The Other Renewable Resource:

The Potential for Improving Energy Efficiency in Armenia

Report to the World Bank

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Armenia can save as much as AMD 132 billion per year in energy expenditure by investing in energy efficiency. This amount is equal to 5 percent of GDP in 2006, or 78 percent of the country's 2006 current account deficit. Armenia can make investments to save natural gas at roughly 40 percent of what it costs to import gas, and can make investments to save electricity at roughly 30 percent of the cost of building new electricity supply.

Is Armenia energy efficient?

In terms of Energy Efficiency, Armenia is already one of the best examples among the former Soviet Republics, but considerably worse than its European peers. Armenia owes some of its success in improving energy efficiency to necessity: Unlike some of its hydrocarbon-rich neighbors, Armenia imports nearly all of its hydrocarbon fuels, and therefore has had to promote reforms to improve the economic efficiency of the sector in order to survive.

However, at least some of Armenia's apparent energy efficiency is attributable to the disappearance of heavy industry, as the industrial collapse in Armenia after Independence was much more severe than in other former Soviet Republics.

Armenia needs to look forwards, not backwards, in setting its energy efficiency goals

In terms of energy efficiency, the former Soviet Republics are no longer Armenia's peer group *per se*. Armenia has declared its desire to better integrate with Europe and therefore should set its energy efficiency goals based on where it is headed rather than where it has been. Armenia's energy intensity is middle-of-the-road compared to member states of the European Union, and considerably worse compared to western European countries. Armenia ranks 17th compared to EU25 countries, with the energy intensity of 0.17 kgoe/US$ of GDP. For comparison, the energy intensity of GDP for Ireland, Switzerland and Denmark, three least energy intensive economies in EU, does not exceed 0.11 kgoe/US$ of GDP.

Why should Armenia care about Energy Efficiency?

Armenia should care about energy efficiency because investments in energy efficiency can improve energy security, increase overall economic welfare, and help keep industry competitive, help improve human health and environment.

Energy efficiency can help improve energy security

Armenia imports nearly two-thirds of its energy needs, and mostly from a limited number of foreign suppliers. Armenia currently benefits from an electricity surplus, but all of its plants are more than three decades old, and loss of any single plant could see that surplus quickly disappear. Depending on demand growth rate and the year of the old nuclear power plant decommissioning, the electricity shortage may be felt as early as 2012. Energy efficiency measures can effectively give Armenia additional reserve capacity not subject to the security concerns of its existing production capacity.

Energy efficiency can help improve economic welfare and industry competitiveness

In terms of economic and fiscal impact, Armenia stands to gain tremendously by investing in energy efficiency. Armenia can save as much as AMD 132 billion per year in energy expenditure by investing in energy efficiency.

The Government of Armenia had, until 1 May 2008, subsidized natural gas prices. After elimination of subsidies, the gas tariffs have increased by 42 percent for small consumers and by 51 percent for large consumers. The electricity end-user tariffs are expected to increase by 10-15 percent, reflecting the removal of gas subsidies. The gas import price, currently at US$ 110 per thousand m^3,till end of 2008, will eventually reach levels faced by other Gazprom customers in the region, which is expected to be US$ 500 per thousand m^3 in 2009.. If the gas import price increases to US$ 500, then, everything else constant, the electricity tariff for end-users will increase as much as by 78 percent; the end-user gas tariff will increase by 200 percent for small consumers and by 300 percent for large consumers.

Armenia's average electricity generation costs are low (US$ 0.037 in 2007) since most plants are old and generation tariffs have negligible capital cost component. Armenia is likely to meet the growing electricity demand through the construction of a new nuclear or thermal plant at a higher cost (US$ 0.07 -0.10 per kWh).

Armenian industry will have to cut operating and maintenance costs in order to survive. Smaller consumers will have to look for ways to get the same level of comfort and utility from their current level of energy consumption, or do with less. The higher energy prices go, the more valuable will be investments in energy efficiency.

Energy efficiency can help Armenia improve human health and environment

Energy consumption has consequences for the health of Armenia's population, and the preservation of key natural resources in the country. Cost of ill-health from the use of less efficient, traditional fuels, like firewood, has been estimated to exceed AMD 1.7 billion per year. With only 283,000 ha of forest, the excessive use of firewood may also have consequences for Armenia's forest. The use of traditional fossil fuels has implications for outdoor air quality and climate change. Air pollution in Armenia's four largest cities exceeds international limits for particulate emissions. The excessive use of hydroelectric generation—as many Armenians who lived through the 1994-1996 energy crisis remember—poses a risk for Armenia's precious hydro resources.

What is the potential for Energy Efficiency Improvement in Armenia?

Investments in energy efficiency can save Armenia roughly 1 TWh of electricity and 600 million m^3 of natural gas, equal to 17 percent of total electricity generated and 32 percent of total natural gas consumed in 2007. Nearly all of this reduction can be achieved through AMD 124 billion investments (of which 99 percent are economically and 97 percent financially viable), in other words, the investments save energy and money for Armenia as a whole as well as for individual entities that make the investment.

The greatest annual savings are in the utilities sector

In the utilities sector, Armenia could save more than AMD 45 billion per year primarily by replacing or upgrading old gas-fired equipment, the largest examples of which are the Yerevan and Hrazdan thermal power plants. Electricity savings in the utility sector come primarily from the use of variable speed electric drives and (as with gas-using equipment) upgrading of the existing capital stock.

Replacement of gas-fired equipment and use of energy efficient lighting offer the greatest savings

Together, these two measures account for roughly two-thirds of the money which can be saved through energy savings in Armenia. Most of the natural gas savings results from upgrading older gas- using equipment with more modern, energy efficient models or improving the thermal insulation in building heating systems. Roughly half of the electricity savings comes from using more energy efficient lamps. An additional 20 percent comes from installation of variable speed motors and replacement of equipment that uses electricity with more modern, efficient models.

Returns to most of the energy efficiency investments identified by the National Program are quite high with payback times of 3-7 years. Public sector investments have payback time of 2-4 years. The financial returns to investments in the utility and industrial sectors are lowest and the payback time is longer, primarily because the capital expenditures required to earn these returns are relatively higher than in the other sectors.

The greatest returns are in the public sector

The organizational measures yield the highest return on investment in the public sector with near immediate payback. Installation of more energy efficient lighting, repair or replacement of valves in heat and water delivery systems within government buildings, and use of variable speed drives require an estimated capital investments of AMD 138 million and have payback period of 2-4 years. The highest returns in this sector are in public administration buildings with investment payback time of less than 2 years. The total investment costs required for realization of potential in the healthcare, social and education sectors is estimated at around AMD 2 billion. The healthcare, social services and education sectors have lower, but still very high positive returns and payback periods of 5-10 years.

What are the barriers to energy efficiency in Armenia?

The question for Armenia is why the economically and financially viable investments are not being made. Many of the barriers to economic efficiency, which also affect energy efficiency, have already been removed in Armenia. Armenia has removed energy price subsidies, and achieved widespread metering in its electricity and gas networks. Energy users (with the exception of some gas users, mentioned below) largely receive the right price signals to make their investment decisions, but still fail to take measures that could save both money and energy.

Cross-sectoral barriers

Three barriers obstruct energy efficiency investments in a range of sectors in Armenia.

- **Lack of sufficient information, skills and data.** Lack of information about the benefits of energy efficiency investments impedes realization of the existing economically and financially viable potential. Armenian consumers lack information on the efficiency of different types of equipment available to their households, and many industrial companies lack the internal expertise and skills necessary to create an energy efficiency investment plan. Consumers and private companies tend to systematically overestimate the costs of energy efficiency investments. The National Program provides a solid foundation for estimating Armenia's energy efficiency potential and using that potential to inform policy. However, the National Program lacks detailed estimates of how to improve energy efficiency in Armenia's two largest energy consuming sectors: transport and heating in buildings.
- **No implementation of legislative framework.** The legislative framework that exists for energy efficiency in Armenia has not yet been implemented through the creation of the necessary regulations, programs and institutions. Some energy efficiency standards exist, but few have been implemented, and apart from programs sponsored by development partners like the World Bank and USAID, few government energy efficiency initiatives exist
- **Inadequate gas tariff structure.** The current natural gas tariff discourages energy savings for smaller gas consumers. Consumers who consume more than 10,000 m^3

per month enjoy a tariff which is roughly half the tariff for customers who consume below that level. This tariff structure gives some small consumers who are near the 10,000 m^3 per month level of consumption to use more gas solely for the purpose of putting themselves in the lower tariff category.

Sectoral barriers

Several other barriers prevent energy efficiency investments in specific sectors. More specifically:

- **Public administration.** Although the budgeting laws allow the public administration bodies to reallocate energy savings, they are not adequately flexible to allow for sufficient incentives to save on energy costs. Additionally, public organizations have limited borrowing capacity.
- **Residential.** Much of the energy inefficiency in buildings is due to poor insulation of common spaces. Apartment owners are reluctant to commit to investments in these spaces because of the risk that other residents may free ride on that investment
- **Utilities.** Energy utilities have an incentive to sell, rather than conserve energy. Energy utility regulation in Armenia (as in many countries) encourages utilities to sell as much as they can to recover their fixed costs, and encourages investment in new production capacity, rather than measures to reduce load.

How can the Government improve energy efficiency in Armenia?

Armenia can improve energy efficiency by implementing its existing legal and regulatory framework, and designating an energy efficiency "champion", directly mandating and investing in public sector energy efficiency, improving data collection, considering limited fiscal incentives for the private sector, and changing tariff regulation to encourage better energy efficiency at the utility and end-use levels.

Implement Armenia's energy efficiency legislation; appoint an energy efficiency "champion"

The Government's ongoing effort to adopt energy efficiency standards needs to be accelerated, and once adopted, the standards must be enforced. An energy efficiency "champion" agency can help accelerate this process, and the agency needs to have support and participation from a variety of sectors within government. The Renewable Resources and Energy Efficiency Fund (R2E2) is a reasonable choice for such an agency. The Fund's Board of Trustees includes Ministers or Deputy Ministers from a wide range of sectors, and its staff have developed expertise in driving energy efficiency policy and implementing a wide range of energy efficiency programs in the country.

An energy efficiency agency can play a critical role in developing and implementing the following measures, often deemed necessary in removing critical barriers to energy efficiency: (i) developing energy efficiency standards; (ii) conducting certification and labeling; (iii) certifying and/or licensing energy auditors; (iv) developing short-term and long-term energy efficiency programs; (v) coordinating the energy efficiency activities in different branches of economy; (vi) disseminating information; (vii) promoting education/awareness of energy efficiency; (viii) funding pilots and demonstrations; (ix) providing technical assistance; (x) providing financial incentives; and (xi) initiating collaboration/partnerships.

Mandate energy efficiency in public administration

The Government can require its agencies to improve energy efficiency by:

- Setting agency-wide or sector-wide energy efficiency targets

- Changing budgeting laws to allow more flexibility to public agencies in retaining most of the savings from energy efficiency
- Benchmarking public agency performance in improving energy efficiency
- Setting energy efficiency standards specific to public agencies, including procurement rules which favor more energy efficient products
- In the interest of promoting the nascent market for firms that provide ESCO-like functions, encourage public agencies to enter into multi-year contracts with private companies

Information campaign

The Government should consider designing and implementing information campaigns to inform the households, private sector, the public institutions and public administration bodies about the benefits of investments in energy efficiency.

Improve data collection

As described above, the National Program is currently the single most comprehensive study of energy use and energy efficiency potential in Armenia. The foundation of the National Program needs be expanded to include detailed surveys of energy use and energy efficiency potential in heating buildings and transportation. Mechanisms must also be put in place to ensure that the National Program can be regularly updated. The Government should proceed to design a set of templates and procedures which ensure the National Program data set can be updated annually and expanded over time.

Investigate further and invest in energy saving measures for public sector entities.

The Government should consider making investments in improving energy efficiency in the public sector. Making such investments will save energy and money for the Government while sending a clear message to the private sector and individual consumers that the Government is dedicated to promoting and investing in energy efficiency. To begin with, the Government should consider investing invest in energy efficiency lighting, variable speed drives, and repair or replacing of valves in building heating and water systems in public administration, health and social buildings.

Provide support for demonstration/pilot projects in the private sector

Fiscal incentives are a reasonable policy tool to encourage energy efficiency in the private sector if they are used to subsidize capital investments that are not being made because of specific market failures (for example, negative environmental externalities not being reflected in energy prices), to provide a public good (for example, providing information on the return to energy efficiency investments through demonstration projects). In Armenia, therefore, the Government may consider providing one-off, limited capital subsidies or loan guarantees for demonstration or pilot projects in the residential or industrial sectors. The R2E2 Fund's on-lending program under the World Bank financed Urban Heating Project provides an excellent example of how a one-time injection of capital can trigger private sector investment in energy efficiency.

Change tariff regulation for energy utilities

There are several measures the Government and the Public Services Regulatory Commission can consider to counter energy utilities' incentives to sell as much energy as possible. These include:

- Use of price cap regulation, which can encourage utilities to save on O&M costs by giving them the opportunity to keep some of the savings

- Consider regulatory mechanisms for de-linking an electric utility's profits from its sales. This can include:
  - Use of a two-part tariff, which allows the utility to recover its fixed costs through a fixed monthly charge, while recovering only its variable costs through the volumetric charge
  - Use of rate "true-ups" to adjust for under- or over-recovery of revenue requirements. True-ups refer to annual rate adjustments and are used to ensure that utilities recover costs, but do not profit beyond levels deemed appropriate by the regulator.
  - Provide incentives to encourage utility capital expenditures in Demand Side Management (DSM) programs. This could be done by, for example, establishing an explicit CAPEX category for energy efficiency investments or granting preferential status to such investments by allowing a higher return on capital for that portion of CAPEX.

1 Introduction

This study identifies a number of priority sectors for investment in energy efficiency in Armenia, identifies barriers to energy efficiency investments, and recommends policies for removing the barriers. The analysis makes use of data from Armenia's National Program on Energy Saving and Renewable Energy ("the National Program"), but goes beyond the National Program's analysis by putting a concrete currency value on different energy savings measures in different sectors.

Armenia's National Program on Energy Saving and Renewable Energy ("the National Program") does an excellent job identifying investments with the greatest *technical* potential for energy savings, but stops short of identifying the investments with the greatest economic and financial potential. In other words, the National Program identifies which investments save Armenia the most energy, but not those investments which can save Armenia the most money.

This study therefore picks up where the National Program left off, by identifying the investments in energy efficiency which save energy while also saving the most money for Armenia's Government, private investors, and private citizens. Understanding the value of the investments is important because it can help the Government:

- Prioritize policy interventions, making those investments which save Armenia the most money overall, or which yield the highest return
- Decide which policy tools to use. If the returns on an energy efficiency investment are high enough, and accrue to the private sector, the Government's need for intervention may be limited to, for example, providing information or facilitating information collection, rather than providing subsidies
- Decide how much effort and money to spend on energy efficiency capital investments, programs, or institutions. For example, the Government will obviously not want to spend more on information campaigns than the value it can reap from energy savings in any particular sector.

These decisions can only be made if the Government knows what different energy efficiency interventions are worth. This paper therefore estimates, in Chapter 4, the value of different investments, in different sectors. This analysis drives the analysis of barriers to energy efficiency in Chapter 4, and recommendations on interventions for removing those barriers.

Concepts of energy efficiency already have considerably more acceptance in Armenia than in many countries of the former Soviet Union. Nevertheless, Armenia still shows considerable potential for improvement. This study therefore begins, in Chapter **Error! Reference source not found.**, with an analysis of why Armenia still needs to care about energy efficiency, and continues in Chapter 3 with an analysis of how far Armenia still has to go to reach aggregate levels of energy efficiency consistent with the countries it strives to have within its socio-economic peer group.

2 Why Should Armenia Care about Energy Efficiency

Energy efficiency is vital to Armenia's energy security, economic competitiveness, natural environment, and the health of its population. Armenia could save AMD 132 billion annually, equivalent to roughly 5 percent of its GDP, by investing in energy efficiency.

Investments in energy efficiency offer Armenia a way to further diversify energy supply, and improve its economic competitiveness, at a much lower cost than investments in new production capacity or energy imports. Energy efficiency investments also allow Armenia to avoid the environmental externalities associated with construction of new production capacity and increased utilization of traditional or fossil fuels. Energy efficiency is important for Armenia, more specifically, because:

- Armenia imports nearly two-thirds of its energy needs, and mostly from a limited number of foreign suppliers. Armenia currently benefits from an electricity surplus, but all of its plants are more than three decades old, and loss of any single plant could see that surplus quickly disappear. Energy efficiency measures can effectively give Armenia additional reserve capacity not subject to the security concerns of its existing production capacity
- On May 1, 2008, after the government eliminated the gas subsidies, the gas tariffs increased by 42 percent for small consumers and by more than 51 percent for large consumers. Currently Armenia pays US$ 110/thousand m^3 however, the current agreement with Gazprom expires end of 2008. Afterwards the gas price for Armenia will eventually reach to the level faced by other Gazprom customers in the region and is expected to be around US$ 500 / thousand m^3 in 2009. The rise in gas import prices will lead to increase in the end-user electricity and gas tariffs. Armenian industries can remain competitive by investing in energy efficiency as the country's comparatively low average generation tariffs are not sustainable in the longer term. The low average generation costs are mostly due to the small amount of capital expenditures included in the tariff as the generation assets are quite old and almost fully depreciated. However, the LRMC of generation in Armenia will be higher as the price of the new generation capacity will increase.
- In terms of economic and fiscal impact, Armenia stands to gain tremendously by investing in energy efficiency. Armenia can make investments to save natural gas at roughly 40 percent of what it costs to purchase a new unit of gas from Gazprom. Armenia can make investments to save electricity at roughly 30 percent of the cost of building new electricity supply. Armenia can save as much as AMD 132 billion per year in energy expenditure by investing in energy efficiency. This amount is equal to roughly 5 percent of GDP in 2006, or 78 percent of the country's 2006 current account deficit.
- Energy efficiency helps Armenia avoid the need for use of traditional and fossil fuels, and the environmental consequences of using them. More specifically, energy efficiency helps avoid the harmful health and safety effects of indoor pollution, and deforestation caused by use of wood fuels. Investments in energy efficiency also help Armenia mitigate problems of outdoor pollution, and reduce reliance on precious hydro-generation. Moreover, Armenia's energy efficiency commitments contribute to reducing climate change, which in addition to showing itself willing to play an important role in reducing greenhouse gas emissions, is worth roughly AMD 10.65 billion in CDM credits annually.

2.1 Energy security

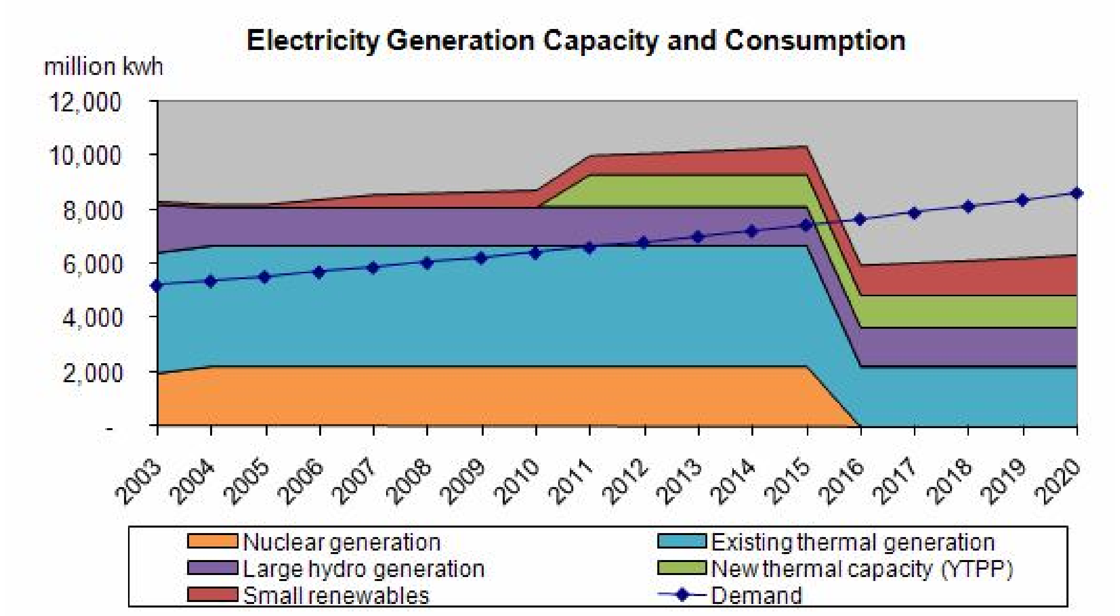
Fuel for more than two-thirds of Armenia's energy needs is imported. Armenia is dependent on the import of hydrocarbons for all of its transport fuel, all gas used for heating (whether industrial or residential) and cooking, and all of the gas used to generate one-third of the country's electricity generation. All of the Uranium needed to supply the

Medzamor nuclear power plant, is also imported, as is all of the diesel, petrol, and naphtha used in Armenia's vehicles.

Most of Armenia's fuel imports come from only a few suppliers. Automobile fuels come almost exclusively from only a few European neighbors. Natural gas comes almost exclusively as imports from Gazprom through Georgia. The Government struck an agreement in 2006 with the Government of Iran to build a southern pipeline, but has since handed control of the pipeline over to Gazprom, as part of a deal to delay an increase in Armenia's gas import price. Armenia currently pays US$ 110/thousand m^3, which is below the current import price of other countries in the region. Uranium also comes exclusively from Rosatom, Russia's federal agency on atomic energy. Russia handed financial management of Medzamor to a subsidiary of RAO UES in 2003 as part of a package of agreements made with the Russian Government to settle Armenia's natural gas and uranium import arrears.

Although current operable capacity is sufficient to meet demand, operating limitations, supply uncertainties, ageing and conditions of generation facilities and inadequate peak load capacity may jeopardize Armenia's ability to sufficiently meet both domestic and export demand in the future. In addition, as demand is expected to grow 2-3 percent annually, Armenia will have to invest significantly in new generation capacity and rehabilitation of existing capacity in order to continue to meet consumer needs. Figure 2.1 shows how Armenia's capacity relative to consumption is expected to evolve.

Figure 2.1: Armenia's forecasted electricity generation capacity versus consumption



Source: World Bank

Operable capacity varies considerably between winter and summer months. Hydropower capacity, which generates roughly 30 percent of electricity in Armenia, is constrained, especially in the winter, by limited pondage, and the need to conserve water for summer irrigation and the possibility of a future energy crisis. Although hydropower capacity is estimated at 728 MW, this can be limited to as little as 400 MW during the winter. Armenia has been able to ameliorate some of the seasonal fluctuation through interregional electricity trading with Iran, but the potential to manage peak load through such an exchange is limited.

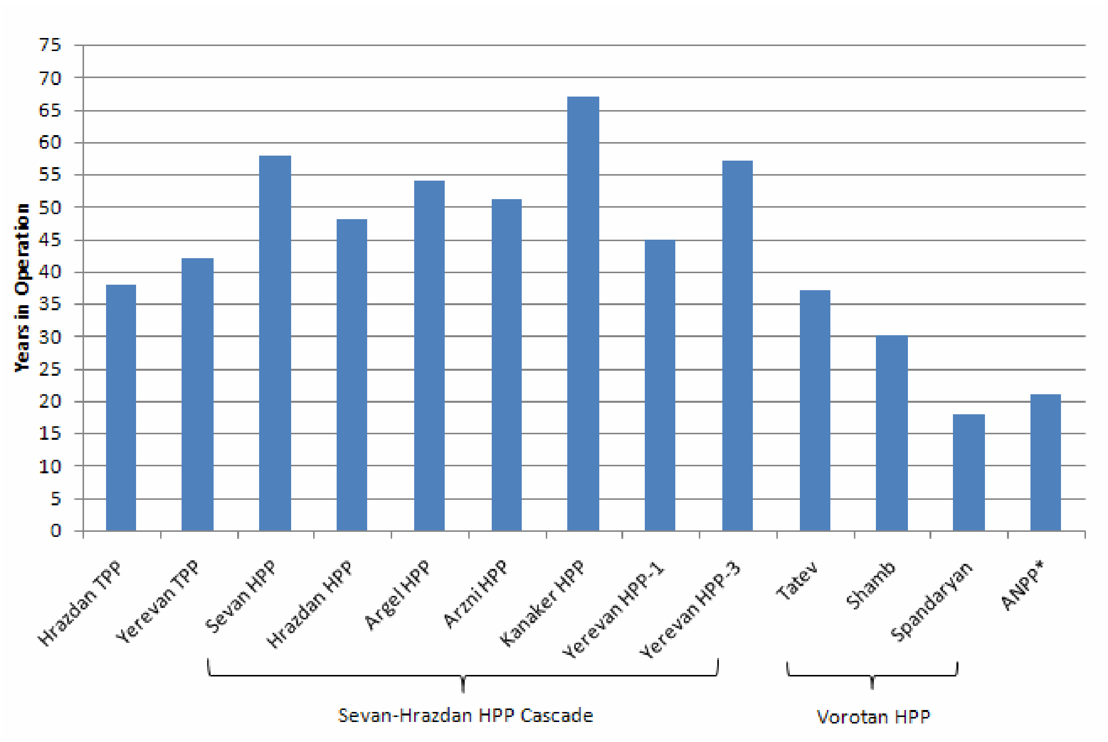
Supply security remains fragile because of insufficient fuel supply diversity among generators. If Armenia loses any single pillar of its electricity generating capacity—nuclear (400 MW), hydro (1000 MW), or gas-fired thermal (1700 MW) —it could have trouble meeting demand during peak periods. The electricity system could probably manage if it lost a single thermal unit or hydro plant. However, due to the limited number of fuel suppliers for any single fuel source, problems with any one type of fuel in Armenia are most likely to affect all plants using that same fuel. This occurred in the 1993-1995 energy crisis when an interruption in gas supply shut down all gas-fired generators in Armenia. This could easily happen again as Armenia still imports most of its natural gas from a single supplier, as well as all of its uranium.

In addition to supply uncertainties caused by geopolitical instability, climatic uncertainty can have a significant impact on electricity supply as well. A dry season would significantly limit output at the Sevan-Hrazdan and Vorotan cascades, and require that Armenia make the difficult choice between preserving the well-being of lake Sevan and having sufficient electric power. Any significant mechanical failure to which the ageing Medzamor plant might be susceptible would remove a crucial source of base-load capacity. Any one of these events would jeopardize the reliability of electricity supply in Armenia. Any two such events occurring simultaneously—as has happened in the past—could plunge Armenia into another energy crisis.

Armenia's electricity generation facilities are in need of significant repairs. Practically all of Armenia's power plants are old and poorly maintained. Overall, 40 percent of Armenia's power plants are over 30 years old. Seventy percent of the country's hydroelectric plants are more than 35 years old and 50 percent are more than 50 years old. Figure 2.2 shows the age of individual generation facilities in Armenia. The primary equipment in thermal power plants has reached the 200 thousand hour level and does not meet international technical, economic, and ecological performance standards.[1] These plants have not performed capital improvements recommended in recent year and their O&M budgets have been consistently under-funded.

[1] "Energy Sector Development Strategies in the Context of Economic Development in Armenia." Adopted by the Government of Armenia at June 23, 2005 session.

Figure 2.2: Age of Armenia's power generation facilities



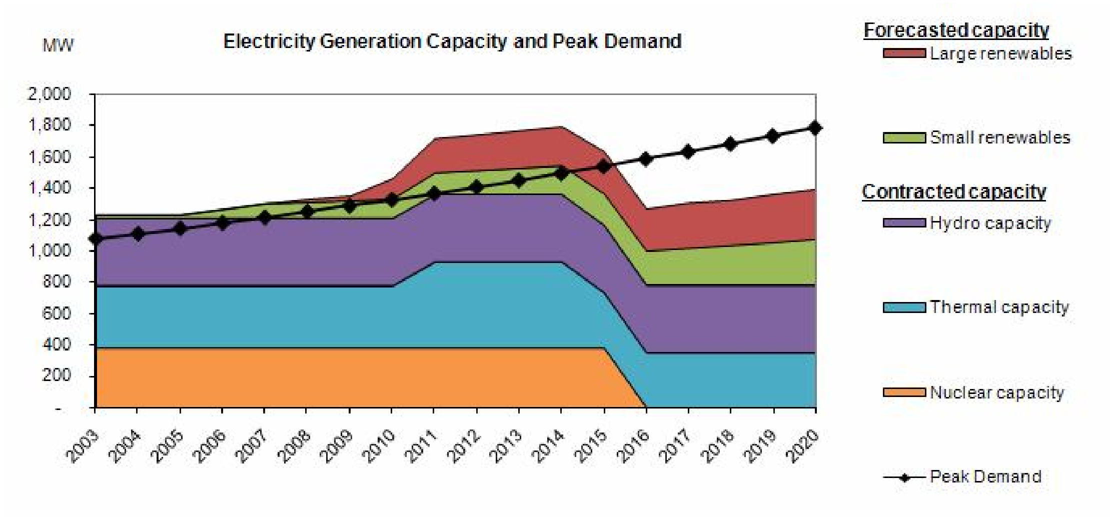
*The six years in which the Metsamor nuclear plant was decommissioned (1989-1995) are not included.

Source: "Energy Sector Development Strategies in the Context of Economic Development in Armenia." Adopted by the Government of Armenia at June 23, 2005 session.

Armenia's level of generation capacity comparable to actual demand, does not accurately reflect the country's real ability to serve peak load. A lack of seasonal load profiles limit analysis of Armenia's ability to meet peak demand, but the general conditions and characteristics of generation suggest that Armenia's peak-load capacity is inadequate relative to base-load capacity. For instance, hydropower plants , the need to meet irrigation requirements and maintain security in the event of an energy crisis necessitate that the Sevan-Hrazdan cascade operate in run-of-the-river mode. This limits the ability of the system operator to manage system peaks. Figure 2.3 shows how Armenia's forecasted generation capacity is expected to evolve relative to peak demand. With a 2-3 percent demand growth rate and without new capacity, the reserve level will gradually decrease and Armenia may have trouble meeting peak capacity requirements as soon as 2015.[2]

[2] The ability of Armenia to meet peak demand requirements varies significantly depending on when the ANPP is decommissioned and when old TPPs are retired.

Figure 2.3: Armenia's electricity generation capacity versus peak demand



Source: World Bank

Investments in energy efficiency offer Armenia a way to further diversify energy supply, and at a much lower cost than investments in new production capacity or energy imports. Armenia's extensive reliance on imports for a large portion of its fuel supply, and potential constraints in supplying electricity at peak demand further demonstrate the need for increased energy efficiency. Energy efficiency can be part of a multi-part solution to increasing energy security and curtailing supply shortages, especially through efforts that aim to influence demand.

2.2 Competitiveness

Energy efficiency investments also present a unique opportunity for Armenian industry. As shown in Chapter 4, Armenia's industries have tremendous potential to improve their international competitiveness by investing in energy efficiency. With the country's abundant hydroelectricity generating capacity and substantial nuclear generation capacity, Armenia has some of the region's lowest cost power. Armenia's average cost of power generation is well below other countries in the region who rely primarily on thermal generation. Its businesses, while benefitting from some of the lowest electricity prices in the region, squander this advantage by using inefficient technologies. If Armenia's industries can make themselves as efficient as their peers abroad, they will find themselves with a significant competitive advantage.

