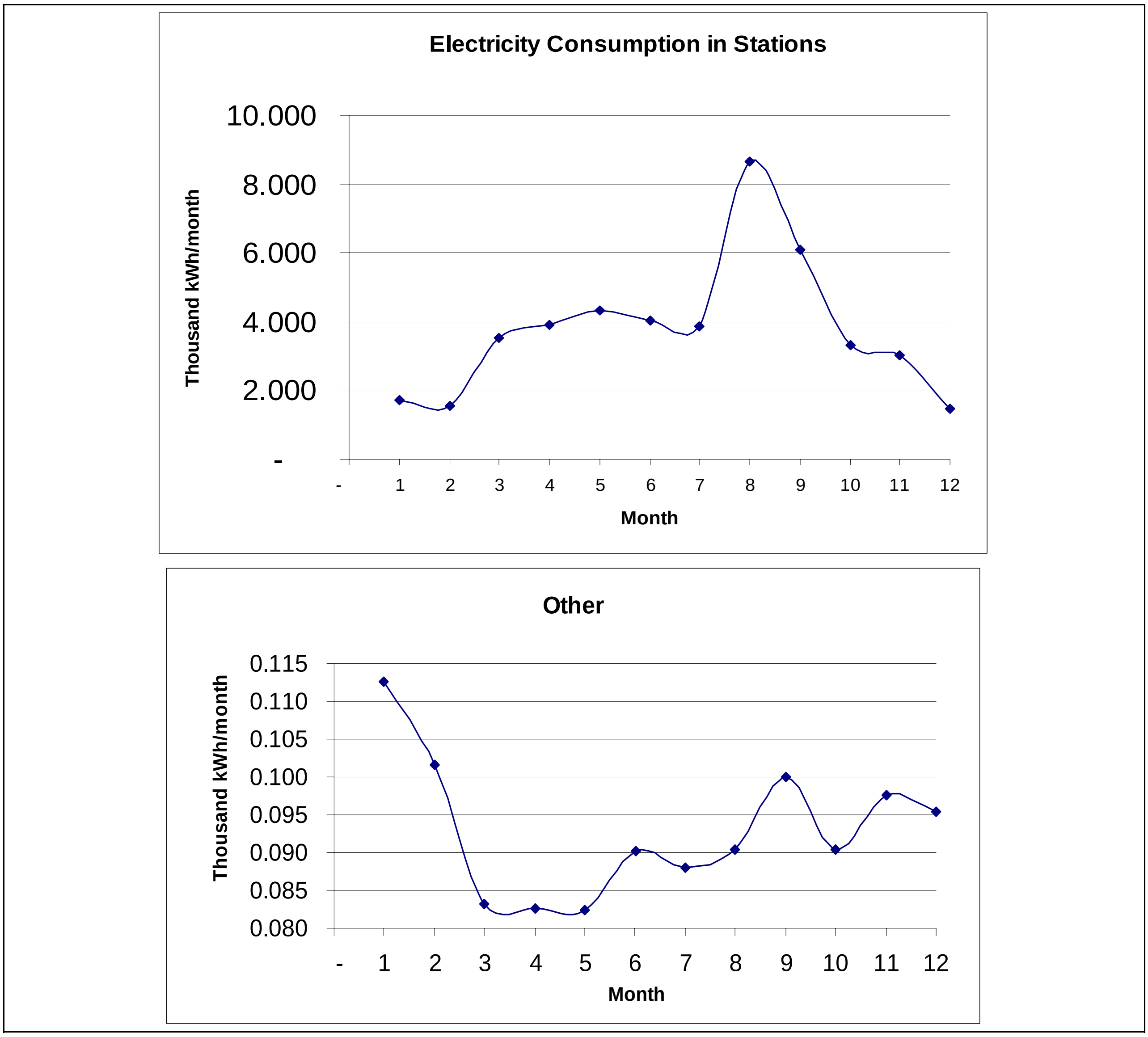


Figure 5.14. Annual consumption profiles of nonresidential consumer categories

The total savings potential has been evaluated on the basis of random analysis by consumer groups. The evaluation used the minimum energy audit data and experience and results of the realized projects reflecting current realistic pictures of characterizing different objects (Cf. Appendix 13).

Through results processing, a summary table of energy saving potential of final electricity consumption and different energy saving measures for all groups has been developed.

Calculations show that in Georgia there is a significant potential for energy saving. Particularly, through transformer points capacities and optimization of performance regimes, 4 million kWh of energy can be saved annually throughout the whole Georgia. This can be achieved specifically by a large-scale switch to energy effective bulbs in the external lighting of large cities— 6-7 million kWh; by means of loss reduction in drinking water supply systems— 30 million kWh, and by means of optimization of water pumping stations performance regimes— 40 kWh of energy. **The total energy saving potential in the non-residential sector is estimated at about 450 GWh annually.**

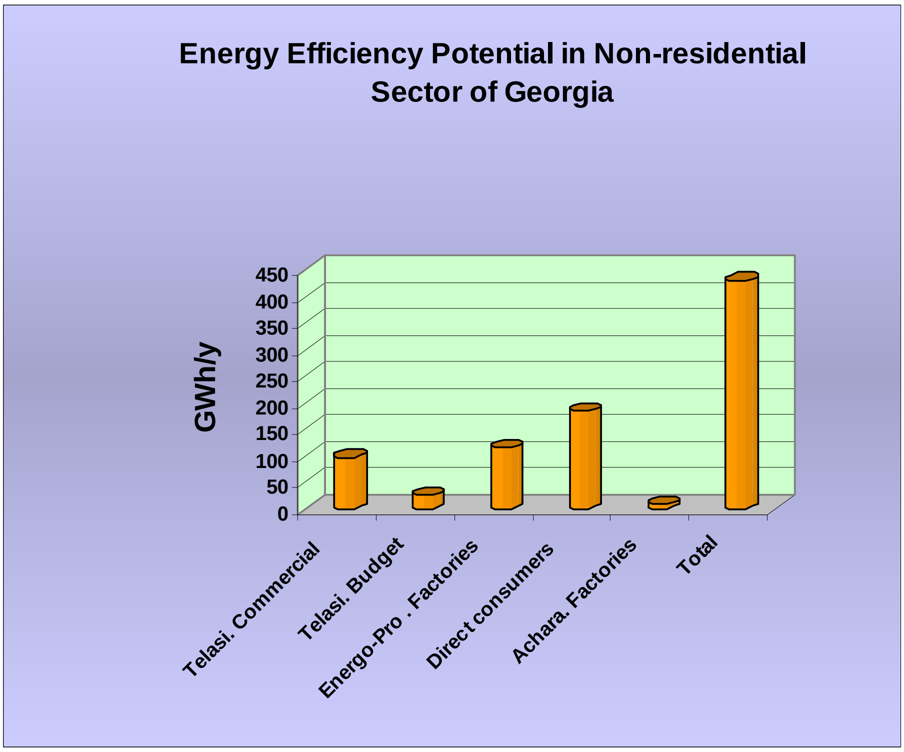


Figure 5.15. Breakdown of Energy Efficiency Potential in Georgia's Non-Residential Sector

A more detailed study of energy efficiency potential, implementation of new energy effective technologies and the practical realization of energy saving measures in energy generation transmission and consumption will significantly improve the energy supply conditions of Georgia, as well as the living conditions of each citizen.

5.3. Other Energy Efficiency Measures

5.3.1. Improvements in electricity and gas distribution

The commercial losses and electricity theft incurred by energy distribution companies are still high and are a major source of energy inefficiency. As a result, a considerable amount of energy is consumed illegally and does not properly contribute to economic turnover of the country. As can be seen from the information provided by distribution companies, the major share of these losses comes during winter season and consequently one can conclude that this stolen energy is mostly used for heating purposes.

We are assuming that the energy that has been used in avoidance of billing and collection is not usefully consumed for the economy and thus we attribute this energy to losses.

We estimate that the commercial losses can be cost effectively reduced down to 6% of total power purchase in Telasi and down to 10% power purchase in Energo-Pro. Our estimate is based on past experience of development in Telasi and UEDC and takes into account the differences in the network of Telasi, which is urban and Energo-Pro, which is rural to a great extent.

Table 5.10 summarizes the potential energy savings due to reduction in commercial losses.

	Power Purchase	Technica Losses	Billing	Comm. losses	Comm. losses %	Target Comm. losses	Estimated saving
Telasi	**1,955.4**	**242.5**	**1,398.8**	**314.1**	**16.1%**	**6.0%**	**197**
Energo-Pro	**2,394.0**	**358.4**	**1,468.1**	**567.5**	**23.7%**	**10.0%**	**328**
Total Saving							**525**

Table 5.10. Commercial losses in electricity distribution companies and the potential of energy recovery.

5.3.2. Introduction of Efficient Wood Stoves

On averagae, wood stoves used in Georgia have the typical efficiency of 35-40%. This means that 60-65% of the energy obtained by burning the wood gets lost to the atmosphere. Making the stoves efficient means to make a better use of this energy and leaves more heat of exhaust gases either in the stove itself or with the heated object, for example, the kettle. Efficient stoves typically can have the efficiency of up to 70-80%. There are many designs of efficient stoves used over the world. Below, we show one of the principles of operation of an efficient wood stove:

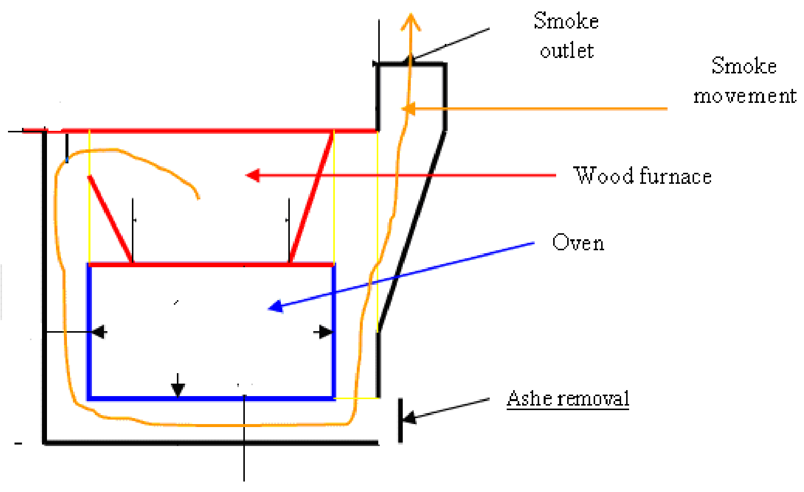


Figure 5.16. An Example of how an efficient wood stove operates

Currently under the USAID Rural Energy Program, Winrock International is promoting the use of energy efficient stoves in rural communities.

Chapter 6
Assessment of Energy Efficiency Measures

6.1. Classification of Energy Efficiency Measures and Criteria for Decision Making

Different approaches can be taken while evaluating the potential of energy conservation. Consequently and in order to eliminate the possibility of misunderstanding we define different levels of efficiency potential:

- *Technical Energy Efficiency Potential* – the effect of full implementation of a certain energy efficiency measure without reference to its costs and the time needed for full implementation
- *Economic Energy Efficiency Potential* – the sum of economically feasible, cost effective measures providing energy conservation
- *Realistic Energy Efficiency Potential* – the potential from implementation of energy efficiency measures, taking into account a realistic penetration rate based on awareness and preparedness of stakeholders.

While analyzing the energy efficiency potential we need to differentiate the consumer level from the level of the state. Indeed the economic potential of certain energy efficiency measures differs for consumers and for the state by the amount of taxes levied by the state and by the profit of service providers or equipment retailers; the economic potential can also be different because of the economy of scale, if some measure is implemented by the state entity on a large scale. Thus certain measures that may not be economical for a particular customer may be economical for the country as a whole, and this is where tax benefits and other state incentives or subsidies have to be applied in order to transfer these benefits to the consumers.

Energy efficiency measures can differ significantly by their costs. Thus it is appropriate to differentiate them as: No-cost, Low-cost and High-cost measures. These measures require a different level and type of promotion, organization and financing for their implementation. The examples of no-cost measures are a change in energy consumption habits or the simplest weatherization activities; an information campaign and simple information about appropriate materials and methods is sufficient for this case. Examples of low-cost measures are incandescent bulb replacement with efficient compact fluorescent bulbs, and more substantial weatherization (that may require some external service to customers). High-cost energy efficiency measures like replacement of window frames or replacement of old electric equipment and appliances can be quite cost effective, but still will be harder to implement due to financing barriers.

For an energy efficiency measure to be attractive for a consumer it must have a proven high profitability. Table 6.1, below, presents estimates of discount rates needed to stimulate adoption of energy efficiency measures for particular stakeholders.

Needed Discount Rate (%)	
Governments	**4-12%**
World bank	**10%**
Public Utility (USA, Sweden)	**6-8%**
Public Utility (Brazil, Thailand)	**10-12%**
Industry	**15-20%**
Residential households	**35-70%**

Table 6.1. Discount rates needed to stimulate action of different stakeholders***;***
Source: Integrated Resource Planning – UNEP 1997.

The table shows that for residential consumers, the typical required return on investment is much higher than for industrial consumers, government or international finance institutions.

In contrast to the simplicity of economic motives for a particular energy consumer, the range of factors and criteria to be taken into account by governments while dealing with energy efficiency is much wider than that for a particular consumer. Factors that should have a motivational effect on governments and trigger their activity to pursue energy efficiency include:

- the effect on a country's energy security and energy independence,
- the effect on the external trade balance,
- the potential to address social and economic development issues, particularly to affect tariffs,
- effects on budget spending, and
- environmental considerations.

The state decision to promote or subsidize certain energy efficiency measures may be based on one or more of the above factors. At the same time, the state policy in energy efficiency should be formulated with the account of all these issues and harmonized with state policies in other spheres including economic policy, state security policy, social policy, environmental policy, etc.

6.2. Assessment of Energy Efficiency Measures

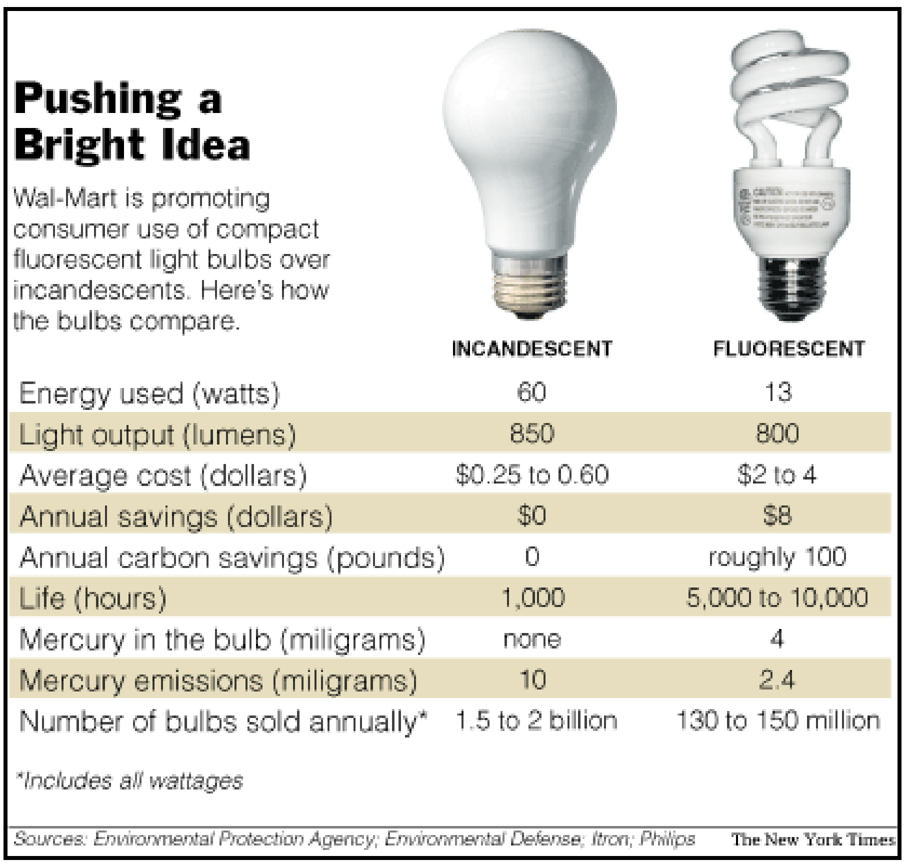
The Example of Bulb Replacement

In this section we will try to present the assessment of a concrete energy efficiency measure at micro (consumer) and macro (country) level. Various outcomes from replacing incandescent bulbs with efficient compact fluorescent bulbs in the residential sector of Georgia will be discussed in detail.

6.2.1 Background Information and Main Parameters

The replacement of incandescent bulbs with compact fluorescent bulbs is the single easiest and probably the most profitable measure to be taken for improvement of efficiency in energy usage in Georgia. Currently the spread of energy efficient fluorescent bulbs is high, limited to commercial entities; while in households, fluorescent bulbs are present in a minority of houses. Although many people know that fluorescent bulbs are more economical, their higher price and a lack of adequate information on their returns hamper the spread of fluorescent bulbs within the consumer population.

According to vendor information, quality fluorescent bulbs consume about 20% of the energy use of incandescent bulbs, providing equivalent light. The average rated laboratory lifetime of incandescent light bulbs is about 750–1000 hours (usually defined as the time it takes half of a given set of lamps to fail under test conditions). Based on rated lifetime, it would take at least 6-11 incandescent bulbs to last as long as one compact fluorescent, which have an average lifetime between 11,250 and 15,000 hours.[1] More realistic information is provided by Wal-Mart, which is conducting an information campaign for promotion of fluorescent bulbs.


Pushing a Bright Idea

Wal-Mart is promoting consumer use of compact fluorescent light bulbs over incandescents. Here's how the bulbs compare.

	INCANDESCENT	FLUORESCENT
Energy used (watts)	60	13
Light output (lumens)	850	800
Average cost (dollars)	$0.25 to 0.60	$2 to 4
Annual savings (dollars)	$0	$8
Annual carbon savings (pounds)	0	roughly 100
Life (hours)	1,000	5,000 to 10,000
Mercury in the bulb (miligrams)	none	4
Mercury emissions (miligrams)	10	2.4
Number of bulbs sold annually*	1.5 to 2 billion	130 to 150 million

*Includes all wattages

Sources: Environmental Protection Agency; Environmental Defense; Itron; Philips — The New York Times

Figure 6.1. Comparison of Fluorescent and Incandescent Bulb Performance; Source: New York Times

[1] EERE Consumer's Guide: Compact Fluorescent Lamps. U.S. Department of Energy. Retrieved on 2007-04-23.

Currently there are two types of fluorescent bulbs on sale in Georgia: the cheaper ones cost around 6-7 Lari and are typically manufactured in China or Turkey. More expensive bulbs of European production cost around 15-24 Lari. The difference in quality of these bulbs is not well studied or documented, and the consumers, who are not certain about additional benefits of the more expensive bulbs, in most cases prefer to buy the cheaper ones.[2] Thus for our calculation we use cheaper fluorescent and incandescent bulbs that are in practice more frequently being sold in the stores.

In the Table 6.2, we present the characteristics of incandescent and fluorescent bulbs to be used in our evaluation of the energy saving potential of bulb replacement.

	Incandescent	**Compact Fluorescent**
Lifetime (hours)	**500h**	**4000h**
Comparison of energy consumption	**100%**	**25%**
Price (GEL)	**0.5**	**7**
Import price (USD)	**$0.2**	**$3**
Cost of installation (GEL)	**0.5**	**0.5**
Percentage currently installed	**80%**	**20%**
Share in lighting load	**94%**	**6%**
Savings after replacing incandescent bulbs with fluorescent	**70% of current electricity consumption for lighting**	

Table 6.2. Basic characteristics of incandescent and fluorescent light bulbs and the study assumptions employed for the comparative evaluation.

Experience shows that actual bulb performance for these cheaper bulbs is often worse than shown on their packages. Thus we downgraded the parameters for our calculations, i.e. instead of a typical 10-12 thousand hours of rated lifetime, we used 4 thousand hours. Further, the power consumption of the bulbs is estimated at 25% of equivalent incandescent bulbs rather then 20% as shown by their vendors.

[2] It would be a useful task for consumer associations or special state entities to investigate and publish the relative benefit of different kind of electric equipment including different bulbs

World Experience for Georgia has made a brief survey of the bulbs' distribution among the households in Tbilisi and the results indicate that number of fluorescent bulbs is no more than 10-15 percent of the total number of lighting bulbs in use in Tbilisi. In the regions this number is supposedly even lower, at least this was observed during several trips made to the Pasanauri-Gudauri region and to West Georgia. Our estimate of the total share of energy efficient bulbs in use is approximately 20%. A simple calculation shows that with these usage estimates, the share of fluorescent bulbs in the total lighting load is less than 6% and that total energy saving potential of bulb replacement is around 70% of the total lighting load considered.

There are incandescent and fluorescent bulbs of different capacity in use and for sale. For the purpose of this study, several assumptions on the distribution of the bulbs of different capacity were made:

Existing Incandescent			Replacement Fluorescent		
Capacity (Watts)	40	25%	Capacity (Watts)	9	25%
	60	25%		15	14%
	75	18%		20	39%
	100	30%		25	22%
	>=150	2%			
Average capacity (W)	71.5		Replacement capacity (W)	17.63	

Table 6.3. Assumed capacity distribution of existing incandescent bulbs and corresponding replacement fluorescent bulbs

6.3. Economic Assessment at the Consumer Level

For the economic assessment of bulb replacement, the figures from Tables 6.2 and 6.3 are used. Two options are evaluated for consumers: 1) keeping their existing incandenscent bulbs and replacing them at incandescent bulb lifetime intervals 2) replacing their existing incandescent bulbs with compact flourescent bulbs. Additional replacement expenses in both cases is estimated at 0.5 Lari (this is the cost of going to shop and coming back and replacing the bulb). Costs of lighting are calculated based on the average tariff 16 tetri/kWh.

Comparing these two options, the higher capital cost of replacing an incandescent bulb with a flourescent bulb is compared to the foregone costs of lighting and replacing incandescent bulbs (cf. Appendix 14.), as incandescent bulbs use more energy and burn out more quickly. The results of such comparison are presented in Figure 6.2.

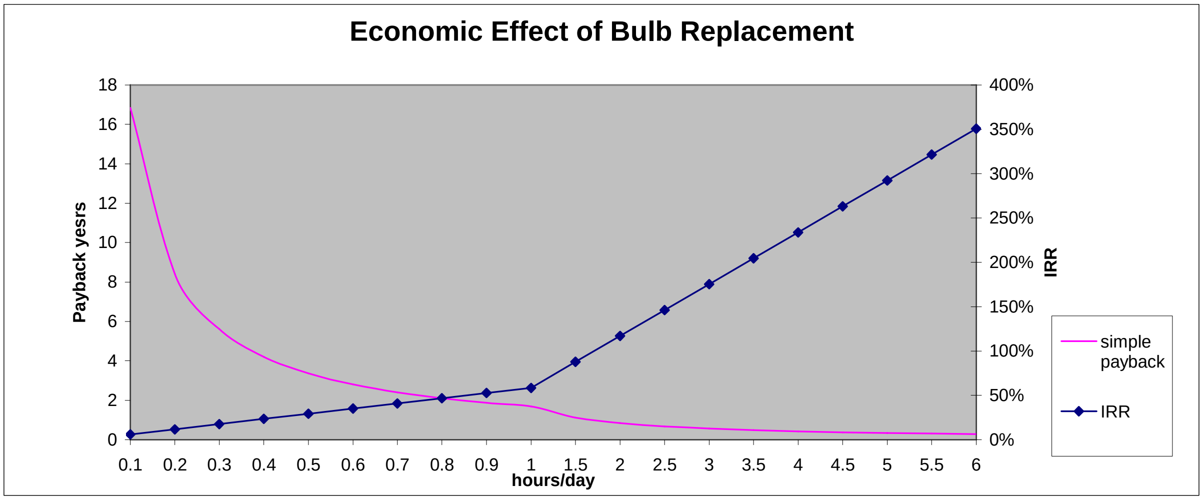


Figure 6.2. Payback period and internal rate of return (IRR) for bulb replacement

The economic decisions of residential consumers are still being mostly made based on simple payback criteria rather than the internal rate of return; thus we have shown both of these parameters for various lighting durations of the bulb to be replaced. Simple payback takes the cost of the investment in switching to fluorescent light bulbs, divided by the energy savings accrued. As Table 6.4 illustrates, a consumer who leaves a light on 4 hours a day will recoup their investment installing a fluorescent light bulb in less than half a year, using a simple payback evaluation.

Unlike the simple payback evaluation, the Internal Rate of Return takes into account that payoffs generated in the near future are worth more than payoffs garnered in the distant future, and discounts accordingly. The rate at which the costs and payoffs add up to 0 is the internal rate of return; higher rates or return generally indicate the worthiness of the investment. For both evaluation methods, the profitability of bulb replacement obviously depends on the actual usage of that bulb. The more the light is used during each day, the more savings are realized.

As both Figure 6.2 and Table 6.4 show, replacing incandescent bulbs is a highly cost-effective measure for almost all active bulbs; even bulbs left on for as little as 25 minutes a day have an internal rate of return of over 20%.

Lighting Time hours/day	**Internal Rate of Return**	**Simple Payback (years)**
0.4	**23.4%**	**4.2**
4	**234%**	**0.42**

Table 6.4. The financial merits of consumers investing in fluorescent light bulbs using the Internal Rate of Return and simple payback evaluation criteria; merits are evaluated for consumers leaving their lights on for 25 minutes a day and 4 hours a day.

6.4 Economic Assessment at the Macro Level

6.4.1 Transmission and Distribution Losses

The benefits of energy saving extend beyond the reductions calculated inside a consumer's residence. For each 1kWh put on the grid for delivery to consumers, 4.41% of that kilowatt-hour is lost in transmission and 12.4% (for Telasi) is lost in the distribution's network.[3] Thus, a simple calculation shows,

1 kWh of energy saved is equivalent to 1.19kWh of energy generated.

6.4.2 Effect on External Energy Dependence

An important benefit brought by energy efficiency and energy saving is the reduced dependence on external energy imports. This benefit has to be properly analyzed and quantified. As explained in Chapter 4 (Energy Balances), for Georgia the energy dependence has a profound seasonal character and thus seasonal influence should be included in the evaluation of any proposed energy efficiency measure.

The seasonal pattern of electricity usage for lighting is given by the chart below.

