Study on the application of energy efficiency and renewable energy advanced technologies in Central Asian Countries

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Executive summary

A summary of the Clean Energy Ministerial 2013 made by IEA contains specific recommendations and proposes supporting actions that can facilitate development and deployment of clean energy technologies and to realize the huge potential for energy and GHG emissions saving that exists around the world. The three key recommendations are:

- Level the playing field for clean energy technologies by
  - I) pricing energy appropriately and encourage investment in clean energy technologies;
  - II) develop policies to address energy systems as a whole; and
  - III) step-up the CCS challenge;
- Unlock the potential for energy efficiency by
  - I) implementing energy efficiency policies and enhancing efficiency standards; and
  - II) leveraging the role of energy providers in delivering energy efficiency;
- Accelerate energy innovation and public Research, Development and Demonstration (RD&D).

The importance of development and dissemination of advanced technologies for grasping the energy efficiency and renewable potential is recognized by all stakeholders around the world. Substantial finds are allocated by governments for research and development of energy efficient and renewable technologies. In addition to that governments are developing and implementing a range of policies that support the development and deployment of advanced technologies.

Overview of energy efficiency and renewable policies in EU, China, Japan and US (influencing clean energy technology development and deployment)

Power generation

Global coal deployment has risen over the last twenty years and in 2010 generation from coal was reported to be 28% higher than all non fossil sources. The global goal fired plants efficiency according to IEA is 33%, while with current state of the art technologies like Ultra-supercritical pulverised coal combustion (USC), efficiency up to 46 % can be achieved.

Some Governments around the world develop policies trying to reduce energy generation from inefficient units and limit CO2 emission from coal generation.

Directive 2010/75/EU on industrial emissions is the successor of the IPPC Directive and is setting stringent requirements in order to minimise pollution from various industrial sources throughout the European Union, including coal fired generation. Operators of industrial installations operating activities covered need to obtain an integrated permit from the authorities. The permit state the emission limit values, which must be based on the Best Available Techniques (BAT). BAT conclusions (documents containing information on the emission levels associated with the best available techniques) shall be the reference for setting permit conditions. Units that do not meet the requirements should be closed down by 2016.

US Environmental Protection Agency (EPA) in 2011 adopted the Cross-State Air Pollution Rule (CSAPR). The rule requires from states to significantly improve air quality by reducing power plant emissions that contribute to ozone and/or fine particle pollution. Other regulations targeting reduction of emissions from coal fired power plants include: Air Combustion Residuals Rule, Ozone Rule, Maximum Achievable Control Technology rule. Coal plants are likely to have SC or USC technology and with the continued shift to natural gas in the country, it is assumed that new coal fired power plants commissioning will be limited

In the period 2066-2011, approximately 85 GW of small and inefficient coal generating plants has been shut within the implementation of China's 11th Five Year Plan (FYP). China has highest rate of SC or USC units in the world. The 12th Five Year Plan (2011 to 2015) limits coal production to 3.8 billion tonnes by 2015 and introduces requirement to all plants of 600 MW to use SC or USC technology. It also explicitly calls for the retirement of small, ageing and inefficient coal plants and sends a strong message about the introduction of a national carbon trading scheme after 2020. As of 2014 new standards will be applicable, limiting mercury emissions for existing plants. The measures introduced in the 12th FYP are estimated to bring 17%decrease in the carbon intensity by 2015 and 40-45% by 2010.

According to IEA global natural gas fired generation has increased by 5 % between 2010 and 2012, however its further penetration and competitiveness is dependent on the existing market conditions and prices in different regions of the world. The main policies that can influence coal to gas switching of power plants include carbon emission trading schemes (examples EU ETS, Californian ETS), however current carbon prices are not stimulating for coal to gas switching.

End-Use energy efficiency

Industrial processes

Improving energy efficiency in energy intense industries like petrochemical, cement, aluminium, iron and steel by using best available techniques could reduce global energy consumption in industry by around 20% in medium and long term. Though most of the energy saving measures that could be applied are specific to the particular industries, certain policy actions can promote further the enhancement of the energy efficiency. Those include introduction of energy management in industries, minimum energy performance standards for energy motors, market transformation programs.

EU directive 2012/27/EU on energy efficiency requires periodic mandatory energy audits for energy intense industries and stipulates that Member states should introduce programmes to encourage SMEs to undergo energy audits and implement the recommendations of the audit. In addition to the directive requirements a number of EU member states have introduced voluntary agreements and programmes for large intensive industries including regular energy audits, target setting and reporting.

Various complementary policies that support and stimulate industrial energy efficiency like tax incentives, loan guarantees and risk sharing, low interest loans, etc. have been in place in a number of EU countries – e.g. UK, Germany.

The EU Ecodesign Directive provides a framework which allows setting mandatory Ecodesign requirements for some products. Since 2009 mandatory energy performance requirements have been introduced for electric motors.

The Japan Act on the Rational Use of Energy (amended in April 2010) sets mandatory energy efficiency targets in the form of benchmarks and 1% annual energy efficiency improvement obligation for all businesses. For designated sectors (Steel, Electricity, Cement, Paper & Pulp, Oil Refinery, Chemical), targets have been set at the energy efficiency level of the best performing companies (top 10% - 20%) within that industrial sub‐sector. These targets must be met in the medium (2015) and long term (2020). In addition the appointment of an energy manager and regular reporting is required from all industries in Japan, and energy intense companies are also obliged to prepare mid and long term energy efficiency plan.

Japan has implemented a tax system to promote investment in energy efficiency technology. This system allows individuals and corporations to claim a tax credit or a flexible depreciation for eligible equipment. The tax credit is equivalent to 7% of relevant equipment acquisition costs to be deducted from the corporate tax amount. This system applies to high-energy saving and high-efficiency equipment.

Several subsidy schemes to promote energy efficiency in all sectors of the economy, including industry are existing in Japan. For industry, the largest scheme in terms of financial volume is the scheme to promote installation of energy-efficient facilities. For larger companies in industry, grants can be given for large-scale investment projects introducing energy conservation equipment or technologies into existing factories and business facilities. One third of the investment cost for the project can be subsidized with an upper limit per project of ¥500 million.

The industrial energy conservation plan developed in China within the 12th Five Year Plan, puts specific targets to cut the energy consumption per unit of industrial value-added output and realize energy conservation. The Plan states the measures and approaches of energy conservation in energy intensive industries, key energy conservation projects and other policy support.

The Top 10,000 Energy-Consuming Enterprises Program aims to cover two thirds of China's total energy consumption, or 15,000 industrial enterprises that use more than 10,000 tonnes of coal equivalent (tce) per year. Industrial energy performance standards set minimum allowable energy efficiency values for existing plants and newly constructed plants, taking into account different types of raw materials, fuels, and capacities. In addition to mandatory minimum energy efficiency standards a set of voluntary, more advanced, have been established.

China introduced electric motors minimum efficiency performance standards in 2008. Furthermore, in 2009, as part of economic stimulus efforts, China implemented a programme to provide incentives to manufacturers for sales of motors that met the new standard, thereby increasing market share and easing the transition to the new standard.

ENERGY STAR programme for US Industry promotes the use of an energy management strategy to assist industry in measuring energy performance, setting goals, and tracking energy savings. The ENERGY STAR for Industry program focuses on energy efficiency in individual manufacturing sectors

Electric Motor Efficiency Standards require motor manufacturers to certify that their motors meet minimum efficiency values before they are allowed to sell their products. Energy performance standards exist for motors in US since 1997.

Building codes

Building energy codes are the main policy instrument to improve efficiency in building stock. The performance based building code is a complex code, that sets absolute minimum energy performance standards for building design and overall energy consumption for heating, cooling, ventilation, hot water, etc. On the other hand prescriptive building codes set requirements for each building element – walls, windows, etc. Other instruments enhancing energy efficiency of buildings include building certification schemes, energy labelling of buildings, financial incentive schemes.

The main policy instrument, related to energy use in buildings in EU is the Energy performance of buildings directive (EPBD recast 2010/31/EU). The directive introduced requirements for certification, inspection and renovations in buildings. Building energy codes are a key driver for implementing energy efficiency measures. Member states have developed and adopted schemes for implementation of EPBD and large variations exist in terms of approach at national level for the building codes application. Energy performance certificates are introduced for different buildings.

Building energy codes are mandatory for all buildings in China. According to China's annual national inspection of building energy efficiency in urban areas, the compliance rates with energy codes at both design and construction stages in urban areas have improved from 53% (design) and 21% (construction) in 2005 to 99.5% and 95.4%, respectively, in 2010.

The U.S. Department of Energy (DOE), through the Building Energy Codes Program (BECP), supports energy efficiency in buildings through the development and implementation of model codes and standards; however energy building codes are not mandatory at federal level. The international Energy Conservation code (IECC) and the ANSI/ASHREA/IESNA Standard 90.1 are the two baseline building codes that may be adopted by states. The IECC addresses all residential and commercial buildings; ASHRAE 90.1 covers commercial buildings and multifamily buildings three stories or less.

Energy using products

Energy efficiency standards and labels are sets of procedures and regulations that, respectively, prescribe the minimum energy performance of manufactured products and the informative labels on these indicating products' energy performance. They are the main policy instrument, used by governments to improve the energy use of products and have proved to be very successful over the years.

Despite the very positive trend in decreasing the energy consumption by various electrical appliances in different countries around the world, still considerable potential exists to reduce energy demand from energy using products including lighting.

The EU Ecodesign Directive establishes a framework under which manufacturers of energy-using products are obliged to reduce the energy consumption. All energy using products sold in the domestic, commercial and industrial sectors are covered by the Directive with the exception of all means of transport which are covered by other legislation. The revised Directive, which entered into force in November 2009, extends the scope of the existing Directive by covering in principle all energy-related products, windows, insulation materials, and certain water using products like shower heads or taps are expected to be covered as well..

The recast Energy Labelling Directive Directive 2010/30/EU extends the energy label to energy-related products in the commercial and industrial sectors, for example cold storage rooms and vending machines. The extension of the scope from energy-using to energy-related products (including construction products) means that the Directive covers any good having an impact on energy consumption during use. These products do not consume energy but "have a significant direct or indirect impact" on energy savings. Examples are window glazing and outer doors.

Japan does not have MEPS; instead it operates the Top Runner standards programme, which sets target values for energy efficiency performance in a future year based on the current highest efficiency level for each type of product. Until now 23 different product categories were covered by the programme, selected mainly from high energy using products.

A voluntary Energy Saving Labelling Program was launched in 2000 aimed at helping can lead consumers to compare energy efficiencies so that they can select products with higher energy efficiency when making a purchase. The labelling is applied to 16 products.

China is one of the world's largest manufacturers of household appliances, lighting, and other residential and commercial equipment. A core part of its 12th Five Year Plan part is the development and adoption of clean efficient energy technologies and energy standards and labels are a prominent element of that plan. China has currently introduced 46 minimum energy performance standards and expanded the coverage of the mandatory energy label to over 25 residential, commercial, and industrial products.

USA has a wide range of minimum energy performance standards, endorsement labels, and comparative labels to improve the energy efficiency of equipment and appliances. The U.S. Department of Energy's Appliances and Commercial Equipment Standards Program develops test procedures and minimum efficiency performance standards for residential appliances and commercial equipment. The first appliance standards were enacted in 1987, and since that time a series of laws and DOE regulations have established, and periodically updated, energy efficiency or water use standards for over 50 categories of appliances and equipment used in the residential, commercial and industrial sectors.

The U.S. DOE and the U.S. Environmental Protection Agency (EPA) jointly manage ENERGY STAR, a successful voluntary endorsement labelling program that began in 1992. The ENERGY STAR label is available for use on more than 60 product categories including home and office electronic equipment, buildings, and household appliances.

Renewable Energy Policies

The number of renewable energy policies is increasing world wide as recognition of its wide range of benefits that include: enhanced energy security, reduced import dependency, reduction of greenhouse gas emissions, improved health, job creation, rural development and wider energy access.