Armenian industries that fail to invest in energy efficiency may not survive the next round of tariff increases. Following a rise in import gas prices from Russia in April 2006, domestic gas prices were raised 53 percent for retail customers and 86 percent for wholesale customers. The Government of Armenia subsidized these prices substantially for industry in hopes of stimulating Armenian industry and making it competitive in foreign markets. Unfortunately, the artificially low gas prices enjoyed by industrial customers will likely have long-term consequences for the competitiveness of Armenian industry. On May 1, 2008, the gas tariffs have increased again by 42 percent for small consumers and by more than 51 percent for large consumers. The gas import price will, without a doubt, eventually reach the levels faced by other Gazprom customers in the region, which are roughly double the level of Armenia's current import price. Gas import price of $500 per thousand m^3 cannot be far off.

It is expected that the electricity tariff will rise in January 2009, by roughly 5-7 percent, to reflect the elimination of gas subsidies on May 1, 2008. If the gas import price is US$500/ thousand m^3, then the electricity end-user tariff will increase by 78 percent. The end-user gas tariffs will increase by 200 percent for small consumers and by 300 percent for large consumers (see Table 2.2 for more detailed estimates)..

Table 2.2. Gas import price impact on end-user electricity and gas tariffs

Gas import price (US$ per thousand m3)	End-user electricity tariff increase	End-user gas tariff increase for small consumers	End-user tariff for large consumers
220	27 percent	42 percent	96 percent
300	42 percent	114 percent	135 percent
500	78 percent	200 percent	300 percent

Source: Author's calculations

As the National Program on Energy Saving and Renewable Energy has shown, during 2001-2005 the energy consumption in the industrial sector has doubled, with energy costs making up 25 to 40 percent of Armenian businesses' operating and maintenance (O&M) costs.

Box 2.2: Selected business stories

A glass company producing mainly bottles for beverages and glass containers, with around USD 20 million in annual sales, of which more than half for export to Georgia, reported that the energy constitutes around 14 percent of their production cost, while the share of natural gas is 8 percent. The company acknowledges that their success in the Georgian market is largely explained by lower gas tariffs in Armenia because of both lower border prices and gas subsidies. However, the role of subsidy seems less important today than in 2006 as there is a large border price differential between Georgia and Armenia.

In terms of sustainability, the company believes there will be no major gas tariff increase at least in the medium term. They see border price increase to USD 235 combined with no subsidy as the worst scenario that has almost no chances to materialize. New gas tariffs for industrial consumers (USD 280-300 (in case border price is USD 235) will increase their production cost by around 20 percent, so they would need to cut production of less profitable products and work only in "exclusive" product niche that may result to only 40 percent capacity utilization versus current 70 percent. In general, in a hypothetical scenario of zero tariff differentials between Armenian industrial consumers and their Georgian and Moldovan competitors the company estimates that their sales abroad will be reduced by 50 to 70 percent, while their domestic sales might be reduced by 10 to 20 percent.

The company motivates their recent massive investments to increase the production capacity by lower and stable (as they see it) gas tariffs in Armenia, but they do not think that the absence of Government communication on the possibility of tariff increase should be blamed if their calculations turn to be wrong.

Source: Exploring Armenia's Gas Policy and Challenges Ahead. World Bank, 2006

Armenia's electricity generation costs are low, at least in part, because of the relatively low asset values of its generating plants. As most plants are quite old, their asset values are negligible. Tariffs therefore cover running costs, but no significant capital cost component. The tariff of the nuclear plant, moreover, does not currently include adequate provision for costs of decommissioning. As a consequence, tariffs do not reflect the relatively higher capital costs of the newer plant that Armenia will need in the not-so-distant future (in other words, the long run marginal cost of electricity supply). Armenia is most likely to meet increased demand in one of three ways:

- Increased use of the Hrazdan gas-fired plant, Armenia's most expensive generating facility. Hrazdan's current tariff is AMD 15/kWh (roughly US$ 0.05/kWh), but this tariff will increase to AMD 27/kWh if gas import price is US$220/thousand m^3 and will be AMD 51/kWh if gas import price is US$500/thousand m^3.
- Construction of a new nuclear plant or a gas-fired thermal plant. The cost of electricity of the new plants will be around US$ 0.07 – US$ 0.10 per kWh (roughly, AMD 21 - 30 per kWh).[3]

Any of the above options will require a tariff higher than the current tariff for the Hrazdan plant, and hence is likely to increase the average tariff considerably. Armenian industry will do well to ready itself for the arrival of much higher cost power..

2.3 Fiscal, economic and social impact

Armenia stands to gain tremendously by investing in energy efficiency. Purchasing 1 thousand m^3 of natural gas from Gazprom costs more than twice what it would cost the country to invest in energy efficiency measures that would save 1 thousand m^3. The average cost of an energy efficiency investment that saves gas in Armenia costs less than half of what it costs for Armenia to purchase a new unit of gas from Gazprom. Building 1 kW of new electric generating capacity costs more than five times what it would cost the country to make energy efficiency investments that would save 1kW.

As shown in more detail in Chapter 4, Armenia can save as much as AMD 132 billion per year in energy expenditure by investing in energy efficiency. This amount is equal to roughly 5 percent of Armenia's 2006 GDP, and 78 percent of the country's current account deficit in the same year

Energy costs account for a large percentage of annual budgetary expenditures of public buildings. In a survey of educational, municipal, and healthcare buildings, 35 percent of respondents noted electricity costs of 11-20 percent of total annual expenditure. Electricity costs were particularly large for educational buildings where 38 percent of respondents noted electricity costs as 11-20 percent of total annual building expenditures and 27 percent of respondents reported costs over 20 percent.[4] Many schools close for winter months due to the inability to adequately heat the buildings. When they do operate, they are often heated well below adequate temperatures.[5]

Affordability of utility services is a key issue for many Armenian households. The cost of energy for basic necessities (i.e. heat, hot water, cooking), especially as the cost of natural gas rises, takes a heavy toll on Armenia's low-income households. Heating-related

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[3] Energy Technology Perspectives 2006. Scenarios and Strategies to 2050. OECD/IEA. 2006.

[4] "Energy Consumer Survey in Armenia: Residential, Commercial, Public and Industrial Sectors." Advanced Engineering Associates International. September 2006.

[5] Most residents consider "adequate heating" to be 16ºC at a minimum, however, schools often operate with temperatures below 8ºC. As noted in Chapter 4, however, conditions in schools have been improved substantially through the activities of the Renewable Resources and Energy Efficiency Fund in schools within the scope of the World Bank financed Urban Heating Project.

expenditures make up a significant portion of household income, especially during the 4-6 month heating season. During the winter months, as much as 50 percent of poor families' expenditures are used for heat-related needs.

2.4 Human health and environment

Energy consumption, especially from highly polluting fuel sources, has significant consequences for the health of Armenia's population, the preservation of key natural resources, and the long-term effects of climate change in Armenia.

2.4.1 Health and safety

Use of traditional fuels jeopardizes human health. More specifically, use of such fuels has significant implications for:

- **Indoor air quality.** Most studies measuring disease from air pollution focus primarily on the health impact from outdoor pollution sources. However indoor pollution sources dominate exposure (i.e. solid fuels used for cooking and heating), and therefore can have an even greater negative impact on human health. A 2007 study reported that about 10% percent of Armenian households use wood or other solid fuels as their primary fuel source for cooking, heating, and other home energy needs.[6] In particular, indoor air pollution increases risk for acute lower respiratory infections in children and chronic obstructive pulmonary disease and lung cancer in adult women[7].

  A 2002 study conducted as part of the World Bank's urban heating strategy development in Armenia found the cost of ill-health to women and children under age five as a result of indoor urban smoke exposure to be "in the region of US$3.21 million [roughly AMD 987 million] per year." This figure is estimated to be as high as AMD 1.7 billion in 2007.[8] Although availability of natural gas for heating and cooking purposes has increased since this study was conducted, gas connections remain limited and are often too expensive in most rural parts of Armenia. Based on the same study, 3,467 annual life years are lost per 100,000 children under five, and 120 life years lost per 100,000 women, due to indoor urban smoke exposure. Moreover this study found that smoke exposure related health problems, such as upper respiratory diseases, headaches, sore eyes, swelling of extremities and blood circulation problems, are especially pronounced among poor households.

  A more recent, 2005 study found that only 29 percent of urban multi-apartment households have not had illness cases due to under-heated dwellings during the winter of 2004-2005 (more than14 percent of population had colds of various origins; over 60 percent had influenza, etc.) Children and elderly are obviously more vulnerable to various colds and other illnesses due to the under-heated living space or public buildings (e.g. schools or hospitals), or other consequences of unsustainable heating, such as polluted or very humid indoor air, temperature fluctuations between rooms.[9]

- **Safety:** Deaths, injuries and damage to people caused by gas and CO poisonings, fires and explosions has become a serious problem and they continuously grow with the

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[6] World Bank. Urban Heating Program Study. 2007.

[7] Desai, Manish A. et. al. "Indoor Smoke from Solid Fuels: Assessing the Environmental Burden of Disease at National and Local Levels." Environmental Burden of Disease Series, No. 4. World Health Organization, Geneva: 2004. 7, 62.

[8] Adjusted to the growth rate of nominal GDP in 2002-2007.

[9] Heat Supply Programme. Project Implementation Unit. 2005.

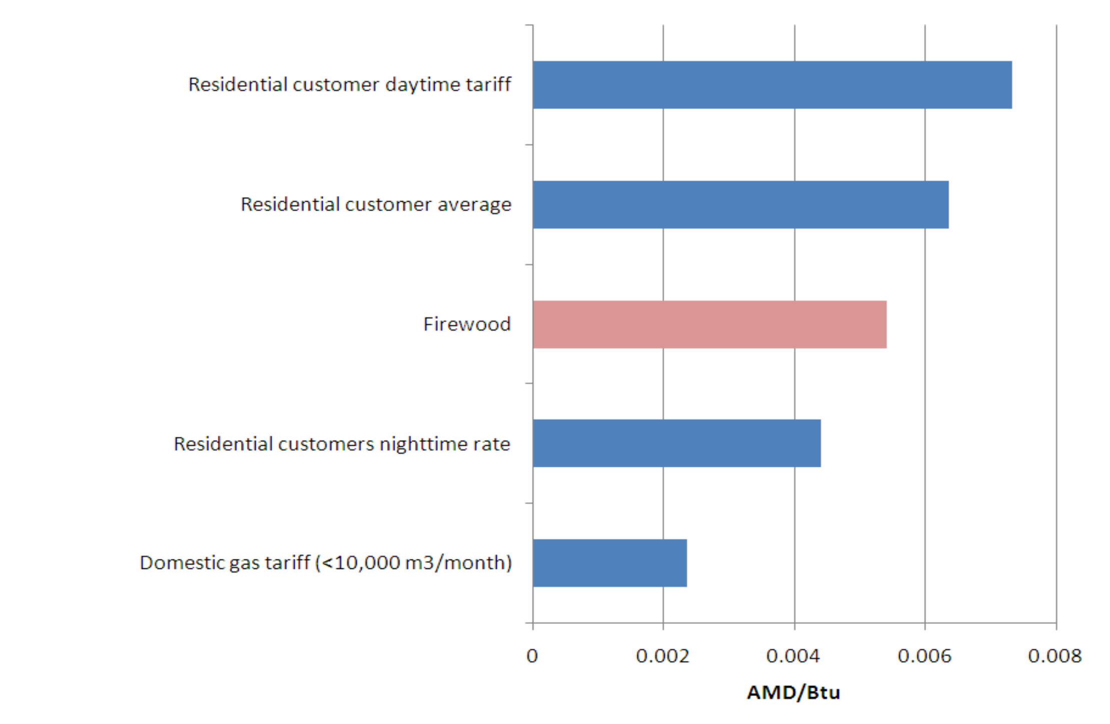
increasing gasification of the country. The accidents now primarily occur mostly because of people's unawareness of gas appliance operation and regulation, the inappropriate level of service quality provided by gas companies, including existence of deteriorated conditions of pipes in many cases. to fight this problem, ArmRusGas has pledged to perform safety inspections as a new function.

2.4.2 Environment and natural resources

The use of wood fuel and fossil fuels in Armenia has consequences for:

Deforestation. Use of fuel wood for heating has broader environmental consequences. Forest coverage shrunk drastically during the energy crisis because the population had to rely on firewood for fuel in order to survive the winter. While fuel wood usage is nowhere near 1992-1995 levels, continued use for subsistence purposes still has a significant impact on Armenia's forest coverage. In 2004, annual wood removal was estimated at 850,000 m^3 of forest coverage per year. This is roughly thirteen times the total legal amount of annual wood removal (63,000 m^3). The illegal removals will continue, and may increase as gas and electricity tariffs continue to increase. As shown in **Error! Reference source not found.**, firewood is already a better value for residential customers, in terms of energy yield, than heating with electricity. Firewood may also come to look attractive to customers relative to natural gas, as Armenia's natural gas import prices reach parity with those Gazprom charges most other countries, With only 283,000 ha of forests, it is in Armenia's interest to preserve this limited resource.

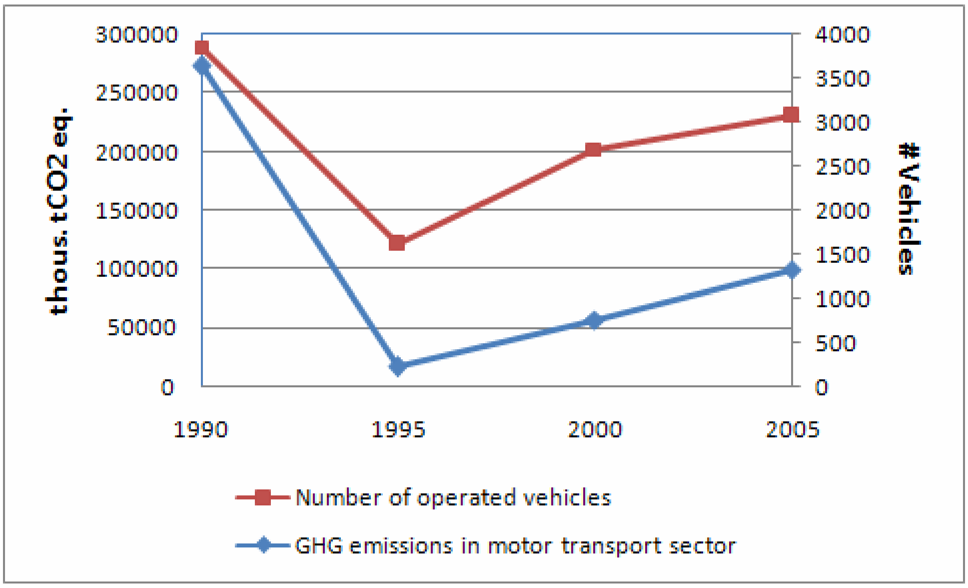
Figure 2.4: Armenia's energy prices in terms of energy content



- **Use of hydro resources.** Heavy reliance on Armenia's hydropower capacity has in the past threatened Lake Sevan. As one of the largest freshwater lakes in the world, Lake Sevan is both a strategic source of reserve capacity and an environmental national treasure for Armenia. Significant drops in the water level during the energy crisis (at one point the lake's volume had dropped as much as 40 percent) led to the intensive growth of aquatic plants, changes in regional climate, and endangered the flora and fauna of the lake's basin.[10] Thanks to proper resource management, water levels at the lake are again returning to their historical levels. However, another energy crisis, precipitated by a gas pipeline interruption or drought could again threaten Lake Sevan.

- **Outdoor air pollution.** Outdoor air pollution is also likely to increasingly become a matter of concern for Armenia. Although, air pollution levels decreased significantly as a result of the energy crisis and economic problems of the mid-1990s, particulate levels in Armenia's four largest cities – Yerevan, Vanadzor, Hrazdan, and Alaverdi – exceed international limits for particulate emissions, with the worst situation experienced in Yerevan.[11] Transportation is the largest air pollutant in Armenia. In 2005 emissions from motor transport accounted for 74 percent of total emissions in the country and 96 percent of total emissions in Yerevan. In addition, annual growth in the number of vehicles in Armenia averages 7 percent, with larger growth trends in Yerevan. Figure 2.5. demonstrates how vehicle ownership and emissions have increased since 1995.

Figure 2.5: CO_2 emissions and change in number of motor vehicles, 1990-2005



Source: "Greenhouse Gas Emissions Reduction and Energy-Efficiency Potential in Transport Sector in Armenia." UNDP, National Gas Vehicle Association. Yerevan: 2006.

- **Climate change.** Armenia may not be a major contributor to greenhouse gas emissions, yet global climate change effects will still have a significant localized impact in Armenia. Most notably, the rise in temperature, which may increase by as much as 2ºC over the next 100 years, and the drop in precipitation levels will have negative consequences including: reduced water supply, reduced plant cultivation, increased evaporation, increased flooding, and increased desertification. These trends are summarized in **Error! Reference source not found.**, which shows how climate change effects will likely impact Armenia's environment and economy in the 21st century.

[10] Renewable Energy Armenia. (http://www.renewableenergyarmenia.am/content/view/310/139/lang,en/)
[11] Global Environmental Outlook 3. United Nations Environment Programme. 2002. 224.

The effects of climate change in Armenia are not necessarily a direct result of Armenia's contribution to rising emission levels. Nevertheless, Armenia can benefit both economically and politically by investing in energy efficiency to reduce greenhouse gas emissions. In light of Armenia's gradual movement toward European compliance standards, and as a (non-Annex B) signatory to the Kyoto protocol, it will benefit Armenia to emerge as responsible contributor to reducing CO2 emissions. In addition, CO_2 reduction achievable by the National Program is worth roughly AMD 10.65 billion annually.

Figure 2.6: What will happen to Armenia as a result of climate change ?

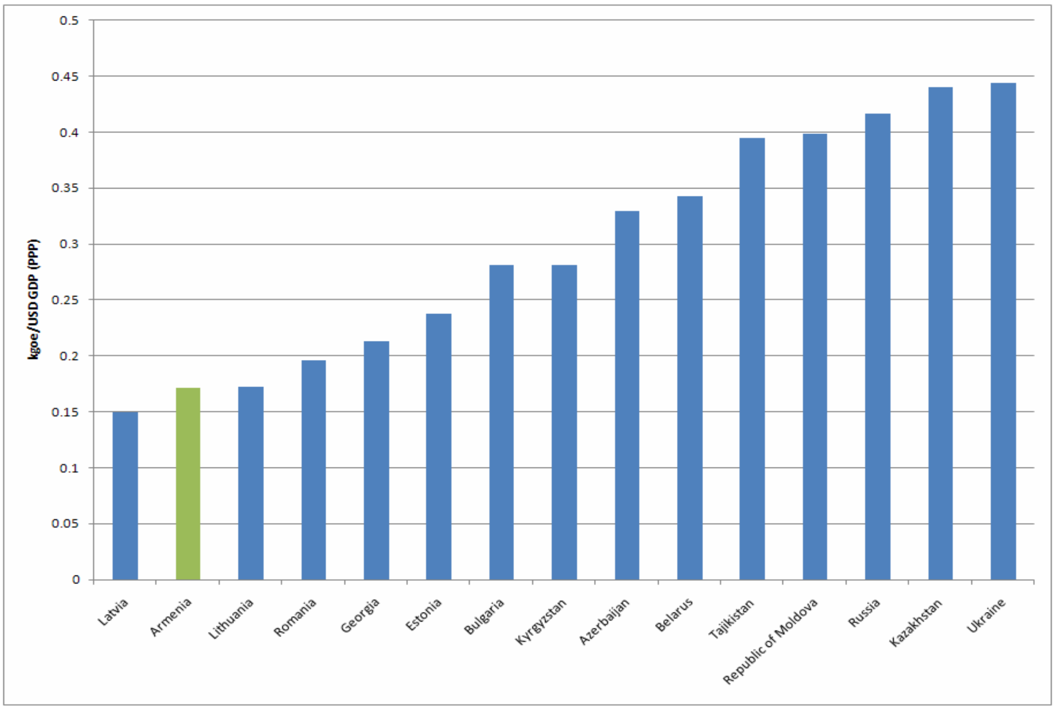
Climate Change Effect	Demonstrated Effects/Potential Impact in Armenia
1.7°C temperature increase by 2100	Agriculture consequences include: decrease of 8-14 percent in plant cultivation efficiency; reduction in pasture area for cattle-breeding, resulting in 30 percent decrease in cattle and 20-28 percent in production of cattle breeding.
10 percent decrease in precipitation by 2100	Reduction of water resources and moist plants by 15-20 percent. Increased chance of drought, reduction in river flows by 15 percent, and increased evaporation by 7-8 percent.
Increase in natural disasters: landslides, floods, droughts, hale, and frosts	Economic damage estimated at AMD1 billion annually.
Flooding and spring inundations	Agriculture and land damage.
Drought	Increase of desertification and climate aridity estimated at 33 percent expansion. Shrinking of forest belt by 21-22 percent. In 2001, drought associated damage to agriculture amounted to US$40 million [AMD 12.3 billion].
Increase in water temperatures and expansion of disease carriers.	Increase in infectious diseases and parasitic diseases. Threat of possible plague outbreak. Demonstrated recent events include a cholera outbreak in 1998 and an increase in three-day malaria, which often proves fatal.

Source: Gabrielyan, Aram. "Capacity building in the Republic of Armenia for the technology needs assessment and technology transfer for addressing climate change problems." Ministry of Nature Protection of the Republic of Armenia, Global Environmental Facility, and UNDP. Yerevan, 2003.

3 Is Armenia Energy Efficient?

In terms of Energy Efficiency, Armenia already appears to be one of the best examples in the region. There is, nevertheless, considerable room for improvement as Armenia continues on its path of economic development.
Unlike other former Soviet states that have been able to rely heavily on domestic hydrocarbon resources to subsidize economic inefficiencies in the energy sector, the Government of Armenia has had to promote reforms to improve the economic efficiency of the sector in order to survive. Other former Soviet Republics that have not undergone the same economic and energy security-related conditions that Armenia endured in the early 1990s have not felt the same pressure to increase energy sector efficiency. Given the great strides made by Armenia in energy sector reform, it naturally follows that Armenia would be one of the more energy efficient of the former Soviet states. This is demonstrated in Figure 3.1, which shows the energy intensities of states in the former Soviet Union.

Figure 3.1: Energy intensity of former Soviet Republics

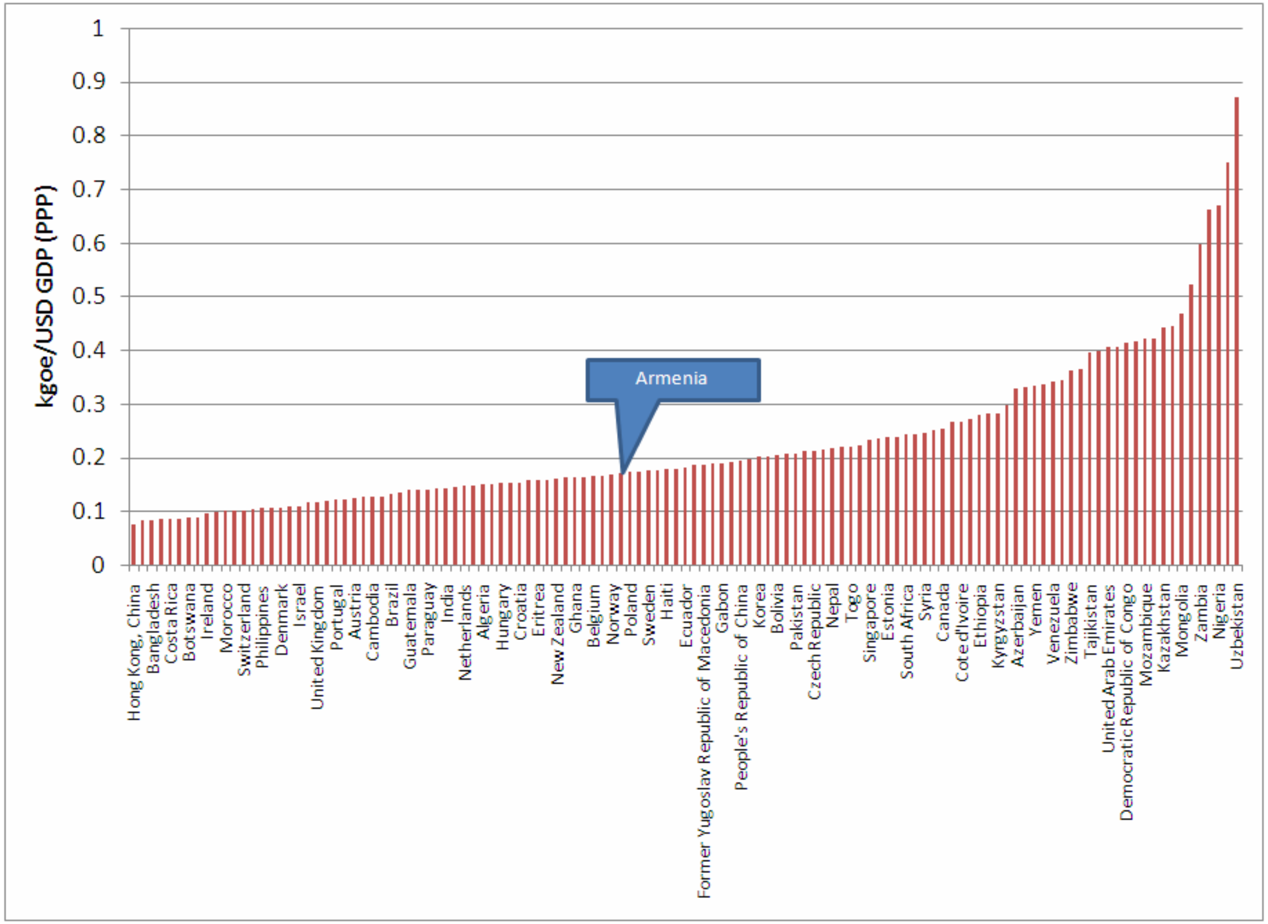


Source: Energy consumption data from the International Energy Agency (IEA), Energy Balances data set. GDP and PPP conversion factor data from the World Bank Development Indicators Database

Relative to all other countries, Armenia is roughly middle-of-the-road in terms of Energy Efficiency. Figure 3.2, demonstrating Armenia's energy intensity per GDP relative to other countries, shows how far Armenia has come and how far it has to go to reach, for example, the energy efficiency levels of Denmark or the UK.[12] Other energy intensity indicators demonstrate this same phenomenon. For example, Armenia ranks 31 out of 122 countries in terms of electricity intensity and 51 out of 135 in terms of energy consumption per capita.

[12] Appendix A shows a comparison of energy intensity per capita in Armenia as compared to 121 other countries.

Figure 3.2: Armenia's energy intensity relative to 121 other countries

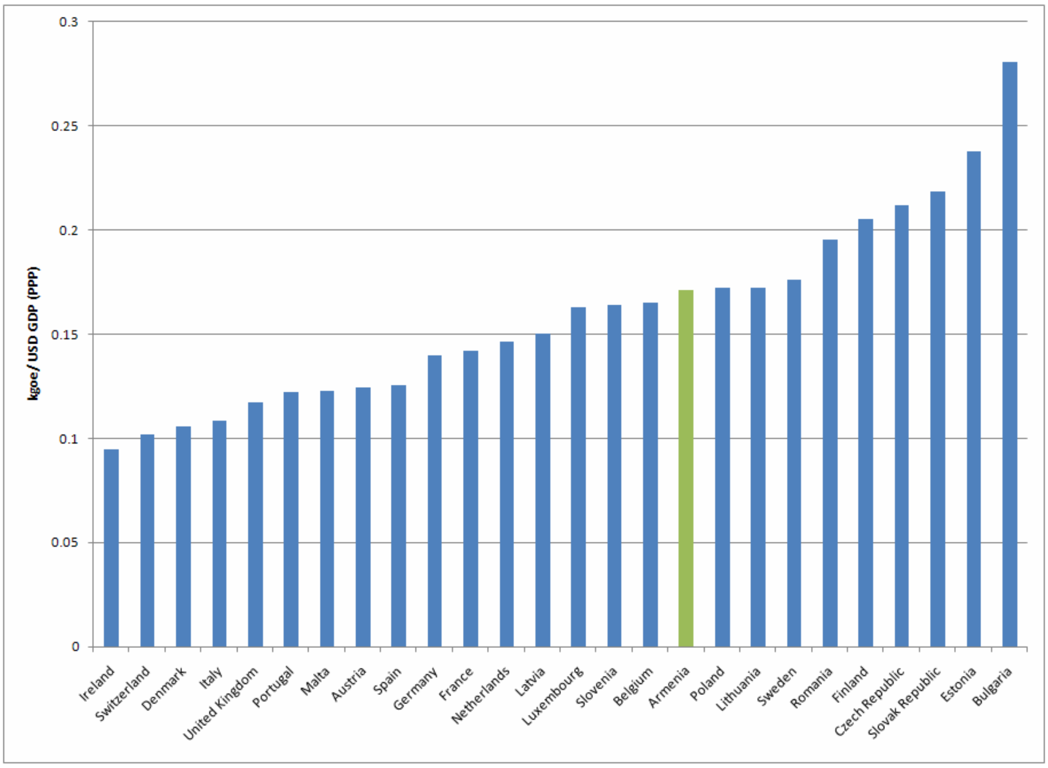


Source: Energy consumption data from the International Energy Agency (IEA), Energy Balances data set. GDP and PPP conversion factor data from the World Bank Development Indicators Database

In terms of energy efficiency, the former Soviet Republics are no longer Armenia's peer group *per se*. The economic and structural reforms undertaken in Armenia's energy sector have launched it into a new category of countries, where energy prices are set at efficient levels, and achieving energy efficiency is no longer about developing mechanisms that increase economically efficient activity. Armenia must decide who it wants its peer group to be, and implicitly, it has done this.

Armenia has declared its desire to better integrate with Europe and therefore should set its energy efficiency goals based on where it is headed rather than where it has been. In this regard, Armenia's relative energy efficiency becomes less remarkable, and the challenge ahead of the country becomes apparent. Armenia's energy intensity is fairly middle-of-the-road with respect to member states of the European Union. Still, compared to western European countries, Armenia fares worse than all with the exception of colder climate countries. Armenia ranks 17th compared to EU25 countries, with the energy intensity of 0.17 kgoe/US$ of GDP. For comparison, the energy intensity of GDP for Ireland, Switzerland and Denmark, three least energy intensive economies in EU, does not exceed 0.11 kgoe/US$ of GDP. Figure 3.2 shows Armenia's energy intensity relative to European countries.