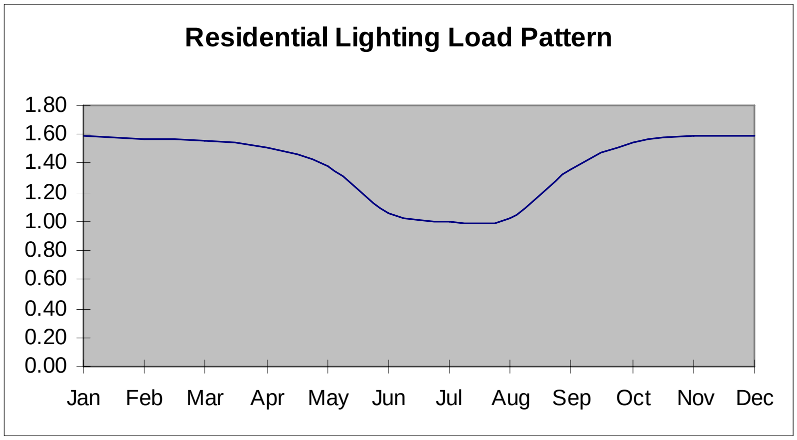


Figure 6.3. Seasonal dependence of residential lighting usage

This curve shows the change of lighting consumption over the year, relative to July (taken as 1). It was derived by taking into account the seasonal variation of daytime duration, ambient luminance intensity, seasonal variation of weather conditions (cloudy and rainy days) and population migration due to holiday season in summer (cf. Appendix 15).

In recent years, Georgia has been reducing electricity imports. This has shifted all external dependence of electricity supply from import of both electricity and natural gas for thermal generation, to only gas import for thermal generation. Accordingly the external dependence of

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[3] GNERC resolution #17 of May 11 2006, "On Normative Electric Energy Losses in the Network of Georgian Power System"

electricity supply is measured by the amount of electricity generated in thermal plants (burning imported gas) and was parameterized by Electric Energy Dependence Seasonal Index ESDIE ((Cf. Chapter 4, Fig. 4.22). Influence on energy dependence can be measured by the change of ESDIE due to certain measures.

For the sake of comparison of different policy options, we compare the effects of energy savings from bulb replacement on energy dependence, and contrast this with the effects of adding the same amount of energy through new hydro-generation (Cf. Appendix 16.).

As an example of hydropower input we use the 2006 generation profile of Lajanuri hydropower plant. Figure 6.4 shows the comparison of normalized curves for energy saving and hydro generation.

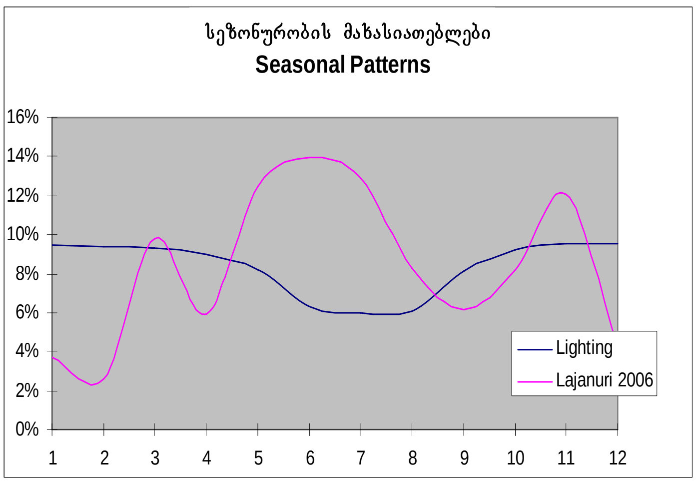


Figure 6.4. Normalized seasonal patterns of hydro-generation and savings in lighting

The typical hydro plant generation pattern shows a maximum in summer and minimum in winter (except the plants with annual regulation capacity like Khrami 1). On the other hand, energy saving potential shows its maximum in the winter period where the maximum consumption happens.[4] Due to their different characteristic profiles, lighting energy saving and hydro generation of the same amount of energy are capable of replacing different volumes of thermal generation as calculated in Appendix 16, and seen from Figure 6.5.

[4] A more rigorous approach would be to compare the lighting curve with reservoir and run of the river plant generation profile separately. However this goes beyond the scope of current study.

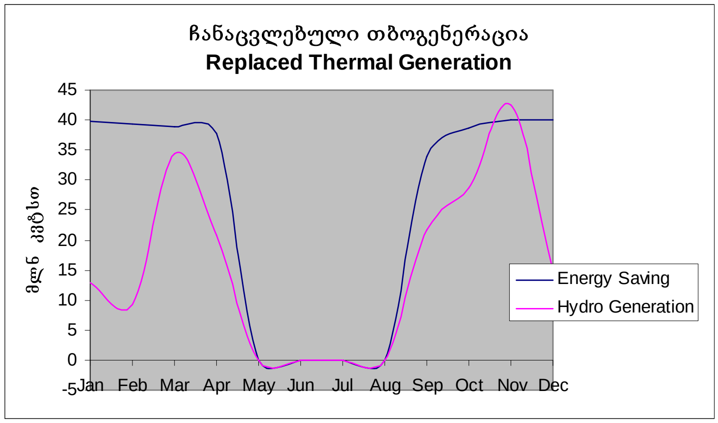


Figure 6.5. Potential for replacement of thermal power by energy saving and equivalent amount of hydro-generation

Although our energy balance computations are comparing a set amount of energy consumption reduced by bulb replacement versus adding that same set amount of energy through hydro generation, the effects differ for two main reasons. Firstly, the saving of 1 kWh resets the need for generation of 1.19 kWh, as mentioned previously. Secondly, the saving potential is concentrated more in the winter period while hydropower potential is concentrated more in the summer, when thermal plants do not operate and where there is already an excess of hydropower. **Thus, the Electric Energy Dependence Seasonal Index is better reduced through energy saving than through equivalent hydropower generation.**

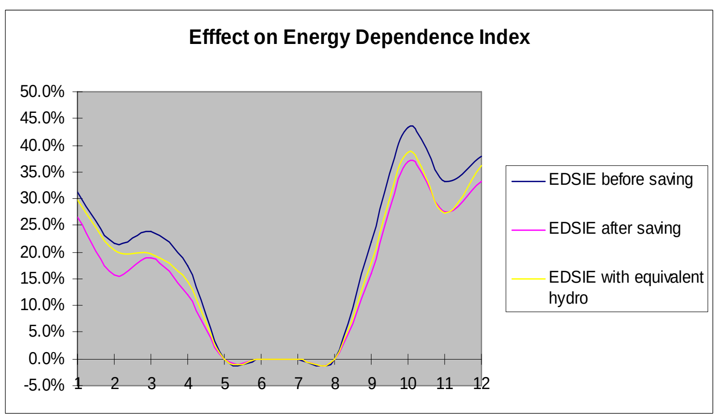


Figure 6.6 Effects of energy saving and equivalent hydro-generation on EDSIE

The volume of replaced thermal generation by energy saving, and additional hydro generation of the same amount of electricity in our example, is given in Table 6.5.

	Energy (GWh)	Replaced Thermal Energy (GWh)
Energy Saving	**353**	**308**
Equivalent Hydro	**353**	**185**

Table 6.5. A comparison of two strategies for reducing thermal energy generation: reducing 353 GWh of consumption by installing fluorescent light bulbs, and increasing hydropower generation by that same amount.

6.4.3 The Effect of Energy Saving on the Average Energy Tariff

Due to displacement of thermal power with energy saving as discussed in the previous section, the generation mix changes by decreasing the share of expensive thermal power and increasing the share of cheaper hydropower. Correspondingly the average seasonal tariff of electric energy gets smaller as can be seen from Figure 6.7.

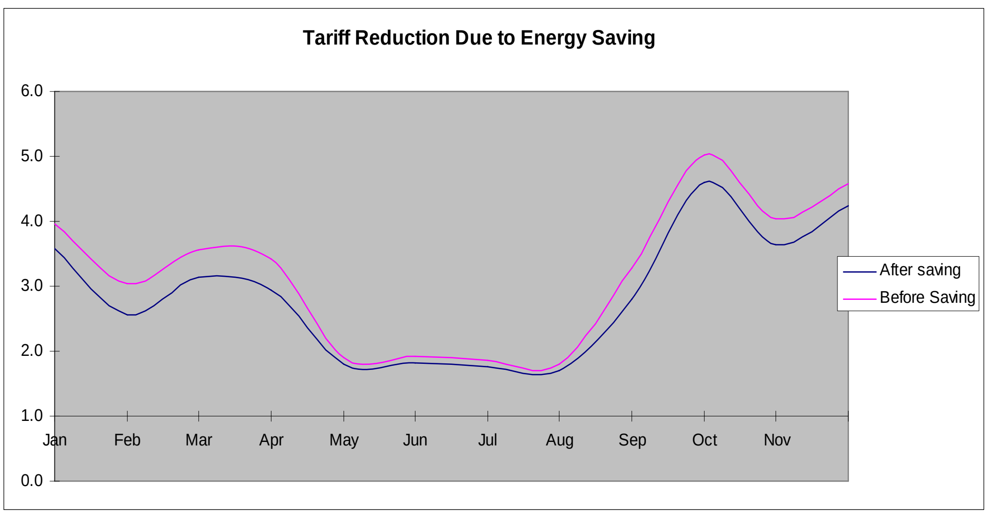


Figure 6.7. Effect of energy saving on average seasonal tariff of generation

Effective tariff reduction varies from 0.009 tetri per kilowatt hour (t/kWh) in summer to as much as 0.48 t/kWh in winter months (cf. Appendix 17.). It is assumed that energy saving will displace the most expensive generation which is the new gas turbine in Gardabani in winter period and one of the more expensive hydro-plants in summer. However, a more rigorous analysis is needed in order to develop a more realistic scenario where the gas turbine will be still partially operating and a proper account of its capacity cost will be made.

6.4.4 Cost of Energy Saving

The need for electricity service can be satisfied in two ways: by adding more generation to the grid or by increasing the efficiency of energy use while providing the same level of end use. Thus both of these methods – additional energy generation and energy saving – serve the same purpose of satisfying the needs of the economy and population in the end use. In making the policy decision on sector development, the costs of these two options should be compared.

In order to estimate the cost of energy saved through replacement of incandescent bulbs we use the figures from Table 6.2.

For reference, we chose the cheaper fluorescent bulb with an average capacity of 71.5W,[5] shorter lifetime and a typical lighting duration of 500 hours a year. In such a case, the bulb is operating for 8 years and saves about 215 kWh of electric energy as well as 1 GEL additional investment each year. We calculate the cost of saved energy as a net discounted investment over the kilowatt hour of saved energy; In our calculations we use the **discount rate of 12%,** which is lower than commercially available financing rates, but at the same time represents an expectation of cheaper financing from international financial institutions or government, if the latter decides to provide incentives for energy efficiency and energy saving. The result is subsequently summarized.

[5] This is not the capacity of the actual bulb but rather represents the average expected capacity of many replacement bulbs

Cost of Electricity Saved in 8 Years				
Investment	7.5	GEL		
Annual lighting duration	500	hours	Investment/saving	
Lifecycle	4000	hours	Year	GEL
Operation life	8	years	1	-6.5
Discount rate	12%		2	1
Investment saved	8	GEL	3	1
Electricity saved over lifetime	215.5	kWh	4	1
Net Present Value of investment costs/savings	(1.73)	GEL	5	1
Cost of saved electricity			6	1
Simple	**(0.23)**	Tetri/kWh	7	1
Discounted	**0.8**	Tetri/kWh	8	1

Table 6.6. Cost of saved energy

One can see that the cost of a saved kilowatt hour from bulb replacement is 0.8 Tetri/kWh. This number should be compared with the cost of new hydropower generation estimated at 7-9 Tetri/kWh. **Thus the cost of saving energy is about 10 times less than the cost of additional generation of the same amount of energy.** We expect that a more rigorous analysis with the account of construction time, environmental costs and taxes will significantly increase this ratio.

6.4.5. Contribution to External Trade Balance and Budget Spending

The external trade balance of Georgia in 2006 is negative: -2385.2 million USD.[6] The import of goods exceeds the export almost four times. Such a large negative balance raises some concerns over the long term sustainability of the country's development. The share of natural gas import in this negative trade balance is more than 300 million USD. Replacement of incandescent bulbs with fluorescent bulbs has a potential to offset some of this amount. To investigate this potential we have made several basic assumptions (cf. Appendix 18).

Assuming the average daily lighting period of 3 hours and a 4 year lifetime we derive that the number of bulbs to be replaced every four years is about 6 million. Table 6.7 summarizes the results of our calculation.

[6] Statistics Department of Georgia http://statistics.ge/main.php?pform=92&plang=2

Highest Marginal price of imported gas ($/kcm)	$235 /kcm
Gas specific consumption (cm/kWh)	0.3
Lighting duration (h/day)	3
Bulb lifecycle (years)	4
Number of bulbs to be replaced	6,010,000
Import price of a bulb	3
Total cost of import ($mln)	18.03
Electricity Saving GWh	350
Replaced Energy of thermal plants (GWh)	308
Volume of replaced gas (mcm/y)	110.4
Cost of replaced gas (USD million /y)	26.0
Net Present Value (NPV) of bulb replacement *for country ($ million)*	**54.3**
Internal Rate of Return (IRR) of replacement project	**140%**

Table 6.7. Contribution of bulb replacement project to external trade balance

Thus, within the assumptions given above, **the replacement of 6 million bulbs provides 85.6 million USD positive contribution to the external trade balance** over the period of 5 years, with discounted present value of 54.3 million USD (at 12% discount rate).

For comparison, the hydro-plant of comparable output would take the same period (5 years) to build without providing any positive cash flow.

Due to the increase in gas prices it became necessary to provide a state loan to energy companies in 2006 - 2007, which would help them maintain the tariffs at existing levels. The situation in the current year is not clear yet; however, if we assume that the need for budget subsidization of tariffs remains, then it is not hard to see that bulb replacement and corresponding reduction of gas imports can substantially offset this need. In other words, **the cost-effective spending by electricity consumers will at the same time reduce the need for budget subsidization by $26 million every year.**

6.4.6. Carbon Emissions Reduction

The Ministry of Environment and Natural Resources (MoENR) of Georgia is the “Clean Development Mechanism Designated National Authority” under the Kyoto Protocol of United Nations Framework Convention on Climate Change. The MoENR has calculated the baseline

CO_2 emission factor for Georgia in compliance with Clean Development Mechanism methodology.[7] The Baseline Emission Factor is:

$$EF_{2006} = 0379 \text{ tons } CO_2/MWh$$

The programmatic approach to the Clean Development Mechanisms (CDM) being currently developed by the World Bank Carbon Finance Unit can potentially attract additional CDM financing to the bulb replacement program.[8]

This can be used to evaluate the amount of CO_2 emissions that could be offset by replacement of incandescent lamps with compact fluorescent bulbs. Indeed the simple calculation shows that saving of 350 GWh would result in carbon emission reduction of energy saving of 132 thousand tons of CO_2 and generate a revenue of $1.32 million through carbon credit trading.

6.4.7 Penetration Rates

The rate of replacement of incandescent bulbs by compact fluorescent bulbs strongly depends on the information available to customers. Currently there is no targeted information delivery to consumers on this issue. Figures 6.8 and 6.9 show the estimate of the rate of bulb replacement depending on the level of awareness of customers as calculated in Appendix 19.

Generally, the internal rate of return for investments is not an evaluation criterion the Georgian public employs when making purchasing decisions. A more familiar evaluative method is the simple payback period; so, for the evaluation of consumer behavior we use the latter. We assume that the one year payback is a figure that would stimulate a significant number of people to make their choice in favor of fluorescent bulbs during one year. This corresponds to two-hour daily duration of lighting and 340% rate of return for the 8 year fluorescent bulb lifetime. If properly informed, in one year, 50% of people who use incandescent lamps for 2 hours a day, would replace their incandescent bulbs with fluorescent ones. We also assume that those who use some of the incandescent lamps for less then 12 minutes a day (corresponding to payback period of 10 years) will not bother to replace those bulbs, although the rate of return for the lifetime of fluorescent bulb will be 34%. At the other spectrum of use are the incandescent lights used for more than 4.1 hours a day, which corresponds to half a year payback and we assume that 95% of such lights would be replaced during a year.

The charts in Figures 6.8-6.9 shows how the distribution of bulbs in the population would change in four years depending on the level of information available to consumers.

[7] http://www.climatechange.telenet.ge/!_PIC_DOC_!/EF_English.pdf
[8] Programmatic CDM-Introduction, Klaus Oppermann – WB/ CF Presentation May, 2006Washington DC

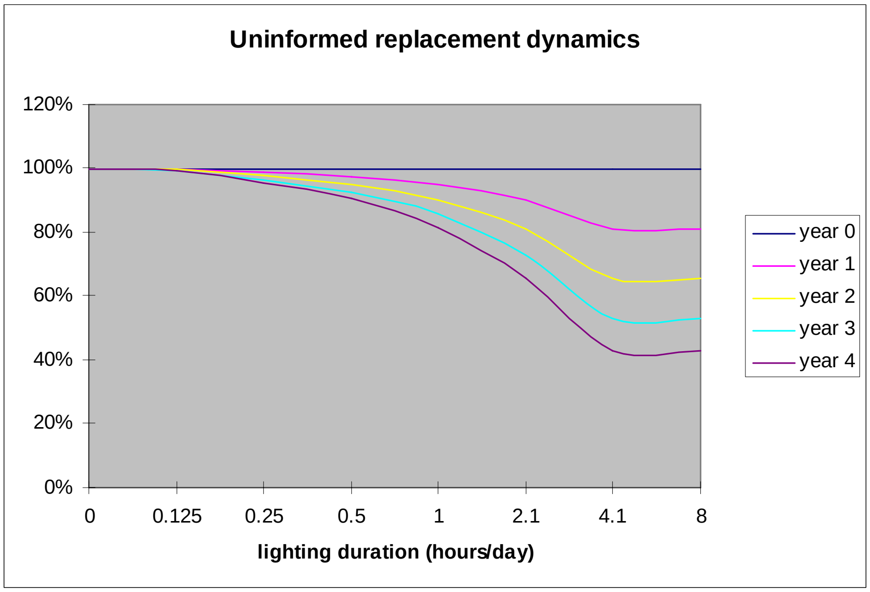


Figure 6.8. The percentage of remaining incandescent bulbs, in absence of a comprehensive information campaign explaining the benefits of investing in fluorescent lighting.

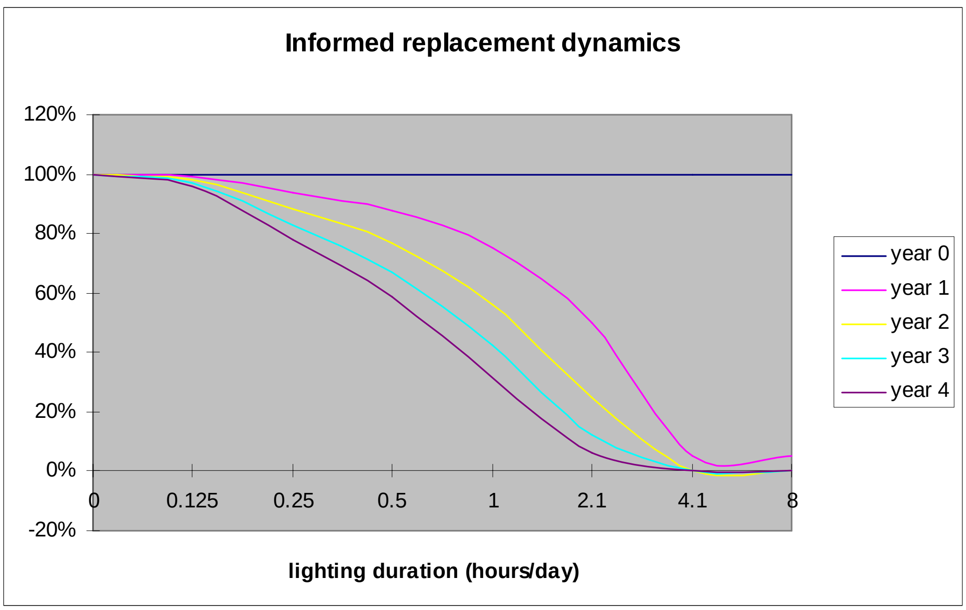


Figure 6.9. The percentage of remaining incandescent bulbs in case of effective information campaign.

The curves show the percentage of remaining incandescent bulbs as a function of lighting duration over the four year period. Figure 6.10 shows the percentages of the total potential saving over these four years in both cases.

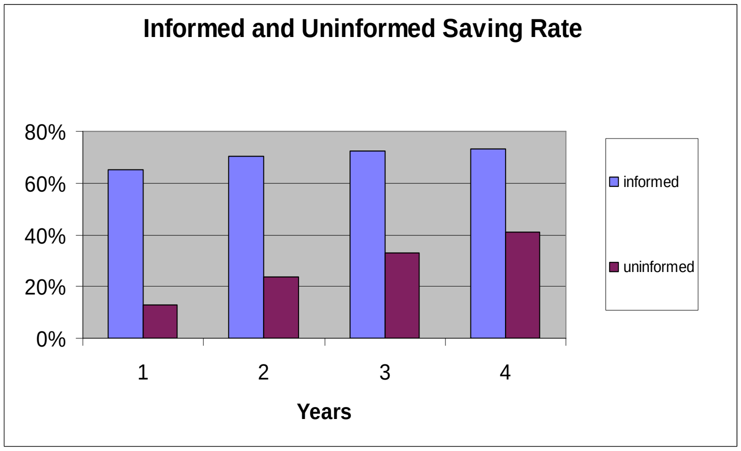


Figure 6.10. Percentage of efficiency potential used through bulb replacement depending on if a comprehensive information campaign is employed

This simple estimate shows that over the four year period, the cumulative effect in total energy saving is more then 2.5 times higher with an information campaign than without.

6.5 Conclusions

Bulb replacement is a low cost energy efficiency measure that is highly profitable in a great majority of cases. Replacement by customers does not require additional subsidies or benefits to make the result economically more attractive. The state can play a positive role by properly informing the consumers of the benefits they can derive from such a measure in a timely fashion.

The analysis above can be refined further to incorporate more technical and economic details; for instance, there may be a need for additional compensation of reactive power from the fluorescent bulbs needed in high voltage substations that can slightly affect the economics of bulb replacement on a macro level. On the other hand, environmental consequences can add to the economic efficiency of this measure. Analysis does not also take into account the shortening of a bulb lifetime due to the poor quality of electricity supply. Thermal generation may be needed for system stability as well as for energy, and it may not be possible to fully displace thermal energy with bulb replacement as estimated here.

However even with this first simple evaluation, the benefits of bulb replacement at the customer level and at the state level are obvious. Adequate steps should be taken in order to timely utilize this resource of saving.

Chapter 7
Conclusions and Recommendations

Improvement of gas and electricity distribution systems still remains a major task for developing energy efficiency in Georgia. The following recommendations will assist Georgia in its pursuit of energy efficiency.

I. There are a number of energy conservation measures that require more action on behalf of energy consumers and the government.

- For consumers direct economic benefits can be achieved through no cost, low cost or relatively costly but highly cost effective energy efficiency and conservation measures.

- For the Government there is a whole range of reasons that justify more action for implementing energy efficiency. These reasons cover:
  - compliance with the country's main development goals of accession to European and Euro-Atlantic structures;
  - improvement of energy security, and as a result— national security, of the country;
  - improvement in the competitive position of the Georgian Economy and quality of lives of citizens;
  - savings in budget spending and a positive contribution to the country's trade balance;
  - development of economic activity in the country;
  - reduced need for new generation; and
  - reduced impact on the environment.

II. The potential benefit to be obtained through energy conservation is high.

Up To 1 terawatt hour (TWh) of electricity, up to 250 cubic meters of natural gas and more than a million cubic meters of firewood can be saved just due to improvements in efficiency of energy consumption. In addition, there is a significant efficiency potential in energy generation and supply that needs to be further explored.

III. Energy efficiency potential can be realized through a set of concrete energy saving measures.

Summary of Energy Efficiency Measures

Table 7.1 below summarizes the main energy efficiency measures considered to have a high priority for improvement of energy efficiency in Georgia

Efficiency Measure	Individual Consumer		Government	
	Cost	**Action needed**	**Cost**	**Action needed**
Energy saving habits and practices	No cost	awareness	Low cost	Information campaign
Bulb replacement	Low cost	Awareness and minimal financing	Low cost	Information campaign
Weatherization	Low cost	Awareness and minimal financing	Low cost	Information campaign; Support in organization of specialized small businesses
Energy Efficient Stoves		Awareness and decision making	Low Cost	Promotion campaign, support of small business development
Energy Efficiency of budget entities			Medium cost	Replacement of windows and doors
Variable speed drives	Capital intensive	Decision making and financing	Low cost	Feasibility study, Creation of credit line
Construction standards and norms	N/A	N/A	Low cost	Feasibility study
Thermal insulation of existing buildings	Capital intensive			Feasibility study, Creation of credit line
Informing the consumers of thermal qualities of the new buildings	N/A	N/A	Low cost	Study of thermal qualities of the buildings under construction Introduction of construction

Table 7.1. Energy efficiency measures and actions to be implemented by individual consumers and the government

Utilities are not included in this table, however **the government needs to find the mechanisms of implementing energy efficiency measures through utility companies,** as it is done in many developed and developing countries. The first, most productive step is to encourage and support the distributors in further reducing their commercial losses.

IV. A number of low–cost, highly-effective measures can be launched in the short term without significant organizational measures, based on existing donor support and existing structures.

- An information campaign for the support and promotion of simple measures like bulb replacement can be launched soon, with minor expenses and without complex organizational measures.

- Consumers can be promptly informed about benefits and costs of certain low cost energy efficiency measures in order to enable them save the energy already in coming winter.

- A program of energy efficiency in all government-owned buildings including moving from incandescent to fluorescent lighting.

V. In order to make the energy efficiency measures possible and realize the potential of energy efficiency, the state needs to organize an appropriate legal and institutional framework.

- Develop and approve the Law on Energy Efficiency (with or without inclusion of renewable energy).

- Create a specially-designated authority to lead in the matters of energy efficiency (within the existing government structure or a new one).

- Develop an energy efficiency strategy of the country with clearly formulated targets and related economic development plans.

- Develop long term and short term energy efficiency plans.

- Expand and strengthen the activities of specialized Energy Efficiency Organizations like the Energy Efficiency Center and the Georgian Association of Energy Engineers.

- Encourage and support practical application of Clean Development Mechanism for energy efficiency and renewable energy projects.

- Support the research and development in the field of energy efficiency in order to support the activities in this sector with sound information and the analytical base.