In general terms, countries or regions can implement policy measures for renewable energies through the establishment regulatory and planning instruments, the definition of economic incentives, market facilitation, public information and participatory or voluntary approaches.

Regulatory and Planning instruments refers to the setting of tools from central or local administration governments and include the definition of targets, regulatory principles, standards and codes, among other examples.

The most common renewable energy instruments are present in the domain of definition of targets and regulatory principles for market operation, tax incentives and public financing. The examples of the renewable energy incentive policies include the following: feed in tariffs; electric utility quota obligation, (RPS); net metering; obligations / mandate; tradable renewable energy certificates; targets (in primary energy, final energy or electricity).

Renewable energies and energy efficiency policies can be found at different levels encouraging the implementation of specific initiatives. There are examples of supra-national initiatives, national level policies, regional or state level, local level or even company level.

The Renewable Energy Directive 2009/28/EC established a European framework for the promotion of renewable energy, setting mandatory national renewable energy targets for achieving a 20% share of renewable energy in the final energy consumption and a 10% share of energy from renewable sources in transport by 2020. This Directive also requires the simplification of the administrative regimes faced by renewable energy, together with improvements to the electricity grid, to better allow access for electricity from renewable energy. It established a comprehensive sustainability scheme for bio fuels and bio liquids with compulsory monitoring and reporting requirements.

In order to comply with the Renewable Energy Directive, EU Member States have defined their own policies and ways to achieve the compulsory targets. A mix of different policies came to light in EU countries where several policy types can co-exist. Some of the implemented policies:

- Feed in Tariffs: this mechanism was widely used in some countries providing incentive to the development of wind energy and solar photovoltaic energy. Feed in Tariffs vary significantly among EU countries however countries applying this policy most extensively for renewable energy electricity are Germany and Spain. The UK has currently a feed in tariff specifically dedicated to renewable heat.
- In some European countries feed in tariffs are under revision, justified on the basis of strong growth and investment cost reduction. The revisions introducing retroactive changes resulted in considerable controversy and sometimes even in legal dispute.
- In Europe, France and Italy modified existing Feed in Tariff laws to include tenders for large-scale installations.
- Utility Quota Obligation or Renewable Portfolio Standard (RPS) requirements are being applied to obligated utilities of Member States like Sweden and Italy.
- Tradable Renewable Energy Certificates are being used in Austria and Denmark.
- Net metering is available in Belgium, Denmark and Italy.

The European Union Emissions Trading System (EU-ETS) is another important policy tool. It works on the cap and trade principle to limit the amount of greenhouse gases that can be emitted by factories, power plants and other installations. The system works by putting a price on CO_2 and thereby giving a financial value to each tonne of emissions saved. The cap is set to be reduced over time so that total emissions are forced to fall. The intention is that companies introduce energy efficiency measures and invest in cleaner forms of energy production.

Energy policy in United States is defined at State level, nevertheless at central level, Energy Policy Acts have been passed which include provisions and incentives for renewable energy development. In the United States most of the energy policy incentives take the form of financial incentives: tax breaks, tax reductions, tax exemptions, rebates, loans and specific funding. The targets of the US are to double renewable electricity generation from wind, solar and geothermal sources by 2020 (from 2012 levels).

After the Fukushima Daiichi nuclear power plant disaster following an earthquake in March 2011, energy policy in Japan has been reassessed. At long term the best energy mix should be determined within ten years, by evaluating performance of renewable energy, which is being increasingly introduced after a feed in tariff is in place since July 2012. Within the feed in tariff, solar PV power generation, as well as wind power, geothermal power and hydro power are subject to a specific tariff. Biomass is also subject of tariff on the specific uses of biogas, wood and waste. Hydropower of less than 1 MW and biomass projects are also currently supported by a Renewable Portfolio Standard type of incentive. A specific tax system is available for biomass using projects.

China is now committed to produce 11.4% of total energy from non-fossil fuels by 2015. The government has issued a number of standards for grid connection to solve the constraints of solar and wind development. To boost domestic consumption of renewable energies in China, the government set feed in tariffs, tax credits, preferential land use policies and a renewable energy surcharge.

Overview of the existing energy efficiency and renewable energy technologies applied in the Central Asian countries

The Central Asian countries who are members of the Energy Charter (the Republic of Kazakhstan, the Kyrgyz Republic, the Republic of Uzbekistan, the Republic of Tajikistan, and Turkmenistan) also signed the Energy Charter Protocol on Energy Efficiency and Related Environmental Aspects (ECPEEREA), which came into force in April 1998. The Protocol comprises the specific commitments of prime importance in enhancing energy efficiency and mitigating adverse environmental impacts.

The Central Asian countries have progressed in terms of the implementation of commitments both under ECPEEREA and other international agreements. However this progress has been variable – significant in some instances, yet minimal in others – and thus there is still much to do. Energy efficiency enhancement is yet to fully unleash its potential, particularly on the side of electricity demand (consumption).

Electricity Generation

CA countries are rich in fuel resources and top-ranked globally in coal, oil and gas reserves and water resources. Kazakhstan has the biggest coal and oil reserves, Uzbekistanis and Turkmenistan are rich in gas. Kyrgyzstan and Tajikistan are rich with water resources. The trend of fossil fuel use for electricity and heat production will remain in a long-term. In this case, the key areas in energy efficiency improvement involve new technologies of fossil fuel combustion, use of high-efficiency combined cycle and gas turbine installations, recovery of associated gases for electricity production.

Priority new energy efficient technologies which can potentially be used in coal-fired power generation in Central Asia include: supercritical steam technology (SC), ultra supercritical steam technology (USC), integrated gasification combined cycle (IGCC), and technologies based on fluidized systems (especially for combined heat and power plants). For gas-fired power generation they include: use of efficient open cycle gas turbines (OCGT) and combined cycle gas turbines (CCGT), and combined heat and power generation.

Energy efficiency in the power generation sector in Central Asia can be improved significantly by upgrading and improving efficiency in the existing power plants through advanced energy saving equipment, instruments, materials and automatic control systems; converting direct fuel combustion boilers to combined cycle installations; using new technologies of coal preparation;

optimizing demand management to flatten the load curve and secure reasonable loading in the grid. Significant reduction of transmission losses can be achieved through the upgrade and replacement of outdated and worn-out power and switching equipment at substations, the use of up-to-date dispatch control systems, relay protection and automation, and reactive power compensation and control systems.

Industry

The potential improvement of energy efficiency in industrial enterprises in CA countries is enormous, and is primarily associated with the modernization of obsolete equipment at all stages of the preparation and processing of raw materials and production of finished products, the introduction of automation and control systems (control and energy metering systems, automation systems, climate heating, ventilation , air conditioning, lighting and automation control systems of buildings), the use of modern materials (insulation, lubricants). Industry is represented by the following main sectors: non-ferrous industry; ferrous industry; chemical, oil refinery and petrochemical industry; machine building; paper and pulp industry; industry of construction materials, etc.

The deployment of best available technologies for cement, iron and steel, chemical and petrochemical, food, machinery and other industries is an important condition to active global increase in industrial energy efficiency. Special attention shall be given to energy saving technologies for electric motor drive systems (EMDS). EMDS are responsible for more than 40% of the global electricity demand as well as for about 69% of global industry electricity consumption. Even though that technologies exist to reduce the consumption by 20% to 30% they are still not fully implemented.

Production of iron and steel includes numerous processes. The main processes are coke making, sintering, smelting in blast furnace, casting and steel rolling.

Power consumption can be reduced through application of various technologies including dry coke quenching, recovery of exhaust gas of coke ovens to heat the raw materials, coal pulverisation, gas injection, heat recuperation from air heaters, coal moisture control, top pressure recovery turbines, increased blast furnace top pressure, emissions optimized sintering, application of new insulating materials, flameless burners, thin slab casting and many others.

Key energy-saving measures in machine building and metallurgy include: application of fibre high-efficiency refractory and heat-insulation materials for lining of industrial furnaces; application of thyristor frequency converters in metal induction heating for forging and thermal treatment process; transition from hot pressing to stamping and cold pressing; application of advanced gas burner units; application of recuperative, flat-flame and impulse burners; application of efficient heat carrier routing (counterflow, U-shaped furnaces with recuperation zones, forced convection, flame and thermal curtains, recycling of combustion products); application of recuperative and reclamation devices; expansion of powder metallurgical technique use; heating process automation in furnaces of various applications.

The cement production includes raw material preparation, fuel preparation, clinker making, cooling and grinding. Efficiency can be improved at each stage of production. For example use alternative raw materials, i.e. replacement of limestone with materials which do contain CO_2; this will allow to reduce CO_2 emissions and fuel consumption for calcination; use alternative fuels, i.e., partially or fully replace hard coal or lignite which have high specific CO_2 emission values of combustion; use high efficiency vertical roller mills, classifiers/separators for more precise separation, mixers; use high-efficiency cooling systems (clinker coolers) and heat recovery systems; improve insulation and application of multistage pre-heater stages for clinker preparation.

Chemical and petrochemical industries have various technological processes producing and consuming a lot of heat. Coal, oil and gas are used both as fuel and raw material. However a great portion of the processed energy resources can cover 50% of auxiliary heat demand. This problem requires development and implementation of combined energy technology system integrating energy and thermal power systems to provide higher economic efficiency in achieving target of energy and technology production.

Energy saving and energy efficiency improvement at chemical enterprises is oriented at improvement of the existing technology processes and equipment in production of calcined and caustic soda; deployment of large installations for methanol production; use of gas-phase ethylene polymerization in polyethylene production; upgrading and enlargement of unit capacity of plants in production of chemical fibre; development of membrane technology for separation of fluid and gaseous mediums; development and deployment of production of chlorine and caustic soda in membrane sell; increase in share of orifice method in production of caustic soda; application of high-activity catalysts; production of ethyl aldehyde through direct oxidation of ethen by oxygen; wide deployment of technological process automation.

Pulp and paper production is a very energy intensive industry where the most of energy saving potential relates to the improvement of the cellulose (chemical or mechanical) preparation process, steam generation and heat power recovery systems, drying and bleaching systems. The main areas where the heat demand could be reduced are: 1) infrared radiation; 2) high frequency and microwave heating; 3) heat pumps.

The main glass production stages, which are the most attractive for improvement of energy efficiency, include batch preparation, melting and refining, conditioning and forming. The energy efficiency potential in this industry sector includes improvement of process management, higher rate of scrap glass recycling, increased size of furnaces, use of waste heat in the batch and scrap glass preheating systems or for steam generation, use of oxy-fuel.

Building and housing

All Central Asian countries in the recent past were a part of one country with uniform standards in the building and housing sector. Therefore, the problems they face in housing and public utilities services and building and construction are similar. The same is true for energy efficiency technologies that are used or recommended for use in these countries for the existing and new buildings.

Development and enforcement of strict building codes for new and existing buildings is a fundamental step in increasing the energy performance of buildings. Additional measures and complementary policies might include the introduction of financial incentives, building certificate schemes, schemes that support zero or nearly-zero building construction, etc.

Significant energy saving in the construction sector can be achieved through the use of up-to-date and advanced technologies and materials – building envelope materials, windows, shading, air filtration, heating ventilation and cooling systems, hot water, automation, etc.

Various advanced energy efficient building technologies have already been used in Central Asia for heating, cooling and ventilation, lighting, appliances and energy using equipment. There are advanced technologies for heating and cooling that can also be used in the Central Asian countries, e.g. active solar thermal, application of heat pumps for heating and cooling, co-generation in buildings, however the pace of their deployment is low mainly due to their high investment cost.

Key measures to improve energy savings in the utilities sector include modernization of heating and electricity supply systems; significant result can also be achieved through replacement of heat distribution units at local heat distribution stations and distribution piping adjustment, installation of temperature control units and individual consumption meters. The basic task aimed at introduction of energy efficient technologies is to equip all consumers with energy monitoring and metering devices

Transport

All countries of this region has developed railway, motor and air transport which facilitates the use of commercially available energy-efficiency technologies in this sector in all CA countries.