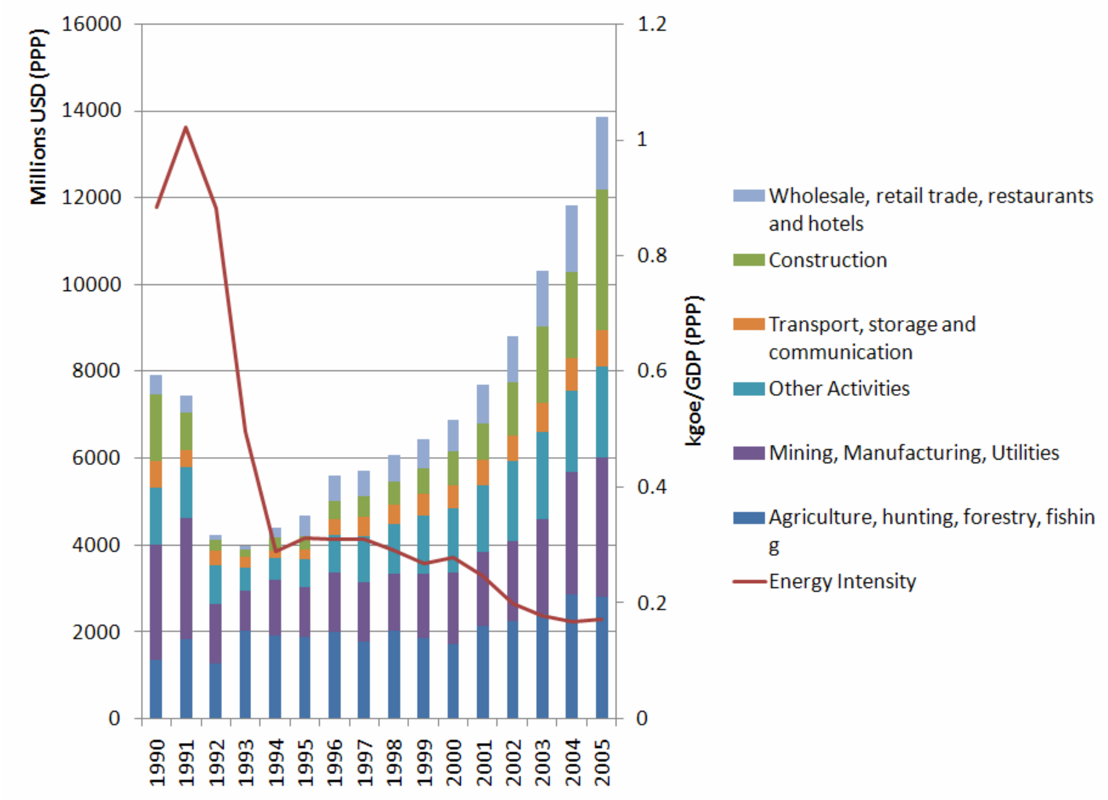
Figure 3.3: Energy intensity of Armenia compared to European countries



Source: Energy consumption data from the International Energy Agency (IEA), Energy Balances data set. GDP and PPP conversion factor data from the World Bank Development Indicators Database

Although Armenia's energy intensity has decreased more than any of the Former Soviet Republics, some of this decrease has been due to changes in the structure of Armenia's economy. Armenia lost relatively more of its industrial output than any other of the former Soviet Republics. Figure 3.4 shows how GDP, the composition of GDP and energy intensity changed in Armenia between 1990 and 2005.

Figure 3.4: Structure of GDP in Armenia



Source: Energy consumption data from the International Energy Agency (IEA), Energy Balances data set. Gross Value Added data from UNDP National Accounts data set. PPP conversion factor data from the World Bank Development Indicators Database.

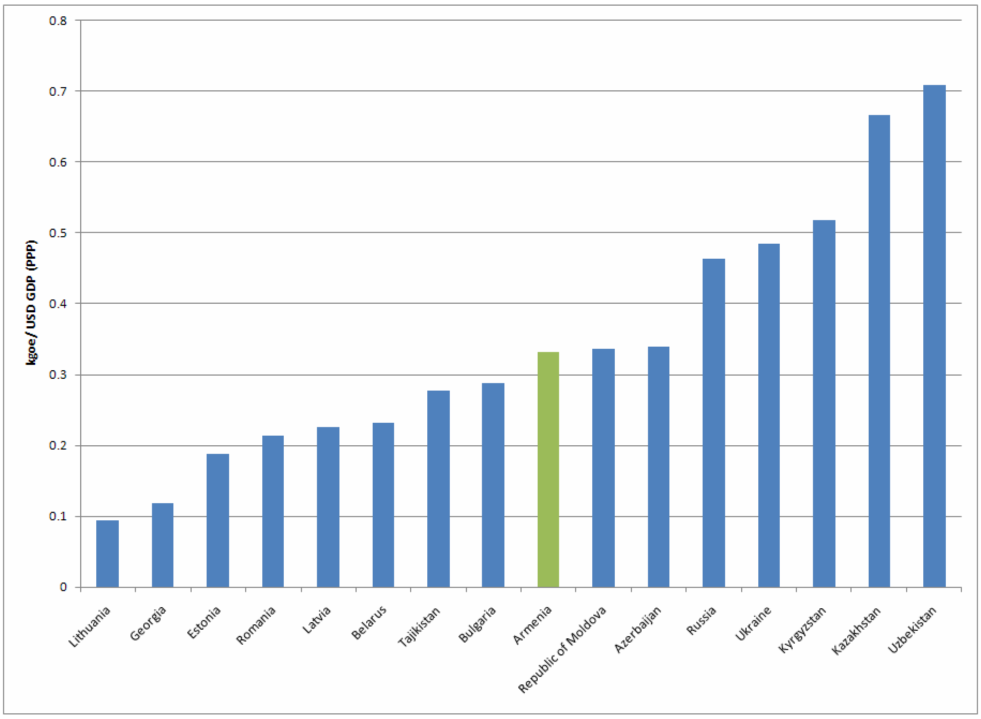
Understandably, the change in the structure of Armenia's economy has led to a significant decrease in domestic energy demand and sector-by-sector patterns of consumption. Yet, even as the value of industrial output in Armenia has decreased relative to other activities, energy consumption patterns of industry have not changed. Between 1992 and 1998, the energy intensity of industry stayed constant or even increased. This had little effect on overall energy intensity, however, due to the increasingly small share of industry in Armenia's GDP.[13]

The energy intensity of the manufacturing sector, in particular, has actually increased since the end of Armenia's energy crisis in 1996. Although the energy intensity of Armenia's manufacturing sector does not appear energy inefficient compared to most former Soviet Republics, it is much less efficient when compared to European countries. Figure 3.5 and Figure 3.6 show how Armenia compares to both former Soviet Republics and European countries, respectively, with regard to manufacturing energy intensity.[14]

[13] Cornillie, Jan and Samuel Fankhauser. "The Energy Intensity of Transition Countries." Energy Economics. 26:3 May 2004, 283-295.

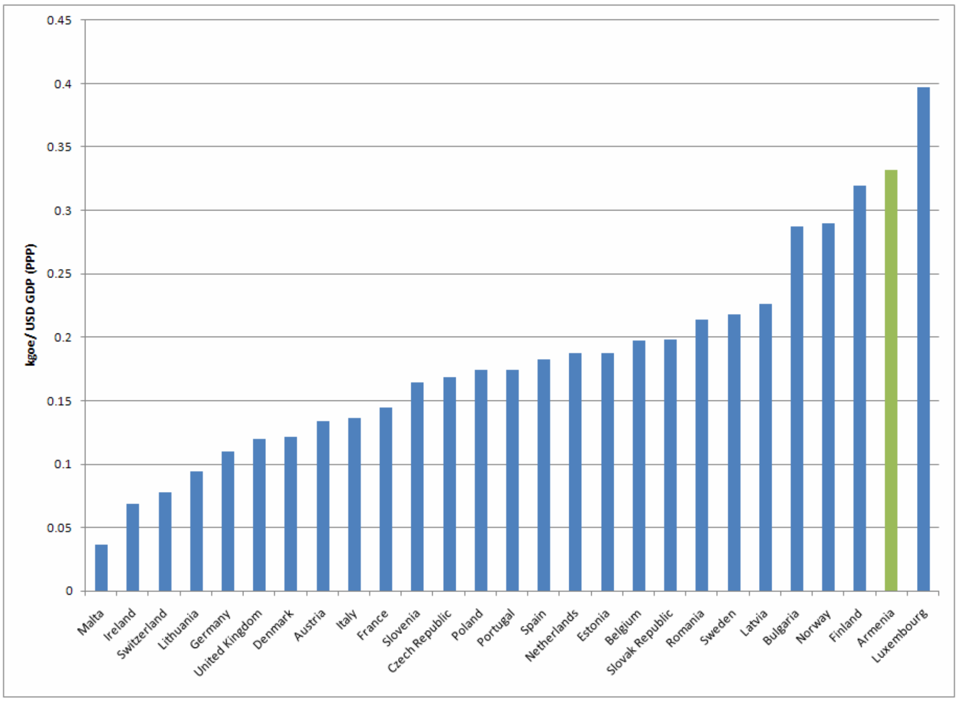
[14] Appendix A contains figures comparing Armenia's energy efficiency to other countries in other economic sectors.

Figure 3.5: Energy intensity of Manufacturing, former Soviet Republics



Source: Energy consumption data from the International Energy Agency (IEA), Energy Balances data set. Gross Value Added data from UNDP National Accounts data set. PPP conversion factor data from the World Bank Development Indicators Database.

Figure 3.6: Energy intensity of Manufacturing, Armenia v. European countries



Source: Energy consumption data from the International Energy Agency (IEA), Energy Balances data set. Gross Value Added data from UNDP National Accounts data set. PPP conversion factor data from the World Bank Development Indicators Database.

4 What is the Potential for Energy Efficiency Improvement in Armenia?

Armenia could save as much as AMD 132 billion annually, equivalent to roughly 4.9 percent of its 2006 GDP, by making the investments recommended by the National Program. Table 4.1 shows 2005 energy consumption by sector in Armenia, the technical potential for savings in each sector, and the value of that potential, if achieved.

Table 4.1: Energy consumption, technical potential, and potential value for energy savings in Armenia

	2005 Consumption	**Technical Potential for Savings**	**Value of Technical Potential**	
Sector	(mtoe)		(million AMD)	As percentage of Armenia's 2006 GDP
Industry	0.41	0.04	8,581.57	0.32%
Public sector	0.04	0.01	1,110.46	0.04%
Households/Civil society	0.50	0.08	13,159.41	0.49%
Utilities	0.62	0.52	45,831.27	1.72%
Transport	0.44	0.01	3,232.61	0.12%
Buildings (heating only)[15]	1.12	0.53	60,274.00	2.26%
Total	3.12	1.21	132,189.32	4.95%

Source: Estimated from National Program

The sectors with the largest potential for savings are, not surprisingly, many of the sectors with the highest volumes of energy consumption, namely, the building heating, transport, and utilities sectors.

In the industry, public, administration, household, and utilities sectors, 99 percent of the technical potential for energy savings can be achieved through investments that are economically and financially viable. In other words, investors, whether those investors are the Government, private companies or individual households or organizations, would earn a positive return on nearly all of the investments recommended by the National Program.

Data from the National Program do not allow for an assessment of economic and financial viability in the buildings sector, but experience from other energy efficiency work in Armenia, and a survey of pricing from equipment suppliers in Armenia (conducted specifically for this study) suggests that roughly 80 percent of the potential

[15] Includes heating in residential and municipal buildings only (of which roughly 90 percent is consumed by residential buildings and 10 percent by municipal buildings). According to the National Program, "The administrative buildings in Yerevan and other cities, as well as the educational, healthcare and cultural facilities, have their own heat supply systems (boiler houses, or electric heaters)."

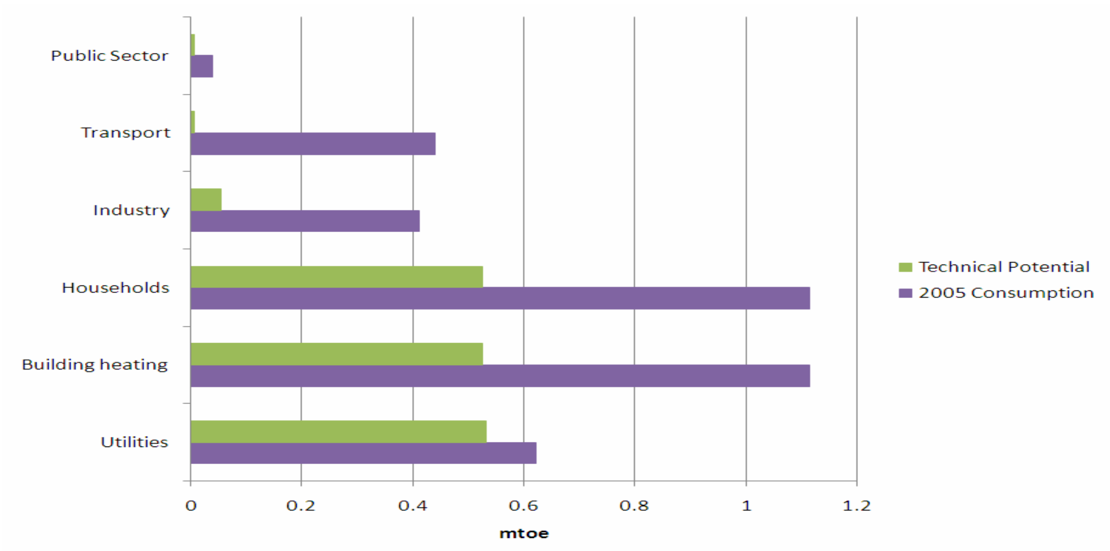
energy savings in buildings are financially viable.[16] Sufficient data were not available from the National Program or others studies, to estimate the economic or financial viability of energy efficiency investments in the transport sector.
The greatest returns on investment come from investing in the public sector and industry. Investments in households' energy efficiency also offer significant economic returns, but relatively low financial returns to individual homeowners. Returns to the utilities sectors and industry are lower because of the substantial capital investments required. Organizational measures have the highest returns in all sectors, as they entail relatively little capital investment (if any).

4.1 Methodology: Estimating energy efficiency potential in Armenia

This chapter identifies the areas for energy efficiency investment that are of highest overall value (total value of the savings in Armenian Drams), and highest return (value of energy savings per Armenian Dram invested) to Armenia. The estimates rely on energy consumption data, and energy savings estimates, and capital cost estimates from Armenia's National Program on Energy Saving and Renewable Energy. The National Program examined energy use by 33 types of consumers, and considered 16 categories of energy savings investments for each of these consumers.

Figure 4.1 shows the National Program's estimates of 2005 consumption, as well as the technical potential to reduce energy consumption in each of these sectors. Technical potential was estimated to be roughly equal to 38 percent of 2005 consumption. Savings in both gas and electricity were considered for each type of consumer.

Figure 4.1: Energy consumption and technical potential[17]



Source: National Program

[16] Alliance to Save Energy-Armenia. 2007.
[17] While Armenia's utilities are undoubtedly energy inefficient, the National Program's estimate of technical potential for energy savings in this sector seems unusually high. This report recommends in Section 6.3 that the Government regularly update the data in the National Program, and may wish to reassess the technical potential in the utility sector during the next update.

This study distinguishes between those investments recommended by the National Program which are:

- **Financially viable.** Financially viable investments save energy and money for the individual consumers—private companies, households, or government agencies—that make the investments. More specifically, an investment is financially viable if the cost of saving a unit of energy (for example 1 kWh) is less than the cost of buying an additional unit of energy. This study assumes a 17 percent opportunity cost of capital for private firms, and a 50 percent opportunity cost of capital for households (individual) investors.[18][19] The cost of buying an additional unit of energy is determined by the tariff, or market price applicable to each particular category of customer. This chapter uses as its reference Armenia's gas and electricity tariffs applicable as of May 2008. The model used to estimate the value and return on each of these investments uses current electricity and natural gas tariffs for each type of (33) customers surveyed by the national program

- **Economically viable.** Economically viable investments may save energy and money for Armenia as a whole, over the lifetime of the investment, but the savings cannot necessarily be captured by any single energy consumer. The Government may be willing to make such investments in the public's interest, but individual energy consumers will not. An investment is economically viable if the cost of saving a unit of energy (for example, saving 1 kWh) is less than the cost to Armenia building a new unit of production capacity (for example, 1 kW).[20] In determining economic viability, this study calculates the cost of saved energy assuming a 10 percent opportunity cost of capital for the Government investing on behalf of the public. This is based on the assumption that Government actors require a lower return on investment than private investors and can also attract capital at lower cost. The cost of building a new unit of production capacity is taken as the cost of building the next power plant in Armenia.[21]

  Economically viable investments are also distinguished from financially viable investments in that their value take into account two positive externalities, namely:

  - Reductions in carbon dioxide (CO_2) emissions. To the extent that Armenia reduces consumption of hydrocarbons, it also reduces CO_2 emissions. The value of the CO_2 credits are therefore included as part of the return for energy efficiency investments from the National Program that reduce gas or electricity consumption.[22] Table 4.2 shows, for the sectors where sufficient data were available, estimates of carbon emissions reduced as a result of making economically and financially viable investments in each sector in Armenia.

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[18] The assumption of a 17 percent rate for private firms is consistent with rates observed with commercial lending in Armenia in 2008. The same assumption was also used in another recent study of energy efficiency in Armenia ("Armenia: Building Energy Efficiency Market Assessment." Alliance to Save Energy for USAID. Yerevan: 2007).

[19] Households will typically have a higher opportunity cost of capital than other private investors because they tend to be more risk averse to making energy efficiency investments, need to borrow at (generally higher) retail lending rates in order to make any significant capital investment, prefer short pay-back periods for energy efficiency investments, and often have what they perceive to be higher value uses for their free cash.

[20] The cost of new production capacity is, in other words, the Long Run Marginal Cost (LRMC) of production for a particular type of energy (electricity, gas, heat, etc.) This study uses US$ 0.05, equivalent to the levelized cost of a new nuclear plant as the LRMC for Armenia.

[21] This paper assumes that the public sector rate of return for Armenia is roughly halfway between the rate of return on long-term government bonds in Armenia and the rate of return required by private sector lenders.

[22] This study assumed a price of 10 Euros per ton CO_2.

Table 4.2: Estimated carbon emissions by sector

Sector	Carbon saved from technically viable investments (thousand tons CO_2)
Industry	78.81
Public sector	7.29
Households	85.45
Utilities	1,200.42
Transport	19.46
Buildings (heating only)[23]	788.36
Total	2,179.79

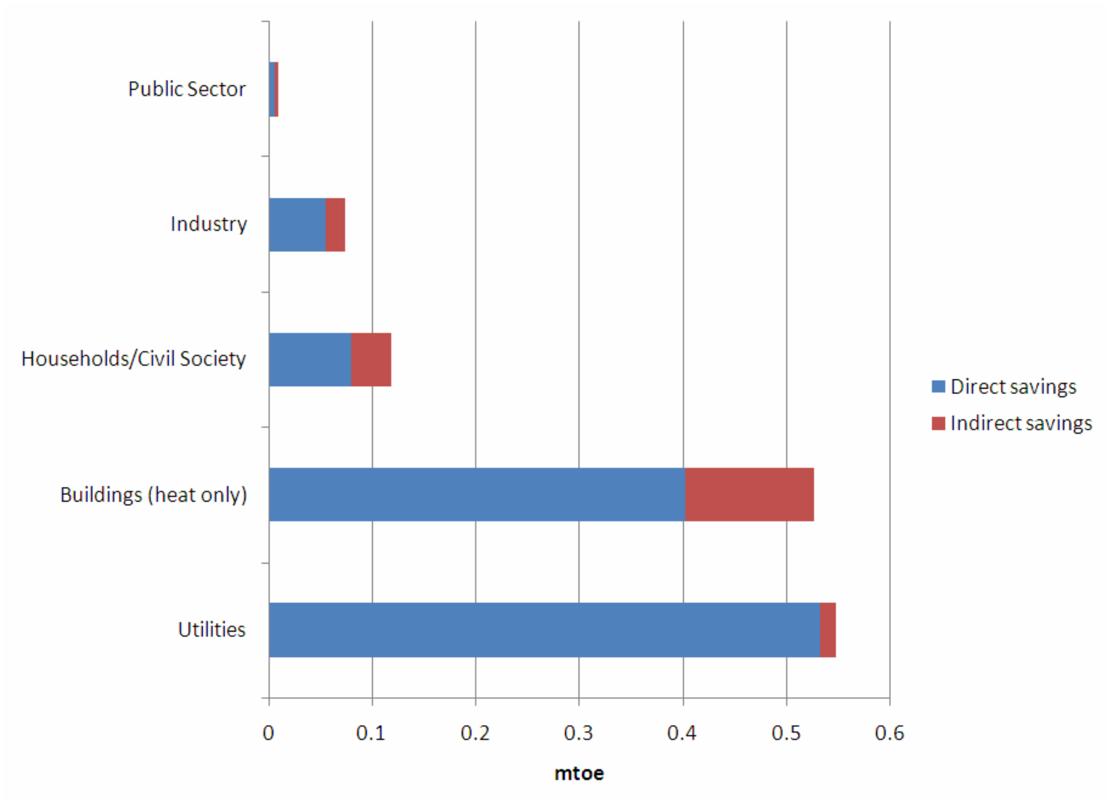
Source: Energy consumption data from National Program; CO_2 emissions estimated from multipliers provided by the International Energy Agency (IEA)

Upstream reductions in natural gas consumption as a result of reduced end-use electricity consumption. The National Program significantly underestimates Armenia's energy savings potential because it overlooks the upstream resources saved as a consequence of reducing end-use consumption. Investments in energy efficiency can save Armenia energy directly, by reducing total final energy consumption, and indirectly, by reducing the volume of fuel required to transform and transport energy for end use consumption (primary supply). A reduction in household electricity consumption reduces the volume of electricity losses, the volume of "own-use" electricity required by the gas-fired Hrazdan and Yerevan thermal power plants, and the volume of fuel those generators must use to serve load.[24]

[23] Includes CO_2 reduced as a result of reduced electricity and natural gas use only. CO_2 reductions as a result of the reduced use of other fuels for heating (for example, wood or propane) are not considered.
[24] "Own-use" refers to the electricity generators use to power their own facilities.

Figure 4.2 shows the direct and indirect savings potential in Armenia.

Figure 4.2: Direct and indirect energy savings in Armenia[25]



Source: World Bank estimate, using data from the National Program and from the 2005 IEA Energy Balance for Armenia.

- **Technically viable.** Technically viable investments save energy, but are not necessarily economically or financially viable for Armenia at the time the analysis was completed.

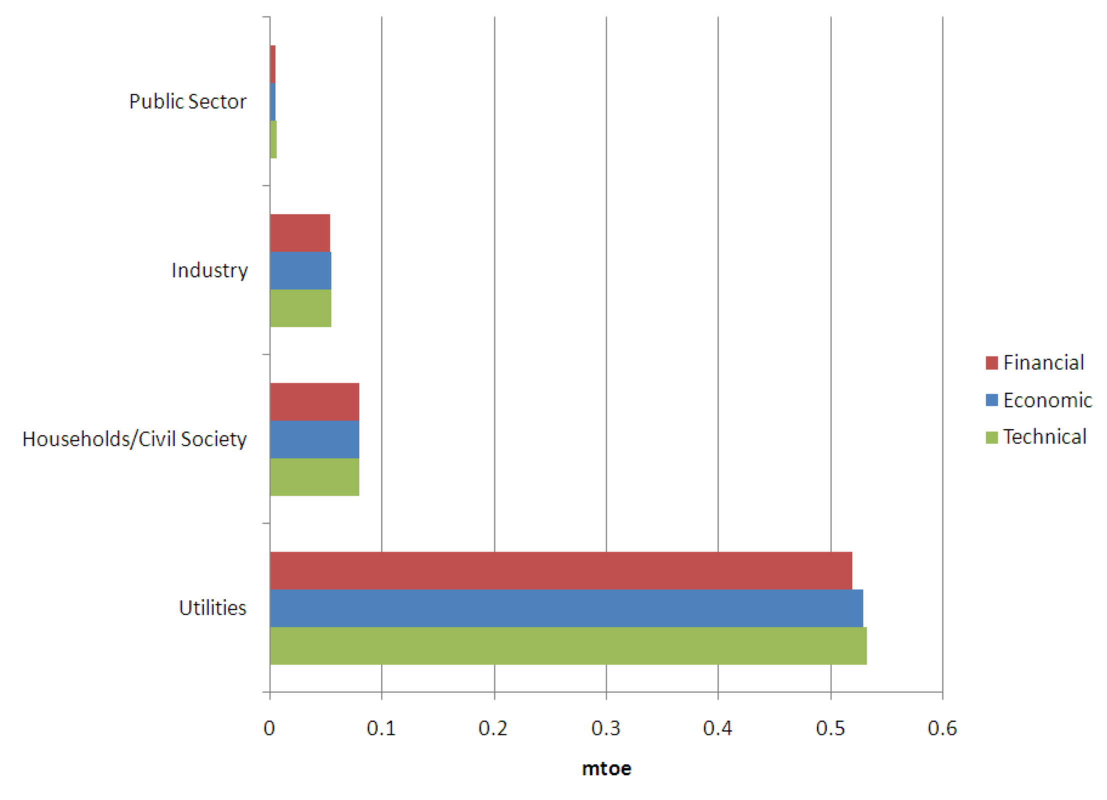
Appendix A includes an additional explanation of the methodology used, and the assumptions used to estimate economic and financial viability of the energy efficiency investments described in the National Program. Appendix C contains a summary of the methodology used, and recommendations made in the National Program.

4.2 Where are the greatest savings?

Armenia can save roughly 1 TWh of electricity and 600 million m^3 of natural gas through investments which are technically viable. As shown in Figure 4.3, nearly all of this reduction can be achieved through investments that are economically and financially viable (99 percent and 97 percent, respectively). The few exceptions are certain high capital cost investments in the utilities sector (water supply and sanitation, irrigation, electricity supply, and natural gas supply).

[25] Because insufficient data were available, estimates of indirect energy savings exclude potential savings from reducing natural gas transmission and distribution losses.

Figure 4.3: Technical, economic, and financial viability of investments



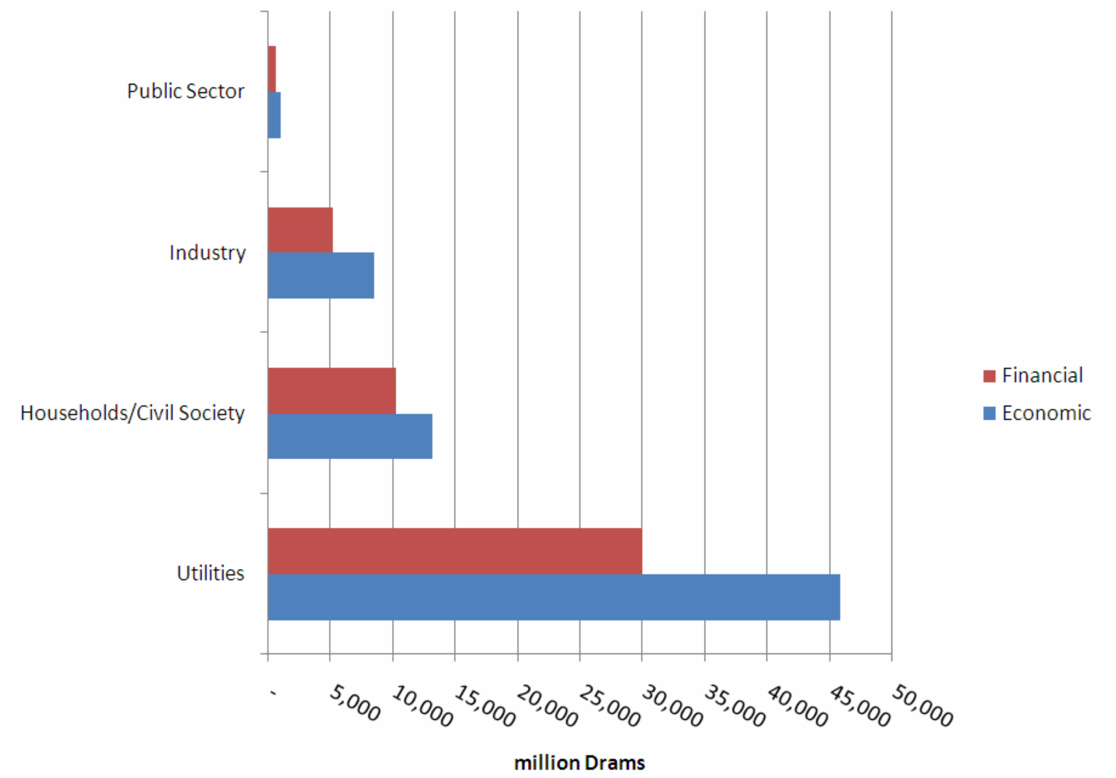
Source: Estimated based on National Program

In terms of energy content expressed in millions of tones of oil equivalent (mtoe), roughly eighty five percent of the energy savings come from implementing measures that save natural gas (.51 mtoe), and 15 percent comes from measures that save electricity (.09 mtoe). All of the investments that save natural gas are economically viable and more than 99.9 percent of the technically potential gas savings is achievable through investments that areof these investments are also financially viable. 98 percent of the electricity savings are achievable through investments that are economically viable, and 92 percent of the electricity savings are achievable through investments that are financially viable.

4.2.1 Where are the greatest annual savings overall?

Armenia could save AMD 68 billion annually, equivalent to roughly 2.5 percent of 2006 GDP, by investing in the economically viable investments recommended by the National Program in the utilities, households, public, and industrial sectors. Figure 4.4 shows the annual value of the savings from economically viable and financially viable investments. The sectors with the largest potential for savings are the sectors with the highest volumes of energy consumption. The total savings and the returns to specific activities within each sector are shown in Appendix D.

