Center for Energy Efficiency (CENEf)

COPENHAGEN CENTRE ON ENERGY EFFICIENCY
SE4ALL EE HUB

Final report

Energy efficiency orbits for transition economies

Prepared for: Copenhagen Centre on Energy Efficiency (C2E2)

ARMENIA
AZERBAIJAN
BELARUS
GEORGIA
MOLDOVA
KAZAKHSTAN
KYRGYZSTAN
TAJIKISTAN
TURKMENISTAN
UZBEKISTAN

2015

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List of Abbreviations

AAGR	Average annual growth rate
ACEEE	American Council for an Energy Efficient Economy
ADB	Asian Development Bank
ADEME	Environment and Energy Management Agency (France)
BAT	best available technologies
bln	billion
BPIE	Buildings Performance Institute Europe
C2E2	Copenhagen Centre on Energy Efficiency
CENEf	Center for Energy Efficiency
CHP	combined heat and power
CIS	Commonwealth of Independent States
CNG	compressed natural gas
CSE	cost of saved energy
DHW	domestic hot water
EBRD	European Bank for Reconstruction and Development
EC	European Commission
EE	energy efficiency
EIT	economies in transition
ESCAP	Economic and Social Commission for Asia and the Pacific
ESCO	Energy Service Company
EU	European Union
Gcal	gigacalory
gce	gram of coal equivalent
GDP	gross domestic product
GEF	Global Environment Facility
GIZ	German International Cooperation Agency
goe	gram of oil equivalent
HPP	hydropower plant
IEA	International Energy Agency
IFC	International Finance Corporation
IFEB	Integrated Fuel and Energy Balance
JSC	Joint Stock Company
kgce	kilogram of coal equivalent
kgoe	kilogram of coal equivalent
km	kilometre
kWh	kilowatt-hour
LAM	Latin America
LPG	liquid petroleum gas
m^2	square metre
m^3	cubic metre
MAF	Middle East and Africa
MER	market exchange rate
MFB	multifamily buildings
mln	million
Mtce	million tons of coal equivalent
Mtoe	million tons of oil equivalent
NSS	National Statistics Service

OECD	Organization for Economic Cooperation and Development
PPP	purchasing power parity
RE	renewable energy
RES	renewable energy sources
SFB	single-family buildings
SOCAR	State Oil Company of Azerbaijan
tce	ton of coal equivalent
thou.	thousand
toe	ton of oil equivalent
TPES	total primary energy supply
TPP	thermal power plant
U.S.	United States of America
UNDP	United Nations Development Programme
UNECE	United Nations Economic Commission for Europe
UNIDO	United Nations Industrial Development Organization
US$	U.S. dollar
USAID	United States Agency for International Development
WHO	World Health Organization

Introduction

This report is prepared by the Center for Energy Efficiency (CENEf) for the Copenhagen Centre on Energy Efficiency (C2E2) under consultancy contract dated September 30, 2014. In compliance with the scope of work, this effort is intended to 'map' energy efficiency developments. The regional coverage includes 10 transition economies: Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Moldova, Tajikistan, Turkmenistan, and Uzbekistan. Each of these countries is unique in terms of culture, people's mentality, policy-making, stakeholders' involvement, etc. The mapping includes the identification of past successful energy efficiency initiatives and activities as described in this report and presented in a spreadsheet database of initiatives and personal contacts attached thereto.

The database describes initiatives, provides information on the timeframe, budget, expected energy savings, measurement and verification methods, challenges and barriers encountered. It also provides information on the local energy efficiency experts. The database is provided as separate files. The information included in the database was sent over to local experts for review. Some feedback was received and based thereupon the database was verified. The methodology used for the research is presented in Section 1.

The main goal of this report is to prioritise the 10 countries in the region with an account of their energy efficiency opportunities based on the available information and to identify at least five countries that have the largest energy efficiency potential and could be targeted for the support of further energy efficiency activities by C2E2.

To attain this goal, the energy efficiency potential in various sectors was assessed for each of the above-listed countries. This effort also included descriptions of the institutional structure in place, government interest and likely commitment to accelerate energy efficiency activities, need for assistance in further energy efficiency improvements. Based on this information the countries were ranked in terms of their energy efficiency levels and efforts using the scoring system developed by CENEf. The rating results are presented in Chapter 1. Chapter 2 presents evolution of GDP energy intensity in these countries. For the purpose of supporting the rating the next 10 country chapters describe the basic parameters of the scoring system based on the available information, the authors' own assessments and the communication with local experts. Country-specific information includes a brief description of key energy efficiency indicators, initiatives, institutions, and policies.

The study was accomplished by Igor Bashmakov, Vladimir Bashmakov, Maksim Dzedzichek, Konstantin Borisov, Oleg Lebedev, Alexey Lunin, and Anna Myshak.

Translation and editing by Tatiana Shishkina.

Report layout by Oxana Ganzyk.

Igor Bashmakov

Executive Director, CENEf

Executive summary

This report was developed by the Center for Energy Efficiency (CENEf) for the Copenhagen Centre on Energy Efficiency (C2E2) to ‘map’ energy efficiency developments in 10 transition economies: Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Moldova, Tajikistan, Turkmenistan, and Uzbekistan.

The mapping includes the identification of past successful energy efficiency initiatives, assessment of energy efficiency potentials and identification of recent energy efficiency initiatives and leading personalities in this field in those countries.

A large variety of information sources were used to accomplish this task, above all statistical data and personal communications. All major energy consuming sectors were screened to obtain a comprehensive picture. For the purpose of structuring all this information an energy efficiency scoring system was used to identify five transition economies that have the largest energy efficiency potential and can be targeted for the support of further energy efficiency activities by C2E2.

The quality and comprehensiveness of data used in the scoring system are not the same for all the 10 countries. Since none of the countries publish national reports describing the results of their energy efficiency activities, many of the metrics are based on expert estimates collected by CENEf from a variety of sources. Since the quality of this information needs improvement, the country rating results are to be used with caution, keeping in mind both the weaknesses of the potential rating system and the quality of data used, which is far from perfect.

Country ranking is based on the following seven major criteria: improvements of energy efficiency indicators in the past; energy efficiency policies and policy implementation governance; energy efficiency potential in different sectors; energy efficiency policy gaps; plans to further develop energy efficiency policies; government interest in, and commitment to, the acceleration of energy efficiency activities; need for assistance in energy efficiency improvement and willingness to collaborate with foreign partners, especially from the EC, and experience in being a recipient under assistance programmes; institutional structure in place for both effective energy efficiency policies implementation in different sectors and for effective accommodation of foreign energy efficiency assistance; availability of officials and energy efficiency experts who may become contact points for the discussion of potential cooperation.

CENEf’s scoring system to a certain degree builds on the methodological approach used in “The 2014 International Energy Efficiency Scorecard”, but uses it only as a starting point. It better reflects both tasks specified for this study and takes into account specific aspects of energy efficiency activities in the 10 countries included in the analysis. All together, CENEf’s rating system builds on 69 metrics split by five scoring blocks: national efforts; power and heat; industry; buildings; transport. Weight is assigned to each indicator, and each metric is estimated according to a special rule. The maximum score is 171. The scoring system proposed by CENEf uses, inter alia, estimates of energy efficiency potential in individual sectors. This is an innovation compared to other rating systems.

With 118 points out of 171 possible, Kazakhstan takes the lead followed by Belarus (91), Kyrgyzstan (84), Armenia (82), Georgia (77), Uzbekistan (77), Tajikistan (76), Moldova (74), Azerbaijan (58), and Turkmenistan (35). Given the conditionality or the chosen scoring system, the 10 countries may be broken down into three groups: champions (Kazakhstan and Belarus); the middle group (Kyrgyzstan, Armenia, Georgia, Uzbekistan, Tajikistan, and Moldova), and underperformers (Azerbaijan and Turkmenistan).

While the comparative scoring within the groups may be not very informative (the activities in place may be more or less effective), the division by groups seems very logical and robust. CENEf's experience-based judgment is that the top two countries are real energy efficiency champions among the 10 economies.

The last group is formed also quite logically: both Azerbaijan and Turkmenistan are rich in fossil fuel resources and therefore do not see energy efficiency as a priority. Turkmenistan provides very cheap energy, which is a poor motivation for consumers to use it effectively.

The middle group includes 6 countries that are relatively close in scoring (74-84 points), all engaged in multiple energy efficiency activities, yet not intensely enough to be promoted to the champions. The ranking of these 6 countries within the group is not necessarily correct.

We can suggest *three possible interpretations* of the rating results. First, the country with the maximum score has a large energy efficiency potential, legislation and regulations, institutions, experts, data, experience in international cooperation. All this would make it the easiest to work with for the purpose of further acceleration of the energy efficiency progress. As the scores of Georgia and Uzbekistan are the same, the first six (not five) countries are: **Kazakhstan, Belarus, Kyrgyzstan, Armenia, Georgia and Uzbekistan.**

Second, the country with the minimum score really lacks momentum and resources needed to spur (or even launch) energy efficiency activities and for this very reason needs assistance from experienced countries to push it along the energy efficiency pathway. As the scores of Georgia and Uzbekistan are the same, the first six (not five) countries are: **Georgia, Uzbekistan, Tajikistan, Moldova, Azerbaijan, and Turkmenistan.**

Third, countries that are neither champions, nor outsiders in energy efficiency have a good potential for energy efficiency improvement and a soil that can accept seeds of change. There is already some experience, some progress, some institutions, yet much needs to be done, and there is a will to enhance energy efficiency activities. These six countries belong to the middle group and include: **Armenia, Georgia, Kyrgyzstan, Moldova, Tajikistan, and Uzbekistan.**

Two countries, namely **Georgia and Uzbekistan**, fit all the three approaches.

Section 1. Methodology

1.1 Estimation of energy efficiency potentials

Not very many scoring systems are available for cross-country energy efficiency comparisons and benchmarking. Nevertheless, some efforts were made to picture and compare energy efficiency activities by country. These include:

- ACEEE International Energy Efficiency Scorecard system[1];
- ODYSSEE MURE project, which is coordinated by ADEME and supported under the Intelligent Energy Europe Programme of the European Commission. This project gathers representatives such as energy agencies from the 27 EU member states plus Norway and Croatia and aims at monitoring energy efficiency trends and policies in Europe;
- ABB project. Country reports. How does your energy efficiency compare to the world's best performing countries?
- ENTRANZE Project;
- Buildings Performance Institute Europe (BPIE) project; and some others.

These projects have different goals, including providing access to comprehensive information on energy efficiency policies and indicators for benchmarking and experience exchange, and cross-country (cross-state in the U.S.) comparisons of who is doing better in the energy efficiency field. Some of them cover all sectors, while others concentrate on individual sectors. Analysis of these systems allows it to identify information needed to estimate energy efficiency progress and future needs of the 10 countries in question.

"The 2014 International Energy Efficiency Scorecard" was recently developed by the American Council for an Energy-Efficient Economy (ACEEE[3]).[2] Only the International Energy Efficiency Scorecard is using different metrics reflecting policies, quantifiable performance indicators, institutions, scale of activities to evaluate how efficiently these economies use energy, via what policies and instruments and how much they do progress in improving energy efficiency. This is quite a new system with only 2 editions published to the date – for 2012 and for 2014, and with evolving energy efficiency rating system. The 2014 edition covers 16 countries with energy efficiency activities and progress reflected via 31 metrics. The scoring system is split by four scoring blocks: national efforts; industry; buildings; transport. Every metric is given weight and rules how it should be estimated.

Authors from ACEEE[3] note that collection of comparable data across nations is a challenging task. In some cases, they assigned scores to a country for a particular metric based on a combination of best estimates and available data. If it works for selected large 16 countries, it should work for the 10 countries selected for this study as well. In many instances their energy use data are incomplete and information on energy efficiency initiatives is hard to collect, verify and systematize.

Analysis of these energy efficiency rating systems allows it to identify information needed to comprehensively estimate energy efficiency progress and future needs of the 10 countries in question. This detailed information is structured in Table 1.1 below along with the sources where this information can be found and data collection methods. As a matter of fact, data from different sources may be contradictory. This problem can be addressed in a number of ways,

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[1] R. Young, S. Hayes, M. Kelly, S. Vaidyanathan, S. Kwatra, R. Cluett, G. Herndon. The 2014 International Energy Efficiency Scorecard. American Council for an Energy-Efficient Economy. July 2014. Report Number E1402.
[2] Ibid.

including assessment of the most reliable data sources; providing data ranges, where appropriate; or just highlighting points of disagreement, where there is no reason to prefer one source to another.

The table below is quite comprehensive, although it lacks information on the barriers to energy efficiency policies, which are quite common across the countries in question. Such information may be found in papers devoted to the critical overview of energy efficiency policies implementation and policy gaps. In some of the 10 countries, writing critical papers on federal policies is not a usual practice. Therefore, information on the barriers, if not available for some country, may be borrowed from publications on the implementation of energy efficiency policies in similar countries and/or via personal communications with the local experts using e-mail and telephone. CENEf has experience in working with experts from such countries and used its contacts to collect the required information. CENEf has also assisted some of these countries in drafting their energy efficiency regulations and policies. This experience was used as well. While much of this exercise relied on the CENEf's knowledge and experience in the region combined with intensive desktop research, it also included some communication with local stakeholders via e-mail and phone as face-to-face consultation/stakeholder workshops.

Description of the countries' energy efficiency activities in later sections is organized in compliance with the structure specified in Table 1.1.

Table 1.1 Data collection technology, sources and structure

Information required	Source of information	Methods of data collection
	National level	
Evolution of GDP energy intensity	Statistical yearbooks	Collection of statistical data
Factors behind evolution of GDP energy intensity: technology and structural shifts	Scientific publications	Literature search
Energy prices	Statistical yearbooks	Collection of statistical data
Energy efficiency legislation	Regulatory acts	Internet search and personal communications with local experts
Number of energy efficiency regulatory acts	Regulatory acts	Internet search and personal communications with local experts
Government agency(ies) with an energy efficiency policy mandate	Regulatory acts, statutes of Ministries and agencies	Internet search and personal communications with local experts
Basic administrative mechanisms to improve energy efficiency	Regulatory acts, scientific publications	Internet search and personal communications with local experts
Basic energy efficiency market mechanisms and economic incentive programmes	Regulatory acts on tax credits, loan programs, etc. scientific publications	Internet search, literature search and personal communications with local experts
Energy efficiency policy spending and financial sources	Regulatory acts, energy efficiency policy monitoring data, scientific publications, estimates	Data on energy efficiency public and other spending in internet, literature search
Energy efficiency R&D spending	Public spending, statistical data	Collection of statistical data, internet, literature search
ESCO market	Energy efficiency policy monitoring data, scientific publications, estimates	Internet, literature search, personal communications with local experts
Water efficiency policy	Regulatory acts, scientific publications	Internet search and personal communications with local experts

Information required	Source of information	Methods of data collection
Heat and power generation and transmission		
Power generation efficiency	Statistical yearbooks, energy balances	Collection of statistical data
Share of CHP in power generation		
Power transmission and distribution losses (%)		
Heat generation efficiency		
Share of CHP in heat generation		
Heat distribution losses		
Energy efficiency regulations in heat and power generation and distribution	Regulatory acts, scientific publications	Internet search and personal communications with local experts
Government agency(ies) with an energy efficiency policy mandate in heat and power generation and distribution	Regulatory acts, statutes of Ministries and agencies	Internet search and personal communications with local experts
Basic administrative mechanisms to improve energy efficiency in heat and power generation and distribution	Regulatory acts, scientific publications	Internet search and personal communications with local experts
Basic energy efficiency market mechanisms and economic incentive programmes	Regulatory acts on tax credits, loan programs, etc. Scientific publications	Internet search, literature search and personal communications with local experts
Renewables development programmes		
White Certificates market		
Heat and power generation and distribution: energy efficiency policy spending	Regulatory acts, energy efficiency policy monitoring data, scientific publications, estimates	Data on energy efficiency public and other spending in internet, literature search, expert estimates[3]
Industry		
Industrial energy intensity	Statistical yearbooks, energy balances	Collection of statistical data
Energy intensity of basic industrial goods		
Share of industrial CHP in the overall electricity generation		
Energy efficiency regulations in the industrial sector	Regulatory acts, scientific publications	Internet search and personal communications with local experts
Government agency(ies) with an energy efficiency policy mandate in the industrial sector	Regulatory acts, statutes of Ministries and agencies	Internet search and personal communications with local experts
Basic administrative mechanisms to improve energy efficiency in the industrial sector	Regulatory acts, scientific publications	Internet search and personal communications with local experts
Basic energy efficiency market mechanisms and economic incentive programmes	Regulatory acts on tax credits, loan programs etc., scientific publications	Internet search, literature search and personal communications with local experts
Long-term agreements	Regulatory acts, scientific publications, estimates	Internet search, literature search, personal communications with local experts
Energy managers training programmes	Energy efficiency policy monitoring data, scientific publications, estimates	Internet search, literature search, personal communications with local experts
Industrial energy efficiency policy spending	Regulatory acts, energy efficiency policy monitoring data, scientific publications, estimates	Data on public and other energy efficiency spending in internet, literature search

[3] Four expert estimation methods to be used were tested in I. Bashmakov. Who, where and how much spends on energy efficiency? Analysis of foreign experience and recommendations for Russia. Akademia Energetiki, No. 1 [57] February 2014. (In Russian).

Information required	Source of information	Methods of data collection
Buildings		
Specific energy consumption per 1 m2 of residential floor space (Energy intensity in residential buildings)	Statistical yearbooks, energy balances	Collection of statistical data
Specific energy consumption per 1 m2 of public floor space		
Specific energy consumption for space heating per 1 m2 of residential floor space per degree-day of heat supply season		
Specific hot water consumption per 1 resident with access to centralized DHW supply		
Share of consumers equipped with:		
• Electricity meters		
• Heat meters		
• Natural gas meters		
• Hot water meters		
Energy efficiency regulations in the buildings sector, including:	Regulatory acts, scientific publications	Internet search and personal communications with local experts
• Building codes		
• Energy efficiency requirements in capital retrofits programmes		
• Energy efficiency certification of buildings		
• Energy efficiency standards for appliances		
• Energy efficiency labeling programme for appliances		
• Meters installation requirements		
Other administrative mechanisms to improve energy efficiency in buildings		
Basic energy efficiency market mechanisms and economic incentive programmes in the buildings sector	Regulatory acts on tax credits, loan programs etc. Scientific publications	Internet search, literature search and personal communications with local experts
Government agency(ies) with an energy efficiency policy mandate in the buildings sector	Regulatory acts, statutes of Ministries and agencies	Internet search and personal communications with local experts
Educational programmes	Regulatory acts, scientific publications	Internet search and personal communications with local experts
Buildings energy efficiency policy spending	Regulatory acts, energy efficiency policy monitoring data, scientific publications, estimates	Data on public and other energy efficiency spending in internet, literature search
Transport		
Specific energy consumption per unit of transport service	Statistical yearbooks, energy balances	Statistical data collection
Specific energy consumption per unit of passenger turnover		
Share of light-duty automobiles in the passenger turnover		
Cargo turnover per unit of GDP		
Average fuel consumption per 1 automobile		
Specific energy consumption per unit of cargo turnover		
Fuel efficiency of new light-duty automobiles		
Share of electric and hybrid cars in the automobile park		
Ratio of railroad transport investments to automobile transport investments		

Information required	Source of information	Methods of data collection
Energy efficiency regulations in the transport sector	Regulatory acts, scientific publications	Internet search and personal communications with local experts
Government agency(ies) with an energy efficiency policy mandate in the transport sector	Regulatory acts, statutes of Ministries and agencies	Internet search and personal communications with local experts
Basic administrative mechanisms to improve energy efficiency in the transport sector	Regulatory acts, scientific publications	Internet search and personal communications with local experts
Basic energy efficiency market mechanisms and economic incentive programmes in the transport sector	Regulatory acts on tax credits, loan programs etc., scientific publications	Internet search, literature search and personal communications with local experts
Long-term agreements in the transport sector	Regulatory acts, scientific publications, estimates	Internet and literature search, personal communications with local experts
Transport energy efficiency policy spending	Regulatory acts, energy efficiency policy monitoring data, scientific publications, estimates	Data on public and other energy efficiency spending in internet, literature search

Source: CENEf.

Part of the information on energy efficiency indicators, whenever available, can be presented in formats close to those used to monitor energy efficiency progress in Russia[4] or applied by ODYSSEE MURE project.

Approval of the regulatory base and development of related institutions may face the following possible reactions: digestion (after an adaptation period), rejection, or distortion[5]. These will be traced by the 10 selected countries. "Growth faults" are natural, given such tight regulations development schedule in many countries. It is important that they be quickly revealed and corrected. However, this is exactly the problem in many countries. Foreign experience is good to borrow to develop a regulatory base but there is a need for qualified staff to study this experience and adapt it to the local environment. The availability of qualified staff capable of making correct decisions is the key factor, particularly if regulatory documents are not discussed by the expert community before they are enforced. Problems with policies implementation are often rooted either in poor policy design or in the lack of institutions and/or trained experts who can appropriately implement proposed policies.

As to energy efficiency policy comprehensiveness and implementation monitoring, it is possible to use the format comparing local policies with 25 IEA energy efficiency policy recommendations. It was well tested in the Russian Federation[6]. Such approach allows it to highlight "white spots" on the energy efficiency policy landscape and to identify potential directions for better governance, policy expansion and further development.

[4] For the Russian Federation see: I.A. Bashmakov, V.I. Bashmakov, K.B. Borisov, M.G. Dzedzichek, O.V. Lebedev, A.A. Lunin, A.D. Myshak. Factors behind Russia's GDP energy intensity decline. Energosberezheniye, No. 1–2014. (In Russian).

[5] Ye. Yasin. Institutional limitations to modernization. Voprosy Ekonomiki (Issues of Economy), No. 11, 2011. (In Russian).

[6] See I. Bashmakov and V. Bashmakov. Comparison of current Russia's Energy Efficiency Policies with Those Pursued by Advanced Economies. CENEf. Moscow, 2012.

1.2 Approach used for the evaluation of the energy efficiency potential

The need for future policies largely depends on the energy efficiency improvement potential. The potential is investigated based on both data from the local sources and literature and on CENEf's estimates.

Three definitions of energy efficiency potential were used in this study[7].

Technical (technological) potential is estimated with an assumption that the whole equipment stock in place is overnight replaced with the best available models. In other words, specific energy consumption will immediately go down from the "country average" to the "practical minimum". Technological potential only provides hypothetical energy efficiency opportunities, taking no account of the implementation costs or limitations.

Economic potential is a part of technical potential, which can be cost-effectively implemented using public cost-effectiveness criteria: discount rates, opportunity costs (export price of natural gas), environmental and other indirect effects and externalities, etc. In this study, a 6% discount rate will be used for economic potential assessments. Of all ancillary benefits, at least two may be considered in this study for assessing the economic potentials: indirect energy savings in the energy sector and the price of carbon. It takes time to implement the economic potential. In this study, the economic potential will be estimated with an assumption that the whole equipment stock in place is overnight replaced with the best available economically sound models, no matter how such replacement can be distributed in time accounting for capital stock turnover restrictions or time needed to scale up production of new technologies.

Market potential is a part of economic potential, which can be cost-effectively implemented using private investment decision-making criteria and given the existing market conditions, prices and restrictions. The real market situation determines the availability of technical opportunities, investment and other resources, decision-making rules, practices and criteria. Market potential evaluations do not take into account any indirect energy savings. There are three major lines of delimitation with economic potential: decision-making practices (other things equal, centrally-planned economies always use energy twice or thrice less efficiently, than market economies); discount rates, and energy prices (no opportunity costs or externalities are taken into account in private decision-making, if they are not incorporated in market prices).

Assessments of the economic and market energy saving potentials build on the energy cost curves developed in compliance with specific incremental capital costs. Incremental capital costs are determined as the difference between the costs of installation/procurement of top efficient equipment or building and the relevant costs of medium-efficient equipment or building. Such incremental costs are normally identified for a unit of capacity, product or service and are determined, inter alia, by the capacity size and technology inputs used. Therefore, they are presented as ranges. Representative values from these ranges were used to obtain more accurate cost estmates. Finally, based on the assumptions on the nominal capacity use corresponding energy savings and costs per unit of saved energy were estimated. Eventually, specific costs per unit of energy savings substantially decline, as shown by the learning curves.

Data related to the best available technologies and costs associated with typical measures were taken from a number of available sources, including vendor pricelists; company reports; energy efficiency policy analysis papers and, more specifically, energy cost saving curves development papers (see Annex 1). Depending on the measure, these data have a certain range of values, of which the average was selected. The costs were related to a unit of final energy savings in tons of coal equivalent.

[7] For more information see I. Bashmakov. Resource of energy efficiency in Russia: scale, costs, and benefits. *Energy efficiency*. November 2009, Volume 2, Issue 4, pp 369-386.

For the purpose of determining the economic and market potentials the cost of saved energy (CSE) was assessed using the following formula:[8]

$$CSE = \frac{CRF * Cc + Cop}{ASE} \qquad (1.1),$$

with:

Cc – incremental capital costs of an energy efficiency measure;

Cop – operation cost evolution or additional effects (increased output, improved quality, etc.);

ASE – annual final energy savings;

CRF – cost reduction factor (normative capital cost effectiveness factor), which is calculated by the formula:

$$CRF = \frac{dr}{1-(1+dr)^{-n}} \qquad (1.2),$$

with *dr* – discount rate, and *n* – equipment lifetime.

Additional costs or benefits (Cop) may include annual evolution of operation costs, removal of externalities related to a specific energy efficiency project, etc. The benefits (for example less frequent replacement of light fixtures resulting from longer lifetime of efficient lamps, etc.) are shown in Cop as negative costs.

For each measure, final energy savings were evaluated based on expected application volumes. Ranking these measures by the costs of saved energy allows it to develop an energy saving curve. In order to answer the question, if a technical measure is effective from the economic or market point of view, the cost of saved energy (CSE) is to be compared to the final energy price.

The cost of saved energy depends on the discount rate applied to annualize the capital costs. In this study, 6% discount rate was used to estimate the economic energy efficiency potential and 12% discount rate was used to estimate the market energy efficiency potential. In addition, 20% discount rate was used to reflect stricter budget limitations and a higher cost of money for some energy consumers. Assessment of the economic potential reveals public benefits, and therefore a low (6%) discount rate is used.

This study considers only proven technologies. They are split by the level of efficiency in the following way: "practicaminimum" – the best practically achieved specific energy consumption worldwide with the use of proven technologies; "actual use abroad" – average or the most common specific energy consumption in other countries; "country average" – average specific energy consumption statistically observed and reported for a country. Much of the information on "practical minimum" and "actual use abroad" was borrowed from the most recent literature on energy efficiency potential assessments and on specific technologies. Technical potential assessments were built on comparisons of local energy efficiency indicators with specific energy consumption for BATs (best available technologies) for the same sectors and subsectors, which were collected from multiple international sources[9].

Wherever possible and practicable (based on the available information), an estimate of energy efficiency potential was based on the actual energy efficiencies of energy consuming facilities distribution curves. For such curves all units/facilities will be split into three groups: "green" – most efficient currently operating units/facilities with, or close to, the "practical minimum" specific energy consumption; "yellow" – units/facilities with specific energy consumption above the green zone, but below "actual use abroad", which will be considered acceptable for the first

[8] See Resource of energy efficiency in Russia: scale, costs and benefits, www.cenef.ru.
[9] See Annex 1 for references.

two decades of the XXI century; "red" – all facilities with specific energy consumption above "actual use abroad", which urgently need replacement or upgrade to release the energy efficiency potential. The efficiency potential may then be estimated as a result of "shaving off" the red zone (low range) and both red and yellow zones (high range) of the "inefficiency hills". The potential is also equal to the gap between "practical minimum" minus "country average" multiplied by the scale of given product or service output. However, in many instances, it will be impossible (for statistical and commercial classified information reasons) to obtain country-wide distribution of facilities by their specific energy consumption. In such instances, distribution along specific average energy consumption observed in other countries may be used as a proxy.

While identifying the economic and market potentials, only cost-effective part of the technical potential is taken into account based on the analysis of energy conservation cost curves (when available) built under different assumptions with applied social and private discount rates, given current and expected energy prices. So as to assess the economic viability of energy efficiency options, the costs of saved energy (*CSE*), or the cost of energy efficiency supply will be assessed.

When indirect energy efficiency effects are estimated, transformation is regularly performed for electricity. It should also be done for district heating, and it can be done for any activity in the energy production and transformation sector and even for energy transportation. Following this sequence, the role of indirect energy efficiency effects scales up. The proposed technique[10] is based on the following presentation of the relationship between primary and final energy consumption by sectors: $PE= AE*PE+FE$, or $PE=(E-AE)^{-1}*FE$, with PE – vector of primary or secondary energy production by energy carriers, AE – a square matrix of coefficients of energy carrier *i* consumed in the energy sector (energy production, transformation and transportation) to produce and deliver to end-users one unit of energy carrier *j*, FE – vector of end-use energy consumption by energy carriers. Each a_{ij} coefficient shows, how much coal, petroleum products, gas, electricity and heat is needed to produce and deliver to all end-users one unit of, say, coal. While this approach requires additional data collection and processing, it provides a more correct evaluation of indirect effects. Any change in FE has not only direct, but also tangible and measurable indirect effects on energy demand. And any change in the energy sector technologies leads to the evolution of AE matrix to AE^1, and also produces both direct and indirect effects.

It is important to identify the key persons (both officials and energy efficiency experts) for personal communications and discussion of cooperation perspectives. These were identified through the information search (publications, interviews, etc.) and based on the contacts already established and personal meetings.

With a comprehensive picture of past energy efficiency activities, energy efficiency policy gaps and energy efficiency potential for the 10 countries, 5 countries of the 10 screened economies are to be selected. Country ranking is based on the following seven major criteria:

- Improvements of energy efficiency indicators in the past;
- Energy efficiency policies and policy implementation governance;
- Energy efficiency potential in different sectors;
- Energy efficiency policy gaps; plans to further develop energy efficiency policies; government interest in, and commitment to, the acceleration of energy efficiency activities;
- Need for assistance in energy efficiency improvement and willingness to collaborate with foreign partners, especially from the EC, and experience in being a recipient under assistance programs;

[10] Bashmakov, I.A. Costs and benefits of CO2 emission reduction in Russia (1993). In Costs, Impacts, and Benefits of CO2 Mitigation. Kaya, Y., Nakichenovich, N., Nordhouse, W., Toth, F. Editors. IIASA. June, 1993.

- Institutional structure in place for both effective energy efficiency policies implementation in different sectors and for effective accommodation of foreign energy efficiency assistance;
- Availability of officials and energy efficiency experts who may become contact points for the discussion of potential cooperation.

To have robust base for cross-country energy efficiency activities comparisons and benchmarking a new scoring systems was created. CENEf's scoring system presented below to a certain degree builds on the methodological approach used in "The 2014 International Energy Efficiency Scorecard", but uses it only as a starting point. It better reflects both tasks set for this study and takes into account specific aspects of energy efficiency activities in the 10 countries included in the analysis.

All together, CENEf's rating system builds on 69 metrics split by five scoring blocks: national efforts; power and heat; industry; buildings; transport. Weight is assigned to each indicator, and each metric is estimated according to a special rule. The maximum score is 171. The scoring system proposed by CENEf uses, inter alia, estimates of energy efficiency potential in individual sectors. This is an innovation compared to other rating systems.

There is no deep science behind the assigning of relative weights to each metric. In some instances (for example, when it comes to annual energy efficiency spending), the use of relative numbers is more informative, but no reliable information is available to be used as denominator. These scoring points (weights) were assigned based mostly on expert judgements and available data (Table 1.2). Selection of indicators to a large degree builds on the ACEEE International Energy Efficiency Scorecard system[11] keeping in mind the scarcity of data available for the countries in focus. In many instances, it is not possible to use indicators expressed as a share of, for example, energy efficiency spending, because no information is available on the total for such spending. (Such information is hardly available even for well-developed countries with good statistics). In some cases, existing policies and measures are broken down by very active, active and formal to show that certain policies are poorly implemented. While there is a "very low" ranking in one case, there is no "very high" score, because the quality of energy efficiency statistics in the 10 countries is anything but very high.

Table 1.2. Energy efficiency scoring system for this study

	Maximum score	Scoring points					
		5	4	3	2	1	0
Total score	**171**						
National efforts	**39**						
Average annual change in GDP energy intensity: 2000-2012	5	-10÷-8%	-8÷-6%	-6÷-4%	-4÷-2%	-2÷0%	growth
Energy efficiency legislation	2				Adopted after 2010	Adopted before 2010	No
Energy efficiency regulation (number of acts)	3			Over 10	5-10	1-5	No
Government agencies with an energy efficiency policy mandate	2				Yes		None
Energy prices (electricity)	3			Over 0.1 US$/kWh	0.06-0.1 US$/kWh	0.02-0.06 US$/kWh	Below 0.02 US$/kWh
Mandatory energy-savings or GDP energy intensity reduction goals	2				Active		None

[11] R. Young, S. Hayes, M. Kelly, S. Vaidyanathan, S. Kwatra, R. Cluett, G. Herndon. The 2014 International Energy Efficiency Scorecard. American Council for an Energy-Efficient Economy. July 2014. Report Number E1402.

	Maximum score	Scoring points					
		5	4	3	2	1	0
Basic administrative mechanisms to improve energy efficiency	2				Active	Formal	None
Basic energy efficiency market mechanisms and economic incentive programmes	2				Active	Formal	None
Annual energy efficiency spending	5	Over 300 US$ million	200-300 US$ million	100-200 US$ million	50-100 US$ million	Less than 50 US$ million	None
Energy efficiency research and development spending	1					Some	None
Size of the energy service market	2			Over 200 US$ million	50-100 US$ million	Less than 50 US$ million	None
Water efficiency policy	2				Active	Some	None
International cooperation in energy efficiency	4			Very active	Active	Some	None
Quality of energy use and energy efficiency data	3			High	Medium	Low	Very low
Number of energy efficiency experts included in the database	2				Over 3	1-3	None
Power and heat	**37**						
Power generation efficiency	3			Over 40%	37-40%	33-37%	Below 33%
Power transmission and distribution losses	3			Below 6%	6-10%	10-15%	Over 15%
Heat generation efficiency	3			Over 90%	80-90%	70-80%	Below 70%
Share of CHP in power generation	3			Over 50%	25-50%	10-25%	Below 10%
Heat distribution losses	3			Below 10%	10-15%	15-20%	Over 20%
Energy efficiency potential	5	Over 50%	40-50%	30-40%	20-30%	10-20%	Below 10%
Energy efficiency regulations in heat and power generation and distribution	2				In place		None
Government agencies with an energy efficiency policy mandate in heat and power generation and distribution	2				In place		None
Basic administrative mechanisms to improve energy efficiency in heat and power generation and distribution	2				Active	Some	None
Basic energy efficiency market mechanisms and economic incentive programmes	2				Active	Some	None
Renewables development programmes	2				Active	Some	None
White Certificates market	2				In place		None
Number of projects included in the database	3			5-10	3-5	1-3	None
Number of experts included in the database	2				Over 3	1-3	None

	Maximum score	Scoring points					
		5	4	3	2	1	0
Industry	**30**						
Level of energy efficiency potential	5	Over 50%	40-50%	30-40%	20-30%	10-20%	Below 10%
Energy intensity of basic industrial goods	2				Low	Medium	high
Energy efficiency regulations in the industrial sector	2				Active	Some	None
Government agencies with an energy efficiency policy mandate in the industrial sector	2				Active		None
Basic administrative mechanisms to improve energy efficiency in the industrial sector	2				Active	Some	None
Long-term agreements	2				Active		None
Energy management systems	2				Active		None
Mandate for plant energy managers	2				Active		None
Mandatory energy audits	2				Active		None
Basic energy efficiency market mechanisms and economic incentive programmes	2				Active		None
Industrial energy efficiency policy spending	2				Over 30 US$ million	Less than 30 US$ million	None
Number of projects in the database	3			5-10	3-5	1-3	None
Number of experts in the database	2				3-5	1-3	None
Buildings	**40**						
Total specific energy consumption per 1 m^2 of residential floor space (energy intensity in residential buildings)	3			Below 100 kWh/m^2	100-200 kWh/m^2	200-300 kWh/m^2	Over 300 kWh/m^2
Specific energy consumption per 1 m^2 of public floor space	2				Below 100 kWh/m^2	100-300 kWh/m^2	Over 300 kWh/m^2
Specific energy consumption for space heating per 1 m^2 of residential floor space	2				Below 50 kWh/m^2	50-150 kWh/m^2	Over 150 kWh/m^2
Specific hot water consumption per resident with access to centralized domestic hot water (DHW) supply	2				Below 20 kWh/m^2	20- 40 kWh/m^2	Over 40 kWh/m^2
Level of energy efficiency potential	5	Over 50%	40-50%	30-40%	20-30%	10-20%	Below 10%
Share of consumers equipped with heat or gas meters	3			Over 70%	50-70%	30-50%	Below 30%
Building codes requirements	2				Adopted after 2010	Adopted before 2010	None
EE building certification & labeling	2				Active		None
Other administrative mechanisms to promote energy efficiency	2				Active	Some	None
Appliances and equipment standards	2				Adopted after 2010	Adopted before 2010	No
Appliances and equipment certification & labeling	2				Mandatory	Voluntary	None
Buildings retrofits policies	2				active	some	None

	Maximum score	Scoring points					
		5	4	3	2	1	0
Basic energy efficiency market mechanisms and economic incentive programmes in the buildings sector	2				active	some	None
Government agencies with an energy efficiency policy mandate in the buildings sector	2				Active		None
Information and educational programmes	2				Active	Some	None
Number of projects in the database	3			5-10	3-5	1-3	None
Number of experts in the database	2				Over 3	1-3	None
Transport	**25**						
Level of energy efficiency potential	5	Over 50%	40-50%	30-40%	20-30%	10-20%	Below 10%
Government agencies with an energy efficiency policy mandate in the transport sector	2				Active		None
Share of automobile transport in freight turnover	2				Below 5%	5-25%	over 25%
Basic administrative mechanisms to improve energy efficiency in the transport sector	2				Active	Some	None
Basic energy efficiency market mechanisms and economic incentive programmes in the transport sector	2				Active	Some	None
Fuel efficiency standards for light-duty vehicles	2				Active		None
Fuel efficiency standards for heavy-duty vehicles	2				Active		None
Use of public transit per person (kpass-km/person)	3			Over 10	4-10	2-4	Below 2
Number of projects in the database	3			5-10	3-5	1-3	None
Number of experts in the database	2				3-5	1-3	None

Source: CENEf

Another problem deals with the quality and comprehensiveness of data used in the scoring system. The 10 focus countries do not publish national reports with the results of energy efficiency activities, so many of the metrics are based on the expert information collected by CENEf from a variety of sources as presented in Sections 2-13. As the quality of this information needs improvement, the country rating results are to be used with caution, keeping in mind both the weaknesses of the potential rating system and the quality of data used, which is far from perfect.

This comment also goes for GDP energy intensity estimates and their dynamics, which basically relies on the IEA energy balances data. However, as shown in many sections below, practically for none of the 10 countries energy balance data provided by IEA are reliable. This undermines the quality of both absolute values and dynamics of GDP energy intensity estimates.

Some indicators, such as government agencies with an energy efficiency policy mandate, or basic administrative mechanisms to improve energy efficiency, or basic energy efficiency market mechanisms and economic incentive programmes, are quite formal. Such agencies may work actively or formally, effectively or with no real impact. At this stage, proposed indicators are weak in reflecting the real importance of government institutions or mechanisms to improve energy efficiency. To some extent it is related to the real theoretical and practical difficulty in identifying the real impact, but also to a tight project schedule that did not allow for more careful looking into the actual policy and institutional impacts.

In addition, the rating builds on the energy efficiency potentials: technical, economic, and market, and shows the potential scale of energy savings.

Below the basic results of the rating are presented as a total across all sectors and for each individual sector.

1.3 Total rating

The total rating results obtained using 69 metrics proposed in CENEf's rating system are shown in Table 1.3 and Figure 1.1.

Table 1.3 Energy efficiency rating of 10 countries (as of 2012-2014)

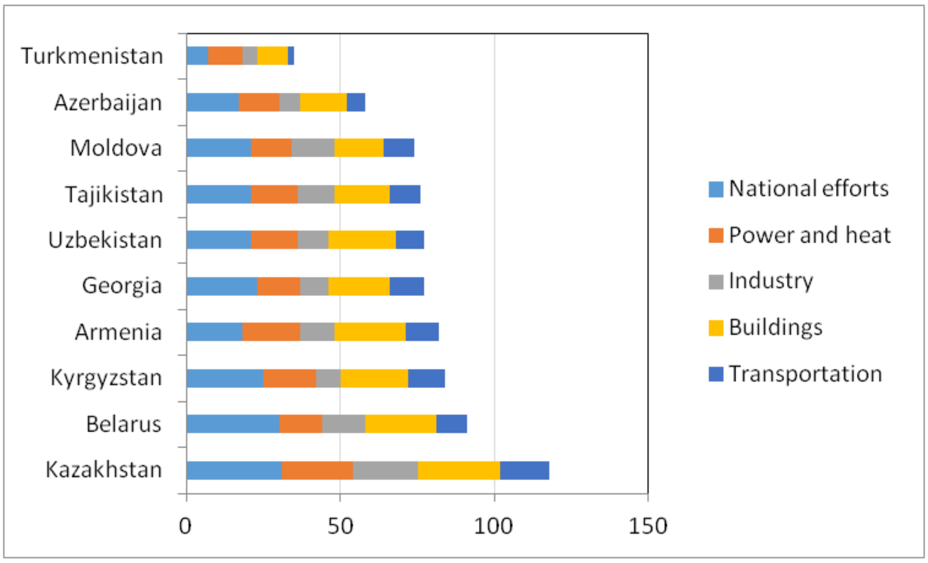
	Maximum possible score	Armenia	Azerbaijan	Belarus	Georgia	Kazakhstan	Kyrgyzstan	Moldova	Tajikistan	Turkmenistan	Uzbekistan
Total score	**171**	**82**	**58**	**91**	**77**	**118**	**84**	**74**	**76**	**35**	**77**
National efforts	**39**	**18**	**17**	**30**	**23**	**31**	**25**	**21**	**21**	**7**	**21**
Change in GDP energy intensity	5	2	5	3	2	1	1	2	3	0	3
Energy efficiency legislation	2	1	1	2	2	2	2	2	2	1	1
Energy efficiency regulations (number of acts)	3	2	0	3	2	3	2	1	1	1	2
Government agencies with an energy efficiency policy mandate	2	2	2	2	2	2	2	2	2	0	2
Energy prices	3	2	2	3	2	2	2	2	1	0	2
Mandatory energysaving or GDP energy intensity reduction goals	2	2	0	2	2	2	2	2	0	0	0
Basic administrative mechanisms to improve energy efficiency	2	1	1	3	1	2	2	1	1	0	1
Basic energy efficiency market mechanisms and economic incentive programmes	2	1	0	2	1	2	2	1	1	0	1
Annual energy efficiency spending	5	0	1	2	1	5	1	1	1	0	1
Energy efficiency research and development spending	1	0	1	1	0	0	0	0	0	0	0
Scale of the energy service market	2	0	0	2	0	0	1	0	0	0	0
Water efficiency policy	2	2	1	1	2	2	2	2	2	2	2
International cooperation in energy efficiency	3	2	1	0	4	4	3	3	4	1	3
Quality of energy use and energy efficiency data	3	0	1	2	1	2	2	1	1	1	1
Number of experts	2	1	1	2	1	2	1	1	2	1	2
Power and heat	**37**	**19**	**13**	**14**	**14**	**23**	**17**	**13**	**15**	**11**	**15**
Power generation efficiency	3	3	2	3	1	1	1	1	0	0	0
Power transmission and distribution losses	3	0	0	2	0	1	0	1	1	0	1
Heat generation efficiency	3	0	0	1	0	1	0	1	1	0	1
Share of CHP in power generation	3	2	2	3	1	2	3	1	0	3	0
Heat distribution losses	3	0	2	3	0	2	0	0	1	2	0
Energy effciency potential	5	1	2	2	3	2	2	1	1	4	4
Energy efficiency regulations in heat and power generation and distribution	2	2	0	2	0	2	2	0	0	0	0
Government agencies with an energy efficiency policy mandate in heat and power generation and distribution	2	2	0	2	2	2	2	2	2	0	2

	Maximum possible score	Armenia	Azerbaijan	Belarus	Georgia	Kazakhstan	Kyrgyzstan	Moldova	Tajikistan	Turkmenistan	Uzbekistan
Basic administrative mechanisms to improve energy efficiency in heat and power generation and distribution	2	2	0	2	0	2	0	1	1	0	1
Basic energy efficiency market mechanisms and economic incentive programmes	2	1	1	1	1	2	1	1	1	0	1
Renewables development programmes	2	2	2	2	2	2	2	1	2	1	1
White Certificates market	2	0	0	0	0	0	0	0	0	0	0
Number of projects	3	2	1	3	2	2	2	2	3	1	2
Number of experts	2	2	1	2	2	2	2	1	2	0	2
Industry	**30**	**11**	**7**	**14**	**9**	**21**	**8**	**14**	**12**	**5**	**10**
Energy effciency potential	5	3	4	3	4	3	3	4	3	4	4
Energy intensity of basic industrial goods	2	0	0	1	0	1	0	0	0	1	0
Energy efficiency regulations in the industrial sector	2	1	0	2	0	2	0	1	1	0	0
Government agencies with an energy efficiency policy mandate in the industrial sector	2	2	1	2	1	2	1	2	2	0	2
Basic administrative mechanisms to improve energy efficiency in the industrial sector	2	1	1	2	0	2	0	1	1	0	0
Long-term agreements	2	0	0	0	0	2	0	0	1	0	0
Energy management systems	2	0	0	0	0	0	0	0	0	0	0
Mandate for plant energy managers	2	0	0	0	0	0	0	0	0	0	0
Mandatory energy audits	2	2	0	2	1	2	1	2	0	0	0
Basic energy efficiency market mechanisms and economic incentive programmes	2	2	0	0	0	2	1	1	1	0	1
Industrial energy efficiency policy spending	2	0	0	0	1	1	0	1	1	0	1
Number of projects	3	0	0	1	1	2	1	1	1	0	1
Number of experts	2	0	1	1	1	2	1	1	1	0	1
Buildings	**40**	**23**	**15**	**23**	**20**	**27**	**22**	**16**	**18**	**10**	**22**
Specific energy consumption per 1 m^2 of residential floor space (energy intensity in residential buildings)	3	2	1	2	2	1	1	1	1	2	1
Specific energy consumption per 1 m^2 of public floor space	2	1	1	1	1	1	1	1	1	1	1
Specific energy consumption for space heating per 1 m^2 of residential floor space per degree-day of heat supply season	2	1	1	1	0	0	0	0	0	1	0
Specific hot water consumption per resident with access to centralized DHW supply	2	0	0	0	0	0	0	0	0	1	0
Energy efficiency potential	5	5	5	3	5	5	5	5	5	3	5
Share of consumers equipped with energy meters	3	3	0	0	2	3	1	1	1	0	3
Building codes requirements	2	0	1	2	1	2	2	1	1	0	2
Building labeling	2	0	0	0	0	0	0	0	0	0	0
Other administrative mechanisms to promote energy efficiency	2	1	0	0	0	2	1	1	1	0	1
Appliances and equipment standards	2	0	0	2	0	2	2	0	0	0	0

	Maximum possible score	Armenia	Azerbaijan	Belarus	Georgia	Kazakhstan	Kyrgyzstan	Moldova	Tajikistan	Turkmenistan	Uzbekistan
Appliances and equipment labeling	2	1	0	2	0	2	2	0	0	0	0
Buildings retrofits policies	2	0	0	2	0	1	0	0	0	0	
Basic energy efficiency market mechanisms and economic incentive programmes in the buildings sector	2	1	1	1	1	1	1	1	1	0	1
Government agencies with an energy efficiency policy mandate in the buildings sector	2	2	0	2	2	2	2	1	2	0	2
Information and educational programmes	2	1	1	2	2	1	1	1	1	0	2
Number of projects	3	3	3	2	2	2	2	2	2	1	2
Number of experts	2	2	1	1	2	2	1	1	2	1	2
Transport	**25**	**11**	**6**	**10**	**11**	**16**	**12**	**10**	**10**	**2**	**9**
Energy efficiency potential	5	5	3	5	5	5	5	5	5	1	5
Government agencies with an energy efficiency policy mandate in the transport sector	2	2	0	2	2	2	2	2	2	0	2
Share of automobile transport in freight turnover	2	1	1	2	1	0	0	0	0	0	0
Basic administrative mechanisms to improve energy efficiency in the transport sector	2	1	1	1	0	1	1	1	1	1	0
Basic energy efficiency market mechanisms and economic incentive programmes in the transport sector	2	1	0	0	0	1	1	1	1	0	0
Fuel efficiency standards for light-duty vehicles	2	0	0	0	0	0	0	0	0	0	0
Fuel efficiency standards for heavy-duty vehicles	2	0	0	0	0	0	0	0	0	0	0
Use of public transit	3	1	1	0	1	3	1	0	0	0	1
Number of projects	3	0	0	0	1	2	1	0	0	0	0
Number of experts	2	0	0	0	1	2	1	1	1	0	1

Source: CENEf

Figure 1.1 Energy efficiency rating of 10 countries (as of 2012-2014)



Source: CENEf

With 118 points out of 171 possible, Kazakhstan takes the lead followed by Belarus (91), Kyrgyzstan (84), Armenia (82), Georgia (77), Uzbekistan (77), Tajikistan (76), Moldova (74), Azerbaijan (58), and Turkmenistan (35). Given the conditionality or the chosen scoring system, the 10 countries may be broken down into three groups: champions (Kazakhstan and Belarus); the middle group (Kyrgyzstan, Armenia, Georgia, Uzbekistan, Tajikistan, and Moldova), and underperformers (Azerbaijan and Turkmenistan).

While the comparative scoring within the groups may be not very informative (real activities may be more effective, than purely formal mentioning), the division by groups seems very logical and robust. Judgment based on the life experience is that the top two countries are real energy efficiency champions among the 10 economies.

The last group is formed also quite logically: both Azerbaijan and Turkmenistan are rich in fossil fuel resources and therefore do not see energy efficiency as a priority. Turkmenistan provides very cheap energy, which gives a poor motivation for consumers to use it effectively.

The middle group includes 6 countries that are relatively close in scoring (74-84 points), all engaged in multiple energy efficiency activities, yet not intensely enough to be promoted to the champions. The ranking of these 6 countries within the group is not necessarily correct.

We can suggest *three possible interpretations* of the rating results. First, the country with the maximum score has a large energy efficiency potential, legislation and regulations, institutions, experts, data, experience in international cooperation. All this would make it the easiest to work with for the purpose of further acceleration of the energy efficiency progress. As the scores of Georgia and Uzbekistan are the same, the first six (not five) countries are: **Kazakhstan, Belarus, Kyrgyzstan, Armenia, Georgia and Uzbekistan.**

Second, the country with the minimum score really lacks momentum and resources needed to spur (or even launch) energy efficiency activities and for this very reason needs assistance from experienced countries to push it along the energy efficiency pathway. As the scores of Georgia and Uzbekistan are the same, the first six (not five) countries are: **Georgia, Uzbekistan, Tajikistan, Moldova, Azerbaijan, and Turkmenistan.**

Third, countries that are neither champions, nor outsiders in energy efficiency have a good potential for energy efficiency improvement and a soil that can accept seeds of change. There is already some experience, some progress, some institutions, yet much needs to be done, and there is a will to increase energy efficiency activities. These six countries belong to the middle group and include: **Armenia, Georgia, Kyrgyzstan, Moldova, Tajikistan, and Uzbekistan.**

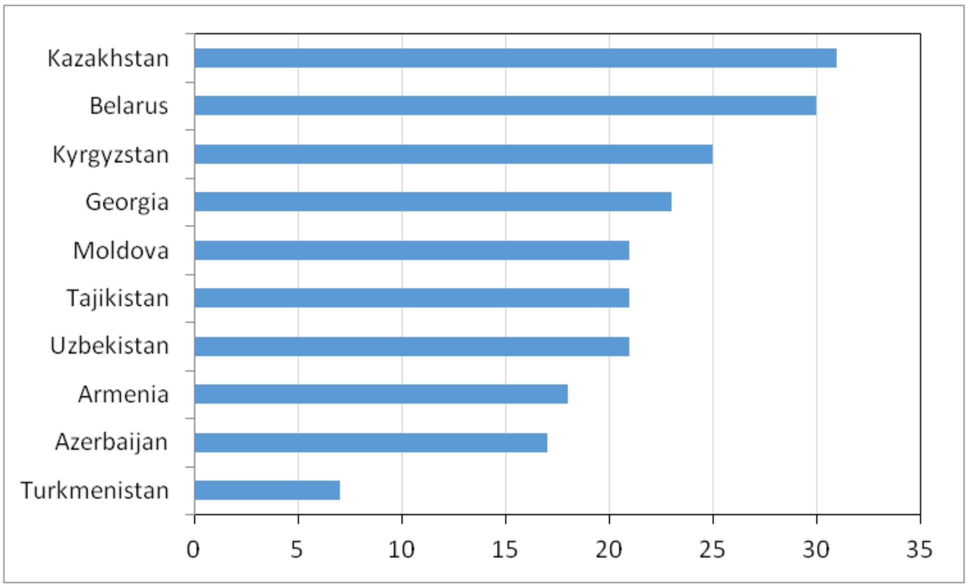
Two countries, namely **Georgia and Uzbekistan**, fit all the three approaches.

In addition to the total scoring, a rating by individual segments is presented below as well. It may be interesting to study in the case only policies in specific sectors are to become the focus for energy efficiency cooperation.

1.4 National level efforts

National level scoring is very much in line with the above country groups, leaving Kazakhstan and Belarus in the champion group and Azerbaijan and Turkmenistan in the underperforming group (Fig. 1.2). However, the last one may be supplemented by Armenia.

Figure 1.2. National efforts. Energy efficiency rating of 10 countries (as of 2012-2014)

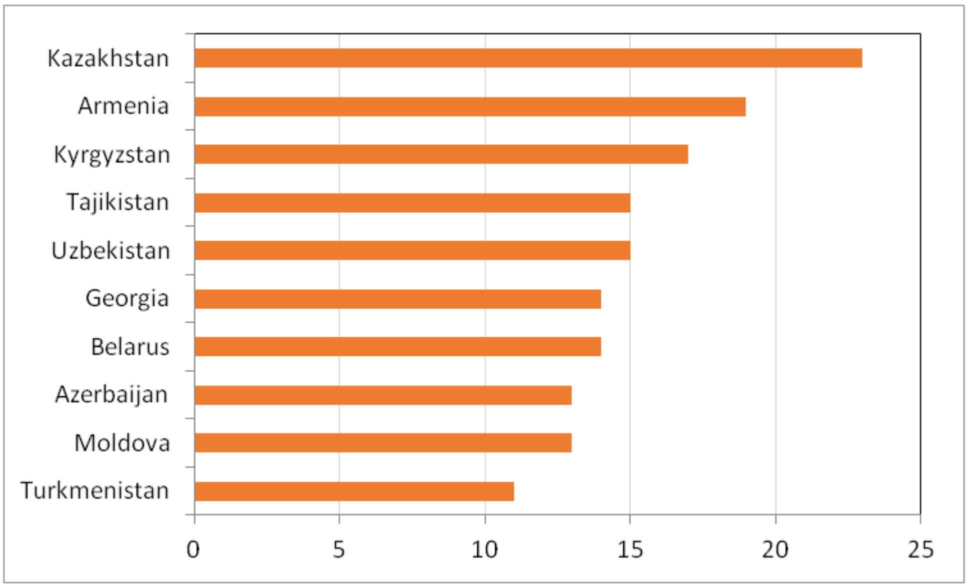


Source: CENEf

1.5 Power and heat

Power and heat generation score puts Kazakhstan, Armenia and Kyrgyzstan to the forefront. The underperforming group still includes Turkmenistan, while the rest 6 countries fall in the middle group (Fig. 1.3).

Figure 1.3. Heat and Power. Energy efficiency rating of 10 countries (as of 2012-2014)

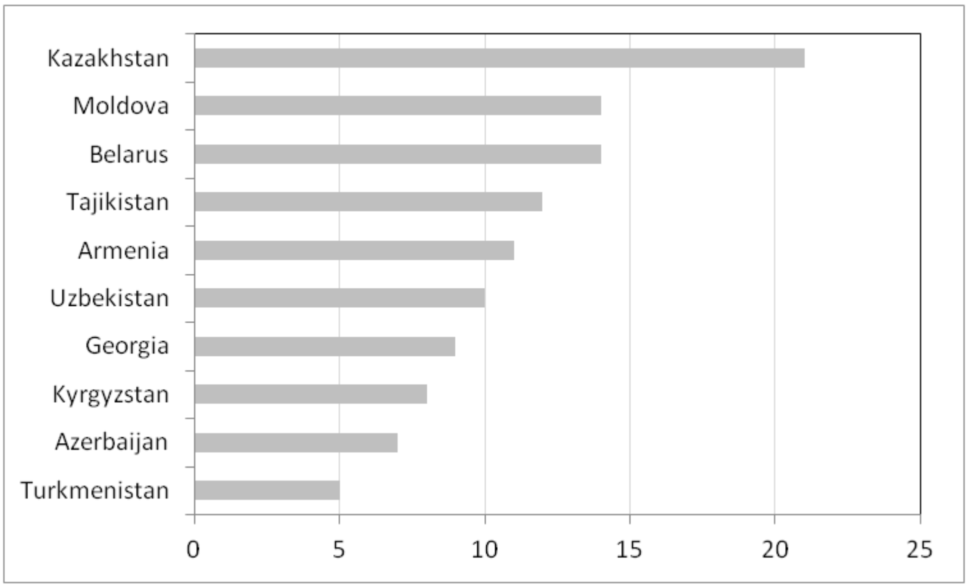


Source: CENEf

1.6 Industry

In industrial energy efficiency activities and progress scoring, Kazakhstan and Belarus are still ahead of the other countries, yet Moldova is very close to Belarus (Fig. 1.4). Azerbaijan, Turkmenistan, and Kyrgyzstan are underperformers.

Figure 1.4. Industry. Energy efficiency rating of 10 countries (as of 2012-2014)

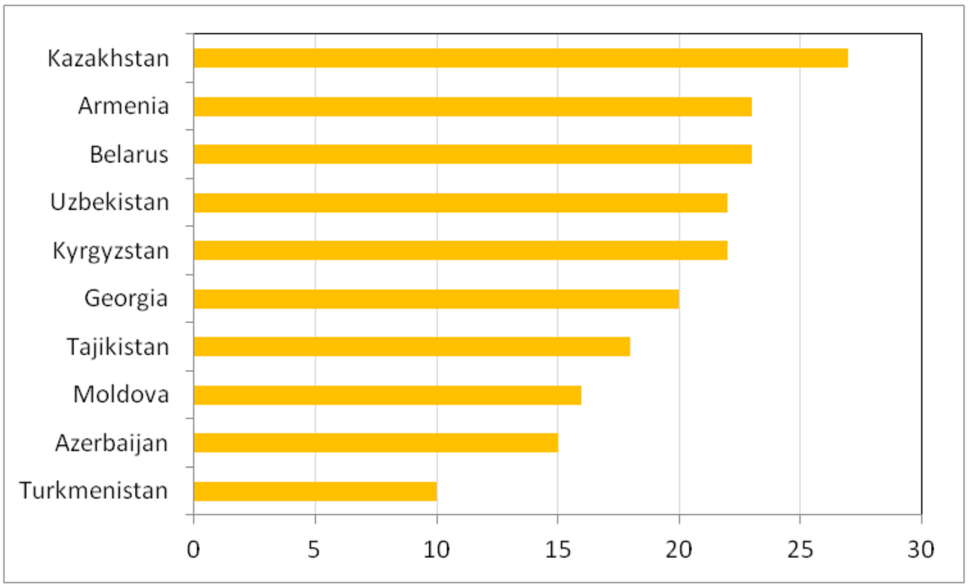


Source: CENEf

1.7 Buildings

Energy efficiency rating in buildings substantially expands the first group to include Belarus, Armenia, Uzbekistan and Kyrgyzstan (Fig. 1.5). The underperforming group (lagging much behind the leaders) shrinks to just one country – Turkmenistan.

Figure 1.5. Buildings. Energy efficiency rating of 10 countries (as of 2012-2014)

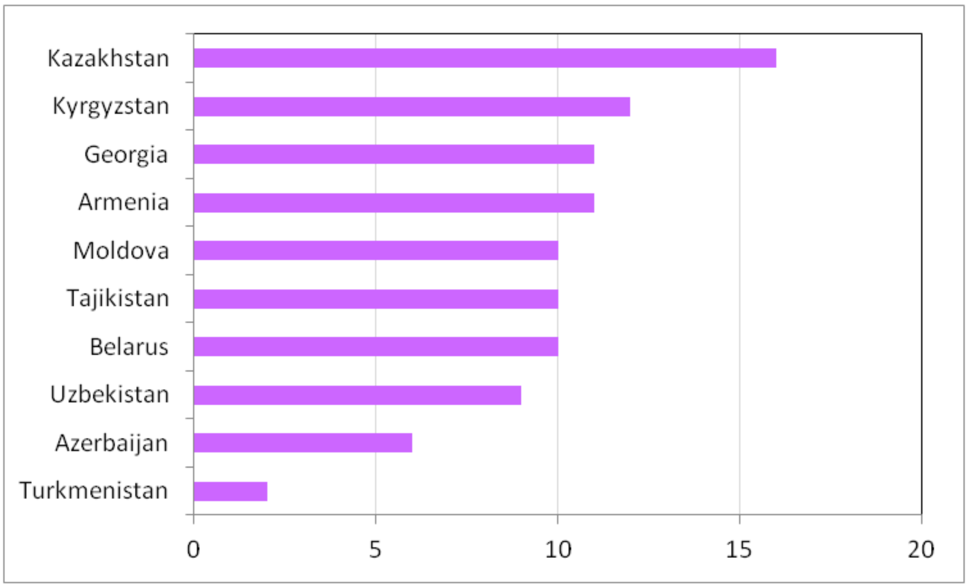


Source: CENEf

1.8 Transport

Scoring in transport energy efficiency is the least reliable due to poor data quality. Kazakhstan stands alone in the champion group, while Turkmenistan and Azerbaijan are the underperformers (Fig. 1.6).

Figure 1.6. Transport. Energy efficiency rating of 10 countries (as of 2012-2014)



Source: CENEf

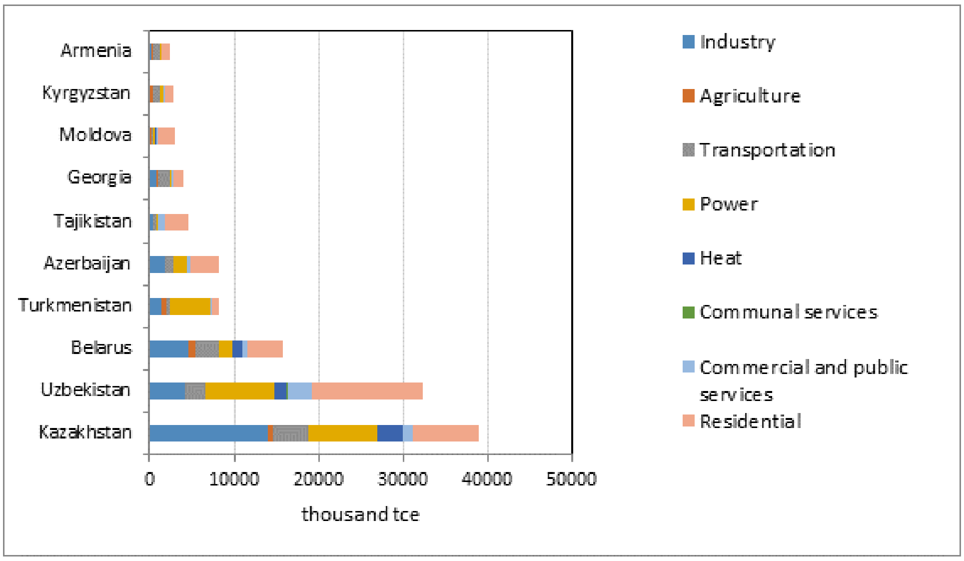
Sector-based scoring keeps the findings formulated for the total rating valid, and confirms the correctness of country grouping by their energy efficiency progress and activities.

1.9 Energy efficiency potentials

Energy efficiency potentials show a country's attractiveness in terms of potential energy savings if more and better policies are used, and those already launched become more effective. No potentials evaluations take account of any indirect energy savings.

If the countries are ranked by the scale of technical energy efficiency potential, then the first five countries are: Kazakhstan, Uzbekistan, Belarus, Turkmenistan, and Azerbaidjan (Fig. 1.7).

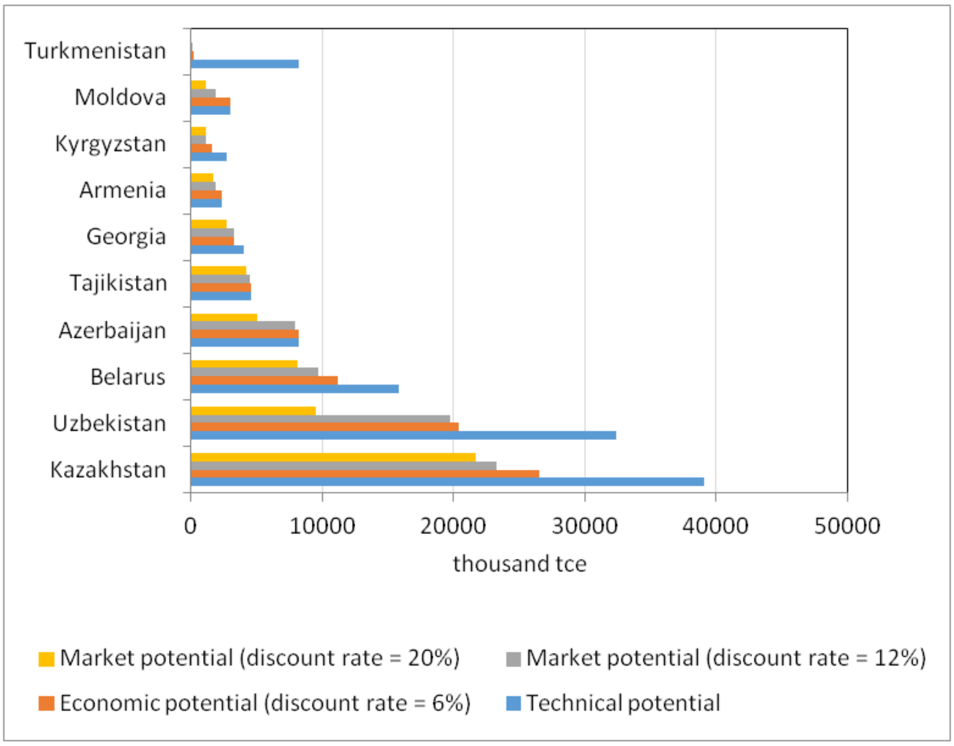
Figure 1.7. Technical energy efficiency potential by sectors



Source: CENEf

When economic and market potentials are used as ranking criteria, Turkmenistan with its very low energy prices has the lowest potential, and the five leading countries are: Kazakhstan, Uzbekistan, Belarus, Tajikistan, and Georgia.

Figure 1.8. Technical, economic and market energy efficiency potentials



Source: CENEf

1.10 Final list of countries for international cooperation in energy efficiency

The four above approaches were used to identify five countries for further productive international cooperation in energy efficiency:

- First: countries with the maximum scores have large energy efficiency improvement potentials, legislation and regulations, institutions, experts, data, and experience in international cooperation: **Kazakhstan, Belarus, Kyrgyzstan, Armenia, Georgia and Uzbekistan;**
- Second: countries with the minimum scores that really lack momentum and resources needed to spur (or even launch) energy efficiency activities and for this very reason need more assistance from experienced countries to push them along the energy efficiency pathway: **Georgia, Uzbekistan, Tajikistan, Moldova, Azerbaijan, and Turkmenistan;**
- Third: countries which are neither leaders nor outsiders in energy efficiency, have a good potential for enhancing energy efficiency activities and a soil ready to accept seeds of change: **Armenia, Georgia, Kyrgyzstan, Moldova, Tajikistan, and Uzbekistan;**
- Fourth: countries with the largest market energy efficiency potentials: **Kazakhstan, Uzbekistan, Belarus, Tajikistan, and Georgia.**

With the multi-criteria approach to selection, the rank is attributed according to the number of times a country is listed in the four above criteria. The highest score (4) is then for Uzbekistan and Georgia, followed by Tajikistan (3). There are several countries with the score 2 (Kazakhstan, Belarus, Kyrgyzstan, Armenia, and Moldova), of which 2 more countries are to be selected. There is no perfect selection method, so based on the information presented by the Center for Energy Efficiency (CENEf) in this report, Copenhagen Centre on Energy Efficiency (C2E2) will have to make a final selection.

Section 2. Economies in transition: champions in GDP energy intensity decline. Retrospective (2000-2013) analysis

Generally speaking, the efficiency of energy use on the national scale may be measured by a variety of indices:

- **energy productivity:** GDP per unit of energy used;
- **GDP energy intensity:** energy consumption per unit of GDP;
- **energy efficiency index:** specially computed complex index that shows energy intensity evolution determined only by technology-based specific energy consumption or by efficiency improvements in different sectors, net of the contribution of structural shifts. Sometimes it is called real energy intensity index[12].

GDP energy intensity is most widely used, although energy productivity, similar to labor productivity, is more adequate, because it is an efficiency indicator, while intensity shows a reverse proportion. Energy efficiency improvement is accompanied by GDP energy intensity reduction and energy productivity growth.

This section presents an analysis of GDP energy intensity dynamics over the past two decades in 10 transition economies: Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Moldova, Tajikistan, Turkmenistan, and Uzbekistan. GDP energy intensity evolution reflects the impacts of many factors: improved technology (use of new equipment; upgrading the existing or phasing-out obsolete equipment); growing capacity load; structural shifts in the entire economy and/or in individual sectors (growing share of less energy intense economic activities due to their faster development). Structural shifts in the economy and capacity load dynamics can reflect either improving economic structure (shift to less energy intensive activities), or manufacturing process management, or business cycle dynamics. Therefore, GDP energy intensity is an informative indicator, but has multiple limitations where the task is to assess energy efficiency driven by technical improvements.

A variety of energy efficiency indices are used in many countries to isolate the impacts of technical and technology factors on the energy intensity evolution. Being relatively complicated to calculate and demanding much additional information, energy efficiency index is used much more rarely, than GDP energy intensity; however it more accurately reflects the contribution of the technology factor. Energy efficiency accounting systems of many countries and groups of countries (IEA, European Union, the U.S., Canada, Australia, New Zealand, Singapore, Russia, etc.) measure energy efficiency progress using different modifications of the energy efficiency index. To date, none of the 10 transition economies in question have developed an energy efficiency accounting system. Just a few months ago such system was developed for the Russian Federation. Therefore, GDP energy intensity is the only available indicator for national energy efficiency comparison.

In order to avoid problems related to GDP and total primary energy use data comparability, IEA dataset is used for GDP energy intensity analysis. Data on total primary energy supply (TPES) in the national statistics sometimes differ from those provided by IEA. All the nuances are reflected in the country chapters. In general, IEA statistics is often incomplete. It does not appropriately

[12] I. Bashmakov, A. Myshak. Russian energy efficiency accounting system. Energy Efficiency (2014) 7:743-759; Ang, B.W., Choi, K.H. (2012). Attribution of changes in Divisia real energy intensity index – an extension of index decomposition analysis. Energy Economics, 34(2012), 171–176.

cover: (a) district heating, and (b) traditional fuels, and to different extents underestimates energy use in all the 10 countries. Therefore, TPES data need much improvement and so GDP energy intensities are not perfectly comparable.

Selecting appropriate GDP metric is also a challenge. At first, GDP in US$ was taken using market exchange rates (MER) for conversion from local currencies, but then GDP presented in PPP was selected for the purpose of comparing GDP energy intensities and exploring their relative values and evolution in 1990-2012.

If market exchange rates are used to estimate GDP, then, as shown in Table 2.1, GDP MER energy intensity in 9 countries is above the global average, but the gap narrows (Fig. 2.1). Back in 1990, GDP energy intensity in all these countries was at least 4 times the global average, and in some of them the gap was close to the order of magnitude. In 1990-2012, GDP energy intensity was steadily approaching the global average, but the gap is still there. For Turkmenistan the gap is more than 6-fold.

Table 2.1 Evolution of GDP MER energy intensity (toe per thousand 2005 US$ market rates)

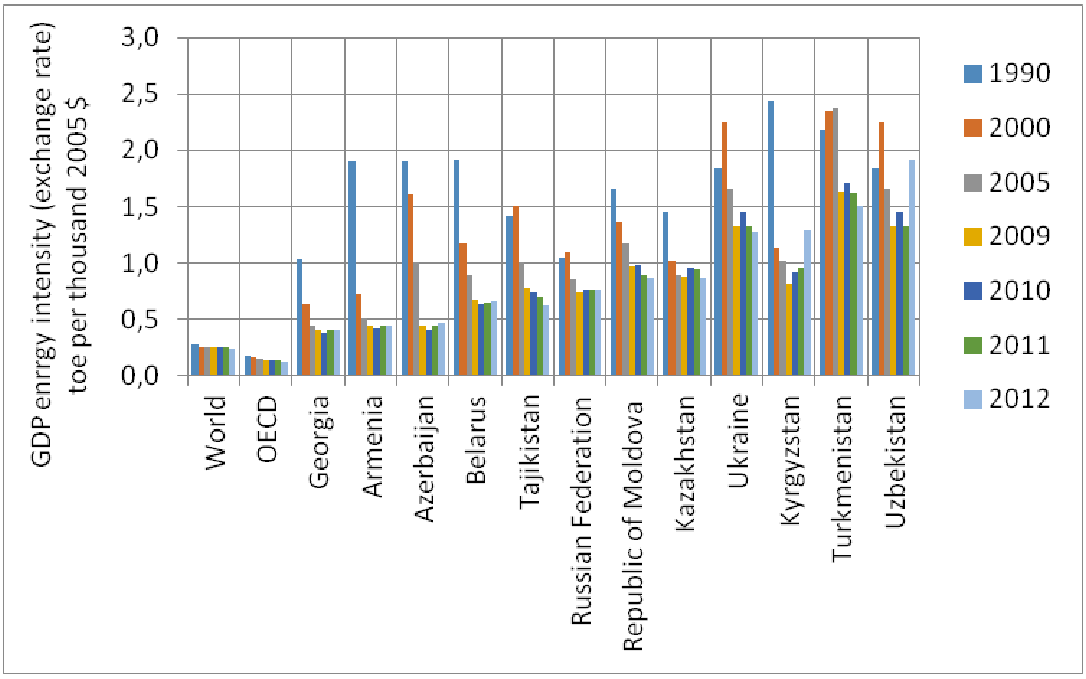
	1990	2000	2005	2009	2010	2011	2012
Armenia	1.9	0.73	0.51	0.45	0.42	0.44	0.45
Azerbaijan	1.9	1.61	1.01	0.44	0.41	0.44	0.47
Belarus	1.92	1.17	0.89	0.67	0.64	0.65	0.66
Georgia	1.03	0.64	0.44	0.4	0.38	0.40	0.40
Moldova	1.66	1.36	1.17	0.97	0.98	0.89	0.86
Kazakhstan	1.46	1.02	0.89	0.88	0.96	0.94	0.86
Kyrgyzstan	2.44	1.13	1.02	0.81	0.92	0.96	1.29
Tajikistan	1.42	1.5	1.01	0.78	0.74	0.7	0.62
Turkmenistan	2.18	2.35	2.37	1.63	1.71	1.62	1.51
Uzbekistan	1.84	2.25	1.66	1.32	1.46	1.33	1.92
World	**0.28**	**0.25**	**0.25**	**0.25**	**0.25**	**0.25**	**0.24**
Russian Federation	1.04	1.09	0.85	0.74	0.77	0.77	0.77
Ukraine	1.84	2.25	1.66	1.32	1.46	1.33	1.28
OECD	0.18	0.16	0.15	0.14	0.14	0.14	0.13

Source: Energy balances of non-OECD countries. 2013 Edition. IEA. 2013. http://www.iea.org/

It is a generally accepted vision, that GDP in PPP is more suitable for a cross-country analysis for countries with large segments of non-traded economy. This is not always true. With GDP expressed in PPP, the picture changes (Table 2.2). Back in 1990, the gap with the global energy intensity was much smaller, varying between 42% for Tajikistan and 4.7-fold for Uzbekistan; and in 2012 GDP (PPP) energy intensities in four countries (Armenia, Azerbaijan, Georgia, and Tajikistan) were below the global average, and Azerbaijan nearly approached the OECD average. Thus, some of the 10 economies are no longer on the list of least energy efficient countries of the world.

The rate at which these economies were converging with the rest of the world in energy intensity decline is unprecedented. Many of these 10 countries are nearly the world champions in GDP energy intensity decline. In most of them (except Kyrgyzstan and Kazakhstan) average rates of GDP energy intensity decline in 2000-2012 were around or higher than 4% per year, which is more than 3 times the global rate and at least two times the OECD rate. Kyrgyzstan came second among the countries with the highest rate of energy intensity decline in 1990-2000, but then returned to the GDP energy intensity growth pathway in 2009. After 2009, GDP energy intensity decline slowed down or even started growing in many countries (Fig. 2.1).

Figure 2.1 Evolution of GDP MER energy intensity



Source: Energy balances of non-OECD countries. 2013 Edition. IEA. 2013. http://www.iea.org/

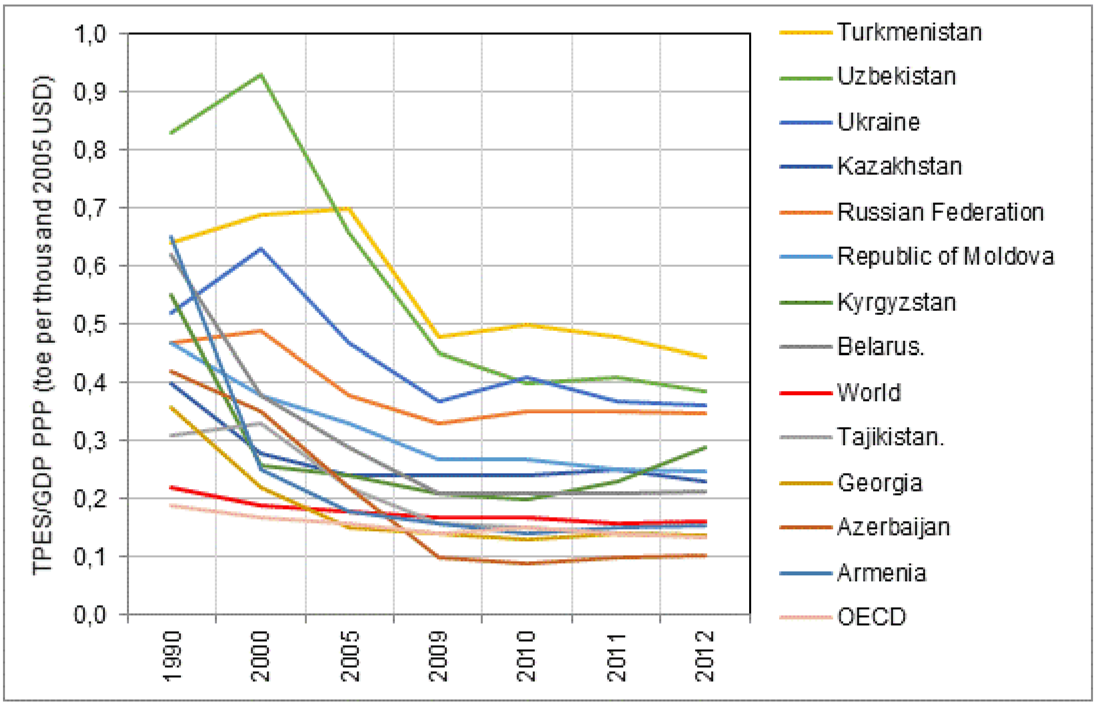
Table 2.2 Evolution of GDP PPP energy intensity (toe per thousand 2005 US$, PPP), GDP and population

	1990	2000	2005	2009	2010	2011	2012	GDP PPP (2012) bln$05	POP (2012) mln
Armenia	0.65	0.25	0.18	0.16	0.14	0.15	0.15	19.30	2.97
Azerbaijan	0.42	0.35	0.22	0.10	0.09	0.10	0.10	131.65	9.30
Belarus	0.62	0.38	0.29	0.21	0.21	0.21	0.21	142.31	9.46
Georgia	0.36	0.22	0.15	0.14	0.13	0.14	0.14	26.78	4.49
Kazakhstan	0.40	0.28	0.24	0.24	0.24	0.25	0.23	321.89	16.79
Kyrgyzstan	0.55	0.26	0.24	0.21	0.20	0.23	0.29	14.23	5.61
Moldova	0.47	0.38	0.33	0.27	0.27	0.25	0.25	13.16	3.56
Tajikistan	0.31	0.33	0.22	0.16	0.15	0.14	0.14	16.57	8.01
Turkmenistan	0.64	0.69	0.70	0.48	0.50	0.48	0.45	57.45	5.17
Uzbekistan	0.83	0.93	0.66	0.45	0.40	0.41	0.39	124.86	29.78
World	**0.22**	**0.19**	**0.18**	**0.17**	**0.17**	**0.16**	**0.16**	**82900.58**	**7037.07**
Russia	0.47	0.49	0.38	0.33	0.35	0.35	0.35	2178.44	143.53
Ukraine	0.52	0.63	0.47	0.37	0.41	0.37	0.36	338.64	45.59
OECD	0.19	0.17	0.16	0.14	0.15	0.14	0.13	39202.41	1254.26

Source: Energy balances of non-OECD countries. 2013 Edition. IEA. 2013. http://www.iea.org/

The whole 1990-2012 timeframe, for which the required data are available, may be split into three periods: 1990-2000 – mostly declining phase of economic development (shorter in some countries, longer in the others); 2000-2009 – economic recovery driven mostly by loading idle capacities that were built back in the Soviet era and only partly by new investments; and 2009-2012 – slower and uneven economic growth affected by the global economic crisis, with slowing down energy intensity decline. As Fig. 2.3 shows, these three periods were characterized by quite variable relationships between GDP growth and GDP energy intensity decline.