Energy efficiency of transportation (by air, rail, motorway) is first of all the efficient fuel consumption. The solution lies in further reducing of the weight of design, improving of the aerodynamic performance of vehicles, using of alternative fuels (combined use of fuels), improving of the fleet, and improving of management and logistics.

Key areas of energy efficiency improvement in the railway industry include: railway electrification; use of liquefied natural gas instead of petroleum fuels; use of advanced locomotives with better efficiency engines; reduction of energy losses at railway electric substations; upgrading of heat supply to railway stations.

Agricultural Sector

Agriculture is another developed sector in all Central Asian countries. The issues of energy efficiency improvement and energy saving in the sector as well as applied technologies (irrigation systems, agricultural buildings and structures, applied specialized machinery and specific technological processes) are similar in all the countries in the region. Energy efficient management can be achieved through the use of combined machinery for tillage operations, energy efficient pumping equipment for irrigation systems, improvement of the machinery fleet, adoption of systems using animal waste for energy generation (biogas units), and utilization of exhaust air heat from the ventilation of livestock houses to heat water and premises.

Energy using products

Policies to limit or phase out inefficient products are crucial for faster deployment of energy efficiency products and equipment. Such policies need to be properly enforced as well as complemented by measures to provide information and increase public awareness (e.g. labels) to ensure maximum take up for most efficient products.

Renewable energy sources

At the same time, thanks to geographic location the CA countries could use the renewables for electricity and heat production. The new technologies and renewables can be used both in stand-alone (mini hydro and wind installations, solar collectors) and for large installations (HPP, wind and solar power plants). Application of all these technologies depends on the nature of the renewable source, location of the specific project (how are it is from its consumer and from the transmission infrastructure) thus affecting its economic characteristics.

Wind is a renewable energy variable source and can be used by wind turbines which transform the kinetic energy of the wind into electricity. Wind energy is the fastest growing energy source of global electricity generation, accounting for about 280 GW worldwide in 2012.

Electricity can be generated when wind speeds exceed 13 kilometres per hour (km/h) and most large wind turbines shut down for safety reasons when wind speeds exceed about 90 km/h.

Wind turbines can be installed in onshore or offshore (not far from the coast) taking advantage of the best wind conditions. Typical project lifetime capital costs can represent 75% to 80% for onshore, whereas 30% to 50% for offshore installations. Therefore operation and maintenance costs are significantly higher in offshore situations.

There are currently about a dozen of wind turbine manufacturers in the world mainly producing in Europe, Asia and America.

Direct solar energy can be used in different forms. The main technologies using this renewable energy sources are: solar thermal collectors; solar photovoltaic (PV) systems; and concentrated solar power (CSP).

Solar thermal collectors are devices that convey the solar radiation and its resulting heat to a heat transfer medium (fluid or air). The medium could be then used directly or in a heat exchanger. Typical applications include domestic, services or industrial hot water production, swimming pool heating, space heating and industrial drying.

A typical domestic hot water thermosiphon system for a single family house has a 2 to 5 sq. meters of collector area and a 100 to 200 litre tank. Whereas a typical forced circulation system for one dwelling has 3-6 sq. meters of collector area and a 150-400 litre tank. Collective systems or multi-purpose systems have a collector surface ranging from ten to several hundred square metres, depending on the energy needs.

Photovoltaic (PV) cells use semiconductor material to convert solar radiation into direct current electricity. In a photovoltaic system, solar modules are typically rated 200 Watt. The solar modules are the arranged in arrays to produce commercial electricity or power large buildings.

Typical conversion efficiencies of PV cells vary between five to 26%. Higher efficiencies are possible in emerging technologies like concentrated solar PV (CPV) that use optics to increase incoming solar radiation.

Production of solar PV systems could also be increased in absolute terms if solar trackers are used. These devices hold the solar modules and automatically follow the apparent movement of the sun. They are available in a one axis or a two axis option of movement.

Within solar PV there are several technologies available depending on the semiconductor material used and on the way it is assembled. Cells deposited on flexible substrates and thin film options are already available in the market. The main options are: crystalline silicon (mono or polycrystalline), amorphous silicon, Cadmium Telluride and Copper Indium/gallium Diselenide/disulphide (CIS, CIGS). New PV products are also coming to the market in the form of organic photovoltaic materials like electronic inks and electronic polymers.

Current practice show that the main constraints for PV development are not on the technology, the source, nor the costs but mostly on its relationship to electricity grids.

Currently the solar PV installed capacity worldwide is of 104 GW. The top countries of PV installed capacity in 2011 were Italy (9 304 MW), Germany (7 500 MW), China (2 500 MW) and US (1 867 MW).

The concentrated solar power (CSP) systems use lenses or mirrors to concentrate sunlight onto a small area. Solar radiation is then converted to heat which drives a heat engine connected to an electrical power generator. There are three main types of technologies available: parabolic trough, Fresnel reflectors and power tower or solar tower. US and Spain concentrate most of worlds CSP projects with an installed capacity of 1 GW and 500 MW respectively.

Hydropower is generally divided into two categories: large-scale installations and small-scale installations. The first usually features dam applications with large water reservoirs and the latter feature limited storage or have configurations of “run-of-river” type. The division of capacities between large and small scale depend on the definition of each national authority.

Large hydro developments are often constrained by environmental and social considerations rather than economic or technical factors. These factors affect the long permitting, planning and construction timelines.

Hydropower is one of the most well known technologies where the learning curve has already been completely achieved. Most of the development costs relate to the transmission infrastructure, as they are often located in remote areas away from existing infrastructure. Operating costs are generally significantly low and a hydro power plant can have a lifetime of about 70 years.

Run of river installations require little or no water storage, minimizing social and environmental impacts.

The dispersion of hydro energy is quite good around the world and the current total installed capacity of smaller installations is of 186 GW.

Biomass is available for energy use in several forms, and include plant materials, algae, manure, waste oils, animal fats, urban and farm wastes, waste waters. These products can be then burned, gasified, or converted into liquid fuels. There are a multitude of pathways to deliver electricity generation, heat or combustion fuels from biomass resources.

Biomass and waste to energy account for about 66 GW of the current total installed capacity for electricity generation in the world.

Ground source heat pumps or geothermal heat pumps are often included as a category of geothermal energy, however, it uses at very shallow depths (2 to less than 100 meters) the thermal inertia of the soil. This energy source makes use of the fairly constant temperatures of the soil all around the year, providing heating in winter and cooling in summer (acting as heating sink). This enables electrically driven heat pumps to deliver low-temperature space heating or cooling all year round at coefficient of performance (COP) ratios in the range of 2.5 to 5.2 and 16 to 42 Energy Efficiency Rating (EER).

Ground source systems have two pipe systems, a primary one is a refrigerant loop used at the appliance cabinet as heat exchanger and the secondary one, a water loop buried in the ground. There are several possibilities of running pipe loops: horizontal installations, vertical installations, pond loops and opens loops. The choice of solution depends on the heating and cooling needs and on the characteristics of the available surrounding area. Most units are easy to install, especially when they are replacing another forced-air system. They can be installed in areas unsuitable for fossil fuel furnaces because there is no combustion and thus no need to vent exhaust fumes. Ductwork must be installed in homes without an existing air distribution system. This solution is one of the most energy-efficient, environmentally clean and cost-effective space conditioning available and it can be applied to residential and services sector. Leading countries using geothermal heat pumps are located in Europe and North America.

Table 4.1 represents the database of renewable energy technologies. Table 4.2 represents the list of manufacturers/distributors of renewable energy technologies.

First of all, in order to stimulate the use of renewable energy sources in the region it is reasonable to promote the construction of mini hydropower plants, the construction of low capacity standalone wind power plants to supply electricity to isolated consumers, the construction of moderate capacity wind farms to supply electricity to remote communities, the installation of solar collectors for water heating, the use of low capacity heat pumping plants to supply heat to various industrial and agricultural facilities and private households and premises, and the use of biogas units. Further into future this may include the construction of wind farms with high capacity equipment to be used in the synchronized power systems, and the construction of solar photovoltaic systems.

Databases for energy-efficiency technologies and their application

The global experience of deployment of energy-efficiency and resource-saving technologies is also applicable in the countries of Central Asia. The existing databases for energy-efficiency and resource-saving technologies for different industry sectors, transport and agriculture are invaluable for the experts in the region.

Based on experience of EU countries, Norway and Croatia, ODYSSEE database was created; it contains data on energy efficiency indicators in industry branches, agriculture and transport and can be found at http://www.odyssee-indicators.org/database/database.php. Analysis of energy efficiency technologies (existing and future) used for power supply (supply of primary energy sources, transportation and distribution, production of electricity and heat) and consumption (industry, transport and utilities) is given at the web-site of Energy Technology Systems Analysis Program, International Energy Agency:http://www.iea-etsap.org/web/E-TechDS/Technology.asp. The web-site http://e3tnw.org/ of Washington State University (Extension Energy Programme) represents database which includes the following key application areas of energy-efficiency technologies: building insulation, compressors, electricity distribution (SMART grids), energy management, cooking, air conditioning control, irrigation, lighting, electric motor, cooling and water heater. Use of renewable energy sources and emerging renewable energy technologies are given in detail at the web-site of National Renewable Energy Laboratory (USA) - http://www.nrel.gov/science_technology/.

Studies and review of energy-efficiency technologies are given at the web-site of International Energy Studies Group (Lawrence Berkeley National Laboratory (USA)) - http://ies.lbl.gov, at multifunctional public internet portal Energy-efficient Russia of the Russian Energy Agency - http://energohelp.net/articles/. List of energy-efficiency technologies is being prepared by the Russian Union of Industrialists and Entrepreneurs http://www.rspp.ru/simplepage/481. Table 4.3 represents a number of the energy efficient technologies by industries, manufacturers/developers of which operate or have their representative offices close to or in the Central Asia.

Major sources of financing

The significant portion of energy efficiency and renewable energies potential has not yet been fulfilled yet in Central Asia because of several existing barriers. End-user electricity and gas prices subsidized, misaligned financial incentives, high upfront investment costs, long simple pay-back time of some investments, as well as the non-internalisation of the carbon costs, form the economic and financial barriers to a further deployment of these technical and technological solutions.

Various known financial instruments shall be used by the governments of the Central Asian countries in order to finance energy efficiency and renewable energy projects, using best available technologies. The main options that shall be used include public or private capital budgets (direct investment, subsidies, and grants), debt financing (loans, lease, and guarantees), Energy Services Companies (ESCOs) and carbon financing. To stimulate private investors, various economic instruments shall also be used by governments as price incentives.

The public sector should play a leadership role by demonstrating the potential of energy efficiency to reduce energy consumption and showcasing new technologies and energy management. Government should stimulate and support different solutions like bundling of similar projects (e.g. schools, hospitals, etc) in order to attract large scale financing providers. Introduction of specific rules governing the public procurement of energy, introduction of regulatory frameworks that can attract additional financial cash flow should be commonly used (e.g. energy saving obligation schemes for utilities and green and white tradable certificates). Removing barriers to private sector investments should be another way for government to provide support.

Governments need to introduce supportive policies and legislation, as well as introduce cost-reflective energy price as one of the main factors influencing the demand of energy efficiency investments. The liberalisation of the energy markets in Central Asia is also an important enabling factor in order to create the right market conditions for Energy Service Companies to operate.

Nowadays, international financial institutions and donors play a key role in setting up different financial mechanisms for energy efficiency and renewable energy projects. This is done in several ways – by providing technical assistance to the governments in the region to improve regulatory and investment frameworks in order to attract investments in the sector and by direct involvement in the design and the financing of specific mechanisms and projects.

Table 5.1 below provides detailed overview of the main regional and bilateral donors and international financial institutions, which are involved in different financial schemes and projects in the area of energy efficiency and renewable energy sources in the five Central Asian Countries.

As it is seen from the international financial institutions strategies for the next few years, their priorities for the region are moving towards providing support to demand side energy efficiency as well as to stimulate investments in renewable energy.