- Develop the planning functionality to incorporate economic and technical factors in the country's development strategy.

- Develop energy efficiency educational and information programs.

VI. There are a number of issues of high importance to be studied outside of the current study's scope.

- The "Use of Tariff" policies for promotion of energy efficiency, including the economic feasibility of introducing
    - seasonal tariffs, and
    - daytime tariffs.

- The effect of daylight savings time on electricity consumption for lighting.

- Efficiency in electricity generation and transmission including:
    - implementation of cogeneration, combined cycle and distributed generation technologies, and
    - optimization of the regimes of power system operation.

- The potential for international trade and utilization of seasonal hydro potential in Georgia, including:
    - establishing regional cooperation for long term stability of energy exchange, and
    - promoting CO_2 cap-and-trade system in the region – to help develop hydro resources in the country.

These issues need to be incorporated in the long term master plan of Georgia's energy sector development.

These recommendations cover the first steps in the direction of improving energy efficiency in Georgia. A wide range of policy measures should be developed for further stages of improving the efficiency of energy use and "the quality of life aspects" of energy use for the society.

Memorandum of Understanding

Between the Government of Georgia and the Government of the Kingdom of Denmark on cooperation for the implementation of the Kyoto Protocol to the UN Framework Convention on Climate Change

The Government of Denmark, in particular the Ministry of Environment, Danish Environmental Protection Agency being the competent Danish authority for the purpose of this Memorandum, hereinafter referred as the Danish Party

and

The Government of Georgia, in particular the Ministry of Environment Protection and Natural Resources being the competent Georgian authority for the purpose of this Memorandum, hereinafter referred as the Georgian Party

Taking into consideration that both Parties are parties to the United Nations Framework Convention on Climate Change, (UNFCCC), and have ratified the Kyoto Protocol to that Convention.

Aiming to implement the provisions of Article 12 of the Kyoto Protocol and its underlying Decisions by the Conference of the Parties to UNFCCC serving as the meeting of the Parties to the Kyoto Protocol (COP/MOP) on the guidelines for its implementation, providing for the transfer from a Party not included, in Annex 1 of UNFCCC to a Party included in Annex 1 of Certified Emission Reductions (CER) accruing from Clean Development Mechanism (CDM) project activities to contribute to compliance with part of its quantified limitation and reduction commitments under Article 3 of the Kyoto Protocol,

Underlining the importance of the domestic policies and measures to meet commitments under the Kyoto Protocol and the supplementary role of the activities under its Article 12,

Accepting any further Guidelines on Article 12 of the Kyoto Protocol to be developed by CoP/MoP, and also taking into account any future decisions by COP/MOP relevant for the prompt and effective implementation of CDM,

Anticipating the entry into force of the Kyoto Protocol,

Considering that co-operation in the field of the CDM under Article 12 of the Kyoto Protocol will result in an efficient contribution to sustainable development and in the reduction of greenhouse gases emissions,

Desirous to express the political will to start and implement a long-standing co-operation on and to facilitate a prompt, efficient implementation of the CDM.

Have agreed as follows:

Article 1
Objective

This memorandum shall apply to procedures that – in accordance with article 12 of the Kyoto Protocol – facilitate the development and implementation of greenhouse gas emission reduction project activities in Georgia and the transfer to Denmark of the agreed part of the CER resulting from those project activities.

Article 2
Competent Authorities

The Ministry of Environment Protection and Natural Resources of Georgia and the Ministry of Environment of the Kingdom of Denmark, Danish Environmental Protection Agency are the competent authorities for agreements on implementation of the projects. For each CDM project there will be prepared a project agreement, which will include all relevant issues to secure the implementation of the specific projects.

Article 3
Contribution of the Georgian Party

1. The Georgian Party will facilitate the development and implementation of projects by supporting the potential beneficiaries interested in carrying out CDM projects with information and formal approval of projects as CDM projects, in accordance with article 12 of the Kyoto Protocol, which meet all national requirements for such project.

2. The project Agreement must contain binding affirmation of the Georgian Party that it will transfer the resulting CERs of the project agreement, to the Danish Party, in accordance with article 12 of the Kyoto Protocol and the guidelines adopted by COP/MOP.

3. The Georgian Party will secure transfer of the agreed and prepaid amount of CERs, within the agreed period for each project as described in the project agreement as long as the CDM-projects keep generating CERs, which can be verified by an independent entity.

4. The project Agreement will also confirm that the transfer of CERs will be free of any specific CDM charge beyond the agreed payment of CERs.

5. The taxation of CDM project activities except transfer of CERs, are to be carried out in accordance with the acting Georgian legislation.

6. The Georgian Party will decide alone and will present to the Danish Party the list of the projects selected to be financed. Priorities will be settled in consultation with both Parties.

Article 4

Contribution of the Danish Party

1. The Danish Party will contribute to the development and implementation of CDM projects by the procurement of CERs originating from those projects or by acceptance and registration of CER procured by private parties from the Georgian Party being the ultimate owners of such CERs. The Danish signatory shall approve the CDM projects in accordance with article 12 of the Kyoto Protocol by signing a project agreement.

2. The Danish Party will inform the Georgian Party about the relevant power of attorney given to private firms.

3. The contribution from the Danish Party to a specific project in Georgia can only be used for the specific project.

Article 5

Payment Schemes

Payment schemes for a CDM project will be agreed on a case by case basis and formally reflected in the project agreements.

Article 6

Independent validation, verification and certification of projects

Validation, verification and certification of projects shall be carried out by independent entities accredited by the executive board under the UNFCCC. Both parties will contribute to the work of these entities.

Article 7

Entering into force

1. The present Memorandum will enter into force at the date of the last notification regarding implementation of the parties of necessary internal procedures for its entry into force.

2. The Memorandum is settled for a period of 5 years and it is automatically prolonged for a period of 5 years, if none of the Parties notifies in writing the other one, with at least 6 months before the end of its validity, about the intention to denounce it.

Article 8

Amendment and earlier termination

1. In case of significant changes in relevant national policies of Georgia or the Kingdom of Denmark which result in difficulties of generation and delivery of CERs by the project executors and/or investors, both parties will do their utmost to have the CERs agreed upon in the project agreement transferred in a practical manner.

2. Parties shall be entitled to notify in written form the other Party about proposed amendments or termination of the present Memorandum. The projects being executed within the framework of the present Memorandum shall be in force until the CER provided by the project agreements are transferred. The Memorandum shall be in force for those projects.

Signed at ...., at ....200....... in two originals each of them in Georgian and English Languages. In case of disagreement regarding the interpretation of present Memorandum, the English text shall prevail.

On behalf of the Government
of Georgia:

TAMAR LEBANIDZE
Minister of Environment Protection and
Natural Resources of Georgia

12/11/2004
Date

On behalf of the Government
of the Kingdom of Denmark:

CONNIE HEDEGÅARD
Minister of Environment
of the Kingdom of Denmark

Nov. 12th. 2004
Date

ურთიერთგაგების მემორანდუმი

საქართველოს მთავრობასა და დანიის სამეფოს მთავრობას შორის გაეროს კლიმატის ცვლილების ჩარჩო კონვენციის კიოტოს ოქმის განსახორციელებლად თანამშრომლობის შესახებ

დანიის მთავრობა, კერძოდ გარემოს დაცვის სამინისტრო, დანიის გარემოს დაცვის სააგენტო, ამ მემორანდუმის მიზნებისათვის უფლებამოსილი დანიური ორგანო, შემდგომში "დანიურ მხარედ" წოდებული,

და

საქართველოს მთავრობა, კერძოდ გარემოს დაცვისა და ბუნებრივი რესურსების სამინისტრო, ამ მემორანდუმის მიზნებისათვის უფლებამოსილი ქართული ორგანო, შემდგომში "ქართულ მხარედ" წოდებული

იმის გათვალისწინებით, რომ ორივე მხარე წარმოადგენს გაეროს კლიმატის ცვლილების ჩარჩო კონვენციის (გკცჩკ) მხარეს, და რატიფიცირებული აქვს ამ კონვენციის კიოტოს ოქმი.

მიზნად ისახავენ რა შეასრულონ კიოტოს ოქმის მე-12 მუხლის პირობები და მისი ქვემდებარე, ამ ოქმის განხორციელების სახელმძღვანელო გადაწყვეტილებები, მიღებული გკცჩკ-ს მხარეთა კონფერენციის (მკ) მიერ, მოქმედის როგორც კიოტოს ოქმის მხარეთა სხდომა (მს), რომლებიც უზრუნველყოფენ კონვენციის დანართ 1-ში არ ჩართული მხარეებიდან დანართ 1-ში ჩართული მხარეებისათვის სუფთა განვითარების მექანიზმის (სგმ) პროექტით დაგროვილი სერტიფიცირებული ემისიის შემცირებების (სეშ) გადაცემას კიოტოს ოქმის მე-3 მუხლით განსაზღვრული მათი რაოდენობრივი შეზღუდვისა და შემცირების ვალდებულებების ნაწილის შესრულებაში წვლილის შესატანად,

ხაზს უსვამენ რა კიოტოს ოქმით ნაკისრი ვალდებულებების შესასრულებლად შიდა პოლიტიკისა და ღონისძიებების მნიშვნელობას და მე-12 მუხლით გათვალისწინებული საქმიანობის დამატებით როლს,

კიოტოს ოქმის მე-12 მუხლთან მიმართებაში მკ/მს-ის მიერ შემდგომ შექმნილი სახელმძღვანელო პრინციპების აღიარებით, ასევე, სგმ-ს დაუყოვნებელ და ეფექტურ განხორციელებასთან დაკავშირებით მკ/მს-ის რაიმე მომავალი გადაწყვეტილებების მხედველობაში მიღებით,

ელიან რა კიოტოს ოქმის ძალაში შესვლას,

ითვალისწინებენ რა იმას, რომ კიოტოს ოქმის მე-12 მუხლით განსაზღვრულ სგმ-ს სფეროში თანამშრომლობა ეფექტურ წვლილს შეიტანს მდგრად განვითარებაში და სათბურის გაზების ემისიების შემცირებაში,

მოწადინებულნი გამოხატონ პოლიტიკური ნება დაიწყონ და განახორციელონ ხანგრძლივი თანამშრომლობა სგმ დარგში და ხელი შეუწყონ სგმ-ს დაუყოვნებლივ ეფექტურ განხორციელებას.

შეთანხმდნენ შემდეგზე:

მუხლი 1
მიზანი

ეს მემორანდუმი იყენებს პროცედურებს, რომლებიც - კიოტოს ოქმის მე-12 მუხლის თანახმად — ხელს უწყობს საქართველოში სათბურის გაზების ემისიების შემცირების მომტანი საპროექტო საქმიანობის გაშლასა და განხორციელებას და ამგვარი საპროექტო საქმიანობიდან მიღებული სემ-ების შეთანხმებული ნაწილის დანიისათვის გადაცემას.

მუხლი 2
უფლებამოსილი ორგანოები

საქართველოს გარემოს დაცვისა და ბუნებრივი რესურსების სამინისტრო და დანიის სამეფოს გარემოს დაცვის სამინისტრო, დანიის გარემოს დაცვის სააგენტო წარმოადგენენ უფლებამოსილ ორგანოებს პროექტების განსახორციელებელი ხელშეკრულებების დასადებად. ყოველი სგმ პროექტისათვის მომზადდება საპროექტო ხელშეკრულება, რომელიც უნდა შეიცავდეს კონკრეტული პროექტების განხორციელების უზრუნველმყოფ შესაბამის საკითხებს.

მუხლი 3
ქართული მხარის წვლილი

1. ქართული მხარე ხელს შეუწყობს პროექტების მომზადებასა და განხორციელებას, აღმოუჩენს რა მხარდაჭერას სგმ პროექტების შესრულებით დაინტერესებულ პოტენციურ ბენეფიციარებს ინფორმაციის მიწოდებით და იმ პროექტების სგმ პროექტებად ოფიციალური დამტკიცებით, რომლებიც კიოტოს ოქმის მე-12 მუხლის შესაბამისად აკმაყოფილებენ ამგვარი პროექტებისათვის გათვალისწინებულ ყველა ეროვნულ მოთხოვნას.

2. საპროექტო ხელშეკრულება უნდა შეიცავდეს ქართული მხარის მიერ იმის ოფიციალურ დადასტურებას, რომ იგი გადასცემს დანიურ მხარეს საპროექტო ხელშეკრულებიდან გამომდინარე სემ-ებს, კიოტოს ოქმის მე-12 მუხლისა და მკ/მს მიერ დამტკიცებული სახელმძღვანელო პრინციპების შესაბამისად.

3. ქართული მხარე გარანტიას იძლევა, რომ გადასცემს შეთანხმებული და წინასწარ გადახდილი სემ-ების რაოდენობას თითოეული პროექტისათვის შეთანხმებული პერიოდის ფარგლებში, როგორც ეს აღწერილია საპროექტო ხელშეკრულებაში, მანამდე, სანამ სგმ პროექტი გამოიმუშავებს სემ-ებს, რომლებიც დამტკიცებული იქნება დამოუკიდებელი ორგანოს მიერ.

4. საპროექტო შეთანხმება ასევე ადასტურებს, რომ სემ-ების გადაცემა თავისუფალია სგმ-სთან დაკავშირებული რაიმე სპეციფიური ხარჯებისაგან სემ-ების შეთანხმებული ანაზღაურების გარდა.

5. პროექტით გათვალისწინებული ღონისძიებების დაბეგვრა, გარდა სემ-ების გადაცემისა, უნდა განხორციელდეს საქართველოს მოქმედი კანონმდებლობის შესაბამისად.

6. ქართული მხარე თვითონ გადაწყვეტს და წარუდგენს დანიურ მხარეს დასაფინანსებლად შერჩეული პროექტების ნუსხას. პრიორიტეტები დადგენდება მხარეების კონსულტაციების შედეგად.

მუხლი 4
დანიური მხარის წვლილი

1. დანიური მხარე წვლილს შეიტანს სგმ პროექტების მომზადებასა და განხორციელებაში ამ პროექტებით წარმოქმნილი სეშ-ების შესყიდვით ან იმ სეშ-ების მიღებითა და რეგისტრაციით, რომლებიც მიღებულია ქართული მხრიდან ამგვარი სეშ-ების საბოლოო მფლობელი კერძო კომპანიების მიერ. დანიის ხელმომწერი მხარე დაამტკიცებს სგმ პროექტებს კიოტოს ოქმის მე-12 მუხლის შესაბამისად საპროექტო ხელშეკრულების ხელმოწერით.

2. დანიური მხარე აცნობებს ქართულ მხარეს კერძო ფირმისათვის სათანადო მინდობილობის გაცემას.

3. დანიური მხარის წვლილი საქართველოში განხორციელებულ კონკრეტულ პროექტში შეიძლება გამოყენებული იქნას მხოლოდ ამ კონკრეტული პროექტისათვის.

მუხლი 5
გადახდის სქემები

სგმ პროექტისათვის გადახდის სქემები შეთანხმებული იქნება გარემოების შესაბამისად ("შემთხვევიდან შემთხვევამდე" პრინციპით) და ოფიციალურად აისახება საპროექტო ხელშეკრულებებში.

მუხლი 6
პროექტების დამოუკიდებელი დამტკიცება, შემოწმება და სერტიფიცირება

პროექტების დამტკიცება, შემოწმება და სერტიფიცირება ჩატარდება კონვენციის აღმასრულებელი საბჭოს მიერ აკრედიტებული დამოუკიდებელი ორგანიზაციების მიერ. ორივე მხარე თავის წვლილს შეიტანს ამ ორგანიზაციების მუშაობაში.

მუხლი 7
ძალაში შესვლა

1. წინამდებარე მემორანდუმი ძალაში შევა მხარეების მიერ მემორანდუმის ძალაში შესვლისათვის აუცილებელი შიდა პროცედურების თაობაზე ბოლო შეტყობინების მომენტიდან.

2. მემორანდუმი ფორმდება 5 წლიანი პერიოდის ვადით და ავტომატურად გრძელდება კიდევ 5 წლიანი პერიოდით, თუ მხარეებიდან არცერთი, მემორანდუმის მოქმედების ვადის დასრულებამდე სულ ცოტა 6 თვით ადრე, წერილობით არ შეატყობინებს მეორე მხარეს დენონსირების თაობაზე განზრახულობის შესახებ.

მუხლი 8

შესწორება და ნაადრევი შეწყვეტა

1. საქართველოს ან დანიის სამეფოს სგმ-თან შეხების მქონე ეროვნულ პოლიტიკაში მნიშვნელოვანი ცვლილებების შემთხვევაში, რის შედეგადაც პროექტის შემსრულებლების და/ან ინვესტორების მიერ სეშ-ების გამომუშავებასა და გადაცემას შეექმნება სირთულეები, ორივე მხარემ ყველაფერი უნდა იღონოს, რათა პრაქტიკულად მოხდეს საპროექტო ხელშეკრულებით შეთანხმებული სეშ-ების გადაცემა.

2. მხარეებს უფლება ეძლევა წერილობით აცნობონ მეორე მხარეს ამ მემორანდუმში შესწორებების შეტანის თაობაზე წინადადებების ან მემორანდუმის მოქმედების შეწყვეტის შესახებ. წინამდებარე მემორანდუმის ჩარჩოებში შესრულებული პროექტები ძალაში რჩება მანამდე, სანამ ხდება საპროექტო ხელშეკრულებით უზრუნველყოფილი სეშ-ების გადაცემა. მემორანდუმი ძალას ინარჩუნებს ამგვარი პროექტების მიმართ.

ხელმოწერილია 2004 წლის 12 ნოემბერს, ორ დედანად, თითოეული ქართულ და ინგლისურ ენებზე. ამ მემორანდუმის ინტერპრეტაციასთან დაკავშირებული შეუთანხმებლობის შემთხვევაში, უპირატესობა მიენიჭება ინგლისური ტექსტს.

საქართველოს მთავრობის სახელით	დანიის სამეფოს მთავრობის სახელით
თამარ ლებანიძე საქართველოს გარემოს დაცვისა და ბუნებრივი რესურსების მინისტრი	კონი ჰიდეგაარდი დანიის სამეფოს გარემოს დაცვის მინისტრი
12/11/2004 თარიღი	4/11 2004 თარიღი

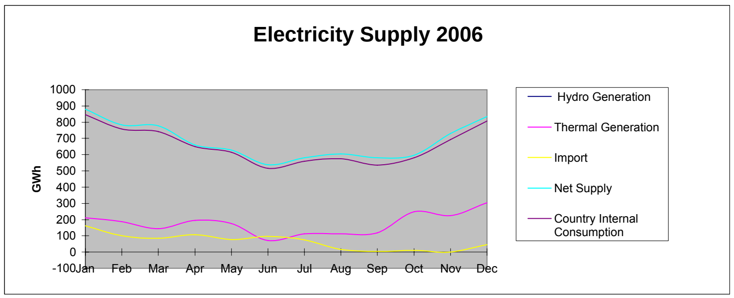
APPENDIX 2

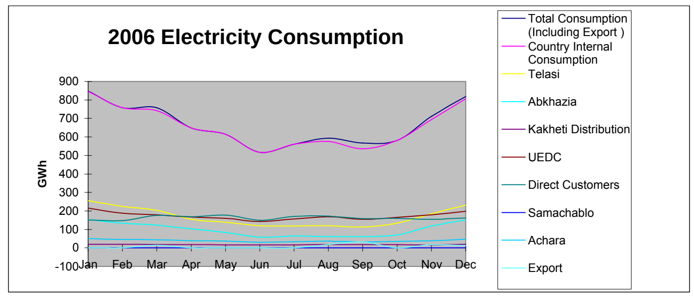
Electricity Supply, 2006

(GWEM/ESCO data), mln. kWh	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Sum
Hydro Generation	506,898,490	495,645,611	549,433,305	358,546,919	376,009,041	370,335,195	393,482,209	475,614,208	460,310,163	338,102,281	505,674,793	485,999,901	**5,316,052,116**
Thermal Generation	211,122,449	187,234,606	144,593,459	194,186,121	174,957,547	71,570,301	112,808,192	112,476,414	117,717,311	248,214,022	224,816,910	304,103,822	**2,103,801,154**
Import	162,137,745	100,701,020	84,238,239	106,316,362	77,015,908	95,927,357	74,486,802	16,658,400	3,761,036	10,747,532	104,227	45,474,014	**777,568,642**
Net Supply=Generation+Import-Generation Losses	**880,158,684**	**783,581,237**	**778,265,003**	**659,049,402**	**627,982,496**	**537,832,853**	**580,777,203**	**604,749,022**	**581,788,510**	**597,063,835**	**730,595,930**	**835,577,737**	**8,197,421,912**

Electricity Consumption, 2006

(GWEM data), mln. kwt.h	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Sum
Total Consumption (Including Export)	**847,260,871**	**758,561,181**	**757,953,320**	**649,161,919**	**613,532,843**	**516,275,176**	**559,764,075**	**594,075,229**	**567,689,209**	**581,746,081**	**710,317,358**	**819,195,655**	**7,975,532,917**
Country Internal Consumption=Total Consumption-Export-Transmission Losses)	**846,064,113**	**758,561,181**	**743,097,472**	**649,161,919**	**613,532,843**	**516,275,176**	**559,764,075**	**575,857,372**	**536,258,604**	**581,187,831**	**693,094,737**	**806,599,608**	**7,879,454,931**
Telasi	254,679,874	223,792,758	203,453,009	154,821,155	139,839,914	120,090,107	117,593,621	119,260,634	113,129,935	134,307,560	183,778,989	231,127,189	**1,995,874,745**
Abkhazia	153,225,144	133,991,134	124,183,721	102,477,564	83,728,166	58,388,577	64,216,261	60,894,598	60,809,288	69,998,720	118,955,860	150,805,582	**1,181,674,615**
Kakheti Distribution	19,666,043	19,232,427	18,263,781	17,638,270	16,324,672	15,996,829	16,952,488	18,396,827	17,251,056	17,602,794	16,334,182	19,046,514	**212,705,883**
UEDC	215,968,888	187,261,215	179,258,488	166,307,964	159,445,100	142,352,808	156,831,260	168,475,033	154,766,503	165,258,513	179,233,103	197,834,792	**2,072,993,667**
Direct Customers	151,550,897	148,149,997	174,718,697	168,411,356	177,379,625	149,234,367	170,630,878	172,653,960	158,420,555	159,402,705	155,385,731	161,022,084	**1,946,960,852**
Samachablo	0	0	0	0	0	0	0	0	0	0	0	0	**-**
Achara	50,973,267	46,133,650	43,219,776	39,505,610	36,815,366	30,212,488	33,539,567	36,176,320	31,881,267	34,617,539	39,406,872	46,763,447	**469,245,169**
Export	1,196,758	0	14,855,848	0	0	0	0	18,217,857	31,430,605	558,250	17,222,621	12,596,047	**96,077,986**
Transmission losses	**32,897,813**	**25,020,056**	**20,311,683**	**9,887,483**	**14,449,653**	**21,557,677**	**21,013,128**	**10,673,793**	**14,099,301**	**15,317,754**	**20,278,572**	**16,382,082**	**221,888,995**