Figure 2.1 The 10 countries' GDP PPP energy intensities converging with the global average (toe per thousand 2005 US$, PPP)



Source: Energy balances of non-OECD countries. 2013 Edition. IEA. 2013. http://www.iea.org/

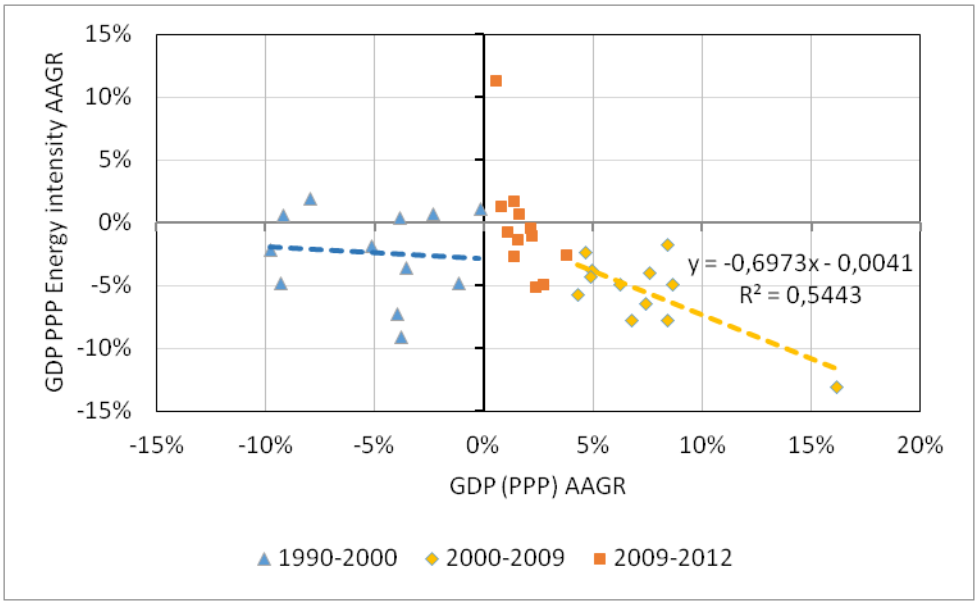
Dramatic economic recession that dominated in the 1990's was either driving GDP energy intensity up, or slowing down its decline, through structural changes in favour of more competitive energy intensive sectors, like energy supply and metallurgy, and sectors such as housing and transport (with a small energy use reaction to recession), and through declining capacity loads in the manufacturing sector driving specific energy intensities in this sector up. Really impressive is the rate of GDP energy intensity decline in many of these countries (Fig. 2.2 and Table 2.3).

Table 2.3 Evolution of GDP PPP and GDP energy intensity

	GDP average annual growth rates		GDP energy intensity annual average growth rates	
	1990-2000	**2000-2012**	**1990-2000**	**2000-2012**
Armenia	-3.8%	7.6%	-9.1%	-4.0%
Azerbaijan	-5.2%	12.5%	-1.8%	-9.6%
Belarus	-1.2%	6.7%	-4.8%	-4.7%
Georgia	-9.3%	6.3%	-4.8%	-3.8%
Kazakhstan	-3.6%	7.9%	-3.5%	-1.5%
Kyrgyzstan	-4.0%	3.8%	-7.2%	0.9%
Moldova	-9.8%	4.7%	-2.1%	-3.5%
Tajikistan	-9.2%	8.1%	0.6%	-7.1%
Turkmenistan	-2.4%	8.5%	0.8%	-3.6%
Uzbekistan	-0.2%	7.2%	1.1%	-7.1%
World	**3.0%**	**3.8%**	**-1.5%**	**-1.4%**
Russia	-3.9%	4.7%	0.4%	-2.8%
Ukraine	-8.0%	4.0%	1.9%	-4.5%
OECD	2.8%	1.7%	-1.1%	-2.0%

Source: Energy balances of non-OECD countries. 2013 Edition. IEA. 2013. http://www.iea.org/

Figure 2.2 **Relationship between economic growth and GDP PPP energy intensity decline**



Note: Dotted lines show trends.

Source: CENEf.

On the contrary, 2000-2009 restorative growth was accompanied by significant energy intensity reduction reaching astounding 10% per year on average in Azerbaijan. The above factors were working right in the opposite direction. Much of this GDP energy intensity decline was driven by structural shifts and growing capacity load. In general, 1% GDP PPP growth was accompanied by 0.7% GDP PPP energy intensity reduction and only 0.3% additional primary energy use. In 2009-2012, GDP growth rates substantially declined, while the relationship between GDP growth and energy intensity decline was nearly the same as in 2000-2009 with the only exception of Kyrgyzstan.

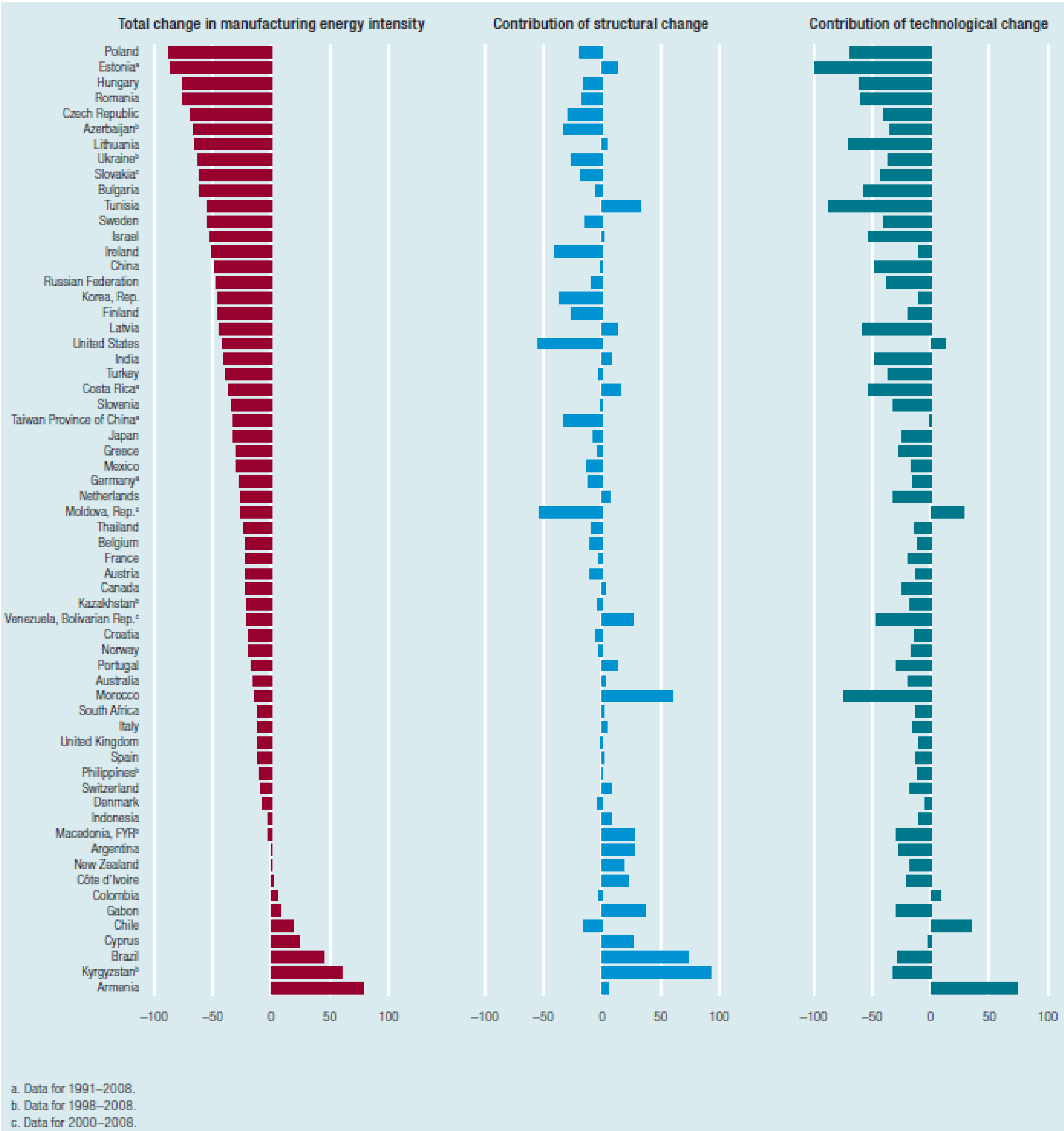
A study for the Russian Federation showed that if different factors are taken into account, then average annual contribution of the technology factor to GDP energy intensity reduction is less than 1%.[13] While in some countries contribution of technological factors may be larger (double or even triple the figure for Russia), a decomposition analysis, if provided, would probably show that other factors, like structural shifts, capacity loads, climate, energy prices, appliances saturation, etc., were mostly responsible for such dynamic GDP energy intensity decline in 2000-2012 and there still remains a large technological gap with the advanced economies.

The latter finding is supported by a UNIDO study (Fig. 1.4). Technological change has been bringing energy intensity down in Azerbaijan, Kazakhstan, and Kyrgyzstan (but at a rate lower than 4% per year), while in Armenia and Moldova it slowed down industrial energy intensity decline.

Given that structural changes in the industrial sector are just a small part of overall structural changes in the whole economy in favour of the services sector, it is clear that ***energy efficiency index*** which reflects energy intensity dynamics determined exclusively by technology-based specific energy consumption or by sectorial energy efficiency improvement net of the structural shifts contribution would show smaller progress towards technological frontier compared to GDP energy intensity.

[13] I. Bashmakov, A. Myshak. Russian energy efficiency accounting system. Energy Efficiency (2014) 7:743-759.

Figure 2.3 Components of change in industrial energy intensity by economy, 1995–2008 (percent)



Source: Industrial Development Report 2011. Industrial energy efficiency for sustainable wealth creation. Capturing environmental, economic and social dividends.

No matter which indicators are used to evaluate the progress towards energy efficiency improvement in the 10 selected countries, one can see that these countries were very fast sliding down the energy inefficiency hill. However, this process slowed down significantly after 2009 and the 10 countries need additional policy push to regain energy intensity decline momentum. It is important to at least double the contribution of technological advances to the energy intensity decline.

While global energy-related CO_2 emission showed breath-taking growth over the last decade to a value higher than 50% above the 1990 level in 2012, economies in transition (including the 10 countries considered) managed to keep their emissions much below the 1990 levels. Some of them cut their emissions by more than 70%. Emissions were down to the 2000 level mostly due to the economic recession. But then large income-driven energy-related GHG emissions in 2001-

2012 were largely neutralized by reduced energy intensity and fuel switch (Table 2.4). Nevertheless, the GHG emission growth trend is observed in 7 of the 10 countries.

Table 2.4. CO_2 emissions in transition economies in 1990-2012

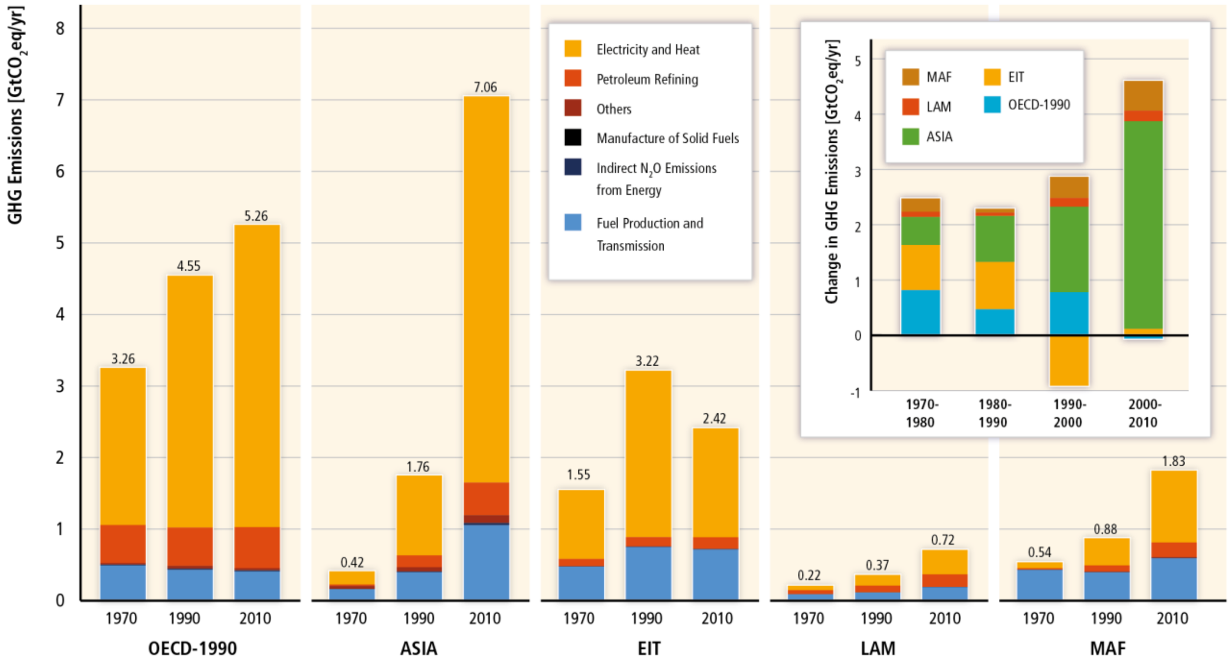
	CO2 emissions, million ton						AAGR		2012/1990
	1990	2000	2005	2010	2011	2012	1990-2000	2000-2012	
Armenia	21	3	4	4	5	5	-16.4%	4.0%	-73.6%
Azerbaijan	55	59	31	24	27	29	0.7%	-5.6%	-46.8%
Belarus	124	59	62	65	66	71	-7.2%	1.6%	-42.8%
Georgia	33	5	4	5	6	7	-17.9%	3.3%	-79.5%
Kazakhstan	236	113	157	234	234	226	-7.1%	5.9%	-4.5%
Kyrgyzstan	23	4	5	6	7	10	-15.1%	6.6%	-57.7%
Moldova	30	7	8	8	8	8	-14.2%	1.3%	-74.8%
Tajikistan	11	2	2	3	3	3	-14.8%	1.8%	-74.9%
Turkmenistan	45	37	48	57	62	64	-1.9%	4.7%	43.4%
Uzbekistan	120	118	109	101	110	111	-0.2%	-0.5%	-7.2%
World	**20989**	**23759**	**27501**	**30509**	**31342**	**31734**	**1.2%**	**2.4%**	**51.2%**
OECD	11150	12625	13024	12510	12340	12146	1.3%	-0.3%	8.9%
Russian Federation	2179	1497	1512	1577	1653	1653	-3.7%	0.8%	-24.1%
Ukraine	688	292	306	272	285	281	-8.2%	-0.3%	-59.1%

Source: CO2 emissions from fuel combustion. © OECD/IEA, 2013.

Economies in transition were the only region that managed to decouple economic growth and energy supply emissions, its 2010 GDP being 10% above the 1990 level, while energy supply GHG emissions declined by 29% over the same period. For additional information on regional total and per capita emissions see Fig. 2.5. In some countries (Kazakhstan, Kyrgyzstan, Turkmenistan), energy-related CO_2 emissions grew up very fast after 2000. Turkmenistan is the only country where 2012 emission were far above the 1990 level.

Countries that rely on energy imports showed just insignificant progress along the energy self-sufficiency path, whereas for several energy exporters the ratio of primary energy production to domestic consumption went up substantially (Fig. 2.5). Energy self-sufficiency is an important driver behind energy efficiency activities. But the data analysis has revealed that GDP energy intensity is more determined by economic growth dynamics (Fig 2.2) and structural shifts (Fig. 2.3), than by self-sufficiency.

Figure 2.4 Energy supply GHG emissions by subsectors and regions



Average Annual Growth Rates

	70s	80s	90s	00s
Total world	3.53%	2.43%	1.68%	3.10%
OECD-1990	2.26%	1.10%	1.59%	-0.13%
EIT	4.31%	3.12%	-3.31%	0.49%
ASIA	8.23%	6.64%	6.52%	7.89%
LAM	3.67%	1.77%	3.64%	3.13%
MAF	3.89%	1.00%	3.76%	3.66%

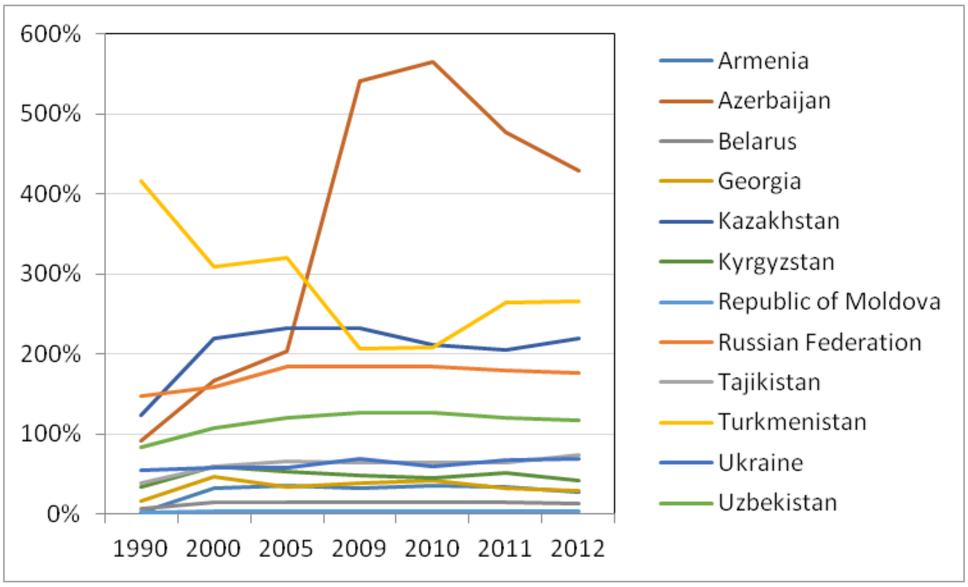
Per Capita Energy Sector Emission [$t/CO_2eq/yr$]

	1980	1990	2000	2010
Total world	1.91	2.03	2.08	2.50
OECD-1990	5.10	5.32	5.81	5.34
EIT	6.18	7.80	5.61	5.93
ASIA	0.40	0.62	1.00	1.92
LAM	0.85	0.83	1.00	1.21
MAF	1.39	1.15	1.30	1.46

OECD90, ASIA countries, transition economies (EIT), Africa and the Middle East (MAF), and Latin America (LAM). The right-hand graph shows contributions made by different regions to decadal emissions increments.

Source: Bruckner T., I.A. Bashmakov, Y. Mulugetta, H. Chum, A. de la Vega Navarro, J. Edmonds, A. Faaij, B. Fungtammasan, A. Garg, E. Hertwich, D. Honnery, D. Infield, M. Kainuma, S. Khennas, S. Kim, H. B. Nimir, K. Riahi, N. Strachan, R. Wiser, and X. Zhang, 2014: Energy Systems. In: Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Edenhofer, O., R. Pichs-Madruga, Y. Sokona, E. Farahani, S. Kadner, K. Seyboth, A. Adler, I. Baum, S. Brunner, P. Eickemeier, B. Kriemann, J. Savolainen, S. Schlumer, C. von Stechow, T. Zwickel and J.C. Minx (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Figure 2.5 Energy self-sufficiency index. 1990-2012



Source: Energy balances of non-OECD countries. 2013 Edition. IEA. 2013. http://www.iea.org/

Section 3. Armenia

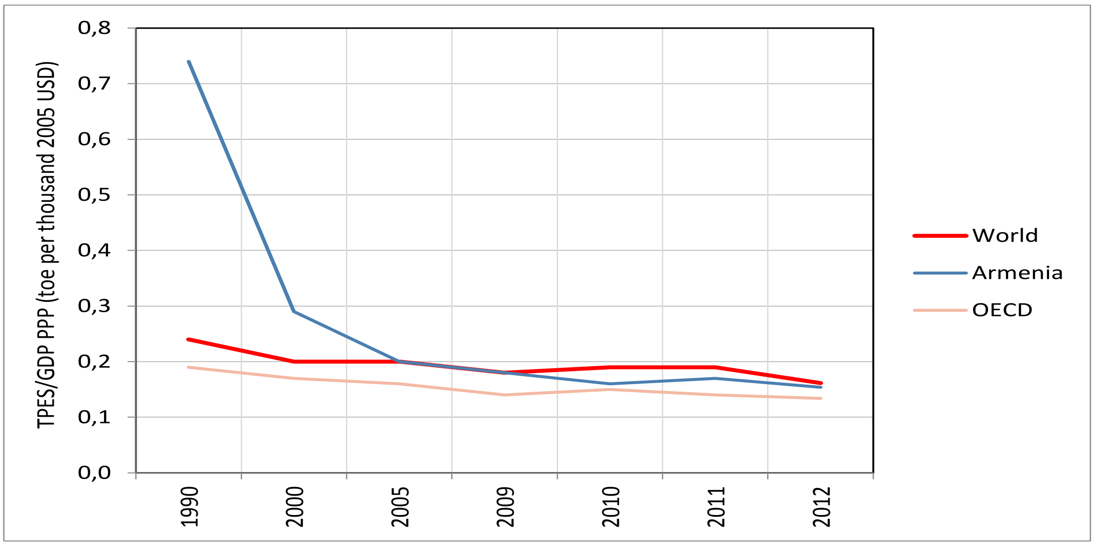
3.1 National level

Population in 2012: 2.97 mln; GDP PPP in 2012: 19.3 bln US$2005 (IEA[14]).

GDP intensity level. No official statistical data on GDP energy intensity are available, which is likely a result of the missing integrated fuel and energy balance (IFEB)[15]. For this reason, evaluation of GDP energy intensity will be based on the IFEB presented by IEA. Armenia has one of the lowest GDP energy intensity among the 10 CIS countries under consideration. GDP (in PPP) energy intensity dropped by 76% between 1990 and 2012 (Fig. 3.1). Most of the decline was observed before 2000. Average annual rates of energy intensity reduction in 2000-2012 equal 4%, both in terms of GDP MER and GDP PPP. However, since 2010 GDP energy intensity has stopped declining and even grew up slightly in 2011.

Armenia's GDP energy intensity is lower than the global average, or than energy intensity in some European countries.

Figure 3.1. 1999-2012 GDP Energy Intensity Evolution in Armenia



Source: Energy Balances of Non-OECD Countries. 2013 Edition. IEA. 2013. http://www.iea.org/

Factors behind GDP energy intensity evolution. No decomposition studies have been found to allow for the identification of factors behind GDP energy intensity evolution. Obviously, structural and technological factors are fully responsible for the slow and uneven GDP energy intensity decline over the recent years. In the 1990's, a dramatic decline was driven by shrinking heavy industry (as industrial collapse in Armenia after the country had obtained sovereignty was much more severe, than in the other former Soviet republics) and lack of fuel import.

Energy prices. According to the National Statistical Service, average electricity tariff in 2012 was 9 US cents/kWh; natural gas tariff was 380 US$/1000 m^3. A detailed evolution of electricity, natural gas and LPG tariffs over 2008-2012 is shown in Table 3.1.

Natural gas tariffs for end-users are set by the Public Services Regulation Commission. For customers whose monthly consumption is below 10 thousand m^3, the tariffs are fixed; for customers whose monthly consumption is above 10 thousand m^3, tariffs are calculated by a

[14] http://www.iea.org/statistics.

[15] Officially, the requirement for IFEB development is still in force, but IFEB is just not developed.

formula that takes into account the exchange rate determined by the Central Bank of Armenia. Natural gas tariffs are not subsidized by the government.

The Public Services Regulation Commission sets electricity tariffs for end-users. They are differentiated by time of use: day (07:00 - 23:00) and night (23:00 - 07:00) and depend on the voltage level and the type of connection to the power supply (direct or indirect feeder). The Public Services Regulation Commission also sets tariffs for electricity generated from renewable sources. In accordance with the law "On energy", all electricity produced from renewable sources is subject to mandatory purchase during the first 15 years of the plant commissioning.

Table 3.1 Electricity, natural gas and LPG average tariff evolution

Items	Units	2008	2009	2010	2011*	2012	2013**
Natural gas	drams/m^3	75.7	93.0	123.0	132.0	132.0	156.0
	US$***/m^3	0.25	0.26	0.33	0.35	0.33	0.38
	% of the previous year		+2.8	+32.3	+7.3	0.0	+18.0
Electricity	drams/kWh*	25.0	30.0	30.0	30.0	30.0	38.0
	US$***/kWh	0.08	0.08	0.08	0.08	0.07	0.09
	% of the previous year		+20.0	0.0	0.0	0.0	+27.0
LPG	drams/kg	589.7	528.7	557.1	590.8	624.4	
	US$**/kg	1.93	1.46	1.49	1.59	1.55	
	% of the previous year		-10.4	+5.4	+6.0	+5.7	

* - The tariff is 25 drams/kWh; if a two-rate meter is installed, the night tariff is 15 drams/kWh; after April 1, 2009 day and night tariffs are 30 and 20 drams/kWh respectively.
** - The tariff is 38 dram/kWh; if a two-rate meter is installed, the night tariff is 28 drams/kWh.
*** - Drams/US$ exchange rates are fixed by the Central Bank of Armenia.

Sources: data of the Statistical Yearbook "Armenia 2013" and http://www.armenianow.com/society/51219/natural_gas_in_armenia_tigran_sargsyan_armen_manukyan.

Energy conservation and efficiency spending. In June 2014, the national government presented an investment plan for a large-scale programme of renewable energy development. Solar and geothermal are priority sources of renewable energy that will obtain federal support. The programme budget is US$ 40 million, including US$ 14 million grants from international financial institutions and US$ 26 million concessional loans.

Government agencies with an energy efficiency policy mandate. National institutions responsible for energy conservation and energy efficiency are as follows:

- the national government is responsible for the enforcement of legislation, including energy saving and energy efficiency regulations;
- Ministry of Energy and Natural Resources addresses a wide range of strategic goals, including energy efficiency, through the implementation of national projects, programmes and drafting legislation. The Ministry is responsible for the following investment programmes: district heating sector – rehabilitation and renovation of existing thermal plants, construction of a new system on the base of cogeneration plants; renewable sector – development of economically viable projects in wind, solar and geothermal energy;
- Ministry of Construction regulates construction activities, including insulation and building energy efficiency standards;
- National Statistical Service is in charge of the statistical information, including data on fuel and energy consumption, tariffs, floor space, etc.;

- Renewable Energy and Energy Efficiency Fund. The Fund was established in accordance with Government Resolution No.799-N dated April 28, 2005. Prime Minister of Armenia presides at the Board of Trustees. The World Bank through GEF provided a US$ 20 million loan and a US$ million grant; EBRD provided a US$ 7 million loan; and the Cafesjian Family Foundation provided a US$ 3 million loan. The key objectives of the Fund are to facilitate investment in the energy sector and renewables sector, as well as in the development of the energy and renewables market. The Fund is going to be proactive in areas such as policy development, the removal of barriers, the creation and development of opportunities for stakeholders in the financial sector, the development of energy services, as well as in other activities aimed at improving national energy security, reducing the reliance on fuel imports and reducing energy consumption on the national level;
- Public Services Regulation Commission.

Energy efficiency legislation. Law No. 3-P-148 "On Energy" dated March 21, 2001 lays a basis for the regulation of the energy sector, including tariff setting; licensing; contracts for electricity, heat and natural gas supply.

The Law “On Energy Saving and Renewable Energy” dated November 9, 2004 specifies the principles and mechanisms for the implementation of the national policy in energy conservation and renewable energy.

The basic goal of the National Programme of energy conservation and renewable energy is to achieve 30% of electricity production from renewable sources by 2020. Besides, the National Programme defines energy saving potential, measures, projections and institutional mechanisms to attain the specified targets.

National Energy Strategy looks into energy efficiency improvements among other priorities.

Action Plan of the Government of the Republic of Armenia aims at implementing the National Programme of energy conservation and renewable energy. The Plan specifies the steps to attain the Programme goals and is intended for monitoring. The Action Plan is to be implemented in three stages: 2011-2013; 2014-2016; and 2017-2020.

At the first stage, the Plan includes: development of integrated fuel and energy balance (IFEB)[16]; development of short- and long-term investment programmes in energy efficiency; informational campaigns; training in energy saving and energy efficiency; development of energy efficiency standards; certification of energy auditors; development of methodology to assess economic feasibility of energy saving and energy efficiency measures.

At the second stage, it also intends to amend the building codes in the part related to energy performance of space heating, hot water and ventilation systems so as to specify maximum permitted energy consumption in buildings. The intention is to issue a building permit only if this requirement is met. In order to achieve this objective, it was decided to develop a methodology to assess specific energy consumption of buildings; establish laboratories to test buildings materials, structures and power equipment (windows, insulation, boilers, etc.) used for the construction of new buildings that will help ensure their good quality and compliance with national standards.

Action Plan of the Ministry of Energy and Natural Resources specifies the steps to be taken by the Ministry to implement the specified tasks, including energy saving and efficiency. Ministry of Energy and Natural Resources is responsible for most items of the Action Plan.

Energy efficiency R&D spending. No data found.

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[16] No IFEB was found in the public domain.

ESCO market. The energy efficiency legislation in force does not introduce the ESCO mechanism. According to the Economic Commission for Europe, there are no operating energy service companies in Armenia[17], although Armenian ESCO Association was mentioned in the past[18]. To date, no information on its performance has been found.

International cooperation. A bunch of projects have been implemented with the funding provided by international financial institutions (World Bank, European Bank for Reconstruction and Development, GEF, UNDP, etc.).

3.2 Heat and power generation and transmission

Power generation efficiency. There are three sources of data to assess the effectiveness of power generation, transmission and distribution: IEA energy balances; data provided by the National Statistical Service (NSS); information in the public domain (Internet, media, etc.). According to the NSS, approximately 8,036 million kWh were generated in 2012; of these 42% were generated by CHPs with 48% overall efficiency; 29% were generated by hydropower plants; and 29% by the nuclear power plant. A small part of electricity was produced by wind farms.

Power transmission and distribution losses. Based on the NSS data[19], the share of distribution losses is about 12% (981 million kWh); own process needs stand at 4% (337 million kWh).

Heat generation efficiency. District heating is not widely used in Armenia for the following reasons. In the late 1980's, Armenian district heating system included 55 subsystems producing about 20 million Gcal per year. However, a long blockade of the country destroyed the local fuel supply system and the facilities are now in a critical condition for the lack of maintenance and having been damaged by the 1988 earthquake.

Reliable data on district heating are not available. Reportedly[20], heat generation in 2000 was only 5% (927 thou. Gcal, including 612.5 thou. Gcal by CHP and 314.7 thou. Gcal by boiler-houses) of the 1990 level. Heat generation by industrial boilers, which used to contribute 29% to the overall heat generation, was practically terminated. Industrial consumption amounted to 406.2 thou. Gcal; consumption in other sectors to 316.2 thou. Gcal. According to the 2012 Review of the Armenian energy market, heat generation in 2012 amounted to 90 thou. GJ (about 21 thou. Gcal), which is 51.5% less, than a year earlier. Thus, over the past 25 years, heat generation dropped nearly 1,000-fold (99.9%).

Share of transmission and distribution losses. Heat losses in 2000 may be assessed (without correction for process needs) at 22%. No assessments for later years can be made. As to the share of district heat losses, IEA energy balance reports 0% for the recent years, which may be explained by a negligible value or missing data.

Renewables development programmes. In Armenia, there are solar, hydro, geothermal and wind development programmes. A special tariff rate is fixed for developers for a 15 years' period.

"White certificates" market. No such programmes launched to the date.

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[17] Economic Commission for Europe. Financing Energy Efficiency and Renewable Energy Investments for Climate Change Mitigation Project. Development of Energy Service Companies Market and Policies. United Nations. New York and Geneva, 2013.
[18] http://www.iisd.org/pdf/2009/bali_2_copenhagen_escos.pdf, p. 32.
[19] http://www.armstat.am/en
[20] UNDP/GEF/ARM/95/G31/A/1G/99 "Armenia country-study on climate change. Phase II".

3.3 Industry

Industrial energy intensity. According to the Government 2011-2013 Action Plan, energy intensity of industrial output amounted to 329 kgoe/thou US$[21]. CENEf's estimate for 2012, which builds on the statistical data and IEA IFEB (see Table 3.2), is 138 kgoe/10^3 US$ in current prices and 190 kgoe/10^3 US$ in 2009 prices.

Table 3.2 Evolution of energy intensity of industrial production

Items	Units	2009	2010	2011	2012
Energy and fuel consumption	10^3 toe	508	316	352	385
Industrial output	bln drams	669.4	824.4	999.0	1,121.9
	10^6 US$*	1,843	2,206	2,682	2,792
	10^6 US$ (in comparable prices)	1,843	1,907	2,113	2,026
Energy intensity	kgoe/10^3 US$	297	143	131	138
	kgoe/10^3 US$ (in 2009 prices)	297	166	167	190

* - Recalculated in US$ using average exchange rate fixed by the Central bank of Armenia.

Sources: estimated based on the statistical book "Industry of the Republic of Armenia" and IEA IFEB.

Energy intensity of basic industrial goods. No data available.

Energy efficiency regulations in the industrial sector. According to the Plan adopted by the national government for 2011-2013 with a view to promote energy conservation and renewable energy use programme, the following measures are to be implemented in the industrial sector:

- development of new technological complexes (production lines and the infrastructure);
- heat efficiency improvement;
- financing energy efficiency measures in the industrial sector;
- renovation of natural gas distribution system;
- renovation of power distribution system;
- installation of reactive power compensation.

Government agencies with an energy efficiency policy mandate in the industrial sector. Ministry of Energy and Natural Resources.

Basic administrative mechanisms to improve energy efficiency in the industrial sector: mandatory energy audits; energy data reporting; energy expertise.

Basic energy efficiency market mechanisms and economic incentive programmes: taxation and pricing policies.

Long-term agreements. None.

Energy management systems. No information found.

Energy efficiency policy spending. No data on investments in industrial energy efficiency are available.

3.4 Buildings

Specific energy consumption per square meter of residential floor space (energy intensity in residential buildings). In Armenia, most buildings were constructed during the Soviet era

[21] Year not specified.

(35-60 years ago), when energy performance parameters were practically ignored. Many existing buildings are half-ruined and not fit for living. According to some energy audits, average specific residential energy consumption is 160 kWh/m^2 per year[22] and varies between 171 kWh/m^2 per year[23] and 218 kWh\m^2 per year for stand-alone buildings[24]. These findings are contrary to the indicators estimated on the basis of statistical data for residential buildings and energy consumption in 2012. According to the IFEB, residential energy consumption amounted to 665 ktoe, translating to 7,723 million kWh. With 93.4 million square meters total housing area, specific energy consumption would be just about 83 kWh/m^2 per year. This is too low to be true. Most likely, the energy balance of the International Energy Agency does not take complete account of total residential fuel and energy consumption. This assumption is underpinned by the fact that the balance does not include the use of solid fuels (except coal), which are used individually by many buildings. Another possible explanation is under-consumption and/or unrecorded consumption of other energy resources, as determined by very few meters installed and low-consumption standards (primarily for natural gas). For the sake of comparison, average specific energy consumption in Russia is 370-380 kWh/m^2 per year, and such striking difference (nearly 4.5-fold) can hardly be attributed to climate or any other factors.

Specific energy consumption per square meter of public floor space. Integrated fuel and energy balance of the International Energy Agency is also a source of energy consumption data for the public sector. However, there are no data in the public domain on public buildings floor space, and so energy efficiency can be evaluated, very relatively, as poor.

Energy costs constitute a large share of annual expenses incurred by public buildings. In a survey of educational, municipal, and healthcare buildings, 35% of those surveyed admitted that electricity bills amount to 11-20% of their total annual spending. Electricity costs were particularly high for educational buildings, where 38% of respondents reported their electricity bills at 11-20% of the total annual spending, whereas 27% of respondents reported the share of electricity costs above 20%.[25] Many schools close down in winter, because they cannot provide adequate space heating. When they do operate, they often maintain indoor air temperatures way below adequate levels[26].

Share of consumers equipped with energy meters. No accurate data are available on natural gas, electricity and heat meters penetration in the residential sector. However, a study carried out by the World Bank ("The Other Renewable Resource: The Potential for Improving Energy Efficiency in Armenia") mentions high electricity and natural gas meters saturation rates.

Specific hot water consumption per household with access to centralized domestic hot water (DHW) supply. No such data are available. An analysis revealed that, with the minor exceptions, centralized DHW supply systems are out of operation in Armenia.

Government agencies with an energy efficiency policy mandate in the buildings sector. Ministry of Urban Development is the main government agency responsible for energy efficiency policy in the buildings sector.

Building codes requirements. In 2004, Armenia joined the international standard system "Thermal performance of buildings", which takes into account the requirements of the EU relevant documents. A corresponding document was developed in 2008 under the UNDP/GEF

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[22] Task 6 Report. Demand-Side Management Study. Danish Energy Management, p. 92.

[23] http://www.undp.org/content/dam/undp/documents/projects/ARM/MTE-Report_Buildings_Armenia_FINAL.pdf, p. 34.

[24] http://www.unece.org/fileadmin/DAM/energy/se/pp/gee21/Int._Training_Course_Istanbul/ArmeniaVahramJalalyan.pdf

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

[26] Most residents agree, that "adequate heating" provides at least 16ºC indoor air temperature, however, schools often operate at less than 8ºC.

project. In 2009, proposals for energy audits and certification of residential buildings were developed under the same project. In 2013, legal and institutional measures were drafted looking to improve energy efficiency in urban development (currently under discussion).

Basic administrative mechanisms to improve energy efficiency. Government 2011-2013 Action Plan aims at the implementation of energy conservation and renewable energy programme and includes the following measures:

- introduction of new energy efficiency building codes for newly erected and refurbished buildings;
- development and testing of the methodology for buildings project assessment;
- introduction of standards for buildings materials;
- introduction of buildings certification;
- pilot projects of the “best” building construction;
- energy-efficient construction and capital retrofits of existing buildings;
- information campaigns;
- others.

Basic energy efficiency market mechanisms and economic incentive programmes in the buildings sector: pricing policies and subsidies.

3.5 Transport

Specific energy consumption per unit of transport service. According to the IEA balance, annual fuel consumption transporatation in 2012 amounted to 377 thousand toe. Most of the fuel used was gasoline and diesel fuel. No information is available on the energy efficiency in the transport sector.

Government agencies with an energy efficiency policy mandate in the transport sector. The Ministry of Transport and Communications is the key government agency responsible for energy efficiency policies in the transport sector.

Basic administrative mechanisms to improve energy efficiency in the transport sector. The Government 2011-2013 Action Plan that aims at the implementation of energy conservation and renewable energy use programme includes the following measures:

- stricter emission requirements;
- routes optimization;
- phasing out dated cars;
- modernization and promotion of electric transport;
- railway locomotives park renovation;
- fuel switch of cars to natural gas.

Basic energy efficiency market mechanisms and economic incentive programmes in the transport sector: taxation and pricing policies.

3.6 Agriculture

Much of the demand for water and energy resources is formed by the agricultural sector, where they are mainly used for irrigation (according to some estimates, inefficient pumping equipment is responsible for 80% of the total energy consumption). Since 1998, the World Bank and other international institutions have funded projects in this area with a view to introduce modern irrigation methods and to upgrade the pumping plants.

The Government 2011-2013 Action Plan includes energy efficiency programmes and renewable energy enhancement activities through the introduction of gravity irrigation systems, replacement of pumping equipment and repair of channels.

3.7 Technical energy efficiency potential for Armenia

3.7.1 Approach and data sources

Technical energy efficiency potential for Armenia is assessed based on the approaches described in the section 1. Four sets of data were used for this purpose (Table 3.3). Data on the economic activities were basically collected from national statistical sources for 2012-2013, which are listed in corresponding sections, and other public domain sources. Data on specific energy use in different applications were collected from official documents, publications and studies. Where no appropriate data were available, proxies for countries with similar conditions were used. Technical potential assessments were built on comparisons of local energy efficiency indicators (listed in Tables 3.4, 3.5, 3.6, 3.7, and 3.8) with specific energy consumption for BATs (best available technologies) for the same sectors and subsectors, which were collected from multiple international sources.

Table 3.3 Data collection technology and structure

Information required	Source of information	Methods of data collection
Data on economic activity	Statistical yearbooks and books, open sources	Collection of statistical data, internet search
Energy prices	Statistical yearbooks	Collection of energy prices

The technical energy efficiency potential for Armenia is assessed with a few exceptions by multiplying the 2012-2013 activity level by the gap between the country-specific energy efficiency and BAT energy efficiency for the same activity.

The technical potential assessment is structured by different sectors including: power and heat generation, transmission and distribution, industry, transport, buildings, and other sectors (including agriculture, street lighting, water supply, etc.). Where possible, estimates generated in this study are compared with local estimates of the energy efficiency potential for similar activities. Whenever the information is sufficient, the reasons for mismatching are identified. Where reliable information for some energy use activities was not available, such activities were skipped from the potential evaluation study.

So as to identify the economic and market potentials, the costs of saved energy were compared to the 2013 or 2014 energy prices in order to see if an individual measure is economically viable.

Summary of energy efficiency potential estimation for Armenia:

- Power and heat 179.9 thou tce
- Industry 171.6 thou tce
- Transport 702.2 thou tce
- Services 47.9 thou tce
- Residential 937.3 thou tce
- Other 258.0 thou tce
- **Total** **2.4 Mtce**

3.7.2 Power and heat

CENEf's assessment builds on the energy use and power and heat generation data available from statistical books, publications and other sources, including internet resources. For some parameters information was not available, and so they were assessed using proxies, including parameters for similar installations in Russia. Therefore, the estimates of the technical potential are by no means perfect. CENEf has tried its best to make them as reliable as possible, despite the difficulties related to obtaining the required data.

Information on power generation in 2013 came from the yearbook "Industry of the Republic of Armenia". There are data on power generation by stations (CHPs, the Armyanskaya Nuclear Plant, hydro power plants and wind farms) and on the fuels they use, as well as on their contributions to the total power generation. Based on this information, power generation is grouped by the types of stations. In 2013, CHPs were responsible for 41% of power generation; nuclear plants for 28%; hydro power plants for 31%; wind farms for slightly over 0%. Total power production in 2013 amounted to 7,710 million kWh.

Hydro power plants and wind farms are not considered in this study, because they are associated with renewable energy, rather than with energy efficiency. Diesel power plants are not mentioned in the statistics or elsewhere. Currently, the nuclear plant is reaching end of its lifetime and the plan is to build a new energy efficient unit in 2020[27]. Since at this point design work is under way, the technical energy saving potential is taken negligible (equal to zero).

Table 3.4 Energy efficiency potential in power and heat generation, transmission and distribution (as of 2013)

Integrated technologies of goods, work, and services production	Units	Scale of economic activity	Units	Specific consumption in 2010	Practical minimum	Actual consumption abroad	Comments	Estimated technical potential, 1000 tce
Gas-fired co-generation plants retrofits	mln kWh	667	gce/kWh	386	205	262	CCGT with 60% efficiency	120.8
Own needs consumption	mln kWh	135	%	4.3%	4.0%	5.0%	Global practice –North America	0.04
Electricity transmission	mln kWh	8,805	%	12.3%	6.9%	7.0%	Global practice – Japan	58.6
Gas-fired boilers retrofits	thou. Gcal	11	kgce/Gcal	165	151		Equipment with 95% efficiency	0.2
Electricity consumption for heat generation by boilers	thou. Gcal	11	kWh/Gcal	23	7	9	Finland	0.02
Heat distribution	thou. Gcal	10	%	10.6%	5.4%		Replacement of heat pipes (new technology)	0.2
Total for power and heat								**179.9**

Source: CENEf

[27] http://www-pub.iaea.org/MTCD/Publications/PDF/TE_1656_Web.pdf

In Armenia, there are two natural gas-fired CHPs. Data on the economic activity for their technical potential assessment were calculated as the total power generation by CHPs less the economic activity of Yerevan CHP and the 5^{th} power block of Hrazdan CHP that generates power at energy efficient combined-cycle gas turbines (commissioned in 2010 and 2012 respectively). In 2013, power production by the 5^{th} power block of Hrazdan CHP amounted to 1.1 bln kWh[28], and by Yerevan CHP to 1.4 bln kWh[29]. Total power generation by CHPs amounted to 3.173 bln kWh in 2013. Therefore, the volume of economic activity at natural gas-fired CHPs, which is the base for the assessment of the technical energy saving potential, amounted to 667 mln kWh (Table 3.4). Specific fuel consumption for electricity generation by inefficient turbines of the Hrazdan CHP is 386 gce/kWh (270 goe/kWh) -- calculated as the average for 2002-2009, prior to the commissioning of the combined-cycle gas turbine[30].

The share of losses in electric networks is calculated based on the electricity balance presented in the statistical book "Industry of the Republic of Armenia".

The energy saving potential in district heat production is very low because of its negligible volume (for detail see Section 3.2). Heat supply by CHPs is negligible, too (the heat produced by CHPs is mostly used for own needs and delivered to a few nearby consumers). Heat is produced by boilers (mostly gas-fired units), some of which operate in accordance with the energy efficiency standards (for example, high-power boiler in Avan District of Yerevan). Therefore, it is assumed that half of the heat produced is generated by efficient boilers.

Heat losses were estimated at 15.5%[31].

According to the IEA energy balance data, about 2 Mtce are annually used for power and heat generation, own use, transmission and distribution. CENEf estimates the technical energy efficiency potential in this sector at 0.2 Mtce, or at about one tenth of annual consumption by this sector. An alternative assessment of the energy saving potential (excluding the potential in gas distribution networks)[32] is about 0.6 Mtce; however, this assessment builds on the 2007 data, and a large share of the technical potential has been already implemented through the gas turbines installed in the recent years (see above). Taking into account that two thirds of the power generation capacity are operating with new combined-cycle gas turbines, the two assessments are getting much closer to each other.

3.7.3 Industry

The technical energy efficiency potential for industry is assessed (Table 3.5) using 2013 data on industrial activities from the statistical book "Industry of the Republic of Armenia" and data on specific energy use in Russia and Kazakhstan, as this information on Armenia is not available in the open sources.

The potential is estimated for 6 energy intensive homogenous products and 7 cross-cutting technologies.

The number of industrial electric motors in operation is estimated with an account of electricity consumption by the industry, share of electric motors and average annual electricity consumption by one motor. In addition, it is assumed that 45% of industrial motors can be equipped with variable speed drives.

The number of lights at industrial sites is assessed with an account of electricity consumption by the industry, share of lighting and average annual electricity consumption by each light.

[28] http://www.gazprom.ru/about/production/energetics/
[29] http://www.slaq.am/eng/news/194799/
[30] http://energo-cis.ru/wyswyg/file/armeniya.pdf
[31] http://www.oe-eb.at/de/osn/DownloadCenter/Studien/Energy-Efficiency-Finance-Armenien.pdf, p. 6.
[32] http://www.oe-eb.at/de/osn/DownloadCenter/Studien/Energy-Efficiency-Finance-Armenien.pdf, p. 18.

The technical energy efficiency potential in the industry is assessed at 0.17 Mtce, which is about 31% of the 0.56 Mtce used in industry. Importantly, the assessment of the technical potential as shown in the table relies on many assumptions, is for indicative purposes only and needs improvement. It provides a larger estimate, than the one made by other experts (0.055 Mtce) back in 2007.[33] That estimate split the potential by sub-sectors, but provided no further detail on how the potential was split by products or cross-industry technologies. Obviously, 10% technical energy saving potential for industry is a very low estimate. Even advanced economies, which apply much more advanced technologies, yet have gaps with BATs, have much larger potentials. According to UNIDO, energy intensity of the Armenian industry in 2008 was 11 times higher, than in Germany. It is just an illustration of the large potential to improve energy efficiency of the Armenian industry[34].

Table 3.5 Energy efficiency potential in industry (as of 2013)

Integrated technologies of goods, work, and services production	Units	Scale of economic activity	Units	Specific consumption in 2010	Practical minimum	Actual consumption abroad	Comments	Estimated technical potential, 1000 tce
Aluminum	10^3 t	28	kgce/t	1,845	1,599	1,763	Global practice	6.8
Zinc ore and blanch	10^3 t	16	kgce/t	640	130		Global practice	8.2
Copper	10^3 t	195	kgce/t	910	490		Global practice	82.0
Cement production	10^3 t	431	kgce/t	24	11	13	Global practice	5.6
Meat and meat products	10^3 t	77	kgce/t	211	50		Chelyabinskaya Oblast	12.5
Bread and bakery	10^3 t	293	kgce/t	157	89		Tambovskaya Oblast	19.9
Efficient motors	10^6 units	0.2	kWh/motor	9,956	8,507		Global practice	30.3
Variable speed drives	10^6 units	0.1	kWh/drive	9,956	9,356		Global practice	5.6
Efficient industrial lighting	10^6 lights	0.1	kWh/ light	247	160		Global practice	0.7
Total for industry								**171.6**

* Here and in similar tables below the 'Comments' column shows reference to the BAT value. Mostly global BAT were used, but where global data for BAT are not reported, data for selected Rissian regions (oblasts) were used as proxies.

Source: CENEf

3.7.4 Transport

Energy efficiency potential for transport was estimated for railroad transport, pipelines, aviation, automobiles and municipal electric transport (metro, trams and trolleybuses). Like in the other sectors, this effort is quite data demanding.

Data on the transport service of the railroad, air and municipal electric transport in 2013 were taken from the statistical book "Transport and Communication of the Republic of Armenia",

[33] http://www.oe-eb.at/de/osn/DownloadCenter/Studien/Energy-Efficiency-Finance-Armenien.pdf, p. 14.
[34] UNIDO. Industrial Development Report 2011. Industrial energy efficiency for sustainable wealth creation. Capturing environmental, economic and social dividends.

although not always information on transport service was available in required formats. In some instances data presented in passenger-km and (or) freight-km were to be converted to brutto-freight-km (gross-freight-km) to fit statistically available data on specific energy use. For the railroad sector, the calculated values were split between electric and diesel trains based on the distribution of the train types.

In Armenia, there are only natural gas pipeline networks. Natural gas is fully imported from Russia and Iran. Natural gas imports in 2013 amounted to 2,361 million m^3. Consequently, this value was adjusted to m^3-km based on the Russian statistics and the difference in the length of natural gas distribution pipelines. Information on the bus park and the amount of light- and heavy-duty vehicles was taken from the open sources[35].

Data on specific energy use by many vehicles are very scarce, and what is available comes in formats very similar to those used in Russia. Therefore, for automobile transport CENEf's estimates of Russian specific energy use were taken as proxies. This approach makes the estimate just preliminary and waiting for further improvement, but it can serve a starting point for improving energy efficiency potential assessments in the transport sector.

CENEf estimates the energy efficiency potential in transport at 0.7 Mtce in 2013 (see Table 3.6). The largest potential comes from switching to effective hybrid models in automobile transport and modernization of diesel locomotives.

Table 3.6 Energy efficiency potential in transport (as of 2013)

Integrated technologies of goods, work, and services production	Units	Scale of economic activity	Units	Specific consumption in 2010	Practical minimum	Comments	Estimated technical potential, 1000 tce
Railroad electric traction	10^7 tkm gross	2,985	kgce/10^4 tkm gross	12.0	10.0	Values for some Russian regions	6.0
Diesel locomotives	10^7 tkm gross	15,737	kgce/10^4 km gross	62.2	40.0	2020 target for Russia	349.4
Metro electric traction	10^6 tkm gross	5	kgce/103 km gross	6.5	4.3	Moscow	0.01
Trolley-bus electric traction	10^6 tkm gross	2	kgce/103 km gross	7.9	5.9	Average for Russia	0.004
Gas pipeline transport	10^6 m^3-km	18,369	kgce/10^6 m^3 km	28.2	25.00	2020 target for Russia	58.8
Eco-driving	10^3 tce	259	kgce/10^6 m^3km	100%	95%	Global practice	13.0
Shifting to hybrid light-duty vehicles	10^3 vehicles	248	tce/vehicles/ year	1.23	0.74	Global practice	121.9
Shifting to hybrid buses	10^3 buses	11	tce/buses/ year	6.5	3.91	Global practice	29.7
Shifting to hybrid heavy-duty vehicles	10^3 vehicles	41	tce/vehicles/ year	7.5	4.52	Global practice	123.4
Air transport	10^6 passenger-km	2	kgce/ passenger-km	60.3	54.27	Global practice	0.01
Total transport							**702.2**

Source: CENEf

[35] http://www.who.int/violence_injury_prevention/road_safety_status/2013/country_profiles/armenia.pdf.

There is just one reference to an alternative estimate of the energy efficiency potential in the transport sector, which is assessed as low as 0.01 Mtoe[36]. Measures that can help implement this potential include optimization of routes, stations, and the number and operation of traffic lights, introduction of energy efficient public transport, and replacement of dated vehicles, switch to LPG and CNG, street improvements, and better driving skills. It seems that the technical potential in this sector is substantially underestimated. There are no other sources reporting energy saving potential in this sector.

3.7.5 Buildings

The buildings sector includes residential, public and commercial buildings. Industrial and agricultural buildings are not considered. Data on the residential living space were obtained from the statistical book "Housing stock of the Republic of Armenia"[37]; however, information on the public and commercial buildings stock and energy use is not available (scarce information that *is* available, does not look reliable, because it refers to stand-alone buildings and is extremely inconsistent.

Based on the available data, residential energy use in the recent years fluctuates up and down around 1 Mtce depending on weather conditions. Total living space in 2013 amounted to 95 million m^2, and energy consumption was 951 thousand tce. There is practically no district heating (with some minor exceptions) in Armenia[38]. Simple calculation shows that total specific energy use is about 10 kgce/m^2/year (81 kWh/m^2/year), providing the entire buildings space is heated. District heat is supplied to just about 0.3 million m^2 of the living space.

For the purpose of the energy saving potential assessment in multifamily buildings, specific minimal energy use was assumed equal to that in Russia. For single-family houses, the value for a "passive house" was used as the reference level. Therefore, the assessed potential assumes a very deep renovation of the existing buildings stock.

Data on other activities in the housing sector were estimated based on the national statistics, while data on specific energy use for current practices were taken similar to those for Russia, except for space heating. Statistical books on services ("Trade and Services in the Republic of Armenia", "Education and Culture in the Republic of Armenia", etc.) provide no data on public or commercial floor space. Therefore, the data were reconstructed by multiplying the number of people (schoolchildren, patients, etc.) in public and commercial buildings by standard specific floor space. For countries with a similar level of development the ratio of public and commercial floor space to the living space in the residential sector is about 1:4 to 1:5[39]. For Armenia, the estimated value is 22.7 million m^2, or 24%.

According to the IEA energy balance data, 0.2 Mtce were used in this sector in 2012. Therefore, specific energy use is 7.6 kgce/m^2/year (62 kWh/m^2/year).

The overall technical energy efficiency potential in the housing sector is estimated at 0.9 Mtce; in the public and commercial buildings sector at 0.2 Mtce. Total energy saving potential in buildings is estimated as exceeding 1 Mtce (see Table 3.7 for more detail). Importantly, this value is very close to the total energy consumption across the whole buildings sector as reported by IEA. As mentioned above, this is due to the incompleteness of data on solid fuels use in the buildings sector presented in the IEA energy balance. No data are available regarding how many households rely on solid fuels for their space heating. According to some assessments, their

[36] http://r2e2.am/wp-content/uploads/2012/07/The-Potential-for-Improving-Energy-Efficiency-in-Armenia.pdf, p. 30.
[37] http://www.armstat.am/en/
[38] http://pdf.usaid.gov/pdf_docs/Pnacx795.pdf, p. 6.
[39] M. Economidou. Project lead. Europe's buildings under the microscope. A country-by-country review of the energy performance of buildings. October 2011. Buildings Performance Institute Europe (BPIE); Transition to Sustainable Buildings. Strategies and opportunities to 2050. IEA. 2013.

share is rather high (34% households rely on firewood)[40]. Accounting for “missing” energy consumption makes the estimate of the energy efficiency potential in buildings more robust.

Table 3.7 Energy efficiency potential in the buildings sector (as of 2013)

Integrated technologies of goods, work, and services production	Units	Scale of economic activity	Units	Specific consumption in 2010	Practical minimum	Actual consumption abroad	Comments	Estimated technical potential, 1000 tce
Residential buildings								
Renovation of centrally heated multifamily buildings	thou. m^2	300	kgce/m^2	10.2	7.1		60% of 2012 building codes requirements	0.9
Renovation of single-family buildings	thou. m^2	94,352	kgce/m^2	10.7	4.9		Passive houses	548.2
Replacement of appliances with top efficient models	thou. people	3,017	tce/person	0.110	0.055	0.12	Global practice	165.9
Lighting renovation	thou. light fixtures	15,775	W	50.85	20.00	35.00	Global practice	33.0
Renovation of the cooking equipment	thou. m^2	94,652	kgce/m^2	3.50	1.50	2.80	Global practice	189.3
Total residential buildings								**937.3**
Public and commercial buildings								
Renovation of centrally heated buildings	thou. m^2	75	kgce/m^2	7.6	7.1	18.0	60% of 2012 building codes requirements	0.04
Renovation of the cooking equipment	thou. m^2	11,335	kgce/m^2	1.8	1.4	1.3	Global practice	4.2
Efficient gas-fired space heating boilers	thou. m^2	11,335	kgce/m^2	32.7	26.7	30.2	Global practice	41.9
Lighting renovation	thou. m^2	22,671	kWh/m^2	32.7	16.4	27.8	Global practice	45.6
Procurement of efficient appliances	thou. m^2	22,671	kWh/m^2	71.8	51.6	56.6	Global practice	56.2
Total public and commercial buildings								**147.9**
Total buildings								**1,085.2**

Source: CENEf

3.7.6 Other sectors

According to the IEA energy balances, 0.14-0.17 Mtce are used annually for the last few years in agriculture, but this entire volume is attributed to electricity alone and does not account for other energy carriers. However, there is a large stock of tractors and other machinery and plenty of greenhouses primarily heated by natural gas. Therefore, the potential as calculated in this study is not directly comparable with energy consumption as registered in the IEA balance.

[40] UNDP/GEF/ARM/95/G31/A/1G/99 “Armenia country-study on climate change. Phase II”, p. 22.

Data on the number of tractors in use were obtained from the statistical publication "The presence of agricultural machinery and its serviceability as of January 1, 2014". Based on the Russian experience[41], there is a technical possibility to reduce specific energy use per tractor by about 65%. The floor space of glass greenhouses as of 2011 is 120 hectares. Based on the Russian experience[42], specific energy use by glass greenhouses may be reduced by about 50%.

The overall potential of improving fuel efficiency of tractors is estimated at 0.2 Mtce; and that in greenhouse space heating at 0.1 Mtce. Total energy saving potential in agriculture is estimated at 0.3 Mtce per year.

Two other components of the energy efficiency potential were assessed, namely, street lighting and adjustable speed drives at municipal water supply systems. Electricity consumption by public utilities was obtained from the statistical yearbook "Industry of the Republic of Armenia" less electricity consumption for own needs. Electricity consumption for street lighting was estimated as total electricity consumption by public utilities less electricity consumption by 5 water supply systems registered in Armenia. Contribution of municipal water and street lighting systems amounts to 2400 tce.

All together, the contribution of "other sectors" to the energy efficiency potential was estimated at 0.3 Mtce (see Table 3.8).

Table 3.8 Energy efficiency potential in "other sectors" (as of 2013)

Integrated technologies of goods, work, and services production	Units	Scale of economic activity	Units	Specific consumption in 2010	Practical minimum	Actual consumption abroad	Comments	Estimate of the technical potential, 1000 tce
Tractors fuel efficiency	10^3	11,656	kgce/ha	20	7		Global practice	154.3
Renovation of greenhouses	$10^3 m^3$	6,000	kgce/m^3	34	17		Average for Russia	101.3
Adjustable speed drives in water supply systems	mln kWh	75	%	100%	75%		Global practice	2,3
Street lighting renovation	mln kWh	2	%	100%	70%		Global practice	0.1
Total								**258.0**

Source: CENEf

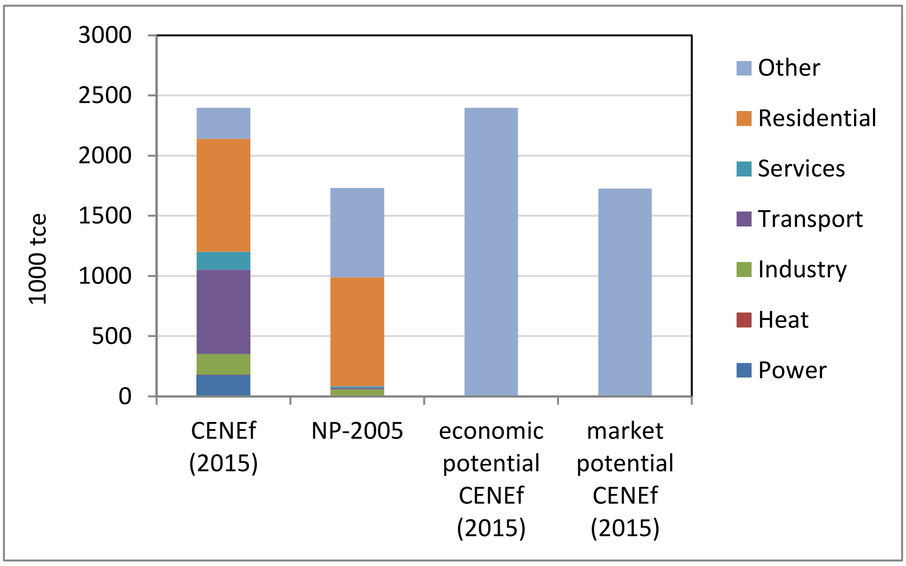
3.7.7 Comparisons of total technical energy efficiency potential estimates

Total technical energy efficiency potential for Armenia as of 2013 is estimated at 2.4 Mtce, or 56% of TPES as reported by IEA (see Fig. 3.2) and probably close to 50% of energy use, if all "missing" energy use is accounted for. This estimate builds on the assumption that all process measures will be implemented independently, without accounting for integral direct or indirect effects related to the reduction of potential in the power and heat generation, if end-use demand for power and heat is reduced through measures implemented in final energy use sectors. This estimate is higher, than energy saving to 2020 reported in the National Programme (1.7 Mtce).[43]

[41] Bashmakov, I. Resource of energy efficiency in Russia: scale, costs, and benefits. Energy Efficiency. (2009). V.2.
[42] Bashmakov, I. Resource of energy efficiency in Russia: scale, costs, and benefits. Energy Efficiency. (2009). V.2.
[43] http://r2e2.am/wp-content/uploads/2012/07/The-Potential-for-Improving-Energy-Efficiency-in-Armenia.pdf, p. 30.

This can partly be explained by the fact, that what is called "potential" in the National Programme is in fact savings to be obtained by 2020. So it only covers part of the potential. What the Programme reports is closer to CENEf's estimate of the market potential. In addition, both potential assessments cover different sets of activities and the data used for both present specific energy use and for BATs are inconsistent. CENEf's assessment breaks down the potential with a much higher itemization to allow for better-tailored energy efficiency policies.

Figure 3.2 Estimates of technical, economic and market energy efficiency potentials for Armenia



Sources: CENEf and the National Programme on Energy Efficiency and Renewable Energy

Anyway, the technical energy efficiency potential is large and basically concentrated in the power, agriculture, residential and public sectors. The question is: how much of it is economically attractive?

3.7.8 Economic and market energy efficiency potentials

Economic and market potentials are assessed based on the comparison of energy prices and costs of saved energy. 2013 energy prices were used in the study (see Table 3.9). The share of incomes spent to pay the energy bills is a more important driver behind rational energy use, than the level of energy prices[44]. If consumer spending is about 7%, then it means that there is practically no room left for residential energy price increase before energy prices reach the level beyond which either payments collection will go down or many households will be forced to reduce resource consumption below the sanitary level.

Table 3.9 Energy prices in Armenia in 2013[45]

	Units	Drams	US$	US$/tce
Electricity	kWh	38	0.09	703.1
Natural gas	m^3	156	0.38	330.4
Gasoline	t	500,000	1,219.5	841.0
Diesel fuel	t	500,000	1,219.5	852.8

Source: National Statistical Service

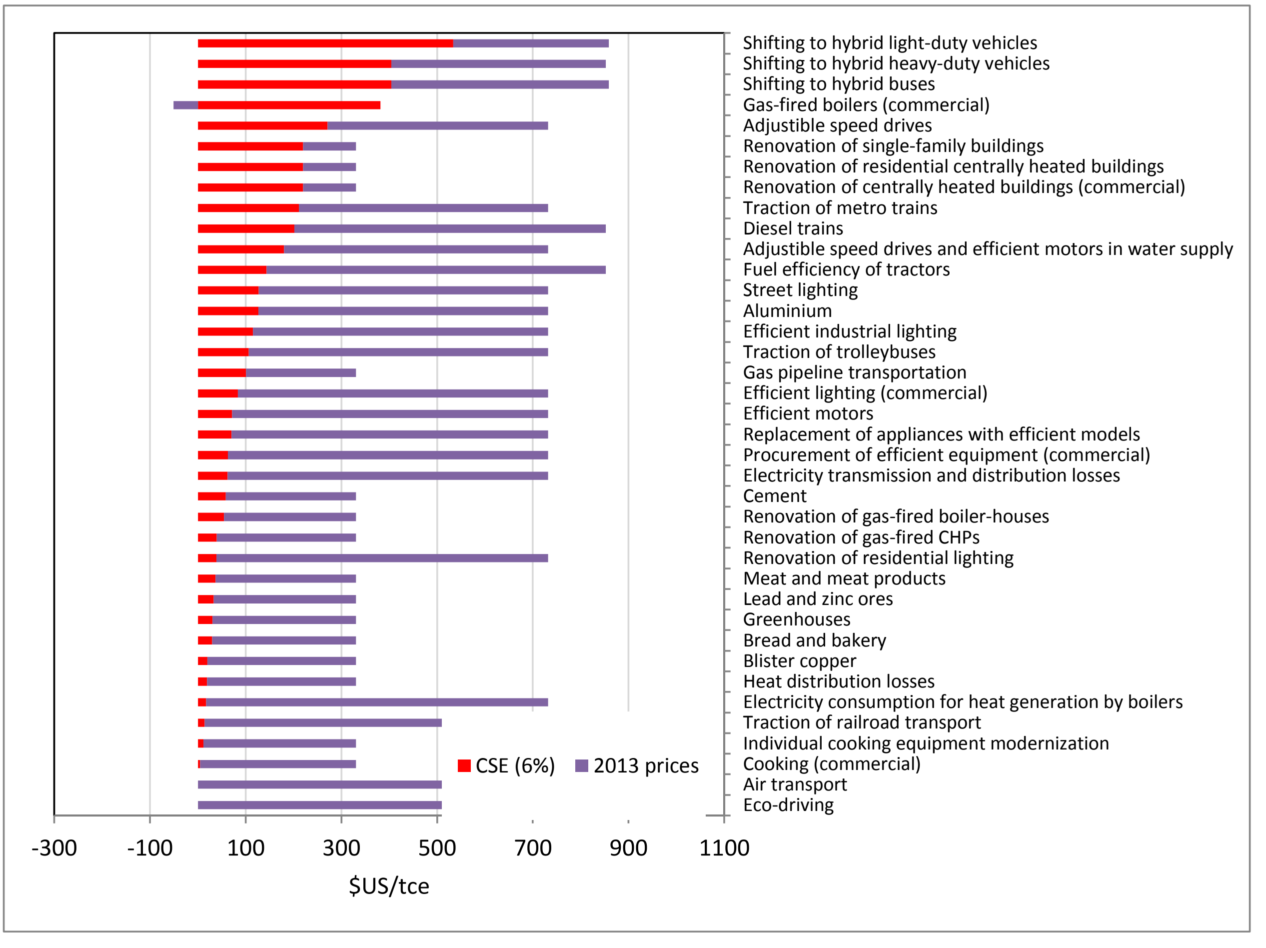
[44] I. Bashmakov. Three Laws of Energy Transitions // Energy Policy. – July 2007. – P. 3583-3594; Bashmakov I.A. Ability and willingness of residential consumers to pay their housing and municipal utility bills // Voprosy ekonomiki (Issues of Economy). – 2004. No. 4.
[45] Statistical yearbook "Prices and Tariffs in the Republic of Armenia"; and http://autotraveler.ru/armenia/dinamika-izmenenija-cen-na-benzin-v-armenii.html#.VNnli_7kf3Y.

Better energy use efficiency is a good solution. A problem arises when modern expensive equipment is needed in order to reduce energy consumption. In this case economically attractive solutions are determined by the cost of saved energy being lower, than energy price.

The cost of saved energy depends on the discount rate applied to annualize the capital costs. In this study, 6% discount rate was used to estimate the economic energy efficiency potential and 12% discount rate was used to estimate the market energy efficiency potential. In addition, 20% discount rate was used to reflect stricter budget limitations and a higher cost of money for some energy consumers.

Some measures, for which costs of saved energy appeared to be higher, than the energy price, are economically not attractive for the society and are not included in the economic potential (Fig. 3.3). In Armenia, gas-fired boilers are out of the economic energy efficiency potential. Relatively high energy prices are the key reason why most measures are economically attractive. With economic constraints, 2.44 Mtce of the technical energy efficiency potential decrease to 2.40 Mtce of the economic potential.

Figure 3.3 Economic energy efficiency potential for Armenia (for 6% discount rate as of 2013)



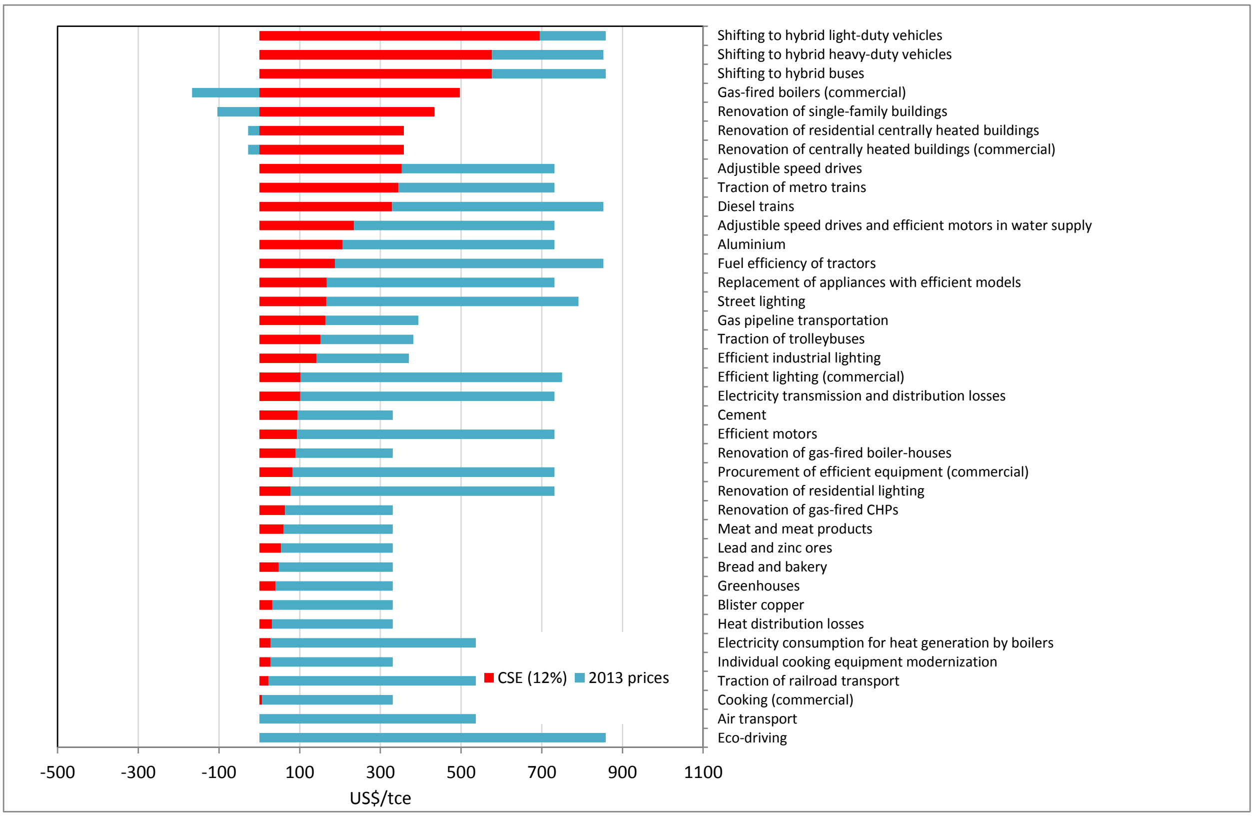
Notes: The figure shows the CSE (costs of saved energy) (red) and the gap between energy price in a given activity and the cost of saved energy (blue). Due to the fact that different energy carriers are used in individual activities, the price is average weighted for all energy carriers used. All prices are presented in US$/tce. If the gap is negative, the measure is considered economically not attractive and is excluded from the economic potential assessment.

Sources: CENEf

Better accounting for private parameters in the economic decision-making via higher costs of capital (12% and 20% discount rates) allows for an assessment of the market energy efficiency potential. It is lower, than the economic potential, but not very much lower. For the two discount rates mentioned it stands at 1.84 and 1.73 Mtce respectively (Fig 3.4 and 3.5). Making long-term funding for energy efficiency measures more easily available would allow it to bridge the gap between the economic and market energy efficiency potentials.

Even with current energy prices and the 20% discount rate applied in investment decision-making, the market potential to improve energy efficiency in Armenia amounts to approximately 41% of primary energy use as reported by IEA. Importantly, accounting for co-benefits and subsidies for currently not economically attractive energy efficiency measures, as well as steady energy price growth may scale up the economic and market potential closer to the technical one.

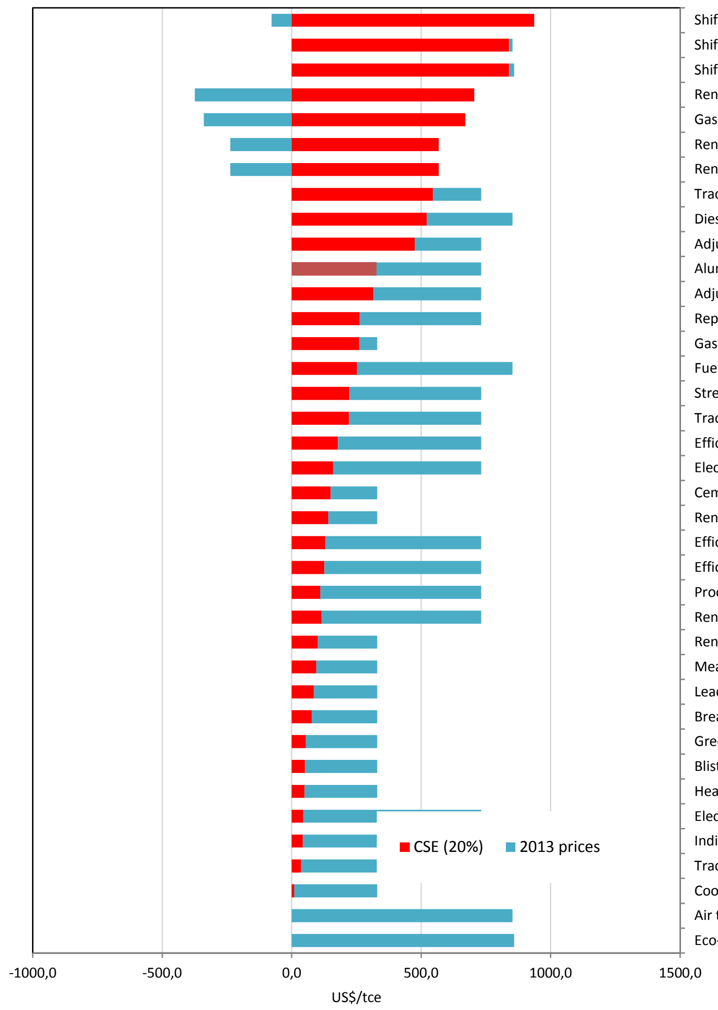
Figure 3.4 Market energy efficiency potential for Armenia (for 12% discount rate as of 2013)



The figure shows the costs of saved energy (red) and the gap between energy price in a given activity and the cost of saved energy (blue). Due to the fact that different energy carriers are used in individual activities, the price is average weighted for all energy carriers used. All prices are presented in US$/tce. If the gap is negative, the measure is considered economically not attractive and is excluded from the market potential assessment.

Sources: CENEf

Figure 3.5 Market energy efficiency potential for Armenia (for 20% discount rate as of 2013)



The figure shows the costs of saved energy (red) and the gap between energy price in a given activity and the cost of saved energy (blue). Due to the fact that different energy carriers are used in individual activities, the price is average weighted for all energy carriers used. All prices are presented in US$/tce. If the gap is negative, the measure is considered economically not attractive and is excluded from the market potential assessment.

Sources: CENEf

Section 4. Azerbaijan

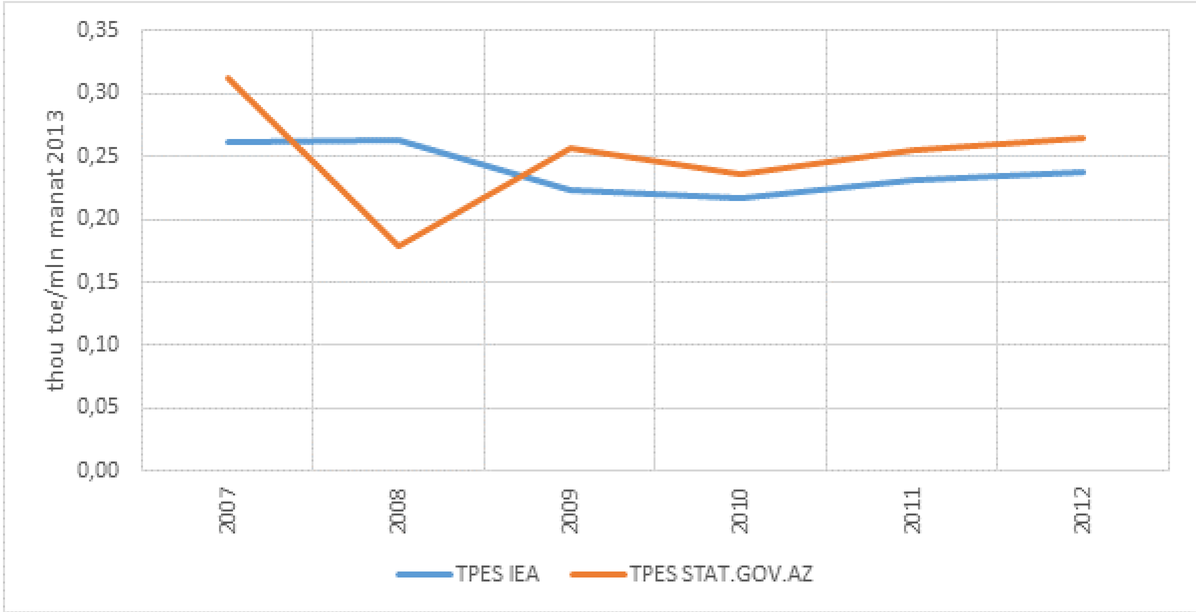
4.1 National energy efficiency level

Population in 2012: 9.3 mln; GDP PPP in 2012: 131.65 bln US$2005 (IEA[46]).