Section 1: Introduction

In recent times throughout various regions of the world the international community has been putting more emphasis on energy efficiency and renewable power. In principle, all governments understand the importance of extending and propagating advanced technologies in renewable energy and energy efficiency, as reflected in the concepts of national sustainable development. Energy efficiency and renewables-based power systems are understood as instruments to solve climate change and environmental problems, alleviate energy poverty and restore the competitiveness of national economies.

Considerable attention is given to this issue by both UN and other interstate and international organizations. Significant funds are allocated by national governments, international financial institutions and non-governmental organizations and foundations for the research and development of energy efficiency and conservation technologies and for the introduction of renewables.

This study presents an overview of the policies pertaining to energy efficiency and renewables use in the European Union, the United States, Japan and China, and the role of international organizations in propagating state-of-the-art technologies in energy efficiency and renewables. A brief overview of existing technologies as well as manufacturing issues is presented, together with a review of a number of advanced technologies in energy efficiency and renewables which can be successfully implemented in the Central Asian region to meet the requirements of sustainable energy development.

The Central Asian countries who are members of the Energy Charter (the Republic of Kazakhstan, the Kyrgyz Republic, the Republic of Uzbekistan, the Republic of Tajikistan, and Turkmenistan) also signed the Energy Charter Protocol on Energy Efficiency and Related Environmental Aspects (ECPEEREA), which came into force in April 1998. The Protocol comprises the specific commitments of prime importance in enhancing energy efficiency and mitigating adverse environmental impacts, and particularly specifies that the signatory states shall:

- Define energy efficiency policy and establish the programmed objectives and strategies;
- Establish legal frameworks contributing to energy efficiency;
- Elaborate, implement and update the programmes which may, *inter alia,* envisage the following measures: economic and environmental appraisal of the actions, standards setting, innovative approaches to capital investments in energy efficiency, development of databases, support of combined electricity and heat production;
- Ensure proper institutional and legal frameworks;
- Engage in international cooperation/assistance as well as promote management technologies, services and methods in the whole energy cycle from exploration and production to electricity consumption in any sector of the economy.

The Central Asian countries have progressed in terms of the implementation of commitments both under ECPEEREA and other international agreements. However this progress has been variable – significant in some instances, yet minimal in others – and thus there is still much to do. Energy efficiency enhancement is yet to fully unleash its potential, particularly on the side of electricity demand (consumption).

The Central Asian countries are notable for their advanced industrial systems, specifically in the following industries: ferrous and non-ferrous metallurgy; chemical, oil refining and petrochemical; mechanical engineering; fuel (oil, gas and coal extraction); mining; construction materials; pulp and paper; food and light industries. The construction, housing and utilities sector, transport (railway, motor, air) and agriculture are also highly developed. The study outlines a number of databases on energy-efficient technologies developed in the United States, the European Union, the Russian Federation and by the International Energy Agency.

The potential of demand-side energy efficiency is tremendous. At the same time the Central Asian countries can significantly improve energy efficiency through fossil fuel electricity and heat production using advanced technologies in modernized and new coal and gas power plants – an issue also addressed in the study.

The study reviews the whole range of advanced technologies suitable for Central Asia and oriented towards renewables-based power plants, since the region possesses significant resources of all major types of renewables.

The study focuses on the main sources of finance for boosting advanced technologies in the sphere of energy efficiency and renewables in Central Asia, both for the time being and in the near future. International organizations, being currently among the major players in financing and boosting energy efficiency and renewables in Central Asia, will further and regularly assist in consulting the Central Asian countries in terms of policies and the sharing of know-how and experience to enable them to boost energy efficiency performance figures.

Section 2: Overview of energy efficiency and renewable policies in EU, China, Japan and US (influencing clean energy technology development and deployment)

IEA in its input to Clean Energy Ministerial 2013 makes specific recommendations and proposes supporting actions that can facilitate development and deployment of clean energy technologies and to realize the huge potential for energy and GHG emissions saving that exists around the world. The three key recommendations are:

- Level the playing field for clean energy technologies by
  - I) pricing energy appropriately and encourage investment in clean energy technologies;
  - II) develop policies to address energy systems as a whole; and
  - III) step-up the CCS challenge;
- Unlock the potential for energy efficiency by
  - I) implementing energy efficiency policies and enhancing efficiency standards; and
  - II) leveraging the role of energy providers in delivering energy efficiency;
- Accelerate energy innovation and public Research, Development and Demonstration (RD&D).

The importance of development and dissemination of advanced technologies for grasping the energy efficiency and renewable potential is recognized by all stakeholders around the world. Substantial finds are allocated by governments for research and development of energy efficient and renewable technologies. In addition to that governments are developing and implementing a range of policies that support the development and deployment of advanced technologies.

The following section will review the main advanced technologies, applicable in various sectors as well as existing policies, supporting the development and deployment of these technologies in EU, Japan, China and US.

2.1 Power generation

Power generation – coal

Global coal deployment has risen over the last twenty years and in 2010 generation from coal was reported to be 28% higher than all non fossil sources. In Asia, coal demand is growing particularly in China and India. In Europe due to lower prices of coal and increase of imports of cheap coal form USA, a significant increase of the coal generation is registered in first half of 2012 mainly in Spain (65%), UK (35%) and Germany (8%).

The global goal fired plants efficiency according to IEA[1] is 33%, while with current state of the art technologies like Ultra-supercritical pulverised coal combustion (USC), efficiency up to 46 % can be achieved. However despite the availability of technologies still too many inefficient power plants are being constructed.

[1] Tracking clean energy progress, 2013

Advance technologies are being developed in Europe, USA and Japan for years; recently other countries are also introducing research and development programmes (China, Russia). The main efficient and less carbon intensive technologies existing and under development for coal generation include:

- Higher efficiency, lower emissions coal technologies - including single pulverised coal combustion (SC) .
- Ultra-supercritical pulverised coal combustion (USC) and
- Integrated gasification combined cycle (IGCC) – due to very high cost, current efforts are on improving reliability and reducing cost
- Carbon Capture and Storage (CCS) – yet to be demonstrated at commercial scale

Some Governments around the world develop policies trying to reduce generation from inefficient units and limit CO2 emission from coal generation.

European Union

Directive 2010/75/EU on industrial emissions is the successor of the IPPC Directive and is setting stringent requirements in order to minimise pollution from various industrial sources throughout the European Union, including coal fired generation. Operators of industrial installations operating activities covered need to obtain an integrated permit from the authorities. The permit state the emission limit values, which must be based on the Best Available Techniques (BAT). BAT conclusions (documents containing information on the emission levels associated with the best available techniques) shall be the reference for setting permit conditions. Units that do not meet the requirements should be closed down by 2016.

The EU Emission Trading Scheme (ETS) was introduced in 2005. Within the scheme a cap or limit is set on the total amount of green house gases that can be emitted by power plants and other installations. Within their cap companies receive allowance, which can be traded. The emission reductions achieved through the implementation of the first two faces 2005-2008 and 2009-2012 were estimated to be around 21%.

USA

US Environmental Protection Agency (EPA) in 2011 adopted the Cross-State Air Pollution Rule (CSAPR). The rule requires from states to significantly improve air quality by reducing power plant emissions that contribute to ozone and/or fine particle pollution. Other regulations targeting reduction of emissions from coal fired power plants include: Air Combustion Residuals Rule, Ozone Rule, Maximum Achievable Control Technology rule. Coal plants are likely to have SC or USC technology and with the continued shift to natural gas in the country, it is assumed that new coal fired power plants commissioning will be limited

China

In the period 2066-2011, approximately 85 GW of small and inefficient coal generating plants has been shut within the implementation of China's 11th Five Year Plan (FYP). China has highest rate of SC or USC units in the world. The 12th Five Year Plan (2011 to 2015) limits coal production to 3.8 billion tonnes by 2015 and introduces requirement to all plants of 600 MW to use SC or USC technology. It also explicitly calls for the retirement of small, ageing and inefficient coal plants and sends a strong message about the introduction of a national carbon trading scheme after 2020. As of 2014 new standards will be applicable, limiting mercury emissions for existing plants. The measures introduced in the 12th FYP are estimated to bring 17%decrease in the carbon intensity by 2015.

Japan

Coal fired power plants produce around a quarter of the total electricity generated in Japan. As a result of taking various environmental measures and introduction of best available technologies at thermal power plants, Japan has achieved the world's top-level energy efficiency[2]. It is estimated that the introduction of Japanese technologies to coal-fired power plants in three big countries alone, namely the United States, China and India, could reduce emissions by approx. 1.3 billion tons-CO_2/year, which is almost equivalent to the total annual CO_2 emissions in Japan today. According to the Electricity review 2013, sulphur oxides and nitrogen oxides emissions from Japanese thermal power plants are reported to be within the level of 0.2 g/kWh.

Power generation – natural gas

According to IEA[3] global natural gas fired generation has increased by 5 % between 2010 and 2012, however its further penetration and competitiveness is dependent on the existing market conditions and prices in different regions of the world. In USA the process of converting power plants from coal to gas is continuing, following the shale gas revolution in United States, but in Europe an opposite trend is observed in first half of 2012 (drop of 15 % in gas fired generation in Germany, 12% in Spain and 33% in UK)

The main policies that can influence coal to gas switching of power plants include carbon emission trading schemes (examples EU ETS, Californian ETS), however current carbon prices are not stimulating for coal to gas switching.

2.2 End-Use energy efficiency

Industrial processes

Improving energy efficiency in energy intense industries like petrochemical, cement, aluminium, iron and steel by using Best available techniques could reduce global energy consumption in industry by around 20% in medium and long term. Though most of the energy saving measures that could be applied are specific to the particular industries, certain policy actions can promote further the enhancement of the energy efficiency. Those include introduction of energy management in industries, minimum energy performance standards for energy motors, market transformation programs.

European Union

EU directive 2012/27/EU on energy efficiency requires periodic mandatory energy audits for energy intense industries and stipulates that Member states should introduce programmes to encourage SMEs to undergo energy audits and implement the recommendations of the audit. In addition to the directive requirements a number of EU member states have introduced voluntary agreements and programmes for large intensive industries including regular energy audits, target setting and reporting.

[2] 2013 Electricity review by the Federation of electricity power companies of Japan
[3] Tracking clean energy progress, 2013

According to voluntary agreements made on a sector level with industry in the Netherlands, companies commit to an energy efficiency target (2% per year), an energy efficiency plan, define measures and a timeline.

Since 1996 Denmark has used voluntary agreements on energy efficiency as an important instrument to improve the energy efficiency in industry. The voluntary agreement scheme is closely integrated with the Green Tax Package as companies, who enter an agreement, receive a rebate on the green taxes. By 2004 approximately 280 Danish companies have entered an agreement, representing more than 50 per cent of the total energy consumption in the industry.

In Germany a scheme exists that provides a subsidy as well as technical advice to SMEs that are willing to undergo an energy audit and introduce energy management programme.

Various complementary policies that support and stimulate industrial energy efficiency like tax incentives, loan guarantees and risk sharing, low interest loans, etc. have been in place in a number of EU countries – e.g. UK, Germany.

The EU Ecodesign Directive provides a framework which allows setting mandatory Ecodesign requirements for some products. Since 2009 mandatory energy performance requirements have been introduced for electric motors and the annual savings until 20120 are estimated to the amount of 135 TWh. The requirements cover IE2 (high efficiency); IE3 (Premium efficiency) or IE2+VSD, 7.5 kW - 375 kW from 2015 and IE3 or IE2+VSD, 0.75 kW - 375 kW from 2017.

Japan

The Japan Act on the Rational Use of Energy (amended in April 2010) sets mandatory energy efficiency targets in the form of benchmarks and 1% annual energy efficiency improvement obligation for all businesses. For designated sectors (Steel, Electricity, Cement, Paper & Pulp, Oil Refinery, Chemical), targets have been set at the energy efficiency level of the best performing companies (top 10% - 20%) within that industrial sub - sector. These targets must be met in the medium (2015) and long term (2020). A higher level target can be adopted in the future if further energy - saving potentials can be taken into account. The benchmarks are based on sector studies and are negotiated between government and the sector, although it is unclear whether international or domestic benchmarks are being used. Every year, companies must report progress on status of the benchmarking indicator, energy intensity reduction (by at least 1% annually) and the status of its energy management system. Based on companies' reports, the indicator's average value and standard deviation for each sub - sector will be published by the government.