Electricity Supply, 2006

(GWEM data), mln. kwt.h

No.	Item	January	February	March	April	May	June	July	August	September	Octomber	November	December	Sum
	GENERATION													
	Generation of Hydro Plants	**506,898,490**	**495,645,611**	**549,433,305**	**358,546,919**	**376,009,041**	**370,335,195**	**393,482,209**	**475,614,208**	**460,310,163**	**338,102,281**	**505,674,793**	**485,999,901**	**5,316,052,116**
1	Enguri	206,593,234	190,565,288	171,065,925				50,517,716	249,403,262	254,501,952	105,038,109	217,318,202	207,106,935	**1,652,110,623**
2	Vardnili	46,676,976	38,639,335	31,985,222	21,871,080	22,871,904	11,586,960	18,101,424	39,330,588	39,184,860	20,420,532	30,197,112	42,305,604	**363,171,597**
3	Khrami 1	32,618,111	50,216,943	48,328,236	38,571,583	28,001,950	26,545,525	19,507,326	17,971,169	12,059,700	19,141,565	14,911,167	26,817,315	**334,690,590**
4	Khrami 2					4,273,837	28,496,343	25,346,720	20,747,642	16,335,311	17,349,606	2,353,349	3,300,838	**118,203,646**
5	Shaori	7,152,600	6,208,900	7,333,600	10,560,415	6,702,100	2,489,900	5,573,164	185,991			1,948,877	18,873,600	**67,029,147**
6	Dzevruli	15,963,708	7,274,146	6,158,657	12,801,396	11,912,414	10,883,758	6,541,706	3,805,051	705,782		504,931	7,774,167	**84,325,716**
7	Moonlake Georgia	3,644,608	1,372,934	1,245,424	2,959,944	3,026,019	4,336,776	2,448,354	699,497	94,961			2,343,137	**22,171,654**
8	Jinvali	48,968,132	42,561,890	41,981,632	44,928,800	50,444,192	52,349,878	41,890,736			1,192,252	32,543,806	33,494,166	**390,355,484**
1	Vartsikhe	48,556,332	70,080,841	85,453,288	74,436,276	76,897,519	71,464,122	64,134,681	40,390,573	33,864,337	42,739,165	60,504,119	52,541,159	**721,062,412**
2	Rioni	20,273,638	21,873,331	25,402,068	24,972,905	26,054,026	25,239,726	26,434,315	24,195,677	23,375,264	25,194,608	25,748,092	21,709,653	**290,473,303**
3	Gumati	12,263,326	10,384,839	22,354,033	22,986,363	21,674,506	25,633,927	25,294,307	15,943,226	13,827,455	17,842,713	19,786,081	12,237,329	**220,228,105**
4	Lajanuri	10,100,560	7,239,409	26,748,002	16,216,716	34,123,187	38,282,790	35,399,862	22,634,495	16,813,703	22,423,013	33,077,638	11,635,204	**274,694,579**
5	Bjuja	1,786,218	1,549,926	4,036,830	7,430,640	8,662,374	4,772,334	3,911,292	1,590,960	3,028,536	3,657,318	4,085,634	2,322,012	**46,834,074**
6	Alazani	2,133,914	1,012,471	-	-	-	1,317,629	76,262	632,002	356,515	-	-	-	**5,528,793**
7	Atshesi	4,681,339	6,620,312	9,681,274	9,428,893	9,682,971	3,441,960	5,418,015	1,207,011	2,778,756	3,985,548	7,010,064	7,009,404	**70,945,547**
8	Chitakhevi	8,229,960	7,632,740	10,982,280	10,421,380	10,853,660	9,149,720	9,762,140	7,180,820	7,301,020	9,045,200	8,653,320	7,620,860	**106,833,100**
9	Zahesi	14,306,889	12,114,071	23,523,415	21,913,798	20,316,994	10,935,079	11,878,140	4,422,871	5,989,193	10,195,368	12,074,888	11,312,809	**158,983,515**
10	Ortachala	7,665,840	7,176,600	11,226,960	9,435,240	9,602,280	9,144,720	7,475,760	3,271,320	3,728,520	6,154,200	7,097,400	6,595,560	**88,574,400**
11	Martkopi	478,132	352,333	432,793	380,207	215,783	343,014	441,447	370,844	880,509	1,127,692	966,500	-	**5,989,254**
12	Sioni	2,423,627	2,161,492	1,900,520	2,000,811	2,320,708	3,737,429	3,853,277	4,173,389	2,971,877	2,202,703	465,205	-	**28,211,038**
13	Tetrikhevi	3,009,912	2,264,696	2,799,655	2,047,812	985,718	2,098,906	2,515,138	1,573,086	2,961,268	4,265,026	3,791,580	32,116	**28,344,913**
14	Satskhenisi	4,722,703	3,810,432	4,219,547	3,364,364	1,622,465	4,065,180	4,703,069	2,186,519	4,538,508	6,194,799	5,366,526	93,304	**44,887,416**
15	Xadori	-	372,632	6,617,002	15,297,923	19,009,796	18,209,466	16,189,111	9,341,894	10,427,384	14,095,550	11,334,585	6,305,245	**127,200,588**
1	Abhesi	215,333	188,513	164,732	153,263	152,611	123,809	150,785	127,114	113,223	121,923	135,491	142,346	**1,789,143**
2	AlgeTi	-	-	-	-	-	-	280,940	477,424	591,096	434,920	155,348	-	**1,939,728**
3	Chalahesi	308,400	405,600	564,800	497,600	222,600	18,200	45,000	24,000	20,244	99,552	259,936	95,464	**2,561,396**
4	Ckhorhesi	390,629	68,474	480,329	1,129,984	1,165,834	1,011,264	919,529	270,426	343,464	290,789	-	-	**6,070,722**
5	Dashbashi	512,422	574,598	539,114	600,761	698,724	710,771	706,853	552,776	289,845	249,329	242,638	270,162	**5,947,993**
6	Intsobahesi (feri)	73,000	51,300	310,062	427,039	413,665	443,608	389,476	267,655	296,110	302,606	318,046	172,894	**3,465,461**
7	Kabalhesi	137,352	256,280	245,648	-	225,892	-	-	-	-	-	-	-	**865,172**
8	Kakharetihesi	-	-	-	-	-	-	-	-	-	-	-	-	**-**
9	Mashaverahesi	-	-	-	-	-	-	-	-	-	77,626	188,288	185,825	**451,739**
10	Misaqcieli ento	474,387	384,156	237,785	355,918	395,017	329,576	345,632	435,838	445,901	400,104	407,892	524,459	**4,736,665**
11	Ritseulahesi	1,864,170	1,471,217	2,528,428	2,477,559	2,507,155	2,255,785	2,316,377	1,285,809	1,548,589	2,205,448	2,408,595	1,546,503	**24,415,635**
12	Squrhesi	117,846	90,541	80,189	71,889	76,653	125,906	131,059	119,408	128,781	156,471	205,906	155,343	**1,459,992**
13	Tiriphonhesi	-	-	-	-	-	-	46,221	335,188	475,503	662,319	896,966	615,181	**3,031,378**
14	KHertvisihesi	44,738	45,840	50,735	58,325	75,698	80,630	70,616	78,751	54,014	55,352	31,666	-	**646,365**
15	Machakhelahesi (bakur)	480,000	596,550	714,270	708,825	744,435	647,580	580,260	374,205	-	583,965	631,770	775,665	**6,837,525**
16	Kekhvihesi	-	-	-	-	-	-	-	-	232,358	162,510	9,216	5,524	**409,608**
17	Kazbegihesi	30,454	26,981	40,850	39,210	76,354	62,924	85,499	7,727	29,852	6,600	19,315	35,782	**461,548**
18	Energetiki	-	-	-	-	-	-	-	-	15,772	27,800	24,644	44,336	**112,552**
	Generation of Thermal Plants	**211,122,449**	**187,234,606**	**144,593,459**	**194,186,121**	**174,957,547**	**71,570,301**	**112,808,192**	**112,476,414**	**117,717,311**	**248,214,022**	**224,816,910**	**304,103,822**	**2,103,801,154**
1	Mtkvari	138,239,015	148,448,520	58,436,164	130,612,678	141,446,498	1,503,513			72,431,630	153,993,181	145,137,855	159,200,429	**1,149,449,483**
2	Tbilsresi	72,883,434	38,786,086	81,445,885	55,506,274	27,863,429	36,171,498	71,758,502	77,424,474	111,981	44,821,821	48,171,315	108,963,093	**663,907,792**
3	Air Turbine (Energy Invest)			4,711,410	8,067,169	5,647,620	33,895,290	41,049,690	35,051,940	45,173,700	49,399,020	31,507,740	35,940,300	**290,443,879**
	Country Internal Generation	**718,020,939**	**682,880,217**	**694,026,764**	**552,733,040**	**550,966,588**	**441,905,496**	**506,290,401**	**588,090,622**	**578,027,474**	**586,316,303**	**730,491,703**	**790,103,723**	**7,419,853,270**
	Total Import	**162,137,745**	**100,701,020**	**84,238,239**	**106,316,362**	**77,015,908**	**95,927,357**	**74,486,802**	**16,658,400**	**3,761,036**	**10,747,532**	**104,227**	**45,474,014**	**777,568,642**
	Including:													-
1	*Armenia*	*58,007,218*	*67,305,789*	*57,135,007*	-	-	-	*3,299,789*	-	-	-	-	-	*185,747,803*
	trl Alaverdi	48,943,772	61,992,379	57,135,007	-	-	-	3,299,789	-	-	-	-	-	171,370,947
	trl Ninotsminda	6,626,756	3,362,627	-	-	-	-	-	-	-	-	-	-	9,989,383
	trl Lalvari	2,436,690	1,950,783	-	-	-	-	-	-	-	-	-	-	4,387,473
2	*Russia*	*71,360,091*	*21,472,790*	*23,501,430*	*98,580,050*	*71,148,041*	*83,202,433*	*66,826,305*	*16,658,400*	*2,054,316*	*10,747,532*	-	-	*465,551,388*
	trl Kavkasioni	47,392,773	13,875,784	20,658,678	62,540,788	45,107,081	41,036,353	34,301,505	-	2,054,316	10,747,532	-	-	277,714,810
	trl Salxino	22,419,408	7,144,896	2,842,752	36,039,262	26,040,960	42,166,080	32,524,800	16,658,400	-	-	-	-	185,836,558
	trl Dariali	1,547,910	452,110	-	-	-	-	-	-	-	-	-	-	2,000,020
3	*Azerbaijan*	*4,084,403*	-	-	-	-	-	-	-	*1,706,720*	-	*104,227*	*13,712,391*	*19,607,741*
	trl Gardabani	4,084,403	-	-	-	-	-	-	-	-	-	-	-	4,084,403
	trl Gard paral	-	-	-	-	-	-	-	-	1,706,720	-	104,227	13,712,391	15,523,338
4	*Turkey*	*28,686,033*	*11,922,441*	*3,601,802*	*7,736,312*	*5,867,867*	*12,724,924*	*4,360,708*	-	-	-	-	*31,761,623*	*106,661,710*
	trl Achara	28,686,033	11,922,441	3,601,802	7,736,312	5,867,867	12,724,924	4,360,708	-	-	-	-	31,761,623	106,661,710

		January	February	March	April	May	June	July	August	September	October	November	December	Sum
	Import+ Internal Generation	880,158,684	783,581,237	778,265,003	659,049,402	627,982,496	537,832,853	580,777,203	604,749,022	581,788,510	597,063,835	730,595,930	835,577,737	8,197,421,912

Electricity Consumption, 2006
(GWEM data), mln.kwt.h

	CONSUMPTION	January	February	March	April	May	June	July	August	September	October	November	December	Sum
	Distribution Companies	**478,544,328**	**423,149,969**	**389,120,287**	**314,442,599**	**276,708,118**	**224,688,001**	**232,301,937**	**234,728,379**	**223,071,546**	**256,526,613**	**358,475,903**	**447,742,732**	**3,859,500,412**
1	Abkhazia	153,225,144	133,991,134	124,183,721	102,477,564	83,728,166	58,388,577	64,216,261	60,894,598	60,809,288	69,998,720	118,955,860	150,805,582	**1,181,674,615**
2	Samachablo													-
3	Achara	50,973,267	46,133,650	43,219,776	39,505,610	36,815,366	30,212,488	33,539,567	36,176,320	31,881,267	34,617,539	39,406,872	46,763,447	**469,245,169**
4	Telasi	254,679,874	223,792,758	203,453,009	154,821,155	139,839,914	120,090,107	117,593,621	119,260,634	113,129,935	134,307,560	183,778,989	231,127,189	**1,995,874,745**
5	Kakheti distribution	19,666,043	19,232,427	18,263,781	17,638,270	16,324,672	15,996,829	16,952,488	18,396,827	17,251,056	17,602,794	16,334,182	19,046,514	**212,705,883**
6	UEDC	215,968,888	187,261,215	179,258,488	166,307,964	159,445,100	142,352,808	156,831,260	168,475,033	154,766,503	165,258,513	179,233,103	197,834,792	**2,072,993,667**
	Direct Customers	**151,550,897**	**148,149,997**	**174,718,697**	**168,411,356**	**177,379,625**	**149,234,367**	**170,630,878**	**172,653,959**	**158,420,555**	**159,402,705**	**155,385,731**	**161,022,084**	**1,946,960,851**
1	Phero	55,378,287	58,796,296	70,279,138	67,496,963	68,979,112	59,594,786	63,823,911	61,781,814	52,799,263	47,073,306	48,191,493	48,223,898	**702,418,267**
2	Chiatur Manganese	2,998,730	2,552,118	3,306,137	3,211,406	3,279,878	3,018,617	3,153,980	3,348,253	3,332,405	3,598,582	3,571,780	3,639,831	**39,011,717**
3	Georgian Manganese													-
4	Kaspicementi	5,232,592	5,671,794	5,571,893	5,933,471	6,961,408	6,589,013	7,097,482	7,584,688	6,724,578	7,559,249	7,602,458	8,175,387	**80,704,013**
5	Rustavcementi	3,415,952	1,904,779	4,259,413	6,248,760	5,864,165	6,022,665	6,261,824	7,081,067	5,848,714	6,484,781	6,461,429	5,548,751	**65,402,300**
6	Madneuli	4439546	3946422	4482165	3499352	4248415	4197380	4775915	5126511	5192053	5706291	5811003	6100500	**57,525,553**
7	Energy Invest	17,669,099	16,979,334	23,263,321	22,744,594	24,526,642	11,462,802	24,817,062	25,260,006	23,286,489	24,994,261	22,641,365	23,953,239	**261,598,214**
8	Metro	5,904,661	5,479,013	5,822,480	5,304,761	5,348,491	5,163,765	4,905,617	4,806,426	4,890,889	5,358,347	5,528,893	5,899,779	**64,413,122**
9	Street Lighting	3,057,131	2,200,998	2,580,434	2,140,446	2,036,116	1,882,066	1,807,001	1,932,030	2,309,958	2,807,367	3,171,208	3,575,405	**29,500,160**
10	Tbilisi Water	27,194,830	25,011,682	27,179,862	24,106,639	27,623,378	26,769,681	28,011,566	28,073,408	26,432,688	27,415,840	25,475,993	25,603,704	**318,899,271**
11	Railway	26,260,069	25,607,561	27,973,854	27,724,964	28,512,020	24,533,592	25,976,520	26,576,387	26,563,856	27,656,035	26,530,495	30,127,995	**324,043,348**
														-
1	Railway (sacxenicy) o/c													-
2	Mtkvari o/c								672,319	241,405				**913,724**
3	Tbilsresi o/c									236,420	219,548	199,058		**655,026**
4	Tb. Water (Jin) s/m								411,050	520,030	365,400			**1,296,480**
5	Tb. Water (Tetr) o/c												82,346	**82,346**
6	Shaori HPP o/c									36,161	109,299	81,776		**227,236**
7	Dzevrula HPP o/c										50,345	63,725		**114,070**
8	Rusmetal (sion) o/c												35,533	**35,533**
9	Chkhorocku HPP o/c											37,226	37,122	**74,348**
10	Alazani HPP o/c											8,204	5,515	**13,719**
11	Martkopi HPP o/c												1,590	**1,590**
12	Kabali HPP o/c									2,286	4,054	9,625	11,489	**27,454**
13	Machakhela HPP o/c									3,360				**3,360**
14	Rusenergo Trans.l/c													-
	Sum	**630,095,225**	**571,299,966**	**563,838,984**	**482,853,955**	**454,087,743**	**373,922,368**	**402,932,815**	**407,382,338**	**381,492,101**	**415,929,318**	**513,861,634**	**608,764,816**	**5,806,461,263**
	Total Export	**1,196,758**	**-**	**14,855,848**	**-**	**-**	**-**	**-**	**18,217,857**	**31,430,605**	**558,250**	**17,222,621**	**12,596,047**	**96,077,986**
	Including													-
1	*Russia*									10,150	558,250			**568,400**
2	*Turkey*								9,235,257	31,253,310				**40,488,567**
3	*Azerbaijan*	1,196,758		2,887,645										**4,084,403**
4	*Azerbaijan (par)*			11,968,203					8,982,600	167,145		17,222,621	12,596,047	**50,936,616**
	Net Consumption	**631,291,983**	**571,299,966**	**578,694,832**	**482,853,955**	**454,087,743**	**373,922,368**	**402,932,815**	**425,600,195**	**412,922,706**	**416,487,568**	**531,084,255**	**621,360,863**	**5,902,539,249**
														-

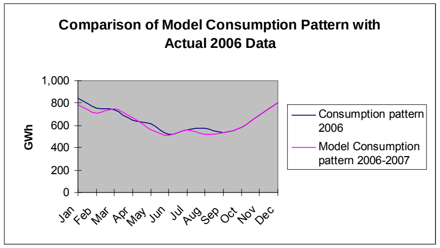
Dynamics of Electricity Balance 2000-2006

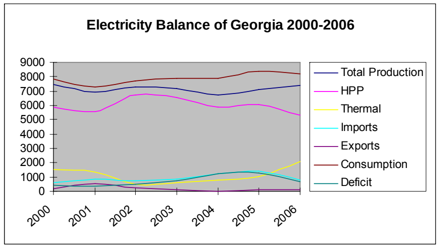
	2000	2001	2002	2003	2004	2005	2006
Total Production	7446	6942	7256	7163	6706	7100	7419.9
HPP	5905.6	5571.5	6742.9	6527.9	5892.9	6070	5316
Thermal	1540.4	1370.5	513.5	635.1	813.2	1030.6	2103.8
Imports	611.5	877.6	713.2	844.2	1210	1399	777.6
Exports	210.5	523.3	244.5	109.3	-	120	96
Consumption	7847	7296.3	7724.7	7898	7916	8379	8197.4
Deficit	401	354.3	468.7	735	1210	1279	681.6

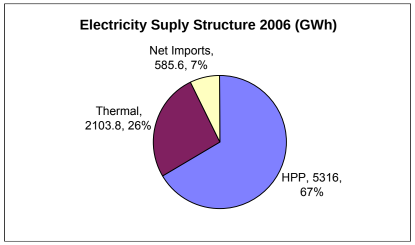
	2000	2001	2002	2003	2004	2005	2006
Total Production	7446	6942	7256.4	7163	6706.1	7100.6	7419.9
HPP	5905.6	5571.5	6742.9	6527.9	5892.9	6070	5316
Thermal	1540.4	1370.5	513.5	635.1	813.2	1030.6	2103.8
Imports	611.5	877.6	713.2	844.2	1210	1399	777.6
Exports	210.5	523.3	244.5	109.3	0	120	96
Consumption	7847	7296.3	7725.1	7897.9	7916.1	8379.6	8197.4
Net Imports	401	354.3	468.7	735	1210	1279	681.6

HPP	5316
Thermal	2103.8
Net Imports	585.6

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Consumption pattern 2006	846	759	743	649	614	516	560	576	536	581	693	807	7,879
Model Consumption pattern 2006-2007	784	706	746	671	563	508	559	520	535	580	693	806	7,672,655,702







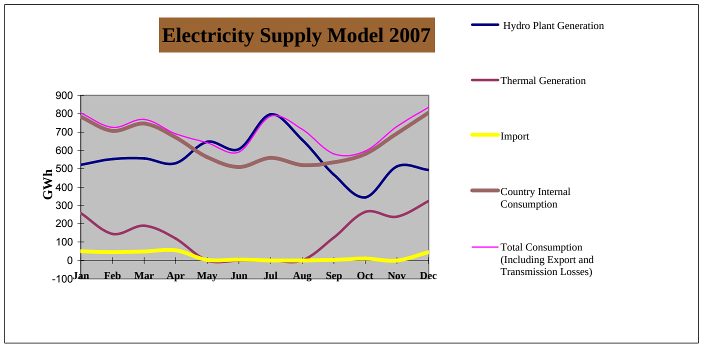
APPENDIX 3

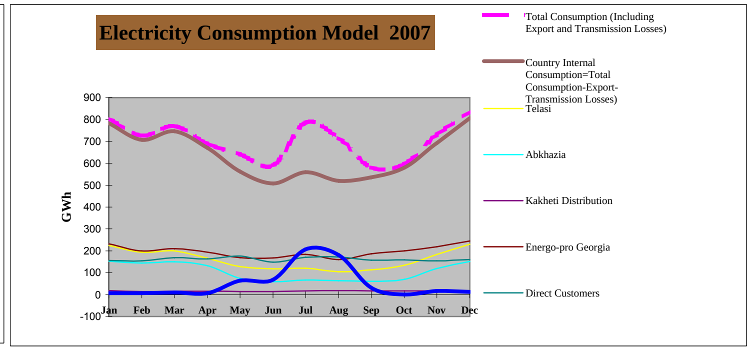
Model Electricity Balance 2007

(ESCO data), GWh

Electricity Generation, 2007	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Hydro Plant Generation	521.70	553.25	557.00	530.63	647.67	607.40	**796.80**	**656.80**	466.84	343.00	512.88	492.90	**6,686.87**
Thermal Generation	257.66	145.11	189.47	119.15	0.32	0.32	0.30	0.00	125.21	264.04	239.15	323.51	**1,664.24**
Import	49.60	44.50	48.50	55.20	3.20	3.90	0.00	0.00	3.80	10.70	0.10	45.50	**265.00**
Generation Losses and Own Consumption	22.80	16.50	19.20	14.60	9.10	8.50	11.81	9.66	14.00	20.60	21.50	26.30	**194.57**
Net Supply=Generation+Import-Generation Losses	**806.16**	**726.35**	**775.77**	**690.38**	**642.09**	**603.12**	**785.29**	**647.14**	**581.85**	**597.14**	**730.63**	**835.61**	**8,421.53**
	466.84	343.00	512.88	492.90	521.70	553.25	557.00	530.63	647.67	607.40			

Electricity Consumption, 2007 (ESCO data), GWh	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Total Consumption (Including Export and Transmission Losses)	**804.05**	**725.43**	**769.50**	**689.92**	**641.40**	**590.23**	**786.57**	**715.81**	**580.87**	**596.46**	**730.25**	**835.35**	**8,465.84**
Country Internal Consumption=Total Consumption-Export-Transmission Losses)	**783.65**	**706.33**	**746.40**	**670.92**	**562.70**	**508.23**	**559.34**	**520.26**	**535.27**	**580.46**	**692.75**	**806.35**	**7,672.66**
Telasi	224.30	193.60	200.00	166.50	128.30	117.81	121.20	105.00	113.10	134.30	183.80	231.10	**1,919.01**
Abkhazia	152.30	144.30	150.70	132.30	74.30	60.00	66.66	63.63	60.80	70.00	119.00	150.80	**1,244.79**
Kakheti Distribution	18.60	14.20	16.20	15.50	14.10	14.10	17.58	**18.97**	17.30	17.60	16.30	19.00	**199.46**
Energo-pro Georgia	232.50	200.10	210.30	193.30	169.30	168.00	183.27	160.00	186.70	199.90	218.60	244.60	**2,366.57**
Direct Customers	155.95	154.13	169.20	163.32	176.70	148.32	170.63	172.65	157.37	158.66	155.05	160.85	**1,942.83**
Export	6.70	7.20	9.70	7.10	64.40	**68.00**	**207.00**	**180.00**	31.50	0.60	17.20	12.60	**612.00**
Transmission losses	13.70	11.90	13.40	11.90	14.30	14.00	20.23	15.56	14.10	15.40	20.30	16.40	**181.18**
Disbalance=Net Supply-Total Consumption	**2.11**	**0.92**	**6.27**	**0.46**	**0.69**	**12.89**	**-1.28**	**-68.67**	**0.98**	**0.68**	**0.38**	**0.27**	**-44.31**





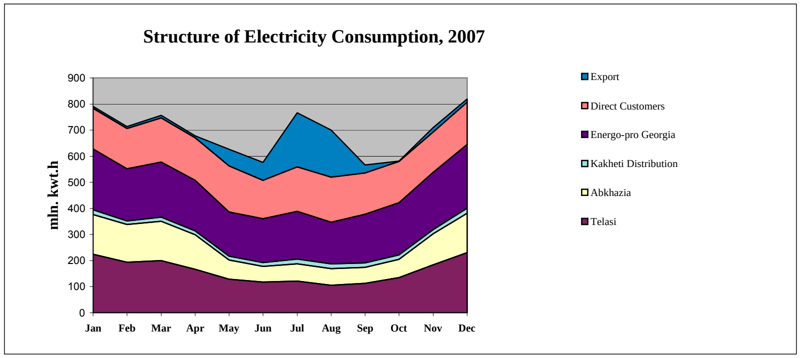
Initial Information▼

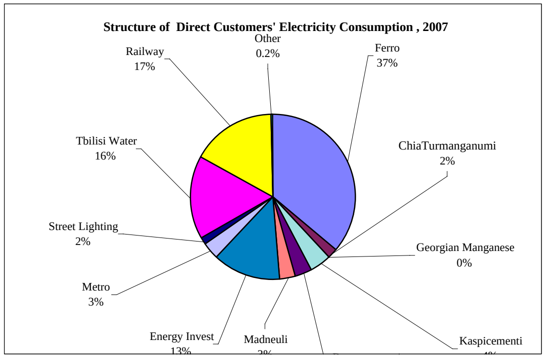
Electricity Supply, 2007	El. Balance 2007								El. Balance 2006				
(ESCO data), GWh	January	February	March	April	May	June	July	August	September	Octomber	November	December	Sum
Generation of Hydro Plants	521.70	553.25	557.00	530.63	647.67	607.40	796.77	656.79	466.84	343.00	512.88	492.90	6,686.82
inc. Control Dam Plants	367.85	397.46	343.51	291.48	378.19	354.77	579.12	506.17	327.48	165.31	303.96	346.86	4,362.17
Enguri	201.62	225.76	186.21	120.69	256.90	251.52	463.74	374.67	258.11	106.49	220.39	210.04	2,876.13
Vardnili	43.41	46.96	42.09	34.99	47.36	28.30	45.43	62.50	39.76	20.69	30.63	42.90	485.01
Khrami 1	30.43	33.57	27.79	24.44	6.49	14.81	16.30	20.03	12.27	19.37	15.11	27.18	247.78
Khrami 2	31.24	33.98	19.88	34.18	7.61	0.10	10.97	0.00	16.53	17.55	2.43	3.35	177.80
Shaori	12.68	8.01	12.07	19.07	12.78	10.45	5.89	12.00	0.00	0.00	1.93	19.17	114.04
Dzevruli	10.04	12.37	18.76	24.34	5.68	7.51	6.24	9.98	0.71	0.00	0.51	7.91	104.05
Moonlake Georgia	3.75	4.36	8.11	9.43	1.22	1.72	0.00	0.00	0.10	0.00	0.00	2.33	31.03
Jinvali	34.69	32.45	28.60	24.34	40.16	40.37	30.55	27.00	0.00	1.22	32.96	33.98	326.32
Inc. Seasonal Plants	153.85	155.78	213.49	239.15	269.47	252.64	217.65	150.62	139.35	177.69	208.92	146.04	2,324.66
Vartsikhe 2005	63.89	61.56	78.19	79.82	82.05	70.39	60.42	40.40	34.38	43.31	61.36	53.25	729.02
Gumati	13.08	13.79	20.28	25.25	23.12	31.24	27.61	16.10	14.00	18.05	20.08	12.37	234.99
Rioni	23.02	23.73	27.48	26.98	27.18	22.92	26.50	24.26	23.73	25.56	26.06	22.01	299.44
Lajanuri	11.05	14.00	25.96	31.74	50.41	38.54	29.50	23.70	17.04	22.72	33.57	11.76	310.00
Ortachala	6.29	6.39	9.23	10.24	5.48	9.53	6.54	3.38	3.75	6.29	7.20	6.69	81.01
Satskhenisi	0.00	0.00	0.00	1.32	5.38	5.17	4.54	3.69	4.56	6.29	5.48	0.10	36.52
Tetrikhevi	0.00	0.00	0.00	0.81	4.26	4.06	3.36	1.49	3.04	4.36	3.85	0.10	25.33
Zahesi	10.85	11.46	17.24	24.14	19.37	21.81	12.86	4.68	6.09	10.34	12.27	11.46	162.57
Bjuja	1.83	1.62	2.84	3.85	8.82	8.52	5.98	1.58	3.04	3.75	4.16	2.33	48.33
Chitakhevi	7.61	7.10	9.53	11.46	10.34	10.75	10.69	7.38	7.40	9.13	8.82	7.71	107.93
Eastern Energy Corporation (Khadori)	4.67	2.64	4.87	6.49	14.00	14.30	14.50	9.39	10.55	14.30	11.46	6.39	113.55
Atshesi	7.10	7.91	10.24	10.24	10.14	6.80	4.63	1.27	2.84	4.06	7.10	7.10	79.43
Total Small Plants	4.46	5.58	7.61	6.80	8.92	8.62	10.51	13.30	8.92	9.53	7.51	4.77	96.53
Generation of Thermal Plants	257.66	145.11	189.47	119.15	0.32	0.32	0.30	0.00	125.21	264.04	239.15	323.51	1,664.24
Mtkvari	171.70	144.89	141.91	47.98	0.00	0.00	0.00	0.00	77.02	163.83	154.36	169.36	1,071.06
Tbilsresi	80.32	0.00	32.34	24.26	0.00	0.00	0.00	0.00	0.11	47.66	51.28	115.96	351.91
Gas Turbine (Energy Invest)	5.64	0.21	15.21	46.91	0.32	0.32	0.30	0.00	48.09	52.55	33.51	38.19	241.26
Import	49.60	44.50	48.50	55.20	3.20	3.90	0.00	0.00	3.80	10.70	0.10	45.50	265.00
Russia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.10	10.70	0.00	0.00	12.80
Turkey	40.50	34.90	38.60	35.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	31.80	180.80
Azerbaijan	9.10	9.60	9.90	20.20	3.20	3.90	0.00	0.00	1.70	0.00	0.10	13.70	71.40
Generation Losses and Own Consumption	22.80	16.50	19.20	14.60	9.10	8.50	11.81	9.66	14.00	20.60	21.50	26.30	194.57
Net Supply=Generation+Import-Generation Losses	806.16	726.35	775.77	690.38	642.09	603.12	785.26	647.13	581.85	597.14	730.63	835.61	8,421.49