Evolution of GDP energy intensity. According to IEA, energy intensity of GDP in MER was declining by 9.8% per year in 2000-2012, and by 9.6% of GDP in PPP.

According to Azerbaijan Statistical Committee GDP and TPES data, GDP energy intensity has been slowly growing since 2010. It should be noted that, regardless of the source used, GDP energy intensity shows growth after 2010 (see Fig.4.1).

Figure 4.1 GDP energy intensity evolution according to IEA and Azerbaijan Statistical Committee



Source: GDP data from Azerbaijan Statistical Committee, consumption data from IEA/AzStat. IEA and Azerbaijan Statistical Committee energy balances only differ in natural gas consumption, which is lower in IEA reports[47]. In 2008, Azerbaijan Statistical Committee reported a sudden decline inTPES.

Factors behind the evolution of GDP energy intensity: technology and structural shifts. No decomposition studies have been found to allow for the identification of factors behind GDP energy intensity evolution.

Energy prices. There is no differentiation between electricity tariffs for different consumer groups in Azerbaijan. Electricity (and gas) market in Azerbaijan is still a vertically integrated monopoly, where the Tariff Council can set wholesale and retail power prices. As of January 2007, retail prices were increased from a subsidized level of 2.4 US¢/kWh to a cost-reflecting level of 7.68 US¢/kWh and were still at this level as of 2014. Fuel prices for power plants are heavily subsidized.

[46] http://www.iea.org/statistics.

[47] Azerbaijan Statistical Committee uses high calorific value to convert natural gas from million cubic meters to oil equivalent. This methodology is used in the U.S., but CENEf uses low calorific value which yields about 10% smaller amount of oil equivalent. IEA uses the same approach, and that is the reason why data provided by IEA and Azerbaijan Statistical Committee differ in natural gas consumption and production. In this analysis, we use low calorific value approach on million cubic meters data provided by Azerbaijan Statistical Committee.

Energy efficiency legislation. All available reports relevant to energy efficiency in Azerbaijan emphasize that energy efficiency is not a high priority, and that energy efficiency legislation is poor[48]. CENEf ended up with the same conclusion.
Azerbaijan energy legislation in force includes:

- Law on the Use of Energy Resources (adopted in 1996; a framework law missing effective instruments);
- Law on Energy (adopted in 1998);
- Law on Power Industry (adopted on April 3, 1998);
- Law on Power Plants and Heat Generation Plants (adopted on December 28, 1999);
- Law on the Subsoil (2001); the Law on Gas Supply (adopted in 1998); and
- Law on Natural Monopolies (adopted on December 15, 1998).

Most national programmes that directly or indirectly involve energy efficiency improvement were launched well before 2010. None of the above documents set clear or transparent targets. Several laws and plans are being developed or enforced under some European projects in Azerbaijan. According to some sources, an Energy Efficiency Action Plan (short-term & mid-term) is being prepared: "The Azerbaijani Ministry of Industry and Energy is developing a National Energy Efficiency Action Plan for 2014-2020", reported an article dated December 2013. However, no Action Plan can be found on the website of the Ministry of Industry and Energy or in mass media[49]; the Ministry of Energy and the International Ecoenergy Academy did not respond to CENEf's enquiry.

Naila Aliyeva[50] observed in 2012, that Azerbaijan had drafted a State Programme of Technical Regulation, Standardization & Conformity Assessment System Development in the field of Energy Saving & Energy Efficiency. The overall purpose of the programme is to obtain energy savings, improve energy efficiency, promote economic development, improve the environment and resource efficiency, as well as the competitiveness of local products, and develop national standards on the basis of regional standards. The target was to develop 69 relevant national standards. It was recently announced, that the draft programme had passed the process of interagency coordination and was submitted for consideration to the Azerbaijan Cabinet of Ministers[51]. Not much information on the programme contents is available in the public domain.

Number of energy efficiency regulatory acts. Although the government recognizes the importance of energy efficiency[52], there is no regulation on specific energy efficiency activities. The basic elements for the promotion of EE are captured in the Law on the Use of Energy Resources enforced in 1996[53]. Article 3 of the Law stipulates that energy efficiency measures are to be implemented during extraction, processing, transportation and storage of energy resources. However, this law does not make it clear, how the proposed energy efficiency policy should be implemented. As these actions are not supported by regulations, they are usually ignored in day-to-day practices. 2013 Report by the Energy Charter Secretariat[54] states, that energy efficiency in Azerbaijan still needs developments in terms of strategy, action plans and legislation.

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[48] In-Depth Review of the Energy Efficiency Policy of Azerbaijan. Energy Charter Secretariat, 2013. http://www.encharter.org/fileadmin/user_upload/Publications/Azerbaijan_EE_2013_ENG.pdf;
[49] http://en.trend.az/business/energy/2221274.html
[50] Resource Efficiency Gains and Green Growth Perspectives in Azerbaijan. Study by Friedrich Ebert Stiftung, October 2012
[51] http://abc.az/eng/news/86062.html
[52] http://en.trend.az/business/energy/2111227.html
[53] http://www.encharter.org/fileadmin/user_upload/Publications/Azerbaijan_EE_2013_ENG.pdf
[54] http://www.encharter.org/fileadmin/user_upload/Publications/Azerbaijan_EE_2013_ENG.pdf

Government agencies with an energy efficiency policy mandate. It is Energy Efficiency, Alternative and Renewable Energy Department of the Ministry of Energy.

Basic administrative mechanisms to improve energy efficiency. The Law on the Use of Energy Resources, which was made effective in 1996, mentions some administrative mechanisms, including:

- mandatory state certification of energy-intensive equipment, both new and in operation;
- mandatory energy audits for enterprises with annual energy consumption above 8,141 MWh;
- subsidies from the State Fund for Rational Use of Energy Resources for the implementation of EE measures and for EE research and development;
- repayment of foreign investments in the efficient use of energy resources from the cost savings generated by these measures;
- energy efficiency standards for a variety of technologies. Compliance is to be monitored in accordance with the Law on Standardization of Azerbaijan;
- thorough inspections: federal agencies check energy consumption levels of industrial enterprises to make sure that energy consumption by both energy and process equipment remains within the acceptable limits and impose fines non-compliance.

However, even after 18 years, regulations necessary to effectively implement the law provisions to promote efficiency measures (the Federal Fund for Rational Energy Use, repayment of foreign investments, etc.) are not in place yet. Despite the law requirements, no information on the accomplished energy audits is available.

Basic energy efficiency market mechanisms and economic incentive programmes. No information available.

Energy efficiency policy spending and financial sources. There are a number of projects financed by international financial institutions, including Asian Development Bank, KfW, USAID, and IFC. During the period between January 2010 and January 2012, the Ministry of Industry and Energy received €13 million under the EU support reform programme[55].

ESCO market. No information available.

Water efficiency policy. Current water resource regulations include[56]: Law on Irrigation and Land Reclamation (1996); Regulations on Water Charges in Agriculture (1996); Water Code (1999); Law on Water Supply and Wastewater (2000). Basic problems include improper irrigation water use, old infrastructure, and water losses.

4.2 Heat and power generation and transmission

Power generation efficiency. CHP power generation efficiency was 37.7% in 2012 and has been stable since 2000.

Table 4.1. Fuel consumption in electricity and heat generation

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
gce/kWh	366	364.5	379.1	375.8	378.9	385.1	391.1	415.1	409.7	409.9	411.3	413.2	409.4	386.2	385.9
gce/Gcal	177.0	180.9	186.9	185.9	182.7	186.1	190.1	210.5	198.1	208.1	212.1	216.4	190.6	195.2	191.1

Source: Promotion of Renewable Energy, Energy Efficiency and Greenhouse Gas Abatement (PREGA) Azerbaijan country report, 2005.

[55] http://eeas.europa.eu/delegations/azerbaijan/projects/list_of_projects/200530_en.htm
[56] http://www.gwp.org/Global/GWP-CACENA_Files/en/pdf/azerbaijan.pdf
http://www.unece.org/fileadmin/DAM/env/water/npd/Pres_Rafig_Final.pdf

The efficiency of electricity-only plants was 41.8% in 2012. Around 30% of thermal power plants use residual oil, 70% are natural gas-fired. The proportion used to be entirely different in the past.

Share of CHP in power generation. Share of CHP units in electricity production was 92% in 2001 and slowly declined to 85-86% in 2012-2013.

Power transmission and distribution losses (%). Electricity losses in 2013 amounted to 14% of TPES and 20% of TFC. Transmission losses are 4-4.5%, whereas distribution losses are very high (up to 17%).

Heat generation efficiency. Heat plants efficiency was 78.7% and CHP efficiency was 37.7% in 2012 versus 65.9% and 22.3% respectively in 2013[57].

Share of CHP in heat generation. In 2012, the share of CHP plants in heat generation was 25%, and of heat plants 75%.

Heat distribution losses. Heat losses amounted to 12% in 2013[58].

Energy efficiency regulations in heat and power generation and distribution. No information available.

Government agencies with an energy efficiency policy mandate in heat and power generation and distribution. No special department.

Basic administrative mechanisms to improve energy efficiency in heat and power generation and distribution. No information available.

Basic energy efficiency market mechanisms and economic incentive programmes. Pricing and taxation.

Renewables development programmes. Federal Programme on the Use of Alternative and Renewable Energy Sources in Azerbaijan Republic, 2004, does not specify any official targets. Draft Law on Alternative and Renewable Energy Sources (ARES) was submitted to the Government for approval in 2011, but there is no information about its approval yet.

During the meeting of the intergovernmental working commission between the United States and Azerbaijan in April 2012, Dr. Akim Badalov, Director of SAARES (State Agency on Alternative and Renewable Energy Sources), made a point that Azerbaijan had set the following targets for the development of RE by 2020:

- 20% share of RE in electricity;
- 9.7% share of RE in energy consumption;
- 2,000 MW of installed RES capacity by 2020.

White Certificates market. No such scheme yet.

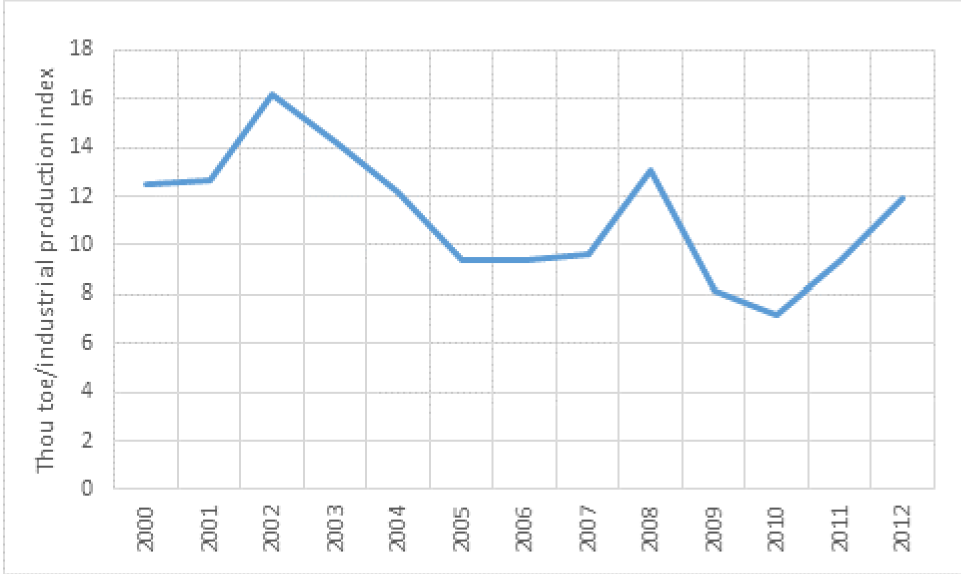
Heat and power generation and distribution: energy efficiency policy spending. Azerenergy has implemented a variety of measures and invested €250 million in the reduction of transmission losses and specific fuel consumption. Efforts are taken to reduce fuel use per kWh of electricity generation from 314 gce in 2011 to 260 gce by 2015 at thermal power plants (TPPs) by introducing new generation capacities and improving the parameters of the existing generation units. US$ 60 million have been secured for the development of RES in Azerbaijan[59].

[57] “Energy of Azerbaijan”. Statistical publication. 2014. Azerbaijan Statistical Committee).
[58] Ibid.
[59] http://www.encharter.org/fileadmin/user_upload/Publications/Azerbaijan_EE_2013_ENG.pdf

4.3 Industry

Industry energy intensity. The ratio of industrial energy consumption to industrial production index has been unstable since 2000, according to the data provided by Azerbaijan Statistical Committee[60] (Fig. 4.2). There is a slow decline trend with large business cycle fluctuations potentially related to capacity load fluctuations.

Figure 4.2. Industrial energy consumption per industrial production index (Azerbaijan Statistical Committee)



Source: IEA, Azerbaijan Statistical Committee

Energy intensity of basic industrial goods. No information is available on energy consumption for major industrial goods production.

Share of industrial CHP in the overall electricity generation. The share of on-site power generation increased from 0.7% to 7.7% over 2001-2012.

Energy efficiency regulations in the industrial sector. No information available.

Government agencies with an energy efficiency policy mandate in the industrial sector. No special agency, apart from the energy efficiency department of the Ministry of Industry and Energy.

Basic administrative mechanisms to improve energy efficiency in the industrial sector. No information.

Basic energy efficiency market mechanisms and economic incentive programmes. Pricing and taxation**.**

Industrial energy efficiency policy spending. No information available.

Long-term agreements. No information available.

Energy managers training programmes. No information available.

4.4 Buildings

Specific energy consumption per m^2 of residential floor space (energy intensity in residential buildings) significantly declined in 2000-2010.

[60] “Energy of Azerbaijan”. Statistical publication. 2014. Azerbaijan Statistical Committee; "Industry of Azerbaijan", Statistical yearbook, Azerbaijan Statistical Committee, Baku, 2014.

Table 4.2. Specific energy consumption by residential buildings, toe/ 10^3 m^2 living area

	Oil prod.	Natural gas	Biofuels	Electricity	Heat	Total
2000	0.75	25.02	0.24	11.35		37.37
2010	0.70	22.56	0.68	4.62	0.31	28.87
2011	0.58	22.50	0.71	4.69	0.45	28.93

Source: housing stock data from Azerbaijan Statistical Committee; consumption by residential sector: data from Azerbaijan Statistical Committee using low calorific value for natural gas

A recent study "Azerbaijan national case study for promoting energy efficiency investment. An analysis of the Policy Reform Impact on Sustainable Energy Use in Buildings"[61] presents a cost-benefit analysis of renovation of a typical multifamily house in Baku that was carried out under the INOGATE project. Energy use for space heating per m^2 before renovation was estimated at 209 kWh/year. However, this figure is correct only for urban households; single-family houses in rural areas obviously have higher unit energy consumption for space heating.

Specific energy consumption per m2 of public floor space. No statistical information is available on commercial buildings. Commercial and service sector energy consumption data are available from IEA and Azerbaijan Statistical Committee.

Specific energy consumption for space heating per m^2 of residential floor space per degree-day of heat supply season. Additional estimates are needed to see how much energy is used for space heating.

Specific hot water consumption per household with access to centralized DHW supply. Azerbaijan Statistical Committee estimates the share of "state, public and housing cooperatives and dwelling stocks (excl. privatized dwellings)" with access to DHW supply at 8.8%. However, no statistical information about hot water consumption is available from the Azerbaijan Statistical Committee.

Share of consumers equipped with water, electricity, natural gas and heat meters. Installation of water meters is just being launched in urban areas of Azerbaijan. Most households are billed for 2 m^3 per person per day. National water operator Azersu OJSC has spurred work on the use of prepaid water meters (smart-meters) for better account of water consumption by consumers, as reported in an article dated November 2012.[62] According to Azersu OJSC website, as of April 1, 2014, water meters were installed at 68,122 customers, or 54.6% of 1,223,272 households served by "Azersu" OJSC. 38,149 customers, or 82.2% of 46,388 non-household customers, have been supplied with water meters. According to mass-media, Azerbaijan is the first CIS country to install smart electricity meters on a large-scale (1.5 mln meters in 2010[63]). Installation of smart gas meters is also under way[64].

Building construction and renovation codes. The legislation is under development. As mentioned by EBRD (2008), Azerbaijan still uses the Soviet standard SNIP II-3-79 "Civil Heating Engineering" that specifies heat transfer resistance values for buildings, but does not classify buildings by the efficiency levels, as practiced in European and Russian standards[65].

Building certification. There is information in mass media about plans to launch Azerbaijan Green Building Council.

Equipment standards. No legislation in this area in force so far.

[61] United Nations Economic Commission for Europe, International Ecoenergy Academy. Azerbaijan national case study for promoting energy efficiency investment. An analysis of the Policy Reform Impact on Sustainable Energy Use in Buildings. Baku, 2013

[62] http://abc.az/eng/news_08_11_2012_69407.html

[63] http://www.news.az/articles/19475,

[64] http://www.metering.com/prepayment-metering-for-azerbaijan/, http://www.metering.com/smart-payment-gas-meter-project-expands-countrywide-in-azerbaijan/, http://en.trend.az/business/energy/2135218.html

[65] EBRD, 2008, Assessment of Sustainable Energy Investment Potential in Azerbaijan.

Household equipment certification programmes. No information available.

Administrative mechanisms of energy efficiency improvement. No information available.

Market mechanisms, incentives. Pricing and taxation**.**

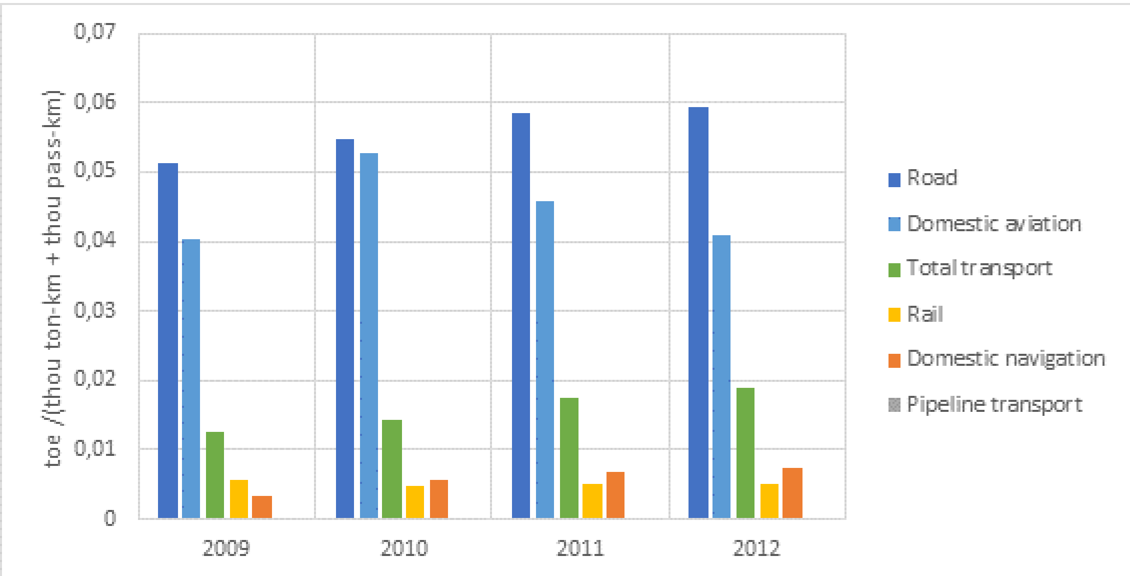
Energy efficiency spending and sources. It was announced, that EBRD is going to provide a US$ 5 million loan so that thousands of households and local businesses in Azerbaijan can implement energy-saving measures[66]. Demirbank will finance installation of energy efficient and renewable technologies, such as insulation, double-glazing, solar water heaters and rooftop solar panels. Another loan of US$ 3 million will be provided by EBRD to Muganbank to help local entrepreneurs and households to purchase and install more energy efficient equipment, appliances and materials. Energy efficiency in Azerbaijan is also promoted through the ESIB-INOGATE programme. The EU is financing Energy Reform Support Programme (ERSP), which will assist Azerbaijan in implementing the agreed priorities. The 'Sustainable Buildings in Azerbaijan; Technical Assistance and Capacity Building' project has been launched by the State Agency on Alternative and Renewable Energy Sources of Azerbaijan (SAARES) in partnership with Norsk Energi (Norway) for the three-year period between May 2011 and April 2014.

Educational programmes. The first Azerbaijani energy auditors received their diplomas in 2013 under the Norsk Energy – SAARES programme. The INOGATE project provides assistance to the Azerbaijan University of Architecture and Construction (AzUAC) in the development of a course curriculum and proposals for a Master's degree programme in "Energy Auditing and Management". Annual Caspian International Power and Energy Exhibition includes categories such as "Energy-efficient and energy-saving technologies and equipment" and a section for "Alternative Energy Sources".

4.5 Transport

Fuel efficiency. Energy balance published by the Statistical Committee provides estimates of energy consumption by different types of transport. Like other types of transport, road transport energy intensity has been growing recently (see Fig. 4.3).

Figure 4.3 Fuel efficiency of transport activity



Source: Azerbaijan Statistical Committee[67]

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[66] http://www.energylivenews.com/2014/08/24/5m-for-energy-efficiency-in-azerbaijan/
http://www.ebrd.com/russian/pages/news/press/2014/140820a.shtml

[67] Statistical Yearbook of Azerbaijan 2014, Azerbaijan Statistical Committee, Baku, 2014.

Table 4.3 Structure of passenger turnover (public transport only)

	2005	2009	2010	2011	2012
Total turnover, million passenger-km	**14747**	**19744**	**20997**	**22881**	**25074**
incl.:					
railway	6.0%	5.2%	4.4%	2.9%	2.4%
sea	0.0%	0.0%	0.0%	0.0%	0.0%
air	10.8%	7.5%	7.7%	9.2%	9.8%
trolleybus	0.0%	0.0%	0.0%	0.0%	0.0%
metro	9.4%	9.8%	8.7%	8.1%	7.9%
road	73.9%	77.4%	79.2%	79.8%	79.9%
bus	70.3%	73.4%	75.0%	75.5%	75.5%
taxi	3.5%	4.1%	4.2%	4.3%	4.4%

Source: Azerbaijan Statistical Committee[68]

Unit fuel consumption per thousand passenger·km. This indicator is down from 0.075 toe/thou pass-km in 2009 to 0.087 in 2012, according to Azerbaijan Statistical Committee. Estimates for road transport are 0.087 in 2009 versus 0.099 toe/thou passenger·km in 2012.

Share of light-duty automobiles in the passenger turnover. The share of road transport (mostly buses) is the largest in the passenger turnover in Azerbaijan.

Share of private cars in the total number of motor vehicles. Azerbaijan Statistical Committee provides information on the shares of different types of transport. Private cars constitute 80.7% of the total number of motor vehicles.

Table 4.4 Transport structure by types

	Motor vehicles, total units	cars	private cars	buses	trucks	cars for special purposes	other	motor-cycles
2005	612,069	78.3%	75.0%	4.4%	14.8%	1.6%	0.9%	0.6%
2009	925,866	82.0%	78.4%	3.2%	12.7%	1.3%	0.8%	0.2%
2012	1,135,936	84.4%	80.7%	2.6%	11.4%	1.1%	0.5%	0.2%

Source: Azerbaijan Statistical committee[69].

Freight turnover per unit of GDP. 1.65 ton-km per manat 2013 (1.32 ton-km per USD2013) in 2012; 1.5 ton-km per USD2013 in 2009 (primary data by Azerbaijan Statistical Committee).

Average fuel consumption per vehicle. Road transport consumed 1.74 toe per motor vehicle / year in 2012 versus 1.43 in 2009 (Azerbaijan Statistical Committee).

Share of electric and hybrid vehicles. No such categories in transport inventory – no electric cars yet. In March, an Azerbaijani car rent company announced that electric cars would be available for rent in the country in the near future. The company is going to deliver 250 to 300 electric vehicles from European manufacturers to Azerbaijan. The vehicles will be used for rent and hire, but there is also a possibility of their use as cabs in the future.

Fuel efficiency of new cars. No data and no legislation in this area.

Energy efficiency spending and sources. No information available.

[68] Statistical Yearbook of Azerbaijan 2014, Azerbaijan Statistical Committee, Baku, 2014.
[69] Ibid.

Administrative mechanisms. The enforcement of Euro-4 standards limited car imports since April 2014.

Market mechanisms. A dramatic increase in fuel consumption in the recent years made the government adopt some tough measures. Azerbaijan Tariff Council raised fuel prices, terms of car loans have become tougher, production of AI-95 gasoline has been suspended, whereas premium gasoline imports have been launched[70].

Government agencies with an energy efficiency policy mandate. No such agencies.

Road transport investment. Large-scale investment in the infrastructure: US$ 9 billion over 2005-2009 (US$ 4.5 billion in road construction and rehabilitation), US$ 13 billion for the modernization and construction of roads, railways and other physical infrastructure, including ports, in 2010-2015.

4.6 Technical energy efficiency potential for Azerbaijan

4.6.1 Approach and data sources

Technical energy efficiency potential for Azerbaijan was assessed based on the approaches described in the Inception report. Four sets of data were used for this purpose (Table 4.5). Data on economic activities in 2012-2013 were collected from national statistical sources which are listed in corresponding sections. Data on specific energy use in various applications were collected from official documents, programmes, presentations and publications. Where no appropriate data were available, proxies for countries in similar conditions were used. Assessments of the technical potential build on the comparisons of those energy efficiency indicators with specific energy consumption for best available technologies (BATs) for the same sectors and subsectors, as reported in multiple international sources.

Table 4.5 Data collection technology and structure

Information required	Source of information	Methods of data collection
Data on economic activity	Statistical yearbooks	Collection of statistical data
Data on specific energy consumption in different sectors in Azerbaijan	Statistical yearbooks, proxies for countries in similar conditions	Literature search
Data on specific energy consumption for best available technologies	Publications	Collection of data from publications on best available technologies
Energy prices	Azerbaijan Tariff Council	Collection of statistical data

Technical energy efficiency potential for Azerbaijan was assessed by multiplying the 2012-2013 activity level by the gap between the country-specific energy efficiency and energy efficiency BAT parameters for the same activity category.

Technical potential assessment was structured by different sectors including: power and heat generation, transmission and distribution, industry, transport, buildings, and other sectors, including agriculture, street lighting, water supply, etc.

For the purpose of identifying the economic and market potentials, the data on costs of saved energy were compared with 2013 or 2014 energy prices so as to see if a measure is economically viable.

Summary of energy efficiency potential estimation for Azerbaijan:

- Power and heat 1,678 thou tce
- Industry 1,844 thou tce
- Transport 878 thou tce

[70] http://en.apa.az/xeber_azerbaijan_makes_public_reason_for_remov_209495.html

- Services 413 thou tce
- Residential 3,766 thou tce
- **Total** **8.2 Mtce**

4.6.2 Power and heat

According to IEA and Azerbaijan Statistical Committee energy balances[71], about 7.5 Mtce of fuel are consumed annually to generate, transmit and distribute power and heat. CENEf's assessment of technical energy efficiency potential in this sector is 1.678 million tce (Table 4.6), or about one third of this sector's annual consumption.

CENEf's assessment builds on the energy use and power and heat generation data available from statistical yearbooks. Data on power generation in 2013 were borrowed from the statistical yearbook "Energy in Azerbaijan". Stations in Azerbaijan are almost entirely fueled with natural gas with a negligible amount of diesel fuel.

Heat generation in 2013 was 1,298 thousand Gcal. Of that volume 22% were generated by CHPs and 78% by boiler-houses. Again, the fuel used is almost 100% natural gas.

Table 4.6 Energy efficiency potential in power and heat generation, transmission and distribution (as of 2013)

Integrated technologies of goods, work, and services production	Units	Volume of economic activity	Units	Specific consumption in 2013	Practical minimum	Actual consumption abroad	Comments	Estimated technical potential, 1000 tce
Gas-fired district power plants (GRES) retrofits	mln kWh	14,870	gce/ kWh	226	205	262	Combined cycle gas turbines (CCGT), 60% efficiency	311
Gas-fired co-generation plants (TETs) retrofits	mln kWh	8,472	gce/ kWh	325	205	262	CCGT with 60% efficiency	1,016
Own needs consumption	mln kWh	23,350	%	6.9%	4.0%	5.0%	North America	83
Electricity transmission	mln kWh	19,701	%	16.6%	6.9%	7.0%	Japan	236.0
Gas-fired boilers retrofits	thou. Gcal	1,022	kgce/ Gcal	167	151		Equipment with 95% efficiency	16.4
Electricity consumption for heat generation by boilers	thou. Gcal	1,022	kWh/ Gcal	23	7	9	Finland	2.0
Heat distribution	thou. Gcal	1,122	%	14.2%	5.4%		Replacement of heat pipes (new technology)	14.1
Total for power and heat								**1,678**

Source: CENEf

[71] Energy of Azerbaijan. Statistical publication. Baku, 2014. Available at: stat.gov.az.

4.6.3 Industry

No data on specific energy use in industry is available in the national statistics, because energy balances in Azerbaijan do not break down industrial energy use by separate products, only by the value added. Therefore, mostly proxies (based on Russian experience in similar conditions) were used. In the case of specific energy use for oil production, Astrakhanskaya Oblast was chosen as a Russian region close to Azerbaijan. Surprisingly, energy balances by both IEA and Azerbaijan Statistical Committee state that no energy resources, other than crude oil, are used in oil refinery, and no electricity or heat is used in gas works. We find it unlikely. We estimated the technical potential in this field of economic activity using Russia's specific energy use for oil refinery.

The potential was estimated for 9 energy intensive homogenous products and for 7 cross-cutting technologies applicable across all industrial sectors.

The technical energy efficiency potential in industry is assessed at 1.844 Mtoe. Importantly, the assessment of the technical potential as shown in the table relies on many assumptions, is for indicative purposes only and needs improvement.

Reduction of associated gas flaring can also be allocated within the industrial sector. There are no precise data on associated gas flaring in Azerbaijan, but SOCAR indicates 276.4 million m^3 of venting and flaring in 2010 after the company took action to reduce gas flaring. In 2010, SOCAR gas production was 7,178 million m^3, so gas flaring amounted to 4%. Before the implementation of the flaring reduction programme, the share of gas flaring was about 8%, so this share was halved by SOCAR over 2008-2010. According to the SOCAR website, together with BP-Azerbaijan, operator of the oilfield block Azeri-Chirag-Guneshli, the company has successfully accomplished a gas flaring reduction project in Chirag field that brought the share of gas flaring down to 2%[72]. But SOCAR produces only about one thirdof Azerbaijani gas, so other gas production sites are probably less efficient in terms of gas flaring. In this study we estimate, that 5% reduction of gas flaring can yield at least 1,000 thou tce in savings.

Table 4.7 Energy efficiency potential in industry (as of 2013)

Integrated technologies of goods, work, and services production	Units	Volume of economic activity	Units	Specific consumption in 2013	Practical minimum	Actual consumption abroad	Comments	Estimated technical potential, 1000 tce
Oil production	10^3 t	43,500	kWh/t	10	10		Astrakhanskaya Oblast	0
Oil refinery	10^3 t	6,761	kgce/t	87	53.9	71	Global practice	224
Natural gas production	10^6 m^3	17,895	kgce/ 1000 m^3	8.7	5,9		Expert estimate	49.8
Iron ore production	10^3 t	141	kgce/t	12.5	8.5	10	Global practice	0.6
Rolled ferrous metal products	10^3 t	255	kgce/t	113.1	31	68	Global practice	21.0
Ethylene	10^3 t	79	kgce/t	799	458	683	Global practice	26.8
Cement production	10^3 t	2,296	kgce/t	13	11	13	Global practice	4.6
Meat and meat products	10^3 t	285	kgce/t	211	50		Chelyabinskaya Oblast	45.9
Bread and bakery	10^3t	1,181	kgce/t	157	89		Tambovskaya Oblast	80.1
Efficient motors	10^6 units	0.6	kWh/motor	9956	8507		Global practice	103.1

[72] http://neftegaz.ru/en/news/view/112739.

Integrated technologies of goods, work, and services production	Units	Volume of economic activity	Units	Specific consumption in 2013	Practical minimum	Actual consumption abroad	Comments	Estimated technical potential, 1000 tce
Variable speed drives	10^6 units	0.3	kWh/drive	9956	9356		Global practice	19.2
Efficient compressed air systems	10^6 m^3	3,381	kgce/ 1000 m^3	18	7		Global practice	39.4
Efficient oxygen production	10^6 m^3	614	kgce/ 1000 m^3	112	90		Global practice	13.8
Efficient industrial lighting	10^6 units	2	kWh/ lighting unit	247	160		Global practice	24.5
Efficient steam supply	10^3 tce	435	%	75%	100%		Global practice	108.9
Fuel savings in other industrial processes	10^3 tce	249	%	80%	100%		Global practice	49.7
Associated gas flaring	10^6 m^3	17,895	%	10.0%	5.0%		Federal requirements	1,033
Total								**1,844**

Source: CENEf

4.6.4 Transport

No data on specific energy consumption is available for light vehicles, buses or heavy vehicles. Therefore, CENEf used estimations for Russia as proxies for specific energy consumption, assuming that the age and model structure of the Azerbaijani vehicle park is similar to that in Russia. Reducing specific energy consumption by motor vehicles to comply with the best available parameters through the use of hybrids can bring 878,000 tce in energy savings.

Table 4.8 Energy efficiency potential in transport (as of 2013)

Integrated technologies of goods, work, and services production	Units	Volume of economic activity	Units	Specific consumption in 2013	Practical minimum	Actual consumption abroad	Comments	Estimated technical potential, 1000 tce
Hybrid light vehicles	10^3 units	959	tce/vehicle/year	1.3	0.76	0.88	Global practice	487.0
Hybrid buses	10^3 units	30	tce/vehicle/year	7.7	4.62	7.10	Global practice	92.0
Hybrid freight vehicles	10^3 units	130	tce/vehicle/year	5.8	3.47	5.64	Global practice	300.0
Total								**878**

Source: CENEf

4.6.5 Buildings

The buildings sector includes residential, public and commercial buildings. Industrial and agricultural buildings are not considered. While local statistical sources provide data on the energy use and living space in the residential sector, information on public and commercial buildings stock and energy use is scarce and not reliable.

In Azerbaijan, the share of district heat in the residential energy balance is extremely low. Residents mostly use natural gas for space heating in individual houses and electricity in big cities. Official statistical yearbook only provides information on the share of centrally heated buildings *excluding* privatized dwellings, whereas the latter account for more than 93% of the total living space. 65% of *non-privatized* buildings (i.e. 4.3% of the overall living space) are officially connected to district heating. This fact is evidenced by an urban household survey that showed that only 4.5% of respondents claim district heating as their primary heat source[73].

Extremely poor heat distribution system makes heat supply very unreliable. Statistical yearbooks do not provide any information on energy consumption for space heating alone, but in 2013 residential heat consumption was 100,900 tce. Assuming that 4.5% of the living space use district heating (5,000,000 m^2), annual energy use per 1 m^2 of an average building should be around 20 kgce. This is a relatively adequate figure, but it only represents energy consumption in a small part of the building stock. A recent study by UNECE[74] presents a cost-benefit analysis of renovation of a typical multifamily building in Baku city that was carried out under the INOGATE project. Energy use per m^2 before renovation was estimated at 209 kWh/year (25.7 kgce/m^2). In our analysis, this figure was assumed for energy consumption in an average multifamily building.

When assessing the economic energy saving potential in residential retrofits and based on the current structure of the energy balance in residential buildings, we assume that of all resources the major savings will be yielded in natural gas (75%) and electricity (25%).

Multifamily buildings account for 54% of the urban living stock[75], which was 59.6 million m^2 in 2013, so about 32.2 million m^2 can be attributed to multifamily buildings with 25.71 tce/m^2 energy losses. CENEf's estimate of energy use per 1 m^2 of single-family buildings (80.0 million m^2) is 33 tce/m^2.

Statistical yearbook on trade only provides data on the space used by shops, but not by offices or other commercial organizations. For countries with a similar level of development the ratio of public and commercial buildings to the housing living space is about 1:4-1:5[76]. Therefore, total public and commercial buildings space is about 23 million m^2. According to the energy balances, energy consumption in this sector in 2013 was 614,000 tce. Specific energy use is 26.7 kgce/m^2/year (217.1 kWh/m^2/year). Public and commercial buildings use mostly electricity (68%) and natural gas (23%). If 66% of the entire energy use in this sector is allocated to space heating, then specific energy use for space heating is about 18 kgce/m^2/year (146.3 kWh/m^2/year).

Total energy saving potential in buildings is estimated at almost 4 Mtce, including 3 Mtce in residential buildings and 1 Mtce in public and commercial buildings (Table 4.9).

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[73] Multi-apartment Housing in Azerbaijan: Issues Note. Housing And Communal Services In The South Caucasus. Infrastructure Department Europe and Central Asia Region. March, 2006.

[74] United Nations Economic Commission for Europe & International Ecoenergy Academy. Azerbaijan national case study for promoting energy efficiency investment. An analysis of the Policy Reform Impact on Sustainable Energy Use in Buildings. Baku, 2013.

[75] Multi-apartment Housing in Azerbaijan: Issues Note. Housing And Communal Services In The South Caucasus. Infrastructure Department Europe and Central Asia Region. March, 2006.

[76] M. Economidou. Project lead. EUROPE'S BUILDINGS UNDER THE MICROSCOPE. A country-by-country review of the energy performance of buildings. October 2011. Buildings Performance Institute Europe (BPIE); Transition to Sustainable Buildings. Strategies and Opportunities to 2050. IEA. 2013.

Table 4.9 Energy efficiency potential in buildings (as of 2013)

Integrated technologies of goods, work, and services production	Units	Scale of economic activity	Units	Specific consumption in 2010	Practical minimum	Actual consumption abroad	Comments	Estimated technical potential, 1000 tce
Housing								
Multi-family buildings renovation	10^3 m^2	32,200	kgce/m^2	25.7	7.1	20.6	60% of 2012 building codes requirements	599
Single-family buildings renovation	10^3 m^2	80,000	kgce/m^2	33.0	4.9	20.6	Passive buildings	2,248
Replacement of appliances with top efficient models	10^3 people	9,356	tce/person	0.044	0.022	0.12	Global practice	206
Lighting renovation	10^3light fixtures	36,839	W	50.85	20.00	35.0	Global practice	77
Renovation of the cooking equipment	$10^3$$m^2$	112,200	kgce/ m^2	3.50	1.50	2.80	Global practice	224
Total residential buildings								**3,353**
Public and commercial buildings								
Renovation of centrally heated commercial buildings	10^3 m^2	7,050	kgce/ m^2	26.0	7.1	18.0	60% of 2012 building codes requirements	77.0
Renovation of hot water use	10^3 m^2	5,875	kgce/ m^2	4.90	2.7	3.3	Global practice	12.9
Renovation of the cooking equipment	$10^3$$m^2$	5,640	kgce/ m^2	1.8	1.4	1.3	Global practice	2.1
Renovation of individually heated commercial buildings	10^3 m^2	16,450	kgce/ m^2	32.7	4.9	30.2	Global practice	215.5
Lighting renovation	10^3 m^2	23,000	kWh/ m^2	32.7	16.4	27.8	Global practice	47.3
Procurement of efficient appliances	10^3 m^2	23,000	kWh/ m^2	71.8	51.6	56.6	Global practice	58.3
Total public and commercial buildings								**413**
Total buildings								**3,766**

4.6.6 Economic and market energy efficiency potentials

Economic and market potentials are assessed based on the comparison of energy prices and the costs of saved energy. 2014 energy prices were used in this study (Table 4.10).

All the above measures are economically attractive for the society (with 6% discount rate used), except renovation of individually-heated commercial buildings (Fig. 4.4). So the economic potential is slightly lower, than the technical potential as assessed above (7,900 instead of 8,200 tce) without accounting for subsidies for deep housing retrofits and steady energy price growth for residential users.

If private parameters in economic decision-making are better reflected in the analysis via higher costs of capital (12% and 20% discount rates), then market energy efficiency potential may be assessed. It is lower, than the economic one, but not very much lower. For the two discount rates mentioned it stands at 7.9 and 5.0 Mtce correspondingly (Fig. 4.5 and 4.6). Making long-term funding for energy efficiency measures more easily available would allow it to bridge the gap between the economic and market energy efficiency potentials.

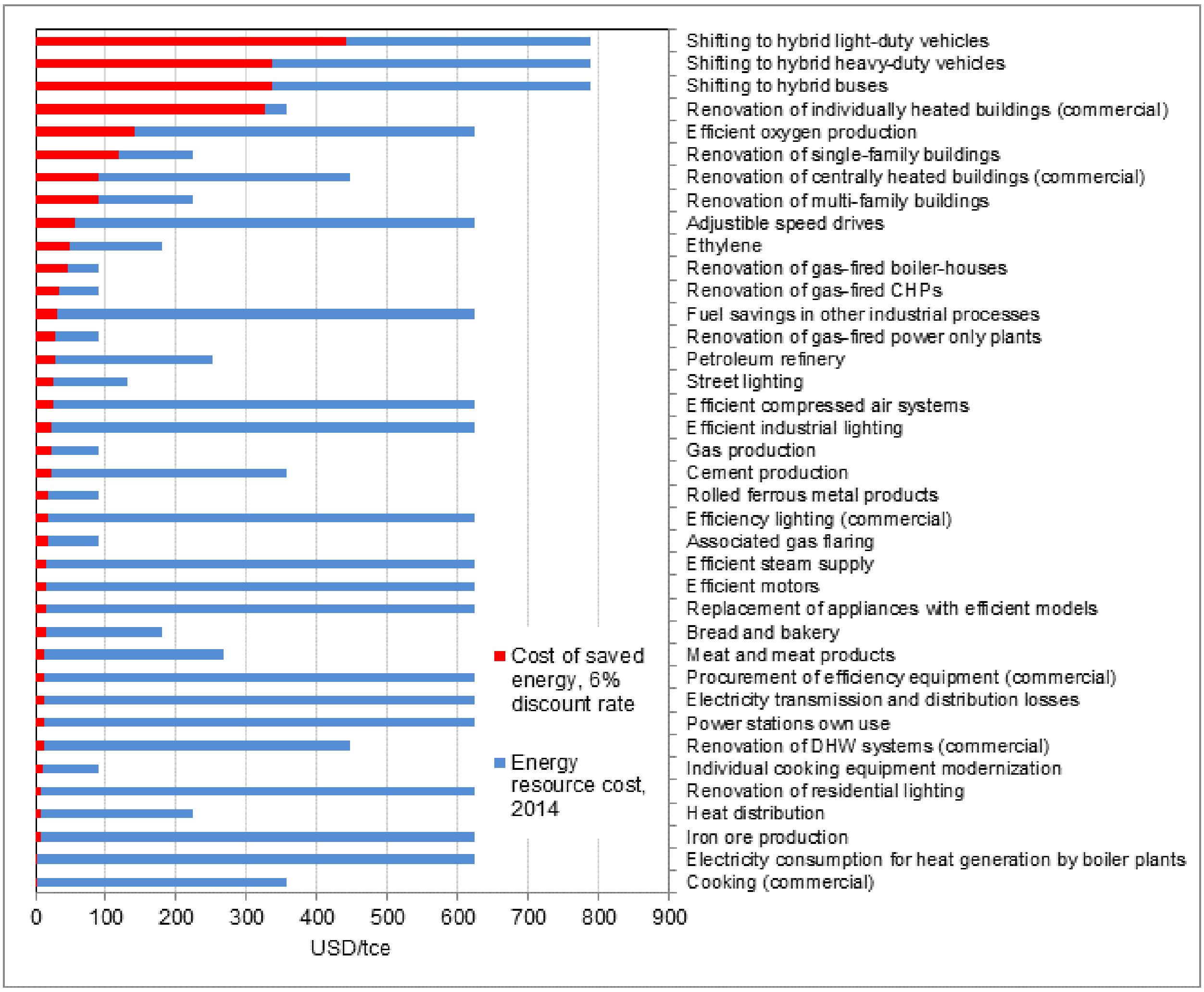
Even with current energy prices and 20% discount rate applied in investment decision-making, the market potential to improve energy efficiency in Azerbaijan amounts to approximately 26% of primary energy use.

Table 4.10 2014 Azerbaijan energy tariffs

Energy resource	Unit	Tariff, manat/unit	Tariff, USc/unit
Electricity for all consumers	kWh	0.06	7.68
District heating for residential users	m^2 living area per month	0.15	19.0
District heating for other users	Gcal	30	3,840 (=38.4 US$)
Hot water for residential users	m^3	0.4	51
Hot water for other users	m^3	1.50	192 (=1.92 US$)
Natural gas (retail)	10^3 m^3	1	128 US$
Natural gas sales to chemical and aluminium enterprises, steel works, and electricity generating companies that need natural gas for production purposes, by connecting to gas mains directly (providing monthly consumption is at least 10 billion m^3)	10^3 m^3	0.8	102.4 US$
Gasoline (AI-95) – retail	ton		1,341
Gasoline (AI-92, 80) – retail	ton		1,174
Diesel – retail	ton		914

Source: Azerbaijan Tariff Council

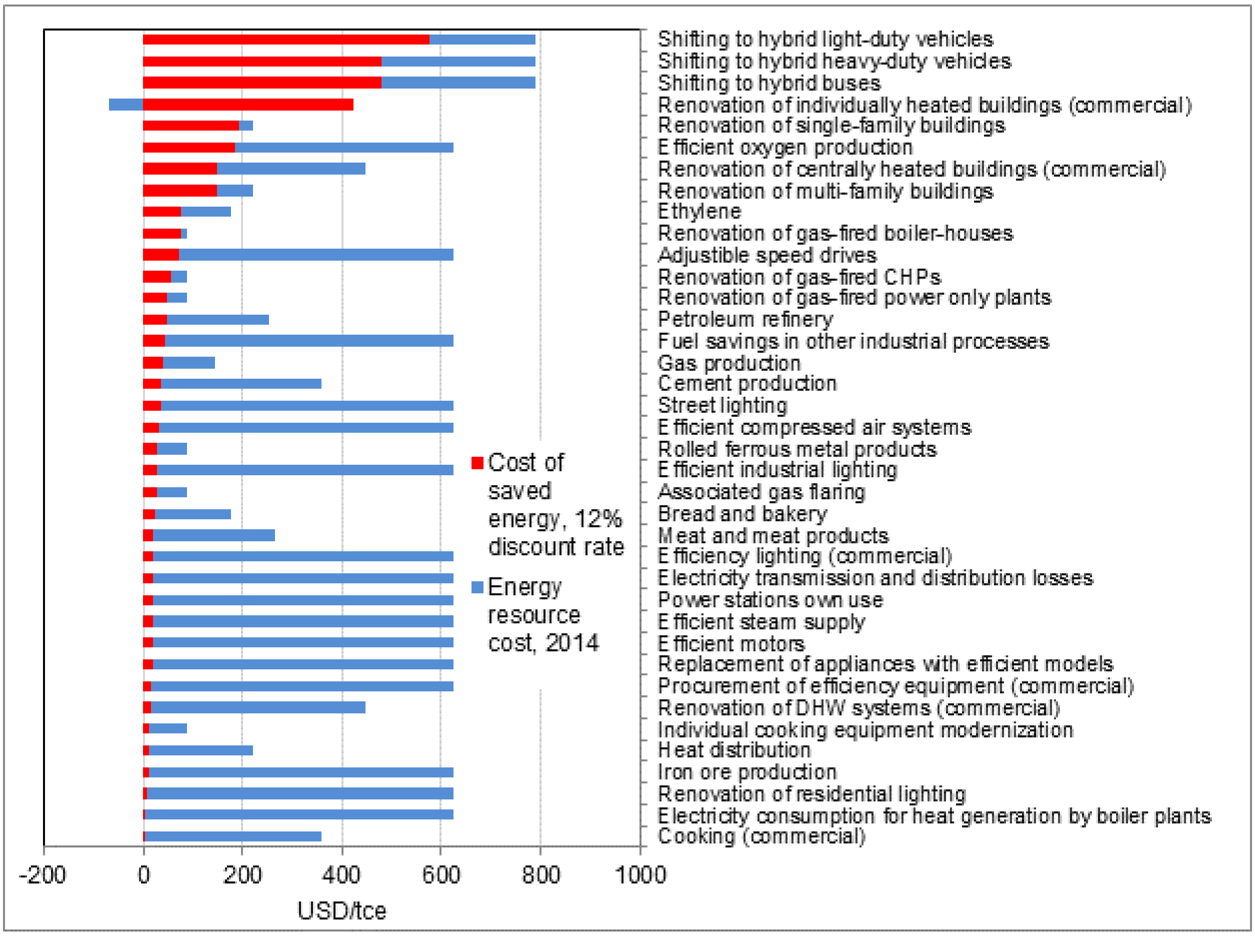
Figure 4.4. Economic energy efficiency potential for Azerbaijan (for 6% discount rate)



The figure shows the costs of saved energy (red) and the gap between the energy price in a given activity and the cost of saved energy (blue). Due to the fact that different energy carriers are used in individual activities the price is average weighted for all energy carriers used. All prices are presented in US$/tce. If the gap is negative, the measure is considered economically not attractive and is excluded from the economic potential assessment.

Sources: CENEf

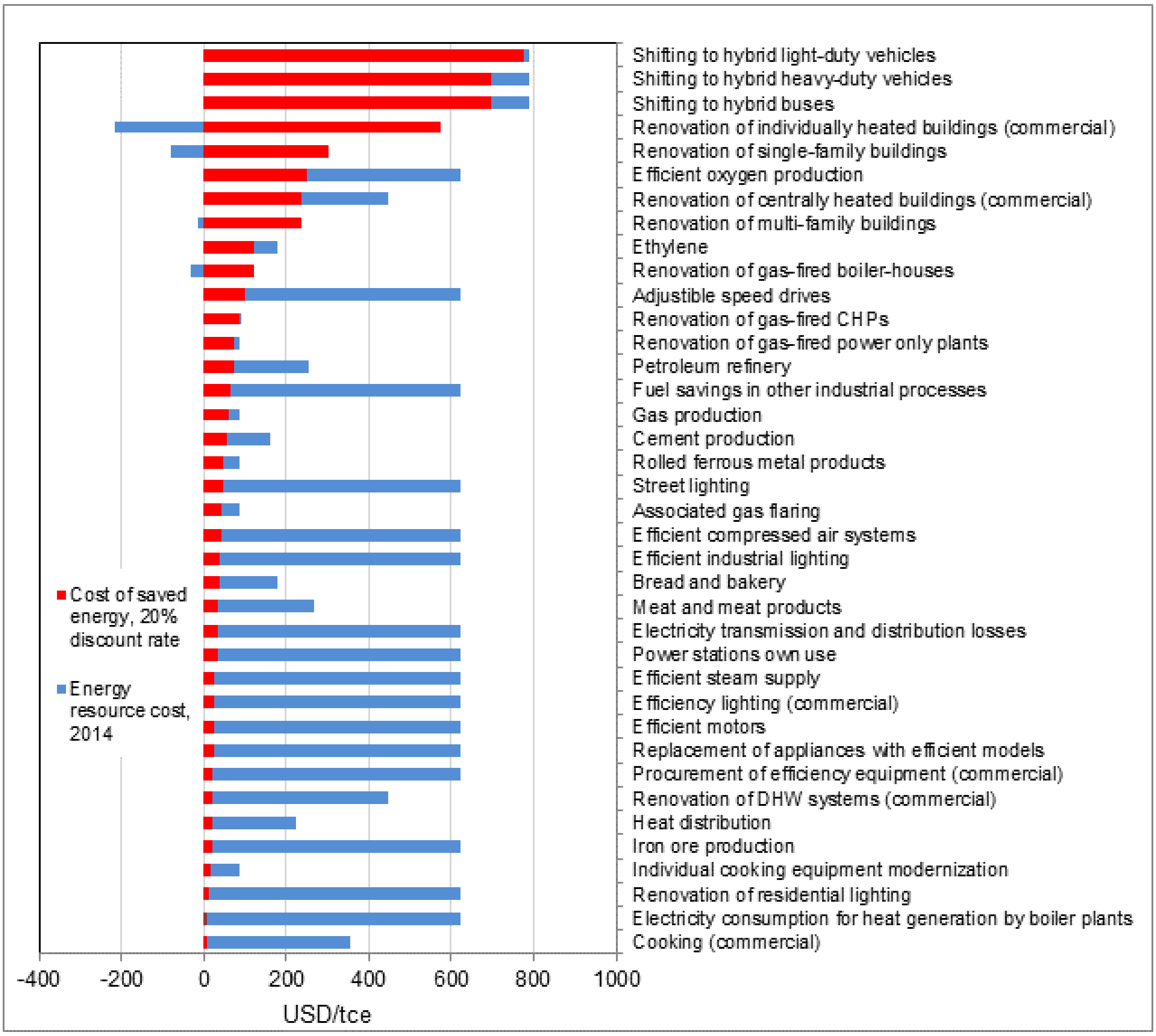
Figure 4.5. Market energy efficiency potential for Azerbaijan (for 12% discount rate)



The figure shows the costs of saved energy (red) and the gap between the energy price in a given activity and the cost of saved energy (blue). Due to the fact that different energy carriers are used in individual activities the price is average weighted for all energy carriers used. All prices are presented in US$/tce. If the gap is negative, the measure is considered economically not attractive and is excluded from the market potential assessment.

Sources: CENEf

Figure 4.6. Market energy efficiency potential for Azerbaijan (for 20% discount rate)



The figure shows the costs of saved energy (red) and the gap between th eenergy price in a given activity and the cost of saved energy (blue). Due to the fact that different energy carriers are used in individual activities the price is average weighted for all energy carriers used. All prices are presented in US$/tce. If the gap is negative, the measure is considered economically not attractive and is excluded from the market potential assessment.

Sources: CENEf

4.6.7 Comparisons of estimated total technical energy efficiency potentials

Ministry of Energy estimates the energy savings potential in Azerbaijan at 10 million tce per year[77]. While making this statement, the Energy Minister also made a point that this potential was mostly in the buildings sector. In the same interview he announced a National Programme of the efficient use of energy resources for 2014-2020; however, it was mentioned that the work was at an early stage as of February 2014, when the Ministry approached stakeholders with a request to set up a working group to develop the programme. There is no information on how this estimate of 10 million tce per year was obtained. CENEf's estimate is 8.2 million tce per year. The real figure may be higher, because specific energy consumption in certain economic activities may be higher in Azerbaijan, than in Russia, and mostly Russian data were used in this analysis as proxies.

A paper titled "Azerbaijan national case study for promoting energy efficiency investment. An analysis of the Policy Reform Impact on Sustainable Energy Use in Buildings"[78] estimates savings from switching to efficient lighting in residential, commercial, industrial buildings and in the street lighting. The authors claim that 1.1 billion kWh (94,600 toe, or 135,300 tce) of energy can be saved annually, if Azerbaijan goes for the replacement of all incandescent lamps with energy efficient lighting. This is very close to CENEf's estimate of potential energy savings in lighting: 148,000 tce.

The Austrian Bank (Osterreichische Entwicklungsbank) published a report on Azerbaijan energy efficiency potential in 2013[79]. The report provides an overview of the energy efficiency situation in the country. However, the authors do not directly assess the energy saving potential from energy efficiency improvements, but aim at highlighting the sectors with the largest potential. The authors come up with a finding that the most attractive sectors for energy efficiency investments include energy intensive industries and residential sector (primarily due to the lack of energy efficiency standards), but low energy prices translate into long paybacks.

[77] http://www.cte.az/2015/?p=news__read&t=top&q=18&l=en.

[78] Azerbaijan national case study for promoting energy efficiency investment. An analysis of the Policy Reform Impact on Sustainable Energy Use in Buildings. United Nations Economic Commission for Europe & International Ecoenergy Academy.

[79] Energy Efficiency Finance. Task 1: Energy Efficiency Potential. Country Report: AZERBAIJAN. Prepared for OeEB by Allplan GmbH in cooperation with Frankfurt School and Local Partners Vienna, October 2013.

Section 5. Belarus

5.1 National level

Population in 2012: 9.46 mln; GDP PPP in 2012: 142.31 bln US$2005 (IEA[80]).

Evolution of GDP energy intensity. IEA reports 4.7% GDP MER annual energy intensity decline over 2000-2012 and 5.5% decline per year for GDP PPP energy intensity. According to the Ministry of Economy, this process has been slowing down in the recent years.

Local sources report 65% decline in GDP energy intensity since 1995 and 30% decline over 2007-2012. The strategic goal is to cut GDP energy intensity by 60% of the 2005 level by 2020.

It is reported that energy costs incurred by all consumers equal 24% of GDP[81]. It seems unlikely though. A country with so huge economic burden of energy costs just has no chance to maintain economic growth. However, energy efficiency must be really a priority for the government.

Energy prices. Mid-2014 electricity prices for residential customers are 0.07 US$/kWh, heat prices are 8.42 US$/Gcal. Natural gas price for the residential sector is 50 US$/1,000 m^3.

Energy efficiency legislation. Federal Law No. 190-Z "On Energy Conservation" is the basic piece of legislation. In addition, some aspects are regulated by Law No. 176-Z "On Natural Gas Supply".

Number of energy efficiency regulatory acts. These include building codes, Republican energy efficiency programme for 2011-2015; Programme to develop a system of energy efficiency technical norms, standards and compliance monitoring for 2011-2015 (incl. Amendments No. 1 and 2 thereto); etc.

Government agencies with an energy efficiency policy mandate. Energy Efficiency Department which reports to the State Committee on Standardization is the main government agency responsible for the implementation of energy efficiency policies.

Basic administrative mechanisms to improve energy efficiency: energy conservation targets have been set in federal, regional, and sectoral programmes, standards for specific energy use, building codes, energy data reporting, energy expertise[82].

Basic energy efficiency market mechanisms and economic incentive programmes: federal subsidies and grants, soft lending with 50% interest subsidy (major support mechanism since 2006), subsidies for buildings retrofits; taxation and pricing policies.

Energy efficiency policy spending and financial sources. In 2012, energy efficiency spending through regional and sectorial programmes totaled to US$ 1.335 billion, including US$ 0.456 billion (34.2%) in private investments; US$ 0.526 billion (39.4%) in loan financing; and US$ 0.166 billion (12.4%) from public funds. For 2013, expected budget was US$ 1.693 billion. As a major stockholder in many companies, the government controls energy efficiency investment.

Energy efficiency R&D spending. No data on energy efficiency research and development spending have been found.

ESCO market. No regulation in support of ESCO schemes has been developed so far. The World Bank project "Development of ESCO in the Republic of Belarus" accomplished in 2004-2005 established 4 ESCOs in the country. Today, their efforts basically focus on the construction of small CHPs.

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[80] http://www.iea.org/statistics.
[81] http://portal-energo.ru/articles/details/id/410.
[82] S. Koval. Organization of energy conservation in Belarus. Electronic magazine. ESCO. No. 8, August 2012.

Water efficiency policy. In 2011, the Government of Belarus adopted federal programme "Clean Water" for 2011-2015.

International cooperation. Belarus has been involved in international energy efficiency cooperation. There were and are projects with the World Bank, UNDP/GEF, ORENA, DENA, REA, etc. The scale of all these projects is relatively small: several millions US$.

5.2 Heat and power generation and transmission

Power generation efficiency. According to IEA, average power generation efficiency is 39%. Local sources[83] report 48%. It is worthwhile applying fuel use allocation method for CHPs to check this indicator for credibility.

Share of CHP in power generation is over 99%.

Power transmission and distribution losses. Local statistical sources report 10% losses in the recent years.

Heat generation efficiency. Average efficiency of boilers is 85%. Boilers contribute 47% to overall district heat generation.

Heat transmission and distribution losses. Country sources report losses of 9.4-9.6% in 2012-2013. Other sources report heat losses at 26% 10 years ago and 17% today, and the government intends to reduce them to 10-12% by 2015.

Energy efficiency regulations in heat and power generation and distribution. The federal programme on the energy sector development requires reduction of specific energy use for power generation by 23-30 gce/kWh and 2% decrease in power transmission and distribution losses by 2016.

Government agencies with an energy efficiency policy mandate in heat and power generation and distribution. The government agency responsible for energy efficiency policy implementation in the heat and power sector is the Ministry of Energy.

Basic administrative mechanisms to improve energy efficiency in heat and power generation and distribution: energy conservation targets have been set by federal and sectorial programmes, standards for specific energy use, energy data reporting, energy expertise.

Basic energy efficiency market mechanisms and economic incentive programmes: federal subsidies and grants, soft lending with 50% interest subsidy (major support mechanism since 2006), pricing and taxation policies.

Renewables development programmes. The strategic goal is to increase the share of renewables in the heat source balance from 13% in 2005 to 25% in 2020. A programme has been adopted to stipulate construction of small hydropower plants to increase generation to 0.51 billion kWh.

White Certificates market. No such programmes launched so far.

Heat and power generation and distribution: energy efficiency policy spending. Some funds allocated for energy efficiency purposes (see above) are used in the power and heat sectors; no specific data have been found so far.

5.3 Industry

Industrial energy intensity. According to UNIDO, energy intensity of the industrial sector in Belarus declined by 44% in 1990-2000 and by another 50% in 2000-2008 (expressed in tonnes

[83] Belarus Federal Energy Development Programme to 2016; Republican Energy Efficiency Programme for 2011-2015.

of oil equivalent per US$1,000 of manufacturing value added)[84]. This decline was driven mostly by structural shifts.

In 2008-2012, industrial production index was up by 16%. At the same time, electricity consumption showed moderate growth: by 7.5%, and heat consumption by only 1.9% (both over the whole period).

Energy intensity of basic industrial goods. Belarus provides data on specific energy use for the manufacture of some industrial products. In 2009-2013, specific energy use declined in automobiles (36% decline), tractors (18% decline) and fertilizers (16% decline) production and grew up in petroleum refinery (15% growth) and cement production (3% growth)[85].

Share of industrial CHP in the overall electricity generation: about 10%.

Energy efficiency regulations in the industrial sector. Many energy intensive industrial enterprises are government-owned. The government specifies energy conservation targets for them. For example, Federal programme for the technical upgrades of foundries, thermal processes, plating and other energy intense industries for 2010-2015 requires nearly 100 thousand tce in savings by 2015.

Government agencies with an energy efficiency policy mandate in the industrial sector. Energy Efficiency Department, which reports to the State Committee on Standardization.

Basic administrative mechanisms to improve energy efficiency in the industrial sector: energy conservation targets set by federal and sectorial programmes, standards for specific energy use, energy data reporting, energy expertise.

Basic energy efficiency market mechanisms and economic incentive programmes: federal subsidies and grants, soft lending with 50% interest subsidy (major support mechanism since 2006), pricing and taxation policies.

Long-term agreements. None.

Energy management systems. There was a standard for energy management introduced in 2009 (STB 1777 *Energy Management Systems. Requirements for Application*), which is in full compliance with the EU standard (ISO 50001 / DIN EN 16001 *Energy Management*). However, it is not applied on a full-scale so far.

Industrial energy efficiency policy spending. Some funds allocated for energy efficiency purposes (see above) are used in the industrial sector; no specific data available.

5.4 Buildings

Specific energy consumption per square meter of residential floor space (energy intensity in residential buildings). Specific energy consumption for space heating and DHW supply to multifamily buildings depends on the building age and type. For dated buildings (built before 1993) specific energy consumption is 230 kWh/m^2; for new buildings (built after 2009) it is 130 kWh/m^2. For energy efficient buildings it was set at 70 kWh/m^2.[86]

Specific energy consumption per m^2 of public floor space. This information is yet to be found. Based on the Russian experience, it should be very close to residential specific energy use, or to 240-300 kWh/m^2.

[84] UNIDO. Industrial Development Report 2011. Industrial energy efficiency for sustainable wealth creation. Capturing environmental, economic and social dividends.
[85] Industry in the Republic of Belarus, 2014. Statistical yearbook. National Committee for Statistics of the Republic of Belarus.
[86] Comprehensive Programme for Design, Construction and Renovation of Energy Efficient Buildings for 2009-2010 with a Perspective to 2020.

Specific energy consumption for space heating per m^2 of residential floor space per degree-day of heat supply season. Specific energy consumption for space heating alone depends on the number of heating degree-days**,** the building age and type. For dated buildings (built before 1993) it is 130 kWh/m^2. For new buildings (built after 2009) it is 90 kWh/m^2. For energy efficient buildings it is set at 40 kWh/m^2.

Specific hot water consumption per resident with access to centralized DHW supply. Specific energy consumption of hot water in multifamily buildings is 221 kgce/person (1,800 kWh/person). For energy efficient buildings it is 95 kgce/person (772 kWh/person).

Share of consumers equipped with energy meters. Based on the data from several sources, the share of individual dwellings with electricity meters is above 95%, and of those with water meters above 90%.

Building codes requirements. Energy efficiency parameters specified for new, upgraded and retrofitted buildings are quite tough. Energy consumption for space heating and ventilation in new buildings is not to exceed 60 kWh/m^2 (with natural ventilation) and 40 kWh/m^2 (with mechanical insulation). In 2009, the government developed a comprehensive programme for design, construction and renovation of energy efficient buildings for 2009-2010 with a perspective to 2020. The goal is to reduce energy use for space heating and ventilation to the above levels.

Other administrative mechanisms to improve energy efficiency: energy metering requirements; energy efficiency standards and labelling for appliances, buildings certification by energy efficiency classes; energy data reporting; energy expertise.

Basic energy efficiency market mechanisms and economic incentive programmes in the buildings sector: subsidies and soft loans for buildings retrofits and building-level meters installation; taxation and pricing policies.

Government agencies with an energy efficiency policy mandate in the buildings sector. Energy Efficiency Department, which reports to the State Committee on Standardization.

Information and educational programmes. There are multiple educational activities, like exhibitions, demo projects, exhibitions, and propaganda.

Buildings energy efficiency policy spending. Some funds allocated for energy efficiency purposes (see above) are used in the buildings sector; no specific data available.

5.5 Transport

Specific energy consumption per unit of transport service. Official statistics on transport do not report data on specific energy use by types of transport.

Government agencies with an energy efficiency policy mandate in the transport sector. Energy Efficiency Department, which reports to the State Committee on Standardization.

Share of light-duty automobiles in the passenger turnover. These data are not reported by the official statistics. However, there are data on the numbers of cars, trucks and buses in use, and with certain assumptions the share of light-duty automobiles can be estimated. In 2005-2013, the number of automobiles went up by 16% and the number of private cars by 67%.

Cargo turnover per unit of GDP. It declined by 14% between 2009 and 2012.

Fuel efficiency of new light-duty vehicles. No official data available.

Energy efficiency policy spending. In 2008-2012, investments in energy efficiency policy implementation in the transport sector increased 2.4-fold to US$ 13 million.

Energy efficiency regulations in the transport sector. No information is available.

Government agencies with an energy efficiency policy mandate in the transport sector. Energy Efficiency Department, which reports to the State Committee on Standardization.

Basic administrative mechanisms to improve energy efficiency in the transport sector: energy conservation targets have been set in federal and sectorial programmes, standards for specific energy use, energy data reporting, and energy expertise.

Basic energy efficiency market mechanisms and economic incentive programmes in the transport sector: federal subsidies and grants, soft lending with 50% interest recovery (major support mechanism since 2006), pricing and taxation policies.

Long-term agreements for transport. None.

5.6. Technical energy efficiency potential for Belarus

5.6.1 Approach and data sources

Technical, economic and market energy efficiency potentials for Belarus were assessed based on the approaches described in the Inception report. Four sets of data were used for this purpose (see Table 5.1). Data on the economic activities were basically collected from national statistical sources for 2010-2013. Data on specific energy use in different applications were collected from the information provided by energy and gas utilities and from official documents (company annual reports, investment programmes, energy efficiency programmes), presentations and publications in the public domain. Where the required information was not available, proxies for countries with similar climate and economic conditions were used.

The assessment of the technical potential in Belarus builds on the comparison of actual specific energy consumption in various applications against specific energy consumption for BATs for the same sectors and subsectors, which were collected from multiple international sources.

Table 5.1 Data collection technology and structure

Information required	Source of information	Methods of data collection
Data on economic activities	Statistical yearbooks and reviews	Collection of statistical data
Data on specific energy consumption in various sectors in Belarus	Information provided by energy and gas utilities and from official documents (company annual reports, investment programmes, energy efficiency programmes), presentations and publications in the public domain	Data search
Data on specific energy consumption for BATs	Publications in the public domain	Literature search
Energy tariffs for various consumer groups in Belarus	Statistical energy price yearbooks, information provided by energy utilities (Belenergo, Beltopgas, Belarus oil company)	Data search

The technical energy efficiency potential for Belarus is assessed by multiplying the 2010-2013 activity level by the gap between the country-specific energy consumption and BAT energy consumption for the same activity.

The technical potential assessment is structured by different sectors, including:

- power and heat generation, transmission and distribution,
- industry,
- transport (pipeline, air, automobile, urban electric, and railroad),
- buildings,
- agriculture,

- street lighting, and
- water supply.

Where possible, estimates generated in this study are compared with local estimates of the energy efficiency potential for similar activities.

Where reliable information for some energy use activities was not available, such activities were skipped from the potential evaluation study.

Evaluation of the economic and market potentials helps reveal the most effective measures and technologies that may be recommended for Belarus. So as to identify the economic and market potentials, the costs of saved energy were compared to the 2013 energy prices in order to see if an individual measure is economically viable.

Summary of energy efficiency potential estimation for Belarus:

- Power and heat 3,721 thou tce
- Industry 4,077 thou tce
- Transport 2,783 thou tce
- Residential and public buildings 4,904 thou tce
- Other 734 thou tce
- **Total** **16.2 Mtce**

5.6.2 Power and heat

CENEf's assessment of the technical energy efficiency potential in the power and heat sector (power and heat generation, transmission, and distribution) builds on the official data provided by the largest energy and gas utilities in Belarus (Belenergo, Beltopgas) and data available from statistical yearbooks, energy efficiency programmes, reports, presentations, and publications in the public domain (including internet resources).

Information on the power and heat generation, transmission, and distribution in 2013 was obtained from the data provided by Belenergo and the National Committee for Statistics of Belarus.

Natural gas is the basic fuel used by thermal power plants and boilers (95.5%). The share of residual oil is 2.5%, fuel wood 0.6%, peat and lignin 0.5%, associated gas 0.9%.

Total installed electric capacity as of 01.01.2014 was 9,221 MW, including large and small thermal power plants of Belenergo (91.9%), large and small on-site industrial cogeneration plants (7.7%), hydropower plants (0.3%), and windpower units (0.02%).

In 2013, total power generation by power plants amounted to 31.507 billion kWh, including 28.515 billion kWh (90.5%) by power plants of Belenergo and 2.992 billion kWh (9.5%) by large and small co-generation plants. Transmission and distribution losses in 2013 were 3.537 billion kWh (9.9%).

Total heat production in Belarus was 69.482 million Gcal in 2013, including:

- 30.488 million Gcal (43.9%) by utility cogeneration plants;
- 14.433 million Gcal (20.8%) by district boilers;
- 11.725 million Gcal (9.5%) by on-site industrial boilers;
- 6.582 million Gcal (9.5%) by heat recovery units;
- 6.030 million Gcal (8.7%) by large and small on-site cogeneration plants;
- 224 thousand Gcal (0.3%) by utility condensation thermal power plants.

Distribution heat losses in 2013 equaled 5.747 million Gcal (9.4%).

In 2013, thermal power plants and boilers used 17.805 million tce of fuel (20,226 million m^3 of natural gas), including 13.505 million tce (75.9%) by thermal power plants and 4.3 million tce (24.1%) by boilers.

Information on specific energy use in the power and heat sector was obtained from data provided by energy and gas utilities (Table 5.2). In some instances, specific energy consumption was assessed using proxies, including parameters for similar installations in Russia.

Table 5.2 Energy efficiency potential in Belarus power and heat sector (as of 2013)

Integrated technologies of goods, work, and services production	Units	Volume of economic activity	Units	Specific consumption in 2010	Practical minimum	Actual consumption abroad	Comments	Estimated technical potential, 1000 tce
Gas-fired condensation power plants retrofits	mln kWh	12,404	gce/ kWh	254.9	205	220	CCGT with 60% efficiency (practical minimum); CCGT with 56% efficiency− 58.2% (best CCGT in Russia)	619
Gas-fired cogeneration plants retrofits	mln kWh	18,637	gce/ kWh	254.9	205	220	CCGT with 60% efficiency (practical minimum); CCGT with 56% efficiency− 58.2% (best CCGT in Russia)	930
Reduction of own needs electricity consumption	mln kWh	31,041	%	6.6	4.0	5.0	Global practice (North America)	99
Electricity transmission	mln kWh	35,798	%	9.88	3.5	5.0	Global practice (France, Italy, Spain)	280.9
Gas-fired boilers retrofits	thou. Gcal	26,158	kgce/ kWh	165	152	154	Boiler units with 92…94% efficiency	331.5
Reduction of electricity consumption for heat generation by boilers	thou. Gcal	26,158	kWh/ Gcal	20	7	9	Finland	41.8
Heat distribution	thou. Gcal	61,396	%	9.36	5.0		Improving energy efficiency of the heat networks	382.8
Cogeneration by boilers (transformation of boiler-houses into small cogeneration plants)	mln kWh	3,602					Installation of gas reciprocating units, gas turbines and steam turbines in boiler-houses	443.0
Heat recovery	thou. Gcal	6,528	%	27	90		Global practice	593
Total for heat and power								**3,721.3**

Source: estimated by CENEf

CENEf estimates the technical potential in Belarus heat and power sector at 3.721 million tce, or 21% of the total annual energy consumption by this sector.

According to the Belarus Federal Energy Development Programme to 2016, energy resource savings are expected to be 3.28 million tce (1.265 million tce through energy efficiency technologies at energy generation sites of Belenergo and 2.015 million tce through heat recovery by Belenergo facilities).

CENEf's assessment of the energy efficiency potential in Belarus power and heat sector is pretty close to this figure, while the structure of the potential is different from the one provided in the Federal Energy Development Programme to 2016. CENEf estimates energy savings that can be obtained through energy efficiency technologies at thermal power plants, boilers, in heat and power transmission and distribution at 3.128 million tce and through heat recovery at 0.593 million tce.

According to the Republican Energy Efficiency Programme for 2011-2015, implementation of energy saving technologies and measures in the heat and power sector are expected to bring 2,950,000 to 3,860,000 tce in savings. CENEf's estimate is close to the upper limit of this range. According to the Republican Programme on the Transformation of Boiler-houses into Small Cogeneration Plants for 2007-2010, expected energy savings amount to 155.7 thousand tce. CENEf estimates the technical EE potential of boiler-houses transformation into small cogeneration plants at 443 thousand tce. The difference between the two estimates is determined by the fact that the Republican programme only includes the largest boiler-houses (in all, 47 boiler-houses with 1,747 Gcal/hr total installed capacity).

5.6.3 Industry

The scale of economic activity in the industrial sector was taken from the data provided by the National Committee for Statistics (statistical yearbook "Industry of the Belarus Republic 2014"). Some use was made of the data from annual reports of the leading industrial companies (Belarus steel works, Grodno-Azot, Belaruskaliy, Belshina, Belarusneft). Energy consumption in the basic industries was obtained from the National Committee for Statistics and the Energy Efficiency Department of the Federal Committee for Standardization.

In 2013, industrial energy consumption amounted to 10.59 million tce. The technical potential was estimated for 14 energy intensive products and 5 cross-cutting technologies (Table 5.3).

Specific energy consumption in the manufacture of most products was taken from the statistical yearbook "Industry of the Belarus Republic 2014". In some instances, specific energy consumption was assessed using proxies for Russia (industries and technologies with similar technical parameters and conditions).

CENEf estimates the technical energy efficiency potential in the industrial sector at more than 4 million tce, or 38% annual industrial energy use. According to the Republican energy efficiency programme for 2011-2015, introduction of state-of-the-art energy efficient technologies, processes, equipment will bring 2 to 2.4 million tce in energy savings implementing a substantial part of the potential.

Table 5.3 Energy efficiency potential in industry (as of 2013)

Integrated technologies of goods, work, and services production	Units	Scale of economic activity	Units	Specific consumption in 2010	Practical minimum	Actual consumption abroad	Comments	Estimated technical potential, 1000 tce
Oil refinery	10^3ton	21,156	kgce/t	115	53.9	75.1	Global practice	1,293.3
Oil production	10^3ton	1,645	kWh/t	143	40.0		Global practice	20.9
Gas production	10^6 m^3	228	kgce/ 1,000 m^3	8,7	5.9		Expert estimate	0.6
Electric steel (electric furnace melting)	10^3ton	2,394	kgce/t	125.0	50.0	80.6	Global practice	179.6
Iron ore rolled products	10^3ton	2,159	kgce/t	47.6	31	68.0	Global practice	36.5
Mineral fertilizers	10^3ton	5,280	kgce/t	106	85	131	Global and Russian practice	111.9
Ethylene	10^3 ton	138	kgce/t	848	458	683	Global and Russian practice	53.9
Rubber tyres (for cars and trucks)	10^3 units	5,568	kgce/pcs.	21	12	34	Russian practice	50.7
Pulp	10^3 ton	33	kgce/t	539	404	485	Global practice	4.4
Paper and cardboard	10^3 ton	334	kgce/t	347	241	320	Global practice	35.4
Cement	10^3 ton	5,057	kgce/t	186	110	158	Global practice	386.3
Glass (cast and float glass)	10^3 ton	36,797	kgce/t	510	204	250	Russian practice	901.1
Meat and meat products	10^3 ton	985.5	kgce/t	181	50		Russian practice	129.0
Bread and bakery	10^3ton	312	kgce/t	165	89		Russian practice	23.7
Efficient motors	10^6 units	0.81	kWh/ motor	9,956	8,507		Global practice	143.9
Variable speed drives	10^6 units	0.36	kWh/drive	9,956	9,356		Global practice	26.8
Efficient industrial lighting	10^6 units	3.2	kWh/unit	247	160		Global practice	34.5
Efficient steam supply systems	10^3 tce	1,122	%	65	100		Global practice	392.7
Fuel savings in other industrial processes	10^3 tce	996	%	80	100		Global practice	199.1
Total for industry								**4,077.9**

Source: estimated by CENEf

5.6.4 Transport

The scale of economic activity in the transport sector and energy consumption by basic vehicles were obtained from the National Committee for Statistics (statistical yearbook "Transport and communications in the Republic of Belarus 2014") and the energy efficiency department of the Federal Committee for Standardization. Total energy consumption in the transport sector was 3,669 thousand tce in 2013.

Energy efficiency potential for transport was estimated for air transport, railroad electric transport, pipelines (gas and oil), automobiles and urban electric transport (metro, trolleybuses, and trams).

Specific energy consumption by cars and buses were estimated based on proxies for the same vehicle types operating in similar conditions and with similar parameters in Russia. For urban electric and railroad electric transport specific energy consumption was assessed as a ratio of electricity consumption by each vehicle category to the passenger turnover (million passenger-km) or freight turnover (million ton km). The technical energy saving potential in the transport sector is shown in Table 5.4.

Table 5.4 Energy efficiency potential in transport (as of 2013)

Integrated technologies of goods, work, and services production	Units	Scale of economic activity	Units	Specific consumption in 2010	Practical minimum	Actual consumption abroad	Comments	Estimated technical potential, 1000 tce
Railroad electric traction	10^7 t·km	4,382	kgce/ 10^4 tkm	13.0	10.0		Russian practice	13.0
Air transport	10^6 passenger·km	2,490	kgce/ 10^3 passenger-km	60.3	54.3		Global practice	15.0
Metro electric traction	10^6 passenger-km	2,200	kgce/ 10^3 passenger-km	6.4	4.3		Russian practice	4.7
Trams electric traction	10^6 passenger-km	300	kgce/ 10^3 passenger-km	0.4	0.3		Global and Russian practice	0.03
Trolleybus electric traction	10^6 passenger-km	1,873	kgce/ 10^3 passenger-km	5.1	3.8		Global and Russian practice	2.37
Gas pipeline transport	10^6 m^3·km	37,878, 228	kgce/10^6 m^3·km	0.672	0.5		Global and Russian practice	6.4
Oil pipeline transport	10^3 t km	35,462, 805	kgce/ 10^3 tkm	0.99	0.7		Global and Russian practice	8.8
Shifting to hybrid light-duty vehicles	10^3 pcs.	2,778	tce/pcs.	1.23	0.74		Global practice	1,366.7
Shifting to hybrid buses	10^3 pcs.	45	tce/pcs.	6.5	3.91		Global practice	116.5
Shifting to hybrid heavy-duty vehicles	10^3 pcs.	414	tce/pcs.	7.5	4.52		Global practice	1,249.2
Total for transport								**2,782.7**

Source: estimated by CENEf

CENEf estimates the technical potential in the transport sector at 2,783,000 tce, or 76% of total annual energy consumption in this sector. The Republican energy efficiency programme for 2011-2015 or any other national regulations provide no assessment of energy savings that can be obtained in the transport sector.