In addition the appointment of an energy manager and regular reporting is required from all industries in Japan, and energy intense companies are also obliged to prepare mid and long term energy efficiency plan.

Japan has implemented a tax system to promote investment in energy efficiency technology. This system allows individuals and corporations to claim a tax credit or a flexible depreciation for eligible equipment. The tax credit is equivalent to 7% of relevant equipment acquisition costs to be deducted from the corporate tax amount. This system applies to high-energy saving and high-efficiency equipment.

Several subsidy schemes to promote energy efficiency in all sectors of the economy, including industry are existing in Japan. For industry, the largest scheme in terms of financial volume is the scheme to promote installation of energy-efficient facilities. For larger companies in industry, grants can be given for large-scale investment projects introducing energy conservation equipment or technologies into existing factories and business facilities. One third of the investment cost for the project can be subsidized with an upper limit per project of ¥500 million.

China

The industrial energy conservation plan developed within the 12th Five Year Plan, puts specific targets to cut the energy consumption per unit of industrial value-added output and realize energy conservation. The Plan states the measures and approaches of energy conservation in energy intensive industries, key energy conservation projects and other policy support.

The Top 10,000 Energy-Consuming Enterprises Program aims to cover two thirds of China's total energy consumption, or 15,000 industrial enterprises that use more than 10,000 tonnes of coal equivalent (tce) per year. The key elements of the Top 10,000 Program include establishment of energy conservation working groups in enterprises, implementation of the target set per enterprise, allocating targets to companies, conducting energy audits and developing energy conservation plans, conducting energy efficiency benchmarking, continuation of phasing-out of backward technologies. The saving target is disaggregated to local provinces and cities which estimate total energy-saving targets for their provinces and submit the proposed targets to the central government. Financial rewards are provided to enterprises that achieved energy savings through technical renovation projects within the Energy-Saving Technical Retrofits program

Industrial energy performance standards set minimum allowable energy efficiency values for existing plants and newly constructed plants, taking into account different types of raw materials, fuels, and capacities. In addition to mandatory minimum energy efficiency standards a set of voluntary, more advanced, have been established.

As of 2011 new domestic fixed-asset investment projects in China are required to have energy-efficiency assessments, in order to be accepted for further review and approval. The assessment is done based on existing energy-efficiency regulations and standards and requires the project investor to write Energy-Efficiency Assessment Reports and Reporting Forms. Without an energy-efficiency review or if a project fails to pass the energy-efficiency review, government authorities cannot approve any new construction.

China introduced electric motors minimum efficiency performance standards in 2008. The Chinese government has also been extensively been working with Chinese manufacturers, helping them to design and produce motors that will meet the new standard. Furthermore, in 2009, as part of economic stimulus efforts, China implemented a programme to provide incentives to manufacturers for sales of motors that met the new standard, thereby increasing market share and easing the transition to the new standard.

USA

ENERGY STAR programme for Industry promotes the use of an energy management strategy to assist industry in measuring energy performance, setting goals, and tracking energy savings. Companies that join these programs are known as ENERGY STAR Partners. The ENERGY STAR for Industry program focuses on energy efficiency in individual manufacturing sectors, including cement, corn refining, dairy processing, food processing, glass, iron and steel, metal casting, motor vehicle manufacturing, petrochemicals, petroleum refining, pharmaceuticals, pulp and paper.

Electric Motor Efficiency Standards require motor manufacturers to certify that their motors meet minimum efficiency values before they are allowed to sell their products. Energy performance standards exist for motors in US since 1997.

Building codes

Global Energy consumption in buildings rose by 18% between 2000 and 2010 and is expected by 6.6% by 2020. At the same time huge potential is still untapped in the building sector. Building energy codes are the main policy instrument to improve efficiency in building stock. The performance based building code is a complex code, that sets absolute minimum energy performance standards for building design and overall energy consumption for heating, cooling, ventilation, hot water, etc. On the other hand prescriptive building codes set requirements for each building element – walls, windows, etc. Other instruments enhancing energy efficiency of buildings include building certification schemes, energy labelling of buildings, financial incentive schemes.

EU

The main policy instrument, related to energy use in buildings in EU is the Energy performance of buildings directive (EPBD recast 2010/31/EU). The directive introduced requirements for certification, inspection and renovations in buildings. Building energy codes are a key driver for implementing energy efficiency measures. Member states have developed and adopted schemes for implementation of EPBD and large variations exist in terms of approach at national level for the building codes application. Energy performance certificates are introduced for different buildings.

The EU Energy efficiency directive obliges member states to develop long-term strategies for mobilising investment to renovate existing building stock. It introduces mandatory renovation rate for public buildings and ensure individual metering of energy consumption for all buildings is ensured by 2016.Wide range of financial instruments are available in member states including grants, subsidies, VAT reduction, preferential loans, Third party financing, tax rebates, tax deductions.

China

Building energy codes are mandatory for all buildings in China. According to recent report[4] China has seemingly achieved progress in improving its compliance rate at both design and construction stages. According to China’s annual national inspection of building energy efficiency in urban areas, the compliance rates with energy codes at both design and construction stages in urban areas have improved from 53% (design) and 21% (construction) in 2005 to 99.5% and 95.4%, respectively, in 2010.

Japan

Up to 2012 the building codes and minimum energy performance standards for building were not mandatory, but based on voluntary agreements. According to the Japan’s innovative strategy for energy and environment energy building codes become mandatory for all types of buildings.

USA

The U.S. Department of Energy (DOE), through the Building Energy Codes Program (BECP), supports energy efficiency in buildings through the development and implementation of model

4 ACEEE, Third Parties in the Implementation of Building Energy Codes in China

codes and standards; however energy building codes are not mandatory at federal level. The international Energy Conservation code (IECC) and the ANSI/ASHREA/IESNA Standard 90.1 are the two baseline building codes that may be adopted by states. The IECC addresses all residential and commercial buildings; ASHRAE 90.1 covers commercial buildings and multifamily buildings three stories or less.

Energy using products

Energy efficiency standards and labels are sets of procedures and regulations that, respectively, prescribe the minimum energy performance of manufactured products and the informative labels on these indicating products' energy performance. They are the main policy instrument, used by governments to improve the energy use of products and have proved to be very successful over the years. Due to the EU policies for example significant changes in the market appeared. For example, the energy performance of washing machines has improved from on average 0.30 kWh/kg (class C / D) in 1993 to 0.24 kWh/kg (class B) in 1998, and further to 0.18 kWh/kg (class A / A+) in 2006, representing in total a 40% reduction in the specific energy consumption. For refrigerators, the energy efficiency index improved from an average of 102 (class E) in 1992 to 79 (class C) in 1999, and further down to 42 (class A+) in 2006, representing in total an almost 60% reduction in specific energy consumption5.

Despite the very positive trend in decreasing the energy consumption by various electrical appliances in different countries around the world, still considerable potential exists to reduce energy demand from energy using products including lighting.

EU

The EU Ecodesign Directive establishes a framework under which manufacturers of energy-using products are obliged to reduce the energy consumption. All energy using products sold in the domestic, commercial and industrial sectors are covered by the Directive with the exception of all means of transport which are covered by other legislation. The revised Directive, which entered into force in November 2009, extends the scope of the existing Directive by covering in principle all energy-related products, windows, insulation materials, and certain water using products like shower heads or taps are expected to be covered as well. Detailed actions or implementing measures are developed and adopted for the different types of products and manufacturers have to ensure that the product they offer o the market complies with to the energy and environmental standards set out by the measure.

The recast Energy Labelling Directive Directive 2010/30/EU extends the energy label to energy-related products in the commercial and industrial sectors, for example cold storage rooms and vending machines. The extension of the scope from energy-using to energy-related products (including construction products) means that the Directive covers any good having an impact on energy consumption during use. These products do not consume energy but "have a significant direct or indirect impact" on energy savings. Examples are window glazing and outer doors. Energy labelling requirements are already in force for a number of products and the Commission will adopt delegated regulations for energy labelling in parallel with the adoption of the Ecodesign regulations .

Japan

[5] Energy Charter Secretariat, Review of Energy Standards and Labels for Appliances, Lighting, Vehicles in Energy Charter countries

Japan does not have MEPS; instead it operates the Top Runner standards programme, which sets target values for energy efficiency performance in a future year based on the current highest efficiency level for each type of product. When the target year arrives, new target levels can be established. The programme so far has been quite successful, with most manufacturers gearing up to meet the targets. Until now 23 different product categories were covered by the programme, selected mainly from high energy using products

A voluntary Energy Saving Labelling Program was launched in 2000 aimed at helping can lead consumers to compare energy efficiencies so that they can select products with more higher energy efficiency when making a purchase. The labelling is applied to 16 products including. air conditioners, Electric refrigerators, Electric freezers, Fluorescent lights, Electric toilet seats, TV sets, Computers, Magnetic disk units, Space heaters, Gas cooking appliances, Gas water heaters, Oil water heaters, Transformers, Electric rice cookers, Microwave ovens, DVD recorders).

China

China is one of the world's largest manufacturers of household appliances, lighting, and other residential and commercial equipment. A core part of its 12th Five Year Plan part is the development and adoption of clean efficient energy technologies and energy standards and labels are a prominent element of that plan. China has currently introduced 46 minimum energy performance standards and expanded the coverage of the mandatory energy label to over 25 residential, commercial, and industrial products.

USA

USA has a wide range of minimum energy performance standards, endorsement labels, and comparative labels to improve the energy efficiency of equipment and appliances. The U.S. Department of Energy's Appliances and Commercial Equipment Standards Program develops test procedures and minimum efficiency performance standards for residential appliances and commercial equipment. The first appliance standards were enacted in 1987, and since that time a series of laws and DOE regulations have established, and periodically updated, energy efficiency or water use standards for over 50 categories of appliances and equipment used in the residential, commercial and industrial sectors.

Since 1980, manufacturers of certain appliances have been required to attach comparison labels to their appliances to give consumers important information about energy use. The U.S. Federal Trade Commission's (FTC) Appliance Labeling Rule currently requires Energy Guide labels on refrigerators, freezers, dishwashers, clothes washers, room air conditioners, water heaters, furnaces, boilers, central air conditioners, heat pumps, pool heaters, and televisions.

The U.S. DOE and the U.S. Environmental Protection Agency (EPA) jointly manage ENERGY STAR, a successful voluntary endorsement labelling program that began in 1992. The ENERGY STAR label is available for use on more than 60 product categories including home and office electronic equipment, buildings, and household appliances.

2.3. Renewable Energy Policies

Introduction

The number of renewable energy policies is increasing world wide as recognition of its wide range of benefits that include: enhanced energy security, reduced import dependency, reduction of greenhouse gas emissions, improved health, job creation, rural development and wider energy access.

In general terms, countries or regions can implement policy measures for renewable energies through the establishment regulatory and planning instruments, the definition of economic incentives, market facilitation, public information and participatory or voluntary approaches.

Regulatory and Planning instruments refers to the setting of tools from central or local administration governments and include the definition of targets, regulatory principles, standards and codes, among other examples.

Economic instruments are mechanisms operating market based approaches which use pricing of goods or services to drive the market uptake of concrete decisions. These include tax and charges, subsidies, price differentiation, permits or certificates.

Participatory and voluntary measures include cooperation agreements engaging people towards a common goal.

Finally market facilitation concerns of informing the end-user by influencing and educating towards specific decisions. They include: public awareness campaigns, public information procurement and public acceptance monitoring.

The most common renewable energy instruments are present in the domain of definition of targets and regulatory principles for market operation, tax incentives and public financing.