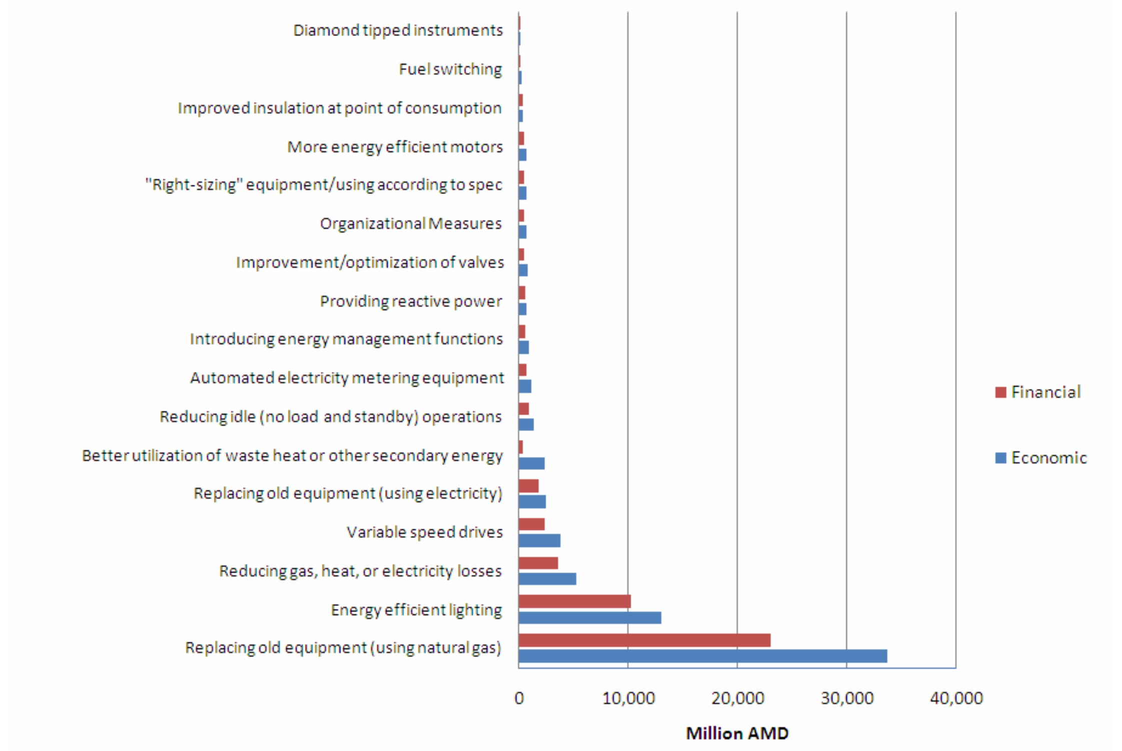
Figure 4.4: Annual value of energy efficiency investments by sector



Source: Estimated based on National Program

Overall, the energy savings of most value comes from simply upgrading older gas-using equipment with more modern, energy efficient models, and installing more energy efficient light bulbs. Together, these two measures account for roughly two-thirds of the money which can be saved through energy savings in Armenia. Most of the natural gas savings results from upgrading older gas- using equipment with more modern, energy efficient models or improving the thermal insulation in building heating systems. Roughly half of the electricity savings comes from using more energy efficient lamps. An additional 20 percent comes from installation of variable speed motors and replacement of equipment that uses electricity with more modern, efficient models. Figure 4.5 ranks the savings achieved through each type of energy saving investment.

Figure 4.5: Annual energy savings by type of energy savings investment[26]



Source: Estimated based on National Program

When talking about economic and financial viability, it is useful to distinguish the actors that would likely be taking the investment decisions. The following subsections therefore look separately at potential for savings in the public sector, households sector, private sector, and utilities sectors, the latter of which have a mix of public and private investors.[27] The potential for savings in the transport sector are also examined, however an assessment of economic and financial viability in this sector has not been possible.

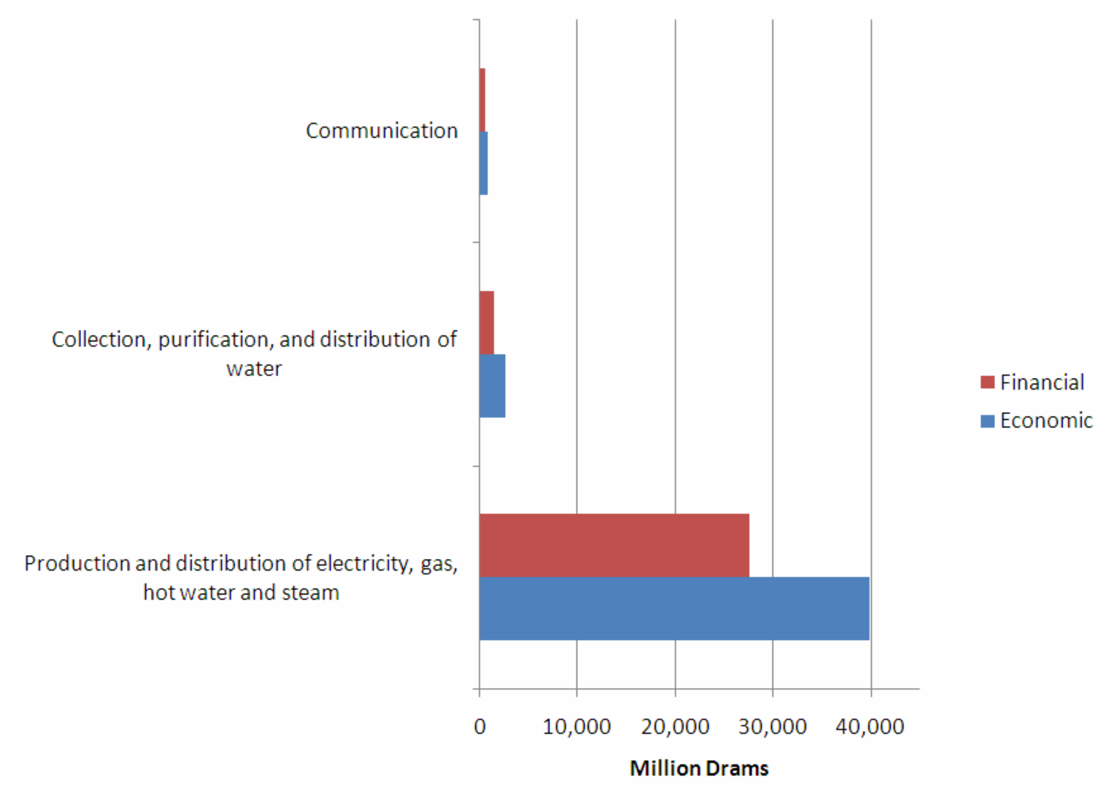
4.2.2 Where are the greatest annual savings in the utilities sector?

Error! Reference source not found. shows the annual energy savings achievable in the utilities sectors. In the utilities sector, the greatest savings are in gas, where simply upgrading the existing capital stock, by replacing old equipment, produces the largest savings. Electricity savings comes primarily from use of variable electric drives and also upgrading the existing capital stock of equipment that uses electricity.

[26] The National Program is an economy-wide assessment of technical potential for energy savings in Armenia and therefore does not always provide detail on the specific types of investments recommended for each sector. It was not always possible for the authors of this study to know exactly what measures the National Program's authors had in mind for each consuming sector. For example, "organizational measures", can mean a wide range of possible energy savings measures. This study is meant to be indicative of what sectors, and what types of energy savings measures, can offer the greatest savings and greatest returns. As recommended in Chapter 4, before making any particular investment, it will be important for the Government to analyze specifically what equipment or what measures are necessary, and in which specific buildings or facilities.

[27] Appendix A includes a summary of how economic activities surveyed by the National Program have been grouped into four categories used in this chapter: Public administration, industry, households, and utilities.

Figure 4.6: Annual energy savings in the utilities sector



Source: Estimated based on National Program

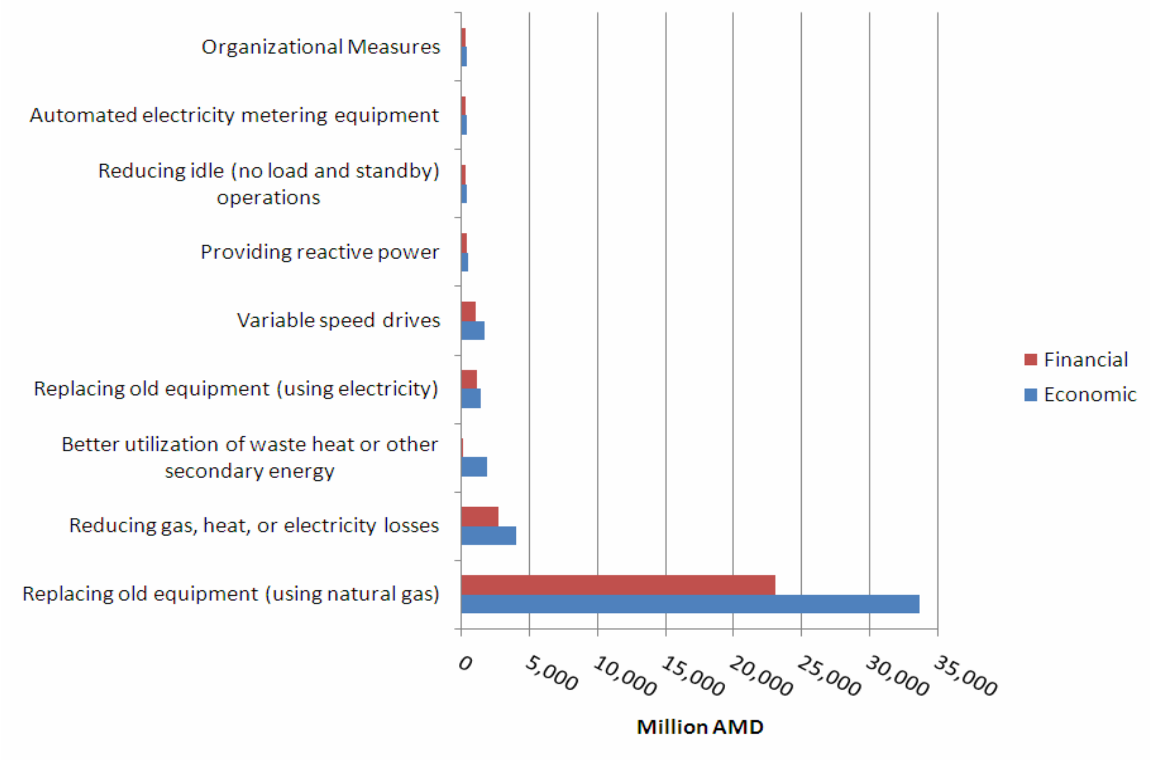
- Savings in the electricity sector can come from improving the efficiency of Armenia's thermal generators, and reducing electricity sector losses. Improving the efficiency of Armenia's thermal generation will likely mean building more efficient plants. The Hrazdan gas plant is extremely inefficient, with a specific energy consumption of 378 grams/kWh. which corresponds to 33% efficiency. This is well below the average OECD value for gas-fired (41%) thermal power plants[28]. Two initiatives are already underway that should improve the efficiency of plants, namely:
  – Installation of a new gas-turbine station with 210 MW capacity in Yerevan TPP
  – Reconstruction of the 5th unit of Hrazdan TPP

.Electricity transmission and distribution losses (of which most of the losses are at the distribution level) also remain considerably higher than the international standard of 6-7 percent, at roughly 15 percent.
In the water supply and sanitation sector, in particular, much savings can be achieved by installing more modern electric pumps. In Yerevan's water supply and sanitation utility (YWSC), for example, water pumps supply approximately two-thirds of the drinking water in the city, and electricity costs therefore make up nearly 80 percent of the existing water tariff . YWSC knows of this potential for savings, and has for several years been working to replace aging pumps.

Figure 4.7 provides more detail on the financial and economic value of investments yielding the most savings in the utilities sector.

[28] Energy Technology Perspectives 2006. Scenarios and Strategies to 2050. OECD/IEA. 2006.

Figure 4.7: Annual energy savings by type of investment in the utilities sector

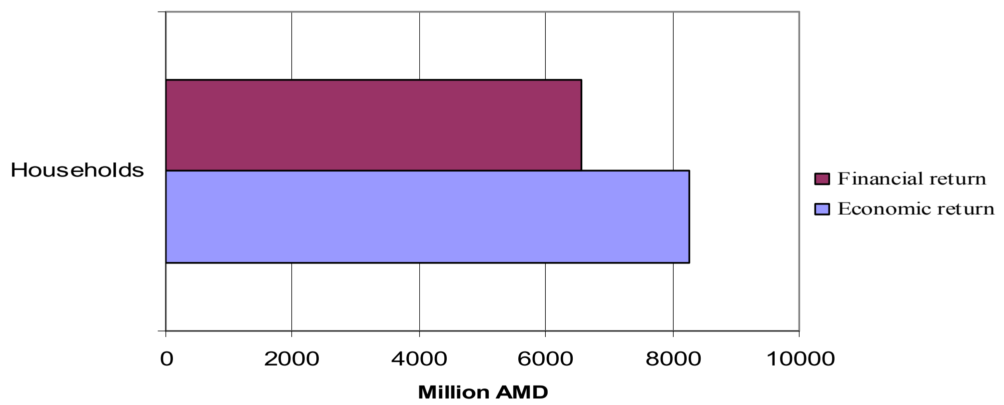


Source: Estimated based on National Program

Where are the greatest annual savings in the households?

Figure 4.8 shows the economic and financial values of annual savings in the household sector.

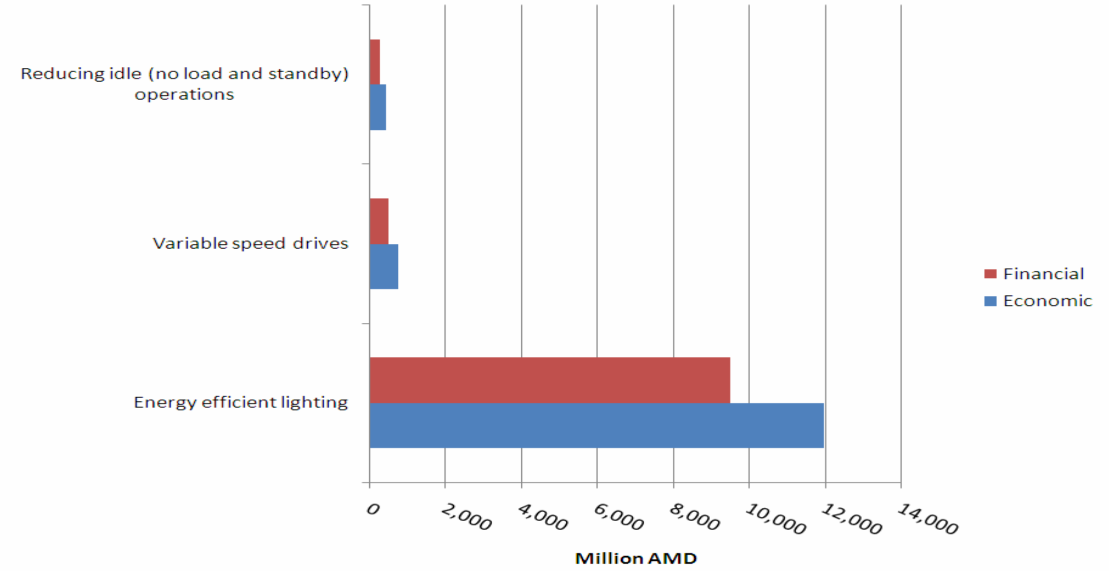
Figure 4.8: Annual energy savings in the residential sector (excludes heating)



Source: Estimated from National Program

Figure **4.9** provides more detail on the financial and economic value of investments yielding the most savings in the households sector.

Figure 4.9: Annual energy savings by type of investment in households (excludes heating)



Source: Estimated from National Program

Electric lighting

Earlier studies in Armenia have shown that significant savings can be reaped from refurbishing lighting systems in the residential sector. This includes both redesign of existing systems and replacement of the existing fixtures with more efficient ones. The design of a typical lighting system usually does not comply with existing lighting norms. The most common case of inefficient lighting in residential premises occurs when the main fixture intended to illuminate the entire space does not provide enough light and the residents use additional lamps to illuminate the space to a level of their personal preference. This can be remedied by redesigning the lighting system of the apartment to make it more efficient. Replacement of the existing lighting systems with more efficient ones may consist of replacement of fixtures or light bulbs with more efficient ones that are offered on the market, for example, fluorescent or compact fluorescent bulbs.

Heating

If measures to reduce household heat energy use are included, the value of energy savings is likely to be much higher.[29] This study estimates the value of the technical potential to improve heat energy use at nearly AMD 60 billion per year; equivalent to roughly 2.3 percent of Armenia's 2006 GDP. As noted above, roughly 80 percent of this savings are achievable through investments that are financially viable.

At the building level, large savings can be achieved by investing in the thermal insulation of walls and roofs with rock wool. Building enveloping (covering the outside walls of buildings with a layer of rock wool) shows promise for great savings,

[29] As noted above, the National Program's estimates of energy savings from improved heating efficiency include energy savings in households as well as municipal buildings. Households represent 90 percent of this heat demand,

however, statistics on annual savings and the cost of investment were not available at the time of this study to include the technical, economic and financial potential of such measures in this report.

Replacing old windows with more efficient, newer models is economically viable in Armenia, but not affordable for the majority of individual residents. Instead, weatherization of windows with insulating materials like silicon or rubber can be implemented as a less expensive alternative.

Evidence from energy efficiency programs in Eastern Europe suggest that the lowest cost measures can be as much as 20-30 percent of energy consumption for heating use, and higher cost measures can save as much as 40-60 percent of energy consumption for heating use. Table 4.3 shows the savings from energy efficiency investments made in buildings in Bulgaria, Lithuania and Poland under the USAID-funded Municipal Network for Energy Efficiency Program.

Table 4.3: Evidence on savings from energy efficiency measures in Eastern Europe

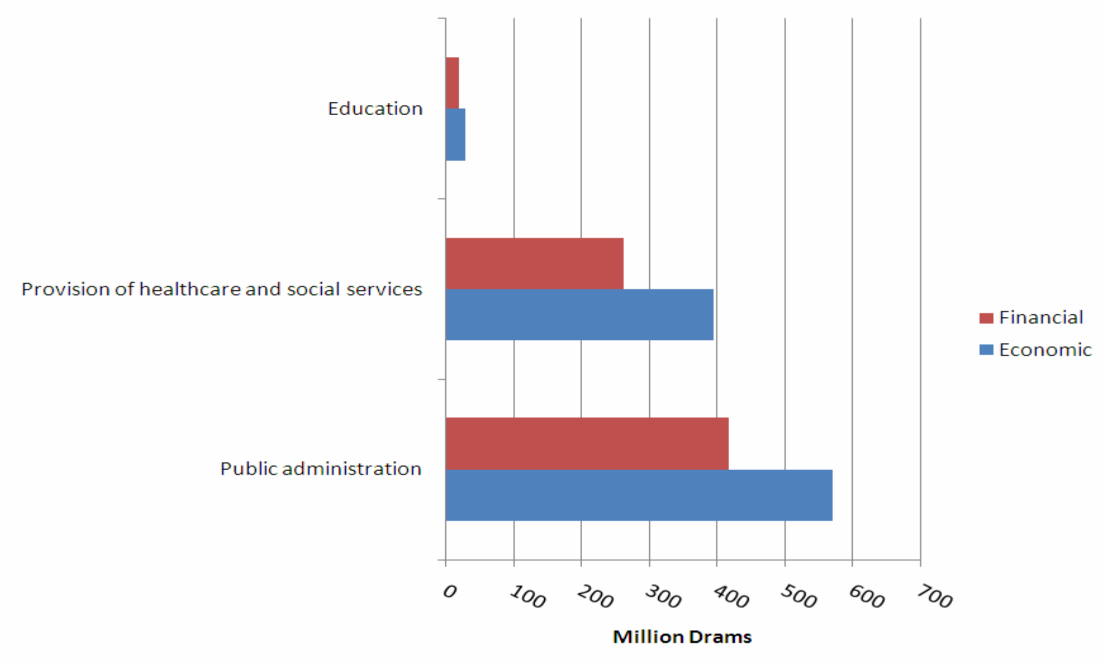
Project location	**Efficiency Measures**	**Energy Savings (percent of savings on consumption)**	**Cost Savings (percent of savings on bills or overall cost savings in US$)**
Pleven, Bulgaria	▪ Weatherization, ▪ TRVs & HCAs, ▪ Radiator shields	26%	23 %
Sofia, Bulgaria	▪ New roof ▪ Insulation (walls, attic, basement) ▪ New windows & exterior doors ▪ Weatherization ▪ Insulation & upgrading interior heating system	60%	US$ 350 per household per year
Vilnius, Lithuania	▪ Weatherization ▪ Insulation (walls, attic, basement)	50%	
Warsaw, Poland	▪ Insulation (walls, attic) ▪ TRVs & HCAs ▪ New boiler for building	52 %	45 %

Source: Municipal Network for Energy Efficiency Program (USAID)

4.2.3 Public sector

Figure 4.10 shows that, of the investments in which the public sector could act directly, those with the greatest net savings are in public administration and healthcare institutions.

Figure 4.10: Annual energy savings in the public sector



Source: Estimated from National Program

In the public administration sector the greatest savings come from reduction of idle processes, improvement of electric lighting in government buildings, use of variable speed drives, and repair or replacement of valves in buildings' heating and water systems. In the education, healthcare and social services sectors the greatest savings come from organizational measures, use of variable speed drives, improvement of electric lighting and repair or replacement of valves in buildings' heating and water systems.

Figure 4.11 shows the greatest savings by type of energy efficiency investment in the public sector.

Figure 4.11: Annual energy savings by type of investment in the public sector

Source: Estimated from National Program

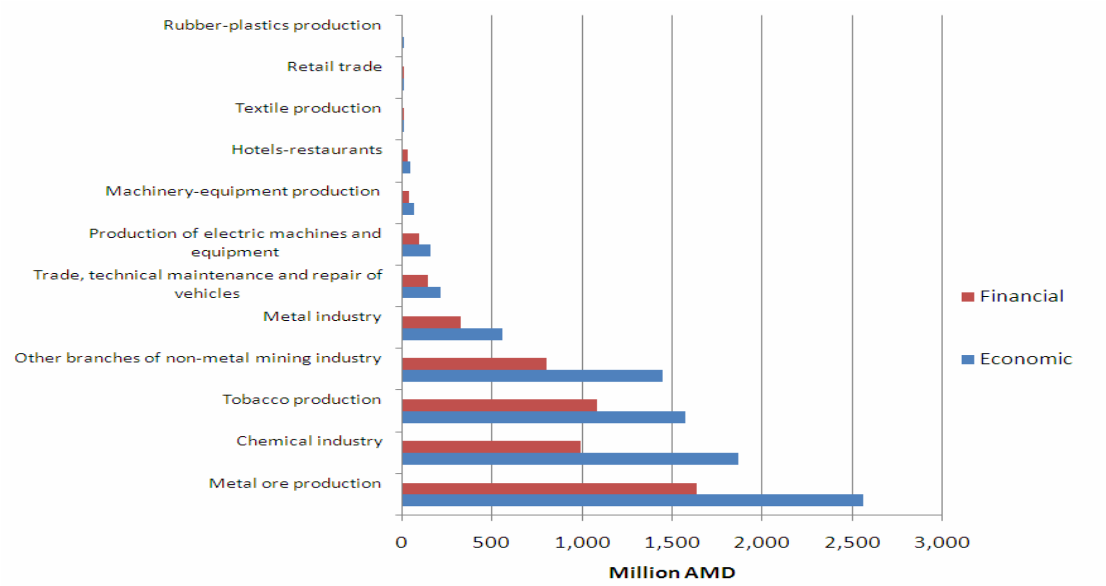
Independent of the National Program data, it should be noted that significant progress has already been made in the education sector. The activities of the Renewable Resources and Energy Efficiency Fund, within the scope of the World Bank-financed Urban Heating Project, have helped to significantly improve heating in schools. The heating systems in these schools have been rehabilitated to use gas, which saves money and allows for higher in-door ambient temperatures.

4.2.4 Industry

As shown in

Figure 4.12, the greatest annual savings in the industrial sector predictably come from the most energy intensive of industries. The measures which save the most energy differ considerably by industrial process. In metal ore production, the greatest savings can be achieved by introducing basic functions (including, possibly, a designated position) of energy management. Replacing old, electricity-using equipment will achieve the most savings in the chemical industry. In tobacco production, the use of automated electricity metering equipment will achieve the greatest savings.

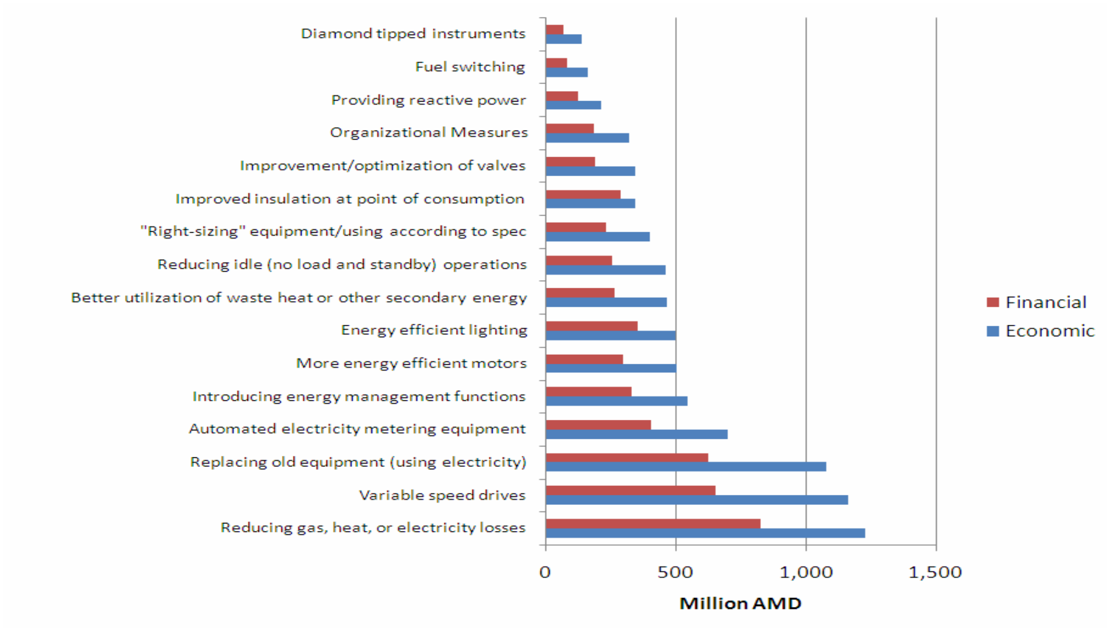
Figure 4.12: Annual energy savings in industry



Source: Estimated from National Program

In industry as a whole, the greatest savings are gas savings, which come primarily from improving the efficiency of natural gas or heat use within the factories themselves. Substantial electricity savings also come from the automation of electric drives, replacing aged capital stock which uses electricity with more efficient models, and use of more efficient electrical lighting.

Figure 4.13: Annual energy savings by type of investment in industry



Source: Estimated from National Program

4.2.5 Transport

The National Program has estimated that Armenia can save seven thousand toe of motor fuels by investing in energy efficiency in the transport sector. Measures expected to bring about these savings include: optimization of routes, stations, and the number and operation of traffic lights, introduction of energy efficient public transport, replacement of older vehicles, fuel switching to liquid and pressurized gas, street improvements, and improvement in the population's driving skills. The National Program's estimates did not include investment costs for implementation of these measures, and no other data were readily available to estimate the annual energy savings for the sector. Nevertheless, these investments are likely to reap considerable savings for Armenia. For example, the average age of a motor vehicle in Armenia is 16 years, resulting in the overconsumption of fuel. As such, gradually upgrading the motor vehicle fleet will bring about additional savings. As the price of oil has continued to rise over the past decade, many Armenian's have begun switching to alternative motor fuels. Armenia now has 93 CNG refueling stations, and in 2005, CNG vehicles constituted 19 percent of Armenia's motor vehicle fleet. Carbon dioxide emissions from CNG vehicles are 3-4 times less than emissions from traditional fuel burning vehicles.[30] However, according to the U.S. Department of Energy, a CNG vehicle gets roughly the same fuel economy as a conventional gasoline vehicle on a gasoline gallon equivalent basis.[31] Hence, although environmentally sustainable, investing in CNG upgrades are not likely to bring about substantial energy savings.

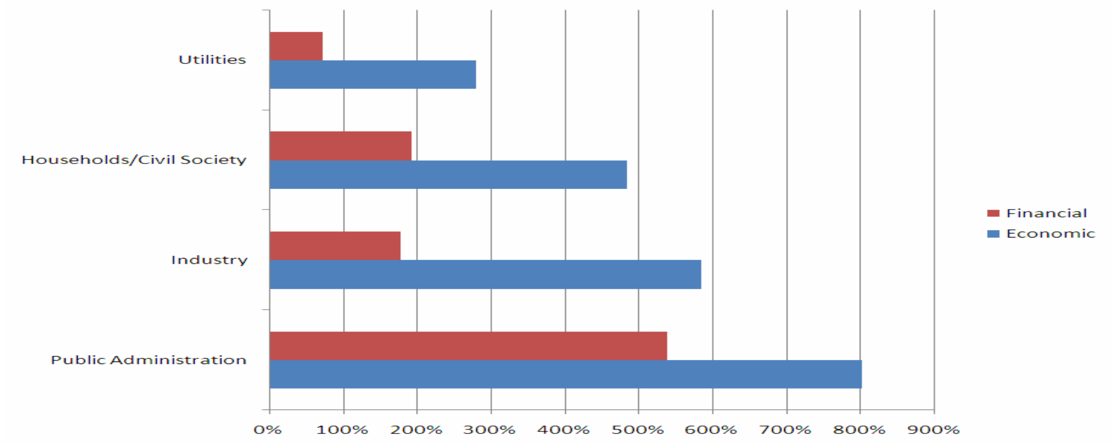
[30] "Greenhouse Gas Emissions Reduction and Energy-Efficiency Potential in Transport Sector in Armenia." National Gas Vehicle Association. UNDP. Yerevan: 2006.

[31] Alternative Fuels & Advanced Vehicle Data Center. Office of Energy Efficiency and Renewable Energy. U.S. Department of Energy.

4.3 Return on investment

Returns to most of the economically and financially energy efficiency investments identified by the National Program are very high.[32] Public sector investments provide the highest return on investment overall. Figure 4.14 shows the total economic and financial return, over 20 years, on the economically and financially viable investments for the high-investments in different sectors. Returns to investments in the utility and industrial sectors are lowest, primarily because the capital expenditures required to earn these returns are relatively higher than in the other sectors.

Figure 4.14: Return on investment by sector



Source: Estimated from National Program

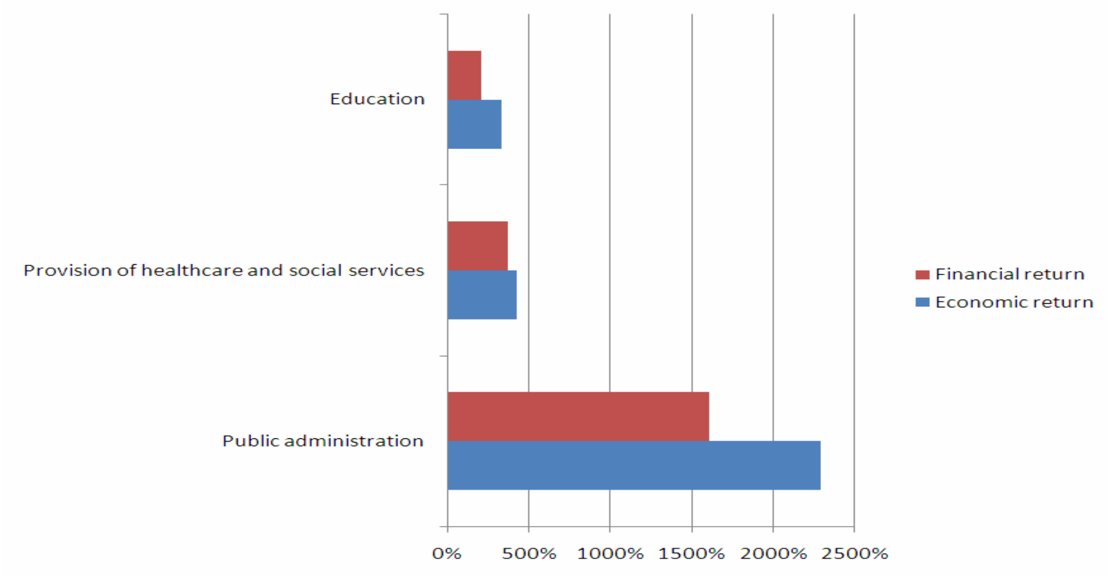
Of the energy efficiency measures considered for public and private investors under the National Program, organizational measures clearly yield the highest return on investment. This is no surprise, as such measures typically require no significant capital expenditure, but can yield substantial savings. Utilities stand to achieve substantial savings through organizational measures, as do a number of industries. The subsections that follow look in more detail at the returns to investments in each sector.