5.6.5 Buildings

This sector includes residential and public buildings. Industrial, agricultural and other (commercial) buildings are not included. Total residential floor space and population were obtained from the National Committee for Statistics (statistical yearbook "Residential construction in the Republic of Belarus 2014"). In 2013, total residential floor space equaled 243.5 million m^2, and population amounted to 9.464 million people.

Residential energy consumption was obtained from the National Committee for Statistics and the energy efficiency department of the Federal Committee for Standardization.

In 2013, energy consumption in the residential sector amounted to 11.433 Mtce. Residential buildings are characterized by the following specific energy consumption parameters: total specific energy consumption 25.7 kgce/m^2 (209.9 kWh/m^2), including electricity 26.2 kWh/m^2 (or 3.22 kgce/m^2); heat 0.096 Gcal/m^2 (or 13.72 kgce/m^2) (space heating 0.054 Gcal/m^2 (or 7.72 kgce/m^2); DHW 0.042 Gcal/m^2 (or 155 kgce/person)); natural gas 7.71 m^3/m^2 (or 8.76 kgce/m^2).

These values were used to assess the technical energy efficiency potential in residential buildings. Specific energy consumption by "passive" houses and by efficient buildings in Russia and Belarus was used as the "practical minimum" (Table 5.5).

National Committee for Statistics does not provide data on the total floor space of public buildings (educational, health care and culture institutions); however, it does provide information on the basic indicators for public organizations in 2013 (including buildings and students for educational institutions, beds and personnel for health care institutions, and users/visitors for culture institutions). And so total public floor space was estimated by multiplying the scale of economic activity by the standard coefficient "floor space saturation, m^2/person".

Thus estimated energy consumption by public buildings (educational, health care and culture institutions) equals 1.794 Mtce. Specific energy use by public buildings as required by the building codes "Energy efficiency in buildings. Estimated energy consumption for space heating and cooling" (16.3 kgce/m^2, or 132.5 kWh/m^2, for space heating and 2.46 kgce/m^2 or 20 kWh/m^2 for DHW) was taken as the "practical minimum".

The technical energy saving potential in residential and public buildings is shown in Table 5.5.

CENEf estimates the technical potential in residential and public buildings at 4.904 Mtce, or 37% of annual energy consumption in these sectors, including 4.274 Mtce in residential buildings and 0.63 Mtce in public buildings. Potential savings attainable through the renovation of centrally heated residential buildings equal 0.987 Mtce, and through the renovation of individually heated residential buildings 0.44 Mtce.

CENEf's estimate is obviously higher, than the assessments of energy savings achievable in residential buildings provided in the Republican Energy Efficiency Programme for 2011-2015 and in the Comprehensive Programme for Design, Construction and Retrofits of Energy Efficient Housing in the Republic of Belarus for 2009-2010 and to 2020. These two documents expect that weatherization can bring 0.25 to 0.4 Mtce in energy savings in residential space heating, and commissioning of at least 6 million m^2/year of energy efficient buildings (up to 60% of the total floor space of commissioned housing) can bring another 0.178 Mtce in savings.

Table 5.5 Energy efficiency potential in residential and public buildings (as of 2013)

Integrated technologies of goods, work, and services production	Units	Scale of economic activity	Units	Specific consumption in 2010	Practical minimum	Actual consumption abroad	Comments	Estimated technical potential, 1000 tce
Renovation of centrally heated public buildings	10^3 m^2	47,214	kgce/m^2	16.3	13.4	14.1	In compliance with the regulations in force in Belarus and Russia	136.0
Renovation of hot water use (public buildings)	10^3 m^2	47,214	kgce/m^2	2.46	1.23		In compliance with the regulations in force in Belarus and Russia	58.1
Renovation of the cooking equipment (public buildings)	10^3 m^2	16,330	kgce/m^2	1.8	1.4	1.3	Global practice	6.1
Renovation of individually heated public buildings	10^3 m^2	21,056	kgce/m^2	7.72	1.86	4.86	In compliance with the regulations in force in Belarus and Russia	123.4
Efficient lighting (public buildings)	10^3 m^2	68,270	kWh/m^2	32.7	16.4	27.8	Global practice	137.3
Procurement of efficient equipment (public buildings)	10^3 m^2	68,270	kWh/m^2	71.8	51.6	56.6	Global practice	169.3
Renovation of centrally heated residential buildings	10^3 m^2	168,400	kgce/m^2	7.72	1.86	4.86	"Passive" houses (EU countries) and energy efficient buildings (Belarus and Russia)	987.3
Renovation of individually heated residential buildings	10^3 m^2	75,100	kgce/m^2	7.72	1.86	4.86	"Passive" houses (EU countries) and energy efficient buildings (Belarus and Russia)	440.3
Renovation of hot water supply in residential buildings	10^3 people	9,464	tce/person	0.155	0.022	0.18	"Passive" houses (EU countries) and energy efficient buildings (Belarus and Russia)	1,253.5
Replacement of appliances with efficient models	10^3 people	9,464	tce/person	0.110	0.055	0.123	Global practice	520.5
Renovation of lighting in residential buildings	10^3 lamps	40,583	W	50.85	20.00		Global practice	85.0
Renovation of the cooking equipment	10^3 m^2	194,800	kgce/m^2	6.57	1.50	2.80	Global practice	987.6
Total for residential and public buildings								**4,904.5**

Source: estimated by CENEf

5.6.6 Other sectors

Other sectors in Belarus include agriculture (tractors and greenhouses), street lighting, variable speed drives and efficient motors in water pumping. The number of tractors and greenhouses was obtained from the National Committee for Statistics (statistical yearbook "Agriculture in the Republic of Belarus 2014").

Assessment of specific energy consumption by tractors and greenhouses in Belarus builds on the data available for similar facilities and operating conditions in the Russian Federation. Based on the Russian experience, there is a possibility to reduce fuel consumption per tractor by about 65%.

In addition to the agricultural sector, the technical energy efficiency potential was assessed for motors used by the pumping equipment in water supply and for street lighting. The technical potential in "other sectors" is shown in Table 5.6.

Table 5.6 Technical potential in "other sectors" (as of 2013)

Integrated technologies of goods, work, and services production	Units	Scale of economic activity	Units	Specific consumption in 2010	Practical minimum	Actual consumption abroad	Comments	Estimated technical potential, 1000 tce
Tractors fuel efficiency	10^3 pcs.	43,800	kgce/ha	20	7		Global practice	580.0
Renovation of greenhouse facilities	10^3 m^3	8,003	kgce/m^3	34	17		Russian practice	135.1
Adjustable speed drives and efficient motors in water supply systems	mln kWh	466.9	%	100	75		Global practice	14.4
Street lighting	mln kWh	122.6	%	100	70		Global practice	4.5
Total for "other sectors"								**734**

Source: estimated by CENEf

CENEf estimates the technical potential in "other sectors" at 0.734 Mtce.

5.6.7 Total technical energy efficiency potential

Total technical energy efficiency potential for Belarus is estimated at 16.220 Mtce, or 50% of TPES, as of 2013. The largest potential is in residential and public buildings (4.90 Mtce); industry (4.07 Mtce); power and heat (3.72 Mtce).

This estimate assumes independent implementation of all technologies, processes, and measures in each sector, taking no account of integral direct or indirect effects related to the reduction of energy production and transportation.

CENEf's estimate is higher, than the value specified in the Republican Energy Efficiency Programme for 2011-2015 (7.1 to 8.9 Mtce). This can be explained by the fact, that the Republican programme does not include *all* sectors of the economy (transport, agriculture, public buildings, and water supply) and to 2020 only accounts for the cost-effective part of the potential.

5.6.8 Economic and market potentials

In Belarus, a larger part of the technical potential in various sectors of economy can be implemented through cost-effective investments. Economic and market potentials can be assessed by comparing energy prices and the costs of saved energy.

Fuel and energy prices in Belarus are shown in Table 5.7. In this table, electricity, heat and fuel prices are also converted to US$/tce. For consumers who use several energy resources, the US$/tce value was determined in accordance with the energy consumption structure. In Belarus, energy prices for residential consumers are much lower, than for industrial plants.

Comparison of energy prices with the costs of saved energy allows it to identify the most effective technologies, processes, and measures to be recommended in the first place in each sector. The cost of saved energy depends on the discount rate applied to annualize the capital costs. In this study, 6% discount rate was used to estimate the economic energy efficiency potential and 12% discount rate was used to estimate the market energy efficiency potential. In addition, 20% discount rate was used to reflect stricter budget limitations and a higher cost of money for some energy consumers.

Economic and market potentials (with 6%, 12%, and 20% discount rates) that can be implemented through energy efficient technologies, processes, and measures are shown in Figures 5.1-5.3.

Table 5.7 Energy prices in Belarus (as of 2013)

	Units	Belarussian ruble	US$	US$/tce
Industry				
Electricity	kWh	1,329.9	0.14	1,110.1
Heat	Gcal	498,322	51.16	357.8
Natural gas	m^3	2,886	0.28	242.84
Residual oil	t	3,877,320	398.08	293.35
Diesel fuel	t	9,720,000	997.95	684.93
Gasoline	t	9,310,560	955.11	637.27
Residents				
Electricity	kWh	633.9	0.07	529.1
Heat	Gcal	82,020	8.42	58.9
Natural gas	m^3	1,940.9	0.20	175.41
Public and other organizations				
Electricity	kWh	1,390.5	0.14	1,250.15
Heat	Gcal	82,020	8.42	58.9
Natural gas	m^3	2,682	0.28	242.6
Street lighting				
Electricity	kWh	1,390.5	0.14	1,250.15
Urban electric transport				
Electricity	kWh	1,088.7	0.112	908.7
Railroad electric transport				
Electricity	kWh	1,329.9	0.14	1,110.1
Belarussian ruble to US$ exchange rate	Bel. ruble/US$		9,740	

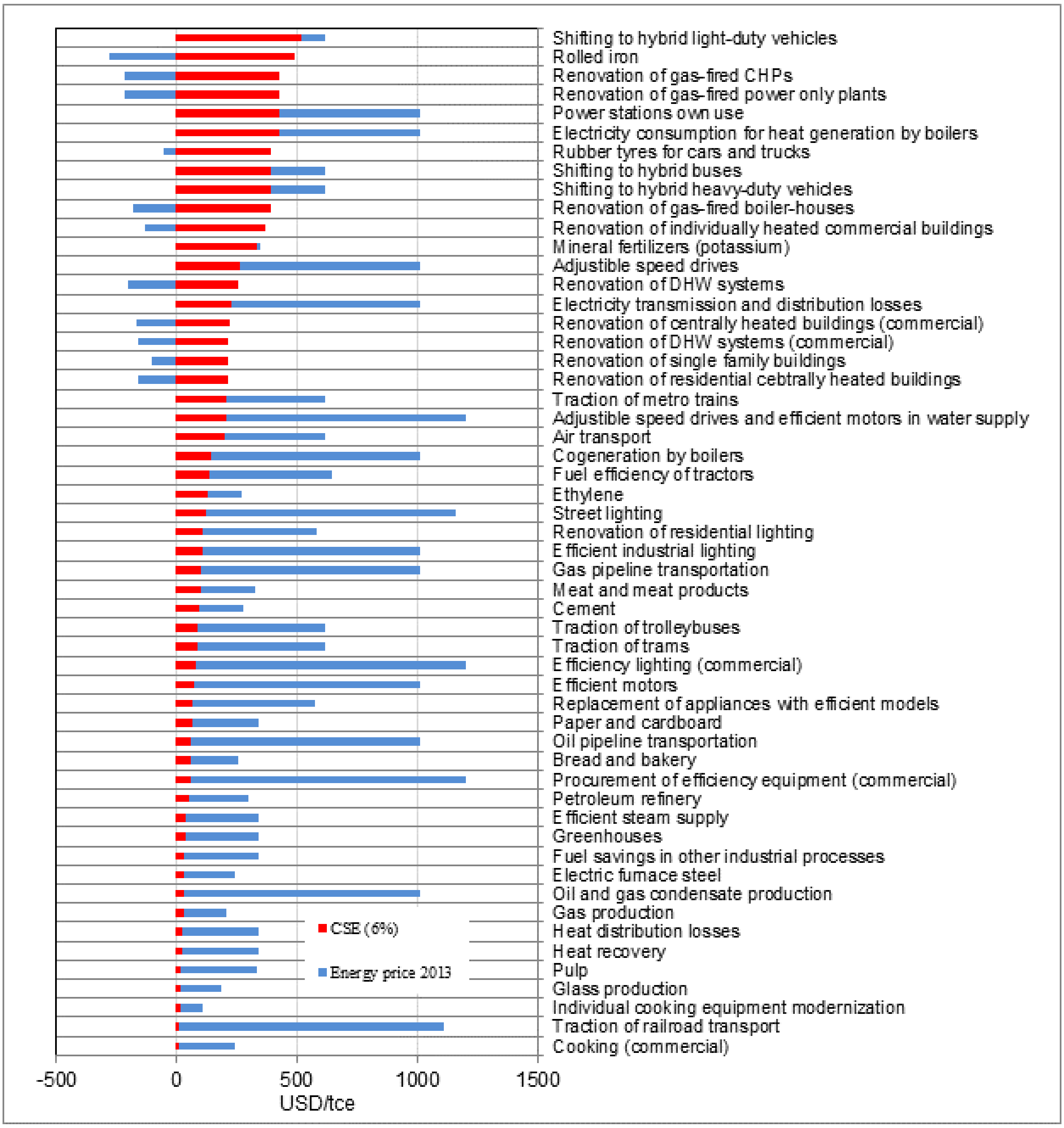
Source: data from the Ministry of Energy.

The figures show the costs of saved energy (red) and the gap between the energy price in a given activity and the cost of saved energy (blue). If the gap is negative, the measure is considered economically not attractive and is excluded from the economic or market potential assessment.

The economic potential (6% discount rate) in Belarus amounts to 11.166 Mtce across all sectors. 11 measures are excluded from the evaluation.

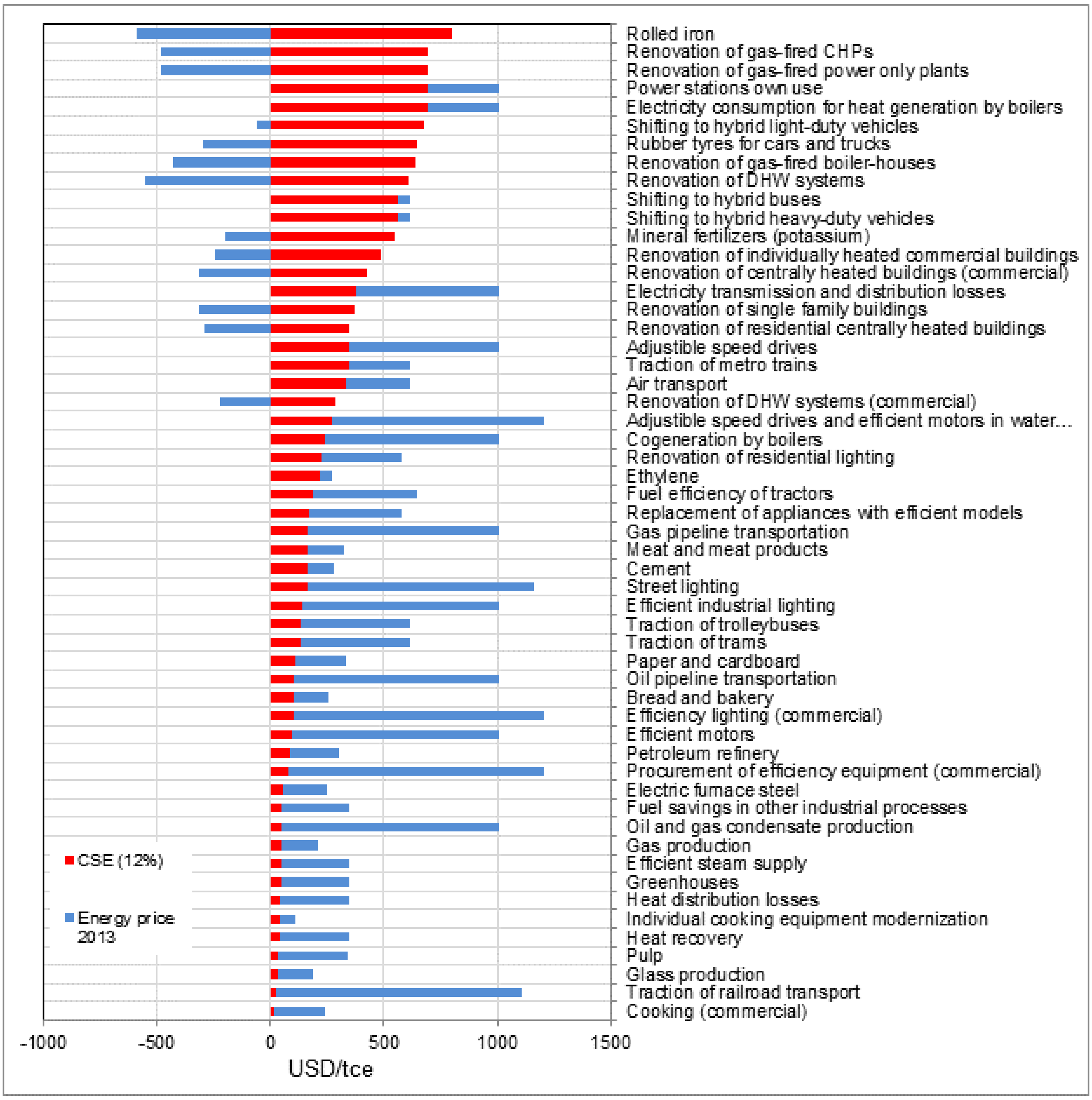
The market potential (12% discount rate) equals 9.688 Mtce across all sectors. 2 more measures are excluded from the evaluation of the market potential. The market potential (20% discount rate) equals 8.128 Mtce across all sectors. 5 more measures are further excluded from the evaluation of the market potential.

Figure 5.1 Economic energy efficiency potential for Belarus (for 6% discount rate as of 2013)



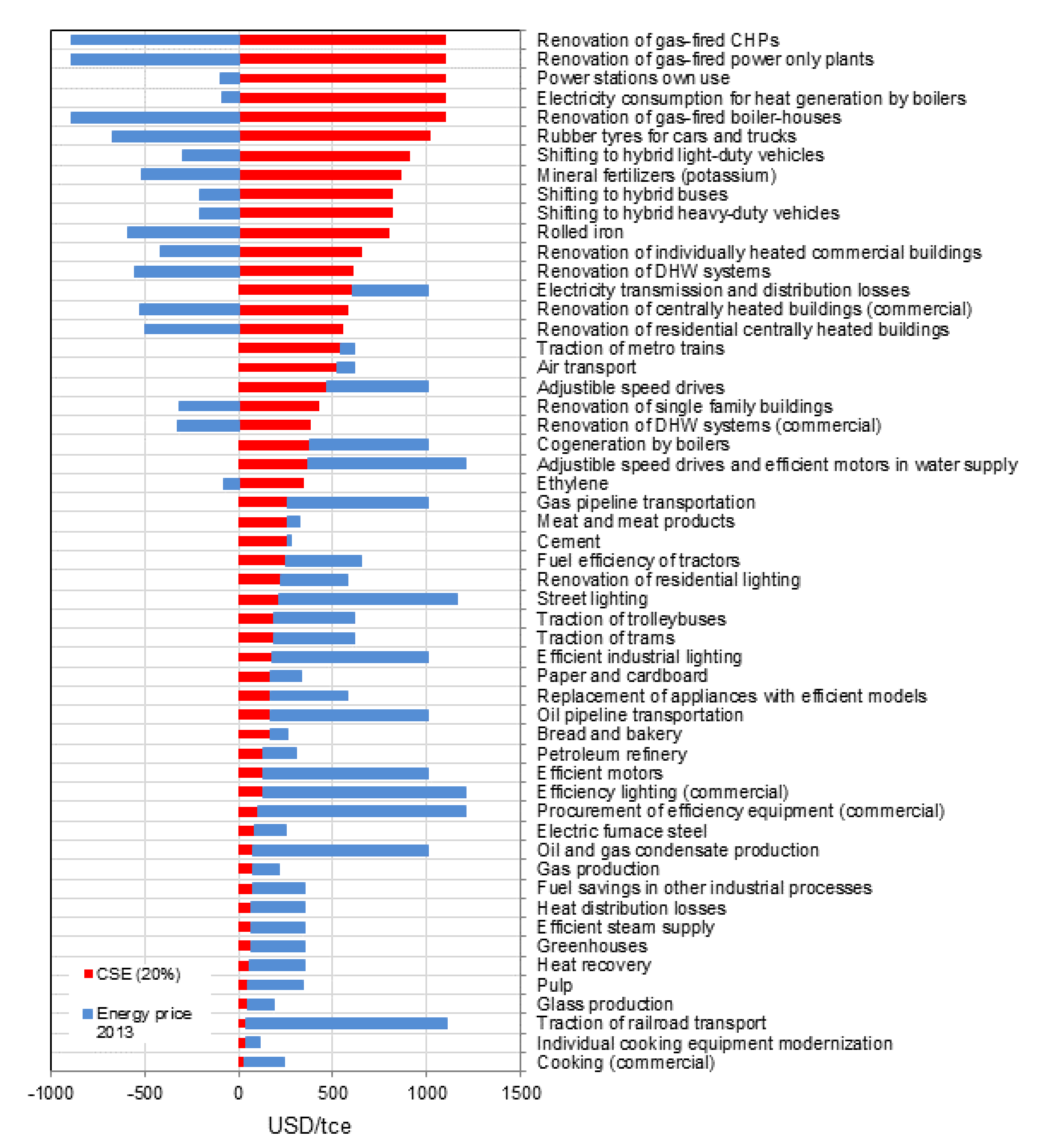
Source: CENEf

Figure 5.2 **Market energy efficiency potential for Belarus (for 12% discount rate as of 2013)**



Source: CENEf

Figure 5.3 Market energy efficiency potential for Belarus (for 20% discount rate as of 2013)



Source: CENEf

Section 6. Georgia

6.1 National level

Population in 2012: 4.49 mln; GDP PPP in 2012: 26.78 bln $US2005 (IEA[87]).

Evolution of GDP energy intensity. According to IEA, energy intensity of GDP was declining in 1990-2000 by 4.6-4.8% per year on average depending on whether MER or PPP is used for the assessment. In 2000-2012, this decline persisted at the rate 3.8% for both GDP MER and GDP PPP energy intensity. Total final energy consumption grew up by 22% between 2004 and 2008. Over the same period, gas consumption increased by 64% and oil consumption by 59%. This, and the relatively high energy intensity of Georgia's GDP make the competitiveness of Georgia's economy particularly vulnerableat the times of high energy prices.

National Statistics Office of Georgia started publishing energy balances in 2013. TPES for 2013 is estimated by this source at 5.9 Mtce[88]. It can be compared to 5.3 Mtce reported for 2012 by IEA. In 2013, real GDP grew up by 3.3%, while TPES for 2013 reported by the country was 11.9% above the IEA estimate. Therefore, TPES reported by the local sources is approximately 10% higher, than the IEA estimate.

Factors behind the evolution of GDP energy intensity: technology and structural shifts. No decomposition studies are available to allow for the identification of factors behind GDP energy intensity evolution. This is partly a result of the energy use data being presented in Georgian energy balances in the old Soviet manner. Such historical information cannot be of much help while exploring the actual evolution of energy demand. Energy consumption is not broken down by sectors. Substantial additional efforts were required to develop an energy balance, which was for the first time published in 2014 and can be effectively used onwards to monitor the energy use structure evolution.

Energy prices. Georgian National Energy and Water Supply Regulatory Commission (GNEWRC) sets tariffs for the generation, transmission dispatch, distribution, import and consumption of electricity and for the transport, distribution and consumption of natural gas. Regulated tariffs are based on supply/distribution costs and approximately total to 8-11 US cents/kWh depending on the voltage. For the purpose of providing additional guarantees for social protection and looking to promote rational use of electricity, rigid step tariffs were introduced: for consumers with monthly electricity consumption up to 100 kWh, between 101 and 300 kWh, and above 301 kWh.

Energy efficiency legislation. Legal and regulatory framework for energy savings and energy efficiency is yet to be developed in Georgia[89]. The energy efficiency legislation in force includes laws that can be viewed as policy guidance (provisions of the Law on Environmental Protection and the Law on Ambient Air Protection). There is no specific energy efficiency law. Some energy efficiency issues are specified by amendments to the Georgian Constitution. For example, via 2010 Ga. Laws 1091 (enacted by SB 194, Act No. 669) the Georgian General Assembly enacted Senate Bill 194, Act No. 669, which amends the Georgian Constitution by adding Article VII, Section IV, Paragraph XII and also adds new O.C.G.A. Title 50, Chapter 37, the "Guaranteed Energy Savings Performance Contracting Act" (the "Act") to exercise the authority granted by Amendment 4. The law became effective on January 1, 2011. There is another example: on November 2, 2010, Georgia approved Constitutional Amendment 4, "Multiyear contracts for energy efficiency or conservation improvement" ("Amendment 4"), which provides

[87] http://www.iea.org/statistics.
[88] Energy balance of Georgia, 2013. National Statistics Office of Georgia. 2014.
[89] Energy Efficient Potential in Georgia and Policy Options for Its Utilization. Prepared for USAID, 2008.

for “guaranteed cost savings for the state by authorizing a state entity to enter into multiyear contracts which obligate state funds for energy efficiency or conservation improvement projects”.

There is also Property Assessed Clean Energy (PACE) act enabling legislation (which permits bond financing through certain authorities to allow the utility customers of participating local governments to finance energy efficiency and conservation improvements through on-bill financing) that was signed into law by Governor Sonny Perdue on May 20, 2010, marked a successful legislative session for energy efficiency and conservation proponents in Georgia, and was expected to provide for increased investment in energy efficiency and conservation improvement projects in Georgia in 2011. There are no effective mandatory or indicative EE standards in the Building Codes. The old Soviet codes for thermal engineering of buildings are implemented on a voluntary basis. In 2013, the Government began the procedure of setting up a working group to develop medium- and long-term energy strategy, but there is little progress in terms of the inclusion of all elements of the energy sector in the energy policy framework.

Number of energy efficiency regulatory acts. Other normative acts regulating energy efficiency activities include Resolution of the Parliament on the "Guidelines for the Federal Policy in the Energy Sector" dating back to 2006.

Government agencies with an energy efficiency policy mandate. Agencies responsible for the implementation of energy conservation policies include Ministry of Energy; Ministry of regional development and infrastructure; the State Agency of Natural Resources; and Georgia Environmental Finance Authority (GEFA), the designated lead agency for the federal ESPC programme. There is only limited institutional capability and experience within the Government in energy efficiency policy development[90].

Basic administrative mechanisms to improve energy efficiency: None found.

Basic energy efficiency market mechanisms and economic incentive programmes: ECSO, bond financing, on-bill financing, taxation and pricing policies.

Energy efficiency policy spending and financial sources. At the end of 2007, the EBRD opened a US$ 35 million credit line to TBC Bank for energy efficiency measures in small and medium-sized industries, and to builders and homeowners (mainly insulation) from 2009 onwards. However to date, only around 100 households have taken advantage of the credit line. A new microcredit line was also launched by the Microfinance Bank with British Petroleum (BP) as a co-financer, covering 15% of the credit given to each consumer to furnish his or her apartment with energy efficient technologies.

The body of energy efficiency activities in Georgia was financed by USAID-sponsored projects (Winrock International, which runs a wide range of RE and energy efficiency programmes).

Energy efficiency R&D spending. No data on energy efficiency research and development spending were found.

ESCO market. There are legal provisions on ESCO development, but no information is available on the scale of the market. Status report on energy service companies market in Europe for 2010 does not mention Georgia[91].

Water efficiency policy. The MoEP is the national body responsible for the development, promotion, and implementation of policies and strategies toward the environmental protection, including wildlife protection and forest management. The Ministry is responsible for the implementation of the Law on Environmental Protection (1996), including monitoring and

[90] In-depth Review of Energy Efficiency Policies and Programmes of The Republic of Georgia Energy Charter Protocol on Energy Efficiency and Related Environmental Aspects (PEEREA). Energy Charter Secretariat. 2012.

[91] A. Marino, P. Bertoldi, S. Rezessy. Institute for Energy. Energy Service Companies Market in Europe - Status Report 2010 - EUR 24516 EN – 2010.

regulation of environmental pollution, regulation of land use and protection of natural resources, including forestry and water. However, there is no special water management programme.

International cooperation. Key partners in international energy efficiency projects are: UNDP, EBRD, KfW, Monitoring Programme of the International Financial Institutions "Green Alternative", Association "Energy and Environment", Oil and Gas Company "Blake", EU Delegation.

6.2 Heat and power generation

Power generation efficiency. Some sources report about 50% efficiency of power generation (see Section 6.2.2 for more detail). They may account for both thermal- and hydropower plants. IEA cite reports 35% efficiency for 2012[92], while the National Statistics Office of Georgia reports 38% efficiency for 2013[93].

Power transmission and distribution losses (%). The Sustainable Energy Action Plan (SEAP) reports that JSC Telasi (Tbilisi energy distribution company) suffers at least 12.4% losses. According to the WEG study in 2006, however, JSC Telasi's losses are up to 16%. Losses in other locations are obviously higher. National Statistics Office of Georgia reports 8% for 2013.

Heat generation efficiency and losses. Both national and IEA energy balances reflect no or negligible district heat production volumes for 2012-2013.

Energy efficiency regulations in heat and power generation and distribution. The are no special requirements. Amendments have been made to the "Regulations of Electricity Wholesale Market", whereby special conditions for small capacity (up to 13 MW) power plants were set.

Government agencies with an energy efficiency policy mandate in heat and power generation and distribution. Ministry of Energy is the government agency responsible for the implementation of energy efficiency policy in the heat and power sector.

Basic administrative mechanisms to improve energy efficiency in heat and power generation and distribution. There is no specific regulation due to the dominance of hydropower generation and lack of district heat production.

Basic energy efficiency market mechanisms and economic incentive programmes: ECSO, bond financing, on-bill financing, taxation and pricing policies.

Renewables development programmes. Federal programme "RE 2008" that specifies the requirements to the construction of new renewable energy generation capacities, particularly HPP, has been in force since 2008. This programme regulates and supports the construction of new renewables projects with the total capacity under 100 MW. On the basis of this programme progress has been recorded in the field of new small- and medium hydroplants. The national Government has signed 15 MOUs on the construction, operation and ownership of HPPs with a total installed capacity of 2,050 MW. Several IFIs have been supporting energy efficiency and renewable development: USAID, UNDP, KfW, GEF, EBRD, the Norwegian Government, EIB, NIF, and others have been funding a great number of activities, including pilot projects, policy analysis, rehabilitation works, training, etc.

White certificates market. No such programmes launched to the date, while on-bill financing system is established.

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92 http://www.iea.org

93 Energy Balance of Georgia, 2013, National Statistics Office of Georgia, 2014.

6.3 Industry

Industrial energy intensity. According to UNIDO, industrial energy intensity declined by 54% in 1990-2000 and by additional 60% in 2008 (in tons of oil equivalent per US$1,000 of manufacturing value added)[94]. This decline was driven partly by structural shifts and mostly by the elimination of heavy industry.

Energy intensity of basic industrial goods. No data available.

Energy efficiency regulations in the industrial sector. No data available.

Government agencies with an energy efficiency policy mandate in the industrial sector. Ministry of Energy is the basic government agency responsible for the implementation of industrial energy efficiency policies.

Basic administrative mechanisms to improve energy efficiency in the industrial sector. No information available.

Basic energy efficiency market mechanisms and economic incentive programmes. No information available.

Long-term agreements. No information available.

Energy management systems. No information available.

Industrial energy efficiency policy spending. Reliable data on energy efficiency investments in the industrial sector are not available.

6.4 Buildings

Specific energy consumption per m^2 of residential floor space (energy intensity in residential buildings). In Georgia, most buildings were constructed back in the Soviet era (35-60 years ago), when energy performance parameters were rarely taken into account. Many existing buildings are half-ruined and not fit for living. A USAID study found out that specific energy consumption per square meter is 4-5 times higher, than in the EU countries[95]. These findings are contrary to the estimates based on statistical data for residential buildings and energy consumption. According to the "Energy balance of Georgia, 2013", residential energy consumption amounted to 2,100 thousand toe, translating to 17.073 billion kWh. With 96.3 million square meters total housing area, specific energy consumption would be about 177 kWh/m^2 per year. For the sake of comparison, specific energy consumption in Russia is 370-380 kWh/m^2/year. The gap may be rooted in the lower number of degree-days, lower share of occupied and heated area, and/or incomplete accounting for energy use in buildings.

Residential electricity consumers in Georgia were divided into three categories. The first category covers consumers whose average monthly consumption varies between 5 and 100 kWh (36% of such customers in Tbilisi). Households in the second category consume 100-300 kWh/month on average (10%). Households in the third category – "passive" consumers (locked up and (temporarily) uninhabited flats) – consume less than 5 kWh/month of energy (14%).[96] If this share of vacant flats is deducted from the overall living space, specific energy use would then escalate to 206 kWh/m^2/year, or about 25 kgce/m^2/year, which is a reasonable estimate.

In November 2008, the Government of Georgia set a goal to reduce energy consumption and associated greenhouse gas emissions in the buildings sector by 30-40% by 2020.

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[94] UNIDO. Industrial Development Report 2011. Industrial energy efficiency for sustainable wealth creation. Capturing environmental, economic and social dividends.

[95] Rural Energy Program, the Energy Efficiency Perspective of the Georgian Residential Sector, USAID, prepared by Winrock International, 2009. http://sdap.ge/docs/microsoft_word_-_energy_efficiency_of_residential_sector.pdf.

[96] Energy Efficient Potential in Georgia and Policy Options for Its Utilization. Prepared for USAID, 2008.

Specific energy consumption per square meter of public floor space. Integrated fuel and energy balances from both the National Statistics Office and IEA are source data on energy consumption in the public sector. However, no statistical data are available on the public buildings floor space, and so energy efficiency cannot be statistically evaluated. While information on the energy consumption structure in public buildings is available, no data were found on specific energy use per unit of floor space. Based on the Russian experience, it should be very close to, or slightly above, residential specific energy use, or 210-300 kWh/m^2. Some information about specific electricity consumption can be found in the paper titled "Energy Efficient Potential in Georgia and Policy Options for Its Utilization. Prepared for USAID, 2008".

Specific energy consumption for space heating per m^2 of residential floor space per degree-day of the heat supply season. The current level of specific energy consumption for space heating during the heat supply season estimated for 7 Tbilisi buildings (erected back in the Soviet era) was estimated at 125 kWh/m^2, according to the USAID project[97]. According to other expert estimates, space heating requires on average 160 kWh/m^2: some 140 kWh/m^2 in apartment buildings and 180 kWh/m^2 in private housing. Space heating is responsible for about 70-80% of residential energy consumption.

Specific hot water consumption per resident with access to centralized DHW supply. Such data were not found, but in many countries with comparable conditions energy use for hot water supply is 140-350 kgce/household/year (1,138-2,845 kWh/household/year), or 50-130 kgce/person/year (406-1,056 kWh/person/year) depending on the household size[98].

Share of consumers equipped with energy meters. In 2011, 55% of consumers were equipped with gas meters. This share was expected to reach 100% by the end of 2013. Electricity meters are installed at 95% of consumers, yet it is not uncommon that 40-70 houses use one meter for all.

Building codes requirements. Ministry of Economy and Sustainable Development of Georgia is developing codes for structural design of buildings (Eurocodes) in cooperation with GIZ (German International Cooperation Agency) and IBC (being translated by USAID, EPI project). Spatial Planning and Construction Code, which is being currently developed, also reflects on construction as a built-in environment. No information on the energy efficiency building codes in force was found.

Other administrative mechanisms to promote energy efficiency. None found.

Basic energy efficiency market mechanisms and economic incentive programmes in the buildings sector. ECSO, bond financing, on-bill financing, taxation and pricing policies.

Government agencies with an energy efficiency policy mandate in the buildings sector. Ministry of Regional Development and Infrastructure, the State Agency of Natural Resources and Georgia Environmental Finance Authority (GEFA).

Information and educational programmes. The New Applied Technology Efficiency and Lighting Initiative (NATELI) has been running since 2009. A USAID-funded programme, it aims at energy audits of common premises in residential buildings in Tbilisi. The project was designed to help educational and health-care institutions and residential buildings get an insight into possible energy saving opportunities. Between 2009 and 2011, Winrock International (via NATELI) made energy audits and trained a group of auditors. Winrock is also operating the energy bus, originally funded by BP, which travels around Georgia showcasing small-scale

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[97] Rural Energy Program, Survey of Current Construction Practices and Recommendations to Building Industry to Improve Energy Efficiency in Georgia, USAID, Prepared by Winrock International (Experts: Ph.D Yu. Matrosov, Ph.D K. Melikidze, N. Verulava), 2008. http://sdap.ge/docs/microsoft_word_-_eng_matrosov_-_final_report_1_.pdf.

[98] CENEf. 2014. Energy efficiency in Russia's residential sector. How to make it low-carbon? Moscow, March 2014. www.cenef.ru

energy efficiency equipment and building materials. It disseminates promotional information on energy efficiency and RE with details on suppliers and financing options.

The Georgian Technical University runs a number of energy efficiency pilot projects in residential buildings and educational institutions. USAID accomplished feasibility studies to improve the efficiency and the standard of performance of stoves in Georgia. In 2008, it held a seminar on energy efficient stove design techniques with the involvement of stove producers from all over the country.

The Georgian energy efficiency centre is running a programme funded by the Dutch and British governments to promote energy efficiency in government buildings. It includes energy audits and promotional materials and involves target representatives of government agencies and departments responsible for energy-related issues.

The message of the initiative "Be Energy Saver at Work and Home to Save Environment" is that low-cost/no-cost do-it-yourself energy efficiency measures and behavioural change can be launched to reduce energy use and to contribute to the reduction of emissions into the atmosphere and to environmental protection.

The Energy Efficiency Centre is also holding energy efficiency seminars for energy managers from various ministries and federal agencies to provide them with information on cost-efficient and environmentally sound energy saving technologies, including presenting case studies of energy audits of government buildings.

6.5 Transport

Specific energy consumption per unit of transport service. According to the assessment made by ENOGATE-SEMISE project in Georgia, the greatest energy saving potential can be found in buildings and in the transport sector (INOGATE: Energy Cooperation between the EU, The Littoral States of the Black and Caspian Seas and their Neighbouring Countries. SEMISE: Support to Energy Market Integration and Sustainable Energy in NIS). No data are available on the average fuel consumption by the vehicle park. Preliminary research has revealed a large potential for improvement.

Too little statistical information is available on the vehicles park to allow for an estimate of energy use efficiency.

Government agencies with an energy efficiency policy mandate in the transport sector. Ministry of Regional Development and Infrastructure; Georgia Environmental Finance Authority (GEFA).

Basic administrative mechanisms to improve energy efficiency in the transport sector. None found.

Basic energy efficiency market mechanisms and economic incentive programmes in the transport sector. ECSO, bond financing, on-bill financing, taxation and pricing policies.

6.6 Technical energy efficiency potential for Georgia

6.6.1 Approach and data sources

Technical energy efficiency potential for Georgia was assessed based on the approaches described in the Inception Report. Four sets of data were used to attain this goal (Table 6.1). Data related to the economic activities were collected from national statistical sources (for 2012-2013), which are listed in corresponding sections. Data related to specific energy use in different applications were collected from official documents, programmes, presentations and publications. Where appropriate data were not available, proxies for countries with similar conditions were used. Assessment of the technical potential builds on the comparison of energy efficiency indicators against specific energy consumption for BATs in the same sectors and subsectors. BATs data were collected from multiple international sources.

The technical energy efficiency potential for Georgia was assessed by multiplying the 2012-2013 activity level by the gap between the country's specific energy efficiency and energy efficiency BAT parameters for the same category of activity.

Table 6.1 Data collection technology and structure

Information required	Source of information	Methods of data collection
Data on economic activities	Statistical yearbooks	Collection of statistical data
Data on specific energy consumption in various sectors in Georgia	Official documents, publications, proxies for countries in similar conditions	Literature search

Assessment of the technical potential was structured by different sectors including: power and heat generation, transmission and distribution; industry; transport; buildings; agriculture; street lighting; water supply; etc. Estimates generated by this study were, where possible, compared with the local estimates of the energy efficiency potential for similar activities. Where the information was sufficient, the reasons for mismatching, if any, were identified.

Based on these comparisons, technical potential estimate ranges were provided. Where reliable information for some energy use activities was not available, such activities were skipped from the potential evaluation study.

So as to identify the economic and market potentials, the costs of saved energy were compared to the 2013 or 2014 energy prices in order to see if an individual measure is economically viable.

Summary of energy efficiency potential estimation for Georgia:

- Power and heat 290 thou tce
- Industry 716 thou tce
- Transport 1,328 thou tce
- Residential buildings 1,281 thou tce
- Services 136 thou tce
- Other 366 thou tce
- **Total** **4.1 Mtce**

6.6.2 Power and heat

CENEf's assessment builds on the data related to energy use and power and heat generation available from official statistical yearbook and publication "Energy balance of Georgia, 2013"[99], government programmes and legal acts, publications, and other sources, including internet resources. For some parameters such information was not available, and so they were assessed using proxies, including parameters for similar installations in Russia. Therefore, the estimates of the technical potential are by no means perfect. CENEf has taken any and all measures to make them as reliable as possible, despite the tight work schedule that did not allow for too extensive data search. Data related to power generation in 2013 were borrowed from the statistical publication "Energy balance of Georgia, 2013". Based on this information, power generation was allocated to various types of stations in Table 6.2. In 2013, CHPs were responsible for 18%, and hydropower plants for 82% of power generation.

Hydropower plants are not the subject of the study because they are associated with renewable energy, rather than with energy efficiency. Diesel power plants are not mentioned in the statistics or elsewhere.

[99] Energy Balance of Georgia, 2013, National Statistics Office of Georgia, 2014.

Total installed capacity equals 2,506 MW, and annual generation amounts to 10.2 billion kWh. 45 projects are currently underway, including the construction of 15 new HPPs, 3 new HPPs (157 MW) construction to be launched in 2014-2015, and 1 windpower plant Faravani (50 MW)[100].

Only total own use power consumption by all power stations is known, so electricity consumption for CHP own needs was determined as a share thereof based on the Russian statistics. Share of electricity distribution losses and power plants own use electricity consumption were determined based on the statistical publication "Energy balance of Georgia, 2013".

According to the IEA energy balance[101], about 2,594 Mtce are annually used for power and heat generation, own use, transmission and distribution. CENEf estimates the technical energy efficiency potential in this sector at 0.290 Mtce, or at about one tenth of annual consumption by this sector.

The Georgian government is committed to further development of Georgia's renewable resources for the purpose of improved energy security, short- and medium-term economic development, and long-term sustainability. Considerable efforts have been taken to facilitate investments in the development of hydropower resources. The economically viable hydropower resources are estimated to be five times the current hydro energy production, and a similar amount for wind power is slightly less than that. Estimates of the achievable potential (15 million kWh) are shown below[102]. The wind power potential of Georgia has been estimated by the Scientific Wind Energy Centre, KARENERGO, according to an indicative list of wind farms with about 2 GW total capacity that are to deliver an estimated 5,000 million kWh of power annually.

Table 6.2 Energy efficiency potential in power and heat generation, transmission and distribution (as of 2013)

Integrated technologies of goods, work, and services production	Units	Scale of economic activity	Units	Specific consumption in 2010	Practical minimum	Actual consumption abroad	Comments	Estimated technical potential, 1000 tce
Renovation of gas-fired co-generation plants (CHPs)	mln kWh	2,472	gce/kWh	321	205	262	CCGT, 60% efficiency	287
Power stations own use	mln kWh	510	%	8.2%	4.0%	5.0%	North America	1
Electricity transmission and distribution losses	mln kWh	1,094	%	13.1%	6.9%	7.0%	Japan	12
Total for power and heat								**290**

Source: CENEf

100 Energy Strategy and Energy Policy Developments for the Promotion of Clean Power Generation in Georgia, Giorgi Tushurashvili, 2013, https://www.energy-community.org/pls/portal/docs/1910181.PDF.
101 http://www.iea.org/statistics/statisticssearch/report/?country=GEORGIA&product=Balances&year=2012
102 In-depth Review of Energy Efficiency Policies and Programmes of The Republic of Georgia Energy Charter Protocol on Energy Efficiency and Related Environmental Aspects (PEEREA). Energy Charter Secretariat.

6.6.3 Industry

The technical energy efficiency potential for industry was assessed (see Table 6.3) using 2013 data on industrial activities from the statistical yearbook, industrial Georgian analytic book[103], annual reports by industrial companies[104], and data on specific energy use in Georgia (where available) or proxies for Russia.

Table 6.3 Energy efficiency potential in industry (as of 2013)

Integrated technologies of goods, work, and services production	Units	Scale of economic activity	Units	Specific consumption in 2010	Practical minimum	Actual consumption abroad	Comments	Estimated technical potential, 1000 tce
Petroleum refinery	10^3t	98	kgce/t	87	53.9	75.1	Global practice	3.2
Oil and gas condensate production	10^3 t	109	kWh/t	130	40		Global practice	1.2
Natural gas production	10^6 m^3	5	kgce/ 1,000 m^3	8.7	5.9		Expert estimate	0.02
Coal production	10^3 t	254	kgce/t	14.0	3.0		Global practice	2.8
Iron ore	10^3 t	1,200	kgce/t	12.5	8.5	10.0	Global practice	4.8
Coke	10^3 t	620	kgce/t	161.5	119.0	143.0	Global practice	26.4
Cast iron	10^3 t	700	kgce/t	664.5	355.0	461.0	Global practice	216.7
Electric steel	10^3 t	1,450	kgce/t	94.8	50.0	80.6	Global practice	65.0
Rolled ferrous metal products	10^3t	1,830	kgce/t	113.1	31	68.0	Global practice	150.8
Electroferroalloys	10^3 t	185	kgce/t	959	700	700	Sverdlovskaya Oblast	47.9
Fertilizers	10^3 t	1,538	kgce/t	163	109	131	Global practice	83.1
Cement production	10^3 t	2,000	kgce/t	24	11	13	Global practice	26.0
Efficient motors	10^6 units	0.4	kWh/ motor	9,956	8,507		Global practice	74.1
Variable speed drives	10^6 units	0.2	kWh/ drive	9,956	9,356		Global practice	13.8
Efficient industrial lighting	10^6 units	0.01	kWh/ lighting unit	247	160		Global practice	0.1
Total for industry								**716**

Source: CENEf

The Georgian energy statistics split industrial energy use only by value-added activities, not by products. Therefore, specific energy use to manufacture basic industrial products cannot be assessed based on the energy statistics, and such data are not reported in other sources, leaving the only option to use proxies to assess the potential.

The potential was estimated for 13 energy intensive homogenous products and for 3 cross-cutting technologies applicable across all industrial sectors. The actual data for the production of 2 products (bread and meat) were found only in monetary terms. The number of motors operating in the industry has been assessed based on the electricity consumption data by the industry, the share of electric motors, and average annual electricity consumption per motor. In addition, it has been assumed that 45% of industrial motors need to be supplied with variable speed drives. The number of light fixtures at industrial sites was assessed based on industrial

[103] The Importance of the Heavy Manufacturing Sector and the Need for an Industrial Policy in Georgia. GeoWel Research, 2014, http://geowel.org/files/rustavi_steel_industrial_policy_english_1.pdf.

[104] Rustavi Metallurgical Plant http://www.rmp.ge/en/about-us/facts-and-figures/; HeidelbergCement in Georgia http://www.heidelbergcement.com/ge/en/country/products/cement.htm.

electricity consumption, the share of lighting therein and average annual electricity consumption per light fixture.

The technical energy efficiency potential in industry is assessed at 716 ktce, or at about 77% of the 935 ktce used in industry as reported by the National Statistics Office of Georgia for 2013.[105] This may be an overestimate. It should be noted that the assessment of the technical potential as shown in the table below relies on many assumptions, is for indicative purposes only and needs much improvement.

6.6.4 Transport

Energy efficiency potential for transport was estimated for railroad transport, pipelines, air, automobiles and urban electric transport. Like in the other sectors, this effort is quite data demanding. Data on the transport service were borrowed from the statistical yearbook "Statistical yearbook of Georgia, 2014"[106], although not always information on transport service was available in required formats. In some instances data presented in passenger-km and (or) freight-km were to be converted to brutto-freight-km to fit statistically available data on specific energy use[107]. As to specific energy use, for many vehicles data for Georgia are available in formats similar to those used in Russia. For automobile transport Russian data on specific energy use were taken as proxies. This approach makes the estimate just preliminary and fit for further improvement, but it can serve a starting point for improving energy efficiency potential assessments in the transport sector in Georgia. Data on the bus park, light-duty and heavy-duty vehicles were taken as available in the public domain[108].

CENEf estimates the energy efficiency potential in transport at 1.3 Mtce in 2013 (Table 6.4). The largest potential comes from switching to effective hybrid automobiles. Estimates of the energy efficiency potential in transport from the local sources are scarce.

Table 6.4 Energy efficiency potential in transport (as of 2013)

Integrated technologies of goods, work, and services production	Units	Scale of economic activity	Units	Specific consumption in 2010	Practical minimum	Actual consumption abroad	Comments	Estimated technical potential, 1000 tce
Railroad electric traction	10^7 tkm gross	6,816	kgce/10^4 tkm gross	12.0	10.0		Values for some Russian regions	13.6
Diesel locomotives	10^7 tkm gross	5,222	kgce/10^4 km gross	62.2	40.0		2020 target for Russia	115.9
Metro electric traction	10^6 tkm gross	54.2	kgce/10^3 km gross	6.5	4.3		Moscow	0.1
Gas pipeline transport	10^6 m^3km	105.606	kgce/10^6 m^3 km	28.2	25.00		2020 target for Russia	337.9
Eco-driving	10^3tce	791	kgce/$10^6$$m^3$ km	100%	95%		Global practice	39.5
Shifting to hybrid light-duty vehicles	10^3 vehicles	739	tce/vehicles/year	1.23	0.74		Global practice	363.4
Shifting to hybrid buses	10^3 buses	52	tce/buses/ year	6.5	3.91		Global practice	135.1
Shifting to hybrid heavy-duty vehicles	10^3 vehicles	106	tce/vehicles/year	7.5	4.52		Global practice	320.1
Air transport	10^6passenger-km	396	kgce/ passenger-km	60.3	54.27		Global practice	2.4
Total transport								**1,328**

Source: CENEf

[105] Energy balance of Georgia, 2013. National Statistics Office of Georgia. 2014.
[106] Statistical Yearbook of Georgia, 2014.
[107] Such conversions were made based on corresponding data for Russia.
[108] http://www.who.int/violence_injury_prevention/road_safety_status/2013/country_profiles/georgia.pdf

6.6.5 Buildings

While data on the living space are available from statistical publications, books (eg. “Country Profile of the Housing Stock. Georgia”[109] and “Electricity Demand for Georgia: 1998-2020”[110]), information on public and commercial buildings floor space and energy use is either not available, or not reliable enough, as it refers to stand-alone buildings and is very inconsistent.

Based on the available data, residential energy use in 2013 was 2.1 Mtce and fluctuates from year to year depending on the weather. Only 0.3% of residents have access to district heat, 0.4% to DHW supply, 21.5% to network gas, 17.9% use LNG and 12.8% use individual heating systems[111]. Therefore, only 34.6% use district heat, gas or other fuels for space heating, while others rely on either electricity or LNG for their space heating or have no heating whatsoever during the whole winter season.

For multifamily buildings, specific energy use was estimated based on available sources at 206 kWh/m^2/year, or about 25 kgce/m^2/year, which looks a reasonable estimate. A slightly lower value is used to assess the potential to reflect some underheating. For single-family houses, the value for a “passive house” was used as the reference level (see Table 6.5). Therefore, the assessed potential assumes a very deep renovation of the existing buildings stock.

Table 6.5 Energy efficiency potential in the buildings sector (as of 2013)

Integrated technologies of goods, work, and services production	Units	Scale of economic activity	Units	Specific consumption in 2010	Practical minimum	Actual consumption abroad	Comments	Estimated technical potential, 1000 tce
				Residential buildings				
Renovation of centrally heated multifamily buildings	10^{3}m^2	198	kgce/m^2	22.00	7.1		60% of 2012 building codes requirements	2.9
Renovation of single-family buildings	10^{3}m^2	46,900	kgce/m^2	22.00	4.9		Passive houses	802.0
Renovation of hot water use	10^3 people	19	tce/person	0.207	0.073	0.12	Global practice	2.5
Replacement of appliances with top efficient models	10^3 people	4,491	tce/person	0.110	0.055	0.12	Global practice	247.0
Lighting renovation	10^{3}light fixtures	16,050	W	50.85	20.00	35.0	Global practice	33.6
Renovation of the cooking equipment	10^3 m^2	96,300	kgce/m^2	3.50	1.50	2.80	Global practice	192.6
Total residential buildings								**1,281**
				Public and commercial buildings				
Renovation of centrally heated buildings	10^{3}m^2	49	kgce/m^2	26.0	7.1	18.0	60% of 2012 building codes requirements	0.9
Renovation of hot water use	10^3 m^2	49	kgce/m^2	4.90	2.7	3.3	Global practice	0.1
Renovation of the cooking equipment	10^{3}m^2	12,350	kgce/m^2	1.8	1.4	1.3	Global practice	4.6

[109] Country profile of housing stock. Georgia. UN, 2007.
[110] Electricity Demand for Georgia: 1998-2020, Tbilisi, 1998, CENEf for Georgia: Least-Cost Development Plan (USAID Prime Contract No. CCN-Q-00-93-00154-00).
[111] Country profile of housing stock. Georgia. UN, 2007.

Integrated technologies of goods, work, and services production	Units	Scale of economic activity	Units	Specific consumption in 2010	Practical minimum	Actual consumption abroad	Comments	Estimated technical potential, 1000 tce
Efficient space heating boilers	10^3m^2	12,350	$kgce/m^2$	32.7	26.7	30.2	Global practice	74.6
Lighting renovation	10^3m^2	12,350	kWh/m^2	32.7	16.4	27.8	Global practice	24.8
Procurement of efficient appliances	10^3m^2	12,350	kWh/m^2	71.8	51.6	56.6	Global practice	30.6
Total public and commercial buildings								**136**
Total buildings								**1,416**

Source: CENEf

Data on the activities in the housing sector were estimated mostly based on the national statistics, while data on specific energy use for current practices were taken similar to those for Russia, except for space heating. Data on public and commercial space were reconstructed using the number of users (schoolchildren, patients, etc.) in public and commercial buildings and data on the average floor space. For countries with a similar level of development the ratio of public and commercial buildings to the housing living space is about 1:4 to 1:5[112]. For Georgia, the estimated value is 24% of the housing living space. According to the Georgian energy balances, 0.3 Mtce were used in commercial and public sector in 2013.

The potential in the residential sector is estimated at 1.28 Mtce (85.4% of energy use); in the public and commercial buildings sector 0.14 Mtce (47.9% of energy use). Total energy efficiency potential in buildings is estimated at 1.78 Mtce (79.4% of energy use) (for more detail see Table 6.5).

6.6.6 Other sectors

According to Georgian energy balances, only 0.02 Mtce in 2013 were used in the agricultural sector. There is a park of tractors and other farm machinery in the country and greenhouse facilities. For this reason, energy use in this sector seems underestimated by the statistics and energy efficiency potential assessments do not match the officially reported energy consumption.

The information on tractors stock was obtained from the statistical publication by Food and Agriculture Organization of the United Nations (FAO)[113]. Based on the Russian experience, specific energy use per tractor may be reduced by about 65%. The area occupied by greenhouse facilities as of 2011 is 120 hectares. Based on the Russian experience, specific energy use per glass greenhouse facility may be reduced by about 50%.

The overall potential in improving the tractors fuel efficiency is estimated at 0.3 Mtce; in the heating of greenhouse facilities at 0.03 Mtce. Total energy saving potential in agriculture is estimated at 0.3 Mtce.

Two more components of the energy efficiency potential were assessed, namely street lighting and variable speed drives in municipal water supply systems. Electricity consumption by public utilities and street lighting was calculated based on the data from the paper titled "Energy

[112] M. Economidou. Project lead. Europe's Buildings Under The Microscope. A country-by-country review of the energy performance of buildings. October 2011. Buildings Performance Institute Europe (BPIE); Transition to Sustainable Buildings. Strategies and opportunities to 2050. IEA. 2013.
[113] http://chinalist.ru/facts/viewyears.php?p_lang=0&p_country=80&p_param=1070

Efficient Potential in Georgia and Policy Options for Its Utilization, USAID"[114]. All together, the contribution of "other sectors" to the energy efficiency potential was estimated at 0.367 Mtce (see Table 6.6).

Table 6.6 Energy efficiency potential in "other sectors" (as of 2013)

Integrated technologies of goods, work, and services production	Units	Scale of economic activity	Units	Specific consumption in 2010	Practical minimum	Actual consumption abroad	Comments	Estimated technical potential, 1000 tce
Tractors fuel efficiency	10^3	24,783	kgce/ha	20	7		Global practice	288.4
Renovation of greenhouses facilities	10^3 m^3	1,600	kgce/ m^3	34	17		Average for Russia	27.0
Adjustable speed drives in water supply systems	mln kWh	1,486	%	100%	75%		Global practice	45.7
Street lighting renovation	mln kWh	136	%	100%	70%		Global practice	5.0
Total								**366.2**

Source: CENEf

6.6.7 Comparisons of total energy efficiency potential estimates

Total technical energy efficiency potential for Georgia as of 2013 is estimated at 4.1 Mtce, or 69% of TPES (see Fig. 6.1). This estimate assumes independent implementation of all technological improvements, taking no account of integral direct or indirect effects related to the reduction of potential in power and heat generation after end-use demand for power and heat is reduced through measures implemented in final energy use sectors. The potential in industry may be overestimated, but overall energy use in some sectors (buildings, agriculture etc.) may be underestimated. Therefore, the technical energy efficiency potential in 2013 may be lower than 69%, but obviously exceeds 50% of TPES.

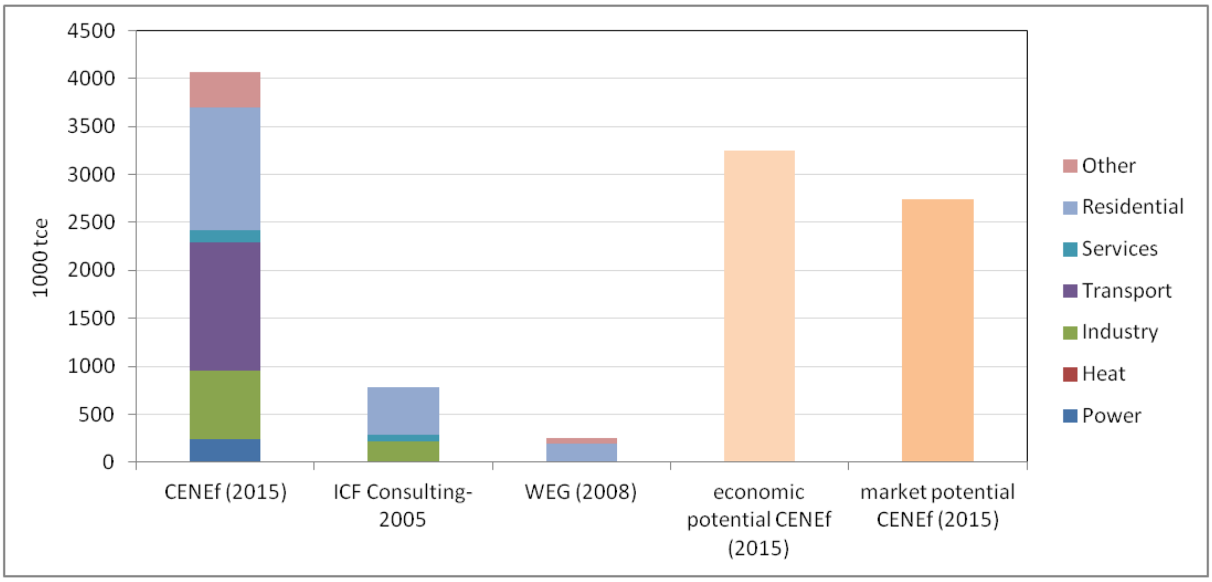
The energy efficiency potential was estimated under World Experience for Georgia[115], the NATELI project[116], through various research efforts, the Energy Efficiency Center[117] and Sustainable Energy Action for Tbilisi[118]. CENEf's estimate is much higher than those. This can partly be explained by different sectors coverage and inconsistency of data used for both present specific energy use and for BATs. CENEf's assessment breaks down the potential with a much higher itemization to allow for better-tailored energy efficiency policies.

The main problem with regard to energy efficiency in both residential and industrial sectors is that most technologies and buildings in use are obsolete and inefficient. This results in the inefficient use of resources, low energy affordability and substantial emissions.

In any case, even accounting for some uncertainty in the level of energy efficiency potential it is large and basically concentrated in industry, transport, and buildings.

[114] Energy Efficient Potential in Georgia and Policy Options for Its Utilization, USAID, p.72, 151, 2008.
[115] See: www.weg.ge
[116] See: www.nateliproject.ge
[117] See: http://www.eecgeo.org/en/eecp-project.htm
[118] See: http://helpdesk.eumayors.eu/docs/seap/1537_1520_1303144302.pdf

Figure 6.1. Estimates of technical, economic and market energy efficiency potentials for Georgia



Source: CENEf

6.6.8 Economic and market energy efficiency potentials

Economic and market potentials are assessed based on the comparison of energy prices and costs of saved energy. 2013 energy prices were used in the study (see Table 6.7). The share of income spent to pay energy bills is a more important driver behind rational energy use, than the level of energy prices[119]. If residential consumer energy spending is about 3 to 4% of his income, it means that there is practically no room left for further energy price increase before energy prices reach the level beyond which either payment collection will go down or many households will be forced to reduce resource consumption much below the sanitary level. Better energy use efficiency is a good solution. A problem arises when modern expensive equipment is needed to reduce energy consumption, while access to affordable financial resources is limited.

In this case economically attractive solutions are indicated by the cost of saved energy being lower, than the energy price. The cost of saved energy depends on the measure lifetime and the discount rate applied to annualize the capital costs. In this study, 6% discount rate was used to estimate the economic energy efficiency potential and 12% discount rate was used to estimate the market energy efficiency potential. In addition, 20% discount rate was used to reflect stricter budget limitations and a higher cost of money for some energy consumers.

Table 6.7 Energy prices in Georgia in 2013

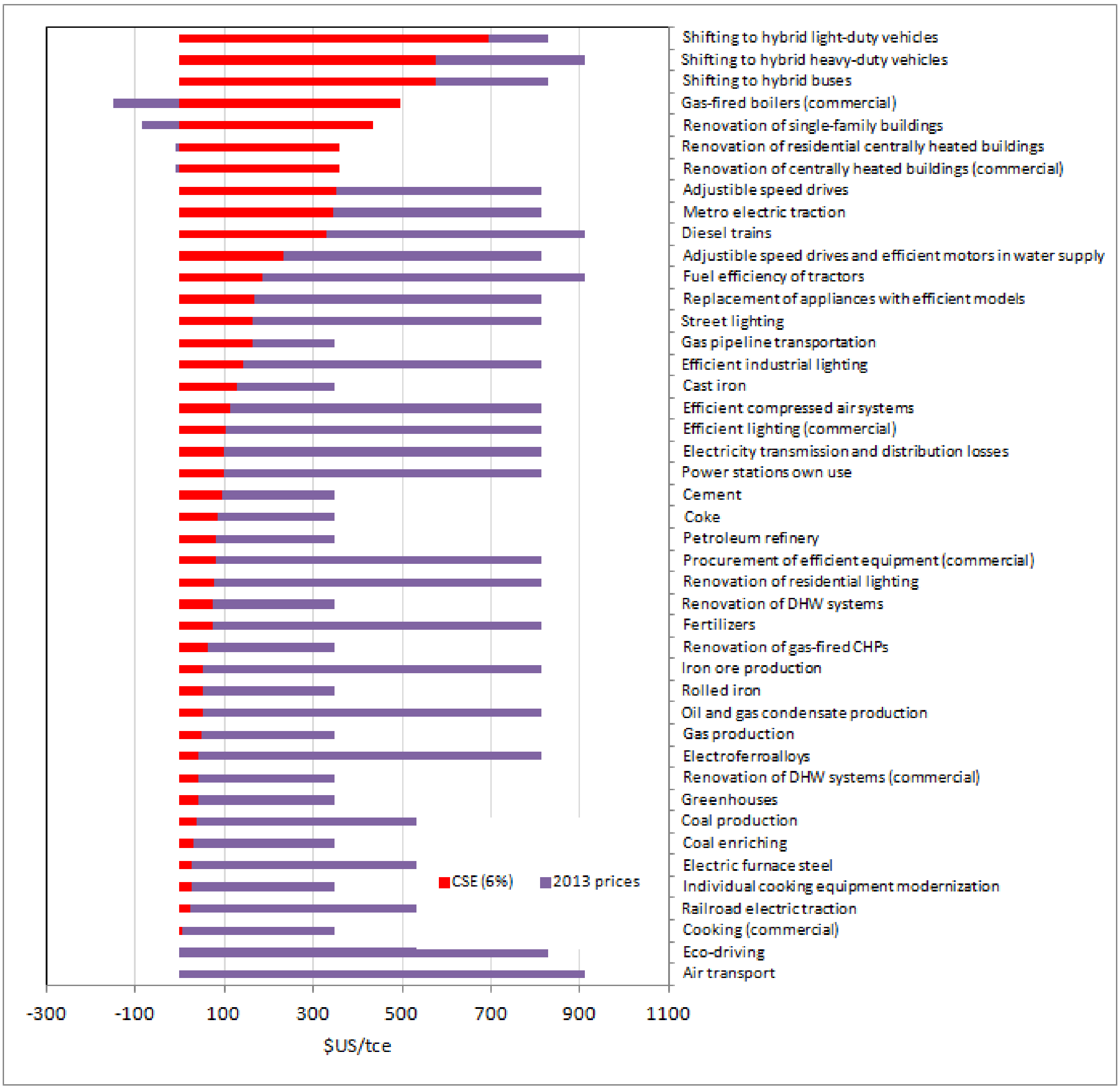
	Units	US$/unit	US$/tce
Electricity	kWh	0.10	813.0
Natural gas	m^3	0.40	348.4
Gasoline	t	1,604.1	909.1
Diesel fuel	t	1,183.5	827.6

Sources: ener2i - Energy Research to Innovation. Country Report Georgia. “Reinforcing cooperation with ENP countries on bridging the gap between energy research and energy innovation”, Energy Efficiency Centre Georgia (EEC), 2014.

[119] I. Bashmakov. Three Laws of Energy Transitions//Energy Policy. – July 2007. – P. 3583-3594; Bashmakov I.A. Ability and willingness of residential consumers to pay their housing and municipal utility bills // Voprosy ekonomiki (Issues of Economy). – 2004. No. 4.

Some measures, for which costs of saved energy appeared to be higher, than the energy price, are economically not attractive for the society and are not included in the economic potential (Fig. 6.2). The main reason why most measures are economically attractive is relatively high energy prices. With economic constraints the 4.1 Mtce of the technical energy efficiency potential shrinks to 3.3 Mtce of the economic potential.

Figure 6.2. Economic energy efficiency potential for Georgia (for 6% discount rate as of 2013)



The figure shows the costs of saved energy (red) and the gap between energy price in a given activity and the cost of saved energy (blue). Due to the fact that different energy carriers are used in individual activities, the price is average weighted for all energy carriers used. All prices are presented in US$/tce. If the gap is negative, the measure is considered economically not attractive and is excluded from the economic potential assessment.

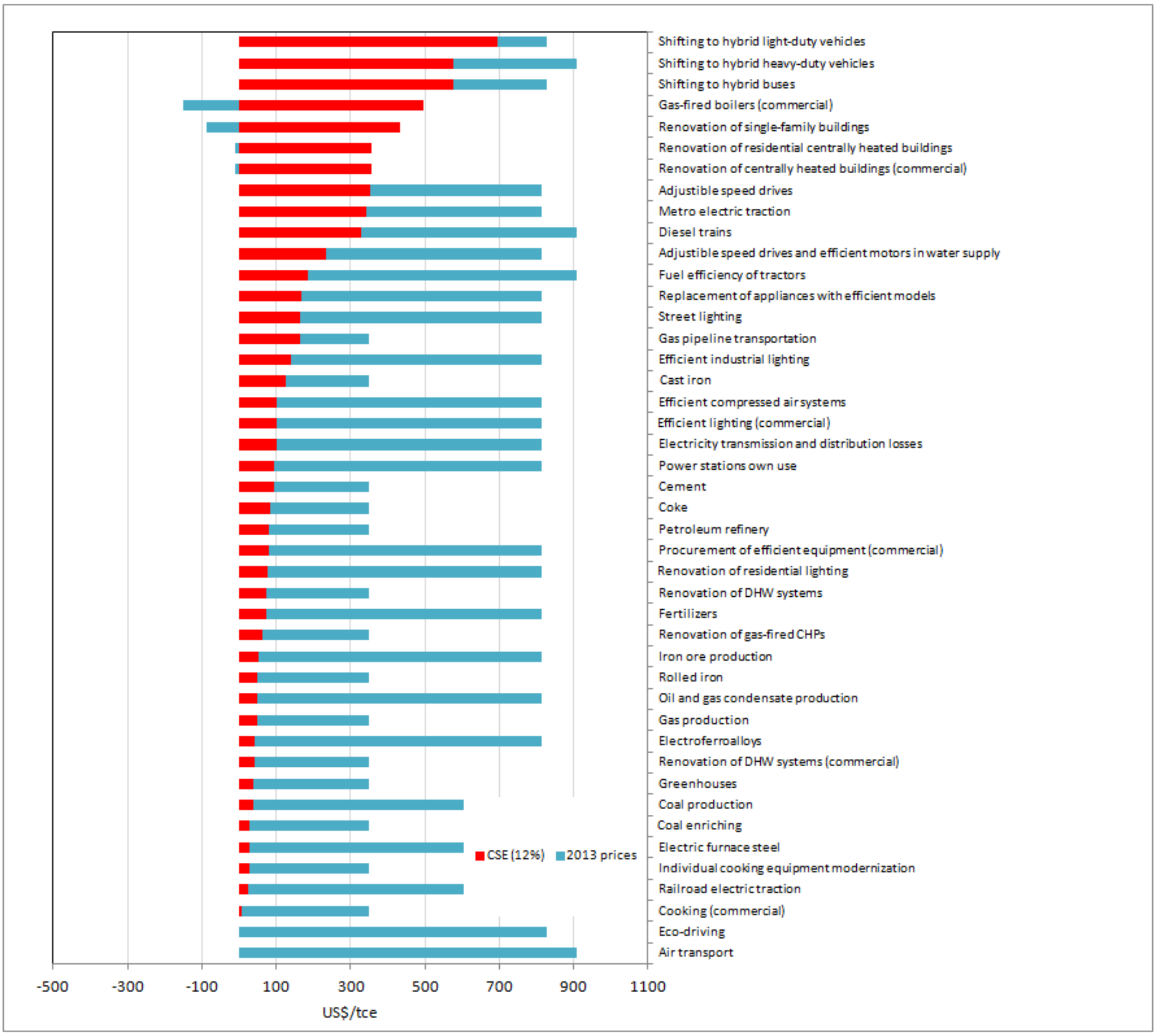
Source: CENEf

Better accounting for private parameters in the economic decision-making via higher weighted average costs of capital (12% and 20% discount rates) allows for an assessment of the market energy efficiency potential. It is lower, than the economic potential, but not very much lower. For the two discount rates mentioned it stands at 3.2 and 2.7 Mtce correspondingly (Fig 6.3 and

6.4). Making long-term funding for energy efficiency measures more easily available would allow it to bridge the gap between the economic and market energy efficiency potentials.

Even with current energy prices and 20% discount rate applied in investment decision-making, the market potential to improve energy efficiency in Georgia amounts to approximately 45% of the statistically reported primary energy use. Importantly, accounting for co-benefits and subsidies for currently not economically attractive energy efficiency measures, as well as steady energy price growth may scale up the economic and market potential closer to the technical one.

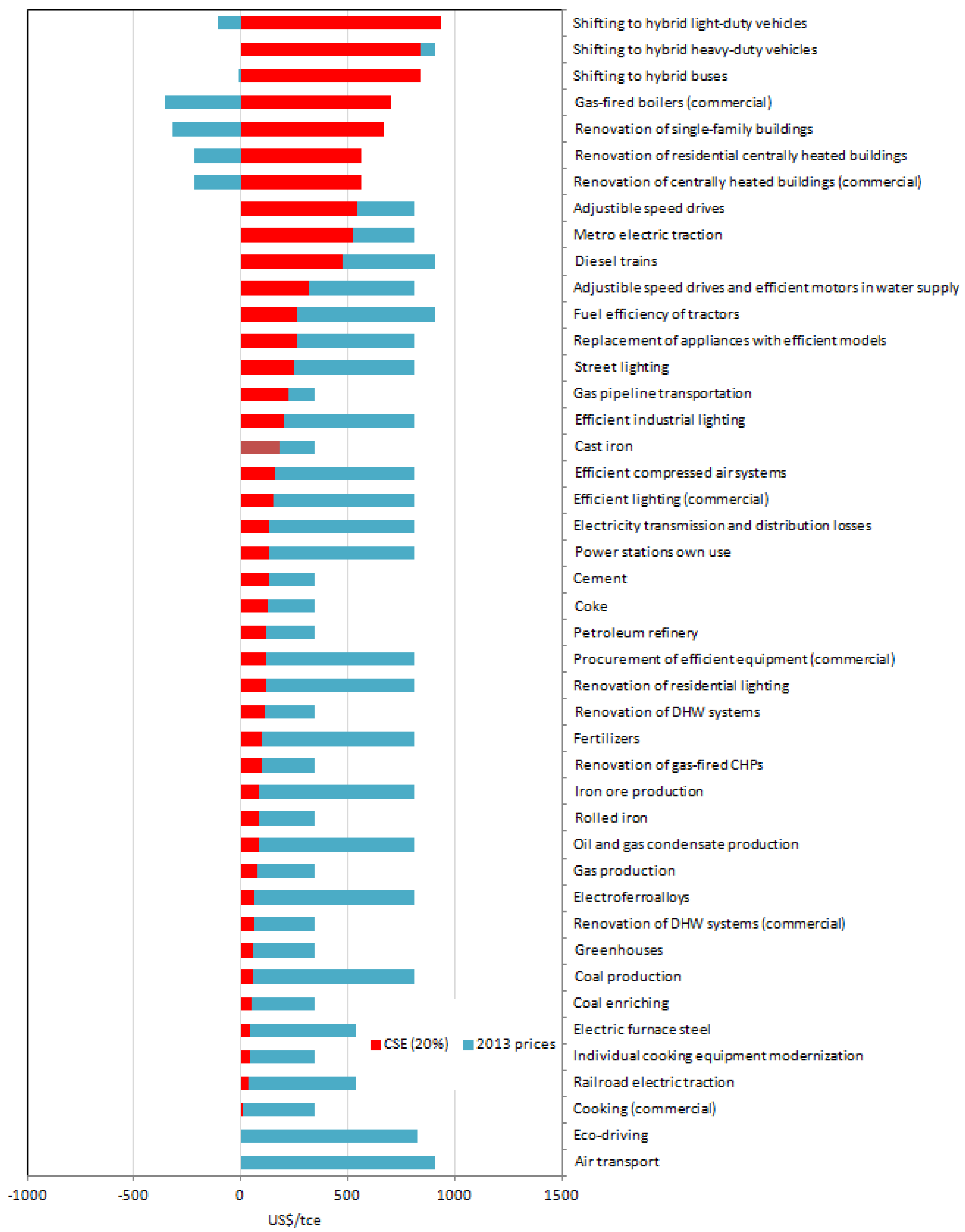
Figure 6.3. Market energy efficiency potential for Georgia (for 12% discount rate as of 2013)



The figure shows the costs of saved energy (red) and the gap between energy price in a given activity and the cost of saved energy (blue). Due to the fact that different energy carriers are used in individual activities, the price is average weighted for all energy carriers used. All prices are presented in US$/tce. If the gap is negative, the measure is considered economically not attractive and is excluded from the market potential assessment.

Source: CENEf

Figure 6.4. Market energy efficiency potential for Georgia (for 20% discount rate as of 2013)



The figure shows the costs of saved energy (red) and the gap between energy price in a given activity and the cost of saved energy (blue). Due to the fact that different energy carriers are used in individual activities, the price is average weighted for all energy carriers used. All prices are presented in US$/tce. If the gap is negative, the measure is considered economically not attractive and is excluded from the market potential assessment.

Sources: CENEf

Section 7. Kazakhstan

7.1 National level

Population in 2012: 16.79 mln; GDP PPP in 2012: 321.89 bln US$2005 (IEA[120]).

Evolution of GDP energy intensity. In 2011, Kazakhstan ranked third in GDP energy intensity among the 10 countries and did not demonstrate any significant progress, so the need to spur the implementation of energy efficiency policies was quite urgent.

Like noted in Section 1, for some obscure reasons IEA reports very high (68%) growth of Kazakhstan GDP in PPP in 2012 and a 63% drop between 1990 and 2012 in the energy intensity of GDP (in PPP). Energy intensity of GDP (in PPP) for 2011 was only 34% below the 1990 level and only 7% below the 2000 level, yet 5% above the 2005 level. If GDP estimates build on market exchange rates, average annual GDP energy intensity decline rate in 2000-2012 was just 1.4%, which is one of the lowest values among the 10 countries. In 2012, it was just 3.4% below the 2005 level.

Data presented in the federal programme "Energy conservation – 2020" show very little progress in GDP energy intensity decline in 2006-2010. According to the energy balances of Kazakhstan[121] statistics, GDP energy intensity evolution over 2008-2012 was very uneven. It went up in 2010, then declined in 2011 and 2012, and in 2012 was 16% below the 2008 level, yet 3% above the 2009 level.

Federal programme "Energy conservation – 2020" specifies a goal to reduce GDP energy intensity by 40% in 2008-2020 and to reduce GDP energy intensity by 10% annually over 2013-2015.

Factors behind the evolution of GDP energy intensity: technology and structural shifts. No decomposition studies have been found to allow for the identification of factors behind GDP energy intensity evolution. This is partly due to the fact that the energy use data are presented in Kazakhstani energy balances in the old Soviet manner, i.e. with very little detail on the energy use structure.[122] Such information cannot be of much help while exploring actual energy demand evolution. Energy consumption is not split by sectors. Substantial additional effort will be required to develop a workable energy balance.

With a slow and uneven GDP energy intensity decline over the recent years, structural factors obviously had certain impacts and technological factor was clearly responsible for less than 0.5% annual GDP energy intensity decline. This obviously is insufficient to bridge the technological gap with the advanced economies.

Energy prices. 2011 electricity price for industry was used as a proxy for energy prices level. It was 7.4 U.S. cents/kWh, or only half of the price in OECD Europe, but exceeded the U.S. or Norway prices. Nominal energy prices for different energy carriers have doubled and tripled since 2000.

Energy efficiency legislation. "Law on Energy Conservation and Energy Efficiency" was adopted on 13.01.2012 and was largely amended in January 2014. This law includes 24 articles. It splits competences between federal, regional and municipal authorities, and promotes the following mechanisms: energy use metering; energy efficiency requirements for new and

[120] http://www.iea.org/statistics.

[121] Kazakhstan Republic Fuel and Energy Balance. 2008-2012. Statistical inventory. Astana, 2013. (In Russian).

[122] For a critical analysis of such formats see: Bashmakov I.A. (2013). Development of long-term comprehensive energy efficiency programmes: methodology and practices. Thesis for a doctor's degree (economics). Institute of Economic Forecasting, Russian Academy of Science. 2013.

retrofitted buildings; energy use data collection and submission for the state register; energy management; equipment standards; prohibition of inefficient equipment turnover; energy audits and energy efficiency expertise; various forms of federal financial support for energy efficiency activities; long-term energy efficiency agreements; and information support.