Concrete examples of the renewable energy incentive policies include the following:

Table 2.1 – Examples of renewable energy incentive policies

Regulatory & Planning	Economic	Participatory & voluntary	Market facilitation
Feed in tariffs	Capital subsidy, grants	Voluntary agreements	Public awareness campaigns
Electric utility quota obligation, RPS	Tax rebates and credits	Public-private cooperation	Public information procurement
Net metering	Public competitive bidding	Public-public cooperation	Public acceptance monitoring
Obligations / mandate	Public investments		
Tradable renewable energy certificates	Price differentiation		
Targets (in primary energy, final energy or electricity)	Cap & Trade		

Feed in Tariffs are based on long-term contracts offered to producers to accelerate investment in renewable energies. Contracts offer a per kWh based remuneration set by the cost of generation of each technology. Often these tariffs are also regressive over time.

Utility Quota Obligation or Renewable Portfolio Standard (RPS) are requirements applied to obligated utilities that should meet specific targets of minimum percentage of generation sold or capacity installed be provided by renewable energies.

Tradable Renewable Energy Certificate is a tool for meeting renewable energy obligations through trading. Certificates are traded among consumers, producers, or serve for voluntary green power purchases. Green certificates are offered for every energy unit (e.g. kWh) generated by a renewable power plant.

Net Metering is the use of a two-way electricity meter which measures the incoming and outgoing electricity between the distribution grid utility and the consumer with its own production.

Cap and Trade or Emissions trading is a market-based mechanism applied to combat pollution by using an economic incentive to emission reduction.

Renewable energies and energy efficiency policies can be found at different levels encouraging the implementation of specific initiatives. There are examples of supra-national initiatives, national level policies, regional or state level, local level or even company level.

Bellow are referred the most relevant renewable energy policies in the European Union, United States, Japan and China.

European Union

The Renewable Energy Directive 2009/28/EC[6] established a European framework for the promotion of renewable energy, setting mandatory national renewable energy targets for achieving a 20% share of renewable energy in the final energy consumption and a 10% share of energy from renewable sources in transport by 2020.

This Directive also requires the simplification of the administrative regimes faced by renewable energy, together with improvements to the electricity grid, to better allow access for electricity from renewable energy. It established a comprehensive sustainability scheme for bio fuels and bio liquids with compulsory monitoring and reporting requirements. All bio fuels used for compliance with the 10% target and that benefit from national support are required to comply with the scheme.

In order to comply with the Renewable Energy Directive, EU Member States have defined their own policies and ways to achieve the compulsory targets. A mix of different policies came to light in EU countries where several policy types can co-exist. Some of the implemented ones were the following:

- Feed in Tariffs: this mechanism was widely used in some countries providing incentive to the development of wind energy and solar photovoltaic energy. Feed in Tariffs vary significantly among EU countries however countries applying this policy most extensively for renewable energy electricity are Germany and Spain. The UK has currently a feed in tariff specifically dedicated to renewable heat.

[6] Text of Directive available at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32009L0028:EN:NOT

- In some European countries feed in tariffs are under revision, justified on the basis of strong growth and investment cost reduction. The revisions introducing retroactive changes resulted in considerable controversy and sometimes even in legal dispute.
- In Europe, France and Italy modified existing Feed in Tariff laws to include tenders for large-scale installations.
- Utility Quota Obligation or Renewable Portfolio Standard (RPS) requirements are being applied to obligated utilities of Member States like Sweden and Italy.
- Tradable Renewable Energy Certificates are being used in Austria and Denmark.
- Net metering is available in Belgium, Denmark and Italy.

As a consequence of Fukushima accident with the Daiichi Power Plant in March 2011 in Japan, several countries modified their energy policy moving away from nuclear energy, and some EU countries among them. In Belgium, a decision was made to shut down three of the oldest reactors by 2015 and to exit nuclear power completely by 2025, provided that alternative sources can meet energy demand and prevent shortages. France has also called for a reduction in the nuclear installed capacity from 75% to 50% by 2025. But the most rapid exit is expected to be from Germany by 2022. A decision was taken to reform energy sector through what is referred to as “Energiewende” (Energy Transition), which focuses on energy efficiency and renewable energy sources together with massive energy infrastructure investments.

The European Union Emissions Trading System (EU-ETS) is another important policy tool. It works on the cap and trade principle to limit the amount of greenhouse gases that can be emitted by factories, power plants and other installations. The system works by putting a price on CO2 and thereby giving a financial value to each tonne of emissions saved. The cap is set to be reduced over time so that total emissions are forced to fall. The intention is that companies introduce energy efficiency measures and invest in cleaner forms of energy production.

Companies receive or buy emission allowances which can then be traded. Other possibility is for companies to buy limited amounts of international credits from emission-saving projects around the world.

A sufficiently high carbon price would promote investment in clean, low-carbon technologies. For several reasons this situation has been far from happening, therefore introducing some difficulties in the implementation of this tool and in achieving significant results. Nevertheless, allowing companies to buy international credits, the EU ETS also acts as a major driver of investment in clean technologies and low-carbon solutions, particularly in developing countries.

At EU level there is also an initiative targeting local authorities and local policies in the area of energy efficiency and renewable energies. The Covenant of Mayors is a European movement involving local and regional authorities, voluntarily committing to increasing energy efficiency and use of renewable energy sources on their territories. By their commitment, Covenant signatories aim to meet and exceed the European Union 20% CO2 reduction objective by 2020.

In order to achieve enhanced results on the implementation of renewable energies in the EU territory, the European Commission is funding several lines of projects targeting dissemination and research, development, demonstration, and deployment (RDD&D) actions. Budget execution for energy activities within the 7th Framework Programme for Research (2007-2013) has been increasing year on year with a total budget of 2 350 million Euro for research & innovation to be spent on hydrogen and fuel cells, renewable electricity generation, renewable fuel production, renewables for heating and cooling, CO2 capture and storage technologies for zero emission power generation, clean coal technologies, smart energy networks, energy efficiency and savings and knowledge for energy policy making. Project proposals are submitted by international consortia for evaluation within specific calls for proposals organised by the European Commission.

United States of America

Energy policy in United States is defined at State level, nevertheless at central level, Energy Policy Acts have been passed which include provisions and incentives for renewable energy development. Although never endorsing the Kyoto Protocol, the recent Obama administration proposed an energy policy reform including a cap and trade program for CO2 reduction, which could enhance the development of renewable energies in the country.

In the United States most of the energy policy incentives take the form of financial incentives: tax breaks, tax reductions, tax exemptions, rebates, loans and specific funding.

The targets of the US are to double renewable electricity generation from wind, solar and geothermal sources by 2020 (from 2012 levels), and to generate 80% of electricity from a diverse set of clean energy sources by 2035.

In order to achieve these goals several initiatives are being designed: an R&D solar programme aimed at achieving directly cost-competitive solar power without subsidies by reducing the levelized cost of solar energy to $.06/kWh by 2020; wind R&D efforts for the technology to be competitive with fossil fuels without subsidies, among other.

The annual budget available to support the development of renewable energies is increasing year by year, having the proposed 2014 budget (approximately USD 3 billion) seen a 56% increase of available funds comparing to 2012[7].

The Office of Energy Efficiency and Renewable Energy (EERE) seek to ensure American leadership in the transition to a global clean energy economy. EERE supports research, development, demonstration, and deployment (RDD&D) through partnerships with some of most innovative businesses and research institutions with the explicit goal of making clean energy technologies directly cost-competitive without subsidies. To achieve this, EERE focuses its RDD&D investments on high-impact activities in the areas of sustainable transportation, renewable electricity, and end-use energy efficiency in buildings and factories.

California is by far the most developed state in terms of renewable energies with about 20.000 MW of total renewable energy installed capacity[8]. To support the growth of the sector, the state has enacted ambitious policies. California is the leader in US on geothermal power, wind power, biomass power and solar power and its early, sustained support for the renewable energy industry has been successful in attracting and incubating leading renewable energy companies which, in turn, has created high-quality jobs.

The main implemented policies in California are the following:

[7] Department of Energy, FY 2014 Congressional Budget Request. Budget Highlights, April 2013. Available at: http://energy.gov/sites/prod/files/2013/04/f0/FY14_DOE_Budget_Highlights_Final.pdf

[8] American Council on Renewable Energy - ACORE (2012); Renewable Energy in the 50 States. Available at: http://www.acore.org/files/pdfs/states/2012-50statereport-lowres.pdf

- Renewable Portfolio Standard (RPS): California requires its electric utilities to derive 33% of their retail sales from eligible renewable energy resources by 2020. There are interim targets of 20% by 2013 and 25% by 2016. In January 2011, was authorized to use generation sources other than those utilities own.
- Net Metering and Interconnection: California's net metering law requires utilities, to provide net metering for renewable energy systems of up to 1 MW, until the utility meets 5% of its customer peak demand or 5 MW for systems owned and operated by a university or local government. California also allows virtual net metering for multifamily affordable housing units and local governments.
- Go Solar California! Campaign: aims to install 3,000 MW of solar power capacity by the end of 2016 and 2,000 solar hot water systems by the end of 2017. Its state-wide budget is $3.3 billion. It provides incentives for existing residential homes and existing and new commercial, industrial, and agricultural properties. It consists of a PV and solar thermal electric rebate program; solar hot water rebate program; single and multi-family affordable homes rebate programs; and solar RD&D grant program.
- Other Incentives: The Self-Generation Incentive Program offers incentives ranging from $0.50/W to $2.25/W to customers who install wind, biogas, energy storage, waste heat, CHP, or fuel cell systems. Incentive payment is capped at 3 MW, and projects over 1 MW receive reduced rates after the first megawatt.
- Renewable Auction Mechanism (RAM): requires utilities to purchase electricity from distributed renewable energy systems within their service territories between 3 and 20 MW in capacity. Each utility is responsible for procuring an allocated share of the 1 GW program total. Competitive auctions are held twice annually for two years.
- Feed-in Tariff: The rules allow customers to enter into 10, 15 and 20 year standard contracts to sell electricity produced by qualifying renewable energy systems of up to 3 MW. Publicly-owned utilities with 75,000 or more customers must develop feed-in tariff programs.
- Tax Incentives: provides tax exemption for expenses relating to the industrial design, manufacture, production, and assembly of clean energy or advanced transportation technologies. California provides a full property tax exclusion for solar electric and thermal systems, or for 75% of a system's value for dual use equipment.
- Property Assessed Clean Energy: The California FIRST Program offers financing for renewable energy systems on non-residential properties that property owners can pay back through their property taxes.

Japan

After the Fukushima Daiichi nuclear power plant disaster following an earthquake in March 2011, energy policy in Japan has been reassessed. The main considerations tend to address the continuation of the nuclear power use and, if yes, to what extent. The government elected in December 2012 has designed a new energy policy and its main messages are at short term that existing nuclear reactors should be restarted as the Nuclear Regulatory Commission confirms safety within three years. At long term the best energy mix should be determined within ten years, by evaluating performance of renewable energy, which is being increasingly introduced after a feed in tariff is in place since July 2012.

Within the feed in tariff, solar PV power generation, as well as wind power, geothermal power and hydro power are subject to a specific tariff. Biomass is also subject of tariff on the specific uses of biogas, wood and waste.

In Japan, solar and wind energy are having a strong expansion. This trend is being supported by a state of the art industrial capacity of world reference in the manufacturing of wind turbines and solar modules. This context of energy crisis in Japan is opening the opportunities for developing renewable energies as large resource is available, there is significant demand and industrial capacity.

Hydropower of less than 1 MW and biomass projects are also currently supported by a Renewable Portfolio Standard type of incentive. A specific tax system is available for biomass using projects.

Fukushima and Nagano local communities set targets for 100% renewables.

China

China is now committed to produce 11,4% of total energy from non-fossil fuels by 2015. The 12th Five Year Plan (2011-2015) has as main targets that the new installed renewable energy capacity will reach 160 GW, including 61 GW of hydropower, 70 GW of wind power, 20 GW of solar power and 7,5 GW of biomass power. To fund this ambitious programme the government increased the renewable energy surcharge rate.

The renewable energy industrial capacity in China is very developed, namely on solar and wind power. In order to absorb internally the solar modules excess production, the Chinese government stimulated the domestic market through the 12th Five Year Plan targets and feed in tariffs for solar and wind power.