4.3.1 Public sector

The Government can earn very high returns by investing in energy efficiency measures within public institutions. Organizational measures yield the highest return on investment, followed by installation of more energy efficient lighting. The healthcare, social services and education sectors have lower, but still very high positive returns.

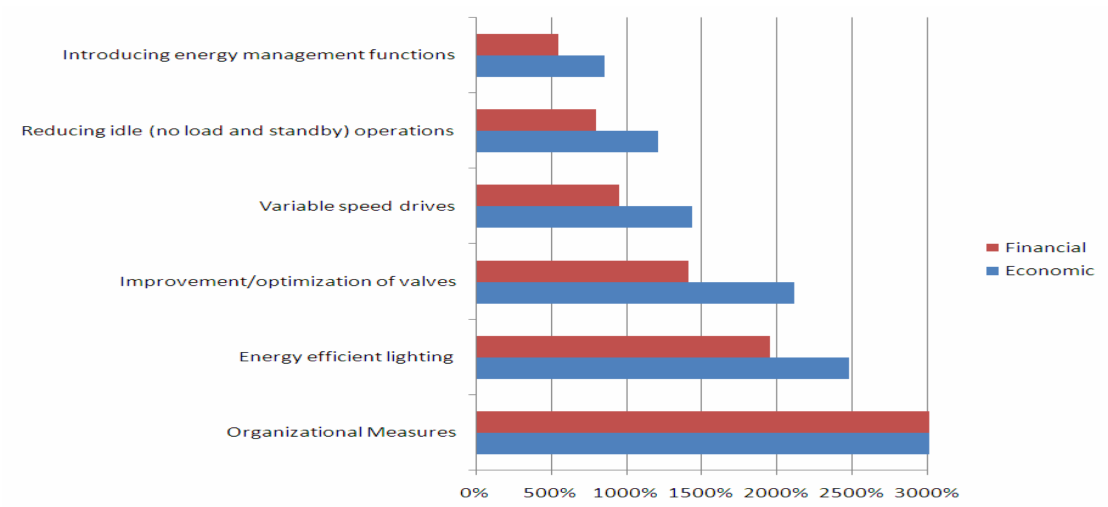
[32] As noted in Section 4.2, data for transport energy use and household heating energy use were not sufficient to allow for a calculation of economic and financial viability, and therefore returns on investments for these sectors were not estimated.

Figure 4.15: Return on investment to public sector activities



Source: Estimated from National Program

Figure 4.16: Return on investment by energy savings measures in the public sector[33]



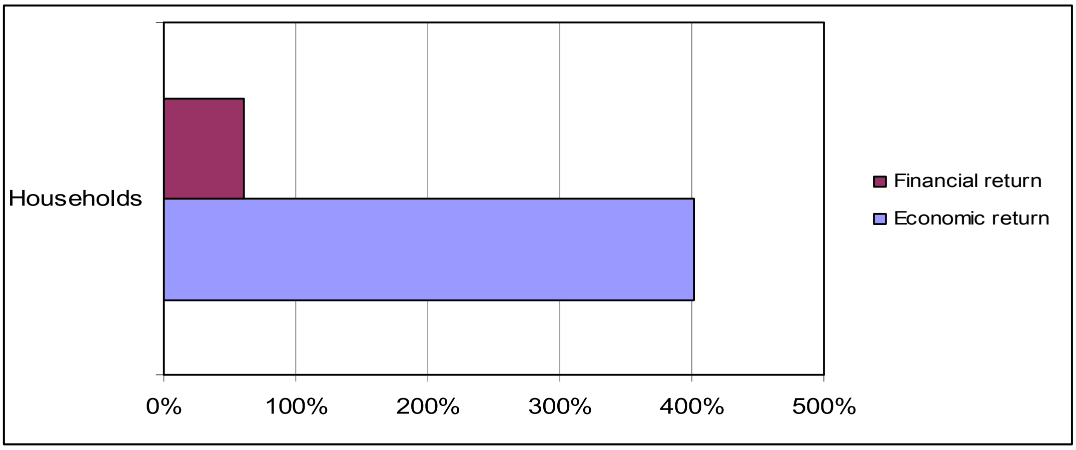
Source: Estimated from National Program

4.3.2 Households

Figure 4.17 shows the returns to energy efficiency investments in the households sector. As the figure shows, the returns from energy efficiency investment in households are much more viable when economic viability is used as a benchmark instead of financial viability. This is because of the assumption (deliberately made by this study) that households have much higher opportunity costs of capital than other investors.

[33] The returns on investments calculated for some measures (most often, organizational measures) often exceed the range shown on the figures in this chapter.

Figure 4.17: Return on investment to households



Source: Estimated from National Program

Figure 4.18 shows the energy savings potential by type of energy savings measure. The highest return on investment to civil society comes from reducing idle operations of electrical equipment (which may include shutting off computers or appliances left in "standby" mode), and the use of variable speed drives. Use of more energy efficient lighting—the only measure for which the National Program provided detailed estimates of household energy savings—offers a 60 percent return for households over a 6.5 year period (based on an assumption about the average life of energy efficient bulbs), even when assuming a 50 percent cost of capital.

Box 4.1: Savings from fuel switching in Armenian households

Under the Armenia-Electricity and Natural Gas Sector Reform Program under the USAID Energy IQC, 2001-2003 project, efficient gas heaters were installed in 150 apartments and single-family houses in Armenia. The investment totaled US$61,500 (AMD 19 million) with an average of US$411 (AMD 126,000) spent in each apartment. The first monitoring survey in a sample of 50 apartments revealed the following:

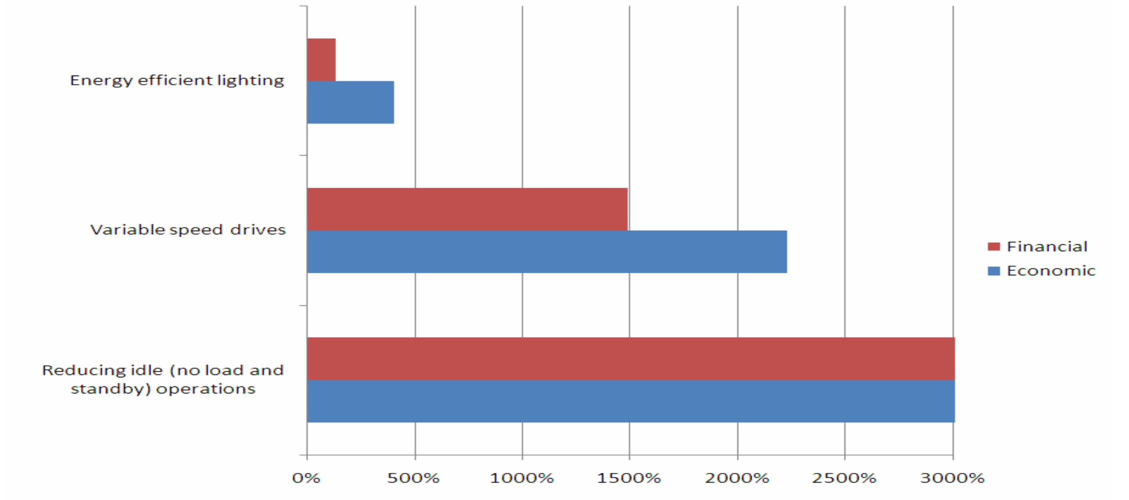
- Residents' energy costs declined by 48% for an average winter month (for heating and cooking), and by 24% for an average summer month (for cooking only)
- Temperature inside the apartments and houses increased on average by 3.2ºC.

The second monitoring the following year revealed that:

- Due to the increased comfort level and more affordable heating option, energy consumption per subscriber increased by about 123 percent
- General energy consumption has increased by 108.6 percent
- In some single-family houses the average energy cost reduction has been 37 percent, and in apartments 47 percent
- The registered monetary savings were 65,265 drams per subscriber (based on past electric bills).
- After the project implementation, the meters showed that the electricity consumption has declined by 58 percent (for 3 buildings),
- The residents of the multi-apartment buildings have completely stopped using oil, propane and wood as a fuel source.

Sources: (1) Armenia: Results of Pilot Project on Fuel Substitution. Contract No. LAG-I-00-98-00005-00. Task Order 13, 3 May 2001; (2) Evaluation of Fuel Substitution Pilot Project. 30 May 2002. Report 1, 19 September 2003. Report 2.

Figure 4.18: Return on investment to households and other public activities by energy savings measure

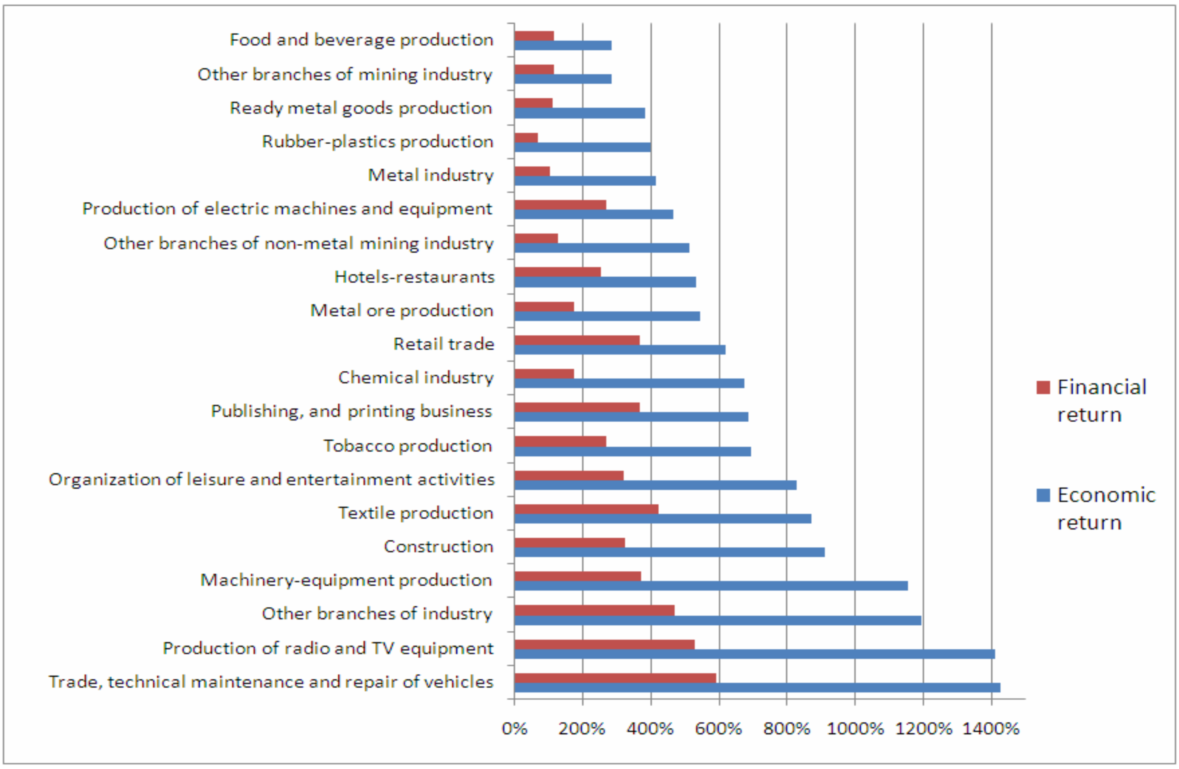


Source: Estimated from National Program

4.3.3 Industry

For private investors in industry, the highest returns from energy efficiency investments are in textile production, publishing and printing, retail automobile sales and repair, and production of radio and TV equipment. The capital investments required in these sectors are low relative to most of the larger, more energy intensive industries.

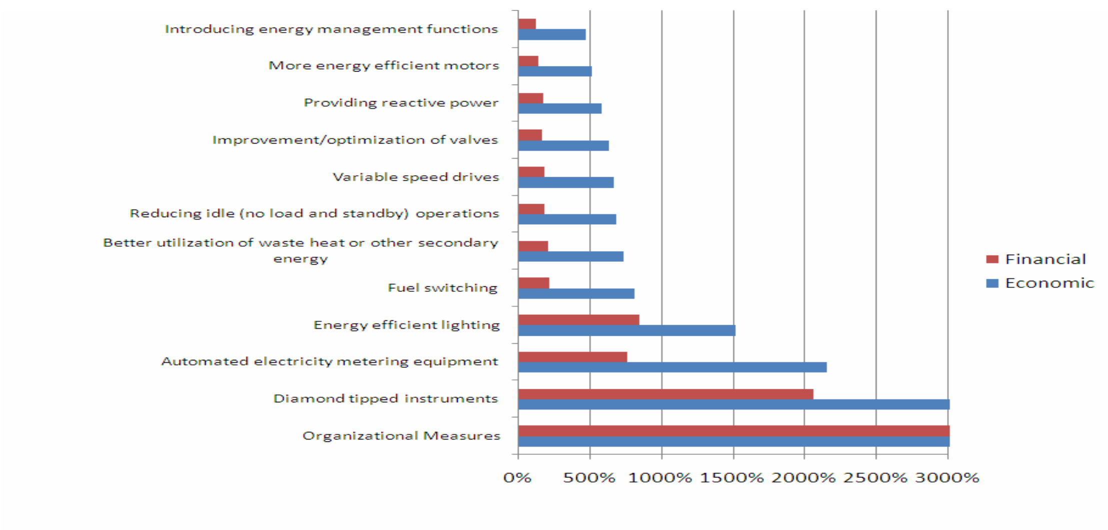
Figure 4.19: Return on investment to industry



SSource: Estimated from National Program

Overall, organizational measures can achieve the greatest return on investment in industry. Specifically, this involves either hiring an energy manager or appointing a department or other organizational structure within a company to oversee and manage energy consumption. Such a measure, which can be implemented at a relatively low-cost, reveals key, company-specific areas where further energy savings can be achieved.

Figure 4.20: Return on investment by energy savings measures in industry



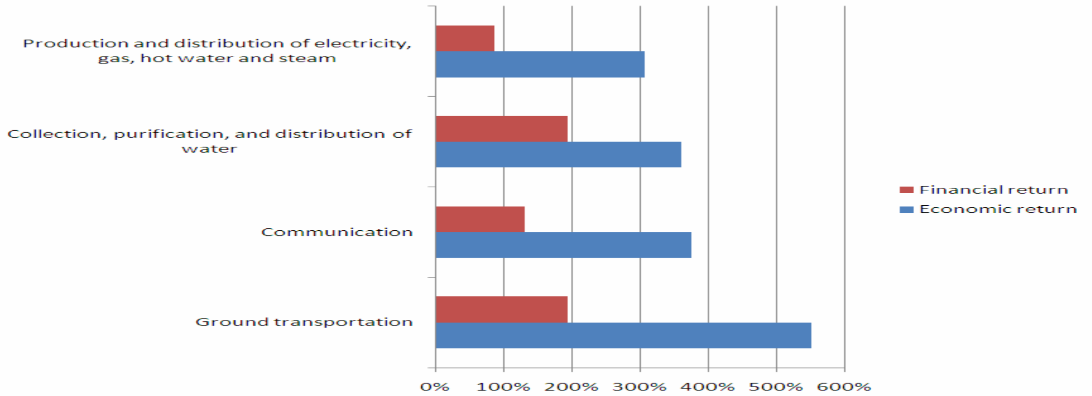
Source: Estimated from National Program

4.3.4 Utilities

As shown in

Figure 4.21, the highest return in the utilities sector comes from investments in the communications sector. Investments in this sector are limited to organizational improvements and the use of more energy efficient lighting, and are therefore lower cost. Investments in the water and sanitation, irrigation and energy sectors are more capital intensive, and more expensive.

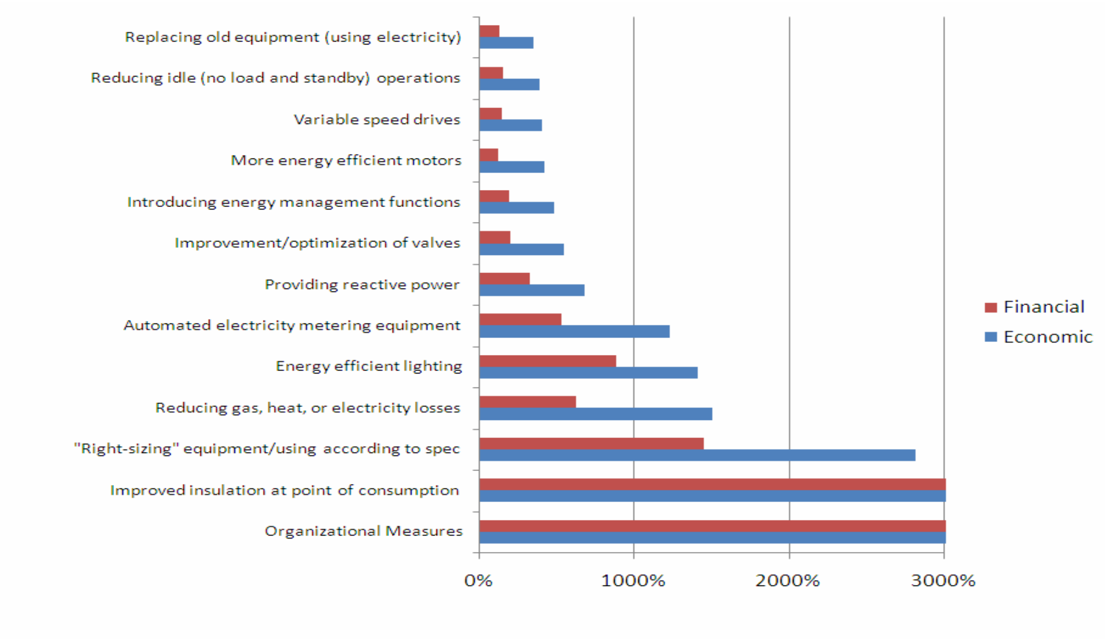
Figure 4.21: Return on investment to utilities



Source: Estimated from National Program

Similar to industry, organizational measures yield the greatest returns overall in the utilities sector. These measures would include the application of efficient operating procedures in energy systems. "Right sizing" equipment or installing equipment that meets proper specifications (given its intended use, for example, the size of the load) also yields high returns on investment for utilities. This includes, for example, optimization of boiler house operation processes, and securing the proper pressure for natural gas supplied to boiler houses. In the electricity sector, it means optimal division of 6-110 kV networks, and improvement of transformer output.

Figure 4.22: Return on investment by energy savings measures in utilities



Source: Estimated from National Program.

5 What are the Barriers to Energy Efficiency in Armenia?

Chapter 4 showed significant potential for Armenia to save both energy and money by investing in energy efficiency. The savings are large in particular sectors, and many of the investments have significant positive returns. The question for Armenia is why these investments—most of which should already be very attractive to investors and managers, whether in public or private organizations—have not yet been made.

The report focuses first on the barriers which cut across multiple sectors, and then, in Section 5.2 on barriers specific to certain sectors in Armenia.

5.1 Cross-sectoral barrier to energy efficiency

Armenia has taken important steps to encourage more efficient use of energy, but many more steps must still be taken. To encourage energy efficiency, Armenia has:

- Created a legal framework for energy efficiency. In 2005, the Government Passed a Law on Energy Savings and Renewable Energy, and has since passed draft building codes (for new buildings) which mandate energy efficiency.
- Created a National Program on Energy Savings and Renewable Energy with solid data on energy use and energy efficiency in Armenia.
- Vastly improved the economic efficiency of energy use through improved regulation of energy utilities. Many of the barriers to economic efficiency which also affect the efficiency of energy resource use—for example, highly subsidized energy tariffs, or the absence of electricity and gas metering—have been largely removed in Armenia.
- Continued to work actively with development partners like the World Bank and USAID on energy efficiency programs to improve heat energy use in public and residential buildings.

Work remains to be done to fortify the gains made by each of these achievements. More specifically:

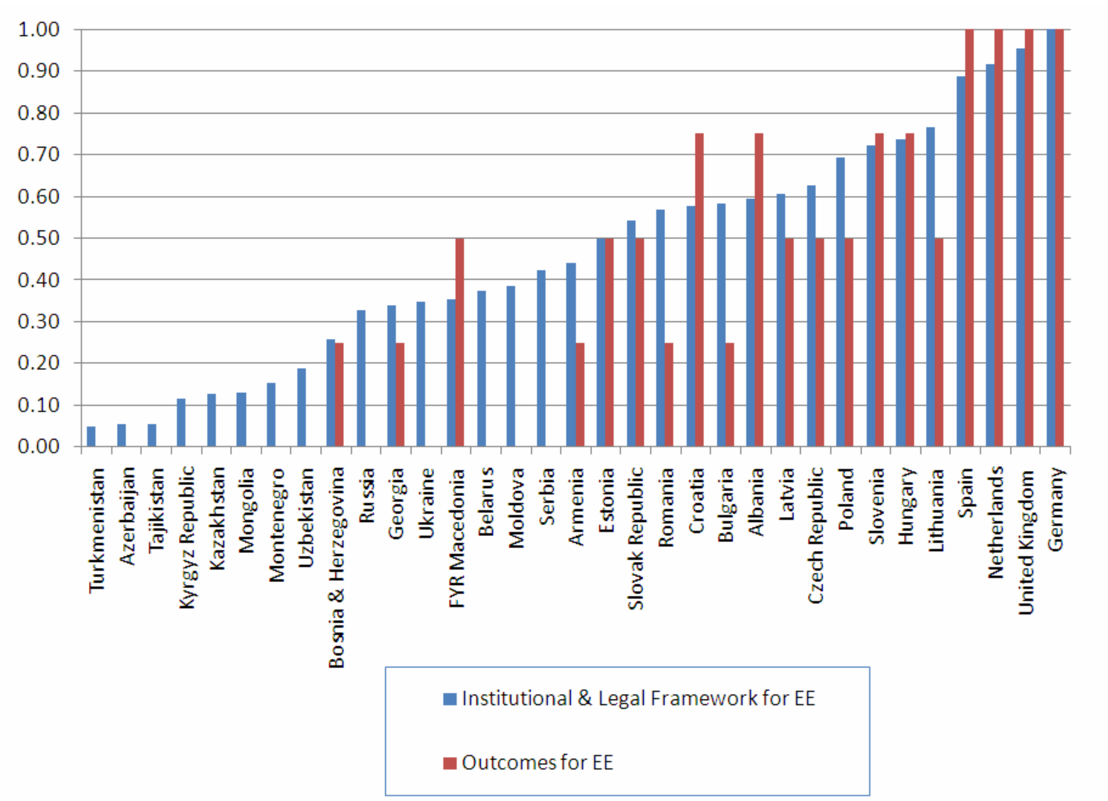
- The legal framework still needs to be implemented and enforced.
- The natural gas tariff encourages wasteful use by some smaller customers.
- Many investors still fail to see the value in energy efficiency investments, despite the successes of donor-sponsored pilot projects, in part because crucial data are still lacking for certain sectors.

5.1.1 No implementation of the legal framework

The legislative framework that exists for energy efficiency in Armenia has not yet been implemented through the creation of the necessary regulations, programs and institutions. Some energy efficiency standards exist, but few have been implemented, and apart from programs sponsored by development partners like the World Bank and USAID, few government energy efficiency initiatives exist.

A recent European Bank for Reconstruction and Development (EBRD) study ranked Armenia quite highly, relative to most of its neighbors, in terms of the legal and institutional framework for energy efficiency, in other words, the laws, institutions, policies, projects, and incentives it has put in place to encourage energy efficiency. The study also finds, however, that implementation of energy efficiency falls short of other countries with comparable legal and institutional frameworks. Figure 5.1 shows the EBRD's study's ratings.

Figure 5.1: Armenia's Legal and Institutional Framework for Energy Efficiency



Source: Securing sustainable energy in transition economies. EBRD. May 2008.

The Government has made some progress in adopting energy efficiency standards under the Law, but the progress has been slow. A Building Thermal Performance

Code was adopted in 2007 but no measures have yet been adopted to ensure its enforcement. No manuals or training exist to ensure the codes are implemented. The state-owned design institutes, and inspectors under the Ministry of Urban Construction (MoUC) remain largely unaware of what the codes entail.

The lag in adoption of standards is due in part to a recent reform in the field of standardization. Technical standards now have the power of law in Armenia and hence need approval from the Ministry of Justice (MoJ) to be implemented. The building codes adopted by the Ministry of Urban Construction cannot therefore become "construction norms" under Armenian legislation as they contain reference to technical standards (GOSTs) which must be cleared by the MoJ.

Appendix E includes a summary of the measures to be implemented under the Law.

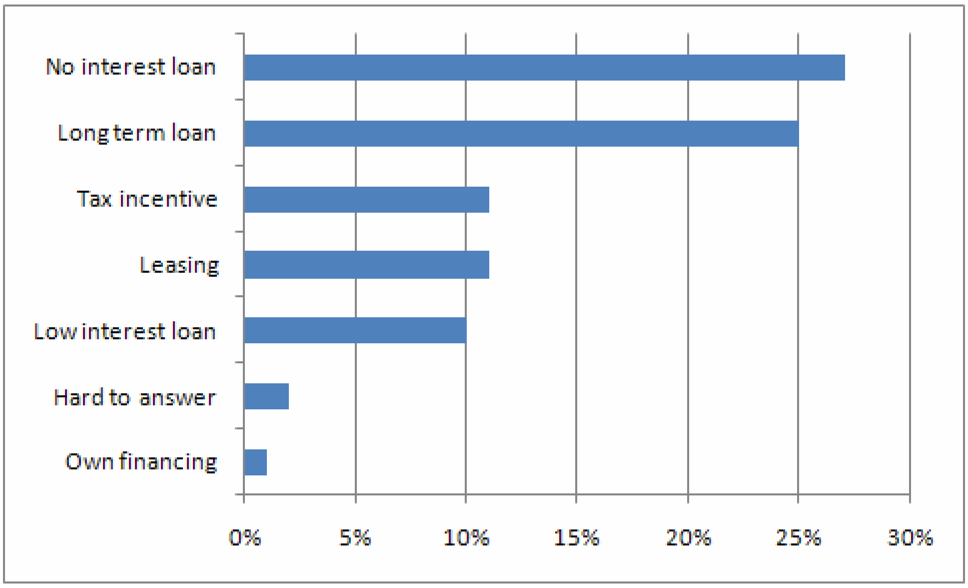
5.1.2 Investors fail to see value in energy efficiency investments

The analysis in Chapter 4 points to a number of investments that should be attractive investments to households and private industry on the basis of financial return. Previous research of energy efficiency in Armenia suggests that these investments are not getting made because private investors, both households and companies:

- **Lack information, skills and data.** Armenian consumers lack information on the efficiency of different types of equipment available to their households, and many industrial companies lack the internal expertise necessary to create an energy efficiency investment plan. The National Program makes specific recommendations of the investments necessary in a range of sectors, but offers little detail on the investments required to improve energy efficiency in transport and heat energy use, which together are responsible for half of all energy consumption in Armenia. In a survey conducted by Advanced Engineering Associates International (AEAI), only 7.9 percent of respondents were familiar with the concept of an energy audit. However, the majority of those who were aware of the concept expressed a desire to have an audit done in their homes. Among private industry, 89 percent of companies believed that energy efficiency measures could reduce energy expenditures in their facilities[34]
- **Underestimate the benefits of energy efficiency.** Consumers and private companies tend to systematically overestimate the costs, and underestimate the benefits of energy efficiency investments. This is a common barrier to energy efficiency in many countries. Surveys of attitudes toward energy efficiency often find that investors (whether households or companies) avoid investments in energy efficiency because they believe they would need additional financial assistance. In the same AEAI survey cited above, sixty-seven percent of households and sixty-three percent of Armenia companies said that they would need financial assistance in order to implement energy efficiency measures. Figure 5.2 shows the types of financial assistance, as identified by company managers that would encourage investment in energy efficiency. Evidence from other countries suggests that, in fact, many energy efficiency investments can be funded without access to credit lines, or, if financing is necessary, financed from existing credit lines.

Figure 5.2: Types of financial assistance needed for investment in EE

[34] "Energy Consumer Survey in Armenia: Residential, Commercial, Public and Industrial Sectors." Advanced Engineering Associates International. September 2006 (www.aeai.am and www.erep.am)



Source:AEAI

The analysis in Chapter 4 also suggests that most of the investments recommended by the National Program are financially viable even with the high returns required by lenders. Lenders, however, often share in the tendency to overestimate the costs and underestimate the benefits of energy efficiency. Banks therefore may be unwilling to offer financing on what they perceive to be an unknown or untested loan products.

5.1.3 Inadequate gas tariff structure

In the natural gas sector, the current structure of customer classes in Armenia discourages energy savings for certain consumers. Natural gas consumers are categorized depending on their monthly volume of consumption: Those with consumption greater than 10,000 m^3/month pay a tariff of AMD 47,000 / thousand m^3 and those with consumption less than 10,000 m^3/month pay a tariff of AMD 84,000/thousand m^3. There is evidence that this structure creates a perverse incentive for customers whose heat consumption near 10,000 m^3/month. These customers mainly include small heat-only boiler stations supplying one or more buildings or SMEs burning gas for production or heating needs. In order to obtain the low wholesale price, these customers intentionally use excessive amounts of gas and are disinclined to invest in energy savings measures. A World Bank study on Urban Heating found an example of residents in one apartment building that all agreed to waste their heat during one month (for example, by leaving windows open) as a way of helping the condominium reach the 10,000 m^3 threshold.

5.2 Sector-specific barriers

In addition to the barriers discussed above, a number of barriers prevent energy efficiency in specific sectors. These barriers are:

- **Public sector budgeting rules.** In the public sector, specific budgeting and contract rules discourage the public sector from taking measures to save energy. More specifically:
  - Budgeting rules tend to limit budgetary organizations' incentives to save energy. The Law on Budget System of the Republic of Armenia allows public administration bodies to reallocate up to 15% of funds between items under the same program budget. However, the recent Annual Budget Laws allow for

reallocations up to 100% of the line item savings, but public administration bodies need to get the Ministry of Finance approval. With greater flexibility, public organizations could transfer the savings to other energy-related expenditures (for example, capital expenditure which will yield further energy savings), or may transfer to other program budgets.

- Public organizations (e.g. state non-commercial organizations and funds) should be encouraged to enter into financing agreements, multi-year contracts, or contracts that pay for the investment through future savings. Energy efficiency investments require medium- to long-term financing, but public organizations have limited borrowing capacity due to small asset base they can pledge. Public organizations cannot borrow against the assets transferred to them by the government, but can borrow against their own assets.