Number of energy efficiency regulatory acts. In addition to the"Law on Energy Conservation and Energy Efficiency", there are energy efficiency building codes, and more than 22 regulations were enforced to stipulate some law provisions. These include Government Decree No. 904 dated 29.08.2013 "On Approval of the Federal Programme "Energy Conservation – 2020"; "Comprehensive Energy Conservation Plan to 2015"; Government Decree No. 1346 dated 24.10.2012 "On Setting Energy Consumption Norms To Manufacture Some Industrial Products", Government Decree No. 1192 dated 13.09.2012 "On Approval of Energy Efficiency Requirements To Predesign And Design Documentation on Buildings, Constructions and Facilities"[123]. These and other recently adopted legal acts introduce specific energy consumption norms for many industrial products, energy efficiency requirements for all types of transport, electric drives, buildings; introduce energy efficiency classes; specify energy audits procedures, voluntary long-term agreements; set up an evaluation system for local authorities' energy efficiency activities and rules for educational and training activities, including on energy management and energy audits. These multiple acts are complementary to the provisions of laws on the power sector, on natural monopolies, on measurements, on urban development, etc. In other words, presently Kazakhstan has a comprehensive and well-developed regulatory framework to implement energy efficiency policies**.**

Government agencies with an energy efficiency policy mandate. The major government body responsible for energy efficiency policies implementation is the Ministry of Industry and New Technologies. The idea was to create a special energy efficiency department within the ministry. In addition, some sections of the federal energy efficiency programme are a responsibility of the Ministry of National Economy, Ministry of Finance, Ministry of Energy, Ministry of Industry and New Technologies, Ministry of Education and Science, Committee on Construction, Housing and Communal Sector and Land Resources Management, Agency on Natural Monopolies Regulation, Construction and Communal Services Agency, Committee on Energy Inspection and Control, JSC "Institute of Electricity Development and Energy Saving"; JSC "Kazakhstan Centre for Housing and Communal Sector Modernization". In addition to the government agencies and companies, there are other institutions, like Kazakhstan Energy Auditors Association, or Kazakhstan Electric Power Association.

Basic administrative mechanisms to improve energy efficiency. There are energy consumption norms for many industrial products, energy efficiency requirements for each type of transport, electric drives, transport equipment; energy metering requirements; energy efficiency classes; mandatory energy audits, building codes, energy data reporting, project energy expertise; ban of inefficient equipment turnover (incandescent lamps) and of associated gas flaring.

Basic energy efficiency market mechanisms and economic incentive programmes. These include emission trading, subsidies for buildings retrofits and building-level meters installation; voluntary agreements, taxation and pricing policies, variable heat charge depending on whether or not a heat meter is installed.

Energy efficiency policy spending and financial sources. Data from Government Decree No. 904 of 29.08.2013 "On Approval of the Federal Programme "Energy conservation – 2020" were used as a proxy for the funds secured for energy efficiency policies. The whole budget for this programme is as shown in Table 7.1.

[123] http://www.zanorda.kz/ru/content/67602-p1200001192

Table 7.1 Energy efficiency policy spending and financial sources

	Total 2013-2020		Annual average
	Million tenge	Million US$	Million US$
All sources	1,182,214	6,502	813
Federal budget	146	0.8	0.1
Local budgets	4,915	27	3.4
Other sources	1,177,153	6,475	809

At first glance, it looks like the budget will provide only 0.4% of the entire funding needed to finance the programme measures. This is too little. The financial leverage ratio is 1 to 250. To date, there has never been such high leverage ratio. For the EU, USA and China it varies between 3 and 7.[124] This just means that it is very unlikely that this programme will obtain expected funding to attain the specified targets, as the federal budget is only going to annually secure negligible financing.

It should be noted, that the total budget of four projects with international financial institutions that are presented in the database and include energy efficiency as an important component amounts to US$ 900 million.

Energy efficiency R&D spending. No data on energy efficiency research and development spending have been found.

ESCO market. The Law "On Energy Conservation and Energy Efficiency" does not introduce the ESCO mechanism. According to the European Economic Commission, there are no operating energy service companies in Kazakhstan[125]. Back in 2009, some pilot projects were implemented in Karaganda.

Water efficiency policy. Federal Committee on Water Resources of the Kazakhstan Republic Ministry of Agriculture is implementing national plan for integrated water resources management and water efficiency in Kazakhstan.

International cooperation. Kazakhstan has been involved into, and is going to proceed with, an extensive international cooperation in energy efficiency. There is a special line in the federal programme "Energy Conservation – 2020" on the development of international cooperation in this area. A Kazakh-German energy efficiency centre was recently created by JSC "Kazakhenergyexpertise" (recently renamed as JSC "Institute of Electricity Development and Energy Saving") and dena (German energy agency). In 2014, International Energy Efficiency Center was opened in Karaganda to provide free energy efficiency consulting to designers, architects, utility enterprises, condominiums and residents. Cooperation is going with UNDP, EC, US, Norway, Korea. Some project activities are being carried on by the World Bank, EBRD and ADB. Organizations like OECD or IEA were also active in energy efficiency[126].

7.2 Heat and power generation

Power generation efficiency. There are two sources of data to assess the effectiveness of power generation, transmission and distribution: IEA energy balances and data provided in the federal programme "Energy Conservation – 2020". Other sources were used as well, including Kazakhstan statistical bulletin on energy balances. According to IEA, more than 90% of

[124] I. Bashmakov. Who, where and how much spends on energy efficiency? Analysis of foreign experience and recommendations for Russia. Akademia Energetiki, No. 1 [57], February 2014.

[125] Economic Commission for Europe. Financing Energy Efficiency And Renewable Energy Investments for Climate Change Mitigation Project. Development of Energy Service Companies Market And Policies. United Nations. New York and Geneva, 2013.

[126] Promoting Energy Efficiency in the Residential Sector in Kazakhstan: Designing a Public Investment Programme. OECD. 2012.

electricity is generated by CHPs with 74-80% overall efficiency. In reality, these data represent generation by fuel power stations, CHPs and boilers, and are not reliable.

A study conducted by ÅF-Consult Ltd for 12 largest power plants in Kazakhstan showed, that average power generation efficiency (brutto) was 36% for power-only stations and just 23% for CHPs, which is 5 to 10% below the level observed in modern plants with similar capacities[127]. Specific fuel consumption is 350 gce/kWh and is to be reduced to 300 gce/kWh by 2020.

Power transmission and distribution losses (%). According to IEA, the share of losses has been 7-9% in the recent years, whereas local statistical sources report 12 to 13%.[128] Distribution losses are 26% and are to be reduced to 15% by 2020.

Heat generation efficiency. According to Government Decree No. 473 dated 30.04.2014, average efficiency of boilers is as low as 40%.[129] This seems too low to take this information as reliable. Another source reports boilers efficiency at more reasonable 75%.

Share of CHP in power generation is 36.6%. Condensing power stations contribute 87.7%, gas turbine units 2.3% and hydro power stations 12.3%.

Heat distribution losses. IEA energy balance reports 10-12% share of district heat loss in the recent years (10% in 2012), while federal statistics estimate it at 12% in 2012. Federal programme "Energy Conservation – 2020" reports distribution heat losses at 37%, and so heat distribution inefficiency requires most serious attention. The losses are to be down to 18% by 2020.

Energy efficiency regulations in heat and power generation and distribution. Government Decree No. 1346 dated 24.10.2012 "On Setting Energy Consumption Norms to the Manufacture of Some Industrial Products" specifies consumption norms for power plants own use and power- and heat losses depending on the networks parameters. Government Order No. 410 dated 28.04.2014 requires boilers efficiency improvements to 84% by 2020. The federal programme "Energy Conservation – 2020" requires 14% reduction in specific energy consumption for electricity generation and 5% reduction in power losses.

Government agencies with an energy efficiency policy mandate in heat and power generation and distribution. Government agencies responsible for energy efficiency policy implementation in the heat and power sector are the Ministry of Industry and New Technologies and Agency on Natural Monopolies Regulation.

Basic administrative mechanisms to improve energy efficiency in heat and power generation and distribution: energy own use norms, energy efficiency requirements for new installations; mandatory energy audits, data reporting, energy expertise.

Basic energy efficiency market mechanisms and economic incentive programmes: emission trading, voluntary agreements, taxation and pricing policies.

Renewables development programmes. Federal programme "Energy Conservation – 2020" requires that the share of renewables in the overall energy production grow up to 3% and that heat losses be reduced by 3.6%.

White Certificates market. No such programmes launched so far.

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[127] http://energypolis.ru/portal/2010/307-generaciya-tonkaya-nastrojka.html

[128] Residential municipal services in Kazakhstan Republic. 2009-2013. Statistical inventory. Astana, 2014. (In Russian).

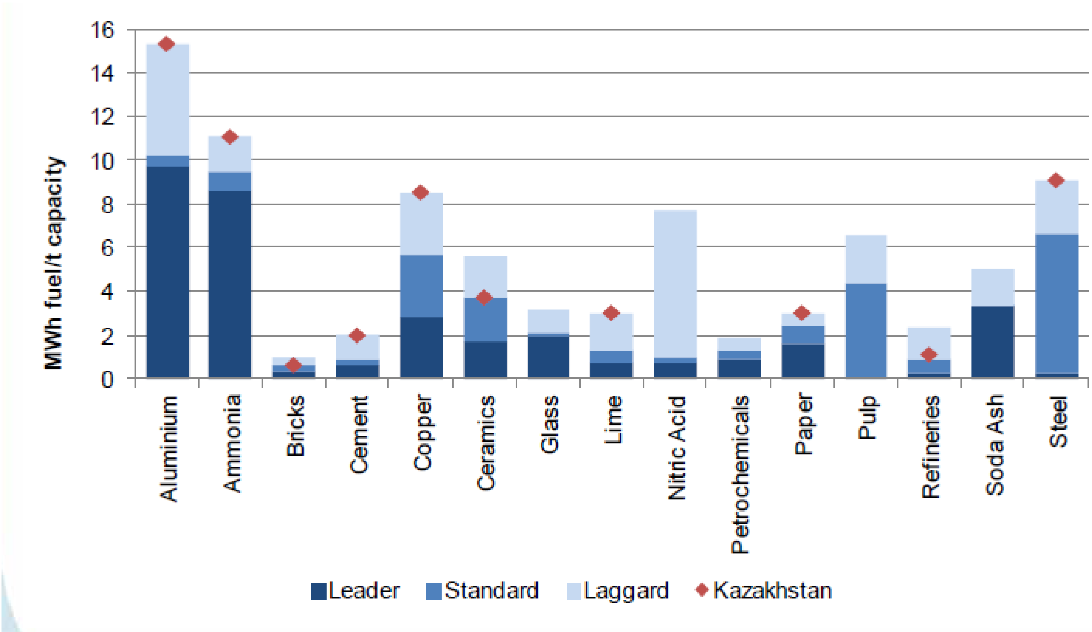
[129] Kazakhstan Republic Government Decree No. 410 dated April 28, 2014 "On the Amendments and Supplements to the Kazakhstan Republic Government Decree No. 473 dated April 30, 2011 "On the Approval of Kazakhstan Republic Residential Municipal Services Modernization Programme for 2011 – 2020".

7.3 Industry

Industrial energy intensity. Industry dominates energy consumption in Kazakhstan (31% of TPES and 55% of final energy consumption). These shares are not only large, but also growing. According to UNIDO, energy intensity of the industrial sector declined by 10% in 1990-2000 and by additional 22% in 2008 (in tons of oil equivalent per US$1,000 of manufacturing value added).[130] This decline was driven partly by structural shifts, but mostly by the reduction of energy intensities in different industries (measured as energy use per value added in constant prices).

Energy intensity of basic industrial goods. As Figure 7.1 shows, energy intensities of many industrial products lag behind not only BATs, but also standard practices. This leaves a lot of room for energy efficiency improvements in the process of technical upgrades.

Figure 7.1 Industrial Energy Intensity in Kazakhstan - International Benchmarks



Source: A. Nasritdinov. Energy Efficiency and Climate Change, Financing Energy Efficiency in Kazakhstan: New Opportunities with EBRD. Almaty. RO European Bank for Reconstruction and Development.

Energy efficiency regulations in the industrial sector. Federal programme "Energy Conservation – 2020" does not set any specific target to reduce overall industrial energy intensity. However, Government Decree No. 1346 of 24.10.2012 sets specific energy consumption norms for dozens of manufacturing processes and some industrial products. These norms are set for industrial technologies introduced before 1980, in the 1980s, and after 1990.

Government agencies with an energy efficiency policy mandate in the industrial sector. The key government agency responsible for industrial energy efficiency policies implementation is the Ministry of Industry and New Technologies.

Basic administrative mechanisms to improve energy efficiency in the industrial sector: energy consumption norms for many industrial products; energy efficiency requirements for electric drives; mandatory energy audits; energy data reporting; energy expertise; prohibition of associated gas flaring.

[130] UNIDO. Industrial Development Report 2011. Industrial energy efficiency for sustainable wealth creation. Capturing environmental, economic and social dividends.

Basic energy efficiency market mechanisms and economic incentive programmes: emission trading, voluntary agreements, taxation and pricing policies.

Long-term agreements. Law "On Energy Conservation and Energy Efficiency" introduces the long-term agreements instrument in Kazakhstan. There are three parties to such agreements: Ministry of Industry and New Technologies; a regional agency, and a large industrial energy user. The latter is motivated by a lower environmental fee. The law stipulates that only large industrial energy users can become part to such agreements by committing to cut their energy use by at least 25% over 5 years. The term of agreement cannot be shorter than 5 years.

Energy management systems. All energy users whose annual energy consumption is above 1,500 tce are mandated to have energy management systems. Energy management system is viewed as a cornerstone of all future activities towards improved energy efficiency. It contributes 3 to 6% to electricity and natural gas savings with paybacks below 3 years.

Industrial energy efficiency policy spending. According to the federal programme "Energy Conservation – 2020", some US$ 18 million are to be leveraged to finance programme activities in the industrial sector. This amount is by no means adequate to the tasks to be accomplished.

7.4 Buildings

Specific energy consumption per m^2 of residential floor space (energy intensity of residential buildings). Based on the IEA and national statistical data on buildings energy consumption and buildings stock floor space, specific energy use in 2012 was 20.8 kgoe/m^2, or 241 kWh/m^2. The latter figure is below that reported for Finland (294 to 320 kWh/m^2) or Russia (363 kWh/m^2), but above the EC average (220 kWh/m^2) or for urban population in China (175 kWh/m^2).[131] Much additional information is needed to assess the comparative energy efficiency level in Kazakhstan – heating and cooling degree-days, number of persons per household, appliances saturation and the level of services. In 2008-2012 (period for which comparable data are available), no specific energy use decline was observed. The task is to reduce specific energy consumption by 30% by 2020.

Specific energy consumption per m^2 of public floor space. While information on the energy consumption structure in public buildings is available, there are no data on specific energy use per unit of floor space. Based on the Russian experience, it should be very close to residential specific energy use, or to 240-300 kWh/m^2.

Specific energy consumption for space heating per m^2 of residential floor space per degree-day of the heat supply season. According to the federal programme "Energy Conservation – 2020", most buildings are of low energy classes, as revealed by energy audits. The programme also states, that average energy use for space heating is 270 kWh/m^2. This is probably correct for multifamily buildings only. In the EC, specific energy consumption for space heating by all buildings is 140 kWh/m^2, in Russia (district heating) 198 kWh/m^2 versus 263 kWh/m^2 (decentralized heating). The figure given for Kazakhstan looks too high and probably covers entire residential energy use, rather than just space heating.

Specific hot water consumption per household with access to centralized DHW supply. This information will require a special investigation, but in many countries energy use for DHW supply is 140-350 kgoe/household/year, or 50-130 kgoe/person/year depending on the household average size.

Share of consumers equipped with energy meters. The"Law on Energy Conservation and Energy Efficiency" requires that all new buildings and facilities need to have energy and water meters installed. For consumers who have no meters energy tariffs are about 40% higher. The "Law on Natural Monopolies and Regulated Markets" requires that all multifamily buildings

[131] CENEf. 2014. Energy efficiency in Russia's residential sector. How to make it low-carbon?

have heat meters by the end of 2014. Based on data from several oblasts, the share of multifamily buildings with meters was only 35% as of mid-2014 (approaching 66% in some regions)[132]. In many instances, local budgets cover the installation costs of building-level heat meters. The share of households that have individual meters is 81% (hot water), 80% (tap water), and more than 95% (electricity).

Building codes requirements. Energy efficiency parameters specified for new, upgraded and retrofitted buildings; determination of energy efficiency classes for all buildings. New codes were introduced in 2012. They were merely copied from the Russian building codes enforced in 2012. No schedule to further improve new buildings' energy efficiency was developed.

Other administrative mechanisms to promote energy efficiency: energy metering requirements; energy efficiency standards and labelling for appliances, buildings certification by energy efficiency classes; mandatory energy audits, energy data reporting, energy expertise; ban of inefficient equipment turnover (incandescent lamps).

Basic energy efficiency market mechanisms and economic incentive programmes in the buildings sector: subsidies for buildings retrofits and building-level meters installation; taxation and pricing policies; higher heat charge for those who have no heat meters.

Government agencies with an energy efficiency policy mandate in the buildings sector. Government agencies responsible for energy efficiency policies implementation in the buildings sector are the Ministry of Industry and New Technologies, Ministry of Regional Development, Construction and Communal Services Agency, JSC "Institute of Electricity Development and Energy Saving".

Information and educational programmes. The Law "On Energy Conservation and Energy Efficiency" requires the development of a national register to which all large energy users will report their energy efficiency levels. Energy audits are another information instrument. The Law also requires educational activities, like exhibitions, demo projects, and propaganda. Kazakhstan annually hosts an international exhibition ReEnergy Kazakhstan and many seminars, conferences and smaller exhibitions.

7.5 Transport

Specific energy consumption per unit of transport service. Some information is available on specific energy consumption for pipeline transport of oil, petroleum products and gas. In 2007, the last two were higher than back in 2000. The intention is to cut these values by 2020 by 11-32%. Specific energy use by electric transport (metro, trams and trolleybuses) was also higher in 2007 compared to 2000, and tasks are set to reduce them to the 2000 levels or even more.

Fuel efficiency of new private cars is to be down from 12 l/100 km to 7 l/100 km, the share of hybrid cars is expected to reach 5% in 2020 from zero in 2007. Per capita public transport turnover is to go up by 29% from 2007 to 2020.[133]

Government agencies with an energy efficiency policy mandate in the transport sector. The main government agency responsible for energy efficiency policies in the transport sector is Ministry of Transport and Communications.

Basic administrative mechanisms to improve energy efficiency in the transport sector: energy efficiency requirements for transport equipment; mandatory energy audits, energy data reporting; energy expertise.

[132] http://dknews.kz/i-uchet-i-kontrol; http://www.inform.kz/rus/article/2440966.
[133] S.A. Turchekenov. OJSC "Kazakhenergoexpertisa". Kazakhstan Republic national report on energy efficiency and energy conservation to improve the synergy effect of national programmes of the CIS member-countries and to improve their energy security.

Basic energy efficiency market mechanisms and economic incentive programmes in the transport sector: emissions trading; voluntary agreements, taxation and pricing policies.

7.6 Technical energy efficiency potential for Kazakhstan

7.6.1 Approach and data sources

Four sets of data were used to assess the energy efficiency potential for Kazakhstan (Table 7.2). Data related to the economic activities were collected from national statistical sources (for 2012-2013), which are listed in corresponding sections. Data related to specific energy use in different applications were collected from official documents, programmes, presentations and publications. Where appropriate data were not available, proxies for countries with similar conditions were used. Assessment of the technical potential builds on the comparison of those energy efficiency indicators with specific energy consumption for BATs (best available technologies) in the same sectors and subsectors. BATs data were collected from multiple international sources.

Table 7.2 Data collection technology and structure

Information required	Source of information	Methods of data collection
Data on economic activities	Statistical yearbooks	Collection of statistical data
Data on specific energy consumption in various sectors in Kazakhstan	Official documents, publications, proxies for countries in similar conditions	Literature search
Data on specific energy consumption for BATs	Publications	Collection of data from publications on BATs
Energy prices	Statistical yearbooks	Energy prices

The technical energy efficiency potential for Kazakhstan was assessed as the 2012-2013 activity level multiplied by the gap between the country's specific energy efficiency and energy efficiency BAT parameters for the same activity category.

Assessment of the technical potential was structured by different sectors including: power and heat generation, transmission and distribution, industry, transport, buildings, agriculture, street lighting, water supply, etc. Estimates generated by this study were, where possible, compared with the local estimates of the energy efficiency potential for similar activities[134]. Where the information was sufficient, the reasons for mismatching, if any, were identified.

Based on these comparisons, technical potential estimate ranges were provided. Where reliable information for some energy use activities was not available, such activities were skipped from the potential evaluation study.

So as to identify the economic and market potentials, the costs of saved energy were compared to the 2013 or 2014 energy prices in order to see if an individual measure is economically viable.

Summary of energy efficiency potential estimation for Kazakhstan:

- Power and heat 11,059 thou tce
- Industry 14,071 thou tce
- Transport 4,170 thou tce
- Residential buildings 7,835 thou tce
- Services 1,226 thou tce
- Other 693 thou tce
- **Total** **39 Mtce**

[134] See for example a comprehensive presentation: S.A. Turchekenov. OJSC "Kazakhenergoexpertisa". Kazakhstan Republic national report on energy efficiency and energy conservation to improve the synergy effect of national programmes of the CIS member-countries and to improve their energy security. Astana, 2013.

7.6.2 Power and heat

CENEf's assessment builds on the data related to energy use and power and heat generation available from statistical yearbooks, government programmes and legal acts, publications, and other sources, including internet resources. For some parameters such information was not available, and so they were assessed using proxies, including parameters for similar installations in Russia. Therefore, the estimates of the technical potential are by no means perfect. CENEf has taken any and all measures to make them as reliable as possible, despite the tight work schedule that did not allow for too extensive data search. Data related to power generation in 2013 were borrowed from statistical yearbooks, including "Kazakhstan national and regional industry. 2009-2013".[135] Some information was also found to serve a basis for expert allocation of power generation by stations (GRES and CHPs) and by fuels, as well as contribution of fuel to power generation. Based on this information, power generation was allocated by various types of stations in Table 7.3. In the recent years, coal-fired power plants have been contributing 67-74% to the overall power generation, gas-fired plants 10-11%, residual oil-fired plants 4-5%. CHPs contribute 42% to power generation by fossil fuel-powered plants, condensed power stations (GRES) 55.4%, and gas turbines 2.6%. Total power production in 2013 was 92.6 bln kWh.

Heat generation in 2013 amounted to 99.9 million Gcal. Of this volume 45% were generated by 40 CHPs, 35% by 28 large boiler-houses with more than 100 Gcal/h capacity, and the remaining 20% by about 2,400 smaller boiler-houses. The structure of fuel use was estimated by CENEf.

Power and heat losses were taken from statistical sources. They are smaller, than those reported in many analytical papers. However, high losses are reported for distribution networks, whereas substantial amounts of power and heat are used by heavy industry, where these resources are often delivered via high voltage power lines and large diameter pipelines at short distances.

Large energy use in heavy industry counterbalances significant losses in distribution networks (which reach 21-26% for power and even higher for heat - up to 33%)[136] making the country average lower, than those in the distribution networks.

Where information on specific energy use was not found in the national sources[137], proxies (based on Russia's experience in similar conditions) were used.

According to the IEA energy balances[138], about 45 Mtce are annually used for power and heat generation, transmission and distribution. CENEf estimates technical energy efficiency potential

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135 Kazakhstan Republic Government Decree No. 724 of June 28, 2014 "On the approval of the Development Concept for Kazakhstan Republic Fuel and Energy Sector to 2030"; S.A. Turchekenov. OJSC "Kazakhenergoexpertisa". Kazakhstan Republic national report on energy efficiency and energy conservation to improve the synergy effect of national programmes of the CIS member-countries and to improve their energy security. Astana, 2013; Sh. Urazalinov. Kazakhstan Electricity Sector: Shape and Perspectives for Further Development. Energetika, No. 1 (44), February 2013. www.kazaenergy.kz; http://www.bourabai.kz/toe/kazenergy.htm#6; Energopolis Journal.html.

136 Energy efficiency programme to 2015. Government of Kazakhstan. 2009. Reproduced also in S.A. Turchekenov. OJSC "Kazakhenergoexpertisa". Kazakhstan Republic national report on energy efficiency and energy conservation to improve the synergy effect of national programmes of the CIS member-countries and to improve their energy security. Astana, 2013.

137 Kazakhstan Republic Government Decree No. 724 of June 28, 2014 "On the Approval of the Development Concept for Kazakhstan Republic Fuel and Energy Sector to 2030"; Energy Efficiency Programme to 2015. Government of Kazakhstan. 2009; S.A. Turchekenov. OJSC "Kazakhenergoexpertisa". Kazakhstan Republic national report on energy efficiency and energy conservation to improve the synergy effect of national programmes of the CIS member-countries and to improve their energy security. Astana, 2013; Kazakhstan Republic Government Decree No. 1346 of October 24, 2012 "On Approval of Energy Consumption Norms and On Recognizing as Void of Kazakhstan Republic Government Decree No. 50 of January 26, 2009 "On Approval of Energy Consumption Norms".

138 Kazakhstan national and regional industry. 2009-2013. Statistical Yearbook. Astana, 2014; Housing and municipal utility sector in the Kazakhstan Republic. 2009-2013. Statistical Yearbook. Astana, 2014; Resource balances and the use of key materials, industrial products and consumer goods in the Kazakhstan Republic. 2008-2012. Statistical Yearbook. Astana, 2013.

in this sector at 11 Mtce (Table 7.3), or at about one fourth of annual consumption by this sector. This estimate very well matches the assessment of the technical potential made by the local experts (10 Mtce[139]), and the structure of the potential is shown in the table. The Energy Efficiency Programme to 2015, which was adopted back in 2009, estimates the power sector potential at 16 Mtce.

Table 7.3. Energy efficiency potential in power and heat generation, transmission and distribution (as of 2013)

Integrated technologies of goods, work, and services production	Units	Scale of economic activity	Units	Specific consumption in 2010	Practical minimum	Actual consumption abroad	Comments	Estimated technical potential, 1000 tce
Renovation of gas-fired power only plants (GRES)	mln kWh	8,000	gce/kWh	325	205	262	Combined cycle gas turbines (CCGT), 60% efficiency	960
Renovation of coal-fired GRES	mln kWh	40,400	gce/kWh	355	273	293	Equipment with 48% efficiency	3,299
Renovation of gas-fired co-generation plants (CHPs)	mln kWh	3,500	gce/kWh	321	205	262	CCGT, 60% efficiency	406
Renovation of coal-fired CHPs	mln kWh	25,900	gce/kWh	349	273	293	Equipment with 48% efficiency	1,952
Renovation of residual oil-fired CHPs	mln kWh	4,000	gce/kWh	322	256	293	Equipment with 48% efficiency	263
Renovation of diesel power plants	mln kWh	500	gce/kWh	454	332	332	Equipment with 37% efficiency	61
Power stations own use	mln kWh	92,616	%	8.2%	4.0%	5.0%	Global practice –North America	478
Electricity transmission and distribution losses	mln kWh	85,057	%	13.1%	6.9%	7.0%	Global practice – Japan	648.6
Renovation of coal-fired boiler-houses	thou. Gcal	45,920	kgce/Gcal	199	159		Equipment with 90% efficiency	1,860.3
Renovation of residual oil-fired boiler-houses	thou. Gcal	4,800	kgce/Gcal	173	155		Equipment with 92% efficiency	85.5
Renovation of gas-fired boiler-houses	thou. Gcal	4,200	kgce/Gcal	165	151		Equipment with 95% efficiency	59.9
Renovation of other boiler-houses	thou. Gcal	600	kgce/Gcal	218	159		Equipment with 90% efficiency	35.2
Electricity consumption for heat generation by boilers	thou. Gcal	54,920	kWh/Gcal	23	7	9	Finland	108.1
Heat distribution losses	thou. Gcal	83,800	%	12.0%	5.4%		Replacement of heat pipes (new technology)	790.9
Electricity cogeneration by boilers	mln kWh							75.0
Total for power and heat								**11,059.8**

Source: CENEf

[139] S.A. Turchekenov. OJSC "Kazakhenergoexpertisa". Kazakhstan Republic national report on energy efficiency and energy conservation to improve the synergy effect of national programmes of the CIS member-countries and to improve their energy security. Astana, 2013.

7.6.3 Industry

Technical energy efficiency potential for industry was assessed (see Table 7.4) using 2013 data on industrial activities from the statistical yearbook[140] and data on specific energy use in Kazakhstan (where available) or proxies for Russia.

Table 7.4 Energy efficiency potential in industry (as of 2013)

Integrated technologies of goods, work, and services production	Units	Scale of economic activity	Units	Specific consumption in 2010	Practical minimum	Actual consumption abroad	Comments	Estimated technical potential, 1000 tce
Petroleum refinery	10^3 t	14,290	kgce/t	87	53.9	75.1	Global practice	467.7
Gas processing	10^9 m^3	3,000	kgce/ 10^3 m^3	62	46.3		2000 level	47.5
Coal processing	10^3 t	32,292	kgce/t	6.3	5.0		Global practice	40.7
Crude oil production	10^3 t	81,787	kWh/t	130	40.0		Global practice	903.4
Natural gas production	$10^6 m^3$	42,405	kgce/ 1000 m^3	8.7	5.9		Expert estimate	118.1
Coal production	10^3 t	119,600	kgce/t	14.0	3.0		Global practice	1,315.6
Iron ore	10^3t	51,689	kgce/t	12.5	8.5	10.0	Global practice	206.8
Iron ore agglomerate	10^3 t	4,816	kgce/t	59.0	50.9	58.0	Global practice	39.0
Iron ore pellets	10^3t	6,820	kgce/t	22.2	21.4	21.4	Kostamuksha mining and concentrating plant	5.5
Coke	10^3 t	2,379	kgce/t	161.5	119.0	143.0	Global practice	101.1
Cast iron	10^3 t	2,635	kgce/t	664.5	355.0	461.0	Global practice	815.5
Basic oxygen steel	10^3 t	2,668	kgce/t	13.0	-15.0	34.0	Global practice	74.7
Electric steel	10^3 t	70	kgce/t	94.8	50.0	80.6	Global practice	3.1
Rolled ferrous metal products	10^3 t	2,277	kgce/t	113.1	31	68.0	Global practice	187.6
Electroferroalloys	10^3 t	1,707	kgce/t	959	700	700	Sverdlovskaya Oblast	442.1
Aluminium	10^3 t	1,840	kgce/t	1,845	1,599	1763	Global practice	452.6
Alumina	10^3t	1,510	kgce/t	478	324	410	Global practice	232.0
Zinc ore and blanch	10^3 t	7,271	kgce/t	640	130		Global practice	3,708.2
Blister copper	10^3 t	269	kgce/t	910	490		Global practice	113.0
Synthetic ammonia	10^3 t	116	kgce/t	1,328	956	1120	Global practice	43.2
Fertilizers	10^3 t	260	kgce/t	163	109	131	Global practice	14.0
Pulp	10^3 t	100	kgce/t	790	404	485	Global practice	38.6
Paper	10^3 t	32	kgce/t	360	241	320	Global practice	3.8

[140] Kazakhstan national and regional industry. 2009-2013. Statistical Yearbook. Astana, 2014.

Integrated technologies of goods, work, and services production	Units	Scale of economic activity	Units	Specific consumption in 2010	Practical minimum	Actual consumption abroad	Comments	Estimated technical potential, 1000 tce
Cardboard	103 t	69	kgce/t	343	237	266	Global practice	7.3
Cement production	10^3 t	7,072	kgce/t	24	11	13	Global practice	91.9
Clinker production	10^3 t	5,759	kgce/t	200	99	145	Global practice	584.0
Meat and meat products	10^3 t	210	kgce/t	211	50		Chelyabinskaya Oblast	33.9
Bread and bakery	10^3 t	743	kgce/t	157	89		Tambovskaya Oblast	50.4
Efficient motors	10^6 units	1.0	kWh/ motor	9,956	8,507		Global practice	178.2
Variable speed drives	10^6 units	0.5	kWh/ drive	9,956	9,356		Global practice	33.2
Efficient compressed air systems	$10^6 m^3$	6,214	kgce/ 1000 m^3	18	7		Global practice	72.5
Efficient oxygen production	$10^6 m^3$	1,080	kgce/ 1000 m^3	112	90		Global practice	24.3
Efficient industrial lighting	10^3 units	4	kWh/ lighting unit	247	160		Global practice	42.5
Efficient steam supply	10^3 tce	7,000	%	75%	100%		Global practice	1,750.0
Heat recovery	thou. Gcal	10,000	%	60%	90%		Global practice	429.0
Fuel savings in other industrial applications	10^3 tce	7,000	%	80%	100%		Global practice	1,400.0
Total for industry								**14,071.0**

Source: CENEf

The potential was estimated for 29 energy intensive homogenous products and for 7 cross-cutting technologies applicable across all industrial sectors. Copper ore production was skipped from the assessment, because the incorrect data on specific energy use in copper ore mining as presented in the "Energy efficiency programme to 2015" (2009) resulted in the overestimation of the energy efficiency potential in this industrial activity (specific energy use is not expected to exceed 0.2 tce/t copper ore, while the figure used is 1.68 tce/t). This large figure is perhaps more appropriate for the estimation of specific energy use for the whole cycle of refined copper production[141], than for ore mining. This error was replicated in another study[142]. Skipping copper ore from the potential evaluation may result in the underestimation of the potential by around 200,000 tce, or less than 2%.

[141] Energy efficiency programme to 2015. Government of Kazakhstan. 2009.
[142] S.A. Turchekenov. Kazakhstan Republic national report on energy efficiency and energy conservation to improve the synergy effect of national programmes of the CIS member-countries and to improve their energy security. Astana, 2013.

The technical energy efficiency potential in industry is assessed at 14 Mtoe, or at about 38% of the 37 Mtce used in industry. It should be noted that the assessment of the technical potential as shown in the table relies on many assumptions, is for indicative purposes only and needs improvement. It provides a smaller estimate, than the one made by the local experts (21.5 Mtce) back in 2009. The local estimate splits the potential for the mining sector (7 Mtce) and the manufacturing industry (14.5 Mtce) and provides no further details on how the potential is split by products or cross-industry technologies. It was noted that the energy saving potential in copper ore mining is overestimated[143]. With an appropriate correction the local estimate may be reduced to about 15-15.5 Mtce, which is quite close to the above assessment by CENEf.

7.6.4 Transport

Energy efficiency potential for transport was estimated for railroad transport, pipelines, air, automobiles and municipal electric transport. Like in the other sectors, this effort is quite data demanding. Data on the transport service were taken from statistical yearbook, although not always information on transport service was available in required formats[144]. In some instances data presented in passenger-km and (or) freight-km were to be converted to brutto-freight-km to fit statistically available data on specific energy use[145]. As to specific energy use, for many vehicles data in Kazakhstan are available in formats similar to those used in Russia[146]. For automobile transport Russian data on specific energy use were taken as proxies. This approach makes the estimate just preliminary and fit for further improvement, but it can serve a starting point for improving energy efficiency potential assessments in the transport sector in Kazakhstan.

CENEf estimates the energy efficiency potential in transport at 5.6 Mtce in 2013 (versus 8-10 Mtce reported consumption[147] in this sector) (Table 7.5). The largest potential comes from switching to effective hybrid models in automobile transport.

Estimates of the energy efficiency potential in transport from local sources are scarce. The Energy Efficiency Programme to 2015 (2009) lists transport potential as part of “other sectors” without identifying the scale of potential in the transport sector. Other sources do not report energy saving potential in this sector at all. Ministry of Energy only plans to develop an energy efficiency programme for transport in 2015[148].

[143] Energy Efficiency Programme to 2015. Government of Kazakhstan. 2009.
[144] Transport in the Kazakhstan Republic.2009-2013. Statistical Yearbook. Astana, 2014.
[145] Such conversions were made based on corresponding data for Russia.
[146] S.A. Turchekenov. Kazakhstan Republic national report on energy efficiency and energy conservation to improve the synergy effect of national programmes of the CIS member-countries and to improve their energy security. Astana, 2013.
[147] Ibid and http://pravo.zakon.kz/4661849-minjenergo-kazakhstana-razrabotaet.html
[148] http://pravo.zakon.kz/4661849-minjenergo-kazakhstana-razrabotaet.html.

Table 7.5. Energy efficiency potential in transport (as of 2013)

Integrated technologies of goods, work, and services production	Units	Scale of economic activity	Units	Specific consumption in 2010	Practical minimum	Actual consumption abroad	Comments	Estimated technical potential, 1000 tce
Railroad electric traction	10^7tkm gross	41,380	kgce/ 10^4 tkm gross	12.0	10.0		Values for some Russian regions	82.8
Diesel locomotives	10^7 tkm gross	9,526	kgce/10^4km gross	62.2	40.0		2020 target for Russia	211.5
Metro electric traction	10^6 tkm gross	0.9	kgce/10^3km gross	6.5	4.3		Moscow	0.0
Trams electric traction	10^6 tkm gross	197	kgce/10^3 km gross	8.7	6.5		Average for Russia	0.4
Trolley-bus electric traction	10^6 tkm gross	6.9	kgce/10^3 km gross	7.9	5.9		Average for Russia	0.0
Gas pipeline transport	10^6 m^3km	50,800	kgce/10^6 m^3 km	28.2	25.00		2020 target for Russia	162.6
Oil pipeline transport	10^6 tkm	65,200	kgce/ 10^3 t km	1.75	1.20		2020 target for Russia	35.9
Eco-driving	10^3tce	3,779	kgce/million m^3km	100%	95%		Global practice	189.0
Shifting to hybrid light-duty vehicles	10^3 vehicles	3,678	tce/vehicles/ year	1.23	0.74		Global practice	1,809.6
Shifting to hybrid buses	10^3 buses	101	tce/buses/ year	6.5	3.91		Global practice	263.0
Shifting to hybrid heavy-duty vehicles	10^3 vehicles	450	tce/vehicles/ year	7.5	4.52		Global practice	1,357.2
Air transport	10^6 passenger-km	9,688	kgce/ passenger-km	60.3	54.27		Global practice	58.4
Total transport								**4,170.2**

Source: CENEf

7.6.5 Buildings

The buildings sector includes residential, public and commercial buildings. Industrial and agricultural buildings are not considered. While local statistical sources provide data on the energy use[149] and living space[150] in the residential sector, information on public and commercial buildings and energy use is scarce and not reliable.

Based on the available data, residential energy use in the recent years stays at 10 to 11 Mtce depending on the weather. Total living space in 2013 amounted to 336 million m^2. Thus specific energy use is 28 to 33 kgce/m^2/year (227.6-268.3 kWh/m^2/year), providing the entire buildings space is heated. Only 40% of the living space has access to district heating. About half of the living space is located in multifamily buildings (20% of all residential buildings in 2013).[151]

If the share of space heating in the total energy use is assumed similar to that in Russia (66%), then specific energy use for space heating is 21 to 23 kgce/m^2/year (170.7-187.0 kWh/m^2/year).

149 Resource balances and the use of key materials, industrial products and consumer goods in the Kazakhstan Republic. 2008-2012. Statistical Yearbook. Astana, 2013.
150 Kazakhstan Republic Housing Stock. 2009-2013. Statistical Yearbook. Astana, 2014; Housing and municipal utility sector in the Kazakhstan Republic. 2009-2013. Statistical Yearbook. Astana, 2014.
151 Ibid.

Energy audits in Kazakhstan have shown that specific energy use for space heating in multifamily buildings is 243 to 273 kWh/m^2/year[152], or 30 to 33 kgce/m^2/year, which is much higher than the average 170.7-187 kWh/m^2/year (21-23 kgce/m^2/year) and even higher than total statistically reported specific energy use. If 4,000 HDD climate zone is used for new multifamily buildings (MFB) in Kazakhstan[153], then specific energy use for space heating by a 4- or 5-storey multifamily building is about 96 kWh/m^2/year, or 12 kgce/m^2/year. Normally, specific energy use for space heating by individual houses is 10 to 40% higher, than by MFB. On the other hand, in single-family houses there is some space that does not have to be heated. Therefore, a similar specific energy use value was taken for both buildings groups to assess the energy efficiency potential. For all MFB specific energy use by a 4- or 5-storey building as specified in the Building Codes less 40% was used to estimate the potential. For single-family houses, the value for a "passive house" was used as the reference level (see Table 7.6). In other words, the potential is assessed assuming a very deep renovation of the existing buildings stock.

Data on other activities in the housing sector were estimated based on the national statistics, while data on specific energy use for current practices were taken similar to those for Russia. For example, only 36% of residents are provided with DHW from district heating systems. Due to a lower access to urban utility services, specific energy use indicators for Kazakhstan may be lower, than those for Russia; however, no data are available to support this assumption.

The overall potential in the housing sector is estimated at 7.8 Mtce. If only the 2012 Building Codes energy efficiency requirements for space heating are used as BAT for both MFB and SFB, then the potential shrinks to 5.4 Mtce.

Statistical yearbook on services provides no information related to the space used by public and commercial buildings[154]. For countries with a similar level of development the ratio of public and commercial buildings to the housing living space is about 1:4 to 1:5[155]. For Kazakhstan, a higher range was used for further calculations. Thus public and commercial buildings space is about 84 million m^2. According to the IEA balances, 5.4 Mtce were used in this sector in 2011, but only 3.6 Mtce in 2012. In the latter case, specific energy use is 43 kgce/m^2/year (350 kWh/m^2/year). Data from the local sources (see reference 136) report specific energy consumption for space heating in schools at 100-370 kWh/m^2/year (12-46 kgce/m^2/year with the average close to 203 kWh/m^2/year (25 kgce/m^2/year) and the total close to 333 kWh/m^2/year (41 kgce/m^2/year)); for kindergartens 100-500 kWh/m^2/year (12 to 62 kgce/m^2/year with the average close to 35 kgce/m^2/year); for clinics 200-1,000 kWh/m^2/year (25 to123 kgce/m^2/year with the average close to 37 kgce/m^2/year). If 66% of the entire energy use in this sector is used for space heating, then specific energy use for space heating is about 210 kWh/m^2/year (26 kgce/m^2/year). This seems a reliable estimate.

Total energy saving potential in buildings is estimated as exceeding 9 Mtce with 7.8 Mtce in residential buildings and the rest in public and commercial buildings (Table 7.6).

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152 Housing and municipal utility sector renovation programme for the Kazakhstan Republic for 2011-2020. Approved by Kazakhstan Republic Government Decree No. 473 of April 30, 2011; E.A. Buksukbaev. Energy Efficiency in the Kazakhstan Republic. June 2010, Miskhor, Crimea, Ukraine; Promoting Energy Efficiency in the Residential Sector In Kazakhstan: Designing a Public Investment Programme. OECD. 2012.

153 As required by the Kazakhstan Republic Government Decree No. 1181 of September 11, 2012 "On Specifying the Energy Efficiency Requirements to Buildings, Constructions, and Facilities and Elements Thereof That Are Part of Envelopes".

154 Services in the Kazakhstan Republic. 2009-2013. Statistical Yearbook. Astana, 2014; Wholesale and Retail Trade in the Kazakhstan Republic. 2009-2013. Statistical Yearbook. Astana, 2014.

155 M. Economidou. Project lead. Europe's Buildings Under The Microscope. A country-by-country review of the energy performance of buildings. October 2011. Buildings Performance Institute Europe (BPIE); Transition to Sustainable Buildings. Strategies and Opportunities to 2050. IEA. 2013.

Table 7.6 Energy efficiency potential in the buildings sector (as of 2013)

Integrated technologies of goods, work, and services production	Units	Scale of economic activity	Units	Specific consumption in 2010	Practical minimum	Actual consumption abroad	Comments	Estimate of the technical potential, 1000 tce
Housing								
Renovation of centrally heated multifamily buildings	$10^3 m^2$	168,000	kgce/m^2	22.00	7.1		60% of 2012 building codes requirements	2,506.6
Renovation of single family buildings	$10^3 m^2$	168,000	kgce/m^2	22.00	4.9		Passive houses	2,872.8
Renovation of hot water use	10^3 people	5,760	tce/person	0.207	0.073	0.12	Global practice	772.5
Replacement of appliances with the most efficient models	1,000 people	16,000	tce/person	0.110	0.055	0.12	Global practice	880.0
Lighting renovation	10^3light fixtures	63,000	W	50.85	20.00	35.0	Global practice	132.0
Renovation of the cooking equipment	10^3 m^2	336,000	kgce/m^2	3.50	1.50	2.80	Global practice	672.0
Total residential buildings								**7,835.8**
Public and commercial buildings								
Renovation of centrally heated buildings	10^3 m^2	35,000	kgce/m^2	26.0	7.1	18.0	60% of 2012 building codes requirements	662.2
Renovation of hot water use	10^3 m^2	12,600	kgce/m^2	4.90	2.7	3.3	Global practice	27.6
Renovation of the cooking equipment	10^3 m^2	28,000	kgce/m^2	1.8	1.4	1.3	Global practice	10.4
Efficient space heating boilers	10^3 m^2	35,000	kgce/m^2	32.7	26.7	30.2	Global practice	211.5
Lighting renovation	10^3 m^2	70,000	kWh/m^2	32.7	16.4	27.8	Global practice	140.8
Procurement of efficient appliances	10^3 m^2	70,000	kWh/m^2	71.8	51.6	56.6	Global practice	173.6
Total public and commercial buildings								**1,226.1**
Total buildings								**9,061.9**

Source: CENEf

7.6.6 Other sectors

Not much information is available to assess the technical energy saving potential in agriculture. According to the IEA energy balances, about 1.2 to 1.3 Mtce are used annually in this sector, and more than half of that amount is liquid fuel for tractors and other machinery. Based on the Russian experience, specific energy use per tractor may be reduced by about 65%. There are other evidences that a similar reduction is possible in other agricultural activities through efficiency improvements[156]. Therefore, the energy efficiency potential in this sector may be estimated at 0.6 Mtce.

Two other components of the energy efficiency potential were assessed, namely street lighting and variable speed drives at municipal water supply systems. All together, contribution of the "other sectors" to the energy efficiency potential was estimated at 0.7 Mtce (Table 7.7).

Table 7.7 Energy efficiency potential in "other sectors" (as of 2013)

Integrated technologies of goods, work, and services production	Units	Scale of economic activity	Units	Specific consumption in 2010	Practical minimum	Actual consumption abroad	Comments	Estimate of the technical potential, 1000 tce
Tractors fuel efficiency	10^3	45,000	kgce/ha	20	7		Global practice	595.9
Adjustable speed drives in water supply systems	mln kWh	2,317	%	100%	75%		Global practice	71.3
Street lighting renovation	mln kWh	704	%	100%	70%		Global practice	26.0
Total								**693.2**

Source: CENEf

7.6.7 Comparisons of total technical energy efficiency potential estimates

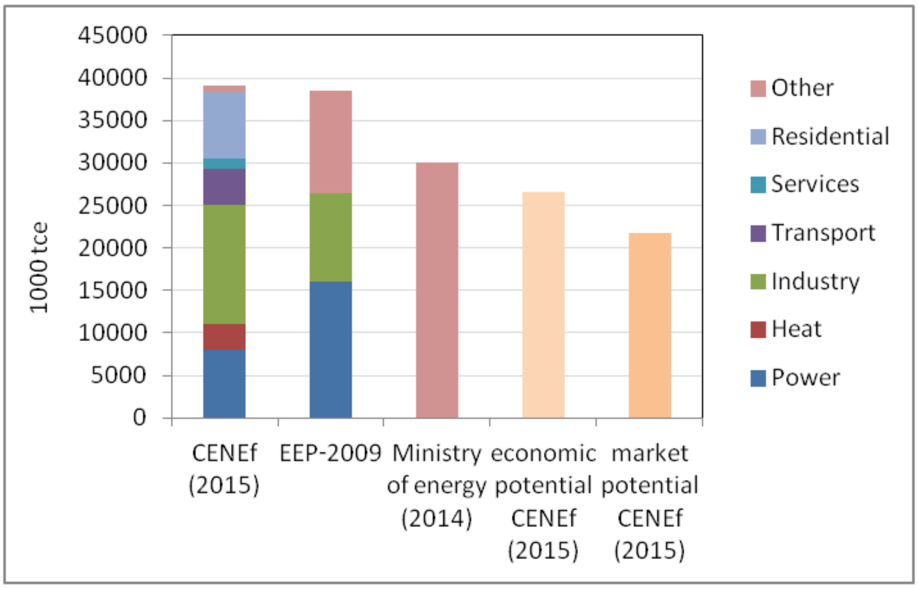
Total technical energy efficiency potential for Kazakhstan as of 2013 is estimated at 39 Mtce of 74-85 Mtce of TPES reported by IEA for 2011-2012. In 2013, it was estimated at 89 Mtce[157].

Thus the potential is close to 44% of TPES. This estimate assumes independent implementation of all technological measures without accounting for integral direct or indirect effects related to the reduction of potential in power and heat generation if end-use demand for power and heat is reduced through measures implemented in final energy use sectors. This estimate is higher than those reported in other publications (Fig. 7.2). This can partly be explained by lower, than in the past, energy use, and partly by covering a different set of activities and inconsistency of data used for both present specific energy use and for BATs.

The most recent statement on the energy efficiency potential was made in 2014 by the Ministry of Energy. It was cited as 27% of 62 Mtoe (89 Mtce) TPES, or about 30 Mtce. CENEf's assessment is very close to the one cited in the Energy Efficiency Programme to 2015 adopted in 2009. CENEf's assessment breaks down the potential with a much larger itemization to allow for better-tailored energy efficiency policies.

[156] S.A. Turchekenov. Kazakhstan Republic national report on energy efficiency and energy conservation to improve the synergy effect of national programmes of the CIS member-countries and to improve their energy security. Astana, 2013.
[157] http://pravo.zakon.kz/4661849-minjenergo-kazakhstana-razrabotaet.html

Figure 7.2. Estimates of technical, economic and market energy efficiency potentials for Kazakhstan



Sources: CENEf; Energy efficiency programme to 2015; http://pravo.zakon.kz/4661849-minjenergo-kazakhstana-razrabotaet.html

In any case, technical energy efficiency potential is large and basically concentrated in the power and heat, industrial and residential buildings sectors. The question is, which part of it is economically attractive?

7.6.8 Economic and market energy efficiency potentials

Economic and market potentials are assessed based on the comparison of energy prices and costs of saved energy. 2013 energy prices were used in the study (Table 7.8). Energy prices in Kazakhstan are lower, than in many EC countries, but they are substantial against the incomes of economic agents. This is the reason why prices for households are lower, than for industrial consumers. The share of income spent to pay the energy bills is a more important driver behind rational energy use, than the level of energy prices[158]. In 2013, the average share of housing and municipal utility costs in consumer spending was about 7%, and for urban households it amounted to 9%.[159] This means, that there is practically no room left for residential energy price increase before energy prices reach the level beyond which either payments collection will go down or many households will be forced to reduce resource consumption below the sanitary level.

A problem arises when modern expensive equipment is needed to reduce energy consumption. In this case economically attractive solutions are indicated by the cost of saved energy being lower, than energy price.

The cost of saved energy depends on the discount rate applied to annualize the capital costs. In this study, 6% discount rate was used to estimate the economic energy efficiency potential[160] and 12% discount rate was used to estimate the market energy efficiency potential, which is close to

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[158] I. Bashmakov. Three Laws of Energy Transitions//Energy Policy. – July 2007. – P. 3583-3594; Bashmakov I.A. Ability and willingness of residential consumers to pay their housing and municipal utility bills // Voprosy ekonomiki (Issues of Economy). – 2004. No. 4.

[159] OECD reports that many cities spend 1.5-6.3% of their income for space heating alone. See: Promoting Energy Efficiency in the Residential Sector in Kazakhstan: Designing a Public Investment Programme. OECD. 2012.

[160] In some studies, 10% social discount rate is used. See: Promoting Energy Efficiency in the Residential Sector in Kazakhstan: Designing a Public Investment Programme. OECD. 2012.

the interest rate for mortgages in Kazakhstan. In addition, 20% discount rate was used to reflect stricter budget limitations and a higher cost of money for some energy consumers.

Table 7.8. Energy prices in Kazakhstan in 2013

	Units	tenge	US$	US$/tce
Non-residential users				
Electricity	kWh	13.156	0.086	703.1
District heat	Gcal	3,707	24.4	170
Natural gas	m^3	14,778	97.1	83.1
Coal	t	4,342	28.5	45.6
Coke	t	45,872	301.5	304.6
Fuel oil	t	49,677	326.5	236.6
Gasoline	t	116,349	764.8	513.3
Diesel fuel	t	129,558	851.6	587.3
Residential users				
Electricity	kWh	10.43	0.069	557.4
District heat	Gcal	2,920	19.2	134
Natural gas	m^3	11,150	73.3	62.7
Gasoline	l	143	0.9	1,253.3
Exchange rate	Tenge/US$	152.13		

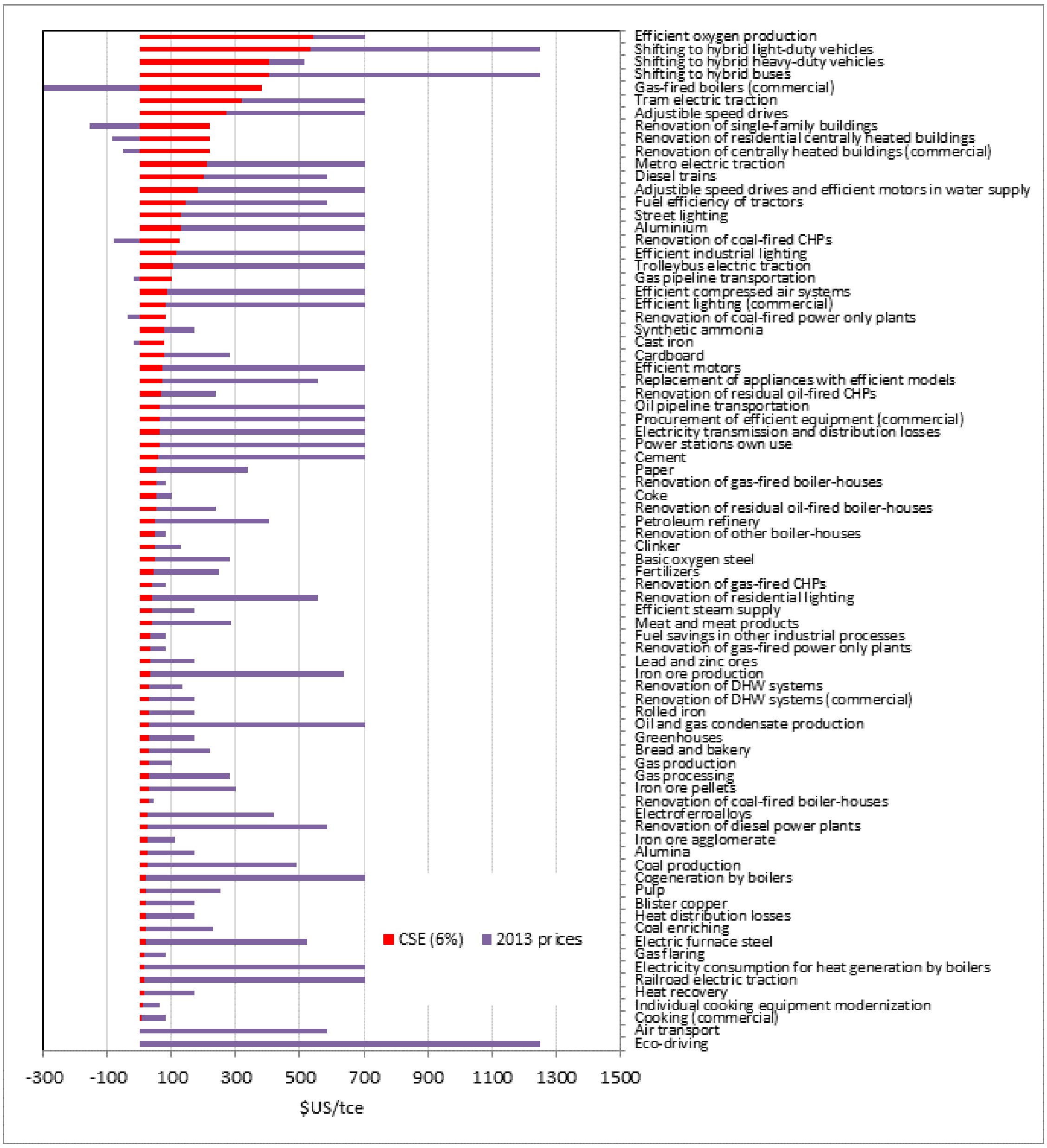
Sources: Industrial prices and tariffs in the Kazakhstan Republic. 2009-2013. Statistical Yearbook. Astana, 2014) (in Russian); Consumer prices in the Kazakhstan Republic. 2009-2013. Statistical Yearbook. Astana, 2014 (in Russian).

Some measures, for which the costs of saved energy appeared to be higher, than the energy price, are economically not attractive for the society and are not included in the economic potential (Fig. 7.3). Those include renovation of coal-fired power plants, renovation of multi- and single-family houses and commercial buildings and some others. This is partly the result of lower energy prices for households, as well as incomplete account for benefits (for example, in the case of renovation of coal-fired power plants the benefits include better reliability of new equipment and environmental benefits). With economic constraints, the 39 Mtce technical energy efficiency potential shrinks to the 26.6 Mtce economic potential. Accounting for co-benefits in coal-fired electricity and heat generation, subsidies for deep housing retrofits, and steady energy price growth for residents may scale up the economic potential closer to the technical one.

Better accounting of private parameters in the economic decision-making via higher costs of capital (12% and 20% discount rates) allows for an assessment of the market energy efficiency potential. It is lower, than the economic potential, but not very much lower. For the two discount rates mentioned it stands at 23.3 and 21.7 Mtce correspondingly (Fig 7.4 and 7.5). Making long-term funding for energy efficiency measures more easily available would allow it to bridge the gap between the economic and market energy efficiency potentials.

Even with current energy prices and the 20% discount rate applied in investment decision-making, the market potential to improve energy efficiency in Kazakhstan amounts to approximately 25% of primary energy use.

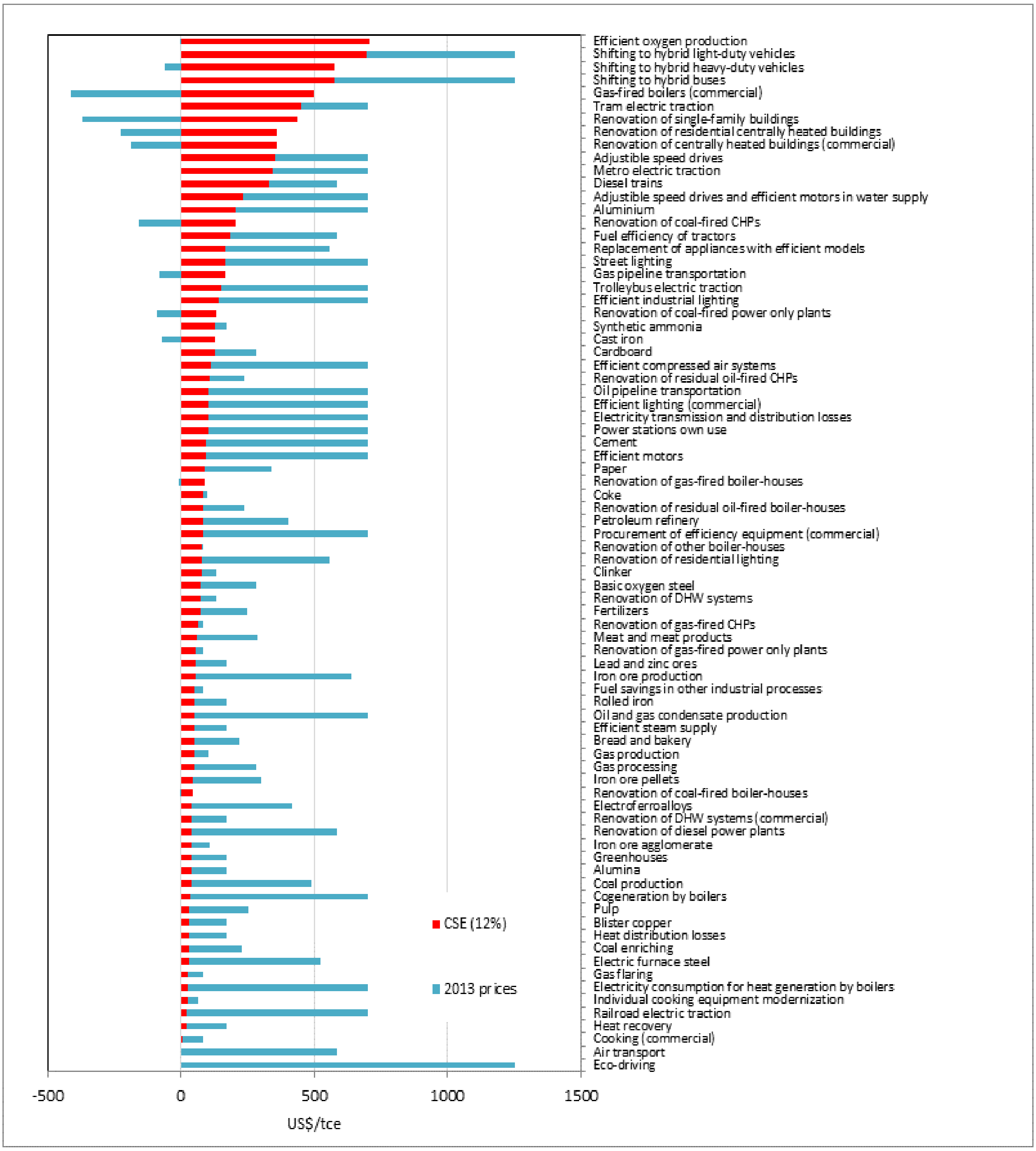
Figure 7.3. Economic energy efficiency potential for Kazakhstan (for 6% discount rate as of 2013)



The figure shows costs of saved energy (red) and the gap between energy price in a given activity and the cost of saved energy (blue). Due to the fact that different energy carriers are used in individual activities the price is average weighted for all energy carriers used. All prices are presented in US$/tce. If the gap is negative, the measure is considered economically not attractive and is excluded from the economic potential assessment.

Source: CENEf

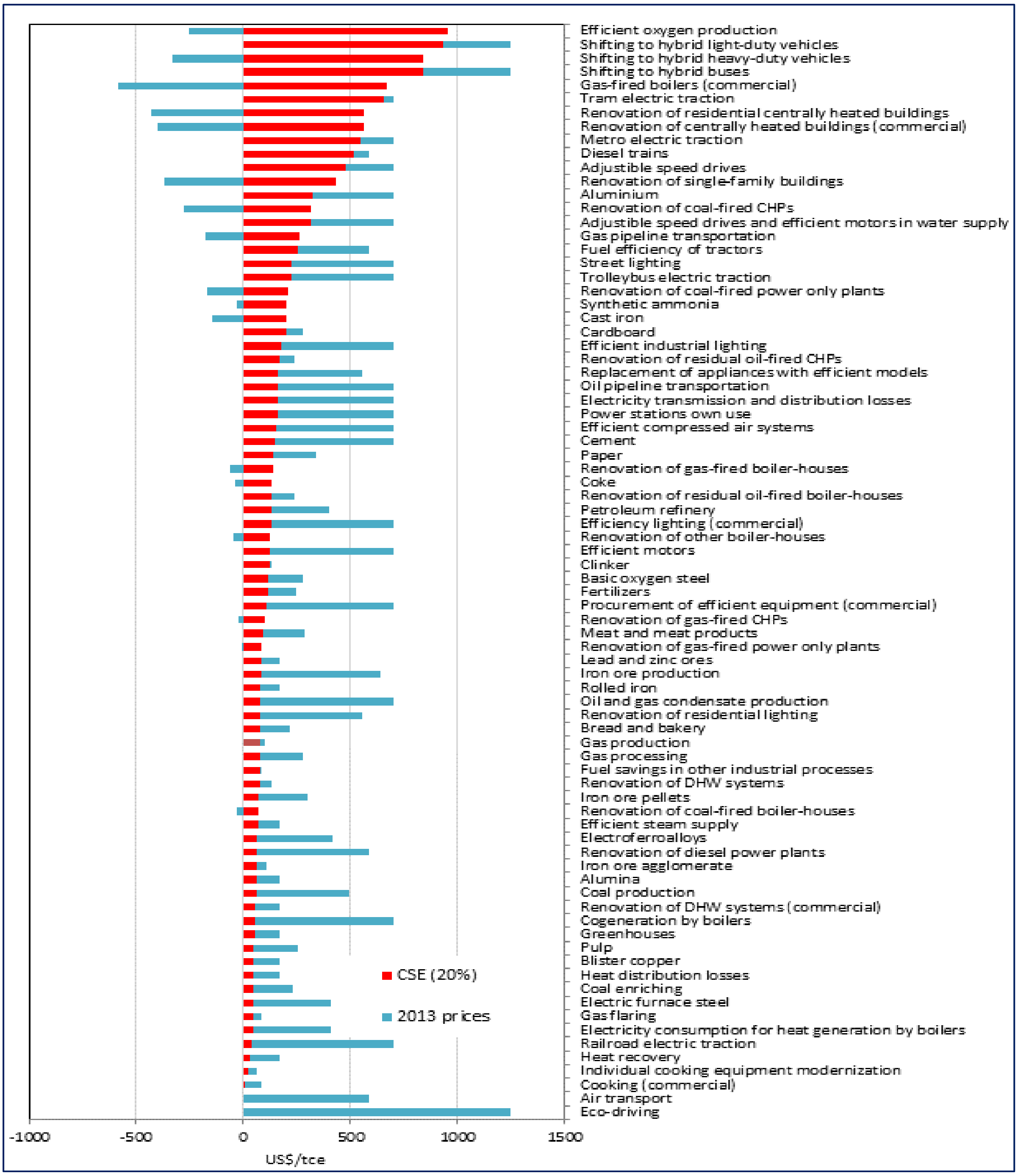
Figure 7.4. Market energy efficiency potential for Kazakhstan (for 12% discount rate as of 2013)



The figure shows costs of saved energy (red) and the gap between energy price in a given activity and the cost of saved energy (blue). Due to the fact that different energy carriers are used in individual activities the price is average weighted for all energy carriers used. All prices are presented in US$/tce. If the gap is negative, the measure is considered economically not attractive and is excluded from the market potential assessment.

Source: CENEf

Figure 7.5. **Market energy efficiency potential for Kazakhstan (for 20% discount rate as of 2013)**



The figure shows costs of saved energy (red) and the gap between energy price in a given activity and the cost of saved energy (blue). Due to the fact that different energy carriers are used in individual activities the price is average weighted for all energy carriers used. All prices are presented in US$/tce. If the gap is negative, the measure is considered economically not attractive and is excluded from the market potential assessment.

Sources: CENEf

Section 8. Kyrgyzstan

8.1 National level

Population in 2012: 5.61 mln GDP PPP in 2012: 14.23 bln $US2005 (IEA[161]).

Evolution of GDP energy intensity. Data presented in the federal programme "National Strategy for Sustainable Development of the Kyrgyz Republic for 2013-2017", in "Federal Energy Saving Programme in the Kyrgyz Republic for 2009-2015" and in "Energy Balances of Kyrgysztan[162] Statistics 2011" do not provide any information regarding the progress in GDP energy intensity evolution. Analysis of Kyrgyzstan efficiency of energy use as demonstrated after having obtained sovereignty shows[163] that in 2012 real GDP was 4.6% above the 1990 level, while energy use was only 70.5% of the 1990 value. Therefore, GDP energy intensity was 36% below the 1990 level, but had been growing since 2000.

According to IEA, energy intensity of GDP (PPP) went down from 0.56 in 1990 to 0.29 toe/1000 US$ in 2012. With GDP expressed in PPP, energy intensity was increasing annually between 2000-2012 by 0.9% (for GDP ER this growth was 1.1% per year). Therefore, Kyrgyzstan was the only country of the 10 economies in question where GDP energy intensity was growing in 2000-2012.

"Federal Energy Saving Programme of the Kyrgyz Republic for 2009-2015" stipulates, that 'the third priority is to halve energy and electricity intensity of GDP through economic restructuring by 2015'.

In 2007, local energy sources covered approximately 50% of the overall domestic energy supply (crude oil – 20%, coal – 40%, electric power – 100%). The reliance on energy imports is still very high: energy imports amount to 44% of Kyrgyzstan's total energy consumption. Available unexplored oil and gas resources in the country are estimated at 289 Mtoe. However, the country's oil self-sufficiency in general is less than 30%, and natural gas is imported from Uzbekistan.

Factors behind GDP energy intensity evolution: technology and structural shifts. To date, no decomposition studies have been found to allow for the identification of factors behind GDP energy intensity evolution. This is partly a result of the energy use data being presented in Kyrgyzstan energy balances in the old Soviet manner. Such information is not of much help while exploring actual energy demand evolution. Energy consumption is not split by sectors. Substantial additional effort will be required to develop a workable energy balance. In accordance with the "Energy Saving Federal Programme in the Kyrgyz Republic for 2009-2015", slow rates of the economy modernization are the main driver behind growing energy intensity.

Energy prices. Average electricity tariff for households is currently US$ 0.0126 per kWh, which is much lower than for industrial consumers (US$ 0.024 per kWh). Two household tariffs are applied depending on electricity consumption levels: US$ 0.01/kWh for users whose consumption is less than 150 kWh per month, and US$ 0.02/kWh for users with higher consumption levels. In addition, households are exempt from VAT (20%) when they pay their electricity bills. This tariff structure was adopted to protect the poor and to mitigate price hikes for households. Via cross-subsidies industrial consumers are currently subsidizing households. Electricity tariffs for the services sector are the same as for industrial consumers.

161 http://www.iea.org/statistics.
162 2011 Fuel and Energy Balance for Kyrgyzstan Republic. http://stat.kg/index.php?option=com_content&task=blogcategory&id=1&Itemid=125.
163 http://www.energoforum.kg/images/library/339.pdf

A uniform district heat tariff is set for households at US$ 9.5 US$/Gcal all over the country. The difference between heat generation costs and the rates for households is subsidized from the federal budget. There is also a cross-subsidy for Bishkek CHP, where losses incurred in heat sales to households are recovered from revenues from hydropower exports to the neighbouring countries.

Natural gas tariff for households is set at the supplier tariff level, while all the costs associated with gas transmission are incorporated in the tariff for industrial consumers. Average coal price for households is lower, than for the industrial and energy sector, because subsidies are provided to certain groups of residents for coal purchase.

Electricity and heat prices and tariffs do not cover the entire costs of energy companies. This incurs economic loss to energy suppliers and reduces consumers' motivation to implement energy-saving measures and improve their energy efficiency[164]. With all this in mind, a major objective of the tariff policy is to phase out the current system of subsidies. Petroleum product prices are uniform for all users.

Energy efficiency legislation

Energy efficiency legislation includes nine basic documents:

1. National Energy Programme for 2008-2010 and Energy Development Strategy to 2025 approved by the Jogorku Kenesh on April 14, 2008;
2. Federal Law on Energy Saving dated 07.07.1998, No. 8;
3. Federal Law on Energy dated 30.10.1996, No. 56;
4. Federal Law on the Power Industry dated 26.01.1997, No. 8;
5. Federal Law on Energy Performance of Buildings dated 26.07.2011, No. 137;
6. Federal Law on Investments in the Kyrgyz Republic dated 23.03.2003, No. 66;
7. Federal Law on Public-Private Partnership in the Kyrgyz Republic" dated 22.02.2012, No. 7;
8. National Sustainable Development Strategy of the Kyrgyz Republic for 2013-2017;
9. Federal Programme on Energy Saving in the Kyrgyz Republic for 2009-2015.

Number of energy efficiency regulatory acts. In addition to these laws, the National Strategy and the Federal Programme, there are energy efficiency building codes and some other regulatory acts stipulating some law provisions. Building codes in force include: SNIP 23-01-2009 "Thermal Protection of Buildings", Building codes 31/03/2001, 31/04/2001, 06/31/2001 - Administrative, Municipal, Public and Residential Buildings[165].

Basic faults of the existing regulatory framework are as follows:

- Law on Energy Saving is not really effective for the lack of real instruments;
- there are shortcomings and gaps, and there is no requirement for setting up an agency with the energy saving mandate;
- no accurate information is available on the facilities subject to certification, standardization, expertise and energy audits;

[164] Energy efficiency in the Kyrgyz Republic: state-of-the-art, goals, problems, and investments. Arkhangelskaya A.V., Chief expert, Electricity generation and transmission department, KR Ministry of Energy and Industry, April 24, 2014, Bangkok, http://www.zanorda.kz/ru/content/67602-p1200001192. (In Russian); Support provided by the civil society to the energy efficiency improvement and deployment of renewables as a basis for climate change adaptation strategy in the KR. Vladimir Korotenko, 2013, http://ekois.net/wp-content/uploads/2013/02/Vladimir-Korotenko_-for-EU-Ru.pdf. (In Russian).

- there are no real economic mechanisms to spur energy-efficient technologies and measures.

So at this point, Kyrgyzstan does not have an effective regulatory framework to implement energy efficiency policies**.**

Government agencies with an energy efficiency policy mandate. Ministry of Energy and Industry is the key government agency responsible for energy efficiency policies. A number of other ministries, authorities and energy companies are also involved in the implementation of energy efficiency policies; these include, for example, the Ministry of Ecology and Emergency Response; the Ministry of Transport and Communications.

The Ministry of Energy and Industry is responsible for activities related to the energy sector development; tariff and price setting; development of the National Energy Programme; development, revision and implementation of energy efficiency measures and programmes and coordination of international assistance in the implementation of projects under various programmes. Department of Energy Efficiency was recently established within the Ministry. Federal Energy Inspectorate under the Ministry of Energy and Industry supervises energy companies and other entities for rational and efficient use of energy and gas and compliance with power facilities O&M and safety rules.

Basic administrative mechanisms to improve energy efficiency: energy metering requirements; building codes, energy data reporting, energy audits, project energy expertise.

Basic energy efficiency market mechanisms and economic incentive programmes. The Federal Programme on Energy Saving in the Kyrgyz Republic for 2009-2015" relies on the following forms of federal support:

- incentives for fuel and energy savings to be obtained through targeted energy efficiency measures;
- setting up an Energy Conservation Fund;
- providing favorable conditions for vendors of energy equipment and materials;
- soft lending for energy efficient projects, import of energy efficient equipment, tools and other materials;
- promotion of the development and introduction of energy efficient technologies and renewable energy sources;
- development of international scientific and technical cooperation, as well as education and training in energy efficiency.

The Energy Conservation Fund will be funded from energy conservation programmes and from contributions made by power generation facilities, transport companies, distribution and other energy companies. Voluntary contributions by legal entities, including foreign entities, could be additional financial sources for the Energy Conservation Fund.

Federal financial support for any energy conservation project is provided primarily on a refundable and preferential basis and for a limited period of time depending on the project relevance and payback. The following mechanisms could also be used:

- energy efficiency project loan repayment schemes. Providing loans from the federal budget to specific projects with business plans is the basic federal support mechanism under the Programme. Such loans cover only some of the energy saving project costs, while the remaining costs are taken care of by energy users from their own resources, borrowed funds or money saved through energy conservation projects. Subsidized loans from the federal budget are provided on a repayable basis for five years;
- use of tariff investment component to promote energy efficiency;

- entitling state-funded entities and organizations that use energy resources to use the energy savings obtained. Monetary savings obtained by public-funded organizations through energy saving activities can be used by these organizations throughout the entire project payback period plus one more year. This provision is applied to encourage energy conservation measures in organizations funded from the local budgets. Upon the expiry of the payback period plus one year, public financing of energy conservation measures is reduced by the amount of savings obtained during the previous year;
- promotion of energy conservation through subsidies to residential consumers. This mechanism means cancellation of feed-in tariffs and use of direct subsidies and investments to implement energy efficiency projects. In the context of social protection of the population it would be appropriate to replace feed-in tariffs with direct subsidies for residential consumers from the local budgets or non-budgetary funds. This scheme implies, that a subsidy covers the use of a standard set of energy-saving appliances by a household, rather than the amount of energy consumed.

Many of these instruments are listed in the Programme, but the scale of their practical application is yet to be explored. It seems very likely that these mechanisms are sort of “paper” instruments.

Energy efficiency policy spending and financial sources. For the purpose of implementing energy efficiency measures in the Kyrgyz Republic, the Swiss Government granted US$ 23.6 million and the World Bank and IDA provided a US$ 4.2 million loan. Moreover, approximately US$ 73 million were allocated by the Northern Development Fund, the Asian Bank for Reconstruction and Development, the Government of Denmark, the World Bank and the IDA for the rehabilitation of power supply and district heating systems to 2002. Gas meters for JSC “Kyrgyzgas” were purchased with a US$ 1.5 million grant provided by the Japanese Government and a US$ 0.65 million loan from the World Bank. A US$ 20 million credit line was opened to support improvements in housing and private enterprises energy efficiency. Loans are accompanied by grants provided by the Investment Fund of the European Union in Central Asia (IFCA).

Energy efficiency R&D spending. No data on energy efficiency research and development spending have been found.

ESCO market. The energy efficiency legislation in force does not introduce the ESCO mechanism. According to the European Economic Commission, there are no operating energy service companies in Kyrgysztan[166]. There were some pilot projects back in 2006 in a Narin kindergarten[167].

Water efficiency policy. Environmental protection measures in the Kyrgyz Republic cover all major environmental problems. The Environmental Strategy aims at creating the environment for the country’s sustainable development, for the preservation of a clean and sound natural environment, biological and landscape diversity and the optimum nature management, including protection of water resources.

International cooperation. Kyrgyzstan participates in TACIS and USAID energy efficiency programmes. Within these programmes, it also cooperates with Denmark, Sweden, Germany, Great Britain, France, Norway, Finland, and the USA. Kyrgyzstan is a member of the interstate CIS Electric Power Council and the Interstate Council of the Central Asian States on the Fuel and Energy Complex.

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[166] Economic Commission for Europe. Financing Energy Efficiency and Renewable Energy Investments for Climate Change Mitigation Project. Development of Energy Service Companies Market and Policies. United Nations. New York and Geneva, 2013.

[167] http://esco-ecosys.narod.ru/2007_12/art27.pdf

In 1995-1996, a pilot residential energy efficiency project was implemented by the European Commission and *Friedeman and Johnson* (Germany). An energy and water efficiency demonstration zone was created in Bishkek in 2000 under the UN Energy Efficiency 21 Project. During 2000-2002, a variety of pilot demonstration projects aiming at the reduction of heat and hot water consumption were successfully implemented. Building on the success of these projects, the Government intends to develop a strategy to encourage investment in buildings retrofits and to promote energy efficiency measures. This process is driven by enhanced energy efficiency in the construction sector, reduced reliance on fuel imports and abatement of the environmental impact provided by the energy sector.

Since 1997, Rehabilitation of Power Supply and Central Heating Systems Project has been implemented in Kyrgyzstan, with the project costs at the first stage amounting to US$ 20 million financed by the IDA, the Asian Bank for Reconstruction and Development, DANIDA, and the Swiss Government. Under this project, renovation of thermal plants in the residential sector in Bishkek, rehabilitation of heat equipment at the CHP and the main heat distribution network in Bishkek were accomplished with assistance provided by the TACIS Programme, the Government of Denmark, and other countries. In addition, with the assistance of the Asian Bank of Reconstruction and Development, modernization of boiler plants in schools, educational institutions, hospitals and child welfare institutions is underway.

The Government of Norway is proactive in the development of small hydropower plants (HPP) in Kyrgyzstan. In particular, it has built a number of small hydropower plants in the Naryn region. In addition, now it intends to set up a fund to finance the development of small- and medium-size HPPs. For this purpose it wants to open an account with one of the local commercial banks so that in future this bank could help minimize the risks associated with lending and guarantee loan repayment.

The UNDP has developed a special programme to promote the development of small energy and energy efficiency technologies. Under the UNDP auspices, a round-table discussion “Development Perspectives of Small Energy and Renewable Energy Sources” was held on October 16, 2008. UNDP/GEF implements a project Improvement of Energy Efficiency in Buildings and Heat and Hot Water Supply, which focuses on supporting measures related to the promotion of energy efficiency in district heating, hot water supply and the use of all types of energy in buildings. UNDP also carries out the project Promotion of Renewable Energy Sources in Remote Regions of Kyrgyzstan and assists in the preparation and publication of guidance handbooks, in particular on bio-installations.

Some donors provide assistance in the development and installation of bio-facilities. Japan-sponsored bio-installations project includes three pilot installations in the Tchuja region. In 2008, the German Technical Cooperation launched a study to explore the potential of Kyrgyzstan in the field of energy efficiency and renewable energy sources (RES) with a view of providing further technical assistance to the country. In general, today no public authority has complete information on the activities related to the promotion of energy efficient technologies and renewable energy sources. Since the Government used to pay little attention to this issue, donors’ activities were organized sporadically without any coordination by an authorized federal agency.