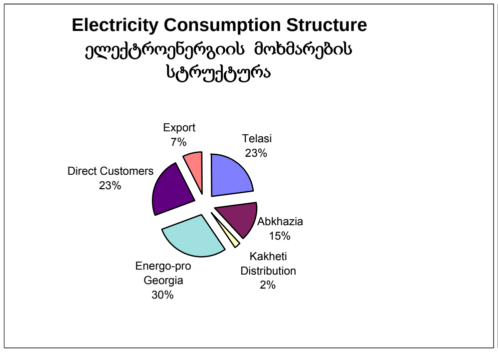
Electricity Consumption, 2007 (ESCO data), mln.kvt.h													
Total Consumption	**806.20**	**726.40**	**775.80**	**690.40**	**642.10**	**603.10**	**785.21**	**647.15**	**581.80**	**597.10**	**730.60**	**835.60**	**8,421.45**
Telasi	224.30	193.60	200.00	166.50	128.30	138.00	121.20	121.20	113.10	134.30	183.80	231.10	**1,955.40**
Abkhazia	152.30	144.30	150.70	132.30	74.30	60.00	66.66	63.63	60.80	70.00	119.00	150.80	**1,244.79**
Kakheti distribution	18.60	14.20	16.20	15.50	14.10	14.10	17.58	**17.44**	17.30	17.60	16.30	19.00	**197.93**
Energo-Pro Georgia	232.50	200.10	210.30	193.30	169.30	168.00	183.27	187.42	186.70	199.90	218.60	244.60	**2,393.99**
Direct customers	155.95	154.13	169.20	163.32	176.70	148.32	216.27	219.07	157.37	158.66	155.05	160.85	**2,034.89**
Export	6.70	7.20	9.70	7.10	64.40	68.40	207.03	53.84	31.50	0.60	17.20	12.60	**486.27**
Transmission losses	13.70	11.90	13.40	11.90	14.30	14.00	20.23	15.56	14.10	15.40	20.30	16.40	**181.18**
Disbalance	**0.04**	**0.05**	**0.03**	**0.02**	**0.01**	**-0.02**	**-0.05**	**0.02**	**-0.05**	**-0.04**	**-0.03**	**-0.01**	**-0.03**

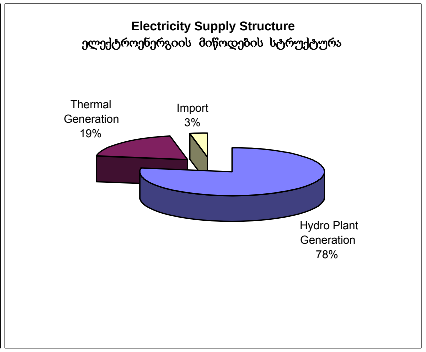
*** -Information for July and August is a forecast**

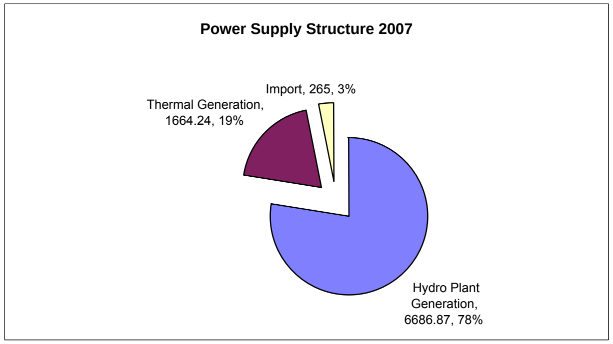
From ESCO data													
Direct Customers	**151,550,897**	**148,149,997**	**174,718,697**	**168,411,356**	**177,379,625**	**149,234,367**	**170,630,878**	**173,737,328**	**159,460,217**	**160,151,351**	**155,785,345**	**161,195,679**	**1,950,405,737**
Ferro	55,378,287	58,796,296	70,279,138	67,496,963	68,979,112	59,594,786	63,823,911	61,781,814	52,799,263	47,073,306	48,191,493	48,223,898	**702,418,267**
Chiatur Manganese	2,998,730	2,552,118	3,306,137	3,211,406	3,279,878	3,018,617	3,153,980	3,348,253	3,332,405	3,598,582	3,571,780	3,639,831	**39,011,717**
Georgian Manganese													**-**
Kaspicementi	5,232,592	5,671,794	5,571,893	5,933,471	6,961,408	6,589,013	7,097,482	7,584,688	6,724,578	7,559,249	7,602,458	8,175,387	**80,704,013**
Rustavcementi	3,415,952	1,904,779	4,259,413	6,248,760	5,864,165	6,022,665	6,261,824	7,081,067	5,848,714	6,484,781	6,461,429	5,548,751	**65,402,300**
Madneuli	4439546	3946422	4482165	3499352	4248415	4197380	4775915	5126511	5192053	5706291	5811003	6100500	**57,525,553**
Energy Invest	17,669,099	16,979,334	23,263,321	22,744,594	24,526,642	11,462,802	24,817,062	25,260,006	23,286,489	24,994,261	22,641,365	23,953,239	**261,598,214**
Metro	5,904,661	5,479,013	5,822,480	5,304,761	5,348,491	5,163,765	4,905,617	4,806,426	4,890,889	5,358,347	5,528,893	5,899,779	**64,413,122**
Street Lighting	3,057,131	2,200,998	2,580,434	2,140,446	2,036,116	1,882,066	1,807,001	1,932,030	2,309,958	2,807,367	3,171,208	3,575,405	**29,500,160**
Tbilisi Water	27,194,830	25,011,682	27,179,862	24,106,639	27,623,378	26,769,681	28,011,566	28,073,408	26,432,688	27,415,840	25,475,993	25,603,704	**318,899,271**
Railway	26,260,069	25,607,561	27,973,854	27,724,964	28,512,020	24,533,592	25,976,520	26,576,387	26,563,856	27,656,035	26,530,495	30,127,995	**324,043,348**
Other	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1,083,369**	**1,039,662**	**748,646**	**399,614**	**173,595**	**3,444,886**
Railway (sacxenicy) o/c													**-**
Mtkvari o/c								672,319	241,405				**913,724**
Tbilsresi o/c									236,420	219,548	199,058		**655,026**
Tb. Water (Jin) s/m								411,050	520,030	365,400			**1,296,480**
Tb. Water (Tetr) o/c												82,346	**82,346**
Shaori HPP o/c									36,161	109,299	81,776		**227,236**
Dzevrula HPP o/c										50,345	63,725		**114,070**
Rusmetal (sion) o/c												35,533	**35,533**
Chkhorocku HPP o/c											37,226	37,122	**74,348**
Alazani HPP o/c											8,204	5,515	**13,719**
Martkopi HPP o/c												1,590	**1,590**
Kabal HPP o/c									2,286	4,054	9,625	11,489	**27,454**
Machakhela HPP o/c									3,360				**3,360**
Rusenergo Trans.l/c													**-**


Structure of Electricity Consumption, 2007
mln. kwt.h
900
800
700
600
500
400
300
200
100
0
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Export
Direct Customers
Energo-pro Georgia
Kakheti Distribution
Abkhazia
Telasi


Structure of Direct Customers' Electricity Consumption , 2007
Other
0.2%
Railway
17%
Ferro
37%
Tbilisi Water
16%
ChiaTurmanganumi
2%
Street Lighting
2%
Georgian Manganese
0%
Metro
3%
Energy Invest
Madneuli
Kaspicementi

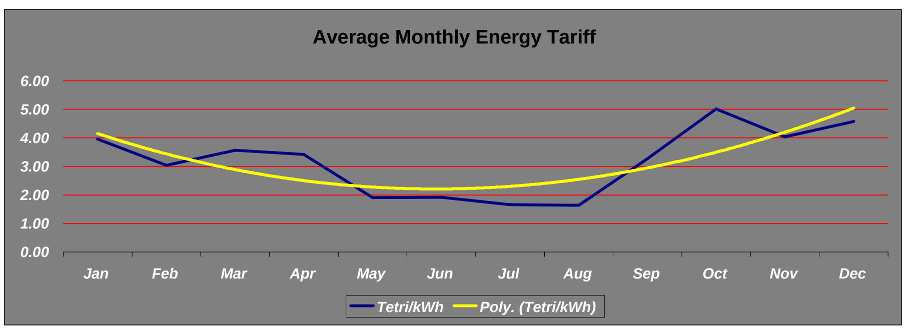

Electricity Consumption Structure
ელექტროენერგიის მოხმარების სტრუქტურა
Export
7%
Telasi
23%
Direct Customers
23%
Abkhazia
15%
Kakheti Distribution
2%
Energo-pro Georgia
30%


Electricity Supply Structure
ელექტროენერგიის მიწოდების სტრუქტურა
Thermal Generation
19%
Import
3%
Hydro Plant Generation
78%


Power Supply Structure 2007
Import, 265, 3%
Thermal Generation,
1664.24, 19%
Hydro Plant
Generation,
6686.87, 78%

APPENDIX 4.

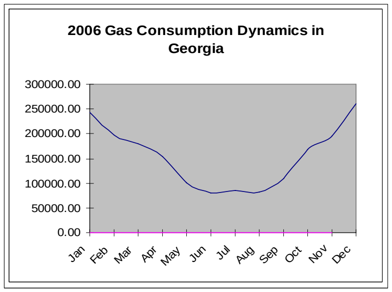
Tariff, tetri	Cost of Electricity Generation , 2006 (GEL)												Annual
	January	February	March	April	May	June	July	August	September	Octomber	November	December	
Cost of Hgeneration	**9,018,931**	**9,355,043**	**10,438,592**	**10,892,414**	**12,327,699**	**11,635,517**	**13,229,585**	**10,729,973**	**7,715,066**	**6,871,308**	**9,401,360**	**8,742,421**	**120,357,909**
	5,526,477	**5,840,225**	**5,442,162**	**5,182,120**	**5,310,904**	**5,057,160**	**7,513,041**	**6,867,657**	**4,024,944**	**2,134,260**	**3,973,378**	**5,252,563**	**62,124,891**
1.187	2,393,262	2,679,779	2,210,276	1,432,586	3,049,362	2,985,558	5,504,546	4,447,285	3,063,808	1,264,047	2,615,975	2,493,182	34,139,665
1.17	507,870	549,402	492,444	409,381	554,148	331,065	531,578	731,203	465,152	242,069	358,357	501,937	5,674,607
1.76	535,497	590,832	489,087	430,183	114,239	260,609	286,810	352,458	215,984	340,933	265,963	478,377	4,360,971
1.51	471,684	513,032	300,162	516,095	114,858	1,531	165,617	0	249,625	264,939	36,755	50,538	2,684,836
3.82	484,280	306,065	461,034	728,357	488,154	399,047	225,113	458,285	0	0	73,611	732,231	4,356,177
3.85	386,562	476,369	722,363	937,120	218,661	288,945	240,240	384,307	27,333	0	19,523	304,564	4,005,987
3	112,576	130,832	243,408	282,961	36,511	51,724	0	0	3,043	0	0	69,980	931,034
1.83	634,746	593,915	523,387	445,436	734,970	738,682	559,138	494,118	0	22,272	603,195	621,755	5,971,613
	3,492,454	**3,514,817**	**4,996,430**	**5,710,294**	**7,016,795**	**6,578,357**	**5,716,544**	**3,862,316**	**3,690,122**	**4,737,049**	**5,427,982**	**3,489,858**	**58,233,018**
1.25	798,682	769,523	977,434	997,718	1,025,609	879,817	755,300	505,000	429,767	541,329	766,988	665,568	9,112,734
3.64	476,227	502,069	738,337	919,229	841,704	1,137,039	1,005,040	586,040	509,452	657,120	730,953	450,385	8,553,596
3.5	805,781	830,629	961,968	944,219	951,318	802,231	927,500	849,065	830,629	894,523	912,272	770,284	10,480,419
3.8	420,081	531,846	986,613	1,206,288	1,915,416	1,464,503	1,121,000	900,600	647,465	863,286	1,275,659	447,059	11,779,815
2.5	157,201	159,736	230,730	256,085	136,917	238,337	163,375	84,475	93,813	157,201	180,020	167,343	2,025,233
2.33	0	0	0	30,720	125,243	120,517	105,759	85,954	106,339	146,511	127,606	2,363	851,013
	0	0	0	0	0	0	0	0	0	0	0	0	0
1.42	154,097	162,738	244,828	342,759	275,071	309,635	182,640	66,470	86,410	146,897	174,260	162,738	2,308,543
4	73,022	64,909	113,590	154,158	352,941	340,771	239,320	63,240	121,704	150,101	166,329	93,306	1,933,392
	0	0	0	0	0	0	0	0	0	0	0	0	0
7.16	334,037	188,803	348,560	464,746	1,002,110	1,023,895	1,038,200	672,539	755,213	1,023,895	820,568	457,485	8,130,049
3.85	273,327	304,564	394,371	394,371	390,467	261,613	178,409	48,934	109,331	156,187	273,327	273,327	3,058,225
Average Weigted Tariff for	1.729	1.691	1.874	2.053	1.903	1.916	1.660	1.634	1.653	2.003	1.833	1.774	**1.800**
Cost of TGeneration	**21,831,269**	**11,881,179**	**16,170,949**	**11,341,882**	**35,563**	**35,563**	**33,429**	**0**	**11,672,676**	**23,563,619**	**20,992,724**	**28,573,190**	**146,132,043**
8.186	14,055,536	11,860,991	11,617,153	3,927,538	0	0	0	0	6,304,962	13,411,106	12,636,049	13,863,949	87,677,285
9.015	7,240,771	0	2,915,489	2,186,617	0	0	0	0	9,590	4,296,511	4,622,585	10,453,564	31,725,128
9.488 11.143	534,962	20,187	1,638,307	5,227,727	35,563	35,563	33,429	0	5,358,123	5,856,002	3,734,090	4,255,678	26,729,631
Average Weigted Tariff for	0.847	0.819	0.853	0.952	1.114	1.114	0	0	0.932	0.892	0.878	0.883	**0.878**
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Average Weigted Energy Tariff (TeTri)	3.958	3.041	3.565	3.422	1.908	1.920	1.664	1.634	3.275	5.014	4.042	4.571	**3.191**

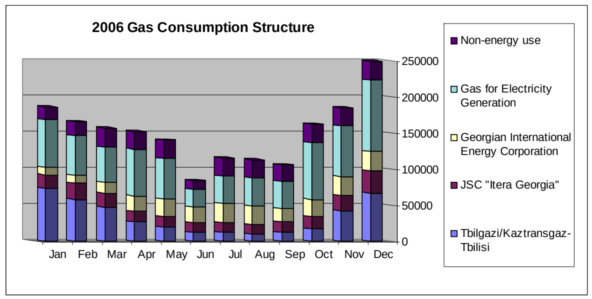


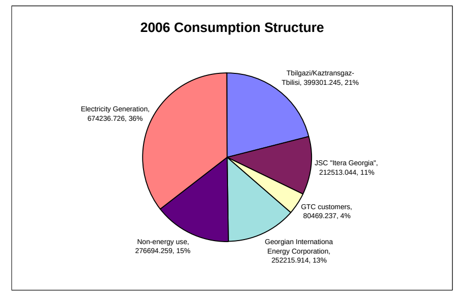
Appendix 5

Gas Consumption 2006

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	**Total**
Tbilgazi/Kaztransgaz-Tbilisi	73248.49	58220.97	47019.70	26882.94	19879.32	12422.46	12252.80	10385.01	12825.46	17321.82	42245.83	66596.46	**399301.25**
JSC "Itera Georgia"	18750.96	22103.38	19744.17	14683.03	14226.55	13068.75	13495.99	13188.25	14070.91	17231.99	21162.10	30786.96	**212513.04**
GTC customers	12721.31	12888.08	11192.43	6389.62	3627.83	4070.22	4980.93	5358.36	40.91	4081.96	6832.47	8285.13	**80469.24**
Georgian International Energy Corporation	10495.40	10961.12	15400.73	21502.49	24745.59	22269.73	26641.21	25378.36	18182.92	23696.46	26098.52	26843.39	**252215.91**
Mtkvari TPP	40462.52	42447.41	17915.78	40433.54	44630.48	0.00	0.00	0.00	23744.93	47119.21	43990.07	49075.89	**349819.84**
Tbilsresi TPP	25107.47	12830.45	28899.09	19992.85	9341.78	13402.14	25119.66	27524.12	0.00	16068.98	16382.33	38071.95	**232740.81**
Gardabani Gas Turbine	0.00	0.00	1681.73	3734.07	1687.54	10717.76	12662.04	11235.81	13909.47	14931.63	9763.81	11352.23	**91676.07**
Non-energy use	17965.37	19127.01	25810.76	24740.86	25863.84	12594.52	25332.60	25144.20	23417.98	25391.54	24744.94	26560.66	**276694.26**
Total	169603.13	166768.43	158263.66	153356.90	141057.35	84475.84	115504.30	112855.75	106192.58	162259.20	185141.54	250749.29	**1806227.96**
Gas for Electricity Generation	*65569.99*	*55277.85*	*48496.60*	*64160.46*	*55659.80*	*24119.90*	*37781.70*	*38759.93*	*37654.40*	*78119.82*	*70136.20*	*98500.08*	**674236.73**





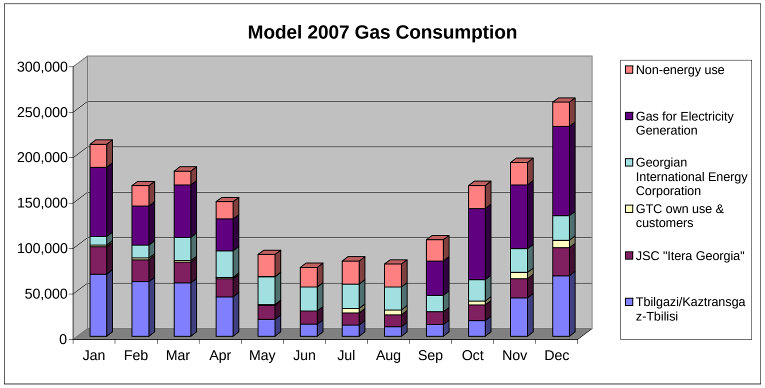


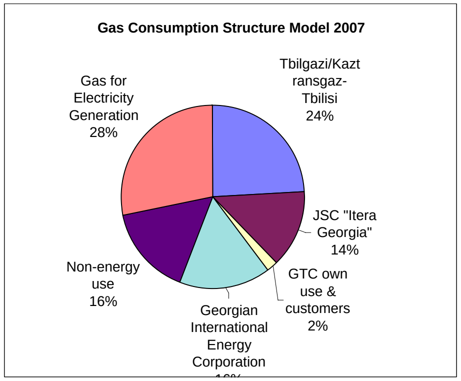
		2006				2007							
	Total	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
Tbilgazi/Kaztransgaz-Tbilisi	399301.25	12825.46	17321.82	42245.83	66596.46	68373.41	60069.42	58624.74	43198.56	18745.23	13244.05	12252.80	10385.01
JSC "Itera Georgia"	212513.04	14070.91	17231.99	21162.10	30786.96	30032.08	24169.78	22915.36	20039.06	15505.37	14542.60	13495.99	13188.25
GTC customers	80469.24	40.91	4081.96	6832.47	8285.13	1999.82	1797.37	1804.23	1623.76	645.45	0.00	4980.93	5358.36
Georgian International Energy Corporation	252215.91	18182.92	23696.46	26098.52	26843.39	9344.16	14219.34	25551.23	29245.70	30615.27	26200.32	26641.21	25378.36
Mtkvari TPP	349819.84	23744.93	47119.21	43990.07	49075.89	49455.16	42807.36	42500.81	14138.51	0.00	0.00	0.00	0.00
Tbilsresi TPP	232740.81	0.00	16068.98	16382.33	38071.95	25063.82	0.00	10426.29	7317.66	32.75	0.00	0.00	0.00
Gardabani Gas Turbine	91676.07	13909.47	14931.63	9763.81	11352.23	1738.35	303.57	4804.25	13451.89	117.68	132.82	0.00	0.00
Non-energy use	276694.26	23417.98	25391.54	24744.94	26560.66	25171.53	22334.49	15096.78	19003.55	24279.51	21568.59	25332.60	25144.20
Total	**1895430.43**	**106192.58**	**162259.20**	**185141.54**	**250749.29**	**211178.32**	**165701.32**	**181723.69**	**148018.68**	**89941.25**	**75688.38**	**82703.53**	**79454.18**
Electricity Generation	674236.73	37654.40	78119.82	70136.20	98500.08	76257.33	43110.93	57731.35	34908.06	150.43	132.82	0.00	0.00
		242604.63	197102.83	179599.84	154119.31	100294.19	80214.36	85873.19	82648.02	109111.61	168722.44	194758.60	**261251.96**

Model 2007 Gas Consumption

54,595,509	57,372,107	47,019,704	26,882,937	19,879,318	12,422,460	12,252,801	10,385,008	12,825,459	17,321,819	42,245,827	66,596,460

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	TOTAL
Tbilgazi/Kaztransgaz-Tbilisi	68373.41	60069.42	58624.74	43198.56	18745.23	13244.05	12252.80	10385.01	12825.46	17321.82	42245.83	66596.46	**423882.79**
JSC "Itera Georgia"	30032.08	24169.78	22915.36	20039.06	15505.37	14542.60	13495.99	13188.25	14070.91	17231.99	21162.10	30786.96	**237140.45**
GTC own use & customers	1999.82	1797.37	1804.23	1623.76	645.45	0.00	4980.93	5358.36	40.91	4081.96	6832.47	8285.13	**37450.38**
Georgian International Energy Corporation	9344.16	14219.34	25551.23	29245.70	30615.27	26200.32	26641.21	25378.36	18182.92	23696.46	26098.52	26843.39	**282016.88**
Mtkvari TPP	49455.16	42807.36	42500.81	14138.51	0.00	0.00	0.00	0.00	23744.93	47119.21	43990.07	49075.89	**312831.93**
Tbilsresi TPP	25063.82	0.00	10426.29	7317.66	32.75	0.00	0.00	0.00	0.00	16068.98	16382.33	38071.95	**113363.78**
Gardabani Gas Turbine	1738.35	303.57	4804.25	13451.89	117.68	132.82	0.00	0.00	13909.47	14931.63	9763.81	11352.23	**70505.69**
Non-energy use	25171.53	22334.49	15096.78	19003.55	24279.51	21568.59	25332.60	25144.20	23417.98	25391.54	24744.94	26560.66	**278046.35**
Total	211178.32	165701.32	181723.69	148018.68	89941.25	75688.38	82703.53	79454.18	106192.58	162259.20	185141.54	250749.29	***1738751.95***
Gas for Electricity Generation	76257.33	43110.93	57731.35	34908.06	150.43	132.82	0.00	0.00	37654.40	78119.82	70136.20	98500.08	**496701.40**





Appendix 6.

Gas Use for Heating 2007

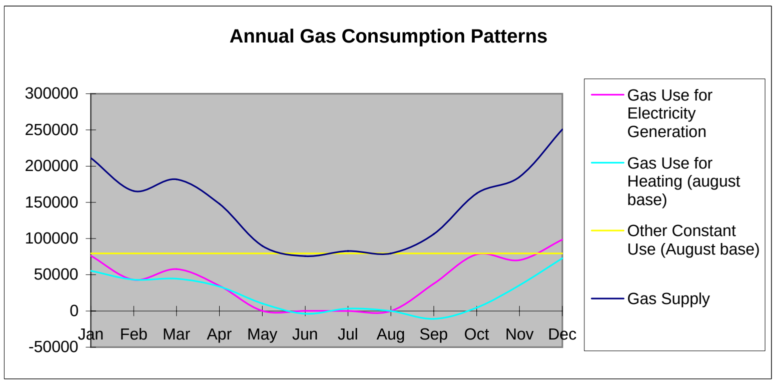
Breakdown by Use

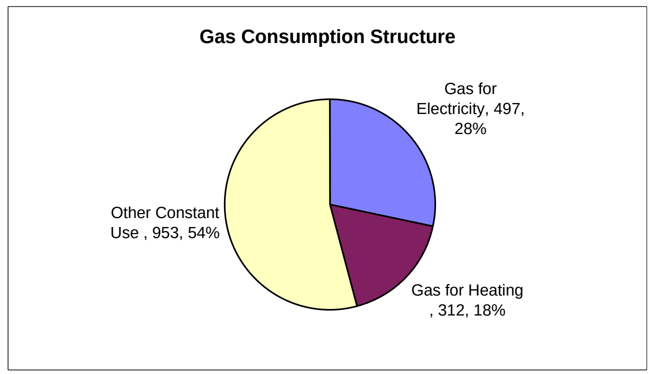
Model Electricity Supply 2007

Electricity Generation, 2007	January	February	March	April	May	June	July	August	September	Octomber	November	December	Sum
Hydro Plant Generation	521.70	553.25	557.00	530.63	647.67	607.40	796.73	776.19	466.84	343.00	512.88	492.90	**6,413.27**
Thermal Generation	257.66	145.11	189.47	119.15	0.32	0.32	0.00	0.00	125.21	264.04	239.15	323.51	**1,663.94**
Import	49.60	44.50	48.50	55.20	3.20	3.90	0.00	0.00	3.80	10.70	0.10	45.50	**265.00**
Generation Losses and Own Consumption	22.80	16.50	19.20	14.60	9.10	8.50	11.81	9.66	14.00	20.60	21.50	26.30	**194.57**
Net Supply=Generation+Import-Generation Losses	**806.16**	**726.35**	**775.77**	**690.38**	**642.09**	**603.12**	**588.19**	**570.34**	**581.85**	**597.14**	**730.63**	**835.61**	**8,147.63**

Model Gas Supply 2007

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Gas Supply	**211178**	**165701**	**181724**	**148019**	**89941**	**75688**	**82704**	**79454**	**106193**	**162259**	**185142**	**250749**	1738752
Gas Use for Electricity Generation	76257	43111	57731	34908	150	133	0	0	37654	78120	70136	98500	496701
Gas Consumption ex. electricity generation	134921	122590	123992	113111	89791	75556	82704	79454	68538	84139	115005	152249	
Gas Use for Heating (August base)	55467	43136	44538	33656	10337	-3899	3249	0	-10916	4685	35551	72795	**288600**
Gas Use for Heating (June base)	59365	47035	48437	37555	14235	0	7148	3899	-7017	8584	39450	76694	**335384**
Other Constant Use (August base)	79454	79454	79454	79454	79454	79454	79454	79454	79454	79454	79454	79454	953450
Other Constant Use (June base)	75556	75556	75556	75556	75556	75556	75556	75556	75556	75556	75556	75556	906667





Appendix 7.