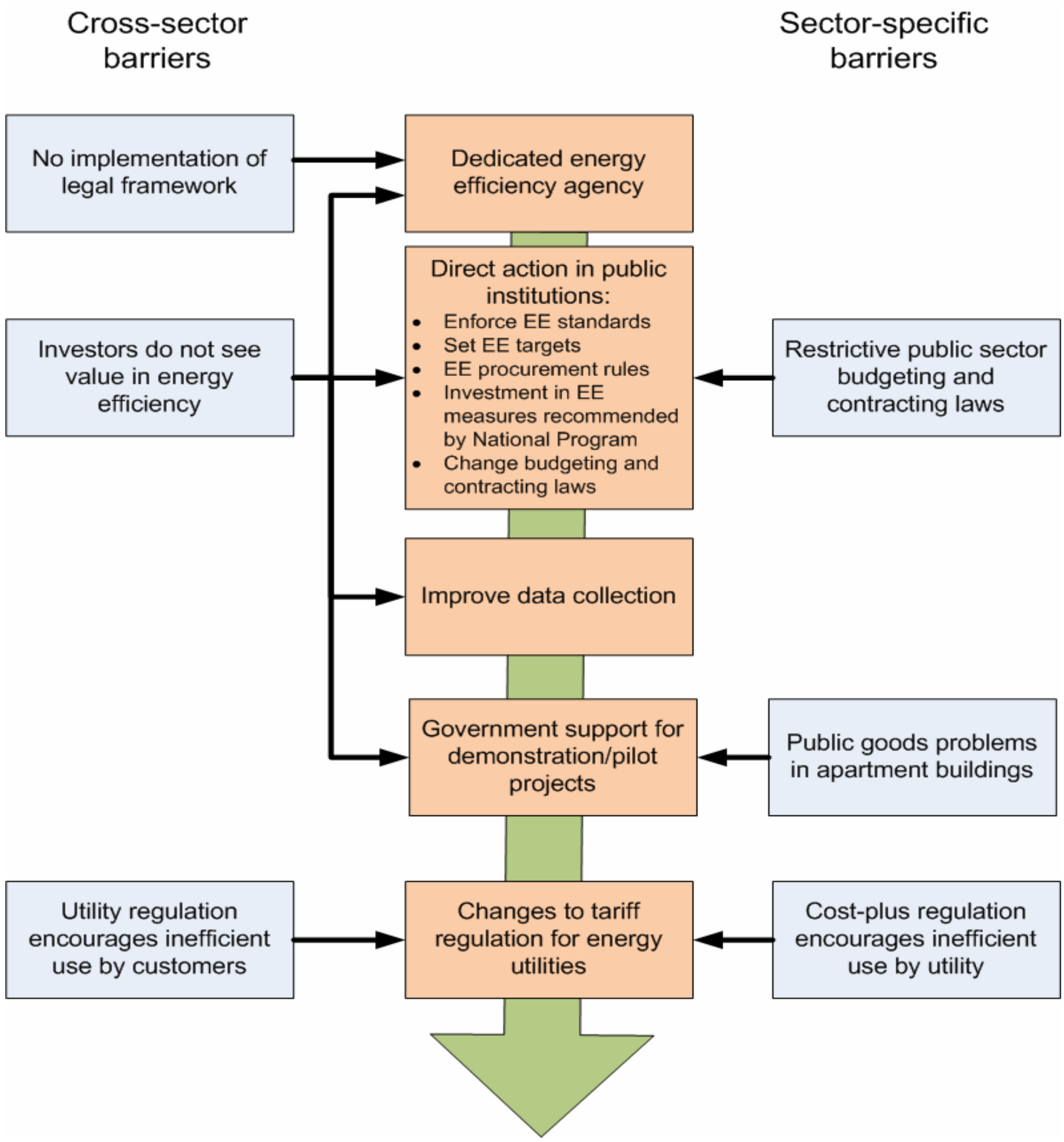
- **Public good problems in the residential sector.** The residential housing sector presents barriers to energy efficiency which may be the most difficult to solve. A principal barrier to energy efficiency in this sector is a misalignment of incentives and responsibilities. A wide array of actors is involved in the construction, management, and use of buildings. All have the ability to influence how energy is consumed within the buildings, but few have the incentive. Those that might have the incentive are worst placed to know what investments might save energy, and if they did know, worst placed to pay for or finance those investments. Condominium-managed buildings make up, on paper, 77.8 percent of the total housing stock in Armenia, including 7,900 multi-apartment buildings and 324,622 apartments. However, only roughly a fifth of the registered condominiums are operating. Key problems and issues hindering energy savings in condominiums include:
  - **Poor condition of common spaces and infrastructure.** Common spaces in residential buildings often account for a large portion of energy savings potential. Much of that savings could be enjoyed by apartment owners, as simple repairs to doors, windows and hallways in common areas, yield substantial savings in heating costs to individual apartment. Low-cost weatherization raises the indoor temperature by 3-5 degrees celsius, and save residents up 10-20 percent on utility bills. More elaborate measures can save up to 7 degrees Celsius. Although the majority of multi-apartment buildings have been privatized in Armenia, and hence apartment owners have a direct stake in communal areas, achieving energy efficiency measures in these spaces still proves difficult. Apartment owners are reluctant to commit to investments in common spaces because of the risk that other residents will free ride on that investment. Due to the coordination, leadership and necessary involvement of all members of the condominium community, these simple investments are rarely realized
  - **Disparate income levels within condominiums.** In almost all condominiums, roughly 10 percent of members are unable to pay member service fees or are exempt from such fees by the decision of the General Meeting of the Condominium's homeowners. Affordability of utilities and energy-related measures continues to be a serious issue for Armenia's socially vulnerable citizens. In a survey conducted by the Alliance to Save Energy for the Armenian Urban Heating Project, thirty-seven percent of respondents stated that they spend more than 50 percent of their monthly income on utilities.
  - **Cost plus tariffs provide little incentive for utility efficiency.** In Armenia as in many counties, utilities' profits depend on revenues. Utilities therefore have an incentive to sell more, not less energy. Energy utilities may also have an

incentive to invest in more expensive energy production capacity, rather than low cost energy savings capacity, because the production capacity becomes a portion of their asset base, on which the regulator allows them to earn a return. The tariff structure in the electricity and natural gas sectors, in particular, encourages utilities to sell as much as they can. Armenia's electricity and gas customers pay a volumetric tariff, without a fixed cost component, which discourages utilities from reducing loads because they risk not recovering all of their fixed costs. The current "cost plus" tariff methodology used to determine the value of the utility's regulated asset base may not provide sufficient incentives for utilities to decrease operating and maintenance (O&M) expenditures to efficient levels, and therefore may not provide sufficient incentives to invest in energy efficiency. This problem is typically a problem with cost-plus regulation *per se*, not the way in which it is implemented by the regulator.

6 How can the Government best improve energy efficiency?

Figure 6.1 shows solutions the Government can adopt to remove the barriers to energy efficiency identified in Chapter 4. The solutions identified can all be implemented in a relatively short time period, over the next 2-5 years. Each of these solutions is discussed in more detail in the subsections that follow.

Figure 6.1: Barriers to energy efficiency and solutions Government can pursue



6.1 Appointment of an energy efficiency agency

The single most important measure is shown at the top of Figure 6.1. Armenia needs an energy efficiency "champion" that can anchor and provide leadership on implementation of energy programs.

The appointment of this champion need not entail the creation of a new entity, but different roles for entities that currently deal with energy efficiency. The R2E2 fund is well suited to move into the role of Government energy efficiency champion. This study recommends the R2E2 fund eventually become the implementing agency for energy efficiency policy directives of the line ministries.

An energy efficiency agency is needed to:

- Coordinate various donor-sponsored and Government programs on energy efficiency. There is considerable potential for overlap between the donor-sponsored programs on energy efficiency.

- Coordinate government policies on energy efficiency. The Ministry of Energy, with its dedicated energy efficiency unit, has developed reforms related to energy efficiency, but energy efficiency policy clearly needs to evolve from all sectors that deal in, for example, construction, housing, transport, and finance.
- Serve as an apolitical thought leader on energy efficiency, and a credible source of information for government agencies and the private sector.
- Serve as a clearinghouse for information on energy efficiency.

In order for such an agency to be successful, it must have credibility, and enough influence to have its recommendations implemented. The R2E2 meets these criteria because it:

- Has enough representation from line ministries, different branches of government to have credibility and influence throughout all sectors of economic activity in Armenia. Its board has broad cross-sectoral representation, with the current exception of representation from the Ministry of Transport, which would be an important agency to include as R2E2 evolves into its new role.
- Has sufficient high level representation and backing to achieve its objectives. Members of its board from the executive branch of government largely include Deputy Ministers or Ministers.
- Has the expertise in matters of energy efficiency and energy savings. As a non-governmental organization, the R2E2 Fund also has the ability to offer salaries that allow it to attract and retain expertise.

Dedicated energy efficiency government agencies have become an increasingly common way to coordinate government action with regard to national energy efficiency policies. In a survey conducted by the World Energy Council, roughly two-thirds of countries surveyed have a national energy efficiency agency and over 90 percent a Ministry department dedicated to energy efficiency. Energy efficiency agencies aid in promoting energy efficiency policies by designing, implementing and evaluating programs and measures that involve a range of stakeholders, including companies, NGOs, and local authorities. Generally, these agencies are public institutions funded through the state budget, a tax on energy, or, in the case of some developing countries, overseas technical assistance funds.

Box 6.1 briefly describes several energy efficiency agencies in other countries, and includes detail on how they are funded. Depending on the scope and responsibility of an energy efficiency agency, such functions may include, but are not limited to: (i) developing energy efficiency standards; (ii) conducting certification and labeling; (iii) administering energy efficiency funds; (iv) certifying and/or licensing energy auditors; (v) developing short-term and long-term energy efficiency programs; (vi) reporting on the implementation of the energy efficiency programs and activities of state energy efficiency fund; (vii) coordinating the energy efficiency activities in different branches of economy; (viii) disseminating information; (ix) promoting education/awareness of energy efficiency; (x) funding pilots and demonstrations; (xi) providing technical assistance; (xii) providing financial incentives; and (xiii) initiating collaboration/partnerships.[35]

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[35] Survey of Energy Efficiency Laws and Policy Provisions in 22 Countries and Two Regions: Recommendations for Policymakers. ASE. 2004. p.11

Box 6.1: Examples of energy efficiency agencies abroad

Brazil: PROCEL, or the National Electricity Conservation Program, a government agency focused exclusively on energy efficiency, was launched in 1985 with the goal of stimulating rational and efficient use of electric energy and reducing the associated environmental impact. The program is funded by the government budget and funds from electric bills, with an annual budget totaling US$100 million (AMD 31 billion). Major accomplishments include savings of 17 billion kWh, equivalent to the annual consumption of 10 million houses, and avoided investments (for increase capacity) totaling US$6 billion (AMD 1.8 trillion).

Denmark: The Danish Energy Authority (DEA), a government agency responsible for a broad range of energy-related functions, addresses: integrated energy planning; economic instruments in energy policy making, including green taxes; CHP; renewable energy sources; heat planning; district heating; environmental aspects of energy policies; energy efficiency in buildings, industry, electrical appliances and equipment, and services; electricity generation, transmission, and distribution; natural gas supply and distribution; and hydrocarbon exploration and production. The integrated policy approach of the DEA has brought about significant results since its inception in 1976. Denmark has managed to double its GDP since the oil crisis, while keeping energy consumption relatively flat and significantly reducing energy intensity and CO2 emissions.

Germany: The German Energy Agency (DENA), is a Public/Public/Private Partnership owned 50 percent by the Federal German government—Ministries of (1) Economics and Technology, (2) Transport, Building and Urban Development and (3) Environment, and 50 percent by KfW Bankengruppe (state-owned). With an annual budget of €15 million, DENA focuses on campaigns, demonstration projects, marketing and promotion of energy efficiency projects, products and related activities. DENA concentrates on profitable projects rising from private funding.

Source: Limaye, Dilip R., et al. "An Analytical Compendium of Institutional Frameworks for Energy Efficiency Implementation." ESMAP Report. World Bank. August 2007.

6.2 Taking direct action to remove barriers in the public sector

As shown in Chapter 4, energy efficiency investments in the public sector have the highest return on investment, and energy efficiency investments in utilities offer the greatest overall savings. Fortunately, in contrast with the other sectors discussed in this chapter, the Government can directly remove barriers to energy efficiency in the public sector, and many segments of the utilities sector, and directly receives the benefits of removing these barriers. Public sector buildings and facilities, also often referred to as "budgetary institutions" are under the control of the state or local governments, and activities to improve their energy efficiency can be implemented through existing administrative measures.

Moreover, improving energy efficiency in the public sector and utilities offers a number of corollary benefits, namely:

- Freeing up fiscal resources, particularly for constrained state and municipal budgets, that can be redirected to meeting other needs
- Sending a strong signal to the private sector and general public about the Government's commitment to energy efficiency, and thereby set the stage for implementing policies in other sectors. There is ample evidence that other actors—households in particular—respond better to examples than to information about environmental issues, of which many view energy savings as a subset. A recent study in California showed that people are more influenced by social norms than information. The study monitored a campaign to get hotel guests to reuse their

towels. The information was given to the guests in three formats. One proposal said that reusing towels was good for the environment. A second proposal focused on cooperation by encouraging guests to partner with the hotel to save the environment. A third proposal—the most successful in getting guest to reuse their towels—suggested that guests should do as their fellow patrons have done and reuse their towels[36]

- "Priming" the market, by creating demand for energy efficient equipment and services. Government demand for energy efficiency equipment and services can help support nascent supplies of these products and services who eventually expand those products and service offerings to other sectors.

The Government can improve energy efficiency in Armenia by:

- **Changing budgeting rules.** Budgeting rules tend to limit budgetary organizations' incentives to save energy. The Law on Budget System of the Republic of Armenia allows public administration bodies to reallocate up to 15 percent of funds between items under the same program budget. Although the recent Annual Budget Laws allow for reallocations up to 100 percent of the line item savings, but public administration bodies need to get the Ministry of Finance approval for each reallocation.. With greater flexibility, public organizations could transfer the savings to other energy-related expenditures (for example, capital expenditure which will yield further energy savings), or may transfer to other program budgets.
- **Set targets and benchmark performance.** Setting target indicators for energy efficiency in government agencies may be an effective tool in Armenia as it has been elsewhere. In the US, the Government has set a target to reduce energy consumption in public buildings by 3 percent annually during 2006-2015. The previous target of 2 percent was successfully met.[37]
- **Benchmarking.** In order for the previous two recommendations to work, national and local governments will need to determine baseline levels of expenditure on energy consumption, as well as targets or benchmarks against which their progress in reducing energy consumption can be judged. The baseline can be fixed based on the public organization's energy expenditure in the most recent year, or an average of recent years. Targets or benchmarks can be set based on comparisons with other public organizations with similar characteristics, such as the area occupied by a public organization, load characteristics, mix of fuels consumed, and number of individuals served (for example, in a school, the average number of pupils attending classes each year). The results of the benchmarking needs to be made easily available to all public organizations, as should possible energy efficiency solutions, best practices and success stories from other sectors in Armenia and from comparable public organizations abroad. Such benchmarking will require more a more robust system of data collection than Armenia has currently. More recommendations on data collection are included in Section 6.3.
- **Encourage public agencies to enter into multi-year contracts with the private sector.** In order to reap the benefit of energy efficiency investments, public agencies need to be able to enter into multi-year contracts. The Box 6.2 describes

[36] Cialdini, Robert B. "Using Social Norms to Preserve the Environment." Arizona State University, Department of Psychology.

[37] "US Federal Government: Energy Efficiency and Market Leader". Jeffrey Harris. Alliance to Save Energy.

the US and Canadian experience in promoting the development of ESCOs. ESCOs are private firms that provide financing, technical consulting, installation, and management services to customers needing efficiency improvements. ESCOs and Energy Performance Contractors (EPCs) represent a significant and growing business in France, where they were invented, and in the United States where they commonly serve industry, commercial buildings, and public institutions. There are two approaches to performance contracting. In the shared savings approach, an ESCO makes an investment and shares the energy savings with the customer. Reduced energy payments generate cash flow for paying off the investment, providing a profit to the ESCO, and yet saving the customer money. After a few years, all the savings belong to the customer. Alternatively, the ESCO can guarantee savings of a given amount, and if the expected savings are not achieved, the ESCO must pay the difference. This guaranteed savings approach gives the customer greater certainty for budget planning, although as a result of the increased risk to the ESCO the portion of the savings given to the customer will generally be less than in a shared savings arrangement. Allowances are made in the contracts, of course, for variables such as extreme weather and increased operation or production schedules.

Allowing entities with ESCO-like functions to enter the market can solve the problem of public organizations not being able to borrow. ESCOs or firms with ESCO-like functions, can enter into financing arrangements with the banks, and take the risk on the loan, while providing energy management services (under so-called Energy Performance Contracts, or EPCs) to public organizations for a fixed fee.

Box 6.2: Evolution of ESCOs in the US and Canada

In the US and Canada, the success of ESCOs and EPCs to promote energy efficiency in public buildings relied heavily upon the successful navigation of public sector contracting requirements and extensive procurement processes. The two countries utilized different approaches to increase the development of EPC-based projects in public buildings.

In the US, where legislation and legislation enactment procedures differ from one level of government to the next, contracting and procurement requirements and barriers were overcome on a state-by-state and agency-by-agency basis. However, once one state had a functioning contracting and procurement system in place to promote EPCs and ESCOs, other states were more willing to adapt those models to their own circumstances. For example, Ohio, in 1985, enacted legislation allowing school districts to purchase energy conservation measures on a multi-year installment basis and to increase the portion of a district's net indebtedness that could be used for energy conservation measures. In the first five years alone, the legislation led to ESCO projects in 167 school districts worth more than $131 million. Now, over forty US states have enacted legislation promoting the usage of EPC in schools and government facilities.

At the federal level, the Comprehensive Omnibus Budget Reconciliation Act of 1985 encouraged federal agencies to implement energy efficiency retrofits through shared energy savings contracts. Subsequent legislation provided further incentives by allowing participating agencies to retain and use a portion of their foregone energy costs. When government agencies realized that energy savings could be reinvested in other areas of their programs, it provided a powerful incentive for staff members to work with ESCOs in identifying projects. The Federal Energy Management Program (FEMP), operated by the Department of Energy, coordinates federal agencies' energy efficiency projects. FEMP maintains a list of approved ESCOs and has developed the Super ESPCs, which allows federal agencies to "bypass procurement procedures and deal directly with prequalified" ESCOs, who compete to win the contracts. By 2007, the Super ESPC concept had investments of us US$1.9 billion (AMD 584 billion) by 19 agencies in 46 states.

In Canada, the development of EPCs and ESCOs for use with public buildings was implemented from the top down. Canada's involvement with EPCs for public buildings began with Ontario Hydro's Guaranteed Energy Performance Program in the late 1980s and received a boost in 1991, when the Canadian government created the Federal Buildings Initiative (FBI) to allow federal departments to contract with ESCOs to develop and implement energy efficiency retrofits through EPC in federal buildings. Natural Resources Canada (NRCan) promotes the FBI program to individual organizations by providing model contracts and bid packages. The FBI has retrofitted 7,500 federal buildings and other facilities, have resulted in Can$240milllion of private sector investment (through 2006) and annual savings of Can$33 million.

Source: "ESCO Development in the United States and Canada" in R. Taylor (2008). Pp 224-238

Thanks largely to a number of donor-funded programs, Armenia does appear to be on its way to developing a nascent ESCO industry. The last few years have seen the emergence of more than thirty companies that provide services such as weatherization of buildings and heating networks, or the design, installation and maintenance of boiler houses. Some of the companies use locally produced heating equipment and weatherization materials while others use imported equipment and materials. These companies typically compete to provide engineering services to donor-(USAID- or World Bank-) funded projects or private residences. However, these firms typically only provide engineering or consulting services, and have not yet grown into roles as performance contractors, in which they would absorb some of the risk of their projects in return for a share of customers' savings.[38] As summarized in Box 6.3 describes the experience with ESCOs and EPCs in other parts of the Commonwealth of Independent States (CIS) and Central and Eastern Europe (CEE) have enjoyed somewhat more success but the experience has been similar.

Box 6.3: Energy Service Companies (ESCOs) and Energy Performance Contractors (EPCs) in the Commonwealth of Independent State (CIS) and Central and Eastern Europe (CEE)

The Czech Republic, Poland, Hungary, Bulgaria, Romania, Latvia and Ukraine (Czech Republic and Ukraine even have some state support mechanisms for ESCOs) have had some success with ESCOs and EPCs.

While most ESCOs are privately owned by local entities or foreign businesses (some ESCOs in the region are owned by Dalkia, Siemens, etc.), in some cases they are established by utility enterprises or public entities. Examples are MPEC (an ESCO owned by Krakow municipality), UkrESCO (owned by the Ukrainian State, now undergoing privatization, where the shares of large Ukrainian state energy companies were provided as collateral for the $30 million EBRD loan), HEP ESCO (owned by a Croatian electric company and in the embryo stage of ESCO development), Hungarian ESCOs owned by local utility companies (E-Partner of DÉMÁSZ/EDF or Synergy of ÉMÁSZ/RWE, which are meant to help utilities maintain customer service quality[39]). In Lithuania, 23 small DH enterprises established an ESCO New Heat ("Naujoji siluma" JSC) in a joint venture with Finnish Private Energy Market Fund. This ESCO implements turnkey modernization projects and carry out their financing. In Macedonia, MT ESCO has 52 percent ownership from MEPSO (the state-owned electric transmission company) and 48 percent ownership from Toplifikacija (the privately owned Skopje district heat company).

The ESCO market in this region has produced only a limited number of performance contracts that repay investments from energy savings. Most companies referred to as ESCOs are merely energy service providers (usually heat suppliers) and the concept of efficiency and energy conservation does not necessarily have a role in their relationship with the clients. The emergence of these ESCO-like companies which committed to leasing non-operational or economically non-viable heating points, converting them to heat-only boilers and rehabilitating heat supply service to multi-apartment buildings has served as a major boost to commercialization of the heat supply service. Such businesses are usually very committed to efficiency of generation and minimization of operational losses. Nevertheless, these companies are not always interested in end-use energy efficiency. Moreover, since such a company sells energy, inefficiency and lack of incentives for saving on the end.-use side would help boost the revenues.

Such ESCO-like companies have developed extensively as small and medium-size businesses in the heat market across the region, and in contrast to the municipal services, devoted serious attention to consumer satisfaction, transparency of billing and collection of fees.

Many obstacles to a vibrant ESCO market remain, including legal barriers which prevent government agencies from keeping (and possibly reallocating) the funds from energy savings on their accounts, the fact that many ESCOs lack the collateral required for commercial loans, and the fact that energy efficiency projects are still perceived as having low returns and low payback periods.

[38] Detailed information about local and foreign producers (companies) as well as information on technical features of their produced heating equipment and weatherization materials in the Armenian market is available in the Report on Armenian Heat Supply and Heating Equipment Market Assessment prepared by the Alliance to Save Energy available at http://www.munee.org/node/107.

[39] Coming in from the cold. M.Evans and E.Douraeva. IEA/OESC. 2004.

- **Enforce energy efficiency in equipment procurement.** The Government may wish to impose technical standards related to, for example, procurement of energy efficient equipment for heating and lighting, or energy efficiency standards for rehabilitation and expansion of capital. Such standards are easier to impose on the public sector than private sector institutions or the population. The Government, in its role as owner of these organizations, faces fewer obstacles to setting new standards, and has a relatively easier time monitoring and enforcing the standards since it may do so through existing, internal governance rather than—potentially difficult and expensive—external monitoring. Moreover, public organizations, because they are not profit oriented, generally have less to lose than private companies (or, more intuitively, less to gain from flouting) standards. Box 6.4 shows how China has taken the initiative to heavily endorse energy efficient lighting in its provinces.

Box 6.4: Energy saving light bulb targets in China

China recently announced that it will require provincial governments to replace 50 million traditional incandescent lamps with heavily-subsidized energy-efficient lights this year. As part of a campaign launched by the Ministry of Finance in January, the goal is to replace inefficient bulbs with 150 million energy efficient light bulbs over the next 5 years. Several provinces received specific targets of 2 or 3 million bulbs, including a 2-million bulb target for Beijing. If all incandescent bulbs were replaced, China would save 60 billion kilowatt hours of power each year, or 22 million tons of coal equivalent each year, reducing emission of carbon dioxide by 60 million tons.

Source: "China sets energy-saving lightbulb target for provincial areas." Xinhua News Agency. 14 May 2008.

- **Investigate further, and invest in the energy savings measures recommended by the National Program.** The analysis in Chapter 4 showed that many of the measures recommended by the National Program had high returns in the public sector. The estimates provided in the National Program are sector-wide estimates, extrapolated from individual energy audits and are, already, nearly three years old. The Government will want to investigate more specifically how the recommendations of the National Program translate into actual investments in actual Government buildings. The Energy Institute and other consultants involved in drafting the National Program can undoubtedly be helpful in this process.
- Table 6.1 recommends a number of investments where the Government can directly make investments that significant overall savings for the economy as a whole, as well as high returns.[40]

Table 6.1: Priority Investments in the Public Sector

Energy savings measure	Capital cost	Gross annual savings	Payback period	Return on Investment	Total Savings

[40] As noted above, this study is based on the National Program's economy-wide assessment of energy efficiency, and is therefore meant only to be indicative of what sectors, and what types of energy savings measures, can offer the greatest savings and greatest returns. Before making any particular investment, it will be important for the Government to analyze specifically what equipment or what measures are necessary, and in which specific buildings or facilities.

	(million AMD)		(years)	(percent)	(million AMD)
Use of energy efficient lighting (in public administration, and health and social and healthcare buildings)	56.52	316.21	<1 year	2,484	1,403.70
Use of variable speed drives in all public buildings	118.81	240.59	1-2 years	1,437	1,915.04
Repair or replace valves in building heating and water systems	57.98	249.05	1-2 years	2,115	866.55

Source: Calculated from the National Program

The National Program has also shown that the Government can make investments that improve energy efficiency in many utilities, just as it would in other Government agencies. The Government still owns, and directly determines capital investment in the water sector, gas sector, rail transport sector (excluding rolling stock), and air transport sector. Most of the savings from energy efficiency in the utilities sector come from measures the government is already taking, namely:

- Improving the efficiency of thermal generation. The Government is already taking steps in this direction by constructing a new unit at the Yerevan Thermal Power Plant, and rehabilitating unit 5 of the Hrazdan Thermal Power Plant. It should be noted, however, that there is a possibility that the output from the new unit at the Yerevan Thermal Power plant may be used exclusively for export to Iran, in exchange for a loan to build a new gas pipeline from Iran to Armenia
- Reducing electricity and gas losses. The Public Services Regulatory Commission (PSRC) has responsibility for regulating tariffs and service quality in Armenia's gas and electricity transmission networks. Regulation of losses is part of this responsibility.

6.3 Information campaigns and better data collection

Lack of information about the potential benefits of the energy efficiency investments is an impediment to both the public and private sector. The dissemination of energy efficiency investments and measures related information including the benefits, the potential energy saving measures, and possible means of financing can facilitate the energy efficiency in the country.

Thanks to widespread metering and good utility regulation, Armenia already has reasonably good public data on energy consumption in different sectors. The National Program is currently the single most comprehensive study of energy use and energy efficiency potential in Armenia. It provides an excellent foundation which deserves to be expanded and regularly updated.

More specifically, the foundation of the National Program needs be expanded to include detailed surveys of energy use and energy efficiency potential in heating buildings and transportation. Mechanisms must also be put in place to ensure that the National Program can be regularly updated. The government should designated agencies to design a set of templates and procedures which ensure the National Program data set can be updated annually and expanded over time.

Moreover, the National Program is an economy-wide assessment of technical potential for energy savings in Armenia and therefore does not always provide detail on the specific types of investments recommended for each sector. It was not always possible for the authors of this study to know exactly what measures the National Program's authors had in mind for each consuming sector. For example, "organizational measures", can mean a wide range of possible energy savings measures. It is therefore important that, before making any particular investment, the Government—perhaps in cooperation with development partners—analyze specifically what equipment or what measures are necessary, and in which specific buildings or facilities.[41]

6.4 Government support for pilot/demonstration projects

Fiscal incentives are a reasonable policy tool to encourage energy efficiency in the private sector if they are used to subsidize capital investments that are not being made because of specific market failures (for example, negative environmental externalities not being reflected in energy prices), to provide a public good (for example, providing information on the return to energy efficiency investments through demonstration projects).

6.4.1 Capital subsidies

In Armenia, therefore, the government may considering providing one-off, limited capital subsidies or loan guarantees for demonstration or pilot projects in the residential or industrial sectors. As noted earlier in this Chapter, private investors often respond better to examples than to raw information about energy efficiency.

6.4.2 Guarantees

Hungary offers an example of how loan guarantees to banks can be use to stimulate energy efficiency investments. To help raise the banking sector's awareness and confidence in energy efficiency financing, the Government could join efforts with development agencies to establish credit lines for building and industrial energy efficiency project financing, using guarantee funds and extensive capacity building. Such an introductory phase will help illustrate the bankability of such projects catalyzing the use of banks' own funds in the future.

[41] As noted in Chapter 4, the Government may also wish to reassess the technical potential for energy efficiency in the utilities sector.

Box 6.5: Hungary Energy Efficiency Co-Financing Program

Begun in 1997, the Hungary Energy Efficiency Co-Financing Program is an IFC and GEF financed loan guarantee program in partnership with local financial institutions. The program offers a partial risk guarantee to financial institutions that provide loans for energy efficient investments as well as technical assistance for both the lenders and project developers. These elements reduce the risk of financing energy efficient investment while also reducing the transaction costs of projects by providing necessary technical knowledge to both parties. By the end of 2006, the US$ 55 million (AMD 17 billion) loan portfolio supported with US$ 17 million (AMD 5.2 billion) of guarantees fostered US$ 93 million (AMD 28.6 billion) worth of energy efficiency investments.

Source: Taylor, Robert et. al. Financing Energy Efficiency, Lessons from Brazil, China, India and Beyond. World Bank. 2008.

6.4.3 Tax relief

Fiscal incentives in the form of tax relief can be an effective long-term measure to increase the attractiveness of energy efficiency investments. It is important to emphasize, however, the difficulties and risks of implementing tax incentives in a country like Armenia where tax collections remain relatively low, and tax evasion and fraud remain problematic. There are three main forms of providing tax relief for purchase of energy efficient equipment:

- Accelerated depreciation improves companies' cash flows by allowing for a faster write off of the cost of equipment against their taxable profit
- Tax rebates allow investors to deduct a part of the equipment costs from profits
- Tax exemptions typically reduce or eliminate custom taxes on energy efficient equipment.

International experience shows that tax relief for specific energy efficient equipment creates incentives for all relevant market participants. These programs typically reach a large number of entities and are less likely to unfairly discriminate between potential participants. Box 6.6 shows examples of tax relief policies in other countries.