Chinese module makers shifted from export-oriented business models to establishing manufacturing bases in target markets and building partnerships with foreign companies to avoid trade friction as it is being verified in recent cases of anti-dumping led by the US and the EU.

The government has also issued a number of standards for grid connection to solve the constraints of solar and wind development. To boost domestic consumption of renewable energies in China, the government set feed in tariffs, tax credits, preferential land use policies and a renewable energy surcharge.

Section 3: Brief review of existing energy efficiency and renewable energy technologies and manufacturers

3.1 Energy Efficiency Technologies in Power Generation

Coal fired plants

The most commonly used technology in coal fired power generation is conventional pulverised coal combustion (subcritical technology, where powdered coal is injected into the boiler and burned. Water flowing through tubing within the body of the combustor is heated to produce steam at a pressure below the critical pressure of water (22.1 MPa). Subcritical units are designed to achieve thermal efficiency up to 38%.

High efficiency low emission technologies (HELE) include Supercritical technology, ultra supercritical technology, Advanced USC (A-USC) and Integrated gasification combined cycle (IGCS). In SC technology steam is generated at above the critical water pressure, therefore no water-steam separation is required during the process. Typical efficiency might reach 43 %. USC operates at higher temperatures and pressure compared to SC and thermal efficiency reaches 45%. State of the art USC operate with steam parameters between 25 MPA and 29 MPa and temperatures up to 620ºC. USC plants are in commercial operation in Japan, Korea, some European countries and recently in China. A-USC is further development of USC with the aim to further raise temperature and pressure, therefore achieving efficiency of 50 %. This requires the use of materials capable to withstand steam conditions of 700ºC to 760ºC and pressure between 30 MPa and 35 MPa. The development of such materials and reducing their cost are currently the main challenges in deploying A-UCS technology. IGCS uses low levels of oxygen or air to turn coal into gaseous fuel and electricity is then produced using combined cycle. IGCS incorporating the latest 1500ºC-class gas turbines can reach efficiency of 50 %. Currently commercial prototype demonstration plants are operating in US, Europe and Japan, with some in construction in China and Korea.

Natural gas fired plants

Global gas fired plants efficiency is improving mainly due to increased deployment of efficient combined cycle gas turbine (CCGT) and open cycle gas turbines (OCGT). In OECD Europe the average efficiency of the existing power plants reached 47% in 2012, compared to 38% in 1990. In non OECD regions average efficiency is around 35%, up from 27% in 1990.

CCGT plants efficiency now exceeds 60% and for OCGT plants it is around 40%. Some demonstration projects aim to have an operational CCGT with 63% efficiency in 2016. Integrated solar combined cycle plants are in development in the Mediterranean region and the potential efficiency in an hybrid gas power plants with a solar concentrator before the gas turbine is estimated to 70 %. Efforts are ongoing to improve the performance of power plants, operating at part load.

3.2 Energy Efficiency Technologies in Industrial Processes

The deployment of best available technologies for cement, iron and steel, chemical and petrochemical, food, machinery and other industries is an important condition to active global increase in industrial energy efficiency. This section will not review the industry specific technologies, but focus on energy saving technologies for electric motor drive systems (EMDS).

EMDS are responsible for more than 40% of the global electricity demand[9] as well as for about 69% of global industry electricity consumption[10]. Even though that technologies exist to reduce the consumption by 20% to 30% they are still not fully implemented.

Electric motor drive system (such as pumps, fans, compressors, etc) efficiency is combination of the effectiveness of the electric motors as well as the other system components. The efficiency of standard AC induction motors is classifies in international standard IEC 60034-30 into three classes for motors 0.75 kW to 375 kW:

- IE3 premium efficiency
- IE2 high efficiency
- IE1standard efficiency

Most electric motors applications are in pumps, fans, compressors and the efficiency of the whole system depends also on the losses in all mechanical and electrical components of the system. There are available engineering solutions to minimise those, however other important conditions influencing the system efficiency are the proper sizing of the motors and other components used as well as optimisation of the operation routine.

3.3 Energy Efficiency Technologies in Buildings – building envelope, heating, cooling and lighting equipment

Energy demand of residential and commercial buildings is rapidly increasing globally. A number of opportunities exist to achieve significant energy savings in the buildings sector. Those include introduction of strict building codes for new buildings plus retrofit of the existing building stock using best energy efficiency materials on the market (insulation for walls roofs, efficient windows, etc). Many different technologies and components contribute to the overall building performance – building envelope materials, windows, shading, air filtration, heating ventilation and cooling systems, hot water, automation, etc. Therefore it is difficult to provide here an overview of existing energy efficient technologies. It is important to underline again however that governmental policy could significantly influence the use of such technologies.

Various commercially available energy efficient building technologies are used for heating, cooling and ventilation, lighting, appliances and energy using equipment as well as deployment of renewable technologies. Advanced technologies (low- and zero-carbon technologies) for heating and cooling are also available e.g. active solar thermal, application of heat pumps for heating and cooling, co-generation in buildings, however the pace of their deployment is lower mainly due to their high investment cost.

Energy efficiency of energy using products and lighting has improved tremendously in past years mainly driven by governmental policies around the world (MEPS and voluntary agreements with manufactures). Efficient appliances are widely available worldwide, however their penetration in much lower in countries where no governmental policies exist to regulate the market.

[9] 4E Electric motor systems “Motor Policy Guide”, 2011
[10] IEA, Energy efficiency opportunities for electric motor drive systems, 2011

3.4 Wind Energy Technologies

Wind is a renewable energy variable source and can be used by wind turbines which transform the kinetic energy of the wind into electricity. Wind energy is the fastest growing energy source of global electricity generation, accounting for about 280 GW worldwide in 2012[11].

Electricity can be generated when wind speeds exceed 13 kilometres per hour (km/h) and most large wind turbines shut down for safety reasons when wind speeds exceed about 90 km/h.

Wind turbines can be installed in onshore (in land) or offshore (at sea not far from the coast) taking advantage of the best wind conditions. Typical project lifetime capital costs can represent 75% to 80% for onshore, whereas 30% to 50% for offshore installations. Therefore operation and maintenance costs are significantly higher in offshore situations.

There are currently about a dozen of wind turbine manufacturers in the world mainly producing in Europe, Asia and America.

The countries with the most installed capacity of wind power generation worldwide in 2012 were: China (75 564 MW), United States (60 007 MW), Germany (31 332 MW) and Spain (22 790 MW)[12].

Grid connection of wind farms might be an issue as often wind resources are located in remote or sensitive areas, therefore far from the existing electricity grid and consumption centres. The potential synergies between the variability and intermittency of wind generation and the availability of large scale storage at hydro are a good solution to avoid supply curtailment[13].

Health and environmental concerns have arisen over time with the increased development of wind farms. Issues such as noise, electromagnetic interference, airplane flight paths, loss of natural habitat, property values, aesthetics and bird and bat fatalities are well understood, and practical steps have been taken to address them. Scientific studies to date have found no evidence of health impacts from wind power projects on human health[14].

3.5 Solar Energy Technologies

Direct solar energy can be used in different forms. The main technologies using this renewable energy sources are:

- Solar thermal collectors;
- Solar photovoltaic (PV) systems; and
- Concentrated solar power (CSP).

Solar thermal energy

Solar thermal collectors are devices that convey the solar radiation and its resulting heat to a heat transfer medium (fluid or air). The medium could be then used directly or in a heat exchanger. Typical applications include domestic, services or industrial hot water production, swimming pool heating, space heating and industrial drying.

[11] Bloomberg New Energy Finance (April 2013); Global Trends in Clean Energy Investment.
[12] Global Wind Energy Council (2013); Wind Energy Statistics 2012.
[13] Supply curtailment means non-dispatchable electricity that cannot be used due to limited transmission capacity or because electricity cannot be used or stored when it is generated.

[14] The Trottier Energy Futures Project (2013); An inventory of Low-Carbon Energy for Canada.

Solar Domestic Hot Water systems are dominating the markets in warmer climates, namely around the Mediterranean, as well as in China. These systems are already installed in vast quantities. In the north of Europe it is common its combined use for domestic hot water production and space heating.

A typical domestic hot water thermosiphon system for a single family house has a 2 to 5 sq. meters of collector area and a 100 to 200 litre tank. Whereas a typical forced circulation system for one dwelling has 3-6 sq. meters of collector area and a 150-400 litre tank.

Collective systems or multi-purpose systems have a collector surface ranging from ten to several hundred square metres, depending on the energy needs.

Solar district heating is also advantageous from the economic and environmental perspective, avoiding the consumption of fossil fuels and several examples exist in Sweden, Denmark, Germany and Austria.

Solar photovoltaics

Photovoltaic (PV) cells use semiconductor material to convert solar radiation into direct current electricity. In a photovoltaic system, solar modules are typically rated 200 Watt. The solar modules are the arranged in arrays to produce commercial electricity or power large buildings.

Typical conversion efficiencies of PV cells vary between five to 26%. Higher efficiencies are possible in emerging technologies like concentrated solar PV (CPV) that use optics to increase incoming solar radiation.

Production of solar PV systems could also be increased in absolute terms if solar trackers are used. These devices hold the solar modules and automatically follow the apparent movement of the sun. They are available in a one axis or a two axis option of movement.

The total PV production is a factor of the solar radiation available (direct and diffuse) and of the area available. Grid connection limits depend on each country/state regulation.

Solar PV arrays can be mounted either on greenfield or on building rooftops, facades, or as architectural building integrated energy devices. Operating and maintaining a solar PV system has very small costs, being the upfront capital costs the most significant part of producing electricity from PV. However, these technologies are already cost competitive in some markets as unit costs have been declining. Module and Balance of System (BoS) costs vary with system size and location.

Within solar PV there are several technologies available depending on the semiconductor material used and on the way it is assembled. Cells deposited on flexible substrates and thin film options are already available in the market. The main options are: crystalline silicon (mono or polycrystalline), amorphous silicon, Cadmium Telluride and Copper Indium/gallium Diselenide/disulphide (CIS, CIGS). New PV products are also coming to the market in the form of organic photovoltaic materials like electronic inks and electronic polymers.

Current practice show that the main constraints for PV development are not on the technology, the source, nor the costs but mostly on its relationship to the grid as traditional grids will have to accommodate more distributed generation in low carbon scenarios. A combination of increased storage, smart grids and automated control of demand and supply will be needed.

Currently the solar PV installed capacity world wide is of 104 GW. The top countries of PV installed capacity in 2011 are Italy (9 304 MW), Germany (7 500 MW), China (2 500 MW) and US (1 867 MW)[15]. The main PV manufacturing plants are also located in China, Europe and the US.

Concentrated Solar Power

The concentrated solar power (CSP) systems use lenses or mirrors to concentrate sunlight onto a small area. Solar radiation is then converted to heat which drives a heat engine connected to an electrical power generator. There are three main types of technologies available: parabolic trough, Fresnel reflectors and power tower or solar tower.

Parabolic troughs are linear parabolic reflectors which concentrate light into a tube positioned above the mirror. Inside the tube there is a thermal working fluid which is used as a heat source for the power generating system. This is the most developed technology from this section.

Fresnel reflectors are made of many thin flat mirror strips which concentrate the radiation into a tube positioned on top. The working principle is then the same of the parabolic trough. This technology is cheaper than the parabolic one because of mirror characteristics.

Solar tower concentrates the radiation on a unique point on its top. Dual axis tracking reflectors (heliostats) are used to concentrate the sunlight. From the top of the tower is also used a working fluid to be used as heat source for power generation. Power-tower development is less advanced than trough systems, but they offer higher efficiency and better energy storage capability.

US and Spain concentrate most of worlds CSP projects with an installed capacity of 1 GW and 500 MW respectively16.

3.6 Hydro Power

Hydropower is generally divided into two categories: large-scale installations and small-scale installations. The first usually features dam applications with large water reservoirs and the latter feature limited storage or have configurations of “run-of-river” type.