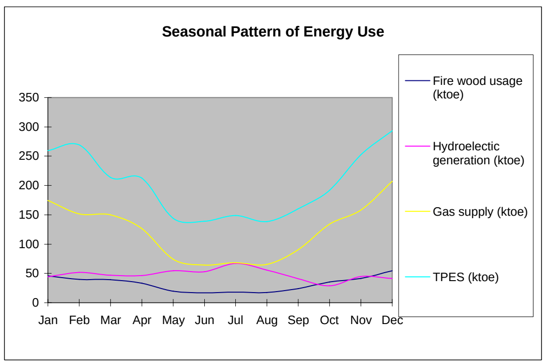
Seasonality and External Energy Dependence Parameters

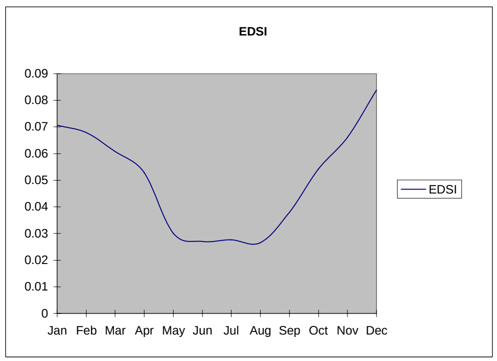
									125.21	264.04	239.15		
Electricity Supply	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	
Thermal Generation	257.66	145.11	189.47	**119.15**	0.32	0.32	0.00	0.00	125.21	264.04	239.15	323.51	**1,663.9**
Import	49.60	44.50	48.50	55.20	3.20	3.90	0.00	0.00	3.80	10.70	0.10	45.50	**265.0**
Export	-6.70	-7.20	-9.70	-7.10	-64.30	-68.60	-208.40	-180.50	-31.40	-0.60	-17.20	-12.60	**1,928.9**
Hydroelectric generation	521.70	553.25	557.00	530.63	647.67	607.40	796.80	656.80	466.84	343.00	512.88	492.90	**6,686.9**
Generation Losses and Own Co	22.80	16.50	19.20	14.60	9.10	8.50	11.81	9.66	14.00	20.60	21.50	26.30	**194.6**
Total Consumption	799.46	719.15	766.07	683.28	577.79	534.52	576.59	466.64	550.45	596.54	713.43	823.01	**10,350.2**

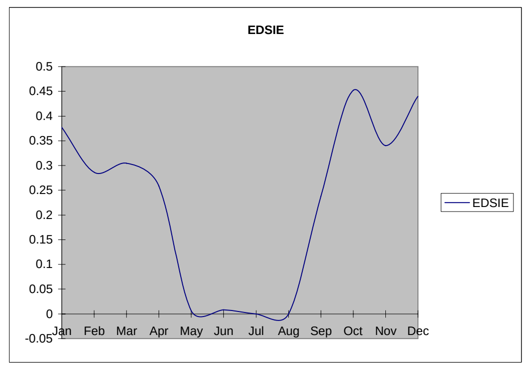
GAS SUPPLY	**Jan**	**Jan**	**Jan**	**Jan**	**Jan**	**Jan**	**Jan**	**Jan**	**Jan**	**Jan**	**Jan**	**Jan**	
Gas use (kcm)	211178.322	165701.323	181723.688	148018.681	89941.248	75688.378	82703.532	79454.176	106192.579	162259.2	185141.54	250749.286	1,738,752
Gas losses (est.)	9,105.15	7,144.37	7,835.19	6,381.97	3,877.90	3,263.38	3,565.84	3,425.74	4,578.59	6,995.96	7,982.55	10,811.29	74967.95
Gas supply	**220,283.48**	**172,845.69**	**189,558.88**	**154,400.65**	**93,819.15**	**78,951.75**	**86,269.37**	**82,879.92**	**110,771.17**	**169,255.16**	**193,124.09**	**261,560.58**	1,813,719.90
Gas supply for heating (mcm)	59232.614	46902.02	48303.963	37422.241	14102.443	-132.815	7015.154	3765.798	-7150.202	8451.007	39316.961	76560.83	333790.0

Total Energy Supply	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	
Fire wood usage (ktoe)	45.9	39.9	39.5	33.2	19.5	17.0	18.0	17.3	23.8	35.3	41.6	54.5	385.3
Hydroelectic generation (ktoe)	44.0	51.7	47.0	46.3	54.7	53.0	67.2	55.4	40.7	28.9	44.7	41.6	575.2
Gas supply (ktoe)	174.4	151.5	150.1	126.3	74.3	64.6	68.3	65.6	90.6	134.0	158.0	207.1	1465.0
Net Electricity Import	3.6	3.6	3.0	4.3	-5.1	-5.7	-17.3	-15.5	-2.5	0.8	-1.5	2.7	-29.6
TPES (ktoe)	259.4	269.1	213.7	212.7	143.7	139.0	148.6	138.3	160.4	191.8	252.4	293.4	2422.4

	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	
30.4	31	28	31	30	31	30	31	31	30	31	30	31	**EDSI**
EDSI	**7.1%**	**6.8%**	**6.1%**	**5.3%**	**3.0%**	**2.7%**	**2.8%**	**2.7%**	**3.8%**	**5.4%**	**6.6%**	**8.4%**	**60.6%**
													EDSIE
EDSIE	**37.7%**	**28.6%**	**30.5%**	**25.9%**	**0.6%**	**0.8%**	**0.0%**	**0.0%**	**23.8%**	**45.2%**	**34.0%**	**44.0%**	**271.0%**
	3.0%	**1.8%**	**2.3%**	**1.7%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**1.2%**	**2.7%**	**2.3%**	**3.6%**	**18.6%**



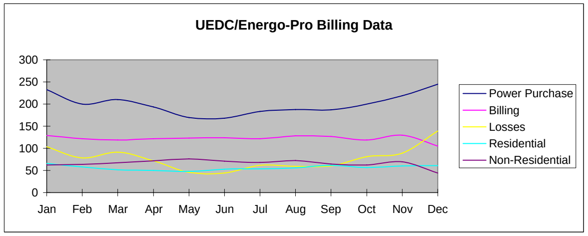


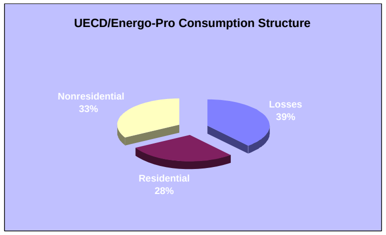


APPENDIX 8.

UEDC/Energo-Pro Consumption Structure

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Power Purchase	232.50	200.10	210.30	193.30	169.30	168.00	183.27	187.42	186.70	199.90	218.60	244.60	2,393.99
Billing	128.62	121.56	118.93	121.64	123.34	123.78	121.64	128.03	126.53	118.86	129.78	105.41	1,468.12
Losses	103.88	78.54	91.37	71.66	45.96	44.22	61.62	59.40	60.17	81.04	88.82	139.19	925.87
Residential	65.96	57.80	51.46	49.86	47.50	52.65	53.87	55.74	61.84	56.24	59.92	61.09	673.94
Non-Residential	62.67	63.76	67.47	71.78	75.84	71.13	67.77	72.28	64.69	62.62	69.86	44.32	794.18





MOTOR INTENSIVE ENTERPRISES

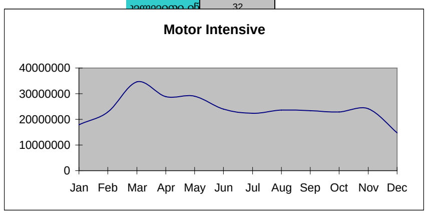
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
31	28	31	30	31	30	31	31	30	31	30	31
1,099,789	1,119,091	1,338,069	1,808,467	1,100,224	1,037,076	1,219,799	1,259,634	1,175,215	1,186,841	1,242,402	924,547
1,219,996	1,721,138	873,114	799,742	810,548	616,406	560,433	481,361	452,128	658,249	1,094,910	460,170
732,596	859,820	789,313	1,240,154	947,324	782,098	685,561	616,280	551,702	518,910	938,475	660,940
3,971,254	8,471,544	3,968,450	10,208,354	9,309,757	8,985,518	8,133,910	8,908,703	9,018,919	8,857,862	7,430,505	5,448,719
9,200,106	7,800,404	26,169,518	13,449,440	15,448,667	11,211,641	10,705,779	10,814,386	10,770,057	9,967,785	12,148,400	5,786,036
668,986	1,904,341	692,461	928,160	871,863	1,084,243	749,066	1,063,997	860,497	883,363	654,531	499,659
986,974	1,030,216	786,689	466,473	483,992	330,099	366,883	514,570	496,052	773,950	602,210	917,423
17,879,733	**22,906,582**	**34,617,644**	**28,900,820**	**28,972,407**	**24,047,111**	**22,421,461**	**23,658,962**	**23,324,602**	**22,846,992**	**24,111,462**	**14,697,526**

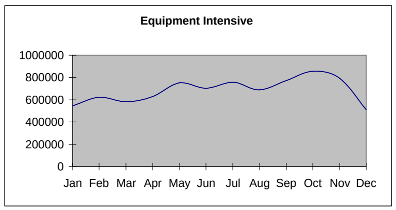
Equipment Intensive

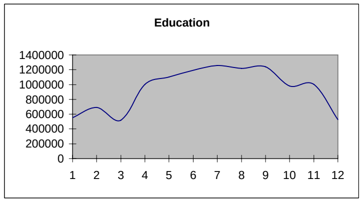
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
228,981	301,530	271,223	251,373	386,730	330,338	358,172	331,889	414,199	363,070	326,134	226,102
108,262	118,442	113,160	162,472	128,209	134,861	150,762	117,218	113,342	176,538	196,985	92,403
200,135	191,051	186,590	200,325	212,869	209,600	221,399	211,466	215,366	197,297	256,117	183,244
6,913	10,143	10,728	13,950	24,355	27,247	27,830	27,247	28,461	118,009	13,184	8,375
544,291	**621,166**	**581,702**	**628,120**	**752,164**	**702,045**	**758,163**	**687,819**	**771,368**	**854,914**	**792,420**	**510,124**

Education

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
157,767	103,607	132,136	198,316	285,897	282,705	346,841	342,560	345,466	281,396	433,378	185,082
48,852	45,557	63,127	47,798	85,884	96,497	96,714	106,752	84,820	70,609	53,039	31,470
27,451	258,388	9,766	131,326	20,119	17,107	25,936	21,444	20,863	20,984	87,509	23,256
40,817	41,201	49,980	37,522	40,771	50,543	47,285	32,896	42,809	36,100	61,588	51,759
208,405	172,803	206,379	501,728	478,024	585,336	563,072	620,350	604,777	461,595	269,292	155,937
67,682	70,984	55,391	85,973	189,996	162,468	175,729	93,470	140,436	110,612	97,774	81,515
550,973	**692,540**	**516,779**	**1,002,663**	**1,100,691**	**1,194,656**	**1,255,577**	**1,217,473**	**1,239,172**	**981,295**	**1,002,580**	**529,019**







OFFICES

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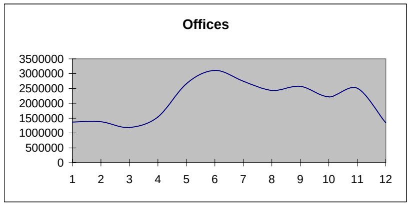
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
72,918	62,335	86,336	103,787	125,553	163,604	150,933	137,522	300,541	136,960	104,783	91,568
850,956	815,098	713,702	873,041	1,721,691	2,143,520	1,727,356	1,531,997	1,471,132	1,381,155	1,892,456	750,605
195,748	242,401	194,976	281,114	487,559	414,530	474,698	429,769	448,991	346,405	263,777	307,741
182,669	228,165	173,411	236,724	268,115	320,753	333,114	263,944	276,780	294,805	213,246	168,412
60,516	28,017	16,408	45,540	58,222	71,446	60,936	75,526	80,869	58,655	36,899	26,527
1,362,807	**1,376,016**	**1,184,833**	**1,540,206**	**2,661,141**	**3,113,853**	**2,747,036**	**2,438,757**	**2,578,313**	**2,217,981**	**2,511,162**	**1,344,853**

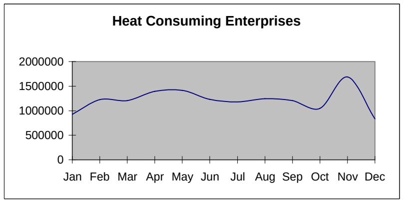
Heat Consumers

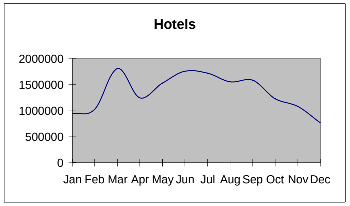
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
174,869	223,512	199,801	338,875	317,588	226,514	313,435	433,584	356,069	262,246	199,708	164,927
442,850	614,491	554,845	548,412	643,545	546,644	487,263	460,697	511,885	399,082	1,064,001	398,297
310,173	388,166	449,391	503,846	452,991	460,119	380,694	347,269	340,438	387,930	424,016	269,938
927,893	**1,226,169**	**1,204,037**	**1,391,133**	**1,414,124**	**1,233,278**	**1,181,392**	**1,241,550**	**1,208,391**	**1,049,257**	**1,687,725**	**833,162**

HOTELS

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
943,455	1,026,090	1,815,726	1,246,856	1,529,352	1,759,774	1,720,621	1,555,094	1,588,124	1,229,144	1,085,305	767,551







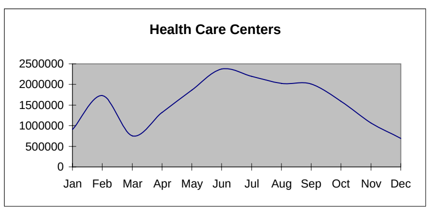
Health Care Centers

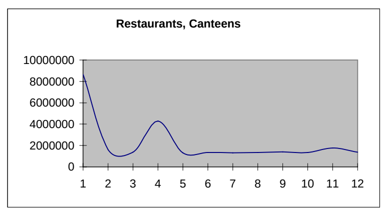
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
439,038	493,050	368,411	497,893	779,819	908,694	855,152	781,546	787,150	640,462	517,272	358,599
424,908	1,222,095	358,720	616,539	1,011,955	1,395,404	1,267,679	1,183,707	1,164,110	898,035	517,457	315,878
45,348	19,687	26,719	208,450	72,557	74,383	71,019	59,928	63,436	53,094	32,707	16,323
909,294	**1,734,832**	**753,850**	**1,322,882**	**1,864,331**	**2,378,481**	**2,193,850**	**2,025,181**	**2,014,696**	**1,591,591**	**1,067,436**	**690,799**

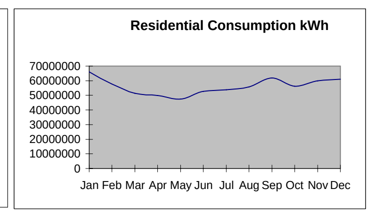
Restaurants & Canteens

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
363,117	413,784	479,246	442,107	432,631	385,084	390,372	438,067	404,242	385,186	472,005	395,962
8,290,903	1,200,795	903,040	3,839,836	886,705	966,370	913,357	910,996	995,340	958,450	1,291,105	972,364
8,654,020	**1,614,580**	**1,382,285**	**4,281,943**	**1,319,336**	**1,351,454**	**1,303,729**	**1,349,063**	**1,399,582**	**1,343,636**	**1,763,110**	**1,368,326**
143,454	238,757	185,955	125,250	205,584	252,209	255,758	247,832	213,479	194,768	238,191	120,677
1,724,373	1,907,222	1,904,985	1,608,402	1,620,440	1,773,691	1,835,047	1,933,398	1,606,463	1,597,471	2,128,167	1,539,534
201,588	125,296	137,313	145,622	165,587	209,473	180,994	187,698	174,672	153,881	188,845	127,514
2,069,415	**2,271,274**	**2,228,252**	**1,879,274**	**1,991,610**	**2,235,373**	**2,271,799**	**2,368,928**	**1,994,614**	**1,946,119**	**2,555,202**	**1,787,725**
29,191	22,967	23,690	27,568	35,310	38,939	39,245	30,836	34,334	31,567	28,619	22,125

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
303,580	278,077	703,057	775,781	830,780	737,406	730,038	1,759,117	1,207,336	625,834	562,828	241,594
18,456	10,141	16,044	16,934	30,425	43,032	32,551	35,394	34,012	20,472	22,642	21,478
47,504	43,651	42,705	50,343	65,054	89,337	72,421	66,194	65,758	63,109	65,568	54,655
369,540	**331,869**	**761,806**	**843,058**	**926,260**	**869,775**	**835,010**	**1,860,705**	**1,307,105**	**709,415**	**651,038**	**317,727**
65,955,170	**57,800,631**	**51,457,557**	**49,855,653**	**47,501,365**	**52,652,232**	**53,870,246**	**55,744,237**	**61,842,152**	**56,244,574**	**59,921,779**	**61,091,492**
257,894	305,004	197,984	279,807	288,984	324,515	285,085	237,351	300,122	290,272	199,184	160,139
56,832	73,462	50,095	141,977	51,505	57,984	47,422	58,527	58,980	36,585	56,037	48,421
109,392	145,088	117,142	140,681	172,296	155,798	240,208	178,279	148,994	132,878	182,463	182,082
126,810	365,741	234,563	972,047	104,631	66,625	57,901	90,076	72,274	63,375	135,561	157,490
1,040,410	1,158,289	1,154,147	1,318,596	1,300,015	1,331,181	1,142,732	1,290,472	1,123,297	938,982	1,426,677	1,013,371
126,565	28,423	46,396	116,623	109,325	121,700	81,317	104,510	106,187	92,285	68,181	29,840
39,580	29,015	16,938	17,767	24,032	25,198	29,191	28,033	25,679	18,888	45,736	27,434
328,779	393,321	417,096	921,826	561,719	820,619	952,032	730,647	795,380	712,667	489,738	386,895
4,432,919	5,640,579	6,084,026	8,479,180	10,960,554	9,706,444	11,619,464	14,791,621	6,445,560	9,143,972	13,278,656	6,110,998
1,042,422	1,306,080	1,441,902	2,530,181	3,730,781	2,745,096	2,558,227	2,352,599	2,816,515	3,000,641	1,333,236	908,982
713,265	2,179,866	1,008,687	1,370,419	1,328,755	1,284,457	1,210,706	863,400	278,711			
13,083,318	13,788,151	15,838,854	12,662,039	12,656,411	14,048,309	12,172,492	14,523,191	12,145,578			
14,918,686	**17,303,843**	**15,355,161**	**17,013,578**	**19,862,115**	**11,892,988**	**14,430,546**	**17,215,468**	**9,025,651**			





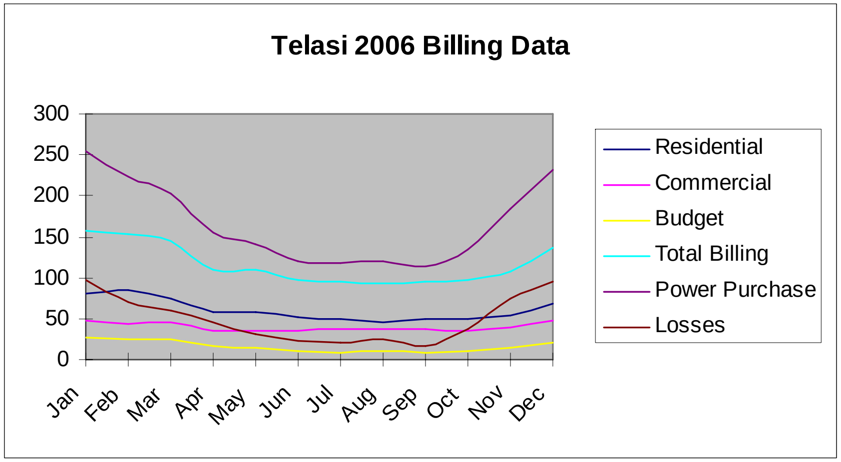


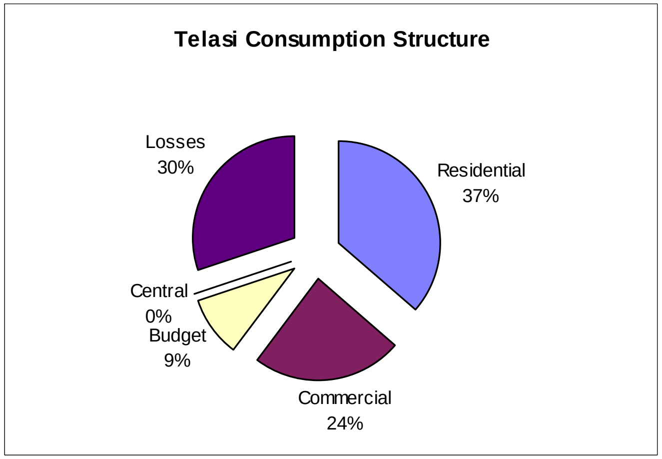
APPENDIX 9

Telasi 2006 Billing Data (GWh billed)

Telasi Data

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Residential	80.61	85.2	74.82	58.55	58.45	52.15	49.86	46.11	49.47	50.64	54.39	67.55	727.8
Commercial	47.73	44.42	44.91	35.25	35.06	35.24	36.83	37.62	37.4	35.85	39.34	48.26	477.91
Budget	27.89	23.98	24.33	16.35	15.29	9.49	9.05	9.87	8.56	10.34	13.98	19.66	188.79
Central	0.3	0.16	0.22	0.18	0.15	0.14	0.14	0.14	0.72	0.65	0.79	0.68	4.28
Total Billing	156.53	153.76	144.28	110.33	108.95	97.02	95.88	93.74	96.15	97.48	108.50	136.15	1398.77
Power Purchase	254.68	223.79	203.45	154.82	139.84	120.09	117.59	119.26	113.13	134.31	183.78	231.13	1995.87
Losses	98.15	70.03	59.17	44.49	30.89	23.07	21.71	25.52	16.98	36.83	75.28	94.98	597.10



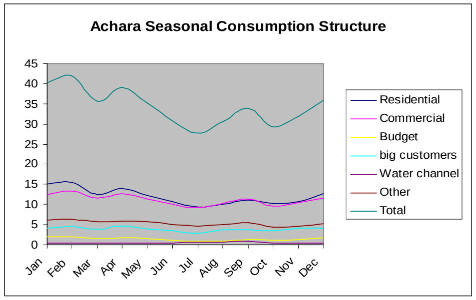


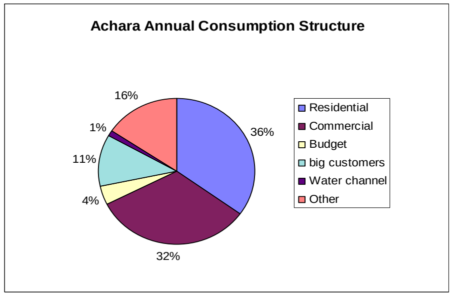
APPENDIX 10

Achara Billing Data

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Residential	15,364,872	14,218,855	12,702,147	13,762,336	12,515,358	10,494,598	9,647,888	10,182,153	11,082,668	10,394,576	10,625,420	12,984,001	143,974,873
Commercial	12,755,038	12,205,980	11,753,074	12,439,565	11,652,235	9,903,816	9,262,606	10,510,844	11,105,104	9,746,491	10,382,009	11,764,124	133,480,886
Budget	1,957,796	1,773,270	1,637,883	1,727,660	1,491,605	1,033,579	967,981	995,443	1,188,489	1,148,220	1,277,793	1,711,242	16,910,961
big customers	4,234,074	4,161,912	3,968,529	4,454,156	3,903,069	3,352,899	2,933,759	3,736,610	3,701,107	3,522,721	4,183,989	4,224,087	46,376,912
Water channel	347,130	346,286	464,113	382,043	398,961	519,254	593,165	585,003	765,847	516,231	489,507	402,687	5,810,227
Other	6,216,038	5,924,512	5,682,549	5,875,707	5,858,600	4,998,084	4,767,702	5,193,788	5,449,662	4,559,318	4,430,719	5,426,108	64,382,785
Refugees	208,189	124,202	234,534	172,560	473,441	80,220	283,980	131,557	67,560	63,480	93,610	135,790	2,069,123
Other	6,007,849	5,800,310	5,448,015	5,703,147	5,385,159	4,917,864	4,483,722	5,062,231	5,382,102	4,495,838	4,337,109	5,290,318	62,313,662

30.4	31	28	31	30	31	30	31	31	30	31	30	31	
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Residential	15.08	15.45	12.46	13.95	12.28	10.64	9.47	9.99	11.24	10.20	10.77	12.74	143.97
Commercial	12.52	13.26	11.53	12.61	11.43	10.04	9.09	10.31	11.26	9.56	10.53	11.54	133.48
Budget	1.92	1.93	1.61	1.75	1.46	1.05	0.95	0.98	1.20	1.13	1.30	1.68	16.91
big customers	4.15	4.52	3.89	4.52	3.83	3.40	2.88	3.67	3.75	3.46	4.24	4.14	46.38
Water channel	0.34	0.38	0.46	0.39	0.39	0.53	0.58	0.57	0.78	0.51	0.50	0.40	5.81
Other	6.10	6.44	5.58	5.96	5.75	5.07	4.68	5.10	5.53	4.47	4.49	5.32	64.38
Total	40.11	41.97	35.53	39.18	35.15	30.72	27.64	30.62	33.76	29.33	31.83	35.83	410.94