Box 6.6: International results from tax relief policies

UK: The British government introduced the 100 percent first-year Enhanced Capital Allowances program in 2001. This measure has resulted in energy efficient and environmentally friendly investments in 7000 equipment units totaling over £3 billion.

Japan: The Energy Conservation and Recycling Assistance Law established accelerated depreciation for energy efficient equipment and led to installation of approximately 25,000 pieces of equipments each year from 1996 to 98.

The Netherlands: The Danish Government introduced the Energy Investment Deduction program in 1997. Firms investing in energy savings could apply for tax deductions for eligible technology. Over 10,000 applicants benefited from €430 million of investments during the first year of the program implementation. Participation in the program peaked in 2001, when over 28,000 applications representing over €1 billion in claims were filed.

Sources: "Tax and Fiscal Policies for Promotion of Industrial Energy Efficiency: A Survey of International Experience" Lynn Price, Christina Galitsky, Jonathan Sinton Ernest Orlando Lawrence Berkeley National Laboratory Berkeley, 2005.

"Payable enhanced capital allowances" HM Treasury, 2007.

"Effectiveness of Subsidizing Energy Saving Technologies: Evidence from Dutch Panel Data," Aalbers, R.F.T., de Groot, H.L.F., Vollebergh, H.R.J., 2004.

6.5 Changes to tariff regulation

The barriers to energy efficiency related to energy utilities can be resolved through changes to the way in which the Public Services Regulatory Commission (PSRC) sets tariffs and allows those tariffs to change over time.

The PSRC has principal responsibility for making sure Armenia's energy and gas utilities:

- Deliver acceptable quality of service at prices that reflect efficient costs of operation and investment
- Provide customers with incentives to save energy, especially if such savings reduce the cost of service.

The PSRC can better ensure the former by moving to a tariff cap or "price cap" regulatory regime. Under price cap regulation (which basically lengthens the period between tariff revisions), the utility can keep any savings on O&M that it achieves between tariff revisions. Price caps focus on outputs rather than inputs. Price caps are usually set for a period of three-five years, and indexed to inflation and fuel prices to protect the utility against cost increases beyond its control. Because utilities can keep any cost savings they achieve during the period of the cap, they have incentives to cut costs, in order to maximize profit. The main challenge of a price cap system is that it requires sophisticated monitoring of service quality to ensure that the utility does not cut costs by rendering poor quality service. Fortunately, the PSRC has now put such a system in place for electricity distribution, and could therefore proceed with price cap regulation in that sector.

The PSRC can ensure that utilities provide customers with incentives to save energy by implementing regulatory mechanisms which de-link a utility's profits from its sales. Some measures regulators have used elsewhere in the World include:

- Implementing so-called "two part" tariffs, which recover fixed and variable costs through separate charges. Electricity and gas tariffs in Armenia are currently charged per unit of energy consumed. With these "one part" tariffs, energy service providers have an incentive to sell as much energy as they can in order to recover their fixed costs. A two-part tariff, in contrast, better ensures that the utility recovers its fixed costs, regardless of customers' consumption levels.

- Introducing rate "true-ups" to adjust for under- or over-recovery of revenue requirements. True-ups refer to annual rate adjustments, different from a regular tariff revision, and are used to ensure that utilities recover costs, but do not profit beyond levels deemed appropriate by the regulator. For example, if the utility recovers more than its forecasted revenue, tariffs are adjusted downward in order to pass through the excess profits to customers. Conversely, if the utility recovers less than the forecasted cost-recovery revenue requirement, tariffs are adjusted upward to allow the utility to recoup those losses in the subsequent year.
  - Providing incentives to encourage utility capital expenditures in DSM programs. Establishing an explicit CAPEX category for energy efficiency investments. A separate category would signal to the electricity companies that the regulator understands the investments required to improve energy efficiency, and the potential benefits of such investments. The regulator could grant preferential status to such investments for example, by allowing for a higher return on capital for that portion of CAPEX (to offset the higher borrowing costs), or allowing the utility to keep some of the efficiency savings.
  - Some regulators add an extra sum to electricity bills to finance Demand Side Management (DSM) investments. In North and South Carolina, for example, regulators are considering allowing Duke Energy, a regional power provider, to charge customers as much as 90 percent of the cost of an unbuilt plant in order to invest in measures like smart grid and meter technology.[42]

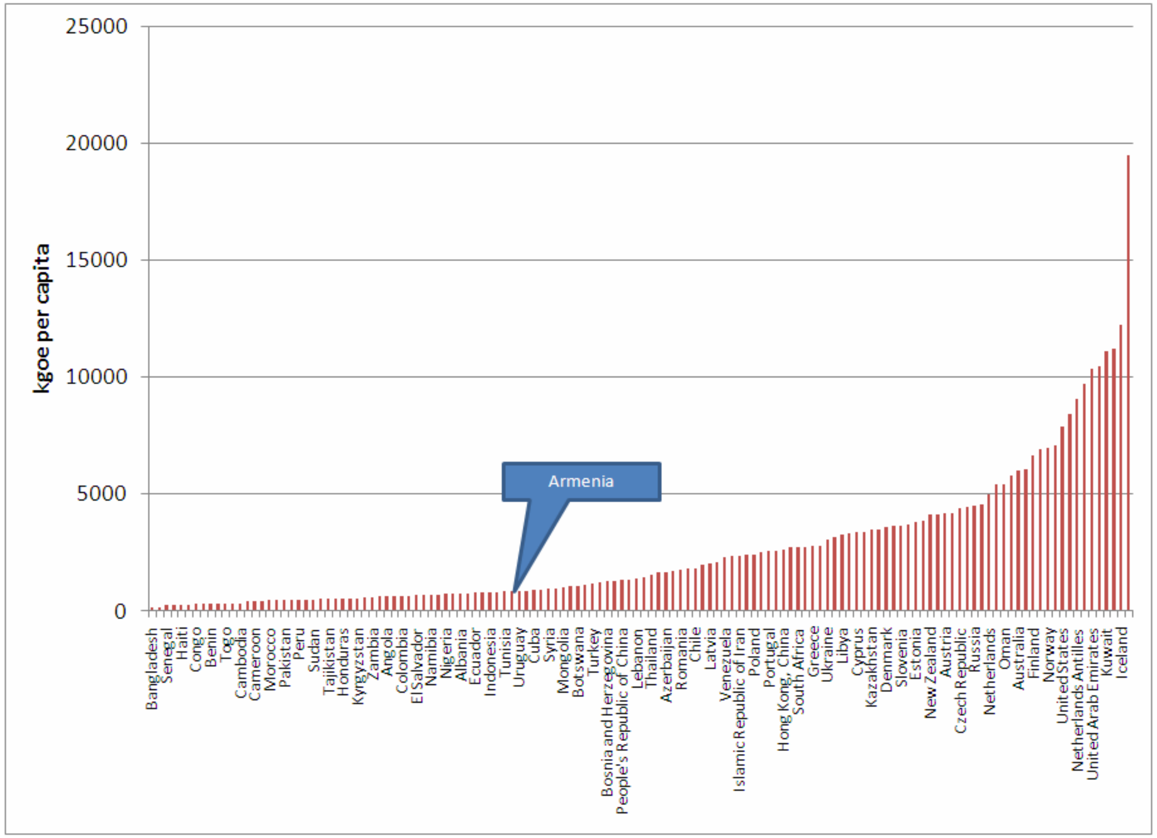
Ultimately, such changes to regulatory treatment of utility tariffs can be difficult to design and implement correctly. Not least of the difficulties will be the potential for resistance from utilities to what they perceive to be a change in regulatory regime, and possibly from customers, as some measures may possibly entail higher tariffs.

Because of these difficulties, it may therefore be worthwhile for the Government to fund, or work with development partners to find funding for technical assistance for the PSRC to determine which changes to regulation are feasible for customers and the utilities, and how to implement them.

[42] Lavelle, Marianne. "When saving power means higher profits." *U.S. News and World Report.* 28 April 2008. 47.

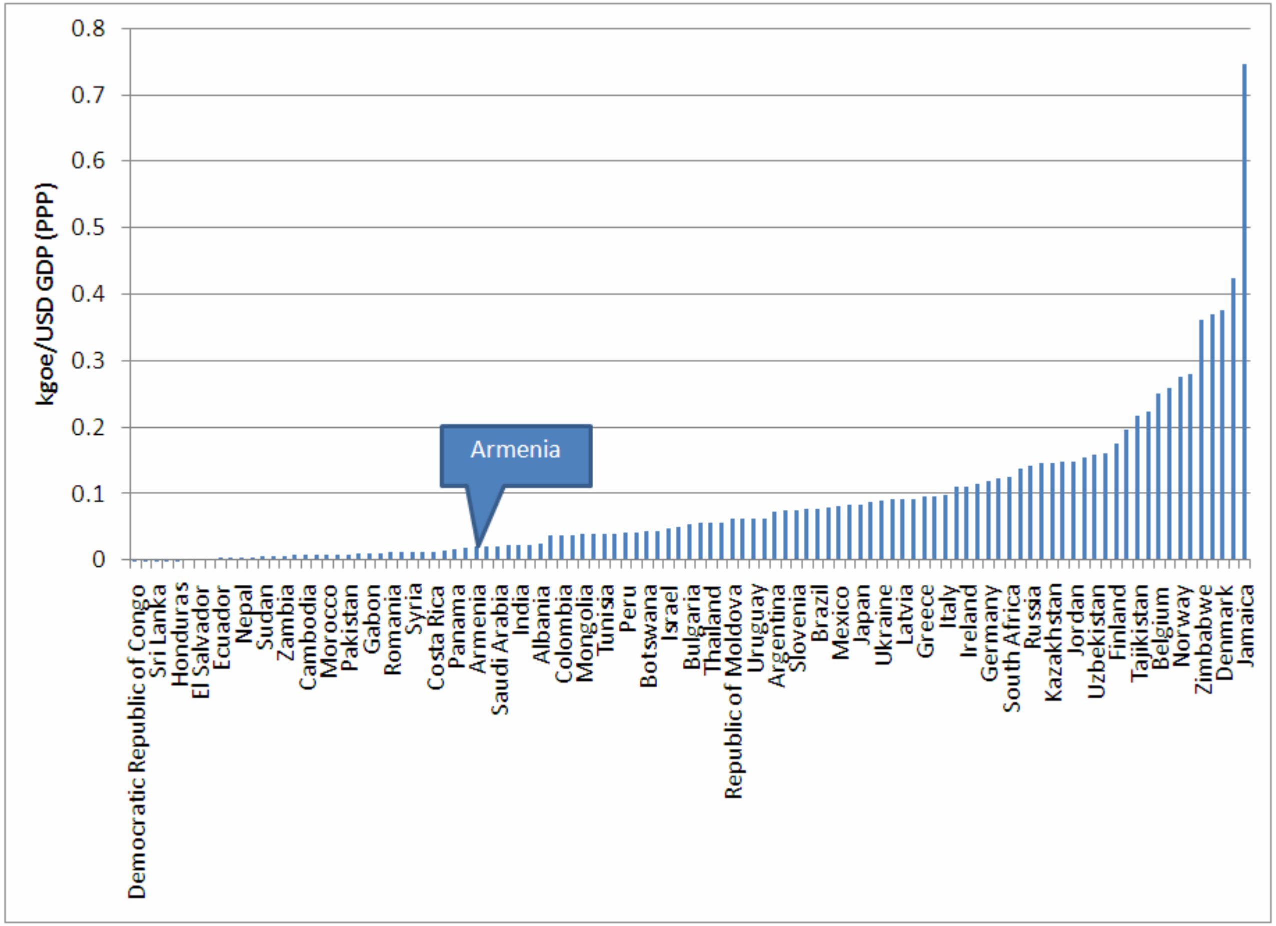
Appendix A: Additional comparisons of energy efficiency in Armenia to other countries

Figure 6.2: Per capita energy efficiency of 122 countries



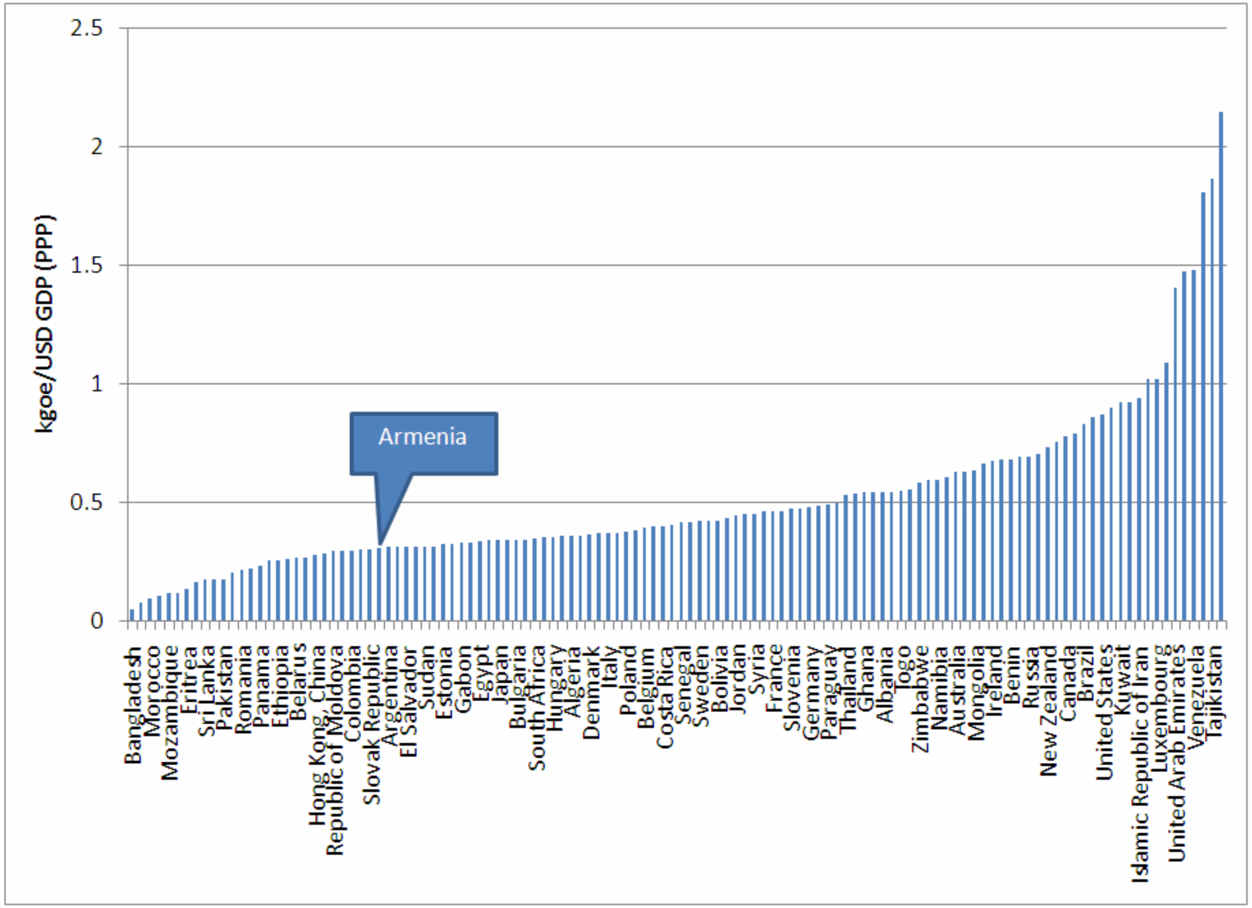
Source: Energy consumption data from the International Energy Agency (IEA), Energy Balances data set. Gross Value Added data from UNDP National Accounts data set. PPP conversion factor data from the World Bank Development Indicators Database.

Figure 6.3: Energy efficiency of Armenia in agricultural production



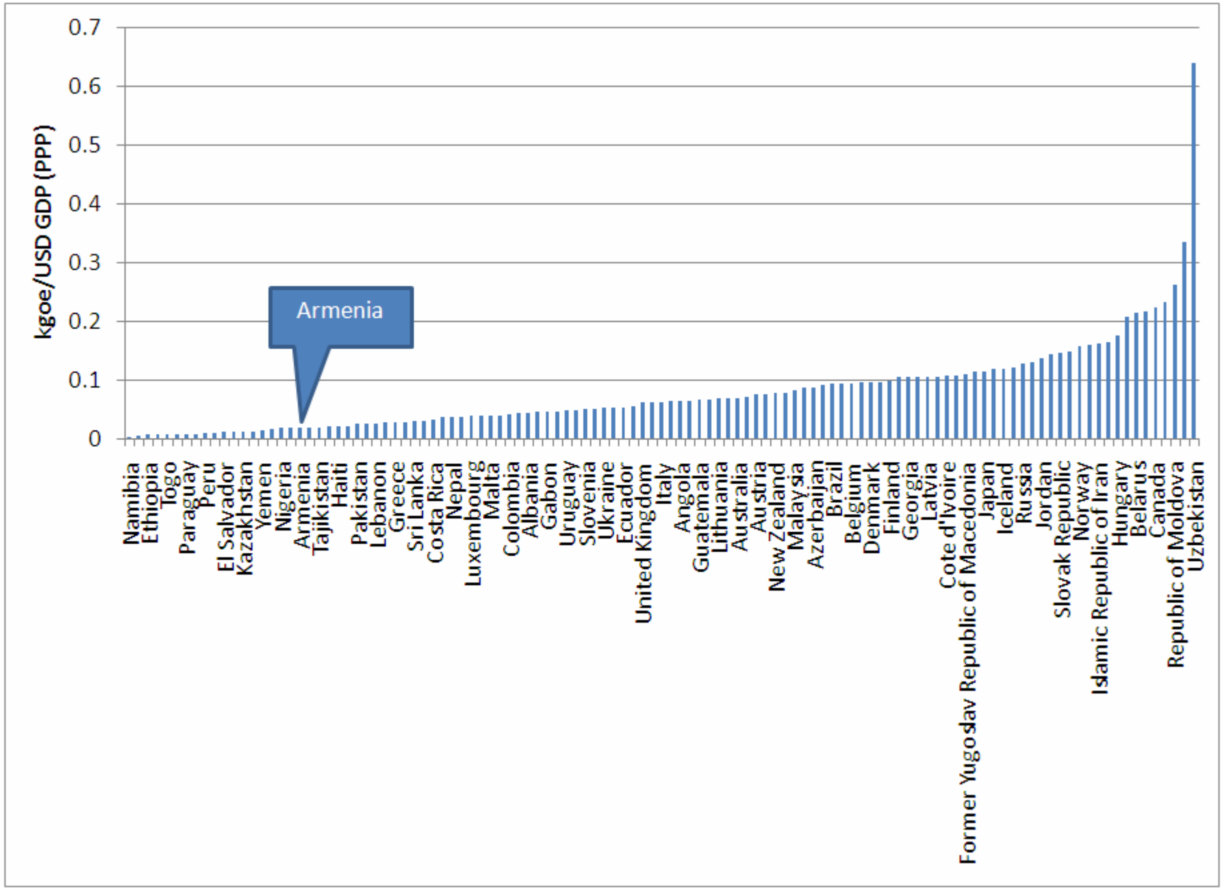
Source: Energy consumption data from the International Energy Agency (IEA), Energy Balances data set. Gross Value Added data from UNDP National Accounts data set. PPP conversion factor data from the World Bank Development Indicators Database.

Figure 6.4: Energy efficiency of Armenia in transport, storage and communication



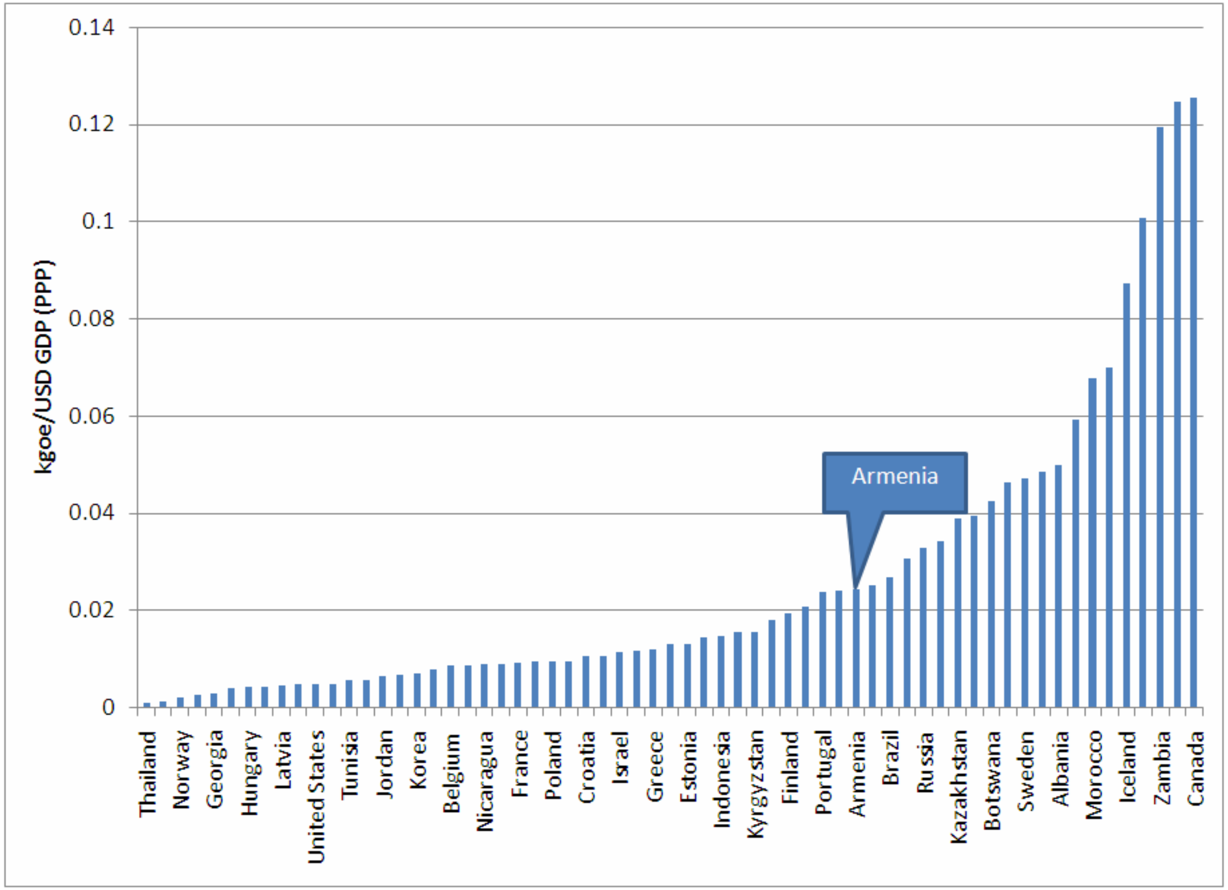
Source: Energy consumption data from the International Energy Agency (IEA), Energy Balances data set. Gross Value Added data from UNDP National Accounts data set. PPP conversion factor data from the World Bank Development Indicators Database.

Figure 6.5: Energy efficiency of Armenia in wholesale, retail, restaurants and hotels



Source: Energy consumption data from the International Energy Agency (IEA), Energy Balances data set. Gross Value Added data from UNDP National Accounts data set. PPP conversion factor data from the World Bank Development Indicators Database.

Figure 6.6: Energy efficiency of Armenia in mining and utilities



Source: Energy consumption data from the International Energy Agency (IEA), Energy Balances data set. Gross Value Added data from UNDP National Accounts data set. PPP conversion factor data from the World Bank Development Indicators Database.

Appendix B: Methodology and assumptions used in calculating economic and financial viability of energy efficiency investments

B.1 Estimates of energy efficiency potential

The "Calculation of Energy Saving Potential by Implemented Measure," estimated in Appendix D of the National Program on Energy Saving and Renewable Energy of the Republic of Armenia serves as the foundation for the calculation of energy efficiency potential in this study.

The National Program examined energy use by 33 types of consumers, and considered 16 categories of energy savings investments for each of these consumers, to compile energy consumption data and determine energy savings estimates for the Armenian economy. This study utilized these estimates as the basis for the technical potential for energy efficiency improvements.

Of the possible universe of energy efficiency investments with technical potential, only some will be financially and economically viable. This study differentiates between economically and financially viable projects in order to determine how Armenia can best capture potential savings from energy efficiency investments. The difference between economically and financially viable investments is modeled by differentiating between: i) the opportunity cost of capital used for public and private investors, ii) the inclusion of indirect benefits of energy savings, and iii) the inclusion of externalities.

Economically and financially viable energy efficiency investments are those investments with technical potential which also yield a positive return on investment for Armenian society as a whole, for private investors (companies, organizations or individuals), or both. Economically viable projects yield a positive return on investment for Armenia as a whole, and hence for the government as a "public investor", but not necessarily for private investors, companies or organizations. Financially viable projects yield a positive return for the private investors who make those investments.

Economically and financially viable investments are identified from the pool of technically viable investments by comparing the cost of an energy efficiency investment to the value of that investment. The "cost of saved energy" (CSE) approach is used to determine the cost of the energy efficiency investment. The costs of an energy efficiency investment include: i) the incremental capital cost of the energy efficiency investment, and ii) any additional costs or benefits of the energy efficiency investment. Box 6.7 shows the CSE formula and describes each variable in the formula.

Box 6.7: Cost of Saved Energy (CSE) Formula

The cost of saved energy (CSE) is an indicator of the cost of saving energy through a given type of energy efficiency investment. CSE is calculated by dividing the cost of the energy efficiency investment by the energy savings the efficiency investment produces. CSE is expressed as:

$$CSE = \frac{CRF * Cc + Cop}{ASE}$$

Where:

Cc=capital costs of the energy efficiency technology

Cop=other costs (or benefits) associated with the energy efficiency investment (if there are additional savings as a result of the energy efficiency investment, for example, increased output or greater reliability, this component is negative)

ASE=annual savings of energy, expressed in terms of volumes of energy saved

CRF=capital recovery factor, which is calculated as follows:

$$CRF = \frac{dr}{1-(1+dr)^{-n}}$$

Where *dr*=the discount rate used by the party considering the energy efficiency investment.

The capital costs (Cc) of the various energy saving measures for each sector in 2005 were provided by the National Program and scaled up to account for inflation. The capital cost of the energy efficiency investment must be weighted by a factor (the capital recovery factor or CRF) which specifies what percentage of the capital cost the investor is willing to bear during each year of the investment's useful life. The value of the CRF in turn depends on the investor's opportunity cost of capital, in other words, the highest return possible from alternative investments.

The additional costs or benefits (Cop) may include avoided capital costs or externalities associated with a particular energy efficiency investment. Benefits are reflected as a negative cost in Cop of the CSE formula in Box 6.7. The total annual costs of the energy efficiency investment (CRF*Cc+Cop) are expressed in terms of a single unit of energy saved (for example, kWh of electricity or m^3 of gas). This is achieved by dividing the total annual costs of the energy efficiency investment by the total annual savings resulting from the investment.

The annual cost of saved energy (CSE) can be compared to the average energy price to determine whether the investment makes sense from an economic or financial perspective. If, for example, the CSE of installing energy efficient lighting is AMD10/kWh, but the investor pays, on average is AMD 25/kWh for electricity, then the investment will yield a positive return and is (in the case of this example) financially viable.

Economic viability

Economic viability is determined by comparing the CSE to the long-run marginal cost (LRMC) of energy supply. Values for LRMC differ based on type of primary fuel source. For natural gas, the LRMC is the current gas import price of AMD 33,807.4 /thousand m^3) plus an estimation of transmission and distribution expenses (AMD 10,929/thousand m^3). This study uses US$ 0.05 (AMD 15.367), equivalent to the short-run marginal cost of Hrazdan Thermal Power Plant and the LRMC of a new plant in the range of US$ 0.07- US$ 0.10 per kWh.

As noted above, the difference between the CSE for economically and financially viable investments is modeled by differentiating between: i) the opportunity cost of capital used for public and private investors, ii) exclusion of applicable taxes, iii) the inclusion of indirect benefits of energy savings, and iv) the inclusion of externalities.

This study assumes a 10 percent opportunity cost of capital for public investors, lower than for private investors. This rate for public investors in Armenia is roughly halfway between the rate of return on long-term government bonds in Armenia and the rate of return required by private sector lenders. Public investors, which may include governments, or possibly some nonprofits or community organizations, will have an interest in making investments which may produce lower returns but which yield benefits for society as a whole.

Economically viable investments are also distinguished from financially viable investments in that externalities are included as part of additional costs (Cop). The largest externality considered is the reduction in carbon dioxide (CO_2) which accompanies many energy efficiency investments. This model assumes that the energy savings achieved in some sectors could be sold as CO_2 reduction credits. The value of these credits is included as an offset (negative Cop) to the cost of saved energy, assuming a sale price of 10 Euros (roughly US$15.90 or AMD 4,887) per ton of CO_2.

Finally, this study distinguished economically viable investments from financially viable investments by accounting for the indirect effects of end-use energy efficiency improvements. Specifically, end use consumption is directly reduced by an energy efficiency investment while primary energy consumption is indirectly reduced because less fuel is required to transform energy for end use consumption. For example, a reduction in household electricity consumption reduces the volume of fuel generators must use to serve load. The less fuel generators burn, the less fuel that needs to be extracted and transported (whether by pipeline, rail, or road), and the less energy that needs to be spent extracting that fuel. A reduction in end-use electricity consumption also reduces the absolute volume of electricity transmission losses, as well as the volume of fuel lost in delivery to the generating station. The value of this "multiplier" was calculated from the IEA's energy balance for Armenia, using a method developed by Russia's CENEf. Sufficient data was not available to do the respective multiplier calculation for reducing end-use gas consumption. Indirect energy savings as a result of the "multiplier effect" are included as an offset (negative Cop) to the cost of saved energy.

Financial Viability

Financial viability is determined by comparing the CSE to the domestic tariff for the respective fuel source consumed. For electricity, expert judgment was used to group the 33 types of consumers distinguished by the National Program into the various customer classes designated by the PRMC. For gas, consumers were grouped into customer classes based on the annual gas consumption data for each sector provided by the National Program. Tariffs for different customer classes are shown in the table below.

Electricity	**AMD/kWh**
35kV and above	16

6(10) kV direct connection and above	12
6(10) kV non-direct connection and above	20
High Voltage Customer Nighttime rate	12
HV Customer Average	15
0.38 kV	25
Medium Voltage Customer Nighttime rate	15
MV Customer Average	21.7
Residential customers	25
Residential customers nighttime rate	15
Residential Customer Average	21.7
Gas	**AMD/m³**
Domestic gas tariff (<10,000 m3 consumption)	84
Domestic gas tariff (>10,000 m3 consumption)	47

This study assumes a 17 percent opportunity cost of capital for private investors, and a 50 percent opportunity cost of capital for households (individual) investors. The assumption of a 17 percent rate for private firms is consistent with rates observed with commercial lending in Armenia in 2008. Households will have a still higher opportunity cost of capital for a number of reasons: They are typically more risk averse to making energy efficiency investments, they would need to borrow at retail lending rates in order to make any significant capital investment, or they have what they perceive to be higher value uses for their free cash.