In 2013, IFC supported a project to generate electricity from waste for a small hotel near Toktogul. In 2013, the World Bank opened a US$ 20 million credit line to support energy efficiency improvements in houses and private enterprises. Loans are accompanied by grants from the Investment Fund of the European Union in Central Asia (IFCA).

8.2 Heat and power generation and transmission

Power generation efficiency. There are two sources of data to assess the effectiveness of power generation, transmission and distribution: IEA energy balances and data provided by the Ministry of Energy and Production of the Kyrgyz Republic.

The Kyrgyz power system includes 18 power plants, including 16 hydropower plants and 2 thermal power plants. In 2009, total electric capacity of Kyrgyz power plants was 3.69 GW. Hydropower plants dominate in electricity generation. A key strategy of the country's energy sector development is further development of hydropower resources to reach 142 billion kWh of power generation. Currently, not more than 10% of hydropower resources are being used. Moreover, there are serious prospects for hydro power construction development. On the Naryn River alone, in addition to the operating five power plants cascade with 2.87 GW aggregate installed capacity, it is possible to build seven more cascades of 33 hydropower plants with 6.45 GW aggregate installed capacity and annual electricity output over 22 billion kWh.

Thermal power plants are located in Bishkek and Osh and supply them with power and heat. Almost all fuel for thermal power plants is imported from the neighboring countries. On average, these power plants generate 12-14 billion kWh of electricity per year, including 2 billion kWh exported to the neighbouring countries (key importers include Kazakhstan, Russia, Tajikistan and Uzbekistan).

No data on specific energy use to generate electricity are available. Therefore, a proxy for Russia was used in the assessment of potential.

Power transmission and distribution losses. In accordance with the Energy Saving Federal Programme in the Kyrgyz Republic for 2009-2015, overall electricity losses in 2011 amounted to 21.2%, while commercial losses amounted to 5.1%, and technical losses to 16.1%. In 2010, total electricity losses were 25.9%.

Heat generation efficiency. Electric boiler plants (overall number nearly 3,000, total heat capacity 4,200 Gcal/hour, which is 3.5 times higher than heat capacity of Bishkek CHP), play an important role in heat generation. Because of power shortage in winter and overloaded distribution networks it was decided to switch electric boiler plants to local fuels. This is not an economically sound decision, because difficulties related to the equipment replacement and fuel delivery were not taken into account. In Kyrgyzstan, more than 450 small boilers will be upgraded in 2014-2020 under the project "An integrated approach to the development of climate-friendly economies of Central Asia[168]" to replace inefficient (50 to 70%) coal-fired boilers with new models with at least 85% efficiency.

Share of CHP in power generation. Every year Kyrgyzstan produces more than 3.1 million GCal of heat, including 76% by CHP in Bishkek and Osh Open Joint Stock Company "Power Plants"; 20% by State Enterprise "Kyrgyzzhilkomunsoyuz"; and the small remaining part by departmental and municipal utility boilers "Bishkekteploenergo".

Heat distribution losses. Heat distribution networks were built in 1960-1970, and as of 2011 distribution losses amount to 30 to 45% ("Energy Saving Federal Programme in the Kyrgyz Republic for 2009-2015").

Energy efficiency regulations in heat and power generation and distribution. "Energy Saving Federal Programme in the Kyrgyz Republic for 2009-2015" requires 0.5 Mtoe annual fuel savings in energy production and consumption.

Government agencies with an energy efficiency policy mandate in heat and power generation and distribution. Ministry of Energy and Industry is the government agency responsible for energy efficiency policy implementation in the heat and power sector.

[168] http://www.vb.kg/doc/248947_v_kyrgyzstane_moderniziryut_bolee_450_malyh_kotelnyh.html

Basic administrative mechanisms to improve energy efficiency in heat and power generation and distribution. ECSO, bond financing, on-bill financing, taxation and pricing policies.

Basic energy efficiency market mechanisms and economic incentive programmes: tax and tariff policies, soft loans.

Renewables development programmes. In accordance with the "National Sustainable Development Strategy of the Kyrgyz Republic for 2013-2017", promotion of small renewable sources through the development of a good investment environment is one of the key directions for the energy sector development.

"White certificates" market. No such programmes launched so far.

8.3 Industry

Industrial energy intensity. Industry dominates in the Kyrgyzstan energy consumption structure (27% of end-use energy consumption). According to the data provided by the National Statistics Committee, the share of electricity and fuel costs in total production costs has grown up from 17.6% in 1992 to 19.1% in 2007.

According to UNIDO, energy intensity of the industrial sector showed 62% decline in 1990-2000 and then grew up by 24% in 2008 (in tons of oil equivalent per US$1,000 of manufacturing value added)[169]. Growth in 1995-2008 was driven mostly by structural shifts, which were partly neutralized by technologies modernization (measured as energy use per value added in constant prices)[170].

Energy intensity of basic industrial goods. No data found.

Energy efficiency regulations in the industrial sector. None found.

Government agencies with an energy efficiency policy mandate in the industrial sector. Ministry of Energy and Industry is the key government agency responsible for the implementation of energy efficiency policies in industry.

Basic administrative mechanisms to improve energy efficiency in the industrial sector: None found.

Basic energy efficiency market mechanisms and economic incentive programmes: tax and tariff policies, soft loans.

Long-term agreements. Some data on long-term agreements are available for Kyrgyzstan.

Energy managers training programmes. None found.

Industrial energy efficiency policy spending. Reliable data on investments in industrial energy efficiency are not available.

8.4 Buildings

Specific energy consumption per m^2 of residential floor space (energy intensity in residential buildings). More additional information is needed to assess the relative energy efficiency level in Kyrgyzstan, namely, heating and cooling degree-days, average household size, appliances saturation and level of services. In November 2008, the national government set a goal to reduce energy consumption and associated greenhouse gas emissions in the buildings sector by 30-40% by 2020.

[169] Industrial Development Report 2011. Industrial energy efficiency for sustainable wealth creation. Capturing environmental, economic and social dividends.
[170] Ibid.

In Kyrgyzstan, most buildings were constructed during the Soviet era (35-60 years ago), when energy performance parameters were practically not taken into account. Many existing buildings are half-ruined and not fit for living. According to the IEA balance, residential energy consumption amounted to 1,062 thousand toe, translating to 8,634 million kWh. With 52.3 million square meters total housing area, specific energy consumption would be about 165 kWh/m^2 per year. For the sake of comparison, specific energy consumption in Russia is 370 to 380 kWh/m^2/year. The gap may be determined by a smaller number of degree-days, lower share of occupied and heated area, and incomplete accounting for energy use in buildings (traditional fuels).

Specific energy consumption per 1 m^2 of public floor space. IEA energy balances are also a source of energy consumption data in the public sector. However, there are no statistical data on public buildings floor space, and so specific energy use cannot be statistically evaluated. Public buildings floor space is assessed by CENEf at 6.18 million m^2, and so specific energy consumption would be estimated at about 430 kWh/m^2/year. While information on the energy consumption structure in public buildings is available, there are no data on specific energy use per unit of floor space. Based on the Russian experience, it should be slightly above residential specific energy use, or 210-300 kWh/m^2.

Specific energy consumption for space heating per m^2 of residential floor space per degree-day of the heat supply season. According to some expert estimates[171], space heating requires 160 kWh/m^2: 140 kWh/m^2 in apartment buildings and 180 kWh/m^2 in private housing.

Specific hot water consumption per household with access to centralized DHW supply. Such data were not found, but in many countries energy use for hot water supply is 140-350 kgoe/household/year, or 50-130 kgoe/person/year depending on the household size.

Share of consumers equipped with energy meters. According to the "Energy Saving Federal Programme in the Kyrgyz Republic for 2009-2015", in 2009 heat meters saturation was below 10%. The federal programme requires 100% metering of power and gas consumption by legal entities by 2015.

Building codes requirements. The Ministry of Construction with support provided by UNDP/GEF project "Improving Energy Efficiency in Buildings" developed and made effective from 1 January 2010 new building codes and regulations for buildings thermal performance (SNIP KR 23-01: 2009 "Thermal Engineering (thermal protection of buildings)" and JV KR 23-101: 2009 "Design of Thermal Performance of Buildings").

Other administrative mechanisms to improve energy efficiency. Energy audits are carried out in the buildings of the services sector: hospitals, schools, and kindergartens; activities are also underway in the field of equipment upgrading. The intention is to develop standards and labelling for appliances.

Basic energy efficiency market mechanisms and economic incentive programmes in the buildings sector: subsidies for buildings renovation and building-level meters installation; taxation and pricing policies.

Government agencies with an energy efficiency policy mandate in the buildings sector. Government agencies responsible for energy efficiency policies in buildings are the Ministry of Energy and Industry and the Ministry of Construction.

Educational programmes. Energy Conservation Programme for 2009-2013 requires energy efficiency education and training. Extensive propaganda takes place under the framework of the UNDAF/GEF project "Improving Energy Efficiency in Buildings". For the purpose of

[171] Energy Charter Protocol on Energy Efficiency and Related Environmental Aspects PEEREA. Kyrgyzstan regular energy efficiency review 2011, p.13.

improving energy efficiency, seminars are held on the renovation of space heating systems in hospitals, schools, and kindergartens.

8.5 Transport

Specific energy consumption per unit of transport service. In primary energy consumption transport (10%) comes third after the residential sector (60%) and industry (30%). Annual fuel consumption by vehicles amounts to 0.4 to 0.6 Mtoe. Almost 99% of the fuels used are gasoline and diesel fuel.

Government agencies with an energy efficiency policy mandate in the transport sector. Ministry of Transport and Communications is the basic government agency responsible for energy efficiency policy in the transport sector.

Basic administrative mechanisms to improve energy efficiency in the transport sector. The following energy efficiency measures have been implemented: restrictions on second-hand motor vehicle imports; annual motor vehicle inspections; upgrading of public motor vehicle fleets; information and training; energy efficiency requirements to transport equipment; mandatory energy audits, energy data reporting; energy expertise.

Basic energy efficiency market mechanisms and economic incentive programmes in the transport sector: taxation and pricing policies.

8.6 Technical energy efficiency potential for Kyrgyzstan

8.6.1 Approach and data sources

Technical energy efficiency potential for Kyrgyzstan was assessed based on the approaches described in the Inception Report. Four sets of data were used to attain this goal (Table 8.1). Data related to the economic activities were collected from national statistical sources (for 2012-2013), which are listed in corresponding sections. Data related to specific energy use in different applications were collected from official documents, programmes, presentations and publications. Where appropriate data were not available, proxies for countries with similar conditions were used. Assessment of the technical potential builds on the comparison of these energy efficiency indicators against specific energy consumption for BATs in the same sectors and subsectors. Data on BATs were collected from multiple international sources.

Table 8.1 Data collection technology and structure

Information required	Source of information	Methods of data collection
Data on economic activities	Statistical yearbooks	Collection of statistical data
Data on specific energy consumption in various sectors in Kyrgyzstan	Official documents, publications, proxies for countries in similar conditions	Literature search
Data on specific energy consumption for BATs	Publications	Collection of data from publications on BATs
Energy prices	Statistical yearbooks	Energy prices

The technical energy efficiency potential for Kyrgyzstan was assessed by multiplying the 2012-2013 activity level by the gap between the country’s specific energy efficiency and energy efficiency BAT parameters for the same category of activity.

Assessment of the technical potential was structured by different sectors, including power and heat generation, transmission and distribution; industry; transport; buildings; agriculture; street lighting; water supply; etc. Estimates generated by this study were, where possible, compared with the local estimates of the energy efficiency potential for similar activities. Where the information was sufficient, the reasons for mismatching, if any, were identified.

Based on these comparisons, technical potential estimate ranges were provided. Where reliable information for some energy use activities was not available, such activities were skipped from the potential evaluation study.

So as to identify the economic and market potentials, the costs of saved energy were compared to the 2013 or 2014 energy prices in order to see if an individual measure is economically viable.

Summary of energy efficiency potential estimation for Kyrgyzstan:

- Power and heat 340.6 thou tce
- Industry 98 thou tce
- Transport 788 thou tce
- Residential buildings 936 thou tce
- Services 151 thou tce
- Other 352.7 thou tce
- **Total** **2.7 Mtce**

8.6.2 Power and heat

CENEf's assessment builds on the data related to energy use and power and heat generation available from official statistical yearbook, government programmes and legal acts, publications, and other sources, including internet resources. For some parameters such information was not available, and so they were assessed using proxies, including parameters for similar installations in Russia. Therefore, the estimates of the technical potential are by no means perfect. CENEf has taken any and all measures to make them as reliable as possible, despite the tight work schedule that did not allow for too extensive data search. Based on this information, power generation was allocated by various types of plants in Table 8.2. In 2013, CHPs were responsible for 29% of power generation; hydro power stations for 71%. Total power generation in 2013 amounted to 2,474 thousand tce.

Hydropower stations are not the subject of this study, because they are associated with renewable energy, rather than with energy efficiency. Diesel power stations are not mentioned in the statistics or elsewhere.

Only total electricity consumption for own needs is available, so electricity consumption by CHPs for their own needs was determined as a share based on Russian statistics. Shares of electricity distribution losses and power stations own uses have been calculated using data from the IEA energy balance.

According to the IEA energy balance[172], about 2.327 Mtce are annually used for power and heat generation, own use, transmission and distribution. CENEf estimates technical energy efficiency potential in this sector at 0.416 Mtce, or at about one tenth of annual consumption by this sector.

The Kyrgyzstan government is committed to further development of renewable resources for better energy security, short- and medium-term economic development and long-term sustainability. Considerable effort has been made to put into place a legal and regulation framework to facilitate investment in the development of hydropower resources.

[172] http://www.iea.org/statistics/statisticssearch/report/?country=KYRGYZSTAN&product=Balances&year=2012

Table 8.2. Energy efficiency potential in power and heat generation, transmission and distribution (as of 2013)

Integrated technologies of goods, work, and services production	Units	Scale of economic activity	Units	Specific consumption in 2010	Practical minimum	Actual consumption abroad	Comments	Estimated technical potential, 1000 tce
Renovation of gas-fired co-generation plants (CHPs)	mln kWh	81	gce/kWh	321	205	262	CCGT, 60% efficiency	9
Renovation of coal-fired CHPs	mln kWh	728	gce/kWh	349	273	293	Equipment with 48% efficiency	55
Power stations own use	mln kWh	3,361	%	5.3%	4.0%	5.0%	Global practice –North America	5
Electricity transmission and distribution losses	mln kWh	13,200	%	22.2%	6.9%	7.0%	Global practice – Japan	247.7
Renovation of coal-fired boiler-houses	Gcal	555	kgce/Gcal	199	159		Equipment with 90% efficiency	22.5
Renovation of gas-fired boiler-houses	Gcal	99	kgce/Gcal	165	151		Equipment with 95% efficiency	1.4
Total								340.6

Source: CENEf

8.6.3 Industry

Technical energy efficiency potential for industry was assessed (Table 8.3) using 2013 data on industrial activities from annual statistical yearbook, industrial Kyrgyzstan statistical yearbook[173] and data on specific energy use in Kyrgyzstan (where available) or proxies for Russia.

The potential was estimated for 13 energy intensive homogenous products and for 3 cross-cutting technologies. The number of motors operating in the industrial sector was estimated based on industrial electricity consumption, share of electric motors and average annual electricity consumption per motor. It was assumed that 45% of industrial motors require variable speed drives. The number of light fixtures at industrial plants was assessed based on industrial electricity consumption, share of lighting therein, and average annual electricity consumption per light fixture.

Technical energy efficiency potential in industry is assessed at 98 thousand toe, or about 11.2% of 868 thousand toe used in industry. This is due to the nature of the craft industry. It should be noted that the assessment of the technical potential as shown in the table below relies on many assumptions, is for indicative purposes only and needs improvement.

[173] Statistical book "Industry of Kyrgyzstan Republic 2008-2012", 2013, Bishkek.

Table 8.3 Energy efficiency potential in industry (as of 2013)

Integrated technologies of goods, work, and services production	Units	Scale of economic activity	Units	Specific consumption in 2010	Practical minimum	Actual consumption abroad	Comments	Estimated technical potential, 1000 tce
Oil and gas condensate production	10^3 t	79	kWh/t	130	40		Global practice	0.9
Natural gas production	10^6 m^3	29	kgce/ 1000 m^3	8.7	5.9		Expert estimate	0.08
Coal production	10^3 t	1164	kgce/t	14.0	3.0		Global practice	12.8
Pulp	10^3 t	14	kgce/t	790	404	485	Global practice	5.5
Paper	10^3 t	2	kgce/t	360	241	320	Global practice	0.2
Cardboard	10^3 t	0.03	kgce/t	343	237	266	Global practice	0.01
Cement production	10^3 t	1240	kgce/t	24	11	13	Global practice	16.1
Meat and meat products	10^3 t	7	kgce/t	211	50		Chelyabinskaya Oblast	1.2
Bread and bakery	10^3 t	109	kgce/t	157	89		Tambovskaya Oblast	7.4
Efficient motors	10^6 units	0.3	kWh/motor	9,956	8,507		Global practice	45.0
Variable speed drives	10^6 units	0.1	kWh/drive	9,956	9,356		Global practice	8.4
Efficient industrial lighting	10^6 units	0.01	kWh/ lighting unit	247	160		Global practice	0.1
Total for industry								**98**

Source: CENEf

8.6.4 Transport

Energy efficiency potential in transport was estimated for railroad transport, pipelines, air, automobiles and urban electric transport. Like in the other sectors, this effort is quite data demanding. Data on the transport service were taken from statistical yearbook "Statistical Yearbook of Kyrgyzstan 2009-2013"[174], although not always information on transport service was available in required formats. In some instances, data presented in passenger-km and (or) freight-km were to be converted to brutto-freight-km to fit statistically available data on specific energy use[175]. As to specific energy use, for many vehicles data in Kyrgyzstan are available in formats similar to those used in Russia. For automobile transport Russian data on specific energy use were taken as proxies. This approach makes the estimate just preliminary and fit for further improvement, but it can serve a starting point for improving energy efficiency potential assessments in the transport sector in Kyrgyzstan. Data on the number of buses, light- and heavy-duty vehicles were taken from the open sources[176].

CENEf estimates the energy efficiency potential in transport at 0.8 Mtce (41.5% of consumption) in 2013 (Table 8.4). The largest potential comes from switching to effective hybrid models in automobile transport. Estimates of the energy efficiency potential in transport from local sources are scarce.

[174] Statistical yearbook "Kyrgyzstan Republic 2009-2013", 2013, Bishkek.
[175] Such conversions were made based on corresponding data for Russia.
[176] http://www.who.int/violence_injury_prevention/road_safety_status/2013/country_profiles/kyrgyzstan.pdf.

Table 8.4. Energy efficiency potential in transport (as of 2013)

Integrated technologies of goods, work, and services production	Units	Scale of economic activity	Units	Specific consumption in 2010	Practical minimum	Actual consumption abroad	Comments	Estimated technical potential, 1000 tce
Railroad electric traction	10^7 tkm gross	1,234	kgce/ 10^4 tkm gross	12.0	10.0		Values for some Russian regions	2.5
Diesel locomotives	10^7 tkm gross	2,310	kgce/10^4 km gross	62.2	40.0		2020 target for Russia	51.3
Tram electric traction	10^6 tkm gross	7	kgce/10^3 km gross	6.5	4.3		Moscow	0.02
Gas pipeline transport	10^6 m^3km	9.878	kgce/10^6 m^3 km	28.2	25.00		2020 target for Russia	31.6
Eco-driving	10^3tce	632	kgce/10^6 m^3km	100%	95%		Global practice	31.6
Shifting to hybrid light-duty vehicles	10^3 vehicles	601	tce/vehicles/ year	1.23	0.74		Global practice	295.5
Shifting to hybrid buses	10^3 buses	32	tce/buses/ year	6.5	3.91		Global practice	83.2
Shifting to hybrid heavy-duty vehicles	10^3 vehicles	93	tce/vehicles/ year	7.5	4.52		Global practice	279.9
Air transport	10^6 passenger -km	2099	kgce/ passenger-km	60.3	54.27		Global practice	12.7
Total transport								**788**

Source: CENEf

8.6.5 Buildings

The buildings sector includes residential, public and commercial buildings. Industrial and agricultural buildings are not considered. While statistical publications provide data on the living space (the state programme "Affordable Housing 2020"[177]), information on public and commercial buildings stock is not available. Data on their energy use is either not available (for public and commercial buildings), or not reliable enough, because they refer to stand-alone buildings and are not consistent.

Residential energy use in the recent years has been fluctuating around 1.06 Mtce and was partly determined by weather conditions. Public and commercial buildings stock with access to district heating was estimated at one quarter of the residential floor space, and this estimate was confirmed by practice.

For multi-family buildings, specific energy use in Russia was used as a proxy. For single-family houses, the value for a "passive house" was used as the reference level. Therefore, the assessed potential is assuming a very deep renovation of the existing buildings stock.

Data on other activities in the housing sector were estimated based on the national statistics and reasonable expert estimates, while data on specific energy use for current practices were taken similar to those for Russia, except the space heating data. Data on the public and commercial floor space were reconstructed using the number of people (schoolchildren, lecturers, etc.) in public and commercial buildings and required average floor space. For countries with a similar

[177] Kyrgyzstan state programme "Affordable Housing 2020", 2012.

level of development the ratio of public and commercial buildings to the housing living space is about 1:4-1:5[178]. For Kyrgyzstan, the calculated ratio is 24% of the housing floor space.

According to the IEA balances, 0.325 Mtce were used in the public and commercial sectors in 2012. The potential in the residential sector is estimated at 0.936 Mtce (88.1% of the consumption); in the public and commercial buildings at 0.15 Mtce (46.4% of the consumption). Total energy saving potential in buildings is estimated as exceeding 1 Mtce (78.3% of the consumption) (for more detail see Table 8.5).

Table 8.5 Energy efficiency potential in the buildings sector (as of 2013)

Integrated technologies of goods, work, and services production	Units	Scale of economic activity	Units	Specific consumption in 2010	Practical minimum	Actual consumption abroad	Comments	Estimated technical potential, 1000 tce
Residential buildings								
Renovation of centrally heated multifamily buildings	10^3 m^2	15.761	kgce/m^2	22.00	7.1		60% of 2012 building codes requirements	77.5
Renovation of single-family buildings	10^3 m^2	36.567	kgce/m^2	22.00	4.9		Passive houses	259.6
Renovation of hot water use	10^3 people	1,555	tce/person	0.207	0.073	0.12	Global practice	208.5
Replacement of appliances with top efficient models	10^3 people	5,777	tce/person	0.110	0.055	0.12	Global practice	317.7
Lighting renovation	1,000 light fixtures	5,151	W	50.85	20.00	35.0	Global practice	10.8
Renovation of the cooking equipment	10^3 m^2	30,903	kgce/m^2	3.50	1.50	2.80	Global practice	61.8
Total residential buildings								**936**
Public and commercial buildings								
Renovation of centrally heated buildings	10^3 m^2	3940	kgce/m^2	26.0	7.1	18.0	60% of 2012 building codes requirements	2.41
Renovation of hot water use	10^3 m^2	3940	kgce/m^2	4.90	2.7	3.3	Global practice	2.41
Renovation of the cooking equipment	10^3 m^2	6,181	kgce/m^2	1.8	1.4	1.3	Global practice	1.43
Efficient space heating boilers	10^3 m^2	6,181	kgce/m^2	32.7	26.7	30.2	Global practice	1.17
Lighting renovation	10^3 m^2	6,181	kWh/m^2	32.7	16.4	27.8	Global practice	4.76
Procurement of efficient appliances	10^3 m^2	6,181	kWh/m^2	71.8	51.6	56.6	Global practice	4.76
Total public and commercial buildings								**151**
Total buildings								**1,086**

Source: CENEf

[178] M. Economidou. Project lead. Europe's Buildings Under the Microscope. A country-by-country review of the energy performance of buildings. October 2011. Buildings Performance Institute Europe (BPIE); Transition to Sustainable Buildings. Strategies and opportunities to 2050. IEA. 2013.

8.6.6 Other sectors

According to the IEA energy balances, 0.136 Mtce have been annually used in agriculture in the recent years, but it is incorrect to attribute this entire volume to electricity alone. There is a big fleet of tractors and other farm machinery. Besides, there is a bunch of greenhouse facilities that are primarily heated with natural gas. For this reason, the potential will be much larger, than the value in the IEA balance.

Information on the tractor park is presented in the statistical yearbook "Agriculture of Kyrgyzstan 2009-2013"[179]. Based on the Russian experience, specific energy use per tractor may be reduced by about 65%. Glass greenhouse facilities floor space is 50 hectares, as of 2011. Based on the Russian experience, specific energy use per glass greenhouse facility may be reduced by about 50%. The overall potential in improving the fuel efficiency of tractors is estimated at 0.352 Mtce; in space heating of greenhouse facilities it is 0.001 Mtce. Total energy saving potential in agriculture is estimated at 0.35 Mtce.

Two more components of the energy efficiency potential were assessed, namely street lighting and variable speed drives at municipal water supply systems. Electricity consumption by public utilities and street lighting was calculated using data from the statistical yearbook and IEA balances less electricity consumption for own needs.

All together, the contribution of "other sectors" to the energy efficiency potential was estimated at 0.353 Mtce (Table 8.6).

Table 8.6 Energy efficiency potential in "other sectors" (as of 2013)

Integrated technologies of goods, work, and services production	Units	Scale of economic activity	Units	Specific consumption in 2010	Practical minimum	Actual consumption abroad	Comments	Estimated technical potential, 1000 tce
Tractors fuel efficiency	10^3	26,562	kgce/ha	20	7		Global practice	351.7
Renovation of greenhouse facilities	10^3 m^3	50	kgce/m^3	34	17		Average for Russia	0.8
Adjustable speed drives in water supply systems	mln kWh	5	%	100%	75%		Global practice	0.2
Street lighting renovation	mln kWh	1	%	100%	70%		Global practice	0.02
Total								**352.7**

Source: CENEf

8.6.7 Comparisons of total technical energy efficiency potential estimates

Total technical energy efficiency potential for Kyrgyzstan, as of 2013, is estimated at 2.7 Mtce, or 54.3% of TPES (Fig. 8.1). This estimate assumes independent implementation of all technological measures without accounting for integral direct or indirect effects related to the reduction of potential in power and heat generation after end-use demand for power and heat is reduced through measures implemented in the final energy use sectors.

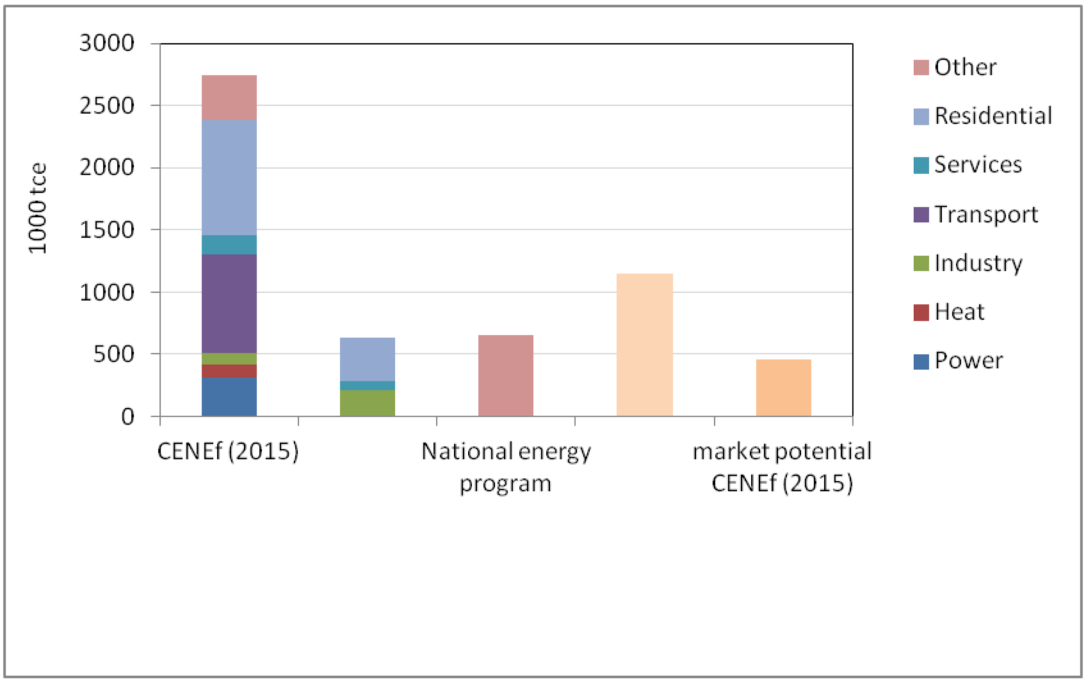
[179] Statistical yearbook "Agriculture of Kyrgyzstan Republic 2009-2013", 2014, Bishkek.

The energy efficiency potential is estimated by A.V. Arkhangelskaya (Ministry of Energy and Industry)[180] and in the National Energy Programme of the Kyrgyz Republic for 2008-2010 until 2025[181] and other projects.

CENEf's estimate is slightly higher, than those reported in the above sources. This can be partly explained by the coverage of a different set of activities and by the inconsistency of data used for both present specific energy use and for BATs. CENEf's assessment breaks down the potential with a much larger degree of itemization to allow for better-tailored energy efficiency policies.

The key problem with regard to energy efficiency in both residential and industrial sectors is that most industrial and energy technologies that date back to the Soviet era are dated and inefficient. This results in the inefficient use of resources and significant emissions that adversely impact the environment and the economy. At this stage, therefore, economic and environmental interests in the residential, industrial, and power generation sectors converge.

Figure 8.1. Estimates of the technical, economic and market energy efficiency potentials for Kyrgyzstan



Sources: CENEf

Anyway, the technical energy efficiency potential is large and basically concentrated in the power and heat, services, and residential buildings sectors.

8.6.8 Economic and market energy efficiency potentials

Economic and market potentials are assessed based on the comparison of energy prices and the costs of saved energy. 2013 energy prices were used in the study (Table 8.7).

Costs of saved energy depend on the discount rate applied to annualize the capital costs. In this study, 6% discount rate was used to estimate the economic energy efficiency potential and 12% discount rate was used to estimate the market energy efficiency potential. In addition, 20%

[180] See: A.V. Arkhangelskaya, Ministry of Energy and Industry, Energy Efficiency in the Kyrgyz Republic: State, Problems, Challenges and Investment, Bangkok, 2014.
[181] See: National Energy Program of the Kyrgyz Republic for 2008-2010 until 2025, Resolution of the Jogorku Kenesh of the Kyrgyz Republic dated April 24, 2008 No. 346 –IV.

discount rate was used to reflect stricter budget limitations and a higher cost of money for some energy consumers.

Table 8.7 Energy prices in Kyrgyzstan in 2013

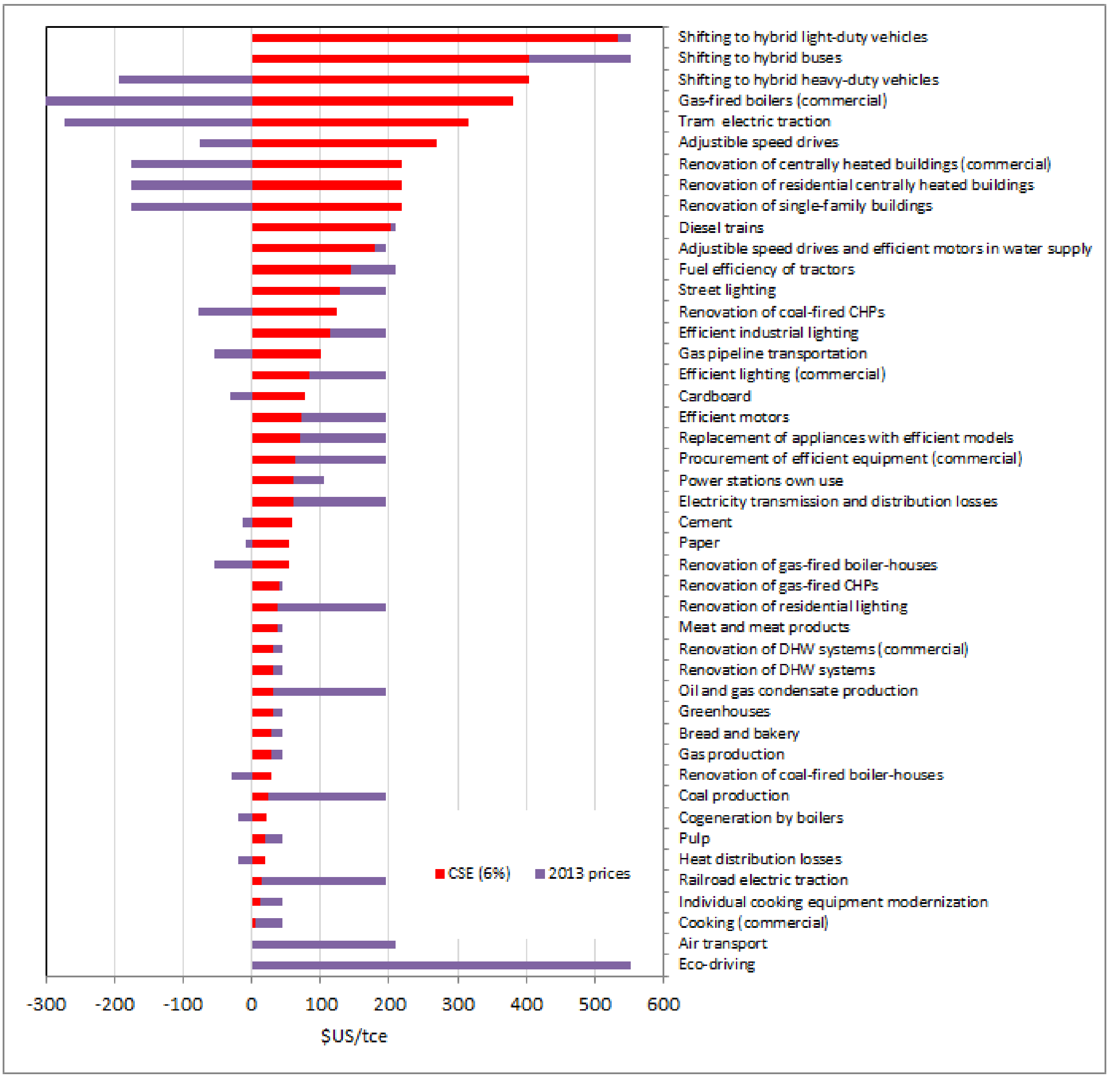
	Units	US$	US$/tce
Electricity	kWh	0.13	105.7
Natural gas	m^3	0.06	45.3
Gasoline	t	678.5	551.7
Diesel fuel	t	258.0	209.8

Sources: Energy Charter Protocol on Energy Efficiency and Related Environmental Aspects PEEREA. Kyrgyzstan regular energy efficiency review 2011, p.13.

Some measures for which the costs of saved energy appeared to be higher, than energy price, are economically not attractive for the society and are not included in the economic potential (Fig. 8.2). In the case of Kyrgyzstan, gas-fired boilers are out of the energy efficiency list. With economic constraints, the 2.7 Mtce technical energy efficiency potential shrinks to the 1.6 Mtce economic potential.

If private parameters in economic decision-making are better reflected in the analysis via higher costs of capital (12% and 20% discount rates), then market energy efficiency potential may be assessed. It is lower, than the economic potential, but not much lower. For the two discount rates mentioned it stands at 1.2 and 0.5 Mtce respectively (Fig. 8.3 and 8.4). 23 measures are excluded from the market energy efficiency potential with a 12% discount rate, 30 are excluded when using a 20% discount rate. Making long-term funding for energy efficiency measures more easily available would allow it to bridge the gap between the economic and market energy efficiency potentials.

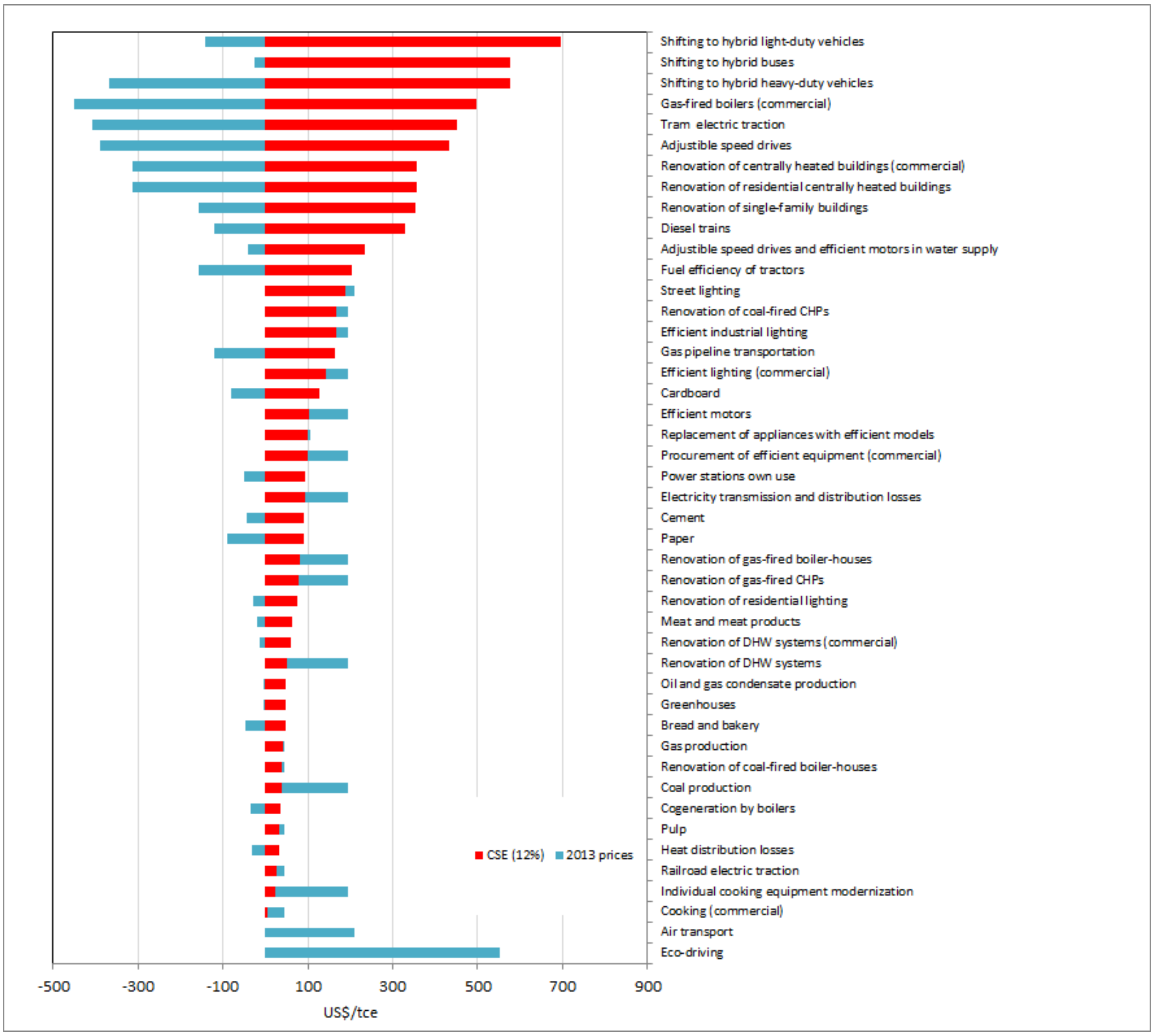
Figure 8.2. Economic energy efficiency potential for Kyrgyzstan (for 6% discount rate as of 2013)



The figure shows the costs of saved energy (red) and the gap between energy price in a given activity and the cost of saved energy (blue). Due to the fact that different energy carriers are used in individual activities, the price is average weighted for all energy carriers used. All prices are presented in US$/tce. If the gap is negative, the measure is considered economically not attractive and is excluded from the economic potential assessment.

Source: CENEf

Figure 8.3. Market energy efficiency potential for Kyrgyzstan (for 12% discount rate as of 2013)

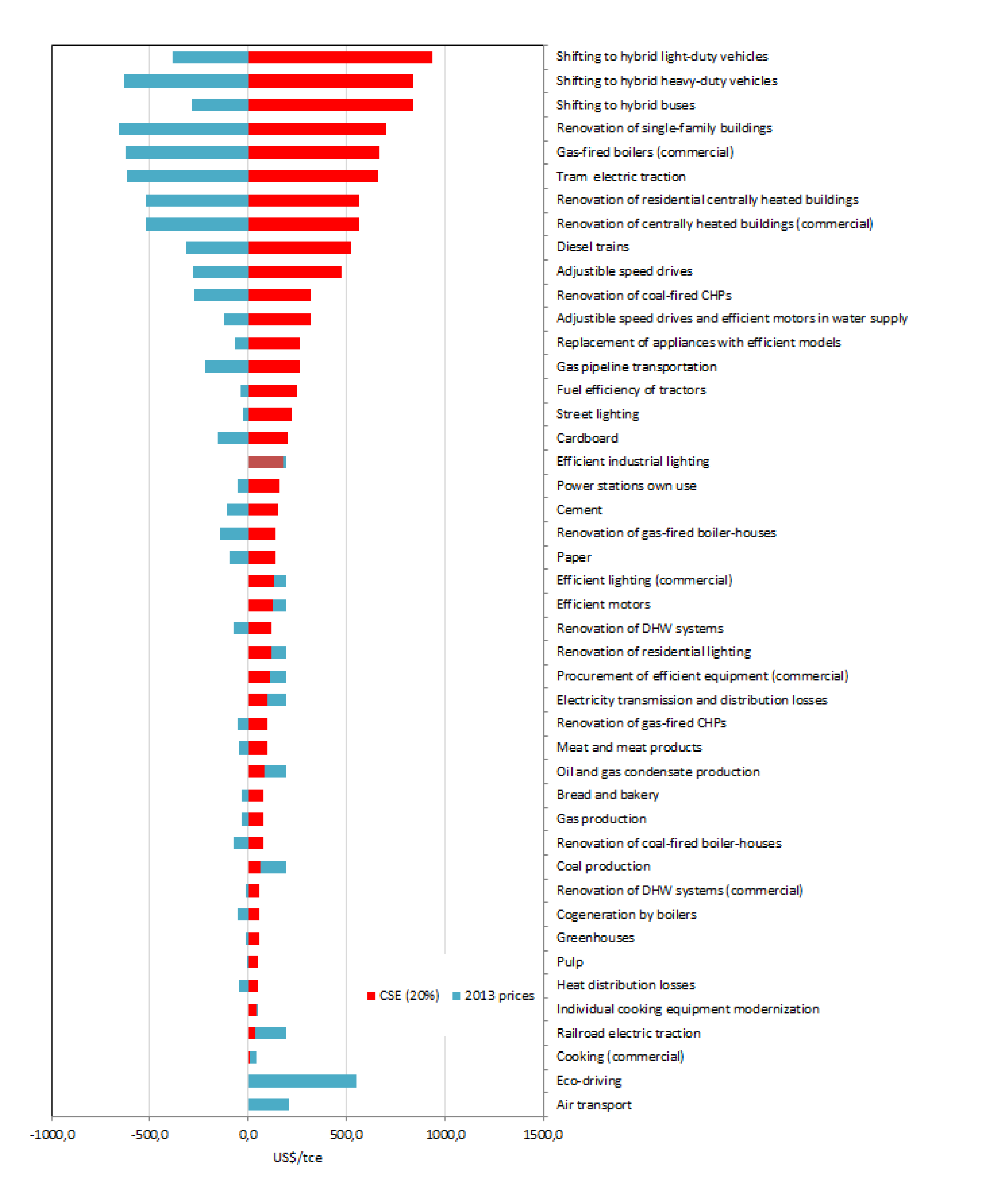


The figure shows the costs of saved energy (red) and the gap between energy price in a given activity and the cost of saved energy (blue). Due to the fact that different energy carriers are used in individual activities, the price is average weighted for all energy carriers used. All prices are presented in US$/tce. If the gap is negative, the measure is considered economically not attractive and is excluded from the market potential assessment.

Source: CENEf

Even with current energy prices and the 20% discount rate applied in investment decision-making, the market potential to improve energy efficiency in Kyrgyzstan amounts to approximately 9% of primary energy use. It should be pointed out that accounting for co-benefits and subsidies for energy efficiency measures that are not economically attractive, as well as steady energy price growth may scale up the economic and market potential closer to the technical one.

Figure 8.4. Market energy efficiency potential for Kyrgyzstan (for 20% discount rate as of 2013)



The figure shows the costs of saved energy (red) and the gap between energy price in a given activity and the cost of saved energy (blue). Due to the fact that different energy carriers are used in individual activities, the price is average weighted for all energy carriers used. All prices are presented in US$/tce. If the gap is negative, the measure is considered economically not attractive and is excluded from the market potential assessment.

Sources: CENEf

Section 9. Republic of Moldova

9.1 National level

Population in 2012: 3.56 mln; GDP PPP in 2012: 13.16 bln US$2005 (IEA[182]).

Evolution of GDP energy intensity. GDP MER energy intensity was declining at 3.7% per year and GDP PPP energy intensity was declining at 3.5% per year on average between 2000 and 2012. In 2012, Moldavian GDP in PPP decreased by 0.8% of the 2011 level. GDP PPP energy intensity was going down by 2.8% per year during 1990-2012.

National Development Strategy "Moldova 2020" approved by Law No. 166 dated 11 July, 2012, requires only 10% energy intensity reduction over the 2010s. Energy use in the buildings sector is expected to be 10% down by 2020, and 10% of public buildings are to be renovated in the long-run. Government Decree "On the National Energy Efficiency Programme for the 2010s" requires 20% further GDP energy intensity reduction by 2020 compared to 2010. Later, similarly to the EU member states, Moldova also set up an intermediary energy savings target of 9% versus the 2009 baseline to be attained by 2016, or to reduce energy end-use in all sectors by 428 ktoe[183].

Energy prices. In 2010, natural gas price was 250 US$/1000 m^3. In 2012, electricity price was around 10 US cents/kWh.

Energy efficiency legislation. Energy efficiency legislation in Moldova includes the following documents:

- Law on Renewable Energy No. 160 of 12.07.2007;
- Law on Energy Efficiency No. 142 of 02.07.2010;
- Law on the Energy Efficiency of Buildings No. 128 of July 11, 2014;
- Government Resolution on the National EE Programme for 2011-2020 No. 833 of 10.11.2011;
- Government Resolution on the Energy Efficiency Fund No. 401 of 12.06.2012.

These pieces of legislation aim at the reduction of the following indicators by 2020 as compared to 2010: energy intensity by 10%; transmission and distribution losses: electricity by 11%; natural gas by 39%; district heat by 5%; share of natural gas in the energy balance from 53% down to 45%; energy consumption by the buildings sector by 10%. The intention is to renovate at least 10% of public buildings by 2020 and reduce GHG emissions by at least 25% of the 1990 level.

Government agencies with an energy efficiency policy mandate. Ministry of Economy is the key federal agency in the energy sector. Ministry of Regional Development and Construction is responsible for energy performance in the construction sector. Ministry of Transport and Road Infrastructure is responsible for the renovation of and upgrading transport networks and for monitoring and regulating the motor vehicle fleet. Agency for Energy Efficiency is the key government agency responsible for the implementation of national energy efficiency policies. This Agency is subordinate to the Ministry of Economy, yet has a separate budget.

Basic administrative mechanisms to improve energy efficiency: energy efficiency requirements for electric drives, transport equipment; energy metering requirements; energy

[182] http://www.iea.org/statistics.
[183] National Energy Efficiency Action Plan for 2013-2015. Approved by Government Decision No. 113 dated February 7, 2013.

efficiency classes; energy audits, building codes and buildings certification, energy expertise; prohibition against inefficient devices turnover (incandescent lamps).

Basic energy efficiency market mechanisms and economic incentive programmes: subsidies for buildings retrofits and installation of building-level meters; voluntary agreements, taxation and pricing policies, different heat rates depending on whether or not heat meters are installed.

Energy efficiency policy spending and financial sources. According to the Energy Efficiency Agency, the costs of projects under way total to US$ 85 million. According to the National Energy Efficiency Action Plan for 2013-2015, the intention is to allocate about US$ 7.5 million for energy efficiency improvements in end-use sectors.

Energy efficiency R&D spending. No data on energy efficiency research and development spending are available.

ESCO market. The size of the ESCO market in Moldova is unknown. Energy efficiency fund provides certain support to the ESCO business in the country, especially in the industrial and buildings sectors.

Water efficiency policy. Moldova is a country with very scarce per capita water resources. National water and environmental legislation includes the following documents:

- National Water Policy Concept;
- Economic Growth and Poverty Combating Programme;
- EU – Moldova Integration Plan.

The basic challenge to be addressed through the national water resource policy is sustainable management of water as a natural component (resource) and as an economic category (goods).

9.2 Heat and power generation and transmission

Power generation efficiency[184]. The energy system of Moldova includes one large thermal power plant located in the Transnistrian Region (Administrative Territorial Units on the Left Bank of the Dniester River); 3 municipal combined heat and power plants; 9 CHPs beside sugar factories; and 2 hydropower plants. The efficiency of power generation is about 36%. Total energy use for both power and heat generation is 77.5%.[185]

Share of CHP in power generation is 93%. Combined heat and power generation is practiced at CHP-1 in Chisinau (66 MW (electric) and 296 MW (heat) installed capacity); CHP-2 in Chisinau (240 MW (electric) and 1,397 MW (heat) installed capacity) and CHP–North in Balt (24 MW (electric) and 165 MW (heat) installed capacity).

Power transmission and distribution losses (%). In 2010, transmission and distribution losses of three major electricity retailers were: 10.43% (RED Nord); 12.98% (RED Nord-Vest); 13.68% (RED Union Fenosa). Electricity losses dropped in 2010 by 33% on average of the 2005 values. In 2011, average transmission and distribution losses were 12.5%.[186]

Share of CHPs in heat generation is 60%. Around 95% of Chisinau residents and 90% of Balt residents have access to district heating. In the other 13 cities only a few residential consumers have access to district heat, which is basically supplied to public buildings.

[184] Republic of Moldova: National Energy Policy Information for Regional Analysis. United Nations Economic Commission for Europe Energy Efficiency 21 Programme.
[185] National Energy Efficiency Action Plan for 2013-2015. Approved by Government Decision No. 113 dated February 7, 2013.
[186] L. Belinschi and E. Stratulat. National Agency for Energy Regulation. The process of the organization and implementation of energy efficiency principles in the Republic of Moldova. Missouri, November 6, 2012.

Heat generation efficiency. Total efficiency of boilers is close to 90%. Heat supply to the residential sector is a top national priority. After district heating was cut-off in most cities of Moldova, autonomous heating systems were installed to work on various fuels. These heating systems do not meet minimum security requirements and have adverse environmental effects.

Heat distribution losses. In 2010, heat distribution losses were around 20%. Compared to 2005, they increased by 50%.

Energy efficiency regulations in heat and power generation and distribution. Challenges faced by the energy sector are as follows:

- promotion of cogeneration. Overall efficiency of new cogeneration thermal power plants is to be at least 80% (heat) and 45 to 50% (electric);
- reduction of electricity distribution losses from 13% in 2011 to 7-10% in 2020, i.e. annual reduction by 0.52-0.82%;
- reduction of heat distribution losses from 21% in 2010 to 5% in 2020.

Government agencies with an energy efficiency policy mandate in heat and power generation and distribution. Government agencies responsible for the implementation of energy efficiency policies in the power and heat sector are Ministry of Economy and Agency for Energy Efficiency.

Basic administrative mechanisms to improve energy efficiency in heat and power generation and distribution: process energy use norms, energy efficiency requirements for new installations; mandatory energy audits, data reporting, energy expertise.

Basic energy efficiency market mechanisms and economic incentive programmes: voluntary agreements, taxation and pricing policies.

Renewables development programmes. National energy efficiency programme to 2020 provides incentives for electricity generation from renewable sources.

White Certificates market. No such programmes launched. Ministry of Economy and Agency for Energy Efficiency will be considering a possibility to deploy a 'white certificates' scheme to spur energy efficiency. Agency for Energy Efficiency will also see if it is economically sound to impose fixed energy savings obligations on energy retailers.

9.3 Industry

Industrial energy intensity. Industry is responsible for only 5.3% of final energy consumption. In 2012, fuel and energy consumption by the industrial sector dropped by 23% of the 2005 level[187]. According to UNIDO, energy intensity of the industrial sector dropped by 23% during 1990-2000 and by additional 9% by 2008 (in tons of oil equivalent per US$1,000 of manufacturing value added)[188]. But energy intensity in the industrial sector is still 3-4 times higher, than in the EU member states[189].

Energy efficiency regulations in the industrial sector. "National Energy Efficiency Programme to 2020" does not set any specific target to reduce overall industrial energy intensity. The Programme requires the use of equipment and technologies with lower energy consumption, than currently used. It includes the following measures:

[187] Fuel and energy balance of the Moldova Republic for 2005-2012 based on the data provided by the Republic of Moldova National Statistics Bureau.
[188] UNIDO. Industrial Development Report 2011. Industrial energy efficiency for sustainable wealth creation. Capturing environmental, economic and social dividends.
[189] National Energy Efficiency Action Plan for 2013-2015. Approved by Government Decision No. 113 dated February 7, 2013.

- developing the energy efficiency programme for the industrial sector;
- considering introduction of the ‘white certificates’ scheme;
- monitoring of industrial energy consumption by Agency for Energy Efficiency through questionnaires with energy efficiency related questions to be filled in by industrial energy consumers at the end of each year;
- promoting energy management system ISO 50001.

National Energy Efficiency Action Plan for 2013-2015[190]specifies the following measures for the industrial sector to cut industrial energy intensity: continuous monitoring of energy use and technological parameters based on up-to-date measuring and control systems; replacing the old production lines with new energy-efficient and higher-productivity technologies; automating the industrial processes; cutting heat losses; using secondary energy resources in technological processes; advanced equipment for heat generation, with lower GHG emissions and lower adverse effects; more efficient lighting and providing high-quality lighting at the working places depending on the specific lighting requirements of technological processes; sizing the electric motors in accordance with the required load and using modern devices for motor starting, controlling and adjustment; implementing low cost local co-generation plants; refurbishing and replacing inefficient boilers; insulation of steam and hot water pipelines; switching from electric space heating to fuel or biofuel-based heating; thermal retrofits of administrative and production building envelopes (low-e windows, doors, insulation of floors, walls, ceilings, etc.); control, recording and measuring devices; heat recovery in the ventilation systems; redeveloping air compression systems; solar collectors, heat pumps, etc.; installing absorption or cooling systems through evaporation.

Government agencies with an energy efficiency policy mandate in the industrial sector. Government agencies responsible for energy efficiency policy implementation in the industrial sector are the Ministry of Economy and Agency for Energy Efficiency.

Basic administrative mechanisms to improve energy efficiency in the industrial sector: energy efficiency requirements for electric drives; energy audits; energy data reporting; energy expertise.

Basic energy efficiency market mechanisms and economic incentive programmes: voluntary agreements, taxation and pricing policies.

Long-term agreements. National Energy Efficiency Programme to 2020[191] requires the development of voluntary agreements in industrial energy efficiency. According to this Programme, long-term agreements help save 10-20% of the energy used. Voluntary agreements will be transparent and will include, if need be, quantitative targets for monitoring and reporting purposes.

Energy managers training programmes. In compliance with the legislation in force, local authorities shall appoint energy managers (with higher energy education) responsible for energy efficiency and renewable energy use planning and control. With support provided by the Agency for Energy Efficiency, energy managers shall be developing local energy efficiency programmes (every three years) and annual action plans.

At least once a year energy managers shall make analyses of energy consumption by territories to identify potential energy efficiency measures to be implemented. Such analyses shall be made in compliance with the standard format to be developed by the Agency. Filled in forms shall be attached to the annual energy efficiency progress reports.

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[190] National Energy Efficiency Action Plan for 2013-2015. Approved by Government Decision No. 113 dated February 7, 2013.

[191] Government Decree of Moldovia Republic No. 833 of 10.11.2011 “On the National Energy Efficiency Programme to 2020”.

The Agency for Energy Efficiency shall develop Energy Efficiency Guidelines for the public sector and hold training for energy managers.

Industrial energy efficiency policy spending. No assessment of the costs associated with the implementation of energy efficiency policies in the industrial sector is available.

9.4 Buildings

Specific energy consumption per m^2 of residential floor space (energy intensity in residential buildings). Building on energy audits for Moldova, total specific energy use in buildings in 2012 can be estimated at 24.6 kgce/m^2, or 200 kWh/m^2.[192] This brings energy use in the housing sector to 1.97 Mtce versus 1.27 Mtce reported by IEA. If the latter figure is used, then specific energy use by Moldavian buildings is about the lowest in the world – below 100 kWh/m^2, which is not realistic. Moreover, the new building codes set minimum energy performance requirements for Class B at 121 kWh/m^2/year in flats, which should not be higher than the present value. Therefore, either residential energy use data provided by IEA are not reliable and cover only half of the actual energy use, or a large portion of the living space is not heated at all. Part of the problem may root in the poor statistical coverage of energy and fuel use in the housing sector.

Ministry of Regional Development and Construction is going to:

- draft buildings energy efficiency law taking into account external and internal climate factors;
- develop a programme to eventually increase the number of zero-energy public buildings. Starting from December 31, 2018, new public buildings shall have "near zero" energy consumption (below 50 kWh/m^2/annually);
- develop a national plan to eventually increase the number of zero energy buildings, other than public. The Plan shall include interim 2015 energy efficiency targets for buildings; information on policies and financial measures, including the details of renewable energy use requirements for new buildings and existing buildings subject to capital retrofits.

Specific energy consumption per 1 m^2 of public floor space. No statistical data are available on the energy consumption structure in public buildings.

Specific hot water consumption per household with access to centralized DHW supply. A specific research is required.

Share of consumers equipped with energy meters. 100% of industrial and residential customers have conventional electric meters installed. About 85-86% of households are equipped with gas meters. In the cities of Chisinau and Balt, most buildings have heat and flowmeters. In accordance with the National Energy Efficiency Programme to 2020[193], in 2016 gas and heat meters are to be installed at 100% of the buildings.

Building codes requirements. Many construction norms and standards from the Soviet times (SNIP and GOST standards) are outdated. Ministry of Regional Development and Construction is currently preparing a roadmap to update the building codes in Moldova. Introduction of minimum energy performance requirements will yield more than 30% savings. The national Energy Efficiency Programme also requires that the new minimum requirements be applied also to constructions subject to major renovation (25% of the value or area of the building envelope), although annual renovation rate is below 1%.

[192] National Energy Efficiency Action Plan for 2013-2015. Approved by Government Decision No. 113 dated February 7, 2013.
[193] Government Decree of Moldovia Republic No. 833 of 10.11.2011 "On the National Energy Efficiency Programme to 2020".

Other administrative mechanisms to improve energy efficiency in buildings: energy metering requirements; energy efficiency standards and labelling for appliances, buildings certification by energy efficiency classes; energy audits and inspections, energy data reporting, energy expertise; prohibition of inefficient devices turnover (incandescent lamps).

Government agencies with an energy efficiency policy mandate in the buildings sector. Government agency responsible for the implementation of energy efficiency policies in buildings is the Ministry of Regional Development and Construction.

Information and educational programmes. The Ministry of Economy will provide large-scale training for all stakeholders on the institutional, legal and financial aspects, existing or planned, in order to attain national energy efficiency goals and targets. Energy Efficiency Agency will be implementing national information strategy for energy efficiency.

9.5 Transport

Specific energy consumption per unit of transport service. In 2012, transport was responsible for about 15.6% of final energy consumption. As compared to 2005, energy consumption by transport grew up by 40% in 2012.

Passenger vehicle fleet of Moldova is quite dated, 68.2% of the vehicle fleet were commissioned before 2000. The share of new, or nearly new, cars produced between 2010 and 2012 is 2.3% of the total park.

Currently, Moldova imports 99% of all liquid fuels it consumes. Also, fuel consumption shows upward trends.

Government agencies with an energy efficiency policy mandate in the transport sector. Ministry of Transport and Road Infrastructure.

Basic administrative mechanisms to improve energy efficiency in the transport sector. Measures included in the National Energy Efficiency Programme in the Transport Sector are as follows:

- incentives for the use of biofuel as an additive to conventional fuels;
- use of fuel-efficient tyres, reliable and low-noise;
- reduction of electricity and fuel consumption by electric and railroad transport, replacement of dated transport units with new and more efficient models;
- in large cities, traffic restrictions shall be considered; these may include restrictions tied to certain days of the week or to certain streets; besides, road traffic will be prohibited on so-called “green days”.

Basic energy efficiency market mechanisms and economic incentive programmes in the transport sector: emission trading; voluntary agreements, taxation and pricing policies.

9.6 Technical energy efficiency potential for Moldova

9.6.1 Approach and data sources

Assessment of the technical energy efficiency potential for Moldova builds on the approaches described in the Inception Report. Four sets of data were used to attain this goal (Table 9.1). Data related to the economic activities were collected from national statistical sources (for 2012-2013), which are listed in corresponding sections. Data related to specific energy use in different applications were collected from official documents, programmes, presentations and publications. Where appropriate data were not available, proxies for countries with similar conditions were used. Assessment of the technical potential builds on the comparison of those energy efficiency indicators against specific energy consumption for BATs in the same sectors and subsectors. Data on BATs were collected from multiple international sources.

Technical energy efficiency potential for Moldova was assessed by multiplying the 2012-2013 activity level by the gap between the country's specific energy efficiency and energy efficiency BAT parameters for the same activity.

Table 9.1 Data collection technology and structure

Information required	Source of information	Methods of data collection
Data on economic activities	Statistical yearbooks	Collection of statistical data
Data on specific energy consumption in various sectors in Moldova	Official documents, publications, proxies for countries with similar conditions	Literature search
Data on specific energy consumption for BATs	Publications	Collection of data from publications on BATs
Energy prices	Statistical yearbooks	Energy prices

Assessment of the technical potential was structured by different sectors including: power and heat generation, transmission and distribution, industry, transport, buildings, agriculture, street lighting, water supply, etc. Estimates generated by this study were, where possible, compared with the local estimates of the energy efficiency potential for similar activities. Where the information was sufficient, the reasons for mismatching, if any, were identified.

Based on these comparisons, technical potential estimate ranges were provided. Where reliable information for some energy use activities was not available, such activities were skipped from the potential evaluation study.

So as to identify the economic and market potentials, the costs of saved energy were compared to 2013 or 2014 energy prices in order to see if an individual measure is economically viable.

Summary of energy efficiency potential estimation for the Republic of Moldova:

- Power and heat 311 thou tce
- Industry 64 thou tce
- Transport 349 thou tce
- Residential buildings 2,022 thou tce
- Services 203 thou tce
- Other 54.7 thou tce
- **Total** **3.0 Mtce**

9.6.2 Power and heat

CENEf's assessment builds on the data related to energy use and power and heat generation available from statistical yearbooks, government programmes and legal acts, publications, and other sources, including internet resources. For some parameters such information was not available, and so they were assessed using proxies, including parameters for similar installations in Russia. Therefore, the estimates of the technical potential are by no means perfect. CENEf has taken any and all efforts to make them as reliable as possible, despite the tight work schedule that did not allow for too extensive data search.

Data related to power generation in 2013 were borrowed from statistical yearbooks[194]. Some information was also found to serve a basis for expert allocation of power generation by stations

[194] "Republic of Moldova: National Energy Policy Information for Regional Analysis. United Nations Economic Commission for Europe Energy Efficiency 21 Programme. 2009".

(GRES and CHPs) and by fuels, as well as contribution of fuel to power generation. Based on this information, power generation was allocated to various types of stations in Table 9.2.

The basic fuel for electricity production in Moldova is natural gas. CHPs contribute 27% to electricity generation, condensed power stations (GRES) 64%, and hydro stations 9%. Total power production in 2013 amounted to 905 million kWh.

Heat generation in 2013 amounted to 2.7 million Gcal. Of this volume 38% were generated by CHPs, 62% by large and small boiler-houses. The structure of fuel use was estimated by CENEf. Power and heat losses were taken from statistical sources and publications. Distribution losses amount to 13% for power and up to 21% for heat.

Where information on specific energy use was not found in the national sources, proxies (based on Russia's experience in similar conditions) were used.

According to the IEA energy balances, about 1.01 Mtce are annually used for power and heat generation, transmission and distribution. CENEf estimates the technical energy efficiency potential in this sector at 0.31 Mtce (Table 9.2), or at about one fifth of annual consumption by this sector.

Table 9.2. Energy efficiency potential in power and heat generation, transmission and distribution (as of 2013)

Integrated technologies of goods, work, and services production	Units	Scale of economic activity	Units	Specific consumption in 2010	Practical minimum	Actual consumption abroad	Comments	Estimated technical potential, 1000 tce
Renovation of gas-fired power-only plants (GRES)	mln kWh	579	gce/kWh	360	205	262	Combined cycle gas turbines (CCGT), 60% efficiency	90
Renovation of gas-fired co-generation plants (CHPs)	mln kWh	244	gce/kWh	414	205	262	CCGT, 60% efficiency	51
Renovation of diesel power plants	mln kWh	1.5	gce/kWh	454	332	332	Equipment with 37% efficiency	0.2
Power stations own use	mln kWh	905	%	5.6	4,0	5.0	Global practice –North America	1.8
Electricity transmission and distribution losses	mln kWh	4,186	%	13.0	6,9	7.0	Global practice – Japan	31.4
Renovation of coal-fired boiler-houses	thou. Gcal	215	kgce/Gcal	223	159		Equipment with 90% efficiency	13.9
Renovation of residual oil-fired boiler-houses	thou. Gcal	108	kgce/Gcal	191	155		Equipment with 92% efficiency	3.8
Renovation of gas-fired boiler-houses	thou. Gcal	1,283	kgce/Gcal	179	151		Equipment with 95% efficiency	36.2
Renovation of other boiler-houses	thou. Gcal	68	kgce/Gcal	218	159		Equipment with 90% efficiency	4.0
Electricity consumption for heat generation by boilers	thou. Gcal	1,674	kWh/Gcal	23	7	9	Finland	3.3
Heat distribution losses	thou. Gcal	2,681	%	21.0	5.4		Replacement of heat pipes (new technology)	59.8
Electricity cogeneration by boilers	mln kWh							15.8
Total for power and heat								**311.2**

Source: CENEf

9.6.3 Industry

The technical energy efficiency potential for industry was assessed (see Table 9.3) using 2013 data on industrial activities from the statistical yearbook[195] and data on specific energy use in Moldova (where available) or proxies for Russia.

The potential was estimated for 5 energy intensive homogenous products and 7 cross-cutting technologies applicable across all industrial sectors.

The technical energy efficiency potential in industry is assessed at 0.064 Mtoe, or at about 36% of the 0.178 Mtce used in industry. Importantly, the assessment of the technical potential as shown in the table relies on many assumptions, may only serve indicative purposes and needs improvement.

Table 9.3 Energy efficiency potential in industry (as of 2013)

Integrated technologies of goods, work, and services production	Units	Scale of economic activity	Units	Specific consumption in 2010	Practical minimum	Actual consumption abroad	Comments	Estimate of the technical potential, 1000 tce
Cast iron	10^3 t	0.9	kgce/t	664.5	355.0	461.0	Global practice	0.3
Electric steel	10^3 t	0.1	kgce/t	94.8	50.0	80.6	Global practice	0.004
Aluminium	10^3 t	0.01	kgce/t	1,845	1,599	1,763	Global practice	0.003
Meat and meat products	10^3 t	34	kgce/t	211	50		Chelyabinskaya Oblast	5.6
Bread and bakery	10^3 t	131	kgce/t	157	89		Tambovskaya Oblast	8.9
Efficient motors	10^6 units	0.02	kWh/ motor	9,956	8,507		Global practice	2.7
Variable speed drives	10^6 units	0.01	kWh/ drive	9,956	9,356		Global practice	0.5
Efficient oxygen production	10^6 m^3	0.5	kgce/ 1000 m^3	112	90		Global practice	0.01
Efficient industrial lighting	10^6 units	0.1	kWh/ lighting unit	247	160		Global practice	0.6
Efficient steam supply	10^3 tce	2	%	75%	100%		Global practice	0.4
Heat recovery	thou. Gcal	322	%	60%	90%		Global practice	13.2
Fuel savings in other industrial applications	10^3 tce	158	%	80%	100%		Global practice	31.6
Total for industry								**63.8**

Source: CENEf

9.6.4 Transport

Energy efficiency potential for transport was estimated for railroad transport, pipelines, air, automobiles and urban electric transport. Like in the other sectors, this effort is quite data demanding. Data on the transport service were taken from statistical yearbook, although not always information on transport service was available in required formats[196]. In some instances data presented in passenger-km and (or) freight-km were to be converted to brutto-freight-km to

[195] Anuarul Statistical Republicii Moldova. Statistical Yearbook of the Republic of Moldova. Chisinau. 2013.

[196] Road Vehicles Registered in the Republic Of Moldova (end-year). Statistical Bulletin (reference). Chisinau. 2004-2013. Transport Means Inventory (end-year). Statistical Bulletin (reference). Chisinau. 2004-2013.

fit statistically available data on specific energy use[197]. As to specific energy use, for many vehicles data in Moldova are available in formats similar to those used in Russia. For automobile transport Russian data on specific energy use were taken as proxies. This approach makes the estimate just preliminary and fit for further improvement, but it can serve a starting point for improving energy efficiency potential assessments in the transport sector in Moldova.

CENEf estimates the energy efficiency potential in transport at 0.35 Mtce in 2013 (versus 0.53 Mtce reported[198] consumption in this sector) (Table 9.4). The largest potential comes from switching to effective hybrid models in automobile transport.

Estimates of the energy efficiency potential in transport from local sources are scarce. Other sources do not report energy saving potential in this sector at all.

Table 9.4. Energy efficiency potential in transport (as of 2013)

Integrated technologies of goods, work, and services production	Units	Scale of economic activity	Units	Specific consumption in 2010	Practical minimum	Actual consumption abroad	Comments	Estimated technical potential, 1000 tce
Railroad electric traction	10^7tkm gross	13,600	kgce/10^4 tkm gross	12.1	10.0		Values for some Russian regions	28.6
Diesel locomotives	10^7 tkm gross	1,328	kgce/10^4 km gross	63.0	40.0		2020 target for Russia	71.9
Trolley-bus electric traction	10^6 tkm gross	32	kgce/10^3 km gross	7.9	5.9		Average for Russia	0.1
Gas pipeline transport	10^6 m^3km	10,508	kgce/10^6 m^3 km	28.2	25.0		2020 target for Russia	33.6
Shifting to hybrid light-duty vehicles	10^3 vehicles	183	tce/vehicles/ year	1.23	0.74		Global practice	89.8
Shifting to hybrid buses	10^3 buses	11	tce/buses/ year	6.5	3.91		Global practice	27.9
Shifting to hybrid heavy-duty vehicles	10^3 vehicles	30	tce/vehicles/ year	7.5	4.52		Global practice	91.6
Air transport	10^6 passenger -km	875	kgce/ passenger-km	60.3	54.27		Global practice	5.3
Total transport								**348.8**

Source: CENEf

9.6.5 Buildings

The buildings sector includes residential, public and commercial buildings. Industrial and agricultural buildings are not considered. While data on energy use[199] and living space[200] in the residential sector are available from the local statistics, information on public and commercial buildings and on their energy use is scarce and not reliable.

Based on the available data, residential energy use in the recent years stays at 0.9-1 Mtce depending on the weather. Total living space in 2013 amounted to 80.2 million m^2. Thus specific

[197] Such conversions were made based on corresponding data for Russia.
[198] Statistical Yearbook of the Republic Of Moldova. Chisinau. 2013.
[199] Energy Balance. Statistical Bulletin (reference). Chisinau. 2005-2013.
[200] Dwelling stock and equipment of dwelling stock (end-year). Statistical Bulletins (references). Chisinau. 2005-2013.

energy use is 24.6 kgce/m^2, or 200 kWh/m^2[201], assuming the entire buildings space is heated. Only 46.8% of the living space have access to district heat.

The energy efficiency potential is assessed assuming a very deep renovation of the existing buildings stock.

Data on other activities in the housing sector were estimated based on the national statistics, while data on specific energy use for current practices were taken similar to those for Russia. For example, only 39% of residents are provided with DHW from district heating systems. Due to a lower access to urban utility services, specific energy use indicators for Moldova can be lower, than those for Russia; however, no data are available to support this assumption.

For countries with a similar level of development the ratio of public and commercial buildings to the housing living space is about 1:4 to 1:5. For Moldova, the 1:4 ratio was used for further calculations. Thus public and commercial buildings space is estimated at about 20 million m^2.

Total energy saving potential in buildings is estimated at more than 2.2 Mtce with 2 Mtce in residential buildings and 0.2 Mtce in public and commercial buildings (Table 9.5). The potential in buildings may be smaller, if a large part of the living space (about 50%) is unheated in winter. In reality, of course, it does not stay unheated; it's just that people increasingly shift to individual heating using firewood, which is not taken into account by the official statistics on residential fuel use.

Table 9.5 Energy efficiency potential in the buildings sector (as of 2013)

Integrated technologies of goods, work, and services production	Units	Scale of economic activity	Units	Specific consumption in 2010	Practical minimum	Actual consumption abroad	Comments	Estimated technical potential, 1000 tce
Housing								
Renovation of centrally heated multifamily buildings	10^3m^2	30,155	kgce/m^2	24.6	7.1		60% of 2012 building codes requirements	528.3
Renovation of single-family buildings	10^3m^2	35,031	kgce/m^2	24.6	4.9		Passive houses	985.9
Renovation of hot water use	10^3 people	780	tce/person	0.207	0.073	0.12	Global practice	104.5
Replacement of appliances with top efficient models	10^3 people	3,560	tce/person	0.110	0.055	0.12	Global practice	195.8
Lighting renovation	10^3light fixtures	13,367	W	50.85	20.00	35.0	Global practice	28.0
Renovation of the cooking equipment	10^3 m^2	80,200	kgce/m^2	3.5	1.5	2.8	Global practice	160.4
Total residential buildings								**2,002.9**
Public and commercial buildings								
Renovation of centrally heated buildings	10^3 m^2	5,013	kgce/m^2	26.0	7.1	18.0	60% of 2012 building codes requirements	94.8
Renovation of hot water use	10^3 m^2	5,013	kgce/m^2	4.9	2.7	3.3	Global practice	11.0

[201] National Energy Efficiency Action Plan for 2013-2015. Approved by Government Decision No. 113 dated February 7, 2013.

Integrated technologies of goods, work, and services production	Units	Scale of economic activity	Units	Specific consumption in 2010	Practical minimum	Actual consumption abroad	Comments	Estimated technical potential, 1000 tce
Renovation of the cooking equipment	10^3 m^2	20,050	$kgce/m^2$	1.8	1.4	1.3	Global practice	7.5
Efficient space heating boilers	10^3 m^2	2.549	$kgce/m^2$	32.7	26.7	30.2	Global practice	0.02
Lighting renovation	10^3 m^2	20,050	kWh/m^2	32.7	16.4	27.8	Global practice	40.3
Procurement of efficient appliances	10^3 m^2	20,050	kWh/m^2	71.8	51.6	56.6	Global practice	49.7
Total public and commercial buildings								**203.3**
Total buildings								**2,206.2**

Source: CENEf

9.6.6 Other sectors

Not much information is available to assess the technical energy saving potential in agriculture. According to the IEA energy balances, about 60-80 10^3 tce are used annually in this sector, and more than half of that is liquid fuels for tractors and other machinery. Based on the Russian experience, specific energy use per tractor may be reduced by about 65%. There are other evidences that a similar reduction is possible in other agricultural activities through efficiency improvements. Therefore, the energy efficiency potential in this sector may be estimated at 49 Mtce.

Two other components of the energy efficiency potential were assessed, namely street lighting and adjustable speed drives at municipal water supply systems. All together, the contribution of "other sectors" to the energy efficiency potential was estimated at 55,000 tce (Table 9.6).

Table 9.6 Energy efficiency potential in "other sectors" (as of 2013)

Integrated technologies of goods, work, and services production	Units	Scale of economic activity	Units	Specific consumption in 2010	Practical minimum	Actual consumption abroad	Comments	Estimated technical potential, 1000 tce
Tractors fuel efficiency	10^3	3,704	kgce/ha	20	7		Global practice	49.1
Adjustable speed drives in water supply systems	mln kWh	136	%	100%	75%		Global practice	4.2
Street lighting renovation	mln kWh	39	%	100%	70%		Global practice	1.4
Total								**54.7**

Source: CENEf

9.6.7 Comparisons of total technical energy efficiency potential estimates

Total technical energy efficiency potential for Moldova as of 2013 is estimated at 2.98 Mtce of 3.37 Mtce TPES reported by IEA for 2013. Thus the potential is close to 88% of TPES. It may amount to about 50% of total energy use, if all energy resources used in the buildings and agricultural sectors are fully integrated in the energy balance. The potential in buildings may be smaller, if a large part of the living space stays unheated in winter.

This estimate assumes independent implementation of all technological measures without accounting for integral direct or indirect effects related to the reduction of potential in power and heat generation if end-use demand for power and heat is reduced through measures implemented in final energy use sectors.

Technical energy efficiency potential is basically concentrated in power and heat, industrial and residential buildings sectors. The question is, how much of it is economically attractive?

National Energy Efficiency Action Plan for 2013-2015 approved by Government Decision No. 113 dated February 7, 2013 sets a target to save 867 ktoe (1.24 Mtce) by 2016, including: 116 ktoe in power and heat; 87 ktoe in industry; 200 ktoe in transport; 75 ktoe in public buildings and services; and 390 ktoe in households. So a large part of the technical potential (42%) is to be implemented by 2016. This estimate is quite close to CENEf's assessment of the market energy efficiency potential (1.13 Mtce, see below).

9.6.8 Economic and market energy efficiency potentials

Economic and market potentials are assessed based on the comparison of energy prices and costs of saved energy. 2013 energy prices were used in the study (Table 9.7). Energy prices in Moldova are lower, than in many EC countries, but they are substantial against the incomes of economic agents. This is the reason why prices for households are lower, than for industrial consumers.

The cost of saved energy depends on the discount rate applied to annualize the capital costs. In this study, 6% discount rate was used to estimate the economic energy efficiency potential and 12% discount rate was used to estimate the market energy efficiency potential, which is close to the mortgage interest rate in Moldova. In addition, 20% discount rate was used to reflect stricter budget limitations and a higher cost of money for some energy consumers.