APPENDIX 11

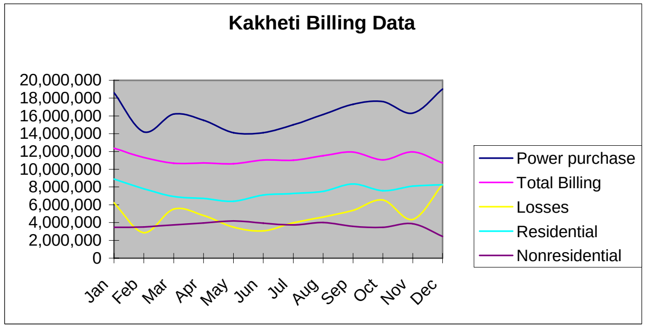
KAKHETI DATA RECONSTRUCTION

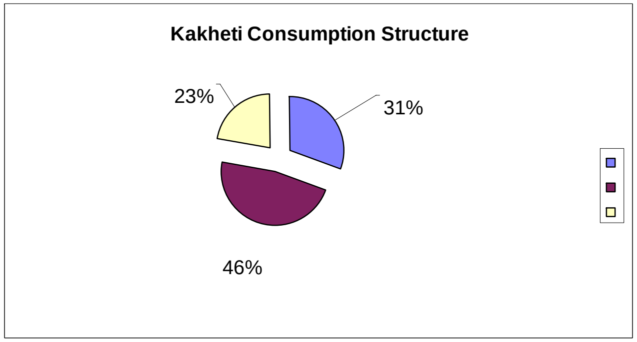
Based on may 2007 data

Billing		commercial	direct consumers	35kv	Nonresidential	Residential			Total Residential
						1-100	100-300	>300	
10,613,361		2627447	1470549	95200	4193196	5410281	726399	273889	6,410,569

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
UDC												
Residential	65,955,170	57,800,631	51,457,557	49,855,653	47,501,365	52,652,232	53,870,246	55,744,237	61,842,152	56,244,574	59,921,779	61,091,492
Nonresidential	62,669,512	63,762,379	67,472,467	71,779,761	75,838,555	71,127,411	67,773,888	72,281,618	64,686,025	62,615,625	69,858,088	44,318,848
Residential Pattern	1.39	1.22	1.08	1.05	1.00	1.11	1.13	1.17	1.30	1.18	1.26	1.29
Nonresidential Pattern	0.83	0.84	0.89	0.95	1.00	0.94	0.89	0.95	0.85	0.83	0.92	0.58

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Power purchase	18,600,000	14,200,000	16,200,000	15,500,000	14,100,000	14,100,000	15,000,000	16,150,000	17,300,000	17,600,000	16,300,000	19,000,000	**194,050,000**
Total Billing	12,366,076	11,326,002	10,675,105	10,697,074	10,603,765	11,038,418	11,017,376	11,519,519	11,922,497	11,052,599	11,949,301	10,695,068	**134,862,801**
Losses	6,233,924	2,873,998	5,524,895	4,802,926	3,496,235	3,061,582	3,982,624	4,630,481	5,377,503	6,547,401	4,350,699	8,304,932	**59,187,199**
Residential	8,901,011	7,800,511	6,944,479	6,728,293	6,410,569	7,105,707	7,270,084	7,522,990	8,345,937	7,590,513	8,086,772	8,244,631	**90,951,496**
Nonresidential	3,465,065	3,525,491	3,730,626	3,968,781	4,193,196	3,932,712	3,747,292	3,996,529	3,576,560	3,462,086	3,862,529	2,450,437	**43,911,305**





APPENDIX 12

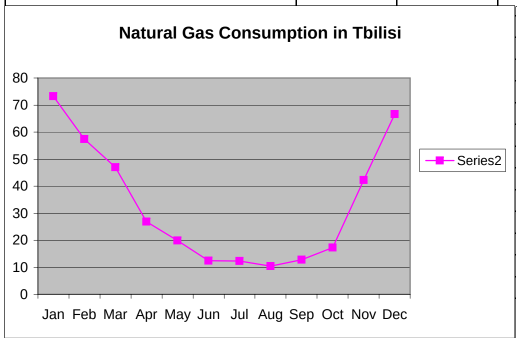
Kaztransgaz Natural Gas Purchase and Distribution According to Billing Data

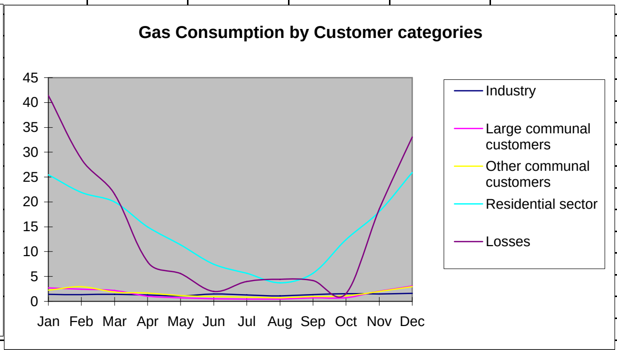
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Sum	
Purchased by ltd. "Kaztransgaz-Tbilisi" In total	106169112	73360676	75918793	46875784	29221100	12422460	12252801	10385008	12825459	17321819	42245827	66596460	505595299	
"Mtkvari Energetika" IX block	7813157	3158123											10971280	
"Tbilsresi"	25107468	12830446	28899089	19992847	9341782								96171632	
Received in the city in Total	73248487	57372107	47019704	26882937	19879318	12422460	12252801	10385008	12825459	17321819	42245827	66596460	*398452387*	119535716
Total realization, among this	31824270	28686694	25488507	18935780	14313264	10440159	8266563	5944268	8678483	15788223	23636316	33539410	220263751	178188636
Didi diRomi	757280	798602	637558	318646	216968	128270	113912	86334	123321	183231	651672	1066168	5081962	
Ltd "varkeTilairi"	801011	927102	731262	404652	265863	144412	136864	113772	152576	235631	664356	1145884	5723385	
Ltd "gardabangazi" (Kojori)	30150	24697	17113	8592	13926	3574	12115	9134	6042	7016	24523	26726	183608	
Ltd "iberia-2004" (Krtsanisi village)	17400	52589	17437	0	0	0	0	2696	7603	14578	37563	0	149866	
Tsavkisi-Shindisi	66300	71515	63509	33222	20940	12712	17100	15317	17631	35231	72234	88630	514341	
Tabaxmela	0	0	0	0	0	4253	6649	3239	4106	7035	4410	4935	34627	
Ltd "Vake"	0	0	0	9010	735	1193	1710	1917	2620	2900	4900	9000	33985	
Industry	1425694	1366363	1444730	1274589	1071107	1471704	1313143	1082741	1360065	1539998	1509480	1578542	16438156	
Large communal customers	2723384	2421620	2167685	1044845	719636	537531	440365	441306	721285	733272	2051788	3075560	17078277	
Communal customers									429832	508305	1039890	1539580	3517607	
Small communal customers	2101112	2845953	1805648	1609295	1116879	972496	785576	654641	483443	535002	876537	1328203	15114785	
Tax-free (embassies)	131674	103672	67089	47555	56966	19043	49349	31264	38459	39822	81773	114147	780813	
Residential sector, emong this:	23770265	20074581	18536476	14185374	10830244	7144971	5389779	3501907	5331500	11946202	16617190	23562035	155612339	
Samgori	2224134	1588869	1664331	1245516	1177789	641203	555082	351743	8	1240867	1416118	1950285	14055945	
Gldani	2033911	1463042	1533634	1356946	1155340	566745	397997	341859	1215	1078260	1477125	2137297	13543371	
Digomi	1170742	827151	887579	689004	383109	409944	308481	109118	400	526231	773189	1086432	7171380	
Chugureti	1413360	998994	1141389	741416	754691	546154	474024	238109	2246	781182	963076	1243916	9298557	
Saburtalo	3738837	3551072	2795832	2057451	1502349	1012154	757195	383077	27876	1574713	2592539	3620832	23613927	
Vake-Tskneti	2671856	2656153	2136121	1591908	1246186	460323	449994	310127	5259	1126020	1880801	2552745	17087493	
Mtatsminda	2054464	2090674	1506808	1428705	711551	513240	343734	264272	2140	924474	1486913	2225895	13552870	
Isani	2192207	1597921	1335506	1005572	627468	532222	433998	276583	846	714049	768239	1099949	10584560	
Vazisubani			439974	478007	280470	194246	161960	77246	243	538490	696579	1046406	3913621	
Saburtalo - Nutsubidze	1800920	1572257	1320587	972732	739122	494492	389572	217666	3441	806413	1365213	1870694	11553109	
Didube	1433162	1071997	1031431	778973	596405	433328	252992	206014	889	658250	898664	1317036	8679141	
Krtsanisi	578667	453939	422138	343768	203550	154958	147460	104314	534	316158	356175	573123	3654784	
Sanzona	2458005	2202512	2321146	998043	965568	662365	421245	381421	1316	979137	1202660	1746931	14340349	
Nadzaladevi				497333	486646	523597	296045	240358	6902	681958	739899	1090494	4563232	
Losses cub.m.	41424217	28685413	21531197	7947157	5566054	1982301	3986238	4440740	4146976	1533596	18609511	33057050	178188636	
%	56.55	50.00	45.79	29.56	28.00	15.96	32.53	42.76	32.33	8.85	44.05	49.64	44.72	

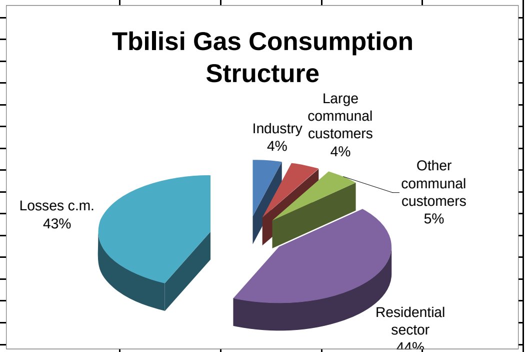
Inaccuracy in data. Has been multiplied by 100

Natural Gas Purchase and Distribution (mcm)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Sum
Industry	1.4	1.4	1.4	1.3	1.1	1.5	1.3	1.1	1.4	1.5	1.5	1.6	16.4
Large communal customers	2.7	2.4	2.2	1.0	0.7	0.5	0.4	0.4	0.7	0.7	2.1	3.1	17.1
Other communal customers	2.2	2.9	1.9	1.7	1.2	1.0	0.8	0.7	1.0	1.1	2.0	3.0	19.4
Residential sector	25.4	21.9	20.0	15.0	11.3	7.4	5.7	3.7	5.6	12.4	18.1	25.9	172.6
Losses	41.4	28.7	21.5	7.9	5.6	2.0	4.0	4.4	4.1	1.5	18.6	33.1	172.9
Gas Purchase	73.2	57.4	47.0	26.9	19.9	12.4	12.3	10.4	12.8	17.3	42.2	66.6	398.5







APPENDIX 13

Summary of Implemented Pilot Projects and Energy Audits

The results of Energy Efficiency Pilot Projects and Energy Audits conducted over a number of years are summarized below in order to provide the guidance on rough estimation of the energy efficiency potential in different sectors of economy of Georgia.

Industrial Entities

- **Water Pipeline**

In the whole Georgia about 100 water pipeline in the distribution companies are registered. Their total annual consumption constitutes 93 mln kWh.

If we follow the "Tbiltskalkanali" data for the year 1999, when drinking water delivery equaled to 203 352 000 m^3/sec and energy consumption – 70 235 302 kWh, energy capacity of drinking water represented 0.345 kWh/m^3. If this specific data are spread upon the regions of Georgia, consumed 92 713 500 kWh shall correspond to 269 mln m^3 water consumed per year.

According to common evaluation, water losses in the result of leakage from pipes and repair works, faulty taps and bolts, low culture of water consumption equals to 20%. If water losses are reduced to 5%, about, 40.3 mln cubic meters of water will be saved per annum equivalent to 13.8 mln kW. The share of lighting in the water pipeline system general energy consumption is insignificant.

- **Manufacturing Base of Tbilisi "Wood Service" LLC**

Below are presented the results of energy audit conducted at a manufacturing base of Tbilisi "Wood Service" LLC (Tbilisi, 14 Peikrebis str.) in 2006 on the basis of the order of energy efficiency centre.

The company is manufacturing window and door frames, parquet, strips.

The aim of the audit was:

- investigation of internal energy resources existing at the plant;
- identification of the possibility of development non-waste production.

During the course of audit there the company's energy data for the year 2004-2005 were used.
In the result of the audit, it was defined, that the installed capacity of the plant constitutes 366 kW. Engine machinery is its basic consumers.

The amount of wood waste equals to 300 t per year and energy potential – 1 281 990 kWh in a year (2 112 working hour per year). This potential can be used for acquiring thermal and electric energies.

Actually, in the result of the waste utilization it is possible to obtain 750 kg/hour steam or 22 t/hour hot water. We can dry 30 m^3 of wood (4-6 days cycle). Through utilization of wood waste according to co-generation scheme there can be obtained the energy of 160 kW capacity and 300 kW of thermal energy.

In the result of gasification of 142 kg/hour waste (607 kW of thermal potential) 355 m^3/hour generator gas (546 kW of thermal capacity) will be obtained.

- **Tbilisi Metro Station "Tavisuplebis Moedani" (Liberty Square))**

We present the data of energy audit for Tbilisi Metropoliten Station "Liberty Square". The audit was conducted in 2006 on the basis of the order of energy efficiency centre.

Average working capacity of Tbilisi Metropoliten – 8-12 MW;
Peak capacity – 15-20 MW;
Energy consumption – 72 mln kWh/year.

The following energy effective measures can be carried out in Tbilisi Metropoliten:

- stabilization of feeding voltage;
- modernization of basic and emergency lighting;
- optimal operation of traction motors;
- optimization of train operation.

In the "Liberty Square" station the measures of equipment feeding voltage stabilization for ventilators, drainage pumps and escalators were studied. Electric feed of the equipment is carried out by means of unstable voltages: 380 (15029%) causing excessive losses in feeding cables and engines (engine burning in some cases).

In order to resolve the problem in escalators, pumps and ventilators feeding lines there are installed voltage correctors providing voltage stabilization by 5%.

Total potential savings are given in the table below:

Name	Saving MWh/year	Saving USD/year	Investment USD
Pump	504.3	24500	31600
Ventilator	195.9	9600	14700
Escalator	699	34300	51000
Total	1399	68370	97300

The period of simple payback is 1.4 year.

Implementation of analogous measures is possible in the rest of the Metro stations (22 stations in total), that will significantly reduce the Metro energy consumption.

- **Rustavi "Kartuli Cementi" LLC**

As a result of conducted energy audit it was determined that in "Klinker" made cement clay drier 50-60% of fuel gas (natural gas) can be saved through utilization of the heat of hot exhaust gases of technological processes in raw material and coal mills.

- **Tbilisi Bread Baking Plant # 14**

The energy audit conducted in 2005 has identified that through elimination of steam and compressed air leakage, replacement of old steam boilers and bread baking ovens, implementation of thermal insulation works it is possible to reduce gas consumption by 20-25%. Annual gas consumption represented 1.13 mln m^3.

- **Mukhiani Water Pumping Station (Tbilisi)**

The working regimes of engines, pumps and transformers were optimized. 514 MWh and USD 16 200 were saved in a year.

- **Tbilisi Metropoliten**

In metro stations “Tsereteli” and “Politeknikuri” energy effective measures of emergency lighting and voltage stabilization were implemented. 1 100 MWh and USD 34 800 were saved in a year. Payback period – 2.6 years.
\

- **“Tolia” Ice Cream Plant**

Refrigerator was replaced and voltage was stabilized. 54 MWh and USD 21 800 were saved in a year. Payback period – 2 years.

- **“Vake” Sausage Plant**

Refrigerator was replaces and voltage was stabilized. 171 MWh and USD 10 100 were saved in a year. Payback period – 2.3 years.

<u>Tertiary Sector</u>

- **Tbilis Children’s Clinic # 1**

Energy efficiency measures of weatherization, lighting and heating were carried out in 2002. 37 MWh and USD 5 950 were saved in a year. Payback period – 4 years.

- **Hotel “Bakuri” (Batumi)**

Energy efficiency measure was carried out. 20.94 MWh and USD 5 950 were saved in a year. Payback period – 1.7 years.

- **Tbilis Youth House (UMCOR)**

Energy efficiency measures of lighting, weatherization and heating were carried out. 39 MWh and USD 3 000 were saved in a year. Payback period – 3 years.

- **National Oncology Centre (Tbilisi)**

Energy efficiency measures of lighting, weatherization and heating were carried out. 69 MWh and USD 9 600 were saved in a year. Payback period – 3 years.

- **v. Rveli o Borjomi Region**

Energy efficiency measures of lighting, weatherization and heating (sawdust stove) were carried out. 24 MWh and USD 3 200 were saved in a year. Payback period – 5 years.

- **Azeri School (Bolnisi region)**

Energy efficiency measures of lighting, weatherization and heating were carried out. 74 MWh and USD 466 were saved in a year. The project was of humanitarian type.

- **Old People's House "Chagara" (Bolnisi)**

Energy efficiency measures of lighting, weatherization and heating (sun collectors) were carried out. 46 MWh and USD 2 460 were saved in a year. Payback period – 4 years.

- **Telavi Daycare School**

Energy efficiency measures of lighting, weatherization and heating were carried out. 79 MWh and USD 3 472 were saved in a year. Payback period – 4.6 years.

- **Bioequipment in Kakheti (Kveda Khodasheni)**

Bioequipment was installed for a farm. 48 MWh and USD 2 700 were saved in a year. Payback period – 3.4 years.

- **Tbilisi Studio**

Energy efficiency measures of lighting, weatherization and heating were carried out. 12.5 MWh and USD 1 526 were saved in a year. Payback period – 2.8 years.

- **Tbilisi Store (Vazha-Pshavela Ave.)**

Energy efficiency measures of lighting, weatherization and heating were carried out. 12.5 MWh and USD 1 637 were saved in a year. Payback period – 2.1 years.

- **Restaurant in Zhinvali**

Energy efficiency measures of lighting, weatherization and heating were carried out. 49 MWh and USD 917 were saved in a year. Payback period – 3.9 years.

- **Eight-storied Dwelling House in Zhinvali**

Energy efficiency measure of weatherization was carried out. 162 MWh and USD 3 100 were saved in a year. Payback period – 3.9 years.

- **Five-storied Dwelling House in Dusheti**

Energy efficiency measure of weatherization was carried out. 80 MWh and USD 1 530 were saved in a year. Payback period – 4.6 years.

- **Restaurant "Aragvi" in Dusheti**

Energy efficiency measures of lighting, weatherization and heating were carried out. 125 MWh and USD 1 420 were saved in a year. Payback period – 6.5 years.

- **Tbilisi Secondary School # 56**

Energy efficiency measures of lighting, weatherization and heating were carried out. 17 MWh and USD 4 700 were saved in a year. Payback period – 3.3 years.

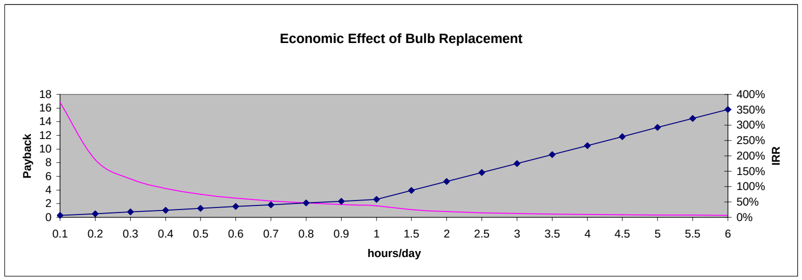
APPENDIX 14.

Distribution of Bulbs By Capacity

Existing incandescent				Replacing fluorescent			
Capacity		Average capacity		Capacity	Replacement capacity		Cost
40	25%	10		9	0.25	2.25	4
60	25%	15		15	0.14	2.15	5.00
75	18%	13.5		20	0.39	7.73	6.00
100	30%	30		25	0.22	5.50	7.00
150	2%	3					5.58
	100%	**71.5**	**wt**	Replacement capacity		**17.63 wt**	

Analysis of a profitability of incandescent bulb replacement

	Incandescent	**Fluorescent**
Quantity%	80%	20%
Bulb cost (GEL)	0.5	7
living period of bulb (hours)	500	4000
Replacement cost	0.5	0.5
Ratio of capacities	100%	25%
Part in total consumption	94.1%	5.88%
Division of bulbs living periods		8
Electricity cost (GEL)		0.16
Norm of discount		12%
Annual duration of calculated lighting (hours)		500
Daily duration of calculated lighting (hours)		1.37



Lighting duration in a day (hours)		1.37	500.05							5.720572		
	1	2	3	4	5	6	7	8	9	10	11	12
Incandescent												
Replacement cost	1	1	1	1	1	1	1	1	1	1	1	1
Electricity expense		5.72	5.72	5.72	5.72	5.72	5.72	5.72	5.72	5.72	5.72	5.72
Total	1	6.72	6.72	6.72	6.72	6.72	6.72	6.72	6.72	6.72	6.72	6.72
Fluorescent												
Replacement cost	7.5	0	0	0	0	0	0	0	0	7.5	0	0
Electricity expense		1.43	1.43	1.43	1.43	1.43	1.43	1.43	1.43	1.43	1.43	1.43
Total	7.5	1.43	1.43	1.43	1.43	1.43	1.43	1.43	1.43	8.93	1.43	1.43
Difference	**-6.5**	**5.29**	**5.29**	**5.29**	**5.29**	**5.29**	**5.29**	**5.29**	**5.29**	**-2.21**	**5.29**	**5.29**
Calculated IRR	**80%**											
Calculated period of payback (year*)	**1.23**											
Calculated NPV (GEL)	**5.5**	Haw to invest money profitable - take annually						80%				
IRR	80.1%											
Period of payback (year*)	1.23											

Calculated period of payback=Investment/(difference of investments+difference of operational costs)

Lighting duration in a day	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1
IRR	5.8%	11.7%	17.5%	23.4%	29.2%	35.1%	40.9%	46.8%	52.6%	58.4%
Period of payback	16.83	8.42	5.61	4.21	3.37	2.81	2.40	2.10	1.87	1.68

Lighting duration in a day	1.5	2	2.5	3	3.5	4	4.5	5	5.5	6
IRR	87.7%	116.9%	146.1%	175.3%	204.5%	233.8%	263.0%	292.2%	321.4%	350.7%
Period of payback	1.12	0.84	0.67	0.56	0.48	0.42	0.37	0.34	0.31	0.28

Appendix 15-1

Lighting Consumption Patterns

In order to provide a cross check to other analytical methods, a model has been developed based on relatively simple assumptions for the behavior of a typical family in Tbilisi. It was assumed that the actual lighting seasonal pattern can be approximated by a model where the average routine times for: waking up, going to work/school, coming home and going to bed, were estimated for the families in Tbilisi. The average lighting use time was estimated based on climatologic and physical geography data for Tbilisi. The differences in sunrise and sunset times, as well as change in luminance due to different angles of sun lighting,[1] were taken into account.

The standards for indoors luminance[2] and a study on typical daylight factors for various windows[3] were used in order to determine the average time residents switch off lights in the morning, and switch them on in the evening, relative to all aforementioned conditions. It was found that taking into account the daily luminance data does not require significant modification of our initial model and does not cause significant additional seasonal variation of the lighting consumption curve.

In addition we have taken into account the number of low-cloudy days in different months[1] by assuming that some percentage of average lighting consumption is due to weather conditions. We have also accounted for different lighting behavior on weekends, by modeling a later wake up time and assuming that the family on average spends half of the weekend days outdoors. The assumptions on different parameters were changed in order to define the sensitivity of our conclusions. As a result we present the curve below.

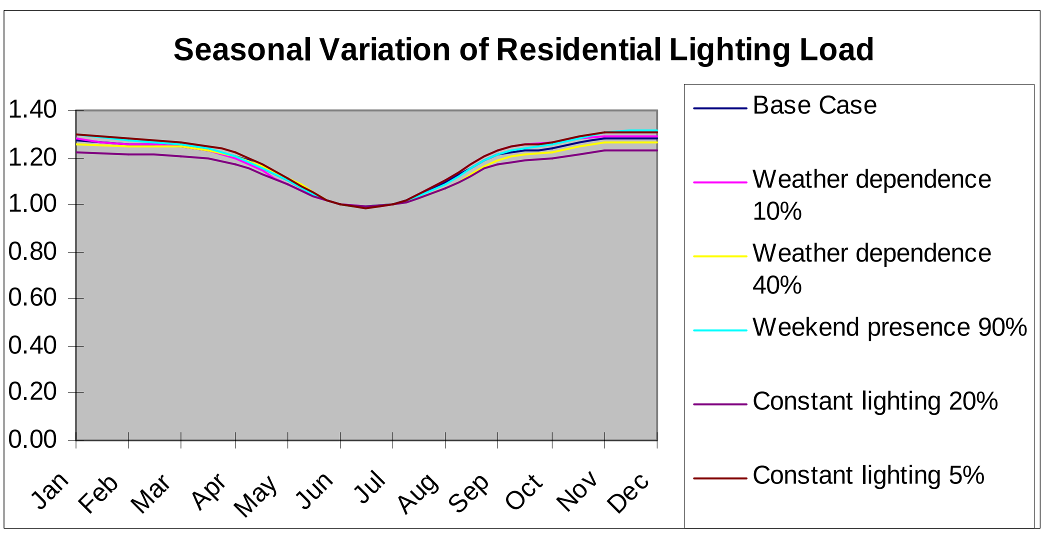


Figure A1. Residential lighting patterns as determined by the study model

[1] G.G.Svanidze – Climate of Tbilisi, Hydrometeoizdat, Saint-Petersburg, 1992
[2] H.Kuchling- Physics Handbook, Mir, 1985
[3] http://www.inive.org/members_area/medias/pdf/Inive%5Cclima2000%5C1997%5CP100.pdf

Using different assumptions the seasonal lighting load in January varies within the interval of 1.2-1.3 times the minimal amount of consumption in July.

In order to properly account for seasonal population migration for summer holidays we have introduced an additional seasonal reduction factor for June through September. Figure 2 shows the resulting curve representing the seasonal variation of lighting consumption in households.