This study further distinguishes financially viable projects from economically viable projects by excluding from the CSE calculation the value of any externalities or indirect energy efficiency savings. Private investors will undoubtedly make investments which have positive (and negative) externalities, and yield indirect energy savings, but the investor will not likely consider these factors important when deciding whether to invest in energy efficiency.

B.2 Estimates of Annual Energy Savings

To estimate gross annual savings from the energy savings investments recommended by the National Program, this study multiplied the volume of energy savings potential (as estimated by the National Program) by the "value" of the savings. The economic value of energy savings is equal to the LRMC of the fuel used by the customer and determines the "economic savings" potential of the investment. The financial value of energy savings is equal to the domestic tariff paid by the customer and determines the "financial savings" potential of the investment.

B.3 Estimates of Return on Investment

To estimate the return on investment from the energy savings investments recommended by the National Program, this study calculated the present value of savings over the life of the asset. Different asset lives were used for each of the energy savings investments. The appropriate discount rates, as discussed in B.1, were used to distinguish between economic and financial rates of return.

B.4 Categorization of economic activities in the national program

This study categorizes the 36 economic activities considered by the National Program as shown in the following table.

Economic activity in National Program	Sector categorization for this study
Households	Household
Metal ore production	Industry
Other branches of mining industry	Industry
Food and beverage production	Industry
Tobacco production	Industry
Textile production	Industry
Publishing, and printing business	Industry
Chemical industry	Industry
Rubber-plastics production	Industry
Other branches of non-metal mining industry	Industry
Metal industry	Industry
Ready metal goods production	Industry
Machinery-equipment production	Industry
Production of electric machines and equipment	Industry
Production of radio and TV equipment	Industry
Other branches of industry	Industry
Construction	Industry
Trade, technical maintenance and repair of vehicles	Industry
Retail trade	Industry
Hotels-restaurants	Industry
Financial agent	Industry
Real estate business	Industry
Experiments-design	Industry

Organization of leisure and entertainment activities	Industry
Foreign companies' activities	Industry
Public administration	Public sector
Education	Public sector
Provision of healthcare and social services	Public sector
Irrigation	Utilities
Production and distribution of electricity, gas, hot water and steam	Utilities
Collection, purification, and distribution of water	Utilities
Ground transportation	Utilities
Air transportation	Utilities
Communication	Utilities

Appendix C: National Program Methodology

The National Program was developed by the Scientific Research Institute of Energy and the Alliance to Save Energy during the period of 2005-2006. After its development, it was submitted to all the stakeholder ministries and the Government of Armenia for review and was approved by the Government on 18 January 2007, and later signed by the Prime Minister on June 13, 2007. In July 2007, the Government started the circulation of the Government Decision to stakeholder Ministries, which in 5 months should provide the Ministry of Energy with the list of proposed energy efficiency measures, timeframes and funding sources in their respective areas. The Ministry of Energy will consequently collect and coordinated the responses and within 4 months present a systematized action plan to the Government.

The statistical data used for the development of the National Program on Energy Saving and Renewable Energy was collected from the following sources:

- Reports of the National Statistical Service of Armenia,
- Data acquired from Design Institutes functioning in energy sector,
- Databases of "High-Voltage Electric Network" and " Electric Network of Armenia",
- Information obtained from the large energy consumers of the RA,
- The information database of Scientific Research Institute of Energy (SRIE).

In the beginning of the works on development of the National Program it was decided to collect the information on the large energy consumers that consume monthly 100,000 KWh and more, through filling the energy passports consisting of 21 tables. Later it became evident that filling the whole energy passport is a hard task and needs more time than was allocated, and sometimes the surveyed companies did not possess the required information. As a result, the SRIE compiled the table called "General information on fuel-energy resources, installed capacity and structural characteristics of buildings", presented in Annex 1 of this report, that consists of all necessary data required for estimation of possible energy savings through implementation of different energy efficiency measures.

After the above mentioned table was filled for 41 large energy consumers, the aggregate energy consumption of which added up to 87 percent of total energy consumption of Armenia, excluding the residential sector, the data was extrapolated for the corresponding sectors of economy. The extrapolation was done using the information from the National Statistical Service of Armenia. Since the survey included the largest consumers in each sector, whether it was industry sector with all its branches, or service sector, there was no certain technique used during the extrapolation, instead it was done mostly linearly through replication of identified shares of energy saving of surveyed consumers based on their energy consumption, to the whole branch of economy, taking into consideration the size, age and technical specifics of each consumer.

Afterwards, the table in Appendix D of the National Program was compiled, which shows the Energy Saving Potential according to the implemented EE measures for 35 major types of economic activities in Armenia. The table also provides the reference codes of activities and the number of companies that consume electric energy and natural gas for all types of activities, according to the reports of National Statistical Service of Armenia. There are the following 16 energy efficiency measures proposed in this table which are applied for each type of economic activity whenever it is possible:

- Elimination of defects and improvement of technological process [F1],
- Decrease of idle process [F2],
- Automation of electric drives [F3],
- Introduction of new energy efficient technological aggregates, with replacement of old ones for electricity and natural gas [F4] (there are two separate columns in the table for electric energy and natural gas),
- Introduction of energy efficient motors [F5],
- Compensation of reactive power [F6],
- Introduction of automatic electricity measuring systems [F7],
- Organizational measures [F8],
- Improvement of thermal insulation in heating equipment and pipelines, reduction of losses in natural gas distribution system [F9],
- Utilization of secondary fuel energy resources [F10],
- Utilization of efficient type of fuel-energy resources [F11],
- Application of diamond coated instruments [F12],
- Improvement of valve system [F13],
- Introduction of modern control systems [F14],
- Modernization of thermal insulation in power facilities [F15],
- Application of energy efficient lamps [F16].

For each of the aforementioned measures the following coefficients were designed

$\alpha_{i,j}$ – the share of energy consumed by the equipment that is subject to i-th EE measure (i=1÷16) for j-th type of economic activity (j=1÷35), based on expert and research estimates, %,

$\beta_{i,j}$ – relative EE potential of i-th measure for j-th type of economic activity, %,

$\gamma_{i,j}$ – cost of energy (natural gas) saved as a result of implementation of i-th measure for j-th type of economic activity, million AMD, $\gamma_{i,j} = A_j \alpha_{i,j} \beta_{i,j} \times 12$, (average cost of electric energy 1kWh= AMD 12), or $\gamma_{i,j} = A_j \alpha_{i,j} \beta_{i,j} \times 39{,}105$ (average cost of 1000 m^3 of natural gas is AMD 39,105), where A_j is the total consumption of electricity or natural gas for j-th type of economic activity,

$\pi_{i,j}$ – potential of i-th measure for j-th type of economic activity, in natural unit, MWh or thousand m^3, $\pi_{i,j} = A_j \alpha_{i,j} \beta_{i,j}$,

$C_{i,j}$ – cost of energy saving measures of i-th measure for j-th type of economic activity, billion AMD, $C_{i,j} = \gamma_{i,j} T_{i,j}$, where $T_{i,j}$ is the payback period of i-th EE measure for j-th type of economic activity. The $T_{i,j}$ are defined for each EE measure and corresponding type of economic activity based on the analysis of data acquired from representatives of each type of economic activity (Annex 2). For example the $T_{16,1}$ is the payback period defined for EE measure F16 – "Application of energy efficient lamps" in economic activity type N1 – "Provision of agricultural services".

Table 28 of the National Program was compiled using the information from the Annex D – the Energy Saving Potential in 35 sectors with different types of economic activity. For each type of economic activity the energy efficiency measures are grouped based on the technical, administrative and energy type similarities. The percentages of energy saving potential for each sector of economic activity are determined based on the total energy consumption in that sector. The total energy saving potential with separation of electric energy and natural gas savings, as well as the total energy saving potential in all sectors of economy are calculated taking into account the share (weight) of each sector's energy consumption in the total energy consumption mix of economy.

The table in Appendix C of the National Program was compiled using the information acquired through surveying of the companies listed in it, using the data collection table presented in Annex 1 of this report. After acquiring the data on cumulative installed electric power, the information on electric power of motors with variable load, and the total annual electricity consumption, the calculation of savings was done through applying new technologies for the motors with variable load and comparing it to the existing situation, taking into account the age and efficiency of the old ones and the efficiency of the new ones. It is necessary to mention that only data on the companies that agreed for the disclosure of that information is included in that table.

Appendix D: Detailed Savings and Returns by Sector and Measure

Type of Activity	Total energy saving potential	Capital Costs	Cost of Saved Energy		Net Value of Savings		Return on Investment	
	Volume		Economic	Financial	Economic	Financial	Economic	Financial
	MWH or tcm	mln AMD	mln AMD/MWh or mln AMD/thousand m³		mln AMD			
Irrigation								
Streamlining technological processes and eliminating system faults	2730	67.5	0.003256887	0.004926948	86.49	54.600	873%	306%
Reducing idle (no load and standby) operations	1853	55.6	0.003951689	0.005978030	58.71	37.060	702%	235%
Variable speed drives	4000	337.5	0.011114127	0.016813208	126.73	80.000	185%	19%
Replacing old equipment (using electricity)	2000	90.0	0.005927534	0.008967044	63.36	40.000	434%	123%
Compensating reactive power	942	36.2	0.005061966	0.007657632	29.84	18.840	526%	161%
Automated electricity metering equipment	3000	45.0	0.001975845	0.002989015	95.04	60.000	1503%	569%
Organizational Measures	495	0.6	0.000157003	0.000237511	15.68	9.900	20079%	8321%
Utilization of secondary energy resources	40360	9553.5	0.031179770	0.047168076	1278.67	807.200	2%	-58%
Improvement/optimization valves	953	36.7	0.005071584	0.007672181	30.20	19.064	525%	161%
Introducing new management and control systems and methods	1610	59.9	0.004899836	0.007412366	51.02	32.206	547%	170%
Total								

Metal ore production								
Streamlining technological processes and eliminating system faults	7484	460.7	0.008108602	0.012266516	237.10	149.680	291%	63%
Reducing idle (no load and standby) operations	497	13.2	0.003500591	0.005295617	15.74	9.934	805%	278%
Variable speed drives	11472	183.5	0.002106971	0.003187379	363.45	229.440	1404%	527%
Replacing old equipment (using electricity)	12044	650.4	0.007113244	0.010760761	381.58	240.882	345%	86%
More energy efficient motors	6905	314.9	0.006007178	0.009087529	218.76	138.100	427%	120%
Compensating reactive power	5245	176.0	0.004420066	0.006686579	166.17	104.900	617%	199%
Automated electricity metering equipment	3701	91.8	0.003267271	0.004942656	117.25	74.020	870%	305%
Organizational Measures	5005	4.8	0.000126328	0.000191106	158.57	100.100	24979%	10365%
Insulation and measures to reduce gas losses	1955	206.4	0.013907387	0.021038791	134.70	92.086	395%	124%
Utilization of secondary energy resources	7721	222.4	0.003794222	0.005739817	244.61	154.420	735%	248%
Improvement/optimization valves	1753	50.5	0.003794427	0.005740127	55.54	35.062	735%	248%
Introducing new management and control systems and methods	12755	535.7	0.005532479	0.008369413	404.08	255.090	473%	139%
Improved insulation	888	97.8	0.014513866	0.021956260	49.48	41.809	284%	115%
Energy efficient lighting	381	4.3	0.002744336	0.003368459	10.38	7.610	894%	494%
Total								

Other branches of mining industry								
Improved insulation	18.1	2.0	0.014555026	0.022018525	1.01	0.853	283%	114%
Total								
Food and beverage production								
Improved insulation	18.1	2.0	0.014555026	0.022018525	1.01	0.853	283%	114%
Total								
Tobacco production								
Variable speed drives	5433	203.0	0.004922094	0.007446036	172.11	108.652	544%	169%
Replacing old equipment (using electricity)	4952	181.6	0.004830074	0.007306831	156.90	99.050	556%	174%
More energy efficient motors	2735	50.8	0.002446628	0.003701205	86.65	54.700	1195%	440%
Automated electricity metering equipment	9355	14.2	0.000199943	0.000302469	296.38	187.100	15745%	6512%
Insulation and measures to reduce gas losses	3897	290.9	0.009833085	0.014875277	268.51	183.560	601%	217%
Improvement/optimization valves	2335	78.4	0.004423680	0.006692047	73.96	46.690	616%	199%
Introducing new management and control systems and methods	591	5.6	0.001248982	0.001889433	18.71	11.812	2437%	959%
Improved insulation	3587	522.8	0.019198432	0.029042969	199.97	168.958	190%	62%
Energy efficient lighting	11058	28.7	0.000630256	0.000773590	301.53	221.166	4226%	2485%
Total								
Textile production								
More energy efficient motors	79	2.7	0.004490556	0.006793216	2.51	1.584	606%	194%

Introducing new management and control systems and methods	30	2.0	0.008870234	0.013418697	0.94	0.594	257%	49%
Energy efficient lighting	457	3.3	0.001752412	0.002150949	12.47	9.146	1456%	830%
Total								
Publishing, and printing business								
Energy efficient lighting	66	0.9	0.003481603	0.004273397	1.79	1.311	683%	368%
Total								
Chemical industry								
Streamlining technological processes and eliminating system faults	4606	37.2	0.001062992	0.001608072	145.93	73.696	2880%	895%
Reducing idle (no load and standby) operations	4659	139.8	0.003951689	0.005978030	147.60	74.544	702%	168%
Variable speed drives	1741	47.1	0.003563148	0.005390252	55.16	27.859	789%	197%
Replacing old equipment (using electricity)	11110	517.3	0.006133130	0.009278065	351.99	177.763	417%	72%
More energy efficient motors	4290	187.9	0.005769405	0.008727830	135.91	68.640	449%	83%
Compensating reactive power	41	3.1	0.009983893	0.015103416	1.30	0.654	217%	6%
Automated electricity metering equipment	6281	67.5	0.001415587	0.002141469	198.99	100.496	2138%	647%
Organizational Measures	2422	0.9	0.000047316	0.000071578	76.73	38.752	66857%	22253%
Insulation and measures to reduce gas losses	1610	169.9	0.013908048	0.021039792	110.90	75.812	395%	124%
Utilization of secondary energy resources	6882	198.2	0.003793591	0.005738862	218.03	110.112	735%	179%
Fuel switching	4150	104.6	0.003320054	0.005022505	131.48	66.400	854%	219%

Improvement/optimization valves	6218	208.9	0.004425438	0.006694706	196.99	99.486	616%	139%
Introducing new management and control systems and methods	119	2.7	0.003001283	0.004540276	3.75	1.896	956%	252%
Improved insulation	1593	147.3	0.012176977	0.018421065	88.83	75.054	358%	156%
Energy efficient lighting	213	2.7	0.003075389	0.003774800	5.81	3.411	787%	324%
Total								
Rubber-plastics production								
Replacing old equipment (using electricity)	152	10.7	0.009257987	0.014005281	4.82	2.436	242%	14%
More energy efficient motors	79	3.5	0.005854355	0.008856340	2.51	1.267	441%	81%
Organizational Measures	60	0.0	0.000087815	0.000132845	1.90	0.960	35977%	11944%
Utilization of secondary energy resources	78	2.0	0.003377512	0.005109427	2.47	1.248	838%	213%
Introducing new management and control systems and methods	148	8.6	0.007674916	0.011610446	4.68	2.362	313%	38%
Improved insulation	1	0.2	0.021772394	0.032936802	0.07	0.102	156%	155%
Total								
Other branches of non-metal mining industry								
Reducing idle (no load and standby) operations	4885	263.8	0.007113602	0.010761302	154.76	78.157	345%	49%
Variable speed drives	16432	644.4	0.005165670	0.007814513	520.59	262.912	513%	105%
Replacing old equipment (using electricity)	3132	145.8	0.006131912	0.009276223	99.23	50.112	417%	72%
More energy efficient motors	441	8.2	0.002449271	0.003705204	13.97	7.056	1194%	332%

Compensating reactive power	1051	37.7	0.004724982	0.007147850	33.30	16.816	571%	124%
Automated electricity metering equipment	1999	45.6	0.003004786	0.004545575	63.33	31.984	954%	252%
Organizational Measures	1182	0.5	0.000055720	0.000084293	37.45	18.912	56758%	18882%
Insulation and measures to reduce gas losses	5952	488.8	0.010816909	0.016363584	410.10	280.357	537%	188%
Introducing new management and control systems and methods	3314	152.7	0.006069066	0.009181151	105.00	53.027	422%	74%
Energy efficient lighting	340	3.7	0.002645803	0.003247517	9.26	5.434	931%	393%
Total								
Metal industry								
Streamlining technological processes and eliminating system faults	604	30.9	0.006732266	0.010184425	19.14	9.060	371%	47%
Reducing idle (no load and standby) operations	702	14.3	0.002688875	0.004067672	22.24	10.530	1078%	269%
Variable speed drives	1639	64.3	0.005169233	0.007819902	51.91	24.578	513%	92%
Replacing old equipment (using electricity)	430	25.2	0.007724789	0.011685893	13.61	6.446	310%	28%
More energy efficient motors	118	4.6	0.005134964	0.007768061	3.74	1.770	517%	93%
Compensating reactive power	74	5.6	0.010003826	0.015133571	2.34	1.110	217%	-1%
Automated electricity metering equipment	416	8.5	0.002688289	0.004066785	13.18	6.240	1079%	269%
Organizational Measures	295	0.1	0.000058047	0.000087813	9.35	4.425	54479%	16982%
Insulation and measures to reduce gas losses	4047	592.8	0.019293007	0.029186040	278.85	190.626	257%	61%

Fuel switching	253	8.5	0.004420234	0.006686834	8.02	3.800	617%	124%
Diamond tipped instruments	2678	9.6	0.000472231	0.000714381	84.84	40.167	6609%	2000%
Energy efficient lighting	1858	26.8	0.003502589	0.004299155	50.67	27.872	678%	249%
Total								
Ready metal goods production								
Replacing old equipment (using electricity)	42	2.1	0.006643090	0.010049522	1.32	0.833	377%	99%
Insulation and measures to reduce gas losses	25	2.6	0.014193823	0.021472106	1.69	1.154	385%	119%
Total								
Machinery-equipment production								
Reducing idle (no load and standby) operations	143	2.6	0.002376541	0.003595179	4.53	2.574	1233%	401%
Replacing old equipment (using electricity)	326	18.0	0.007279971	0.011012981	10.32	5.862	335%	63%
More energy efficient motors	263	11.0	0.005524352	0.008357119	8.33	4.734	473%	115%
Compensating reactive power	116	4.7	0.005359763	0.008108132	3.68	2.088	491%	122%
Automated electricity metering equipment	136	3.1	0.003002509	0.004542130	4.31	2.448	955%	296%
Organizational Measures	174	0.3	0.000234679	0.000355017	5.51	3.132	13400%	4970%
Diamond tipped instruments	1128	4.1	0.000478865	0.000724417	35.73	20.300	6516%	2385%
Total								
Production of electric machines and equipment								
Reducing idle (no load and standby) operations	101	5.5	0.007144738	0.010808403	3.21	2.028	343%	85%
Replacing old equipment (using electricity)	487	23.9	0.006468153	0.009784880	15.42	9.734	390%	104%

More energy efficient motors	148	6.6	0.005874133	0.008886260	4.69	2.960	439%	125%
Compensating reactive power	191	8.3	0.005703398	0.008627976	6.05	3.820	455%	132%
Automated electricity metering equipment	233	4.9	0.002770140	0.004190607	7.38	4.660	1044%	377%
Insulation and measures to reduce gas losses	278	68.0	0.032238963	0.048770400	19.15	13.095	114%	-3%
Fuel switching	365	10.9	0.003933645	0.005950733	11.56	7.300	705%	236%
Diamond tipped instruments	471	2.8	0.000783566	0.001185361	14.91	9.414	3943%	1587%
Improvement/optimization valves	198	6.9	0.004583402	0.006933670	6.28	3.966	591%	188%
Introducing new management and control systems and methods	298	11.1	0.004913055	0.007432362	9.43	5.952	545%	169%
Improved insulation	13	1.5	0.014945875	0.022609794	0.74	0.623	273%	108%
Energy efficient lighting	2283	28.5	0.003032065	0.003721624	62.24	45.652	799%	437%
Total								
Production of radio and TV equipment								
Reducing idle (no load and standby) operations	29	0.5	0.002407351	0.003641788	0.92	0.580	1216%	449%
Automated electricity metering equipment	27	0.6	0.003088011	0.004671476	0.86	0.546	926%	328%
Organizational Measures	29	0.2	0.000863013	0.001305547	0.92	0.580	3571%	1432%
Total								
Other branches of industry								
Insulation and measures to reduce gas losses	5	0.6	0.015694653	0.023742529	0.32	0.395	339%	254%
Diamond tipped instruments	119	0.3	0.000319930	0.000483983	3.78	2.388	9803%	4032%

Introducing new management and control systems and methods	61	2.7	0.005801828	0.008776879	1.94	1.226	446%	128%
Total								
Production and distribution of electricity, gas, hot water and steam								
Streamlining technological processes and eliminating system faults	8288	4.0	0.000063255	0.000095691	188.37	165.760	35830%	20801%
Reducing idle (no load and standby) operations	8818	428.5	0.006401136	0.009683499	200.40	176.354	255%	107%
Variable speed drives	4137	450.0	0.014328098	0.021675234	94.02	82.740	59%	-8%
Replacing old equipment (using electricity)	32362	1216.6	0.004952001	0.007491279	735.50	647.230	359%	167%
Replacing old equipment (using natural gas)	488000	69394.0	0.018731116	0.028336024	33624.17	22986.229	268%	66%
Compensating reactive power	15088	305.0	0.002662746	0.004028144	342.91	301.760	754%	397%
Automated electricity metering equipment	5898	95.5	0.002132849	0.003226528	134.05	117.960	966%	520%
Organizational Measures	7867	4.7	0.000078696	0.000119049	178.80	157.340	28780%	16700%
Insulation and measures to reduce gas losses	57742	1884.0	0.004297844	0.006501684	3978.54	2719.817	1503%	624%
Utilization of secondary energy resources	5773	145.5	0.003319885	0.005022249	131.21	115.460	585%	298%
Fuel switching	161	8.0	0.006529020	0.009876959	3.67	3.228	248%	102%
Improvement/optimization valves	2850	88.9	0.004108833	0.006215752	64.77	57.000	453%	222%

Introducing new management and control systems and methods	5997	237.5	0.005216904	0.007892019	136.29	119.934	336%	153%
Improved insulation	194	0.8	0.000542488	0.000820665	9.09	9.150	8526%	5640%
Total								
Collection, purification, and distribution of water								
Reducing idle (no load and standby) operations	1645	29.6	0.002371014	0.003586818	52.12	32.900	1236%	458%
Variable speed drives	45000	1700.0	0.004976202	0.007527889	1425.67	900.000	537%	166%
Replacing old equipment (using electricity)	20000	5500.0	0.036223820	0.054798605	633.63	400.000	-13%	-64%
More energy efficient motors	4849	227.0	0.006166450	0.009328471	153.62	96.980	414%	114%
Compensating reactive power	2865	110.0	0.005057427	0.007650765	90.77	57.300	526%	161%
Automated electricity metering equipment	4714	76.4	0.002134840	0.003229539	149.35	94.280	1384%	519%
Organizational Measures	3038	9.5	0.000411038	0.000621810	96.25	60.760	7608%	3116%
Utilization of secondary energy resources	13098	1949.0	0.019600557	0.029651295	414.96	261.960	62%	-33%
Improvement/optimization valves	4863	169.2	0.004582799	0.006932759	154.08	97.266	591%	188%
Introducing new management and control systems and methods	3087	77.8	0.003319421	0.005021547	97.81	61.746	854%	298%
Total								
Construction								
More energy efficient motors	45	2.1	0.006176344	0.009343439	1.43	0.900	413%	114%
Organizational Measures	49	0.1	0.000349469	0.000528669	1.55	0.980	8966%	3683%

Total								
Trade, technical maintenance and repair of vehicles								
Reducing idle (no load and standby) operations	3641	8.7	0.000314755	0.000476154	115.35	78.886	9965%	4450%
Replacing old equipment (using electricity)	1459	68.3	0.006167347	0.009329829	46.22	31.606	414%	132%
More energy efficient motors	758	28.2	0.004902250	0.007416017	24.01	16.423	546%	192%
Organizational Measures	891	1.2	0.000174448	0.000263901	28.23	19.305	18061%	8110%
Total								
Retail trade								
Energy efficient lighting	559	8.7	0.003786890	0.004648112	15.23	12.102	620%	366%
Total								
Hotels-restaurants								
Insulation and measures to reduce gas losses	85	10.6	0.016291647	0.024645648	5.88	4.018	323%	91%
Improvement/optimization valves	256	8.9	0.004575857	0.006922257	8.12	5.551	592%	213%
Improved insulation	55	0.8	0.001900422	0.002874917	3.09	2.612	2834%	1538%
Energy efficient lighting	1049	18.9	0.004372171	0.005366500	28.61	22.733	524%	304%
Total								
Ground transportation								
Reducing idle (no load and standby) operations	1658	55.7	0.004424659	0.006693528	52.53	35.928	616%	224%
Replacing old equipment (using electricity)	4067	156.2	0.005058608	0.007652552	128.86	88.126	526%	183%
Total								
Communication								

Replacing old equipment (using electricity)	15200	954.0	0.008267187	0.012506420	481.57	329.340	283%	73%
Organizational Measures	1393	3.2	0.000300703	0.000454897	44.13	30.182	10436%	4663%
Energy efficient lighting	7276	54.1	0.001805578	0.002216206	198.40	157.651	1410%	878%
Total								
State government								
Reducing idle (no load and standby) operations	1685	10.1	0.000790338	0.000790338	53.38	36.508	3909%	2641%
Variable speed drives	5312	58.0	0.001438488	0.001438488	168.29	115.093	2102%	1406%
Improvement/optimization valves	3489	33.5	0.001264825	0.001264825	110.53	75.591	2405%	1613%
Energy efficient lighting	8778	45.3	0.001253274	0.001253274	239.34	190.181	2076%	1629%
Total								
Education								
Insulation and measures to reduce gas losses	244	30.2	0.016298294	0.016298294	16.84	11.512	323%	189%
Improvement/optimization valves	171	3.7	0.002845155	0.002845155	5.43	3.712	1014%	662%
Improved insulation	128	17.8	0.018287724	0.018287724	7.15	6.039	205%	158%
Total								
Provision of healthcare and social services								
Reducing idle (no load and standby) operations	1557	49.3	0.004171341	0.004171341	49.32	33.731	660%	419%
Variable speed drives	2282	60.8	0.003509534	0.003509534	72.30	49.443	803%	517%
Organizational Measures	1145	1.8	0.000205925	0.000205925	36.28	24.808	15285%	10422%
Insulation and measures to reduce gas losses	342	141.1	0.054353062	0.054353062	23.56	16.109	27%	-13%

Fuel switching	2349	222.4	0.012470284	0.012470284	74.43	50.899	154%	74%
Improvement/optimization valves	1101	14.5	0.001735402	0.001735402	34.87	23.846	1726%	1149%
Introducing new management and control systems and methods	892	22.5	0.003322609	0.003322609	28.26	19.327	854%	552%
Improved insulation	2038	1391.1	0.089911600	0.089911600	113.62	95.996	-38%	-48%
Energy efficient lighting	2819	5.1	0.000439338	0.000439338	76.87	61.078	6106%	4832%
Total								
Civil activities								
Reducing idle (no load and standby) operations	13721	32.9	0.000316131	0.000316131	434.70	297.288	9922%	6754%
Variable speed drives	24269	250.5	0.001359620	0.001359620	768.88	525.828	2230%	1494%
Energy efficient lighting	135525	2925.3	0.005241748	0.005241748	3695.37	2936.364	420%	313%
Total								
Population								
Energy efficient lighting	302946	6788.1	0.005441355	0.013534104	8260.46	6563.821	401%	60%
Total								
Organization of leisure and entertainment activities								
Fuel switching	378	11.3	0.003940878	0.005961675	11.97	8.184	704%	263%
Improvement/optimization valves	128	1.8	0.001850908	0.002800014	4.06	2.776	1612%	674%
Total								

Appendix E: Measures to be implemented under the Law on Energy Saving and Renewable Energy

The Law of the Republic of Armenia on Energy Saving and Renewable Energy, passed on November 9, 2004, defines the principles of state policy regarding energy efficiency. The Law provides for the development of mechanisms to enforce a wide array of energy efficiency measures, however, many of these have yet to be developed and implemented. Such mechanisms include the following:

- State-administered programs. The Law allows for: the development, adoption and implementation of a national, targeted program for energy savings and renewable energy, coordination among state programs to promote energy efficiency, and the incorporation of energy savings requirements in state programs on the economic development of Armenia.
- Standards. The Law commissions the Standardization National Body to adopt energy saving national standards with regard to the energy efficiency of:
  - Energy-using devices
  - The production, processing, transformation, transportation, storage and consumption of energy resources
  - Building and construction technical requirements for heating, lighting, ventilation, water supply and sewage
  - Production/industrial processes
- Voluntary labeling. The Law allows for the voluntary certification of energy-using devices at the expense and initiative of the private entity. Such devices will be subsequently labeled based on the energy efficiency indicators described above.
- Statistical data gathering. The Law commissions the Statistics National Body to record data on energy production, imports, processing, transformation, transportation, storage, and consumption. This data is to be used in the submission of energy balances as defined by the law "On State Statistics".
- Training and education. The Law instructs the state administration authorized body for education to incorporate energy savings into the curricula of elementary, secondary, graduate, supplementary and post-graduate educational institutions and to develop energy savings educational training programs for engineering staff.
- Information dissemination. The Law allows for information dissemination via public hearings/discussions, broadcasting, exhibitions, and other propaganda mechanisms. Information that falls within the jurisdiction of public dissemination campaigns includes:
  - Existing energy efficient devices, technologies and machinery,
  - Energy efficiency pilot projects,
  - Energy efficiency national objectives,
  - Environmental, economic and social benefits of energy efficiency.
- Energy audits. The Laws spells out several important factors and suggests certain prerequisite activities related to the development of the energy audit process in Armenia. Such factors and prescribed activities include:

- The definition of purpose of the audit
- The voluntary nature of cooperation
- The measurement of energy efficiency indicators
- The definition of a methodology and documentation format for carrying out an energy audit
- The information to be included in the audit report
- The possibility for tax and/or customs relief for a positive audit conclusion

- International cooperation. The Law recommends international cooperation with regard to the exchange of energy efficient technologies, information, the mutual recognition of standards and certification, and the development and implementation of joint energy saving programs and projects.
- Fiscal incentives. The Laws commissions the authorized state body for energy savings to submit proposals to the government on additions to the Customs Code of the Republic of Armenia and the Republic of Armenia law "On the Approval of List of Products imported by organizations and individual entrepreneurs eligible for zero (0) rate customs duty and excise duty exemption, for which the customs service does not calculate or charge value added tax".
- Updating existing compliance certification. The Law directs the appropriate state body to submit proposals to the government to include energy savings requirements and national objectives in the Republic of Armenia law "On Certification of Compliance of Goods and Services with Normative Requirements".