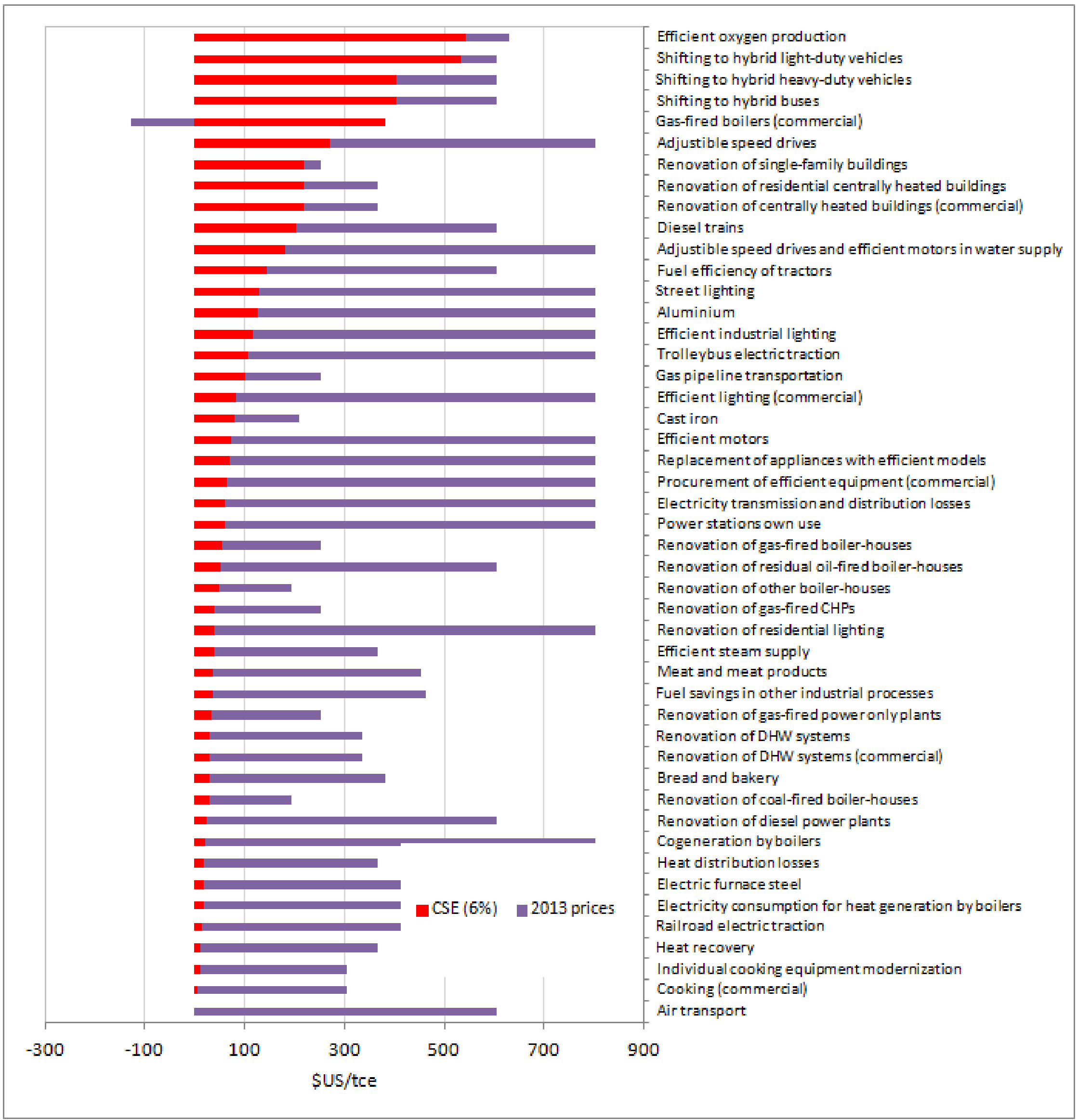
Table 9.7 Energy prices in Moldova in 2013

	Units	lei	US$	US$/tce
Non-residential users				
Electricity	kWh	1.76	0.099	802.6
District heat	Gcal	935.4	52.4	366.3
Natural gas	m^3	5,203.6	291.4	252,5
Coal	t	1,948.9	127.1	192,6
Fuel oil	t	11,407.1	638.8	446,7
Diesel fuel	t	15,423.2	863.7	604.0
Residential users				
Electricity	kWh	1.57	0.088	716.0
District heat	Gcal	764.0	46,7	326,4
Natural gas	1,000 m^3	4850	270	240
Gasoline	l	16.5	0.92	1,286.7
Exchange rate	Leu/dollar	17.86		

Sources: Prices in the Republic of Moldova. 2001-2010. Statistical collection. Chisinau 2011; Statistical Yearbook of the Republic Of Moldova. Chisinau. 2013.

Some measures, for which costs of saved energy appeared to be higher, than energy price, are economically not attractive for the society and are not included in the economic potential (Fig. 9.1). These include renovation of coal-fired power plants, renovation of multi- and single-family houses and commercial buildings, and some others. This is partly the result of lower energy prices for households, as well as incomplete account for benefits.

Figure 9.1 Economic energy efficiency potential for Moldova (for 6% discount rate as of 2013)



The figure shows the costs of saved energy (red) and the gap between energy price in a given activity and the cost of saved energy (blue). Due to the fact that different energy carriers are used in individual activities, the price is average weighted for all energy carriers used. All prices are presented in US$/tce. If the gap is negative, the measure is considered economically not attractive and is excluded from the economic potential assessment.

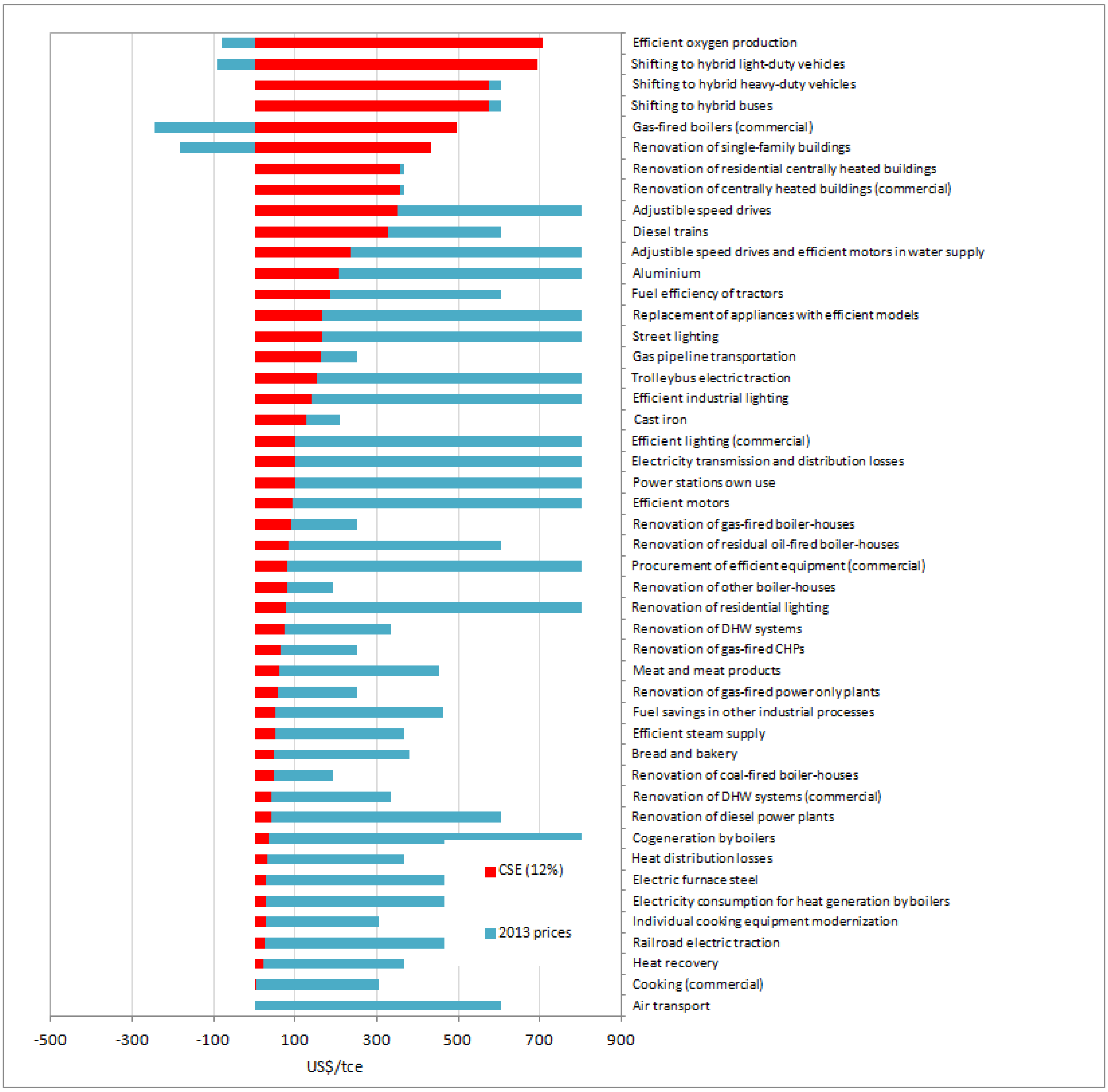
Sources: CENEf

When accounting for co-benefits in heat generation, subsidies for deep housing retrofits, and steady energy price growth for residents, the economic potential is equal to the technical potential (2.98 Mtce).

If private parameters in economic decision-making are better reflected in the analysis via higher costs of capital (12% and 20% discount rates), then market energy efficiency potential may be assessed. It is lower, than the economic potential, but not very much lower. For the two discount rates mentioned it stands at 1.91 and 1.13 Mtce correspondingly (Fig 9.2 and 9.3). Making long-term funding for energy efficiency measures more easily available would allow it to bridge the gap between the economic and market energy efficiency potentials.

Even with current energy prices and the 20% discount rate applied in investment decision-making, the market potential to improve energy efficiency in Moldova amounts to approximately 34% of primary energy use.

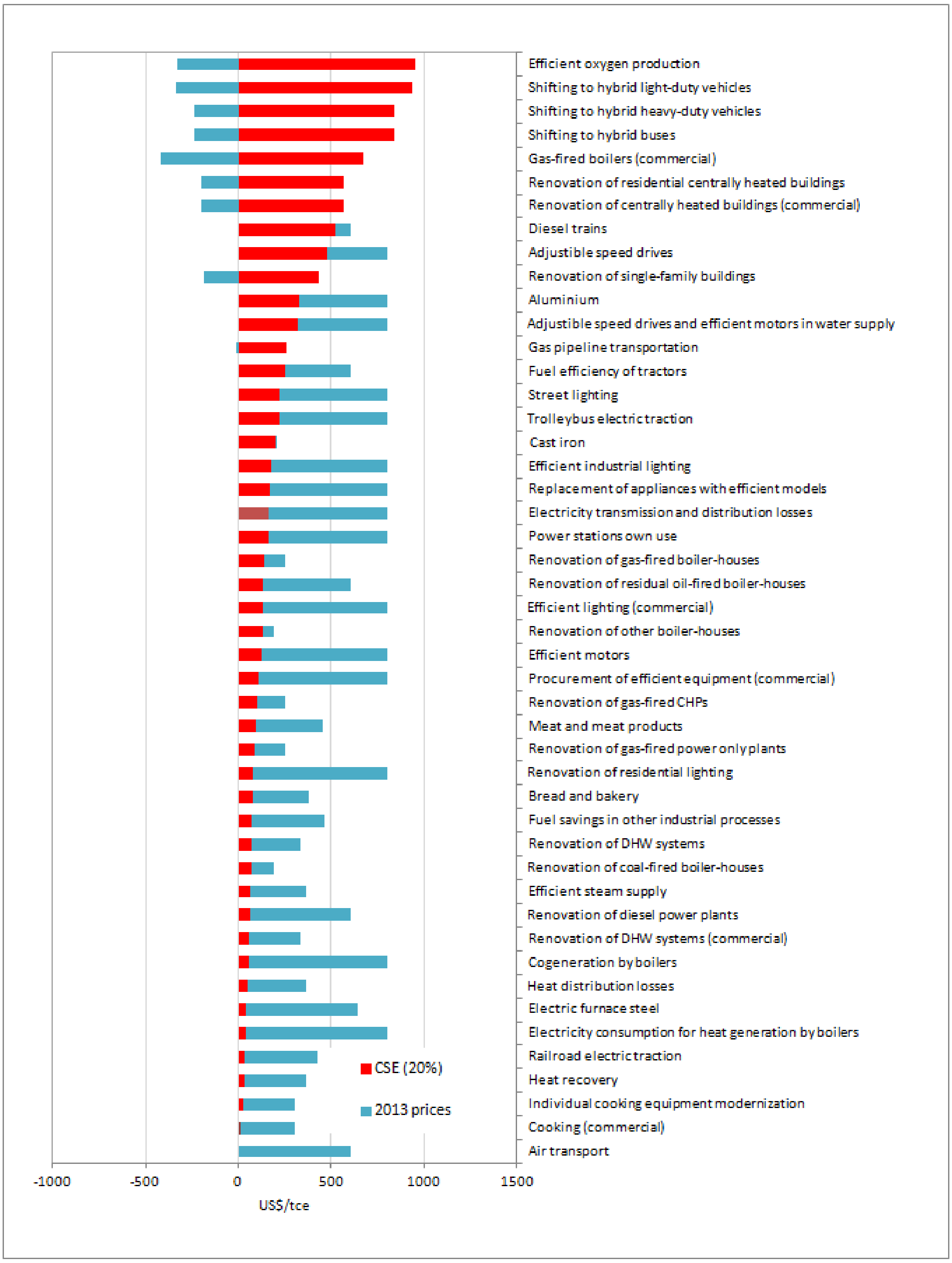
Figure 9.2 Market energy efficiency potential for Moldova (for 12% discount rate as of 2013)



The figure shows the costs of saved energy (red) and the gap between energy price in a given activity and the cost of saved energy (blue). Due to the fact that different energy carriers are used in individual activities, the price is average weighted for all energy carriers used. All prices are presented in US$/tce. If the gap is negative, the measure is considered economically not attractive and is excluded from the market potential assessment.

Sources: CENEf

Figure 9.3 Market energy efficiency potential for Moldova (for 20% discount rate as of 2013)



The figure shows the costs of saved energy (red) and the gap between energy price in a given activity and the cost of saved energy (blue). Due to the fact that different energy carriers are used in individual activities, the price is average weighted for all energy carriers used. All prices are presented in US$/tce. If the gap is negative, the measure is considered economically not attractive and is excluded from the market potential assessment.

Sources: CENEf

Section 10. Tajikistan

10.1 National level

Population in 2012: 8.01 mln; GDP PPP in 2012: 16.57 bln US$2005 (IEA[202]).

Evolution of GDP energy intensity. In 1990-2000, GDP MER energy intensity was growing. Yet in 2000-2012 it started declining on average by 7.1% per year. GDP PPP energy intensity was declining even faster: by 7.7% per year. IEA data on total primary energy supply (TPES) were used for both these indicators. IEA energy balances are widely used to illustrate energy use scale and structure in Tajikistan. However, the IEA balances are incomplete and miss fuel wood and dry dung energy use, while in the buildings sector alone these two energy carriers contribute at least 2 Mtce. This substantial amount needs to be added up to 3.2 Mtce TPES reported by IEA for 2012. In other words, the IEA's estimate of primary energy use in the country covers only about 60% of actual primary energy use. Inadequacy of the IEA energy data is a common problem for Central Asia countries. With traditional energy resources (that are currently ignored by IEA) taken into account, GDP energy intensity values would be higher.

Energy spending of all Tajikistan energy users was assessed at about 12% of GDP[203] -- obviously beyond the economic affordability limits. Energy resources are affordable when this ratio stays below 10-11%.[204] The burden of high energy costs provides incentives for energy efficiency improvements. Another strong driver is electricity shortage in winter time, which remains an acute issue in Tajikistan, which does not have lavish fossil fuel resources and has to rely on its hydropower facilities.[205]

Factors behind the evolution of GDP energy intensity: technology and structural shifts. With GDP growing at 7-9% per year, GDP energy intensity decline is mostly a result of structural changes in the economy, including reduced contribution to GDP of primary aluminium manufacturing (the major energy intensive industrial product in the country) along with other structural shifts. According to the World Bank, Tajikistan's 2011 GDP was dominated by services (60%), followed by industry (20%) and agriculture (20%).

Energy prices. In July 2014, electricity prices in Tajikistan were 15% up and now stand at 2.61 US cents/kWh for residential consumers (incl. VAT); 6.38 US cents/kWh for industrial and non-industrial enterprises; 2.53 US cents/kWh for the public sector, municipal utilities sector, electric vehicles and sports complexes; 0.45 US cents/kWh for vertical reclamation wells and drainage pumping stations; 4.64 US cents/kWh for electric boilers and power systems providing hot water and space heating to the public sector; and 15,67 US cents/ kWh for electric boilers and power systems providing hot water and space heating in the private sector. This was the third electricity price hike since 2010.

Energy efficiency legislation. A number of energy efficiency and energy saving regulatory acts have been enforced after 2002. The Law 'On Energy Saving' was adopted in 2002 and includes 24 articles. The law is rather general and short, just outlining the basics of the energy saving and energy efficiency policy in Tajikistan. The Law promotes the following mechanisms: federal expertise in energy saving; energy audits for enterprises; energy use metering; certification for

[202] http://www.iea.org/statistics.
[203] UNDP. 2011. Energy Efficiency Master Plan for Tajikistan. Energy Efficiency for Economic Development and Poverty Reduction .
[204] Bashmakov I. Three Laws of Energy Transitions // Energy Policy. – July 2007.
[205] D. Fields, A. Kochnakyan, G. Stuggins, J. Besant-Jones. Tajikistan's Winter Energy Crisis: Electricity Supply and Demand Alternatives. The World Bank. Europe and Central Asia Region. CAEWDP Multi-Donor Trust Fund. November, 2012; http://www.carecnet.org/programmes-and-activities/climate-change-and-sustainable-energy/energy-efficiency-in-buildings-in-tajikistan/?lang=en.

energy-using products, works and services; funding and support for federal energy efficiency programmes and R&D; promoting energy efficiency; penalties for inefficient use of energy resources. Albeit the Law specifies many of these mechanisms, more often than not additional government regulations are required to launch them. This law was repealed on September 19, 2013 and replaced by the "Law On Energy Saving and Energy Efficiency". This new law includes 32 articles and is quite close to the one adopted in the Russian Federation in 2009. The new law is still the same type, though it offers a few new mechanisms (labelling; energy passports) and requires funding for renewable energy. It also includes some new articles, including one on buildings. In many aspects, the 2013 law is supplementary to the one of 2002.

Number of energy efficiency regulatory acts. In addition to the law "On energy saving" dated 2002 and the new "Law on Energy Saving and Energy Efficiency" dated 19 September 2013, there are a few other energy saving and energy efficiency regulations. These include the "Law on Energy" dated 2000 and enforced in 2009 by the "Law on the Use of Renewable Energy"; the "Law on the Use of Nuclear Energy" dated 2004; the "Law on the Use of Renewable Energy" dated 2010; Presidential Decree No. 653 "On Additional Measures for Rational Energy Use and Energy Saving" dated 24 April, 2009.

A number of federal standards were adopted in 2014 in compliance with the "Law on Energy Saving and Energy Efficiency", including "Energy Passports for Industrial Energy Consumers"; "Energy Efficiency: a List of Indicators"; "Methods of Monitoring the Compliance with Energy Production Efficiency Requirements.- General requirements"; "Regulatory and Methodology Support - Basic provisions". Some of these acts work in concert with a number of laws that should be considered when addressing energy efficiency and energy saving issues, including environmental protection and licensing legislation, standardization and certification, rates and tax policy.

Government agencies with an energy efficiency policy mandate. The key government agencies responsible for the implementation of energy efficiency policy include: Ministry of Economic Development and Trade, Ministry of Energy and Industry, Ministry of Land Reclamation and Water Resources, Ministry of Transport, Agency for Construction and Architecture, local governments, housing authorities. The State Power Supervision Agency under the Ministry of Energy and Industry of the Republic of Tajikistan is the principal coordinator of energy efficiency in the country.

Basic administrative mechanisms to improve energy efficiency: energy metering requirements, labelling, mandatory energy audits, standards set for specific energy use, energy efficiency standards, building codes, energy data reporting, energy expertise, prohibition of inefficient devices turnover (incandescent lamps), penalties for inefficient use of energy resources.

Basic energy efficiency market mechanisms and economic incentive programmes: government procurement rules, soft loans, including microfinance, pricing and taxation policies.

Energy efficiency policy spending and financial sources. Albeit Tajikistan legislation suggests the development of energy efficiency programmes, only one has been adopted to date, namely the Programme of the Efficient Use of Hydropower Resources and Conservation for 2012-2016. The part of the programme budget secured for energy efficiency improvements includes the following measures:

- reduction of electricity distribution losses through the installation of electronic meters (US$ 83 million);
- development of centralized control and power metering system (US$ 21.6 million);
- construction of a new plant to produce 1.2 to 1.5 million energy saving lamps per year (US$ 1.5 million).

One source reports that the government does not finance energy efficiency measures; however, further in the text it claims that the government has financed the procurement of efficient bulbs by 241,000 low-income households[206].

Energy efficiency R&D spending. No data on energy efficiency research and development spending are available.

ESCO market. The legislation in force does not promote the ESCO mechanism in Tajikistan.

Water efficiency policy. With its huge hydropower resources, Tajikistan ranks the 8th among the countries worldwide. According to the Ministry of Economic Development and Trade, 98% of electricity supplied to the grid is produced by hydropower plants and only 2% by CHPs. The Programme of the Efficient Use of Hydropower Resources and Conservation for 2012-2016 was adopted in 2009.

International cooperation. Tajikistan works with the World Bank, EBRD, ADB, IDB, Energy Charter Secretariat, UNDP, USAID, Russian, Japanese and Chinese Governments; the Tajik - Norwegian Small-Scale Power Initiative conducted a number of surveys of existing small hydropower plants.

10.2 Heat and power generation and transmission

Power generation efficiency. According to the Ministry of Economic Development and Trade, 98% of the electricity supplied to the grid are produced by hydropower plants and only 2% by CHPs.

Power transmission and distribution losses. According to the Ministry of Economic Development and Trade, power transmission and distribution losses amounted to 14.1% in 2010. The goal is to bring them down to 10% by 2030. Other sources report 17.7% losses[207]. The electricity balance provided by the national statistics indicates the losses at 15.5%.[208]

Heat generation efficiency. District heat generation is very limited (218 thousand Gcal). Average efficiency of small capacity boilers stands at 70-84%.

Share of CHP in heat generation is 2%. The rest is generated by boiler-houses.

Heat distribution losses. They account for more than 20%, according to the Ministry of Economic Development and Trade.

Energy efficiency regulations in heat and power generation and distribution. No specific regulations have been found through legislation screening.

Government agencies with an energy efficiency policy mandate in heat and power generation and distribution. The Ministry of Economic Development. Policy issues related to power and heat supply are the responsibility of the Ministry of Energy and Industry. State Power Supervision Agency under the Ministry of Energy and Industry.

Basic administrative mechanisms to improve energy efficiency in heat and power generation and distribution: energy metering requirements, mandatory energy audits, specific energy use standards, energy efficiency standards, energy data reporting, energy expertise, penalties for inefficient use of energy resources.

Basic energy efficiency market mechanisms and economic incentive programmes: government procurement rules, soft loans, pricing and taxation policies.

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206 Energy Charter Secretariat. 2013. Energy efficiency in Tajikistan: in-depth review.
207 UNDP. 2011. Energy Efficiency Master Plan for Tajikistan. Energy Efficiency for Economic Development and Poverty Reduction.
208 Tajikistan in figures. 2013. Tashkent. 2013. Dushanbe. 2014.

Renewables development programmes. The Programme of Renewable Energy Use in 2007 – 2015 in Tajikistan enforced on February 2, 2007 by Government Resolution No. 41; the Law on Renewable Energy Use dated 2010. Renewable energy is a policy focus in Tajikistan. In 2010, the share of renewable energy in primary energy production was 90%. Hydropower is about the only renewable energy source in the country. There are plans and multiple projects under way to significantly expand the hydropower capacity in order to enhance domestic power supply and electricity exports to the neighbouring countries.

White Certificates market. No such programmes launched.

Heat and power generation and distribution: energy efficiency policy spending. No information on the costs of energy efficiency policy implementation is available.

10.3 Industry

Industrial energy intensity. According to UNIDO, energy intensity of the industrial sector declined by only 5% in 1990-2000 and further by 32% in 2008 (in tons of oil equivalent per US$1,000 of manufacturing value added)[209]. Industrial growth in 1995-2008 was driven mostly by structural shifts which were partly neutralized by technology upgrades (measured as energy use per value added in constant prices)[210]. Aluminium industry is responsible for the larger part of industrial energy consumption.

Energy intensity of basic industrial goods. A study accomplished for the World Bank Group provides data on specific energy use in aluminium industry. Aluminium smelting specific energy consumption in Tajikistan is 16.63 kWh/kg, whereas BAT consumption equals 10-11 kWh/kg.

Energy efficiency regulations in the industrial sector. The “Law on Energy Saving and Energy Efficiency” dated September 19, 2013, requires energy efficiency labelling for goods produced in Tajikistan or imported to Tajikistan, including process equipment for industrial plants.

Government agencies with an energy efficiency policy mandate in the industrial sector. Ministry of Energy and Industry, Ministry of Economic Development and Trade, State Power Supervision Agency under the Ministry of Energy and Industry.

Basic administrative mechanisms to improve energy efficiency in the industrial sector: energy metering requirements, labelling, mandatory energy audits, standards for specific energy use, energy efficiency standards, energy data reporting, energy expertise, penalties for inefficient use of energy resources.

Basic energy efficiency market mechanisms and economic incentive programmes: soft loans, pricing and taxation policies.

Long-term agreements. None.

Energy managers training programmes. No information available.

Industrial energy efficiency policy spending: No information available on the costs of industrial energy efficiency policies implementation.

10.4 Buildings

Specific energy consumption per m^2 of residential floor space (energy intensity in residential buildings). Some sources report that specific energy use per m^2 in multifamily buildings in Tajikistan is twice higher, than in Germany (however, no concrete values are

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[209] Industrial Development Report 2011. Industrial energy efficiency for sustainable wealth creation. Capturing environmental, economic and social dividends.
[210] Ibid.

provided[211]). Importantly, according to a survey, a large part of residential consumers use electric heating (33%) and fuel wood (44%) for space heating, while other households use mostly dry dung, coal, and natural gas[212]. There is practically no district heating in Tajikistan.

Specific energy consumption per m^2 of public floor space. While information on the energy consumption structure in public buildings is available, there are no data on specific energy use per unit of floor space. Based on the Russian experience, it should be very close to residential specific energy use, or to 240-300 kWh/m^2.

Specific energy consumption for space heating per m^2 of residential floor space per degree-day of heat supply season. No data available.

Specific hot water consumption per household with access to centralized DHW supply. No data available.

Share of consumers equipped with energy meters. The Law on Energy Saving and Energy Efficiency requires installation of meters, yet does not specify any deadlines. Presently, not many meters are installed.

Building codes requirements. MKS ChT 23-02-99 “Buildings Heat Transfer Resistance” is in force specifying energy efficiency requirements to new and retrofitted buildings.

Other administrative mechanisms to promote energy efficiency: energy metering requirements; energy efficiency standards and labelling for appliances, buildings certification by energy efficiency classes; mandatory energy audits, energy data reporting, energy expertise.

Government agencies with an energy efficiency policy mandate in the buildings sector. Ministry of Economic Development and Trade, Ministry of Land Reclamation and Water Resources, State Power Supervision Agency under the Ministry of Energy and Industry, Agency for Construction and Architecture, local governments.

Basic energy efficiency market mechanisms and economic incentive programmes in the buildings sector: government procurement rules, soft loans, pricing and taxation policies.

Buildings energy efficiency policy spending. No data available.

Information and educational programmes. In September 2011, the second International Forum on Energy Efficiency was held in Dushanbe by the Government of Tajikistan, the Economic Commission for Europe (UNECE) and the Economic and Social Commission for Asia and the Pacific (ESCAP). The forum was attended by representatives of 60 countries.

10.5 Transport

Specific energy consumption per unit of transport service. Presently, 85% of transport services are provided by automobile transport. About 80 to 85% of vehicles are dated (used well beyond their normal lifetimes) and very inefficient. Moreover, roads and related infrastructure is in a very poor shape.

Government agencies with an energy efficiency policy mandate in the transport sector. The main government agencies responsible for energy efficiency policy implementation are Ministry of Economic Development and Trade and Ministry of Transport.

Basic administrative mechanisms to improve energy efficiency in the transport sector: energy metering requirements, labelling, mandatory energy audits, standards for specific energy

[211] Usmonov Sh.Z. Construction Solutions for the Exterior Walls in the Process of Increasing the Width of Residential Buildings of Brownfield Construction in Seismic Hazardous and Dry Hot Conditions of Central Asia]. Vestnik MGSU [Proceedings of Moscow State University of Civil Engineering]. 2014, no. 2, pp. 57-64.
[212] Energy Charter Secretariat. 2013. Energy efficiency in Tajikistan: in-depth review.

use, energy efficiency standards, energy data reporting, energy expertise, penalties for inefficient use of energy resources.

Basic energy efficiency market mechanisms and economic incentive programmes in the transport sector: soft loans, pricing and taxation policies.

10.6 Technical energy efficiency potential for Tajikistan

10.6.1 Approach and data sources

Technical energy efficiency potential for Tajikistan was assessed based on the approaches described in the Inception Report. Four sets of data were used to estimate technical energy efficiency potential (Table 10.1). Data related to the economic activities were collected from national statistical sources (for 2010-2013), which are listed in corresponding sections. Data related to specific energy use in different applications were collected from official documents, programmes, presentations and publications. Where appropriate data were not available, proxies for countries with similar conditions were used. Assessment of the technical potential builds on the comparison of those energy efficiency indicators against specific energy consumption for BATs in the same sectors and subsectors. BATs data were collected from multiple international sources.

Table 10.1 Data collection technology and structure

Information required	Source of information	Methods of data collection
Data on economic activities	Statistical yearbooks	Collection of statistical data
Data on specific energy consumption in various sectors in Tajikistan	Official documents, publications, proxies for countries with similar conditions	Literature search
Data on specific energy consumption for best available technologies	Publications	Collection of data from publications on BATs
Energy prices	Statistical yearbooks	Collection of statistical data

Technical energy efficiency potential for Tajikistan was assessed by multiplying the 2012-2013 activity level by the gap between the country’s specific energy efficiency (if available) or proxy (where the country data were not available) and energy efficiency BAT parameters for the same activity category.

Assessment of the technical potential was structured by different sectors including: power and heat generation, transmission and distribution, industry, transport, buildings, agriculture, street lighting, water supply, etc. Estimates generated by this study were, where possible, compared with the local estimates of the energy efficiency potential for similar activities. Where the information was sufficient, reasons for mismatching, if any, were identified.

Based on these comparisons, technical potential estimate ranges were provided. Where reliable information for some energy use activities was not available, such activities were skipped from the potential evaluation study.

So as to identify the economic and market potentials, the costs of saved energy were compared to the 2013 or 2014 energy prices in order to see if an individual measure is economically viable.

Summary of energy efficiency potential estimation for Tajikistan:

- Power and heat 270 thou tce
- Industry 319 thou tce
- Transport 375.5 thou tce
- Residential buildings 2,785 thou tce
- Services 697 thou tce

- Other 113.7 thou tce
- **Total** **4.5 Mtce**

10.6.2 Power and heat

CENEf's assessment builds on the energy use and power and heat generation data available from statistical yearbooks, government programmes and legal acts, publications, and other sources, including internet resources. For some parameters such information was not available, and so they were assessed using proxies, including parameters for similar installations in Russia. Therefore, the estimates of the technical potential are by no means perfect. CENEf has taken any and all efforts to make them as reliable as possible, despite the tight work schedule that did not allow for too extensive data search.

Data related to power generation in 2013 were borrowed from statistical yearbook[213]. Total power production in 2013 amounted to 17,115 million kWh, including 17,071 million kWh by hydropower plants and only 44 million kWh by thermal plants. Heat generation in 2013 was limited to only 0.218 million Gcal. Power and heat losses were taken from statistical sources and company reports. High losses are reported for distribution networks.

Total technical energy efficiency improvement potential in the power and heat sector is assessed at 0.27 Mtce and it comes mostly from power stations' own use reduction and reduction of transmission and distribution losses.

Table 10.2 Energy efficiency potential in power and heat generation, transmission and distribution (as of 2012-2013)

Integrated technologies of goods, work, and services production	Units	Scale of economic activity	Units	Specific consumption in 2010	Practical minimum	Actual consumption abroad	Comments	Technical potential estimate, 1000 tce
Renovation of gas-fired power stations	mln kWh	44	gce/kWh	380	205	262	Equipment with 48% efficiency	8
Power stations' own use	mln kWh	17,115	gce/kWh	8.2%	4.0%	5.0%	Equipment with 48% efficiency	88
Electricity transmission and distribution losses	mln kWh	15,712	gce/kWh	15.4%	6.9%	7.0%	North America	164.3
Renovation of gas-fired boiler-houses	thou. Gcal	128	kgce/Gcal	191	151		Equipment with 95% efficiency	5.2
Electricity consumption for heat generation by boilers	thou. Gcal	128	kgce/Gcal	40	7	9	Finland	0.5
Heat distribution losses	thou. Gcal	128	kgce/Gcal	20.0%	5.4%		Finland	2.7
Cogeneration by boilers	thou. Gcal		kWh/Gcal				Where is possible	1.3
Total for power and heat								**270.0**

Source: CENEf

[213] Tajikistan in figures. 2013. Tashkent. 2013. Dushanbe. 2014

10.6.3 Industry

Technical energy efficiency potential for industry was assessed (see Table 10.3) using 2012-2013 data on industrial activities from the statistical yearbook[214]. Data on specific energy use in Tajikistan are available only for aluminium production[215]. TALKO, local aluminium company, dominates in industrial electricity use with a share above 80%. In 2011, this company alone used 5,487 million kWh of electricity mostly for electrolyse and 46 million m^3 of natural gas for baked anodes production. Specific energy use for aluminium production was estimated at 16,630 kWh/t, which is well beyond BAT. Specific energy use in baked anodes production is also much beyond the BAT value. In 2013, 412 thousand tons of primary aluminum and 270 thousand tons of baked anodes were produced[216].

Table 10.3 Energy efficiency potential in industry (as of 2012-2013)

Integrated technologies of goods, work, and services production	Units	Scale of economic activity	Units	Specific consumption in 2010	Practical minimum	Actual consumption abroad	Comments	Estimated technical potential, 1000 tce
Petroleum refinery	10^3 t	15	kgce/t	87	53.9	75.1	Global practice	0.5
Crude oil production	10^3 t	27	kWh/t	130	40.0		Global practice	0.3
Natural gas production	10^6 m^3	4	kgce/ 1000 m^3	8.7	5.9		Expert estimate	0.0
Coal production	10^3t	505	kgce/t	14.0	3.0		Global practice	5.6
Aluminium production	10^3 t	412	kgce/t	2,045	1,599	1,763	Global practice	183.8
Baked anodes production	10^3 t	270	kgce/t	276	161		Global practice	31.1
Cement production	10^3 t	384	kgce/t	24	11	13	Global practice	5.0
Clinker production	10^3 t	346	kgce/t	200	99	145	Global practice	35.0
Meat and meat products	10^3 t	27	kgce/t	211	50		Chelyabinskaya Oblast	4.4
Efficient motors	10^6 units	0.12	kWh/motor	9,956	8,507		Global practice	21.4
Variable speed drives	10^6 units	0.05	kWh/drive	9,956	9,356		Global practice	4.0
Efficient compressed air systems	10^6 m^3	7.6	kgce/ 10^3 m^3	18	7		Global practice	0.1
Fuel savings in other industrial applications	10^3 tce	140	%	80%	100%		Global practice	28.0
Total for industry								**319.0**

Source: CENEf

For other products, no data on specific energy use are available, and so proxies from Kazakhstan or Russia were used. The potential was estimated for 9 energy intensive homogenous products and for 4 cross-cutting technologies applicable across all industrial sectors.

The technical energy efficiency potential in industry is assessed at 0.32 Mtoe. It comes mostly from aluminium, anodes and cement production. This is just a crude assessment of the potential, which needs to be explored in more detail.

[214] Tajikistan in figures. 2013. Tashkent. 2013. Dushanbe. 2014.
[215] Energy Audit – TALCO Aluminium Company, Tadjikistan. Final Report. 26.11.2012. Asbjørn Solheim, Raffaele Ragazzon, Dmitry Pedan, Pavel Kulbachny, Anders Sveinsen, Evgeny Chernov, Sergey Fashchevsky, Timur Usmanov. For The World Bank Group.
[216] http://www.tajik-gateway.org/wp/?page_id=24422.

Energy Charter estimates the energy efficiency potential in the industrial sector at 25-30%.[217] Using energy consumption data from the Energy Charter study, it amounts to 0.19-0.23 Mtoe, which is well below CENEf's estimate. A WB report estimates potential savings for TALKO alone at 0.17 Mtce[218].

10.6.4 Transport

Energy efficiency potential for transport was estimated for railroad transport, air, automobiles, and urban electric transport. Like in the other sectors, this effort is quite data demanding. Because not all required information was available from the local sources, proxies were widely used. Data on the transport service were taken from statistical yearbook[219], although not always relevant information was available in required formats. Data on cars were estimated based on the national statistics on private car saturation per 1,000 residents. Data on the truck and bus fleet were taken from a WHO publication[220].

In some instances, data presented in passenger-km and (or) freight-km were to be converted to brutto-freight-km to fit available data on specific energy use[221]. As to specific energy use, for many vehicles data in Tajikistan are available in formats other than those used in Russia. For automobile transport Russian data on specific energy use were taken as proxies. This approach makes the estimate just preliminary and fit for further improvement, but it can serve a starting point for improving energy efficiency potential assessments in the transport sector.

CENEf estimates the energy efficiency potential in transport at 0.375 Mtce in 2013 (Table 10.4).

Table 10.4 Energy efficiency potential in transport (as of 2011-2013)

Integrated technologies of goods, work, and services production	Units	Scale of economic activity	Units	Specific consumption in 2010	Practical minimum	Actual consumption abroad	Comments	Estimated technical potential, 1000 tce
Railroad electric traction	10^7 tkm gross	237	kgce/10^4 tkm gross	12.0	10.0		Values for some Russian regions	0.5
Diesel locomotives	10^7 tkm gross	32	kgce/10^4km gross	62.2	40.0		Task set for Russia for 2020	0.7
Trolley-bus electric traction	10^6 tkm gross	50.0	kgce/10^3 km gross	7.9	5.9		Average for Russia	0.1
Eco-driving	10^3tce	392	kgce/10^6 m^3km	100%	95%		Global practice	19.6
Shifting to hybrid light-duty vehicles	10^3 vehicles	377	tce/vehicles/ year	1.23	0.74		Global practice	185.6
Shifting to hybrid buses	10^3 buses	15	tce/buses/year	6.5	3.91		Global practice	39.3
Shifting to hybrid heavy-duty vehicles	10^3 vehicles	38	tce/vehicles/ year	7.5	4.52		Global practice	114.6
Air transport	10^6 passenger-km	2,500	kgce/ passenger-km	60.3	54.27		Global practice	15.1
Total transport								**375.5**

Source: CENEf

[217] Energy Charter Secretariat. 2013. Energy efficiency in Tajikistan: in-depth review.
[218] Energy Audit – TALCO Aluminium Company, Tadjikistan. Final Report. 26.11.2012. Asbjørn Solheim, Raffaele Ragazzon, Dmitry Pedan, Pavel Kulbachny, Anders Sveinsen, Evgeny Chernov, Sergey Fashchevsky, Timur Usmanov. For The World Bank Group.
[219] Tajikistan in figures. 2013. Tashkent. 2013. Dushanbe. 2014.
[220] http://www.who.int/violance%20injury%20prevention/road%20safety%20status/2013/country%20profiles/.
[221] Such conversions were made based on corresponding data for Russia.

IEA reports only 0.16 Mtce energy consumption by all types of transport[222]. However, this is very unlikely, even if all this fuel were used by automobiles alone, given nearly 400 thousand vehicle fleet. It means that average annual fuel consumption per vehicle is just 0.4 tce, or 0.28 toe, or 370 litres. With that much fuel an average vehicle (car, bus, or truck) can travel only for 3,700 km per year at the most, which is too little. So, like for many other sectors, IEA transport energy use data are not reliable.

The largest potential comes from switching to effective hybrid models in automobile transport. There are no local estimates of the energy efficiency potential in transport.

10.6.5 Buildings

The buildings sector includes residential, public and commercial buildings. Industrial and agricultural buildings are not considered. While the buildings sector is a large energy user, actual energy consumption is uncertain. IEA reports only 327,000 tce energy consumption for this sector; other sources report 443,000 tce of residential electricity consumption alone[223]. With 86.7 million m^2 living space specific energy use will be equal to only 3.8 kgce/m^2 (30.6 kWh/m^2), which is unreasonably low. IEA takes into account only electricity use in buildings. In practice, according to a survey conducted by the Agency on Statistics under the President of the Tadjikistan Republic, 32% of households rely on electricity and 44% on fuel wood for space heating, while only 2% use natural gas, 12% rely on coal, and 10% on dry dung for the same purpose. Less than 1% of residential consumers have access to district heat[224]. National statistics report that only 2.3% of households are connected to pipeline gas, 27.8% are provided with LPG. For space heating 74.5% of households rely on traditional stoves and ovens, 6.7% on local boilers, 17.7% on electricity, and only 0.9% on district heat. In rural areas, firewood, coal and dry dung dominate in space heating.

According to a survey on household energy consumption that included 1.1 million households across the country, about 50% of residential electricity consumption is used for space heating and another 25% for water heating[225]. Therefore, electricity use for space heating may be assessed at 164,000 tce. With an account of inefficient space heating systems (stoves and boilers), poor windows and poor energy performance of the buildings envelopes (lack of insulation), specific energy use for space heating should be at least 25 to 27 kgce/m^2 (203 to 220 kWh/m^2). In multifamily buildings in Dushanbe, where electricity is used for space heating, specific energy use was assessed close to 140 kWh/m^2/year (17 kgce/m^2)[226] – with underconsumption during winter peaks. For single-family houses with less efficient space heating systems it should be much higher, close to 220-244 kWh/m^2/year (27 to 30 kgce/m^2). With 86.7 million m^2 living space this brings the estimate of residential energy use for space heating to 2.17-2.34 Mtce, and total residential energy use close to 3-3.3 Mtce, or 10 times what is reported in the IEA energy balances. This estimate seems reasonable, given that the efficiency of fuel use in space heating is much lower compared to electricity. In other words, IEA substantially underestimates energy use in the residential sector. The same goes for commercial and public buildings and for the agricultural sector.

The table below presents a simplified version of the technical energy efficiency potential assessment. Total energy saving potential in buildings is estimated at more than 3.8 Mtce (Table 10.5).

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[222] IEA. Energy balances for non-OECD countries. 2013.

[223] National case study of energy production and consumption sector in the Republic of Tajikistan “Promotion of investments into energy efficiency to mitigate climate change impact and ensure sustainable development”.

[224] Energy Charter Secretariat. 2013. Energy efficiency in Tajikistan: in-depth review.

[225] http://www.unece.org/fileadmin/DAM/energy/se/pdfs/gee21/projects/others/Tajikistan.pdf.

[226] The USAID “Improving energy efficiency in residential buildings in Dushanbe” Project. Analysis of energy consumption in the multi-apartment residential stock of Dushanbe and assessment of potential for energy efficiency. 2012.

Table 10.5 Energy efficiency potential in the buildings sector (as of 2011-2013)

Integrated technologies of goods, work, and services production	Units	Scale of economic activity	Units	Specific consumption in 2010	Practical minimum	Actual consumption abroad	Comments	Estimated technical potential, 1000 tce
Housing								
Renovation of centrally heated multifamily buildings	$10^3 m^2$	869	kgce/m^2	22.00	7.1		60% of 2012 building codes requirements	13.0
Renovation of single-family buildings	$10^3 m^2$	86,009	kgce/m^2	27.00	4.9		Passive houses	1,900.8
Renovation of domestic hot water use	10^3 people	1,754	tce/ person	0.207	0.073	0.12	Global practice	235.2
Replacement of appliances with top efficient models	10^3 people	8,000	tce/ person	0.110	0.055	0.123	Global practice	440.0
Lighting renovation	10^3light fixtures	11,000	W	50.85	20.00	35.00	Global practice	23.0
Renovation of the cooking equipment	$10^3 m^2$	86,877	kgce/m^2	3.50	1.50	2.80	Global practice	173.8
Total residential buildings								**2,785.8**
Public and commercial buildings								
Renovation of centrally heated buildings	$10^3 m^2$	212	kgce/m^2	25.0	7.1	18.0	60% of 2012 building codes requirements	3.8
Renovation of domestic hot water use	$10^3 m^2$	212	kgce/m^2	4.90	2.7	3.3	Global practice	0.5
Renovation of the cooking equipment	$10^3 m^2$	21,200	kgce/m^2	1.8	1.4	1.3	Global practice	7.9
Efficient space heating boilers	$10^3 m^2$	21,200	kgce/m^2	32.7	4.9	30.2	Global practice	589.4
Lighting renovation	$10^3 m^2$	21,200	kWh/m^2	32.7	16.4	27.8	Global practice	42.6
Procurement of efficient appliances	$10^3 m^2$	21,200	kWh/m^2	71.8	51.6	56.6	Global practice	52.6
Total public and commercial buildings								**696.7**
Total buildings								**3,482.5**

Source: CENEf

10.6.6 Other sectors

Not much information is available to assess the technical energy saving potential in agriculture. Based on the Russian experience, specific energy use per tractor may be reduced by about 65%. Electricity is used substantially for irrigation. But not much information is available to estimate how much can be saved through better water management and more efficient water pumping.

Two other components of the energy efficiency potential were assessed, namely street lighting and variable speed drives at municipal water supply systems. All together, contribution of "other sectors" to the energy efficiency potential was estimated at 0.1 Mtce (Table 10.6).

Table 10.6 Energy efficiency potential in "other sectors" (as of 2011-2013)

Integrated technologies of goods, work, and services production	Units	Scale of economic activity	Units	Specific consumption in 2010	Practical minimum	Actual consumption abroad	Comments	Estimated technical potential, 1000 tce
Tractors fuel efficiency	10^3units	7,613	kgce/ha	20	7		Global practice	100.8
Adjustable speed drives in water supply systems	mln kWh	300	%	100%	75%		Global practice	9.2
Street lighting renovation	mln kWh	100	%	100%	70%		Global practice	3.7
Total								**113.7**

Source: CENEf

10.6.7 Comparisons of total technical energy efficiency potential estimates

Total technical energy efficiency potential for Tajikistan as of 2013 can be estimated at 4.5 Mtce (comparing to 8.2-9.0 Mtce of TPES, as estimated by CENEf). This estimate builds on the assumption that all process measures will be implemented independently, without accounting for integral direct or indirect effects related to the reduction of potential in the power and heat generation, if end-use demand for power and heat is reduced through measures implemented in final energy use sectors.

IEA reports TPES at only 3.2 Mtce for 2012.[227] As shown above, it underestimates the scale of energy use in about all end-use sectors. Significant improvements to the energy statistics are needed for more reliable estimates of both energy use and technical energy efficiency potential.

There are no alternative estimates of the comprehensive technical energy efficiency potential, even in publications that have sections titled "Energy efficiency potential". In some publications it is roughly assessed at 30 to 40%.[228] Poor quality and incomplete national energy balances prevent many from going for such exercises. In some cases, experts point out that energy use in rural buildings can be halved, but non-commercial energy savings are not accounted for in the energy balance[229].

Technical energy efficiency potential is basically concentrated in buildings, transport and industry. The question is, how much of it is economically attractive?

10.6.8 Economic and market energy efficiency potentials

Economic and market potentials are assessed based on the comparison of energy prices and costs of saved energy. 2014 energy prices were used in the study where possible. Data on energy prices in Tajikistan are hard to find. Given large contributions from coal and fuel wood, prices for residential users were estimated based on some publications for individual regions with no data on average prices available from statistics. Therefore, it is hard to make judgements as to how representative those numbers are.

[227] http://www.iea.org/statistics/statisticssearch/report/?country=TAJIKISTAN&product=balances&year=2012.
[228] K. Olimbekov. National case study of energy production and consumption sector in the Republic of Tajikistan "Promotion of investments into energy efficiency to mitigate climate change impact and ensure sustainable development".
[229] V. Bukarika, Z. Morvai, S. Robik, F. Shokhimardonov. Energy Efficiency Master Plan for Tajikistan. Energy Efficiency for Economic Development and Poverty Reduction. Dushanbe. 2011.

Electricity prices in Tajikistan for residential customers are 2.61 US cents/kWh, and for non-residential users they differ by sectors: 6.38 US cents/kWh for industrial and non-industrial enterprises, 2.53 US cents/kWh for the public sector, municipal utilities sector, electric vehicles and sports complexes, 0.45 US cents/kWh for vertical reclamation wells and drainage pumping stations, 4.64 US cents/kWh for electric boilers and power systems that provide hot water and space heating to the public sector, and 15,67 US cents/kWh for electric boilers and power systems that provide hot water and space heating to the private sector. In summer time, when the electricity sector dominated by hydropower facilities faces excess generation, the government subsidizes seasonal rates (0.004 US$/kWh April through September) for export-oriented industries -- aluminum and cotton production.

Table 10.7 Energy prices in Tajikistan in 2014

	Units	Somoni	US$	US$/tce
Non-residential users				
Electricity	kWh	2.16 to 12.65	0.0045 to 0.0638	365.8 to 518.6
Natural gas	10^3 m^3	1,150 to 1,356	237 to 280.0	206 to 243
Coal	t	150 to 200	30 to 40	50 to 66
Gasoline	t	6,842	1,290	865
Diesel fuel	t	5,555	1,046	712
Residential users				
Electricity	kWh	12.65	0.026	211.4
Coal	t	375 to 1,000	77 to 206	115 to 306
Natural gas	10^3m^3	1,356	280	243
Gasoline	l	5.2	0.98	865
LPG	l	3.8	0.78	867
Fuel wood	t	2,000	446	1,715
Exchange rate	sum/dollar	4.846 to 5.307		

Sources: Tajikistan: in-depth energy efficiency review. Energy Charter Secretariat. 2013 (In Russian); http://news.tj/ru/news/antimonopolnaya-sluzhba-tseny-na-benzin-v-tadzhikistane-budut-prodolzhat-padat; http://rus.ozodi.org/content/article/25427743.html; http://rus.ozodi.org/ content/article/26680564.html; http://ru.globalpetrolprices.com/Tajikistan/diesel_prices.

Energy prices in Tajikistan are lower, than in many EC countries, but they are substantial against the incomes of economic agents. The share of income spent to pay the energy bills is a more important driver behind rational energy use, than energy prices[230]. In 2013, statistics reports the share of housing and municipal utility services spending equal to 5.4% of residential expenditures (not accounting for incomes and time spent on wood and dry dung collection[231]). If fuel wood, dry dung and coal are taken into account, the share of housing and municipal utility services will more than double. These energy resources are quite costly (Table 10.7).

In order to maintain the affordability of minimal energy services and to mitigate energy poverty, in addition to cross-subsidies 4.2 million somoni were allocated by the government in 2011 to help 133,360 low-income families pay their electricity bills. For households (with an account of the energy content) electricity is a much less expensive energy carrier, than fuel wood.

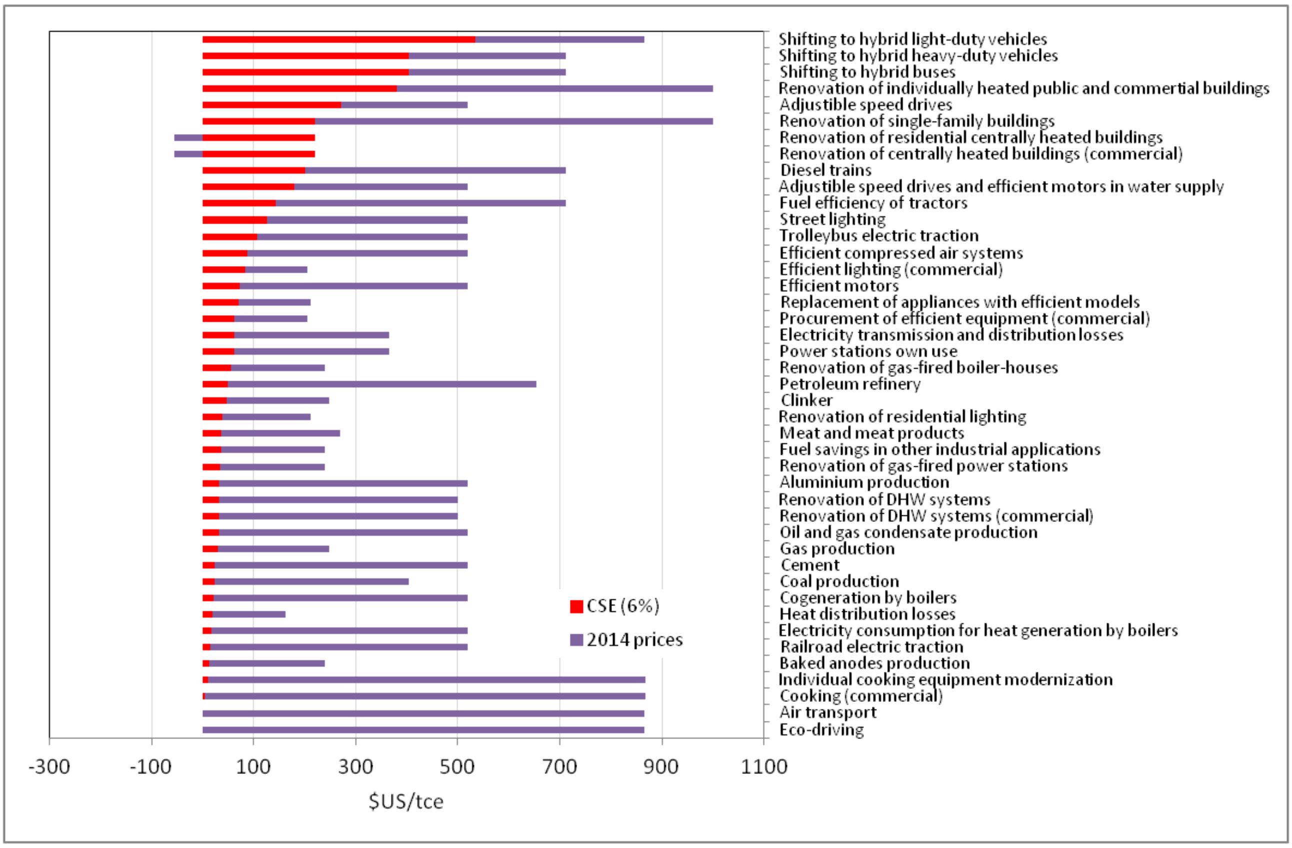
The economic energy saving potential was estimated based on the incremental costs analysis and using 2014 energy prices. Economically attractive solutions are indicated by the cost of saved energy being lower, than the energy price. The cost of saved energy depends on the discount rate

[230] I. Bashmakov. Three Laws of Energy Transitions//Energy Policy. – July 2007. – P. 3583-3594; Bashmakov I.A. Ability and willingness of residential consumers to pay their housing and municipal utility bills // Voprosy ekonomiki (Issues of Economy). – 2004. No. 4.
[231] http://www.stat.tj/ru/database/real-sector/.

applied to annualize capital costs. In this study, a 6% discount rate was used to estimate the economic energy efficiency potential and a 12% discount rate was used to estimate the market energy efficiency potential, which is close to the interest rate for mortgages in Tajikistan. In addition, a 20% discount rate was used to account for stricter budget limitations and a higher cost of money for some energy consumers.

The economic energy saving potential equals 4.5 Mtce. Some measures, for which costs of saved energy appeared to be higher, than the energy price, are economically not attractive for the society and are not included in the economic potential (Fig. 10.1). Those include renovation of multi- and single-family houses and commercial buildings. This is partly the result of low energy prices for households, as well as incomplete accounting for benefits. Accounting for co-benefits, subsidies for deep housing retrofits, and steady energy price growth for residents may scale up the economic potential closer to the technical one.

Figure 10.1. Economic energy efficiency potential for Tajikistan (for 6% discount rate as of 2013)



The figure shows the costs of saved energy (red) and the gap between energy price in a given activity and the cost of saved energy (blue). Due to the fact that different energy carriers are used in individual activities, the price is average weighted for all energy carriers used. All prices are presented in US$/tce. If the gap is negative, the measure is considered economically not attractive and is excluded from the economic potential assessment.

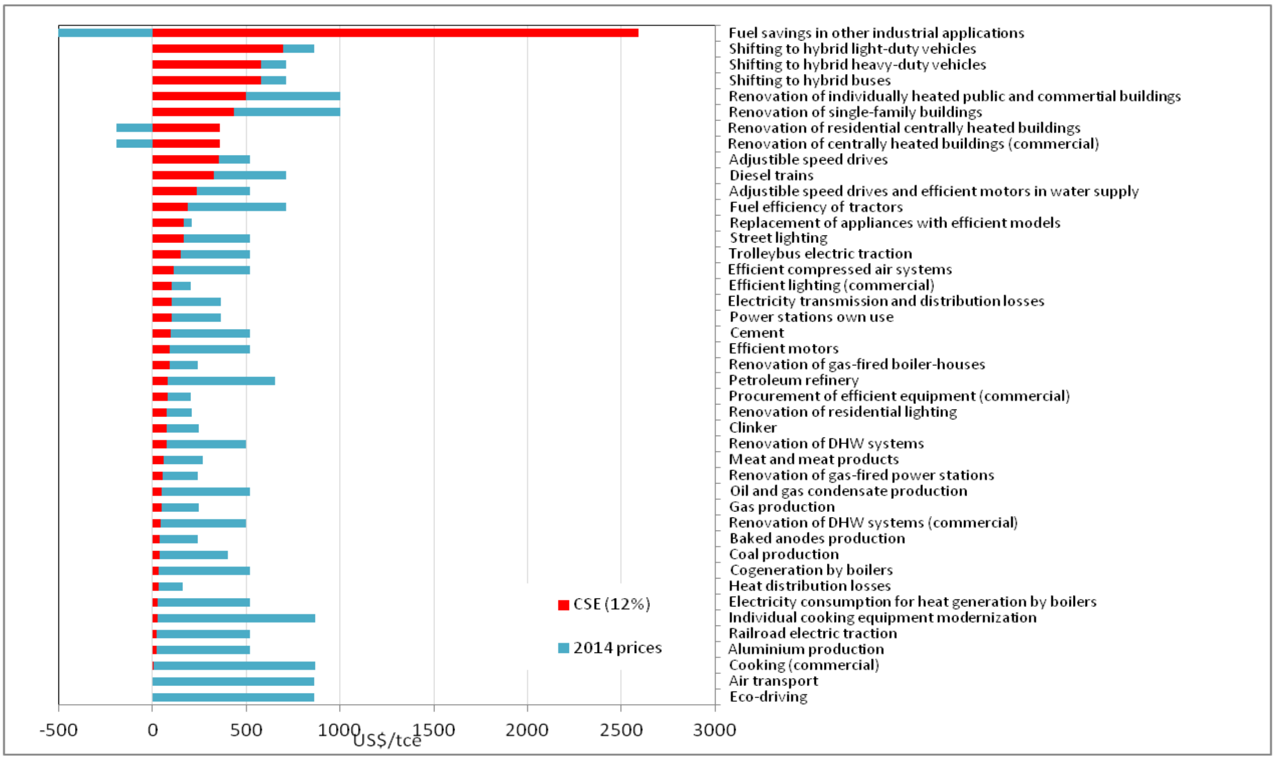
Sources: CENEf

If private parameters in economic decision-making are better reflected in the analysis via higher costs of capital (12% and 20% discount rates), then market energy efficiency potential may be assessed. It declines very slightly when a 12% discount rate is applied, and shrinks to 4.2 Mtce with a 20% discount rate. Therefore, the market potential is not very sensitive to the discount rate. This conclusion to a much larger degree relies on energy price assessments for fuel wood and coal for residential use. One problem related to the assessment of the energy efficiency potential involves resource consumption below sanitary needs by many low-income households.

Therefore, energy efficiency improvements would rather make up for the shortage of comfort, than reduce the costs of providing energy services.

Lack of upfront capital for low-income households increases the real discount much above 20%: to 33-50% and more. Then assistance (subsidies) in implementing energy efficient solutions may be a more promising policy tool, than subsidizing electricity consumption.

Figure 10.2. Market energy efficiency potential for Tajikistan (for 12% discount rate as of 2013)



The figure shows the costs of saved energy (red) and the gap between energy price in a given activity and the cost of saved energy (blue). Due to the fact that different energy carriers are used in separate activities, the price is average weighted for all energy carriers used. All prices are presented in US$/tce. If the gap is negative, the measure is considered economically not attractive and is excluded from the market potential assessment.

Sources: CENEf

The World Bank team has accomplished a large project at TALKO (US$ 87 million) with less than 2 years payback[232]. The USAID study concluded:

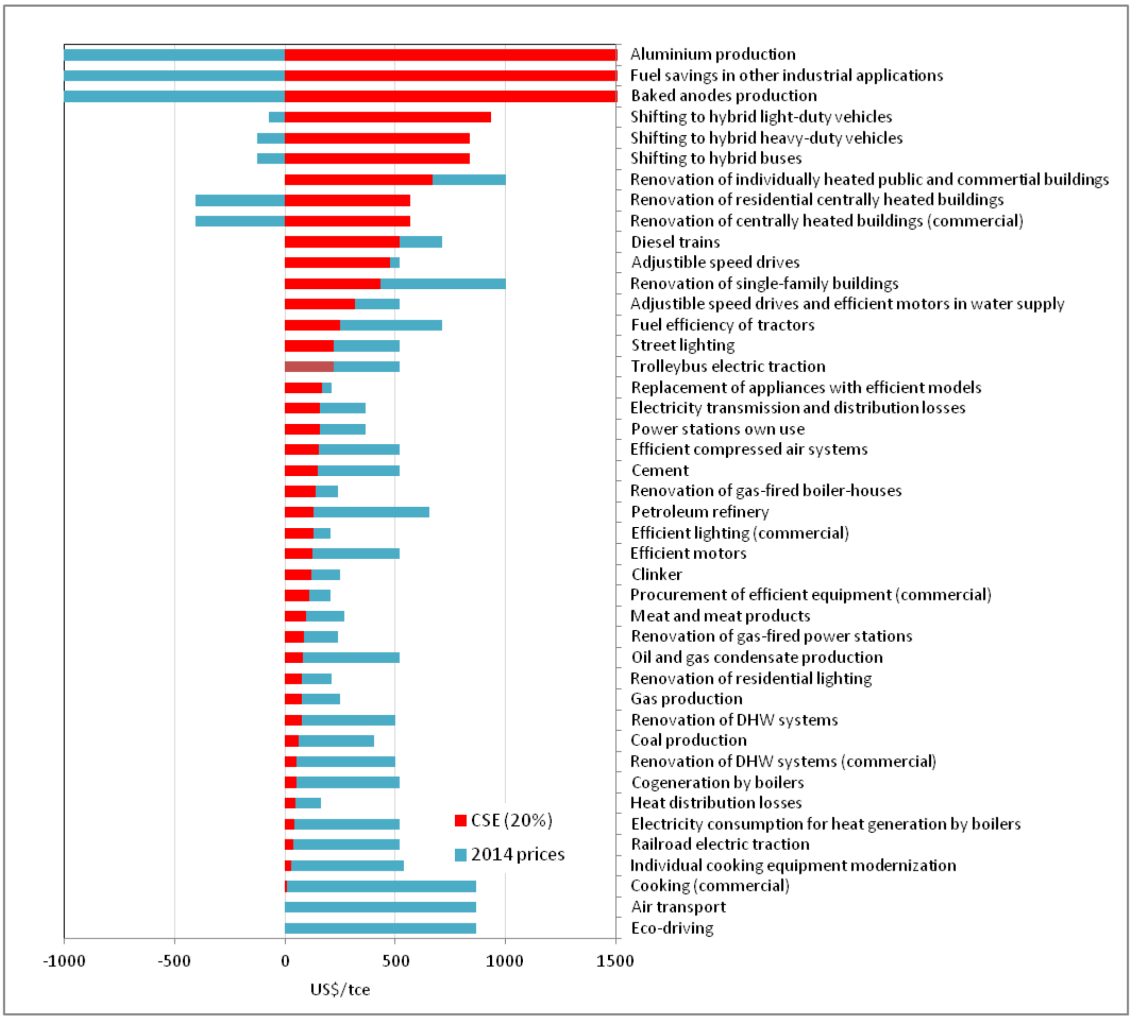
> "*The assessment of energy efficiency measures conducted under the project revealed that building insulation can significantly reduce the consumption of electricity by residents for heating needs and thus reduce their monthly bills for electric energy. However, financial calculations indicated that the measures on complex thermal insulation of buildings are not financially attractive due to relatively low energy tariffs. In other words, electric energy savings in monetary terms does not allow recovering capital costs of complex building insulation, at least within 50-year time interval … Furthermore, economic analysis of possible impact from energy efficiency measures for residential buildings in Tajikistan reveals more benefits than can be covered by financial analysis. As it was noted earlier, currently subsidized electricity tariffs do not achieve a level which allows sustainable development of the power sector, and according to some sources (ADB 2006)*

[232] Energy Audit – TALCO Aluminium Company, Tadjikistan. Final Report. 26.11.2012. Asbjørn Solheim, Raffaele Ragazzon, Dmitry Pedan, Pavel Kulbachny, Anders Sveinsen, Evgeny Chernov, Sergey Fashchevsky, Timur Usmanov. For The World Bank Group.

real cost of power electricity is around 2.7 and 4.5 cents per kWh in summer and winter season respectively. Upon using these estimated values, the payback period (undiscounted) of measures on complete thermal modernization of buildings reduces to 25-28 years"[233].

There are no studies accounting for real costs of traditional space heating and cooking (including the costs of fuel, labor and time needed to collect and deliver these resources, indoor pollution costs, etc.) to compare with simple measures to improve buildings insulation like weatherstripping or low-e coating for windows. Using some of the techniques to improve buildings insulation, which are closer to traditional building construction, makes the economics of energy efficiency improvements more favourable[234].

Figure 10.3 Market energy efficiency potential for Tajikistan (for 20% discount rate as of 2013)



The figure shows the costs of saved energy (red) and the gap between energy price in a given activity and the cost of saved energy (blue). Due to the fact that different energy carriers are used in individual activities, the price is average weighted for all energy carriers used. All prices are presented in US$/tce. If the gap is negative, the measure is considered economically not attractive and is excluded from the market potential assessment.

Sources: CENEf

[233] The USAID "Improving energy efficiency in residential buildings in Dushanbe" Project. Analysis of energy consumption in the multi-apartment residential stock of Dushanbe and assessment of potential for energy efficiency. 2012.

[234] Energy efficient building methods for Tajikistan. Architect R. Jacobsen. Gaia architects. Jan. 2009.

Section 11. Turkmenistan

11.1 National level

Population in 2012: 5.17 mln; GDP PPP in 2012: 57.45 bln US$2005 (IEA[235]).

Evolution of GDP energy intensity. In 1990-2000, GDP MER energy intensity increased. In 2000-2012, it was declining on average by 3.6% per year. GDP PPP energy intensity was declining even faster: by 5.2% per year. Nevertheless, in 2012 Turkmenistan was the most energy intense economy of the 10 countries.

Factors behind evolution of GDP energy intensity: technology and structural shifts. With GDP growing in the range of 8-10% per year (in MER or PPP), the GDP energy intensity decline was mostly a result of structural changes in the economy.

Energy prices. Within some minimum consumption range (so-called limits) energy is free. The government provides for free: 120 l of gasoline per month, 50 m^3 of natural gas, 35 kWh of electricity, and 250 l of drinking water. Where minimum electricity consumption limit is exceeded, electricity price is 0.0042 USD/kWh.

After February 1, 2014, the price of natural gas beyond the minimum consumption limit is 20 manats (around USD 7) per 1,000 m^3 (incl. VAT). 99.7% of settlements are connected to pipeline natural gas supply, so nearly all residents enjoy centralized natural gas supply. Gas prices were last revised back in 1993.

Energy efficiency legislation. Turkmenian energy strategy for the period to 2030 is being developed. Draft Energy Strategy outlines the following priority directions of development: improving fuel efficiency of power plants through the upgrades of combustion systems; improving energy efficiency of municipal services and industry and modernization of heat supply; implementation of energy efficiency measures in the housing and industrial sectors; increasing the share of renewable non-fossil energy sources in the energy balance. Energy saving and energy efficiency legislation of Turkmenistan is under development.

Government agency(ies) with an energy efficiency policy mandate. No data found.

Basic administrative mechanisms to improve energy efficiency. Not yet established.

Basic energy efficiency market mechanisms and economic incentive programmes. No data available.

Energy efficiency policy spending and financial sources. Energy efficiency is not really part of the government policy in Turkmenistan.

Energy efficiency R&D spending. No data available.

ESCO market. ESCO market does not exist in Turkmenistan.

Water efficiency policy. Providing the population with drink water is a priority for official federal policy in Turkmenistan. The basic regulatory act that regulates water management, conservation and efficiency of water use is the Code of Turkmenistan "On water" adopted on 01.11.2004. This Code outlines the basic principles for the regulation of water use across the country:

- water for drinking is provided free of charge, the costs of construction, renovation and maintenance of water supply systems are covered by municipal and national budgets;

[235] http://www.iea.org/statistics.

- water for industrial use is supplied for a fee according to the tariffs;
- exceedance by industrial plants of limits specified for the intake of water and discharge of untreated industrial wastewater entails penalties;
- water for irrigation is available for free within the consumption limits;
- construction, renovation and operation of public water facilities are a responsibility of corresponding public budget.

11.2 Heat and power generation and transmission

Power generation efficiency. Turkmenistan's generation capacities are sufficient to completely meet domestic electricity demand and provide electricity for export. According to the 2011 data, installed electric capacity of thermal and hydropower plants in Turkmenistan is 4,151.2 MW. Natural gas is the main energy resource. Turkmen power system operates in parallel with that of Iran, and there is a technological possibility of connecting to the grids of the neighboring CIS countries for power exchange.

In 2011, specific fuel consumption for electricity generation at CHP was 448.7 gce/kWh. Compared to the 2002 level, it increased by 32.9 gce/kWh, or by 8% (used to be 415.8 gce/kWh in 2002). So the efficiency is below 30%.

Share of CHP in power generation. No data found.

Power transmission and distribution losses. In 2011, electricity transmission and distribution losses equaled 3.97 billion kWh, or 22.7%. In 2002, it was 13.1%.

Heat generation efficiency. In 2002-2011, Turkmen power plants did not produce heat.

Share of CHP in heat generation. In 2002-2011, Turkmen power plants did not produce heat.

Heat distribution losses. No heat distribution in 2002-2011.

Energy efficiency regulations in heat and power generation and distribution. Basic regulatory acts that outline the federal policy in electricity and energy efficiency in relation to power and heat generation, transmission and distribution include:

- Law "On the electricity sector" adopted on August 16, 2014. The law includes 6 chapters and 30 articles. It establishes legal, economic and institutional frameworks in the power industry. This law is aimed at building capacity in the power system of Turkmenistan through further modernization of the industry, use of innovative energy saving technologies and equipment.
- Concept of the electricity sector development for 2013-2020 adopted on April 12, 2013. Implementation is intended in 2 stages:
    - Stage 1 (2013-2016): construction of 8 gas turbine power plants in Akhalskiy, Lebapskiy and Maryisky provinces; reconstruction of power plants in Sadie, Balkanabad and Abadan district near Ashgabat; construction of high-voltage power transmission lines;
    - Stage 2 (2017-2020): construction of 6 plants; construction of overhead high-voltage power transmission lines (500 kV in the direction of Ashgabat-Balkanabad-Turkmenbashi and towards Ashgabat-Mary).

  Implementation of these measures will help increase electricity generation in 2020 to 26.380 billion kWh. Total Concept costs amount to more than US$ 5 billion.

Government agency(ies) with an energy efficiency policy mandate in heat and power generation and distribution. No information found.

Basic administrative mechanisms to improve energy efficiency in heat and power generation and distribution. No information found.

Basic energy efficiency market mechanisms and economic incentive programmes. No information found.

Renewables development programs. In 2012-2013, the country developed a National Strategy for Turkmenistan on climate change and an Action Plan that includes both measures to combat climate change and adaptation measures. The Action Plan is expected to affect all sectors of the economy, but a focus will be made on the key segments (industry, transport and housing), and the priorities include:

- introduction of energy efficiency and energy saving techmologies;
- development of renewable energy;
- technological modernization to ensure further development and competitiveness of the economy.

White Certificates market. No information found.

Heat and power generation and distribution: energy efficiency policy spending. No specific data found.

11.3 Industry

Industrial energy intensity. Overall industrial energy consumption in Turkmenistan amounts to 918 thousand toe.

Energy intensity of basic industrial goods. No information found.

Share of industrial CHP in the overall electricity generation. According to the data for 2012, electric capacity of industrial power plants was 167 MW, or 4% of the total installed electric capacity of all power plants in Turkmenistan. There's no information related to electricity generation by industrial thermal power plants.

Energy efficiency regulations in the industrial sector. No information found.

Government agency(ies) with an energy efficiency policy mandate in the industrial sector. No information found.

Basic administrative mechanisms to improve energy efficiency in the industrial sector. No information found.

Basic energy efficiency market mechanisms and economic incentive programmes. No information found.

Long-term agreements. None.

Energy management systems. No information found.

Industrial energy efficiency policy spending. No information found.

11.4 Buildings

Specific energy consumption per 1 m2 of residential floor space (energy intensity in residential buildings). Residential sector is the major electricity consumer in Turkmenistan (29%, or 3.5 billion kWh in 2009, including 14.8% (1.78 billion kWh) by urban population and 14.2% (1.72 billion kWh) by rural population. Average specific energy consumption per 1 m2 of the total living area is 36.21 kWh/m^2. Electricity consumption limits (free electricity supply) are as follows:

- 35 kWh/person per month (before 2013);

- 25 kWh/person per month (after 2013).

Turkmenistan has also set minimum consumption limits for natural gas (50 m^3/person per month, or 600 m^3/person per year).

Specific energy consumption per 1 m^2 of public floor space. No information found.

Specific energy consumption for space heating per 1 m^2 of residential floor space per degree-day of heat supply season. No information found.

Specific hot water consumption per 1 resident with access to centralized DHW supply. According to UNDP, about 60% of the urban population have access to pipeline water supply 24/7, while others only 6-8 hours a day. Specific water consumption per person is 323 liters/day, and minimum consumption limit is 250 liters/day.

Share of consumers equipped with energy meters. No data are available on the number and share of consumers equipped with electricity, natural gas, and water meters. According to UNDP, in 2010, meters saturation level was 0%.

Building codes requirements. Since 2010, Turkmenistan has been implementing the project Energy Efficiency in Residential Buildings. This project focuses on the identification and implementation of the energy saving potential in space heating and air conditioning (cooling) of residential premises, on the procurement and installation of meters and controls, energy audits of residential buildings and training for the personnel of housing maintenance organizations. The Project budget is US$ 46 million.

Other administrative mechanisms to promote energy efficiency. No information found.

Basic energy efficiency market mechanisms and economic incentive programmes in the buildings sector. No information found.

Government agency(ies) with an energy efficiency policy mandate in the buildings sector. No information found.

Information and educational programmes. No information found.

Buildings energy efficiency policy spending. No information found.

11.5 Transport

Specific energy consumption per unit of transport service. Total fuel and energy consumption in the transport sector amounts to 1,506 thousand toe (including 858 thousand toe of petroleum products; 628 thousand toe of natural gas; 20 thousand toe of electricity), or to 10.7% of the overall domestic energy consumption in 2009.

Share of light-duty automobiles in the passenger turnover. In 2011, the share of light-duty vehicles in the passenger turnover was 87%.

Cargo turnover per unit of GDP. In 2011, specific automobile cargo turnover per unit of GDP was 0.288 tons-km/USD.

Average fuel consumption per 1 automobile. In 2008, minimum fuel consumption limits (free of charge supply) were set for private cars: 120 l/month per person for car owners and 40 l of gasoline or diesel fuel per month for motorcycle owners. These limits were cancelled effective July 1, 2014. No information on the actual fuel consumption by vehicles (automobiles) is available.

Specific energy consumption per unit of cargo turnover. No information found.

Fuel efficiency of new light-duty automobiles. No information found.

Share of electric and hybrid cars in the automobile park. No information found.

Transport energy efficiency policy spending. No information found.

Energy efficiency regulations in the transport sector. No information found.

Government agency(ies) with an energy efficiency policy mandate in the transport sector. No information found.

Basic market mechanisms to promote energy efficiency. No information found.

Long-term agreements in the transport sector. None.

11.6 Technical energy efficiency potential for Turkmenistan

11.6.1 Approach and data sources

Technical, economic and market energy efficiency potentials for Turkmenistan were assessed based on four sets of data (Table 11.1). Data on the economic activities by sectors were collected from national statistical sources for 2010-2012. Data on specific energy use in different applications were collected from the information provided by energy and gas utilities and from official documents (company annual reports, investment programmes, energy efficiency programmes), presentations and publications in the public domain. Where the required information was not available, proxies for countries with similar climate and economic conditions were used.

The assessment of the technical potential in Turkmenistan builds on the comparison of actual specific energy consumption in various applications against specific energy consumption for best available technologies for the same sectors and subsectors, which were collected from multiple international sources.

Table 11.1 Data collection technology and structure

Information required	Source of information	Methods of data collection
Data on economic activities	Statistical yearbooks and reviews	Collection of statistical data
Data on specific energy consumption in various sectors in Turkmenistan	Information provided by energy and gas utilities and from official documents (company annual reports, investment programmes, energy efficiency programmes), presentations and publications in the public domain	Data search
Data on specific energy consumption for Best available technologies	Publications in the public domain	Literature search in the public domain
Energy tariffs for various consumer groups in Turkmenistan	Information provided by energy utilities (Turkmenenergo, Turkmengas, Turkmenneft), Ministry of Energy and Ministry of Municipal Utilities	Data search

Technical energy efficiency potential for Turkmenistan was assessed by multiplying the 2010-2012 activity level by the gap between the country-specific energy consumption and BAT energy consumption for the same activity.

The technical potential assessment was structured by different sectors including: power and heat generation, transmission and distribution, industry, transport (pipeline, air, automobile, urban electric, and railroad), agriculture, street lighting, water supply, and buildings. Where reliable information for some energy use activities was not available, such activities were skipped from the potential evaluation study.

Where possible, estimates generated in this study are compared with local estimates of the energy efficiency potential for similar activities.

Evaluation of the economic and market potentials helps reveal the most effective measures and technologies that may be recommended for Turkmenistan. So as to identify the economic and market potentials, the costs of saved energy were compared to 2012 energy prices in order to see if an individual measure is economically viable.

Summary of energy efficiency potential estimation for Turkmenistan:

• Power and heat	5,197 thou tce
• Industry	1,376 thou tce
• Transport	465 thou tce
• Residential and public buildings	930 thou tce
• Other	670.4 thou tce
• **Total**	**8.7 Mtce**

11.6.2. Power and heat

CENEf's assessment of the technical energy efficiency potential in the power and heat sector (power and heat generation, transmission, and distribution) builds on the official data provided by the largest energy and gas utilities in Turkmenistan (Turkmenenergo, Turkmengas) and data available from statistical yearbooks, energy efficiency programmes, reports, presentations, and publications in the public domain (including internet resources).

Information on the power and heat generation, transmission, and distribution in 2012 was obtained from the data provided by Turkmenenergo and the Ministry of Municipal Utilities. These data allowed it to identify the following power plants and boiler-houses:

- thermal power plants (steam turbine and gas turbine cogeneration units) of Turkmenenergo;
- thermal power plants (industrial on-site steam turbine and gas turbine cogeneration units);
- hydropower plants of Turkmenenergo;
- district boilers of the Ministry of Municipal Utilities.

Natural gas is the basic fuel used by thermal power plants and boilers (99.9%). The share of residual oil is negligible.

Total installed electric capacity as of 01.01.2013 was 4.15 GW, including thermal power plants of Turkmenenergo (95.9%), on-site industrial cogeneration plants (4.0%), and hydropower plants (0.1%).

In 2012, total power generation by power plants amounted to 19.8 million kWh, including 19.0 million kWh (96%) by power plants of Turkmenenergo. The rest was produced by on-site industrial co-generation units (0.8 million kWh, or 4%).

Transmission and distribution losses in Turkmenistan in 2012 were 3.97 million kWh (24%).

Heat production by district boilers of the Ministry of Municipal Utilities was 2.042 million Gcal in 2012. Distribution heat losses in the networks of the Ministry of Municipal Utilities were 215.3 million Gcal (10.8%) in 2012.

In 2012, thermal power plants and boilers consumed 10.988 Mtce of fuel (9,670 million m^3 of natural gas), including:

- 8,303,700 tce (75.5%) by thermal power plants of Turkmenenergo; and
- 2,688,500 tce (24.5%) by on-site industrial thermal power plants and district boilers of the Ministry of Municipal Utilities.

Information on specific energy use in the power and heat sector was obtained from data provided by energy and gas utilities (Table 11.2). In some instances, specific energy consumption was assessed using proxies, including parameters for similar installations in Russia.

CENEf estimates the technical potential in Turkmenistan heat and power sector at 5.20 Mtce, or 47% of the total annual energy consumption by this sector.

The largest energy savings are attainable through the following technologies: modernization of gas-fired cogeneration plants (CCGT units with 58-60% efficiency (electric) – 4.63 Mtce; electricity transmission (reduction of electricity transmission losses) – 0.416 Mtce.