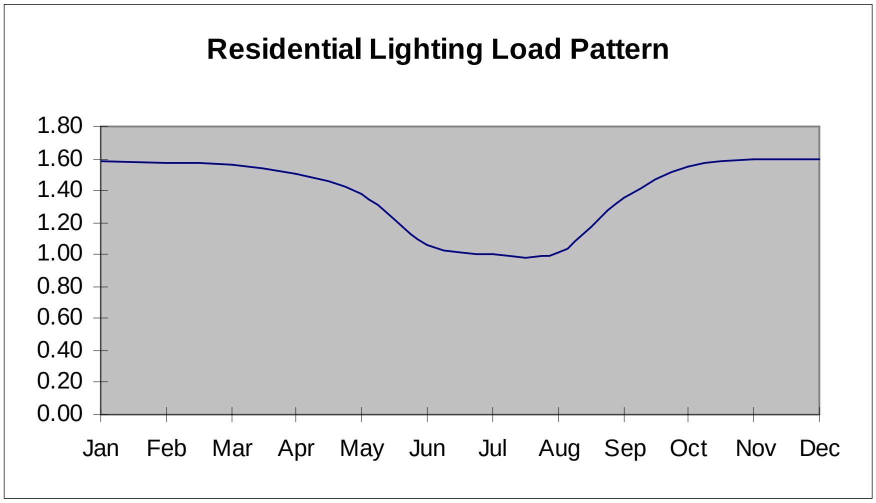


Figure A2. Seasonal variation of the residential lighting load

The method and assumptions used in deriving these curves can be refined by a more detailed analysis. However, this is a task for separate scientific study that goes beyond the scope of current work.

Our calculation does not account for daylight saving time shifts. This is an important factor that needs to be thoroughly studied in order to develop policy recommendations on daylight saving time shifts in Georgia.

APPENDIX 15-2.

SEASONAL VARIATION OF RESIDENTIAL LIGHTING LOAD

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Tbilisi		31	28	31	30	31	30	31	31	30	31	30	31
Sunrise		7:24	6:56	6:13	5:21	4:41	4:25	4:38	5:08	5:39	6:12	6:49	7:20
Sunset		16:54	17:32	18:05	18:39	19:11	19:35	19:34	19:02	18:11	17:20	16:39	16:30
Daytime duration		9:30	10:36	11:52	13:18	14:30	15:10	14:56	13:54	12:32	11:08	9:50	9:10
Low cloud days/month		4.8	4.1	5.0	4.2	2.7	1.5	1.7	1.7	3.2	3.9	5.8	5.3
Total cloudy days/month		12.3	11.5	13.7	12.6	11.4	7.1	7.0	5.8	7.6	9.1	11.9	11.7
Daylight illuminance 8-00 (klx)		25.1	38.1	52.2	51.9	71.2	76.4	70.4	63.0	59.9	59.7	46.3	41.4
Daylight intensity 16-00 (klx)		0.0	29.9	47.6	69.7	63.2	68.7	68.4	64.5	55.7	53.5	0.0	0.0
Average daylight intensity		12.6	34.0	49.9	60.8	67.2	72.6	69.4	63.8	57.8	56.6	23.2	20.7
Daylight factor	**0.5%**												
Indoors illuminance (lx)		0.1	0.2	0.2	0.3	0.3	0.4	0.3	0.3	0.3	0.3	0.1	0.1
Cloudy days/month		12.3	11.5	13.7	12.6	11.4	7.1	7.0	5.8	7.6	9.1	11.9	11.7
% cloudy days		40%	41%	44%	42%	37%	24%	23%	19%	25%	29%	40%	38%

% variable lighting due to outdoors illuminance	**36%**
% of lighting due to internal needs	**10%**

WEEKDAYS

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
wake up time	**7:30**	7:30	7:30	7:30	7:30	7:30	7:30	7:30	7:30	7:30	7:30	7:30
go to work time	**8:40**	8:40	8:40	8:40	8:40	8:40	8:40	8:40	8:40	8:40	8:40	8:40
come home time	**18:30**	18:30	18:30	18:30	18:30	18:30	18:30	18:30	18:30	18:30	18:30	18:30
go to bed time	**23:30**	23:30	23:30	23:30	23:30	23:30	23:30	23:30	23:30	23:30	23:30	23:30
lighting switch-on time night	18:30	18:30	18:30	18:39	19:11	19:35	19:34	19:02	18:30	18:30	18:30	18:30
Lighting time night	5:00	5:00	5:00	4:51	4:19	3:55	3:56	4:28	5:00	5:00	5:00	5:00
Lighting time morning	0:00	0:00	0:00	0:00	0:00	0:00	0:00	0:00	0:00	0:00	0:00	0:00
% of total lighting capacity independent of daylight	**10%**	**10%**	**10%**	**10%**	**10%**	**10%**	**10%**	**10%**	**10%**	**10%**	**10%**	**10%**
morning	1:10	1:10	1:10	1:10	1:10	1:10	1:10	1:10	1:10	1:10	1:10	1:10
night	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00	5:00
	6:10	**6:10**	**6:10**	**6:10**	**6:10**	**6:10**	**6:10**	**6:10**	**6:10**	**6:10**	**6:10**	**6:10**
Consumption	**0:37**	**0:37**	**0:37**	**0:37**	**0:37**	**0:37**	**0:37**	**0:37**	**0:37**	**0:37**	**0:37**	**0:37**
daylight dependent part of total lighting capacity	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%
morning	0:00	0:00	0:00	0:00	0:00	0:00	0:00	0:00	0:00	0:00	0:00	0:00
night	5:00	5:00	5:00	4:51	4:19	3:55	3:56	4:28	5:00	5:00	5:00	5:00
	5:00	**5:00**	**5:00**	**4:51**	**4:19**	**3:55**	**3:56**	**4:28**	**5:00**	**5:00**	**5:00**	**5:00**
Consumption	4:30	4:30	4:30	4:21	3:53	3:31	3:32	4:01	4:30	4:30	4:30	4:30
weather dependent part of total lighting capacity	36%	36%	36%	36%	36%	36%	36%	36%	36%	36%	36%	36%
morning	1:10	1:10	1:10	1:10	1:10	1:10	1:10	1:10	1:10	1:10	1:10	1:10
night	0:00	0:00	0:00	0:09	0:41	1:05	1:04	0:32	0:00	0:00	0:00	0:00
	1:10	1:10	1:10	1:19	1:51	2:15	2:14	1:42	1:10	1:10	1:10	1:10
Consumption	0:10	0:10	0:11	0:11	0:14	0:11	0:10	0:06	0:06	0:07	0:10	0:09
Workday consumption time (h)	5:17	5:17	5:18	5:10	4:44	4:20	4:20	4:45	5:13	5:14	5:17	5:16

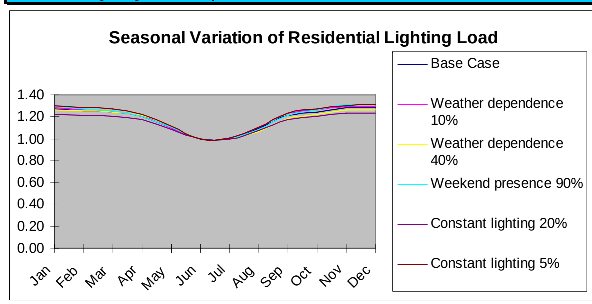
WEEKENDS

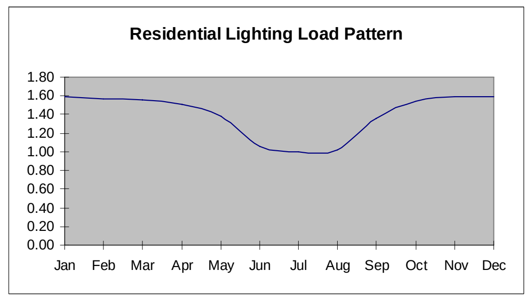
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
% time spent at home		**50%**											
	get up in the morning	9:30	9:30	9:30	9:30	9:30	9:30	9:30	9:30	9:30	9:30	9:30	9:30
	Go to bed at night	23:30	23:30	23:30	23:30	23:30	23:30	23:30	23:30	23:30	23:30	23:30	23:30
	Total time	14:00	14:00	14:00	14:00	14:00	14:00	14:00	14:00	14:00	14:00	14:00	14:00
10%	constant lighting	1:24	1:24	1:24	1:24	1:24	1:24	1:24	1:24	1:24	1:24	1:24	1:24
90%	Variable lighting	5:56	5:22	4:52	4:21	3:53	3:31	3:32	4:01	4:47	5:33	6:09	6:18
36.0%	Weather dependent	1:03	1:11	1:21	1:23	1:16	0:51	0:49	0:38	0:47	0:49	1:01	0:57
Weekend consumption time (h)		4:11	3:58	3:49	3:34	3:17	2:53	2:52	3:01	3:29	3:53	4:17	4:19
		3:28	3:26	3:24	3:18	3:01	2:44	2:44	2:58	3:18	3:23	3:30	3:30
Residential lighting seasonal patterr		**1.27**	**1.25**	**1.24**	**1.20**	**1.10**	**1.00**	**1.00**	**1.09**	**1.21**	**1.24**	**1.28**	**1.28**

Sensitivity analysis

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Base Case	1.27	1.25	1.24	1.20	1.10	1.00	1.00	1.09	1.21	1.24	1.28	1.28
Weather dependence 10%	1.28	1.26	1.24	1.20	1.09	1.00	1.00	1.11	1.23	1.26	1.29	1.29
Weather dependence 40%	1.26	1.25	1.24	1.21	1.12	1.00	1.00	1.07	1.19	1.22	1.26	1.26
Weekend presence 90%	1.30	1.27	1.25	1.21	1.10	1.00	1.00	1.09	1.21	1.26	1.31	1.31
Constant lighting 20%	1.22	1.21	1.20	1.17	1.09	1.00	1.00	1.07	1.17	1.20	1.23	1.23
Constant lighting 5%	1.30	1.28	1.27	1.22	1.11	1.00	1.00	1.10	1.23	1.27	1.31	1.31

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Base Case	**1.27**	**1.25**	**1.24**	**1.20**	**1.10**	**1.00**	**1.00**	**1.09**	**1.21**	**1.24**	**1.28**	**1.28**
Summer holiday factor	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**0.85**	**0.80**	**0.75**	**0.90**	**1.00**	**1.00**	**1.00**
Residential lighting seasonal patterr	**1.59**	**1.57**	**1.56**	**1.51**	**1.38**	**1.06**	**1.00**	**1.02**	**1.36**	**1.55**	**1.59**	**1.59**





APPENDIX 16.

Effect on Energy Dependence Index

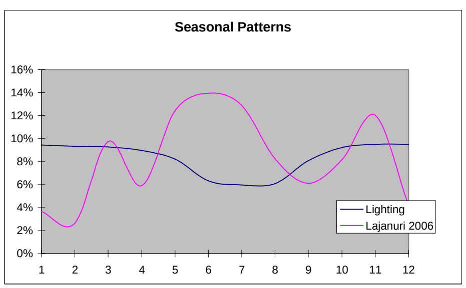
Electricity spent on lighting	500.0	mln kWh	Electricity transmission losses	4.41%	
Among this by incandescent bulbs	470.6	1.29	Electricity distribution losses	12.40%	
Average lighting duration of the existing incandescent bulbs	3	hours	Equivalent generation kWh	1.19	
Quantity of the existing incandescent bulbs	6.0	mln	**1kWh saved replaces**	1.19	**kWh generated**
Additional cost of a replacement of all bulbs	39	mln GEL			
Electricity saving in the year	353	mln kWh			

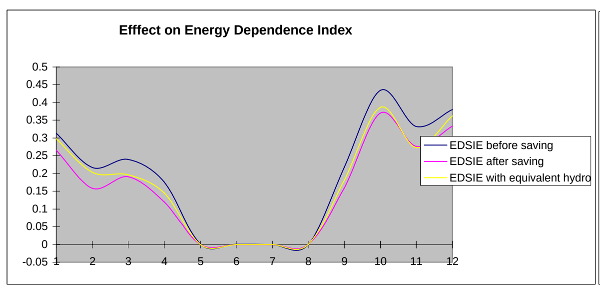
Seasonality of electricity generation and electricity saving

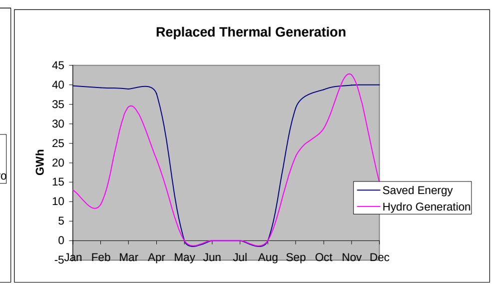
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	თოტალ
Seasonal distribution of lighting cost	**1.59**	**1.57**	**1.56**	**1.51**	**1.38**	**1.06**	**1.00**	**1.02**	**1.36**	**1.55**	**1.59**	**1.59**	16.76
Seasonality of lighting	9.5%	9.3%	9.3%	9.0%	8.2%	6.3%	6.0%	6.1%	8.1%	9.2%	9.5%	9.5%	100.0%
Seasonality of HPP	3.7%	2.6%	9.7%	5.9%	12.4%	13.9%	12.9%	8.2%	6.1%	8.2%	12.0%	4.2%	100.0%
Seasonal distribution of el. Saving	33.37	32.98	32.74	31.69	29.05	22.37	21.05	21.44	28.55	32.57	33.55	33.58	353
Hydro equivalent	12.98	9.30	34.37	20.84	43.84	49.19	45.48	29.08	21.60	28.81	42.50	14.95	353
Generation of thermal pp	257.66	145.11	189.47	119.15	0.32	0.32	0.00	0.00	125.21	264.04	239.15	323.51	
	31	28	31	30	31	30	31	31	30	31	30	31	
Lajanuri 2006	10,100,560	7,239,409	26,748,002	16,216,716	34,123,187	38,282,790	35,399,862	22,634,495	16,813,703	22,423,013	33,077,638	11,635,204	**274,694,579**
Lajanuri 2006 normalized on saving volume	18.39	13.18	48.69	29.52	62.11	69.68	64.43	41.20	30.60	40.81	60.21	21.18	500

Change of energy dependence

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Index of energy dependence	31.4%	21.7%	24.0%	17.5%	0.0%	0.1%	0.0%	0.0%	21.8%	43.4%	33.2%	38.0%	**231.0%**
The same index after saving	26.5%	15.8%	19.0%	12.0%	0.0%	0.0%	0.0%	0.0%	15.9%	37.0%	27.6%	33.3%	**187.2%**
The same index after building of HPP	29.8%	20.3%	19.6%	14.4%	0.0%	0.0%	0.0%	0.0%	18.1%	38.7%	27.3%	36.2%	**204.4%**
Replaced thermal generation													
By saving	39.71	39.25	38.96	37.71	0.00	0.00	0.00	0.00	33.98	38.76	39.93	39.96	308.25
By building of HPP	12.98	9.30	34.37	20.84	0.00	0.00	0.00	0.00	21.60	28.81	42.50	14.95	185.34
													43.8%
													26.6%



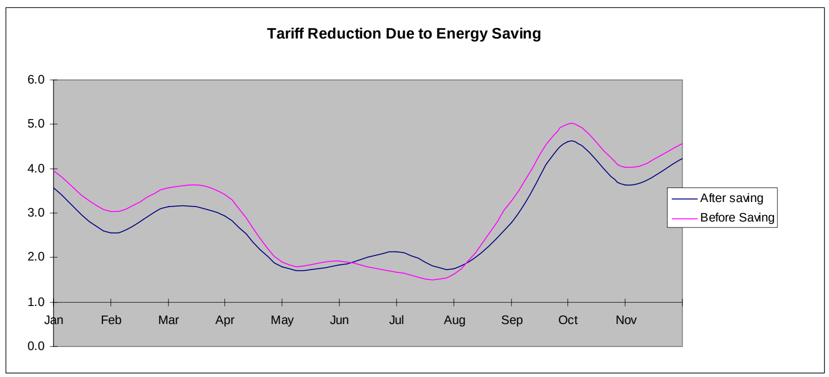




APPENDIX 17

Energy Efficiency Effect on Effective Energy Tariffs

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
EE Saving	33.37	32.98	32.74	31.69	29.05	22.37	21.05	21.44	28.55	32.57	33.55	33.58	353
Equivalent Generation	39.71	39.25	38.96	37.71	34.57	26.62	25.05	25.51	33.98	38.76	39.93	39.96	420
Generation of Thermal Plants	**257.66**	**145.11**	**189.47**	**119.15**	**0.32**	**0.32**	**0.00**	**0.00**	**125.21**	**264.04**	**239.15**	**323.51**	**1,663.94**
Generation of Hydro Plants	521.70	553.25	557.00	530.63	647.67	607.40	600.00	580.00	466.84	343.00	512.88	492.90	**6,766.89**
Total Generation	779.36	698.35	746.47	649.78	647.99	607.72	600.00	580.00	592.05	607.04	752.03	816.41	**8,430.82**
Generation of Thermal Plants	217.94	105.86	150.51	81.44	0.00	0.00	0.00	0.00	91.24	225.28	199.22	283.55	**1,355.04**
Generation of Hydro Plants	521.70	553.25	557.00	530.63	613.42	581.10	574.95	554.49	466.84	343.00	512.88	492.90	**6,302.16**
Cost of Thermal Generation	21,831,269	11,881,179	16,170,949	11,341,882	35,563	35,563	33,429	0	11,672,676	23,563,619	20,992,724	28,573,190	
Cost of Hydro Generation	9,018,931	9,355,043	10,438,592	10,892,414	12,327,699	11,635,517	13,229,585	10,729,973	7,715,066	6,871,308	9,401,360	8,742,421	
Total Cost of Generation	**30,850,200**	**21,236,221**	**26,609,542**	**22,234,296**	**12,363,262**	**11,671,080**	**13,263,014**	**10,729,973**	**19,387,741**	**30,434,927**	**30,394,085**	**37,315,611**	
Cost saving thermal	4,425,420	4,373,308	4,341,320	4,201,521	35,563	35,563	0	0	3,785,949	4,319,153	4,449,418	4,452,552	
Cost saving hydro plants	0	0	0	0	1,308,216	1,004,627	956,952	974,555	0	0	0	0	
Cost saving total	**4,425,420**	**4,373,308**	**4,341,320**	**4,201,521**	**1,343,778**	**1,040,189**	**956,952**	**974,555**	**3,785,949**	**4,319,153**	**4,449,418**	**4,452,552**	
Cost of Generation After Saving	26,424,780	16,862,913	22,268,221	18,032,775	11,019,483	10,630,891	12,306,062	9,755,418	15,601,792	26,115,775	25,944,667	32,863,059	
Average Energy Tariff after saving (t)	3.573	2.558	3.147	2.946	1.796	1.829	2.140	1.759	2.796	4.596	3.643	4.232	
Average Energy Tariff Before Saving (t)	3.958	3.041	3.565	3.422	1.908	1.920	1.664	1.634	3.275	5.014	4.042	4.571	
Energy Tariff Reduction	**0.386**	**0.482**	**0.417**	**0.476**	**0.112**	**0.091**	**-0.476**	**-0.126**	**0.479**	**0.418**	**0.398**	**0.338**	



APPENDIX 18

Influence on a foreign trade balance

foreign trade balance

Price of Russian gas	$235					
Gas spent on 1 kWh generation	0.36					
	3					
Bulbs living duration (year)	4					
Quantity of bulbs to be changed (mln)	6.01					
Imported cost of bulbs (USD)	3					
Cost of bulbs import (mln USD)	18.03					
Electricity saved (mln kWh)	353					
Generated by hydro-equivalent (mln kWh)	353					
Replaced Thermal generation (mln kWh)	308					
	185					
Replaced gas volume (mcm)						
Energy Efficiency	110.4					
Hydro equivalent	66.4					
Cost of gas replaced (mln USD)						
Energy Efficiency	26.0					
Hydro equivalent	15.6					
Cash flow for the country						**Total**
Energy Efficiency	(18.03)	25.95	25.95	25.95	25.95	85.78
Hydro equivalent						
Pure current cost (mln USD)	54.3					
IRR	148%					

Gas volume replaced by saving of 1kWh

Electricity transmission losses	4.41%
Electricity distribution losses	12.40%
Equivalent generation of kWh	1.19
gas volume needed for generation of 1kWh (cm)	0.30
gas saving due to saving of 1kWh (cm)	**0.36**

Reduction of CO2 emission

According to the estimation of WB experts, saving of 1kWh electricity reduce the emission of greenhous 0.379 kg/kWh

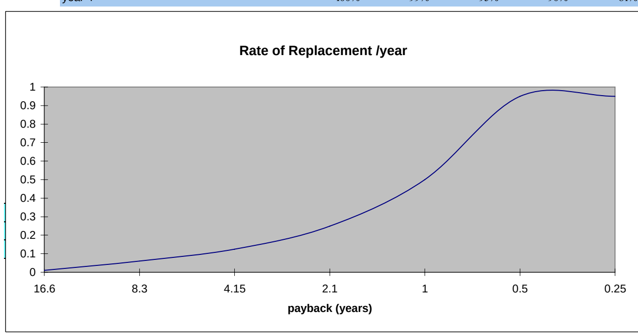
353 mln kWh reduce 133.76 mln kg CO_2

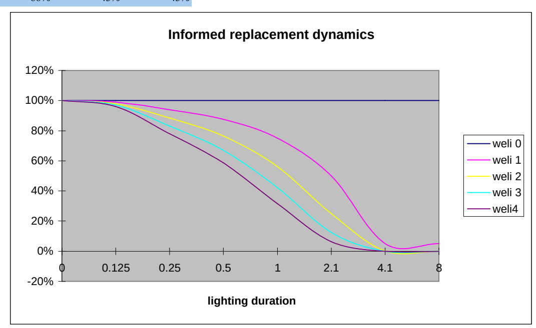
APPENDIX 19-1 **Estimation of Penetration Rate**

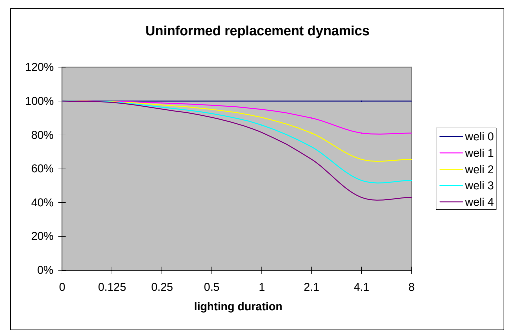
Cost of Electricity saved in	8 years		
Investment	7.5 GEL		
Annual lighting duration	500 hours	Investment/saving	
Lifecycle	4000 hours	year	GEL
Operation life	8 year	1	-6.5
Discount rate	12%	2	1
Investment saved	8 GEL	3	1
Electricity saved over lifetime	215.5 kWh	4	1
NPV of investment costs/savings	(1.73) GEL	5	1
Cost of saved electricity		6	1
Simple	**(0.23)** Tetri	7	1
Discounted	**0.8** Tetri	8	1

Probability of replacement for 1 year payback period 50%
Free distribution of information 20%

lighting duration	0	0.125	0.25	0.5	1	2.1	4.1	8
simple payback (y)	1000	16.6	8.3	4.15	2.1	1	0.5	0.25
% replaced/year	0%	1%	6%	12.50%	25%	50%	95%	95%
year 0	1	1	1	1	1	1	1	1
year 1	100%	99%	94%	88%	75%	50%	5%	5%
year 2	100%	98%	88%	77%	56%	25%	0%	0%
year 3	100%	97%	83%	67%	42%	13%	0%	0%
year 4	100%	96%	78%	59%	32%	6%	0%	0%
% replaced/year	0%	0%	1%	3%	5%	10%	19%	19%
year 0	1	1	1	1	1	1	1	1
year 1	100%	100%	99%	98%	95%	90%	81%	81%
year 2	100%	100%	98%	95%	90%	81%	66%	66%
year 3	100%	99%	96%	93%	86%	73%	53%	53%
year 4	100%	99%	95%	90%	81%	66%	43%	43%







APPENDIX 19-2

Estimation of Effects of Information Capmpaign

lighting time/day	1	2	3	4	5	6	7	8			
bulb density	1	1	1	1	0.7	0.5	0.3	0.2		**potential**	
	1	2	3	4	3.5	3	2.1	1.6	20.2	15.15	
rate of replacement	25%	50%	75%	95%	1	1	1	1			
replacement year1	0.25	0.50	0.75	0.95	0.7	0.5	0.3	0.2	**4.15**		
replacement year2	0.19	0.25	0.19	0.05	0	0	0	0	**0.7**		
replacement year3	0.14	0.13	0.05	0.00	0	0	0	0	**0.3**		
replacement year4	0.11	0.06	0.01	0.00	0	0	0	0	**0.2**		**cumulative**
saving year 1	0.19	0.75	1.69	2.85	2.63	2.25	1.58	1.20	13.13	65%	65%
saving year 2	0.14	0.38	0.42	0.14	0.00	0.00	0.00	0.00	1.08	70%	135%
Saving year 3	0.11	0.19	0.11	0.01	0.00	0.00	0.00	0.00	0.41	72%	208%
Saving year 4	0.08	0.09	0.03	0.00	0.00	0.00	0.00	0.00	0.20	73%	281%

Uninformed Energy Saving

lighting time/day	1	2	3	4	5	6	7	8			
bulb density	1	1	1	1	0.7	0.5	0.3	0.2			
rate of replacement	5%	10%	15%	19%	20%	20%	20%	20%			
replacement year1	0.05	0.10	0.15	0.19	0.14	0.10	0.06	0.04	**0.83**		
replacement year2	0.05	0.09	0.13	0.15	0.11	0.08	0.05	0.03	**0.7**		
replacement year3	0.05	0.08	0.11	0.12	0.10	0.07	0.05	0.03	**0.6**		
replacement year4	0.04	0.07	0.09	0.10	0.08	0.06	0.04	0.03	**0.5**		**cumulative**
saving year 1	0.04	0.15	0.34	0.57	0.53	0.45	0.32	0.24	2.63	13%	13%
saving year 2	0.04	0.14	0.29	0.46	0.42	0.36	0.25	0.19	2.14	24%	37%
Saving year 3	0.03	0.12	0.24	0.37	0.36	0.32	0.24	0.18	1.88	33%	70%
Saving year 4	0.03	0.11	0.21	0.30	0.31	0.29	0.22	0.18	1.65	41%	111%

comparison of savings

	informed	**uninformed**
1	0.65	0.13
2	0.70	0.24
3	0.72	0.33
4	0.73	0.41
cumulative	2.81	1.11