Table 11.2 Energy efficiency potential in Turkmenistan power and heat sector (as of 2012)

Integrated technologies of goods, work, and services production	Units	Volume of economic activity	Units	Specific consumption in 2010	Practical minimum	Actual consumption abroad	Comments	Estimated technical potential, 1000 tce
Gas-fired cogeneration plants retrofits	mln kWh	19,000	gce/kWh	448.7	205	220	CCGT with 60% efficiency (practical minimum); CCGT with 56%-58.2% efficiency (best CCGT in Russia)	4,630
Reduction of own needs electricity consumption by gas-fired cogeneration plants	mln kWh	19,000	%	6.6	4.0	5.0	Global practice (North America, Russia)	61
Electricity transmission (reduction of electricity transmission losses)	mln kWh	16,480	%	24.0	3.5	5.0	Global practice (France, Italy, Spain)	415.5
Gas-fired boilers retrofits	thou. Gcal	2,042	kgce/Gcal	161	152	154	Boiler units with 92…94% efficiency	18.1
Reduction of electricity consumption for heat generation by boilers	thou. Gcal	2,042	kWh/Gcal	20	7	9	Global practice (Finland)	3.3
Heat distribution (reduction of heat distribution losses)	thou. Gcal	1,993	%	10.8	5.0		Improving energy efficiency of heat networks	16.5
Cogeneration by boilers (upgrading boilers to mini-cogeneration units)	mln kWh	424					Installation of gas reciprocating units, gas turbines, and steam turbines in boiler-houses	52.1
Total								**5,196.7**

Source: estimated by CENEf

11.6.3. Industry

The scale of economic activity in the industrial sector was taken from the data provided by Turkmenistan Committee for Statistics (statistical yearbook “Industry of Turkmenistan, 2012”). Some use was made of the data published by the leading industrial companies (Turkmengas, Turkmenneft, Turkmenbashi cluster of oil refineries, Seida oil refinery, Turkmenkhimiya, Turkmencement). Energy consumption in the basic industries was obtained from the websites of Turkmenistan Ministry of Energy and International Energy Agency (IEA). In 2012, industrial energy consumption amounted to 3.28 Mtce, including electricity consumption to 2.85 Mtce.

The technical potential in industry was estimated for 9 energy intensive products and 5 cross-cutting technologies (Table 11.3). Specific energy consumption in the manufacture of most products was assessed using proxies for Russia (industries and technologies with similar technical parameters and conditions).

Table 11.3 Energy efficiency potential in industry (as of 2012)

Integrated technologies of goods, work, and services production	Units	Scale of economic activity	Units	Specific consumption in 2010	Practical minimum	Actual consumption abroad	Comments	Estimated technical potential, 1000 tce
Oil refinery	10^3ton	10,800	kgce/ton	84	53.9	75,1	Global practice	329.7
Oil production	10^3ton	10,900	kWh/t	134.5	40.0		Global practice	126.7
Gas production	$10^6 m^3$	68,900	kgce/10^3 m^3	8.7	5.9		Expert opinion	191.8
Iron ore rolled products	10^3ton	119	kgce/ton	109.3	31	68,0	Global practice	9.4
Mineral fertilizers (nitrogen and phosphate)	10^3ton	774	kgce/ton	233	109	131	Global practice	96.3
Cement	10^3ton	1,587	kgce/ton	222	110	158	Global practice	177.7
Glass (cast and float glass)	10^3 m^2	5,800	kgce/ton	510	204	250	Russian practice	142
Meat and meat products	10^3 ton	574	kgce/ton	198	50		Russian practice	84.9
Bread and bakery	10^3 ton	960	kgce/ton	162	89		Russian practice	70
Efficient motors	10^6 motors	0.19	kWh/motor	9,956	8,507		Global practice	33.3
Variable speed drives	10^6 drives	0.08	kWh/drive	9,956	9,356		Global practice	6.2
Efficient industrial lighting	10^6 lights	0.8	kWh/light	247	160		Global practice	8.0
Efficient steam supply	10^3 tce	164	%	65	100		Global practice	57.4
Fuel savings in other industries	10^3 tce	211	%	80	100		Global practice	42.3
Total								**1,375.8**

Source: estimated by CENEf

CENEf estimates the technical energy efficiency potential in the industrial sector at 1,375,800 tce, or 42% of annual industrial energy use. The largest energy savings can be obtained in oil refinery (329,700 tce), gas production (191,800 tce), cement production (177,700 tce), efficient steam supply (392,700 tce).

11.6.4 Transport

The scale of economic activity in the transport sector was obtained from Turkmenistan Committee for Statistics (statistical yearbooks "Automobile transport in Turkmenistan, 2012" and "Transport and communications in Turkmenistan, 2012").

Total energy consumption in the transport sector was obtained from the websites of Turkmenistan Ministry of Energy and IEA. In 2012, it equaled 3.86 Mtce, including 254.5 million kWh of electricity and 3.83 Mtce of fuel.

Energy efficiency potential was estimated for automobile transport (light- and heavy-duty vehicles and buses). Specific energy consumption by cars and buses in Turkmenistan was estimated based on proxies for the same types of vehicles operating in similar conditions and with similar parameters in Russia. Technical energy saving potential in the transport sector is shown in Table 11.4.

Table 11.4 Energy efficiency potential in transport (as of 2012)

Integrated technologies of goods, work, and services production	Units	Scale of economic activity	Units	Specific consumption in 2010	Practical minimum	Actual consumption abroad	Comments	Estimated technical potential, 1000 tce
Shifting to hybrid light-duty vehicles	10^3 pcs.	441	tce/pcs.	1.23	0.74		Global practice	217.2
Shifting to hybrid buses	10^3 pcs.	13	tce/pcs.	6.5	3.91		Global practice	34.5
Shifting to hybrid heavy-duty vehicles	10^3 pcs.	71	tce/pcs.	7.5	4.52		Global practice	213
Total for transport								**464.7**

Source: estimated by CENEf

CENEf estimates the technical potential in the transport sector at 464,700 tce, or 12% of total annual energy consumption in this sector. The largest energy savings can be obtained by shifting to hybrid motors.

11.6.5 Buildings

This sector includes residential and public buildings. Industrial, agricultural and other (commercial) buildings are not included.

Total residential floor space and population were obtained from Turkmenistan Committee for Statistics (statistical yearbooks "Turkmenistan Standard of Living, 2012", "Statistical Yearbook for Turkmenistan, 2012"). In 2012, total residential floor space equaled 106.9 million m^2, and population amounted to 5.170 million people.

Residential buildings in Turkmenistan break down as follows:

1. One- or two-storey private housing with individual space heating and DHW supply from gas- or electric boilers. The share of this type of housing in Turkmenistan total housing stock amounts to nearly 80%;

2. Apartment buildings with access to district heat and DHW supply from district boilers. In summer time, people living in these buildings use air conditioners. The share of this type of housing in Turkmenistan total housing stock is around 20%. Apartment buildings are broken down as follows:
    - residential buildings erected between 1960 and 1991 (number of floors: 4 to 9; wall material: brick or cement panels);
    - residential buildings erected after 2000 (number of floors: 9 or more; wall material: cement panels with mineral wool insulation).

Residential energy consumption was obtained from the websites of Turkmenistan Ministry of Energy and IEA. Where residential heat and natural gas consumption was not available, these values were estimated using the following regulations:

- Building Code SP 50.13330.2012 Updated version of SNiP 23-02-2003 "Thermal Performance of Buildings";
- Building Code SP 30.13330.2012 Updated version of SNiP СНиП 2.04.01-85* "In-house Water Supply and Sewage";
- Building Code SNiP 2.04.08-87* "Gas supply".

In 2012, energy consumption in Turkmenistan residential sector amounted to 1.96 Mtce, electricity consumption to 4.374 million kWh; heat consumption to 1.355 thousand Gcal; natural gas consumption to 1.079 billion m^3.

Specific energy consumption per m^2 of total residential floor space equals 18.3 kgce/m^2, including electricity – 40.9 kWh/m^2, or 5.03 kgce/m^2; heat for space heating (district heat) – 0.044 Gcal/m^2, or 6.25 kgce/m^2; heat for DHW (housing with access to central DHW supply) – 0.012 Gcal/m^2, or 204 kgce/m^2); natural gas – 10.1 m^3/m^2, or 11.5 kgce/m^2. These values were used to assess the technical energy efficiency potential in residential buildings. Specific energy consumption by EU "passive" houses was used as the "practical minimum".

Turkmenistan Committee for Statistics does not provide any data on the total floor space of public buildings (educational and health care); however, it does provide information on the basic indicators for public organizations in 2012 and for earlier periods (including students in educational institutions and beds in health care institutions). And so total public floor space was estimated by multiplying the scale of economic activity by the standard coefficient "floor space saturation, m^2/person".

Public sector (educational and health care institutions) energy consumption in Turkmenistan was estimated using the above regulatory documents at 642.8 ktce.

Specific energy use by public buildings obtained from the Building Code "Energy Efficiency in Buildings. Estimated energy consumption for space heating and cooling" was taken as the "practical minimum". The technical energy saving potential in Turkmenistan residential and public buildings is shown in Table 11.5.

CENEf estimates the technical potential in residential and public buildings at 1,013 ktce, or 39% of annual energy consumption in these sectors, including 929.7 ktce in residential buildings and 83.3 ktce in public buildings.

Table 11.5 Energy efficiency potential in residential and public buildings (as of 2012)

Integrated technologies of goods, work, and services production	Units	Scale of economic activity	Units	Specific consumption in 2010	Practical minimum	Actual consumption abroad	Comments	Estimated technical potential, 1000 tce
Renovation of centrally heated public buildings	10^3 m^2	2,353	kgce/m^2	6.6	4.9	5.2	In compliance with the regulations in force in Russia	3.9
Renovation of hot water use (public buildings)	10^3 m^2	1,647	kgce/m^2	2.46	1.23		In compliance with the regulations in force in Russia	2.0
Renovation of the cooking equipment (public buildings)	10^3 m^2	11,763	kgce/m^2	1.8	1.4	1.3	Global practice	4.4
Renovation of individually heated public buildings	10^3 m^2	9,410	kgce/m^2	6.6	4.9	5.2	Global practice	15.6
Efficient lighting (public buildings)	10^3 m^2	11,763	kWh/m^2	39	19.5	27.8	Global practice	28.2
Procurement of efficient equipment (public buildings)	10^3 m^2	11,763	kWh/m^2	71.8	51.6	56.6	Global practice	29.2
Renovation of centrally heated residential buildings	10^3 m^2	21,387	kgce/m^2	5.4	1.86	4.86	"Passive" houses (EU countries) and energy efficient buildings (Russia)	76
Renovation of individually heated residential buildings	10^3 m^2	85,546	kgce/m^2	6.5	1.86	4.86	"Passive" houses (EU countries) and energy efficient buildings (Russia)	400.7
Renovation of hot water supply in residential buildings	10^3 people	413.6	tce/person	0.204	0.018	4.04	"Passive" houses (EU countries) and energy efficient buildings (Russia)	77.1
Replacement of appliances with efficient models	10^3 people	1,034	tce/person	0.110	0.055	0.123	Global practice	56.2
Renovation of lighting in residential buildings	10^3 lamps	17,822	W	50.85	20.0		Global practice	37.3
Renovation of the cooking equipment	10^3 m^2	90,893	kgce/m^2	4.60	1.5	2.80	Global practice	281.8
Total for residential and public buildings								**929.7**

Source: estimated by CENEf

11.6.6 Other sectors

Other sectors in Turkmenistan include agriculture (tractors), street lighting, variable speed drives and efficient motors in water pumping.

The number of tractors was obtained from Turkmenistan Committee for Statistics (statistical yearbook "Agriculture in Turkmenistan, 2012"). Assessment of specific energy consumption by tractors in Turkmenistan builds on the data available for tractors operating in similar conditions in the Russian Federation. Based on the Russian experience, there is a possibility to reduce fuel consumption per tractor by about 65%.

In addition to the agricultural sector, the technical energy efficiency potential was assessed for street lighting and motors used by the pumping equipment in water supply. The technical potential in "other sectors" is shown in Table 11.6.

Table 11.6 Technical potential in "other sectors" (as of 2012)

Integrated technologies of goods, work, and services production	Units	Scale of economic activity	Units	Specific consumption in 2010	Practical minimum	Actual consumption abroad	Comments	Estimated technical potential, 1000 tce
Tractors fuel efficiency	10^3 pcs.	50,000	kgce/ha	20	7		Global practice	662.1
Variable speed drives and efficient motors in water supply systems	mln kWh	166.2	%	100	75		Global practice	5.1
Street lighting	mln kWh	88	%	100	70		Global practice	3.2
Total for "other sectors"								**670.4**

Source: estimated by CENEf

11.6.7 Total technical energy efficiency potential

Total technical energy efficiency potential for Turkmenistan is estimated at 8,720.6 thousand tce, or 37% of TPES, as of 2012. The largest potential is in the following sectors: power and heat (5.2 Mtce), industry (1.4 Mtce), and residential and public buildings (1.0 Mtce).

This estimate assumes independent implementation of all technologies, processes, and measures in each sector, taking no account of integral direct or indirect effects related to the reduction of energy production and transportation.

11.6.8 Economic and market potentials

In Turkmenistan, a large part of the technical potential in various sectors of economy can be implemented through cost-effective investments.

Economic and market potentials can be assessed by comparing energy prices and the costs of saved energy. Fuel and energy prices in Turkmenistan are shown in Table 11.7. In this table, electricity, heat and fuel prices are also converted to US$/tce. For consumers who use several energy resources, the US$/tce value was determined in accordance with the energy consumption structure.

Table 11.7 Energy prices in Turkmenistan (as of 2012)

	Units	Turkmenian manat	US$	US$/tce
	Industry			
Electricity	kWh	0.015	0.0052	42.6
Heat	Gcal	8.57	3.0	21.0
Natural gas	m^3	3.11	1.09	0.96
Residual oil	t	14.46	5.06	3.73
Diesel fuel	t	44.17	15.44	10.60
	Residents			
Electricity	kWh	0.012	0.0042	34.1
Heat	Gcal	5.34	1.87	13.1
Natural gas	m^3	2.0	0.7	0.62
Gasoline	t	900	314.7	209.8
	Public and other organizations			
Electricity	kWh	0.015	0,0052	42,6
Heat	Gcal	5.34	1,87	13,1
Natural gas	m^3	3.11	1,09	0,96
	Street lighting			
Electricity	kWh	0.015	0,0052	42,6
Turkmenian manat to US$ exchange rate	Turkmenian manat		2.86	

Source: data provided by Turkmenistan Ministry of Energy and Ministry of Municipal Utilities

Energy prices in Turkmenistan are much lower, than average electricity, heat, and natural gas prices in the Russian Federation.

1. For residential consumers:
   - electricity prices are 30 times lower on average: 0.0042 US$/kWh in Turkmenistan versus 0.13 US$/kWh in the Russian Federation (Moscow);
   - heat prices are 24 times lower on average: 1.87 US$/Gcal in Turkmenistan versus 44.6 US$/Gcal in the Russian Federation (Moscow);
   - natural gas prices (for consumers with gas stoves and access to central DHW supply) are 248 times lower on average: 0.0007 US$/$m^3$ in Turkmenistan versus 0.174 US$/$m^3$ in the Russian Federation (Moscow).
2. For industries and companies:
   - heat prices are 16 times lower on average: 3 US$/Gcal in Turkmenistan versus 49 US$/Gcal in the Russian Federation (Moscow);
   - natural gas prices are 114 times lower on average: 0.001 US$/$m^3$ in Turkmenistan versus 0.114 US$/$m^3$ in the Russian Federation.

In addition to low energy prices, Turkmenistan has introduced free consumption amounts for residential consumers (per month per capita): 35 kWh of electricity; 50 m^3 of natural gas; and 250 liters of water.

Comparison of energy prices with the costs of saved energy allows it to identify the most effective technologies, processes, and measures to be recommended in the first place in each sector. The cost of saved energy depends on the discount rate applied to annualize the capital costs. In this study, 6% discount rate was used to estimate the economic energy efficiency potential and 12% discount rate was used to estimate the market energy efficiency potential. In addition, 20% discount rate was used to reflect stricter budget limitations and a higher cost of money for some energy consumers.

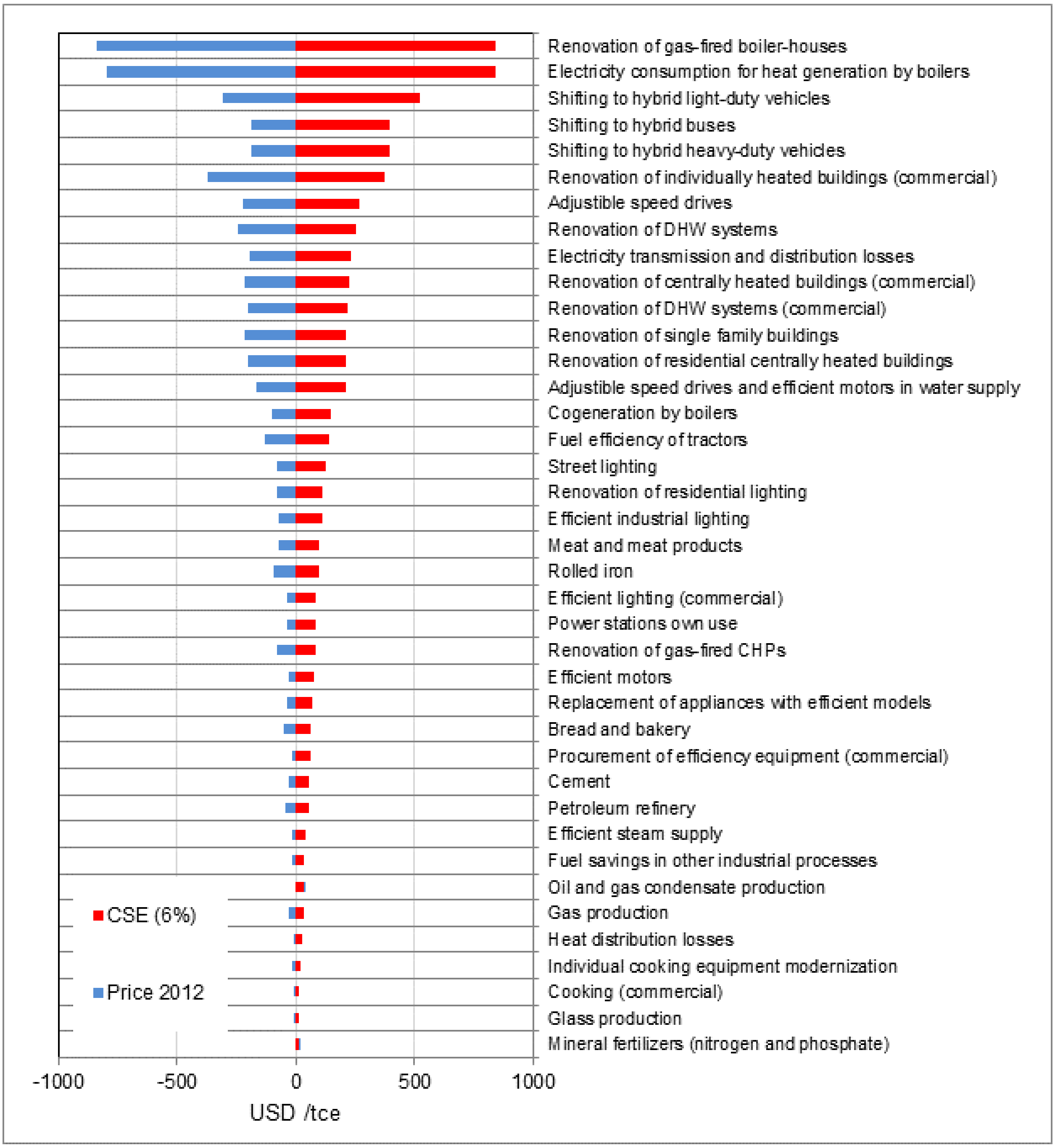
Economic and market potentials (with 6%, 12%, and 20% discount rates) that can be implemented through energy efficient technologies, processes, and measures are shown in Figures 11.1-11.3.

The figures show the costs of saved energy (red) and the gap between the energy price in a given activity and the cost of saved energy (blue). If the gap is negative, the measure is considered economically not attractive and is excluded from the economic or market potential assessment.

The economic potential in Turkmenistan amounts to only 223 ktce across all sectors, or less than 3% of the technical potential. Only 2 industrial technologies are considered for the economic potential: oil production (126.7 ktce) and mineral fertilizers (nitrogen and phosphate) (96.3 thousand tce).

The market potential (12% discount rate) equals 96.3 ktce across all sectors, or 1% of the technical potential. The market potential (12% discount rate) does not include oil production. The market potential (20% discount rate) is completely missing.

Figure 11.1 **Economic energy efficiency potential for Turkmenistan (for 6% discount rate as of 2012)**

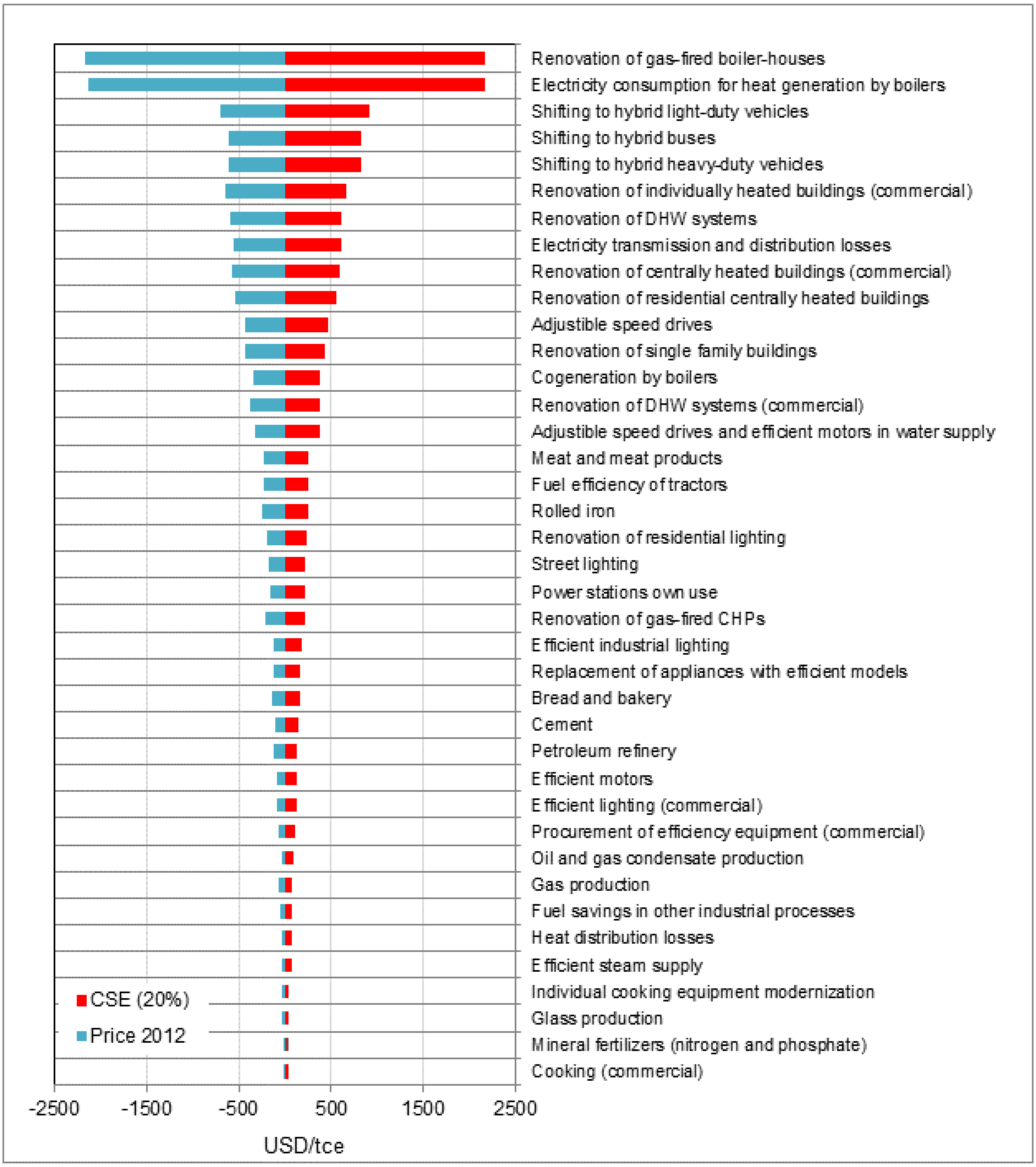


Source: CENEf

Figure 11.2 Market energy efficiency potential for Turkmenistan (for 12% discount rate as of 2012)

Source: CENEf

Figure 11.3 Market energy efficiency potential for Turkmenistan (for 20% discount rate as of 2012)



Source: CENEf

Section 12. Uzbekistan

12.1 National level

Population in 2012: 29.78 mln; GDP PPP in 2012: 124.86 bln US$2005 (IEA[236]).

Evolution of GDP energy intensity. Committee for Statistics of Uzbekistan does not develop national integrated fuel and energy balance (IFEB); however, IEA does, based not on questionnaires annually filled in by the Committee for Statistics, but on sources unknown to the local experts. In its balance IEA does not breakdown "heat" and "other solid fuels" by end-use sectors. Moreover, IEA estimates heat generation in 2011 at 24,150 thousand Gcal, whereas according to the Committee for Statistics it was 32,300 thousand Gcal in 2011 and 33,700 thousand Gcal in 2010[237]. Therefore, energy balance data provided by IEA are not reliable, also affecting the quality of its GDP energy intensity estimates both in absolute values and dynamics.

In 2011, Uzbekistan had the highest GDP energy intensity among the 10 countries under consideration in GDP MER terms and the second highest after Turkmenistan in GDP PPP terms. In 2012, IEA substantially revised the conversion ratio between these two GDP indicators and, while GDP converted using market exchange rates in 2005 prices went up by a reasonable 8.2%, GDP in PPP in 2005 prices increased by 47%. Therefore, GDP energy intensity value estimated using market exchange rates was used in this study for the progress evaluation. In 2000-2012, the decline was modest, at 1.3% per year on average.

Uzbekistan Committee for Statistics reported 13% decline in GDP energy intensity during the first half of 2014.[238] It is not very clear, how the Committee could assess this indicator for a half-year without using an integrated fuel and energy balance. Energy efficiency potential was assessed at 18 to 20 Mtoe, which is equivalent to US$ 4.7 billion gas export revenue loss[239].

Factors behind the evolution of GDP energy intensity: technology and structural shifts. No decomposition studies have been found to allow for the identification of factors behind GDP energy intensity evolution.

Energy prices. With sewage and housing costs included, the share of housing and municipal utility costs exceeds 10% (excluding rent and imputed rent) of the overall personal incomes[240], and the share of residential energy supply costs exceeds 4.5% (or maybe 5% with an account of liquefied gas, wood fuel and kerosene). This is beyond the affordability of local households. Residential energy prices in Uzbekistan are about 2-3 times lower, than in Russia, and much lower, than in the EU[241].

Energy efficiency legislation. In 1997, the "Law on Rational Energy Use" No. 412-1 was enforced. This law provides a very general framework and does not launch any specific mechanisms. Some energy efficiency issues are regulated also by the "Law On the Power

[236] http://www.iea.org/statistics.
[237] Uzbekistan Housing in 2012. Federal Committee for Statistics, Uzbekistan Republic.
[238] http://www.stat.uz/search/
[239] D. Abdusalamov. National Report for the Uzbekistan Republic. Developed under the UN Economic Commission for Europe project Enhancing Synergies in Commonwealth of Independent States (CIS) National Programmes on Energy Efficiency and Energy Saving for Greater Energy Security". GAK Uzbekenergo. 2013.
[240] I. Bashmakov. Ability and willingness of residential consumers to pay their housing and municipal utility bills // Voprosy ekonomiki (Issues of Economy). – 2004. No. 4; I. Bashmakov. Housing Reform: are we erroneously doing what we have designed, or have we erroneously designed what we are doing? Energosberezheniye (Energy Conservation), No. 5 and 6, 2004 (in Russian).
[241] CENEf. Energy Efficiency in Buildings: Untapped Reserves for Uzbekistan Sustainable Development. Developed for UNDP. Moscow. November 2013.

Sector" No. 225 dated 30.09.2009. Draft "Law On Renewable Energy Sources" and draft "Law On Heat Supply" have been submitted for approval.

Energy efficiency regulatory acts. In addition to the "Law On Rational Energy Use", there are a number of other legal acts that require energy efficiency promotion in various sectors. The Government Decree "On Additional Measures to Be Taken to Accelerate the Implementation of "Industrial Energy Efficiency Improvement" Project with the Participation of International Development Association" dated 12.06.2013 launches this US$ 100 million-worth project. In 2011, the Government revised 10 building codes (and adopted new versions thereof) related to energy efficiency. Besides, there are "Heat Distribution Networks and Heating Unit Operation Regulations" and "Regulations on the Installation and Operation of Hot Water- and Heat Meters", as well as a number of other norms and regulations. However, in other areas the work is either just starting, or has not been launched yet.

Government agencies with an energy efficiency policy mandate. At the federal level, urban development activities are supervised by the Ministry of Economy; the State Committee for Architecture and Construction (Gosarchitectstroy); and the State Energy Inspection (UZenergonadzor). On the regional level, energy effciciency policies are implemented by local authorities.

Basic administrative mechanisms to improve energy efficiency: Uzbekistan has energy metering requirements; energy efficiency standards and classes; building codes and certification; energy expertise. There are also requirements for technical audits of equipment, including energy efficiency assessment.

Basic energy efficiency market mechanisms and economic incentive programmes. The "Law On Rational Energy Use" introduces the following market instruments: public co-financing for energy efficiency programmes, setting up inter-sectorial energy efficiency fund, subsidies and taxes, and pricing policies.

Energy efficiency policy spending and financial sources. There are many investment projects, that include energy efficiency components, but no data are available on how much is spent on energy efficiency in all. A US$ 100 million loan agreement signed with the World Bank Group in 2012 to improve industrial energy efficiency can be used as an indicator. Funds received under this 25-years loan were to be spent by the end of 2014. Initially, the loan was limited to US$ 25 million. There is another US$ 180 million WB loan to improve electricity billing and metering systems to reduce commercial losses of electricity.

Energy efficiency R&D spending. No data on energy efficiency research and development spending are available.

ESCO market. The ESCO mechanism is not introduced by the "Law On Rational Energy Use" or any subsequent regulation.

Water efficiency policy. There is a project to improve water supply in some regions using a US$ 81 million loan provided by the International Development Association.

International cooperation. Uzbekistan is deeply involved in international cooperation in energy efficiency. Several loans have been provided by the World Bank group to improve energy efficiency (power sector and industry), by the Asian Development Bank (buildings), there are projects with UNDP (buildings) and with individual countries.

12.2 Heat and power generation

Power generation efficiency. The efficiency of power generation by thermal (mostly natural gas-fired) power plants stands only at 32%.

Power transmission and distribution losses. According to the IEA balances, power transmission and distribution losses are 9.6%. Other sources report 13.8%.[242]

Heat generation efficiency. Natural gas is the main fuel used by thermal power plants and boiler-houses. Wear of boilers, pumps, water treatment and other process equipment in Uzbekistan boiler-houses amounts to 68-88%.

Share of CHP in power generation. Condensing power plants contribute 87.7%, gas turbine units 2.3%, and hydropower plants 12.3% to power generation.

Heat distribution losses. Around 31% of heat distribution networks are dilapidated**.** Total length of heat distribution networks has been declining since 1997. Poor maintenance is the reason why nearly 30% of pipes have no insulation whatsoever. Poor shape of in-house networks determines huge grid water leakages. Heat losses are estimated at 27.6% of the overall heat generation. Accidents and emergencies in heat distribution networks are five to ten times more frequent, than in large Russian cities[243].

Energy efficiency regulations in heat and power generation and distribution. There are no specific regulatory requirements related to energy efficiency in power and heat generation, transmission and distribution.

Government agencies with an energy efficiency policy mandate in heat and power generation and distribution. Ministry of Economy; State Energy Inspection (UZenergonadzor), local authorities for heat supply systems.

Basic administrative mechanisms to improve energy efficiency in heat and power generation and distribution. International loan programmes supported by Presidential Degrees.

Basic energy efficiency market mechanisms and economic incentive programmes. Long-term loans provided by international financial institutions; public funding for heat supply systems; taxation and pricing policies.

Renewables development programmes. Presidential Degree No. 3902-P dated 05.12.2012 has established a working group to develop renewables programme for Uzbekistan.

Heat and power generation and distribution: energy efficiency policy spending. There is US$ 180 million World Bank loan to improve electricity billing and metering systems to reduce commercial electricity losses to be supplemented with US$ 66 million provided by Uzbekenergo utility.

White certificates market. No such programmes launched.

12.3 Industry

Industrial energy intensity. Industry is responsible for about 22% of final energy consumption. According to IEA, in 2011 industrial energy consumption was 4% below the 2000 level. At the same time, industrial production went up by 71%. This yields reduction of industrial energy intensity by 78%, or by 5.4% per year.

Energy intensity of basic industrial goods. Additional data search is required. Associated gas flaring is an important problem resulting in approximately US$ 500 million annual loss.

Energy efficiency regulations in the industrial sector. There are no specific energy efficiency regulations in the industrial sector.

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[242] D. Abdusalamov. National Report for the Uzbekistan Republic. Developed under the UN Economic Commission for Europe project Enhancing Synergies in Commonwealth of Independent States (CIS) National Programmes on Energy Efficiency and Energy Saving for Greater Energy Security". GAK Uzbekenergo. 2013.

[243] CENEf. Energy Efficiency in Buildings: Untapped Reserves for Uzbekistan Sustainable Development. Developed for UNDP. Moscow. November 2013.

Government agencies with an energy efficiency policy mandate in the industrial sector. Basic government agencies responsible for industrial energy efficiency policies include the Ministry of Economy and State Energy Inspection (UZenergonadzor).

Basic administrative mechanisms to improve energy efficiency in the industrial sector: energy expertise.

Basic energy efficiency market mechanisms and economic incentive programmes. Long-term loans provided by international financial institutions, taxation and pricing policies.

Long-term agreements. None.

Energy managers training programmes. Voluntary.

Industrial energy efficiency policy spending. A US$ 100 million loan agreement signed with the World Bank Group in 2012 to improve industrial energy efficiency. This investment is expected to be supplemented with loans from local banks (additional US$ 63 million) resulting in US$ 2 billion savings and 15% decline in industrial energy use by 2022.

12.4 Buildings

Specific energy consumption per m^2 of residential floor space (energy intensity in residential buildings). The buildings sector was responsible for 55% of 2011 end-use energy consumption (or 50% of primary energy consumption, if electricity and heat generation and transmission losses and fuel and energy sector process needs are included). Buildings are responsible for 75% of final heat consumption; 26% of final electricity consumption; 64% of final natural gas consumption; and nearly one third of the overall natural gas consumption (including fuel and energy sector process needs). Summed up with electricity and heat generation for the buildings sector, buildings are responsible for 56% of natural gas consumption.

Specific energy consumption per m^2 of the living area in Uzbekistan is closest to the relevant figures in Russia and the U.S., i.e. countries substantially differing in climate and levels of development and housing amenities. Specific energy consumption efficiency in 2011 was 52 kgce/m^2/year (423 kWh/m^2/year) and even exceeded that in Russia (49 kgce/m^2/year, or 398 kWh/m^2/year), where the average number of degree-days is twice that in Uzbekistan. In the EU, average specific energy consumption in the residential sector varies between 150 kWh/m^2/year in Spain and 320 kWh/m^2/year in Finland. The climate in Uzbekistan more resembles that in Spain. This indicator is 450 kWh/m^2/year in the U.S., 300 kWh/m^2/year in Japan, and around 175 kWh/m^2/year for Chinese urban buildings. To a certain extent, the higher value of specific energy consumption is determined by a larger share of individual low-rise residential buildings. Another factor, which is seldom considered in cross-country comparisons, is a larger size (double, in relation to Russia) of the average household in Uzbekistan[244].

Specific energy consumption per m^2 of public floor space. Public and commercial buildings are responsible for around 10% of final energy consumption. There is a US$ 13 million-worth project to improve energy efficiency of public buildings; the government provides US$ 8.6 million, with the rest cofinanced by the UNDP-GEF project. This project includes rehabilitation of several pilot buildings and construction of new energy efficient buildings.

Specific energy consumption for space heating per m2 of residential floor space per degree-day of the heat supply season. Two thirds of residential energy consumption is related to space heating. In the EU, average residential energy consumption for space heating is 2-3 times lower than in Uzbekistan. Average total energy consumption for space heating of the whole buildings

[244] CENEf. Energy Efficiency in Buildings: Untapped Reserves for Uzbekistan Sustainable Development. Developed for UNDP. Moscow. November 2013.

stock was 0.121 Wh/m²/degree-days; 0.035-0.065 Wh/m²/degree-days for multifamily buildings; and 0.136 Wh/m²/degree-days for single-family houses. For EU countries, average values are 0.035-0.06 Wh/m²/degree-days. To a certain extent, the higher value of specific energy consumption is determined by a larger share of individual low-rise residential buildings in the total housing stock and a larger size (double, in relation to Russia) of the average household in Uzbekistan.

Specific hot water consumption per household with access to centralized DHW supply. In Uzbekistan, average energy consumption for DHW purposes per household is 807 kgce/year versus average EU 230 kgce/year (varying between 65 kgce in Bulgaria and 430 kgce in Estonia), 342 kgce in the U.S. and 205 kgce in Japan[245]. The reasons behind the higher values include a larger size of a household in Uzbekistan (5.9 people versus 2.4 in the EU) and inefficient water heating equipment. Per capita estimate for Uzbekistan is only 13% above the EU average. However, it is important to take into account that only 67% of the population have access to tap water supply. As access to tap water supply increases, energy consumption for DHW purposes may grow up, unless compensated by the efficiency improvements of both water- and water heaters use. In multifamily houses, energy consumption for DHW purposes is 80 to 100 kgce/m^2.

Share of consumers equipped with energy meters. Information on energy and water meters saturation in the housing sector is pretty scarce. According to the available data, 95% of residential gas consumers are equipped with meters. 74% of the total number of flats and individual buildings with access to DHW are equipped with meters[246]. And only 4% of residential buildings have building-level heat meters. More detailed information is available for Tashkent. Only 2% of multifamily buildings there (181 buildings) are equipped with building-level heat meters, 50% of flats have DHW meters, 60% of flats are equipped with tap water meters, 81% of public and 43% of commercial organizations have tap water meters.

Building codes requirements. Under the UNDP/GEF project in the recent years (basically, in 2011) 10 key building codes were revised. According to the revised building codes, energy consumption for space heating is 30 to 40% down from the earlier level.

Other administrative mechanisms to improve energy efficiency in buildings: energy metering requirements, energy expertise; prohibition of inefficient devices turnover (incandescent lamps).

Basic energy efficiency market mechanisms and economic incentive programmes in the buildings sector: subsidies for buildings renovation and building-level meters installation; taxation and pricing policies.

Government agencies with an energy efficiency policy mandate in the buildings sector. Government bodies responsible for energy efficiency policy implementation in buildings are the Ministry of Economy; Federal Committee for Architecture and Construction (Gosarchitectstroy); State Energy Inspection (UZenergonadzor). On the regional level energy efficiency policies are run by local authorities. In addition, UNDP office in Uzbekistan plays an important role as a catalist of energy effciency in the buildings sector.

Buildings energy efficiency policy spending. Apart from the above-mentioned US$ 13 million project, there are no data on energy efficiency investments in the buildings sector.

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[245] Global Energy Assessment. Towards a Sustainable Future. IIASA. Austria. 2012.

[246] According to People’s well-being raising strategy of the Uzbekistan Republic for 2013-2015, in 2011 100% of consumers had natural gas meters, 70% had tap water meters, 60% were equipped with hot water meters. 2013 estimates are 80% for tap water and 73% for hot water.

Educational programmes. In the framework of the WB and UNDP-GEF projects there are educational (seminars, workshops and conferences) and training components, which are the core of Uzbekistani activities in this area.

12.5 Transport

Specific energy consumption per unit of transport service. Transport is responsible for 9-10% of final energy consumption. People tend to switch to personal cars. Passenger-km bus travel was down 2.5-fold from 2000 to 2011. The share of automobiles in freight transport was steadily growing in 2000-2011. Trucks and buses are beginning to switch to natural gas.

Government agencies with an energy efficiency policy mandate in the transport sector. The key government agency responsible for energy efficiency policy in the transport sector is Ministry of Economy.

Basic administrative mechanisms to improve energy efficiency in the transport sector: No information available.

Basic energy efficiency market mechanisms and economic incentive programmes in the transport sector: taxation and pricing policies.

12.6 Technical energy efficiency potential for Uzbekistan

12.6.1 Approach and data sources

Technical energy efficiency potential for Uzbekistan was assessed based on the approaches described in the Inception Report. To a substantial degree the assessment was based on the recent CENEf's study for the UNDP office in Uzbekistan[247], which required estimations of energy efficiency potentials in buildings and heat and power generation. Below potentials for other sectors were assessed, and potentials in buildings and heat and power generation were updated.

Four sets of data were used to estimate technical energy efficiency potential for Uzbekistan (Table 12.1). Data related to the economic activities were collected from national statistical sources (for 2010-2013), which are listed in corresponding sections. Data related to specific energy use in different applications were collected from official documents, programmes, presentations, and publications. Where appropriate data were not available, proxies for countries with similar conditions were used. Assessment of the technical potential builds on the comparison of energy efficiency indicators against specific energy consumption for best available technologies (BATs) in the same sectors and subsectors. BAT data were collected from multiple international sources.

Table 12.1 Data collection technology and structure

Information required	Source of information	Methods of data collection
Data on economic activities	Statistical yearbooks	Collection of statistical data
Data on specific energy consumption in various sectors in Uzbekistan	Official documents, publications, proxies for countries in similar conditions	Literature search
Data on specific energy consumption for best available technologies	Publications	Collection of data from publications on best available technologies
Energy prices	Statistical yearbooks	Energy prices

The technical energy efficiency potential for Uzbekistan was assessed by multiplying the 2010-2013 activity level by the gap between the country's specific energy efficiency (if available) or

[247] CENEf. Energy efficiency in Buildings: Untapped Reserves for Uzbekistan Sustainable Development. Moscow, November 2013. Project implemented for UNDP.

proxy (if country data were not available) and energy efficiency BAT parameters for the same category of activity.

Assessment of the technical potential was structured by different sectors including: power and heat generation, transmission and distribution, industry, transport, buildings, agriculture, street lighting, water supply, etc. Estimates generated by this study were, where possible, compared with local estimates of energy efficiency potential for similar activities. Where the information was sufficient, the reasons for mismatching, if any, were identified.

Based on these comparisons, technical potential estimate ranges were provided. Where reliable information for some energy use activities was not available, such activities were skipped from the potential evaluation study.

So as to identify the economic and market potentials, the costs of saved energy were compared to 2013 or 2014 energy prices in order to see if an individual measure is economically viable.

Summary of energy efficiency potential estimation for Uzbekistan:

- Power and heat 9,668 thou tce
- Industry 4,120 thou tce
- Transport 2,354 thou tce
- Residential buildings 13,223 thou tce
- Services 2,901 thou tce
- Other 162 thou tce
- **Total** **32.4 Mtce**

12.6.2 Power and heat

CENEf's assessment builds on the energy use and power and heat generation data available from statistical yearbooks, government programmes and legal acts, publications, and other sources, including websites. For some parameters such information was not available, and so they were assessed using proxies, including similar generation units and installations in Russia. Therefore, the estimates of the technical potential are by no means perfect. CENEf has taken any and all measures to make them as reliable as possible, despite the tight work schedule that did not allow for too extensive data search.

Data related to power generation in 2013 were borrowed from statistical yearbooks. Natural gas is the basic fuel for both thermal power plants in Uzbekistan (for GAK Uzbekenergo) amounting to 94%, fuel oil to 2%, and coal to 4%. Based on this information, power generation was broken down by various types of stations in Table 12.2. Total power production in 2013 amounted to 53.2 billion kWh. Heat generation in 2013 amounted to 30.7 thousand Gcal. Of this volume 26% were generated by CHPs, with the rest provided by boiler-houses. The share of natural gas in the boilers fuel use was 81%, of liquid fuels 6%, and of coal 13%. Data from Uzkommunhizmat are different: natural gas 92%; coal 6 to 8%, and the rest coming from residual oil and other fuels[248].

Power and heat losses were taken from statistical sources and company reports. High losses are reported for distribution networks. Heat networks are made of steel pipes and welded steel pipes with mineral wool insulation. Nearly 31% of the heat networks are worn out. Since heat pipes replacement policies do not focus on advanced technologies, distribution heat losses have been growing in the recent years. Besides, a high groundwater level and poor maintenance enhance underground pipes corrosion; and many pipes (nearly 30%) have no insulation whatsoever. And the unsatisfactory shape of in-house heat distribution systems in the larger part of the housing stock leads to large network water leakages. Normative distribution heat losses equal 3 thousand

[248] Personal communication with L.B. Zavyalova.

Gcal (9.8%). Heat losses with an account of excessive heat supply were estimated at around 8.4 thousand Gcal/year, or 27.6% of the total heat generation.

Table 12.2 Energy efficiency potential in power and heat generation, transmission and distribution (as of 2011-2013)

Integrated technologies of goods, work, and services production	Units	Scale of economic activity	Units	Specific consumption in 2010	Practical minimum	Actual consumption abroad	Comments	Technical potential estimate, 1000 tce
Renovation of gas-fired power stations	mln kWh	40,113	gce/kWh	380	205	262	Combined cycle gas turbines (CCGT), 60% efficiency	7,012
Renovation of coal-fired power stations	mln kWh	2,180	gce/kWh	404	273	293	Equipment with 48% efficiency	285
Renovation of liquid fuel-fired power stations	mln kWh	530	gce/kWh	322	256	293	Equipment with 37% efficiency	35
Power stations own use	mln kWh	53,200	gce/kWh	8.2%	4.0%	5.0%	Equipment with 48% efficiency	275
Electricity transmission and distribution losses	mln kWh	53,200	gce/kWh	13.1%	6.9%	7.0%	North America	405.7
Renovation of CHPs	thou. Gcal	8,000	gce/kWh	180	159		Equipment with 90% efficiency	164.9
Renovation of coal-fired boiler-houses	thou. Gcal	1,363	%	199	159		North America	55.2
Renovation of residual oil-fired boiler-houses	thou. Gcal	2,953	%	173	155		Equipment with 92% efficiency	52.6
Renovation of gas-fired boiler-houses	thou. Gcal	18,402	kgce/Gcal	161	151		Equipment with 95% efficiency	192.7
Renovation of other boiler-houses	thou. Gcal	600	kgce/Gcal	218	159		Equipment with 90% efficiency	35.2
Electricity consumption for heat generation by boilers	thou. Gcal	22,718	kgce/Gcal	23	7	9	Finland	44.7
Heat distribution losses	thou. Gcal	30,430	kgce/Gcal	27.6%	5.4%		Finland	966.0
Cogeneration by boilers	thou. Gcal		kWh/Gcal				Where possible	145.0
Total for power and heat								**9,668.3**

Source: CENEf

About 22-24 Mtce are annually used for power and heat generation, transmission and distribution. CENEf estimates technical energy efficiency potential in this sector at 9.7 Mtce (Table 12.2), or at about 40% of annual consumption by this sector. In 2013, CENEf estimated the technical energy efficiency potential in heat supply (including CHPs renovation) at 5.9 Mtce, which, if supplemented by the renovation of other power stations and power transmission and distribution networks, is close to the above estimate for the entire power and heat supply sector.

12.6.3 Industry

Technical energy efficiency potential for industry was assessed (see Table 12.3) using 2010-2013 data on industrial activities from the statistical yearbook[249]. Data on specific energy use in Uzbekistan are not available, so proxies from Kazakhstan or Russia were used. The potential was estimated for 15 energy intensive homogenous products and 7 cross-cutting technologies applicable across all industrial sectors.

Table 12.3 Energy efficiency potential in industry (as of 2011-2013)

Integrated technologies of goods, work, and services production	Units	Scale of economic activity	Units	Specific consumption in 2010	Practical minimum	Actual consumption abroad	Comments	Estimated technical potential, 1000 tce
Petroleum refinery	10^3 t	3,233	kgce/t	87	53.9	75.1	Global practice	105.8
Gas processing	bln m^3	3,000	kgce/ 1,000 m^3	62	46.3		2000 level	47.5
Coal processing	10^3 t	2,900	kgce/t	130	40.0		Global practice	32.0
Crude oil production	10^3 t	63,000	kWh/t	8.7	5.9		Global practice	175.4
Natural gas production	10^6 m^3	3,800	kgce/ 1,000 m^3	14.0	3.0		Expert estimate	41.8
Coal production	10^3 t	746	kgce/t	13.0	-15.0	34.0	Global practice	20.9
Basic oxygen steel	10^3 t	3,233	kgce/t	87	53.9	75.1	Global practice	105.8
Rolled ferrous metal products	10^3 t	708	kgce/t	113.1	31	68.0	Global practice	58.3
Synthetic ammonia	10^3 t	1,300	kgce/t	1328	956	1120	Global practice	483.6
Fertilizers	10^3 t	1,172	kgce/t	163	109	131	Global practice	63.3
Paper	10^3 t	5	kgce/t	360	241	320	Global practice	0.6
Cardboard	10^3 t	27	kgce/t	343	237	266	Global practice	2.8
Cement production	10^3 t	6,707	kgce/t	24	11	13	Global practice	87.2
Clinker	10^3 t	6,036	kgce/t	200	99	145	Global practice	612.1
Meat and meat products	10^3 t	179	kgce/t	211	50		Chelyabinskaya Oblast	28.9
Bread and bakery	10^3 t	1,083	kgce/t	157	89		Tambovskaya Oblast	73.4
Efficient motors	10^6 units	1.0	kWh/motor	9,956	8,507		Global practice	178.2
Variable speed drives	10^6 units	0.5	kWh/drive	9,956	9,356		Global practice	33.2
Efficient compressed air systems	10^6 m^3	7,600	kgce/ 1,000 m^3	18	7		Global practice	88.6
Efficient oxygen production	10^6 m^3	1,000	kgce/ 1,000 m^3	112	90		Global practice	22.5
Efficient industrial lighting	10^6 units	5	kWh/ lighting unit	247	160		Global practice	53.1
Efficient steam supply	10^3 tce	4,500	%	75%	100%		Global practice	1,125.0
Heat recovery	thou. Gcal	2,000	%	60%	90%		Global practice	85.8
Fuel savings in other industrial applications	10^3 tce	3,500	%	80%	100%		Global practice	700.0
Total for industry								**4,120.1**

Source: CENEf

[249] Statistical yearbook of the Uzbekistan Republic. 2012. Tashkent. 2013.

The technical energy efficiency potential in industry is assessed at 4.1 Mtce, or nearly 41% of about 10 Mtce used in industry. It should be noted, that the assessment of the technical potential as shown in the table above relies on many assumptions, is for indicative purposes only and needs improvement.

12.6.4 Transport

Energy efficiency potential for transport was estimated for railroad transport, pipelines, air, automobiles and municipal electric transport. Like in the other sectors, this effort is quite data demanding. Data on the transport service were taken from statistical yearbooks, although not always information on transport service was available in required formats[250]. In some instances data presented in passenger-km and (or) freight-km were to be converted to brutto-freight-km to fit available data on specific energy use[251]. As to specific energy use, for many vehicles data in Uzbekistan are not available in formats similar to those used in Russia. For automobile transport Russian data on specific energy use were taken as proxies. This approach makes the estimate just preliminary and fit for further improvement, but it can serve a starting point for improving energy efficiency potential assessments in the transport sector in Uzbekistan.

CENEf estimates the energy efficiency potential in transport at 2.4 Mtce in 2013 (versus 4.5-5 Mtce reported[252] as consumed in this sector) (Table 12.4). The largest potential comes from switching to effective hybrid models in automobile transport. Uzbekistan may start manufacturing them. No local estimates of the energy efficiency potential in transport are available.

Table 12.4 Energy efficiency potential in transport (as of 2011-2013)

Integrated technologies of goods, work, and services production	Units	Scale of economic activity	Units	Specific consumption in 2010	Practical minimum	Actual consumption abroad	Comments	Estimated technical potential, 1000 tce
Railroad electric traction	10^7 tkm gross	9,600	kgce/10^4 tkm gross	12.0	10.0		Values for some Russian regions	19.2
Diesel locomotives	10^7 tkm gross	1,300	kgce/10^4km gross	62.2	40.0		2020 target for Russia	28.9
Trams electric traction	10^6 tkm gross	84	kgce/10^3 km gross	8.7	6.5		Average for Russia	0.2
Trolley-bus electric traction	10^6 tkm gross	20.6	kgce/10^3 km gross	7.9	5.9		Average for Russia	0.0
Gas pipeline transport	10^6 m^3km	40,900	kgce/10^6 m^3 km	28.2	25.00		2020 target for Russia	130.9
Oil pipeline transport	10^3 tkm	2,400	kgce/10^3 t km	1.75	1.20		2020 target for Russia	1.3
Eco-driving	10^3tce	2,050	kgce/10^6 m^3km	100%	95%		Global practice	102.5
Shifting to hybrid light-duty vehicles	10^3 vehicles	2,000	tce/vehicles/ year	1.23	0.74		Global practice	984.0
Shifting to hybrid buses	10^3 buses	50	tce/buses/ year	6.5	3.91		Global practice	130.2
Shifting to hybrid heavy-duty vehicles	10^3 vehicles	305	tce/vehicles/ year	7.5	4.52		Global practice	919.9
Air transport	10^6 passenger-km	6,200	kgce/ passenger-km	60.3	54.27		Global practice	37.4
Total transport								**2,354.4**

Source: CENEf

250 Statistical yearbook of Uzbekistan Republic. 2012. Tashkent. 2013; Uzbekistan in numbers. 2012. Tashkent. 2013.
251 Such conversions were made based on corresponding data for Russia.
252 IEA. Energy balances for non-OECD countries. 2013.

12.6.5 Buildings

The buildings sector includes residential, public and commercial buildings. Industrial and agricultural buildings are not considered. The buildings sector is responsible for 55% of the 2011 end-use energy consumption (or 50% of primary energy consumption, if electricity and heat generation and transmission losses and fuel and energy sector process needs are included). Buildings are responsible for 75% of final heat consumption; 26% of final electricity consumption; 64% of final natural gas consumption; and nearly one third of the overall natural gas consumption (including fuel and energy complex process needs). With electricity and heat generation for the buildings sector, buildings are responsible for 56% of natural gas consumption. With this volume halved through improved efficiency of natural gas, electricity, and heat use, natural gas export could more than double[253]. Residential buildings are the largest energy consumer in Uzbekistan: more energy is spent in this sector, than for electricity or heat generation purposes. Residential buildings are responsible for 33% of primary energy consumption and 46% of final energy consumption; 60% of final heat consumption; 18% of final electricity consumption; 54% of final natural gas consumption. With an account of energy consumption for electricity and heat generation for residential buildings, as well as of own needs and losses associated with energy generation, the share of residential buildings in primary energy consumption in 2011 was 41%.

In the EU, average residential energy consumption for space heating is 2-3 times lower, than in Uzbekistan. Two thirds of residential energy consumption are related to space heating. Since the share of residential buildings that have access to district heat is relatively low (13% of the overall floor space), specific energy consumption largely depends on the efficiency of space heating equipment used. In Uzbekistan, this efficiency is around 75% for gas-fired systems and 55 to 60% for space heating using other fuels.

In 2013, CENEf estimated the technical energy saving potential in the residential sector based on the assumption that the entire housing stock is brought in compliance with the Building Codes KMK 2.01.18-00* “Pre-determined levels of energy consumption for space heating, ventilation, and air conditioning in buildings and facilities” at 13.8 Mtce (61% of the 2011 consumption), and with the entire housing stock brought in compliance with the requirements to passive buildings at 17.6 Mtce (77% of the 2011 consumption). In a table below a simplified version of the technical energy efficiency potential assessment is presented. Total energy saving potential in buildings is estimated at more than 16 Mtce with 13.3 Mtce in residential buildings and the rest in public and commercial buildings (Table 12.5). There are some alternative estimates of the energy efficiency potential in the buildings sector: 11.4 Mtce[254].

[253] CENEf. Energy efficiency in Buildings: Untapped Reserves for Uzbekistan Sustainable Development. Moscow, November 2013. Project implemented for UNDP.

[254] D. Abdusalamov. Uzbekistan Republic national report. Developed under the UNECE project “Energy Efficiency and Energy Conservation to Improve the Synergy Effect of National Programmes of the CIS Member-Countries And to Improve Their Energy Security. GAK Uzbekenergo. 2013.

Table 12.5 Energy efficiency potential in the buildings sector (as of 2011-2013)

Integrated technologies of goods, work, and services production	Units	Scale of economic activity	Units	Specific consumption in 2010	Practical minimum	Actual consumption abroad	Comments	Estimated technical potential, 1000 tce
Housing								
Renovation of centrally heated multifamily buildings	10^3 m^2	87,230	kgce/m^2	22.00	7.1		60% of 2012 building codes requirements	1,301.5
Renovation of single-family buildings	10^3 m^2	371,000	kgce/m^2	27.00	4.9		Passive houses	8,199.1
Renovation of hot water use	10^3 people	7,166	tce/person	0.207	0.073	0.12	Global practice	961.1
Replacement of appliances with top efficient models	10^3 people	30,396	tce/person	0.110	0.055	0.123	Global practice	1,671.8
Lighting renovation	10^3 light fixtures	74,641	W	50.85	20.00	35.00	Global practice	156.3
Renovation of the cooking equipment	10^3 m^2	466,500	kgce/m^2	3.50	1.50	2.80	Global practice	933.0
Total residential buildings								**13,222.7**
Public and commercial buildings								
Renovation of centrally heated buildings	10^3 m^2	20,569	kgce/m^2	25.0	7.1	18.0	60% of 2012 building codes requirements	368.6
Renovation of hot water use	10^3 m^2	20,569	kgce/m^2	4.90	2.7	3.3	Global practice	45.0
Renovation of the cooking equipment	10^3 m^2	16,455	kgce/m^2	1.8	1.4	1.3	Global practice	6.1
Efficient space heating boilers	10^3 m^2	71,500	kgce/m^2	32.7	4.9	30.2	Global practice	1,987.7
Lighting renovation	10^3 m^2	110,000	kWh/m^2	32.7	16.4	27.8	Global practice	221.2
Procurement of efficient appliances	10^3 m^2	110,000	kWh/m^2	71.8	51.6	56.6	Global practice	272.8
Total public and commercial buildings								**2,901.5**
Total buildings								**16,124.2**

Source: CENEf

12.6.6 Other sectors

Not much information is available to assess the technical energy saving potential in agriculture. According to the IEA energy balances, about 2.7 Mtce are used annually in this sector, but only 30% of that is liquid fuels for tractors and other machinery. Based on the Russian experience, specific energy use per tractor may be reduced by about 65%. There are other evidences that a similar reduction is possible in other agricultural activities through efficiency improvements[255]. Therefore, energy efficiency potential in this sector may be estimated at 0.6 Mtce. Electricity use dominates in this sector, and electricity is mostly used for irrigation. However, not much

[255] S.A. Turchekenov. Kazakhstan Republic national report on energy efficiency and energy conservation to improve the synergy effect of national programmes of the CIS member-countries and to improve their energy security.

information is available to estimate how much can be saved through better water management and more efficient water pumps.

Two more components of the energy efficiency potential were assessed, namely street lighting and variable speed drives at municipal water supply systems. All together, the contribution of "other sectors" to the energy efficiency potential was estimated at 0.7 Mtce (Table 12.6).

Table 12.6 Energy efficiency potential in "other sectors" (as of 2011-2013)

Integrated technologies of goods, work, and services production	Units	Scale of economic activity	Units	Specific consumption in 2010	Practical minimum	Actual consumption abroad	Comments	Estimated technical potential, 1000 tce
Tractors fuel efficiency	10^3 units	9,000	kgce/ha	20	7		Global practice	119.2
Adjustable speed drives in water supply systems	mln kWh	540	%	100%	75%		Global practice	16.6
Street lighting renovation	mln kWh	700	%	100%	70%		Global practice	25.8
Total								**161.6**

Source: CENEf

12.6.7 Comparisons of total technical energy efficiency potential estimates

Total technical energy efficiency potential for Uzbekistan as of 2013 is estimated at 32.4 Mtce of 69 Mtce of TPES reported by IEA for 2012.[256] Therefore, the potential is close to 47% of TPES. This estimate assumes independent implementation of all technological measures taking no account of integral direct or indirect effects related to the reduction of potential in power and heat generation if end-use demand for power and heat is reduced through measures implemented in final energy use sectors. There are a number of publications with estimates of energy efficiency potential in Uzbekistan varying between 18 and 20 Mtoe, or 26 and 29 Mtce[257], but they all refer to the ADB report dated 2004[258], so are a decade old. Assuming that the potential has grown up over the 10 years, the above CENEf's estimate seems reliable.

Technical energy efficiency potential is large and basically concentrated in buildings, power and heat sector, and in the industry. The question is, how much of it is economically attractive?

12.6.8 Economic and market energy efficiency potentials

Economic and market potentials are assessed based on the comparison of energy prices and costs of saved energy. 2014 energy prices were used in the study (Table 12.7). Energy prices in Uzbekistan are lower, than in many EC countries, but they are substantial against the incomes of economic agents. The share of income spent to pay the energy bills is a more important driver behind rational energy use, than energy prices[259]. In 2013, according to CENEf's estimates, the share of housing and municipal utility services spending exceeded 10% of residential incomes

[256] http://www.iea.org/statistics/statisticssearch/report/?country=UZBEKISTAN&product=balances&year=2012.

[257] Center for economic research, UNDP. Concept approaches to the development of Green Economy in Uzbekistan. Tashkent-2011.

[258] Asian Development Bank project "Technical assistance to the Republic of Uzbekistan for Energy Needs Assessment", 2004.

[259] I. Bashmakov. Three Laws of Energy Transitions//Energy Policy. – July 2007. – P. 3583-3594; Bashmakov I.A. Ability and willingness of residential consumers to pay their housing and municipal utility bills // Voprosy ekonomiki (Issues of Economy). – 2004. No. 4.

and is beyond the affordability thresholds[260]. This means, that there is practically no room left for residential energy price increase before energy prices reach a level beyond which either payment collection will go down or many households will be forced to reduce their resource consumption below the sanitary level.

The economic energy saving potential was estimated based on the incremental costs analysis and using 2014 energy prices. A problem arises when modern expensive equipment is needed to reduce energy consumption. In this case economically attractive solutions are indicated by the cost of saved energy being lower, than energy price. The costs of saved energy depend on the discount rate applied to annualize capital costs. In this study, 6% discount rate was used to estimate the economic energy efficiency potential and 12% discount rate was used to estimate the market energy efficiency potential, which is close to the mortgage interest rate in Uzbekistan. In addition, 20% discount rate was used to reflect stricter budget limitations and a higher cost of money for some energy consumers.

Table 12.7 Energy prices in Uzbekistan in 2014

	Units	sum	US$	US$/tce
	Non-residential users			
Electricity	kWh	144.3	0.060	487.8
District heat	Gcal	56,984.4	23.7	163.6
Natural gas	10^3 m^3	181,620	75.7	65.6
Coal	t	143,950	60.0	85.7
Fuel oil	t	1,010,000	420.8	307.2
Gasoline	t	2,693,000	1,122.1	752.4
Diesel fuel	t	2,221,000	925.4	638.2
	Residential users			
Electricity	kWh	144.3	0.060	487.8
District heat	Gcal	56,984.4	23.7	163.6
Coal	t	125,100	52.1	70.0
Natural gas	10^3 m^3	181,620	75.7	65.6
Gasoline	l	2,693,000	1,122.1	752.4
Exchange rate	sum/dollar	2,400		

Sources: http://www.uzbekcoal.uz/news.htm; http://sivan.in.ua/arc/2014/07/1084/; https://www.facebook.com/fergananews/posts/829689020388952; http://www.goldenpages.uz/electroenergy/; http://www.goldenpages.uz/kurs.

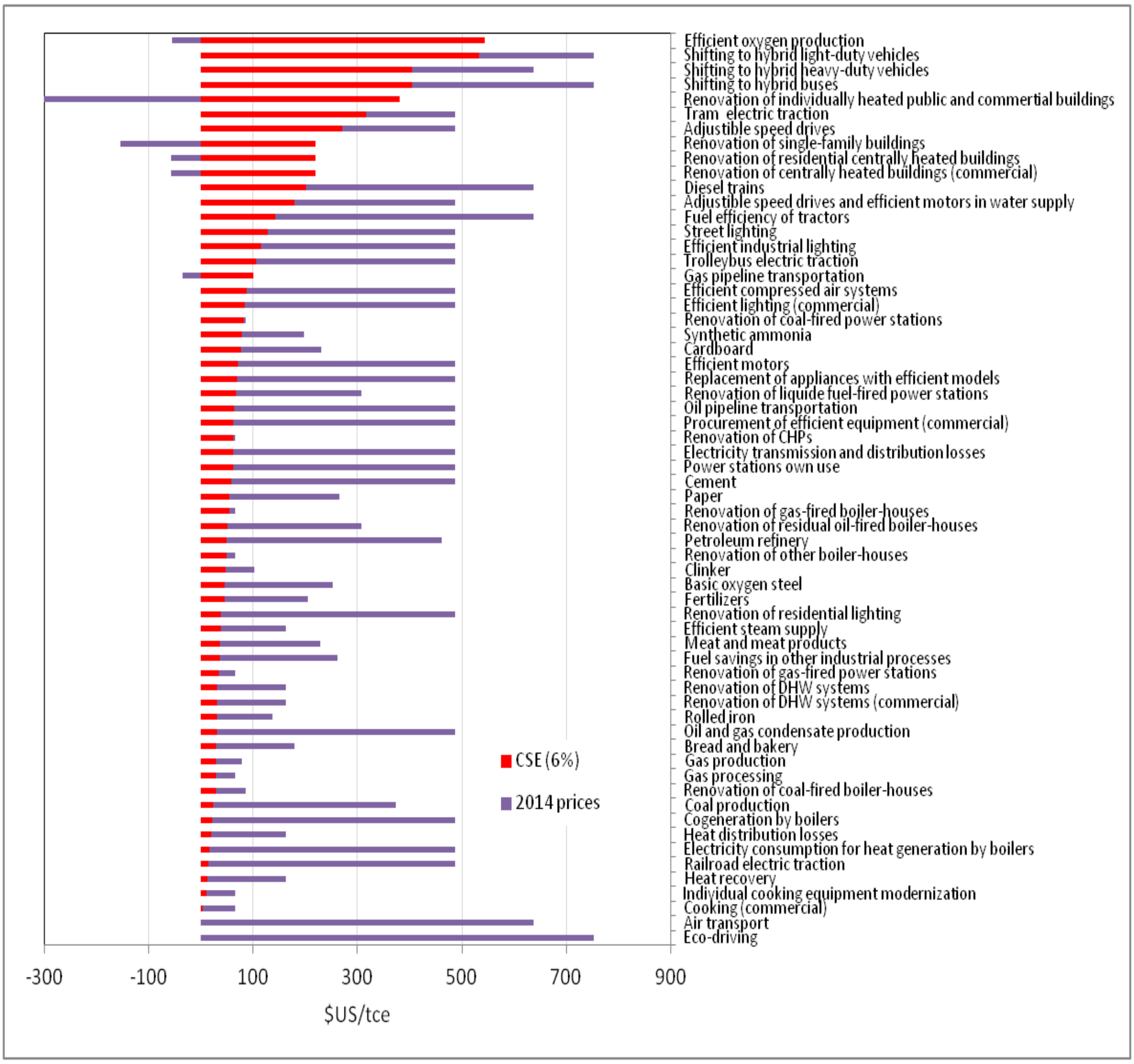
The economic energy saving potential equals 20.4 Mtce. Some measures, for which costs of saved energy appeared to be higher than energy price, are economically not attractive for the society and are not included in the economic potential (Fig. 12.1). Those include, for example, renovation of multi- and single-family houses and commercial buildings. This is partly the result of low residential energy prices, as well as incomplete account for benefits. With export gas price applied as an opportunity cost, measures to improve energy efficiency in buildings become economically viable. Accounting for co-benefits, subsidies for deep housing retrofits, and steady energy price growth for residents may scale up the economic potential closer to the technical one.

If private parameters in economic decision-making are better reflected in the analysis via higher costs of capital (12% and 20% discount rates), then market energy efficiency potential may be assessed. It declines to 19.7 Mtce with 12% discount rate and shrinks further to 9.6 Mtce with 20% discount rate. 10 measures are excluded from the market energy efficiency potential with a 12% discount rate, 17 are excluded when using a 20% discount rate. So the market potential is

[260] CENEf. Energy Efficiency in Buildings: Untapped Reserves for Uzbekistan Sustainable Development. Moscow, November 2013. Project implemented for UNDP.

very sensitive to the discount rate. Taking into account real availability and cost of capital (WACC) cuts the technical potential by more than 3 times: from technically possible 32.4 Mtce to market reasonable 9.6 Mtce. But even with current energy prices and the 20% discount rate applied in investment decision-making, the market potential to improve energy efficiency in Uzbekistan amounts to approximately 14% of total primary energy use.

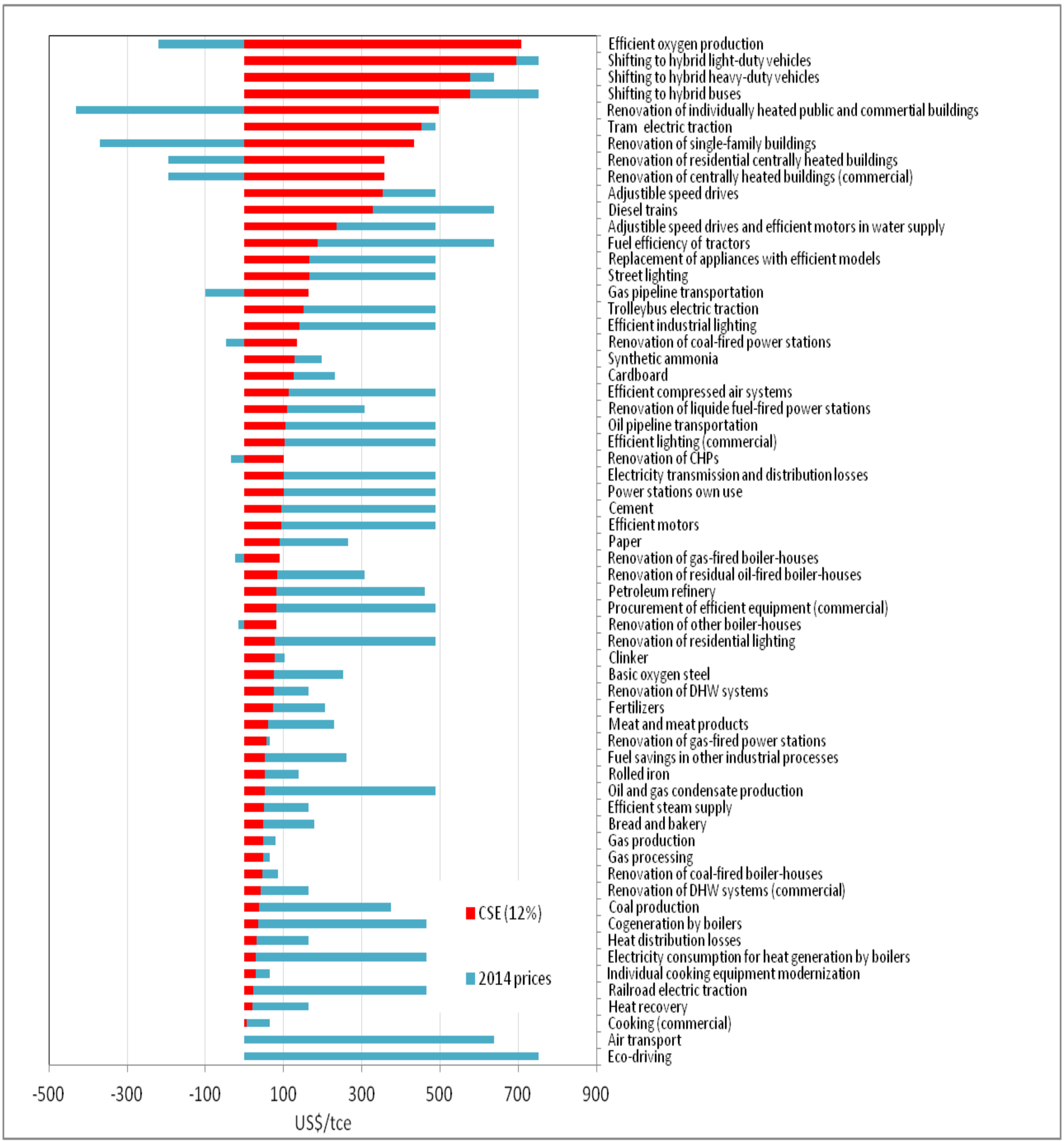
Figure 12.1 Economic energy efficiency potential for Uzbekistan (for 6% discount rate as of 2013)



The figure shows the costs of saved energy (red) and the gap between energy price in a given activity and the cost of saved energy (blue). Due to the fact that different energy carriers are used in individual activities, the price is average weighted for all energy carriers used. All prices are presented in US$/tce. If the gap is negative, the measure is considered economically not attractive and is excluded from the economic potential assessment.

Sources: CENEf

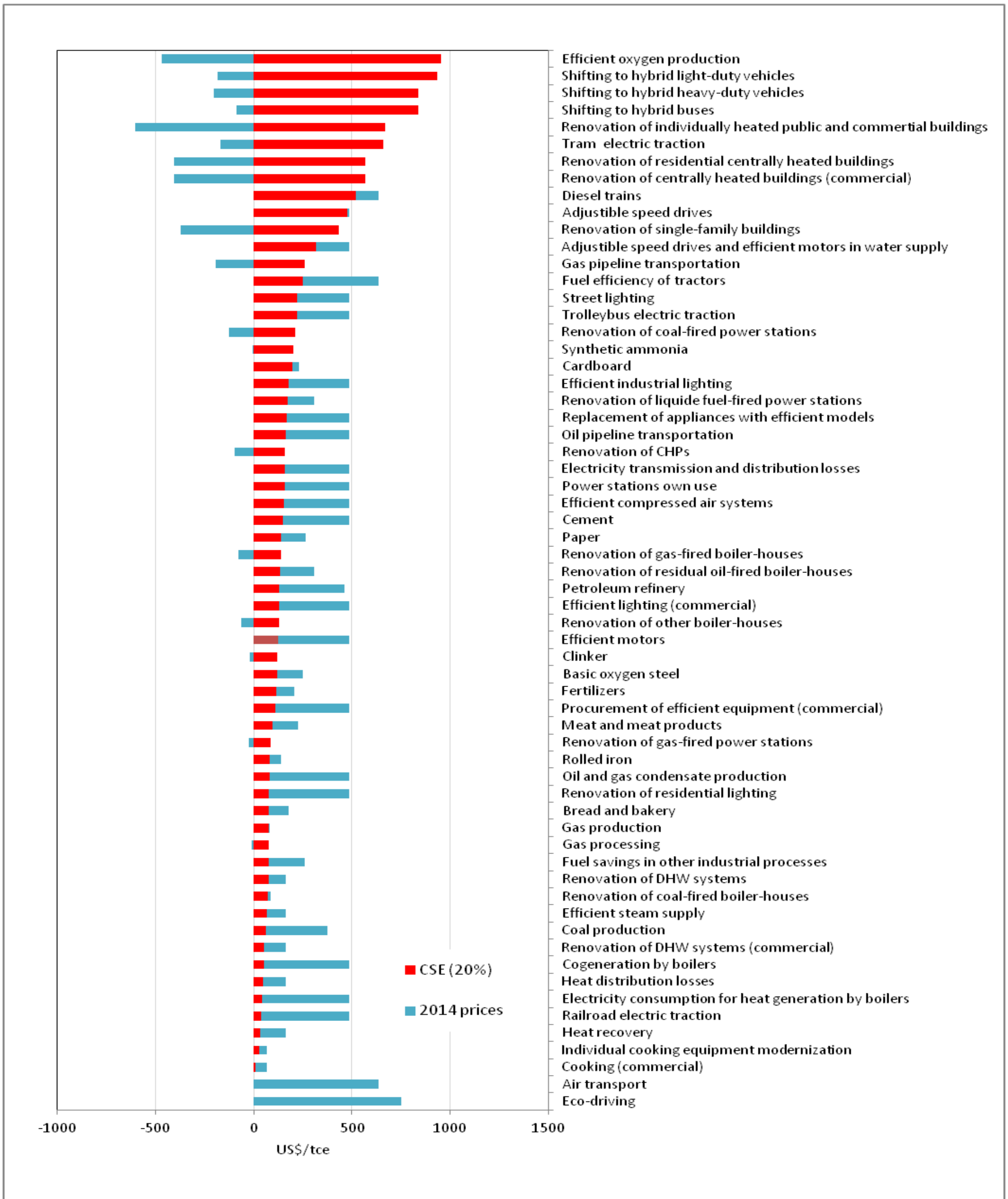
Figure 12.2 Market energy efficiency potential for Uzbekistan (for 12% discount rate as of 2013)



The figure shows the costs of saved energy (red) and the gap between energy price in a given activity and the cost of saved energy (blue). Due to the fact that different energy carriers are used in individual activities, the price is average weighted for all energy carriers used. All prices are presented in US$/tce. If the gap is negative, the measure is considered economically not attractive and is excluded from the market potential assessment.

Sources: CENEf

Figure 12.3 Market energy efficiency potential for Uzbekistan (for 20% discount rate as of 2013)



The figure shows the costs of saved energy (red) and the gap between energy price in a given activity and the cost of saved energy (blue). Due to the fact that different energy carriers are used in individual activities, the price is average weighted for all energy carriers used. All prices are presented in US$/tce. If the gap is negative, the measure is considered economically not attractive and is excluded from the market potential assessment.

Sources: CENEf

Section 13. Database on successful energy efficiency initiatives and activities

Compiling a database on successful energy efficiency initiatives and activities is a challenge. Energy efficiency projects, when announced, provide some information that may be attractive to the general public, but not to the experts who collect data on specific project parameters. In fact, a lot of important information is missing. In project appraisal documentation (in the case of projects financed by international banks and/or organizations) only project proposal information is presented (that is, if project documents are available at all). Many international banks and organizations have internal project monitoring systems, but project monitoring results are often not available for the general public or, if they are, only in formats that do not allow for the development of effective databases to track project outcomes. This is especially true in cases, when actual project implementation risks appear to be much higher, than originally estimated. Any information that may impair either client's or lender's reputation is held back.

Some projects are not targeted for energy efficiency, but have an energy efficiency component. Thus, key project indicators may not include energy efficiency parameters, and so energy efficiency progress is not monitored.

Where national energy efficiency initiatives and activities are in the focus, a monitoring system is often not even part of the project. So monitoring is mostly focused on the financing schedule, and to a much smaller degree (if at all) on the implementation of activities, leave alone energy savings.

In addition, there are intrinsic difficulties associated with monitoring project-generated savings. Monitoring requires accounting for other multiple factors directly and indirectly influencing the scale of energy use and savings. Complex decomposition analysis methods may be needed to eliminate the impacts of other factors. Data intensity and complexity of such methods does not allow for regular monitoring and identification of the energy savings generated by national energy efficiency initiatives and activities.

Database of successful energy efficiency initiatives and activities includes past successful country-specific energy efficiency initiatives and activities that have commenced or have a planned commencement date in the region. The results of these activities are presented in a spreadsheet database of initiatives including (but not limited to) the following:

- regional or country specific initiative;
- a detailed description of the initiative;
- the project timeframe, including any delays and the reasons for those;
- the budget or estimated budget;
- the savings expected from the initiative;
- the savings achieved as well as the method used to determine this (Measurement and Verification);
- challenges and barriers encountered or anticipated.

Not all available sources contain the above information. Therefore, in many instances only partial information may be provided. This is especially true in terms of actually spent budgets and actually generated savings. Monitoring of savings and project effectiveness is a regular procedure for many international projects, but even for those it is often difficult to find these assessments available to the public. Many of the activities initiated by the local implementers do not even specify monitoring of results as a programme activity, and no information on the results achieved is available. This is the reason why the database cells devoted to actual savings achieved are mostly blank.

All activities and initiatives were sorted by sectors. In addition, they were split into 3 groups: initiatives and activities launched by national programmes; projects financed by international organizations (UNDP, EU, etc.), by international financial institutions (WB Group, EBRD, EIB, ADB, IDB, etc.), or implemented as part of cooperation with other countries (USAID, dena, etc.); and all other activities and initiatives.

The Database is provided in the Excel spreadsheet format.

Section 14. Databases on contacts with local energy efficiency experts

The database on contacts with local energy efficiency expects is broken down by countries and by sectors of energy efficiency expertise. It includes local experts working in international organizations and international financial institutions located in a particular country along with local energy efficiency experts working in various national institutions. This database specifies: a person’s name, position, affiliation, and contact information (address, phone, fax, e-mail).

The database is provided in the Excel spreadsheet format.

ANNEX 1

Data sources for the evaluation of best available technologies energy efficiency parameters and incremental capital costs

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