The division of capacities between large and small scale depend on the definition of each national authority.

Large hydro developments are often constrained by environmental and social considerations rather than economic or technical factors. These factors affect the long permitting, planning and construction timelines.

Depending on the hydrology, hydro facilities can generate electricity on demand as they can operate either on base load, middle or peak cycle. They are ideal for load following, spinning reserve, system stability or reserve roles. Hydro reservoirs are understood as low carbon storage options, namely when associated with wind power developments and using upstream pumping.

Hydropower is one of the most well known technologies where the learning curve has already been completely achieved. Most of the development costs relate to the transmission infrastructure, as they are often located in remote areas away from existing infrastructure. Operating costs are generally significantly low and a hydro power plant can have a lifetime of about 70 years.

[15] http://www.solarplaza.com/top10-pv-markets/

[16] http://www.iea.org/topics/solarpvandcsp/

Large reservoirs are often affected by decomposition of organic matter, which produce releases of methane and CO2, however they can also serve as regulation in variation of water levels preventing floods downstream.

Run of river installations require little or no water storage, minimizing social and environmental impacts.

The dispersion of hydro energy is quite good around the world and the current total installed capacity of smaller installations is of 186 GW17.

3.7 Biomass

Biomass is available for energy use in several forms, and include plant materials, algae, manure, waste oils, animal fats, urban and farm wastes, waste waters. These products can be then burned, gasified, or converted into liquid fuels. There are a multitude of pathways to deliver electricity generation, heat or combustion fuels from biomass resources.

Biomass solid fuels are generally burned in power plants, industrial boilers, and building heating systems. Actual limitations deal with the collection, shipping and storage of the wood fuel. Biomass liquid fuels are mostly used in mobility in the form of biodiesel or bio ethanol. Biogas normally refers to bio-methane that is produced from sewage treatment plants and landfills.

Biomass and waste to energy account for about 66 GW18 of the current total installed capacity for electricity generation in the world.

3.8 Geothermal

Geothermal energy makes use of the heat that comes from the interior of Earth. For the use of this source of energy, availability of three elements affects its exploitation: high temperature heat, water availability and rock permeability. Different technologies can be used in different geologic conditions. There are two categories of geothermal technology which use the resource available depending mainly on the available temperature of the resource:

- Hydrothermal which make use of relatively shallow, medium temperature resource (50-120 degrees centigrade) in the form of water or steam emanating from naturally permeable rocks, and that can be tapped directly for the provision of heat and in certain cases for power generation.
- Enhanced geothermal in which very high temperatures are sought through fracturing non permeable rocks. Youngest volcanic geological regions are the most attractive for the exploitation of this resource, where temperatures are reaching 150 degrees centigrade. In this form, heat is used only for power generation.

Geothermal is considered a mature and commercially available technology that can be deployed relatively quickly to supply base load power and, in some circumstances, heat and process steam. Its main advantage over their renewable energy counterparts is the constant availability of the resource at a constant temperature, making it a consistent commercial application, without intermittency drawbacks. Nevertheless challenges remain on the corrosively characteristics of the supply steam.

[17] Bloomberg New Energy Finance (April 2013); Global Trends in Clean Energy Investment
[18] Idem.

Until today geothermal energy has been used where the resource is most available and geological conditions makes it feasible to proceed. Project costs tend to be dependent on the success rate of drilling operations. Currently there are about 11 GW of operating geothermal power plants in the world19. Countries most using geothermal energy for electricity production are US, Philippines, Mexico and Indonesia.

Ground source heat pumps or geothermal heat pumps are often included as a category of geothermal energy however, it uses at very shallow depths (2 to less than 100 meters) the thermal inertia of the soil. This energy source makes use of the fairly constant temperatures of the soil all around the year, providing heating in winter and cooling in summer (acting as heating sink). This enables electrically driven heat pumps to deliver low-temperature space heating or cooling all year round at coefficient of performance (COP) ratios in the range of 2.5 to 5.2 and 16 to 42 Energy Efficiency Rating (EER).

Ground source systems have two pipe systems, a primary one is a refrigerant loop used at the appliance cabinet as heat exchanger and the secondary one, a water loop buried in the ground. There are several possibilities of running pipe loops: horizontal installations, vertical installations, pond loops and opens loops. The choice of solution depends on the heating and cooling needs and on the characteristics of the available surrounding area. Most units are easy to install, especially when they are replacing another forced-air system. They can be installed in areas unsuitable for fossil fuel furnaces because there is no combustion and thus no need to vent exhaust fumes. Ductwork must be installed in homes without an existing air distribution system.

This solution is one of the most energy-efficient, environmentally clean and cost-effective space conditioning available and it can be applied to residential and services sector. Leading countries using geothermal heat pumps are located in Europe and North America.

3.9 Marine Energies

Marine energies are renewable sources of energy as they make use of wave and tidal resources. Nevertheless they are not addressed in this report as their potential for exploitation is not significant in Central Asia as resources of this type of energy are not available.

[19] Bloomberg New Energy Finance (April 2013); Global Trends in Clean Energy Investment

Section 4: Priority energy efficiency and RES technologies for Central Asian countries

4.1 Analysis of the priority development areas and dissemination of advanced technologies in the field of energy efficiency and renewable energy in Central Asia on the basis of national reports

Kazakhstan

As of 1 January 2011 the installed capacity of electric power stations in Kazakhstan was 19.8 thousand megawatts (MW), and their available capacity was 15.8 thousand MW, with 4.0 thousand MW capacity gap and constraint. About 40% of the generating capacity, that is, 40 of the country's 53 thermal power plants have been in service for more than 30 years. Thermal power plants account for 88% of the overall energy mix, and hydroelectric plants account for 12%. Hydropower is the second biggest power source in the energy fuel mix, surpassed only by coal. An analysis of the installed electric generation capacity shows that Kazakhstan unified power system (UPS) is characterized by a prevalence of coal (75%), gas (23%) and fuel oil (2%) fired power plants. In 2011, 86.23 billion kilowatt-hours (kWh) of electricity was produced and 88.14 billion kWh was consumed. Now the new market relations have been introduced into the Kazakh energy sector, and electric power generation was completely restructured, with practically 100% of the national-level generating plants privatized or transferred to private management. A national electric grid and a system operator were set up, with an open, competitive market for electrical power.

Therefore the key feature of Kazakhstan electric power industry is that electricity and heat are produced basically using solid fuels and this trend will continue in the long term. Given power generating capacities located close to coal fields and a large size country area Kazakhstan have to develop of long-distance transmission lines resulting in significant electricity transmission losses.

The following priority new energy-efficient technologies are deemed promising for *electricity generation* in Kazakhstan:

- coal-fired generating capacities using supercritical (SC) technology;
- thermal power plants based on coal gasification;
- thermal power plants based on fluidized bed systems for brown coal;
- use of associated gas.

Energy efficiency could also be significantly improved by upgrading of the installed equipment, introduction of combined cycle technologies at existing gas-fired thermal power plants, introduction of new coal combustion and processing technologies, and use of combined cycle instead of direct fuel combustion in hot water boilers. Transmission losses would be significantly decreased due to modernization and replacement of out-of-date power and switching equipment at substations, use of state-of-the-art dispatch control system, relay protection and automation, reactive power balancing and control devices.

Energy-intensive sectors are the foundation of the country's economy, and power production is the primary consumer of primary energy resources. About 40-50% of all consumption of primary energy sources is used for the production of electricity and heat. The biggest consumer of electricity is industry, with the greatest consumption in mining and metallurgy. Industry, including the electric power, accounts for nearly three-fourths of the country's demand for electricity. In 2010, 15 largest companies accounted for 35.2% of total energy consumption. It shall be noted that the majority of the country's industries currently use obsolete technologies and equipment that is already quite worn down. Energy intensity in the country in general is more than three times than the same in the European Union, which means that Kazakhstan requires three times as much energy per unit of the gross domestic product (GDP). Thus there is an enormous need to modernize equipment, because it is obsolete equipment and out-of-date technologies that are responsible for the most of electricity losses. The ineffective and irrational use of electricity and heat means that it must be produced at thermal power plants in greater quantities with greater environmental impact.

High specific consumption of energy resources in the country's industry as compared to similar industries in other countries shows that Kazakhstan has a large energy-saving potential.

Energy saving and energy efficiency is the priority in all economy sectors, and addressing those issues will solve a large number of energy, environmental and economic problems. Energy efficiency must include measures to rehabilitate capital assets, improve management, enhance the qualifications of production staff and attract large-scale investment. It is thus a prerequisite for success to use the scientific and technical potential, to adopt new and innovative way of thinking and to make energy efficiency attractive for investors as a new specific form of business. Introduction of the energy-saving technologies and projects in industry sector can bring many benefits.

One of the priorities of development of the country's electric power industry is the use of renewable energy resources. The following types of RES look the most promising in Kazakhstan: wind; mini hydro and solar facilities producing heat and electricity. However, it would be a delusion to believe that such resources can fully replace conventional hydroelectric and thermal power plants. All these resources are dependent on either specific location or climate. Thus the renewable energy can only be used to support the main energy sources; it is not possible to rely on them alone. Electricity generation in Kazakhstan is and will be based on conventional sources of energy and nuclear power plants. The renewable facilities will apparently remain less profitable and more capital intensive than conventional sources. For this reason the utilities are not interested in using renewables.

Using RES for improving energy efficiency and energy saving in Kazakhstan would be most effective in case of:

- construction of mini hydropower plants;
- construction of low capacity stand-alone wind power plants of 2, 5, 10, 20, and 100 kW to provide electric power for remote facilities using Bolotov vertical axis wind turbine (2÷5÷10÷20 kW Model Series);
- construction of medium capacity 200 - 800 kW wind farms for distributed load on sparsely populated areas;
- construction of high capacity 1600 – 5000 kW wind farms in the synchronized energy systems;
- use of PV modules with domestic solar-grade silicon;
- construction of electric mixed power plants which combine several energy sources: hydro, solar, and wind.

In 2012 the semiconductor laboratory of the Scientific Research Institute of Experimental and Theoretical Physics (SRI ETF) at Al-Farabi Kazakh National University, developed a new solar panel design. Institute scientists have developed an improved solar panel which generates power seven times more than the existing counterparts. This solar panel generates about 15 W of power, while others, including foreign counterparts, generate less than 2.2 W. Higher output is a result of the significant reduction of PV cell electric resistance. The scientists took the commercially available plate as a basis for development and modified the conductive circuit.

Scientists of Kunayev Mining Institute developed holographic solar concentrators of domestic manufacture. These concentrators will make the production of solar panels cheaper than the recognized counterparts.

The Government adopted a comprehensive plan for increasing energy efficiency in Kazakhstan for 2012 - 2015. It notes that the required reduction in primary energy demand can be achieved through the following measures:

- Reduce fuel consumption for electricity production from the current 350 grams of coal equivalent per kWh to 300;
- Reduce fuel consumption for heat production from 190 kilograms per gigacalorie (Gcal) to 170;
- Reduce net electricity loss in the distribution grid from the current 25.9% to 15.1%;
- Reduce net heat loss in the distribution network from the current 32.8% to 18%;
- Reduce by 10% the absolute electricity consumption by industry from the current 42.1 billion kWh (excluding 6 billion kWh of auxiliary electricity consumption of electric power plants);
- Increase by 2015 the amount of energy obtained from renewable resources (0.5 billion kWh) and hydroelectric power stations (1 billion kWh) by 1.5 billion kWh;
- Stabilize greenhouse gas emissions at 2008 level (229 million tonnes of CO_2 equivalent).

The high energy intensity of GDP is attributable mainly to the obsolete, resource-intensive technologies used by Kazakh industry.

The priority areas in the energy efficiency and energy saving in *Kazakhstan industry* are to:

- ➢ Introduce new energy-efficient technologies instead of the current technologies;
- ➢ Reduce losses in the country’s electrical networks through rehabilitation and replacement of equipment;
- ➢ Use variable-frequency motors in variable-speed drives ;
- ➢ Use automation control for certain units and assemblies;
- ➢ Rehabilitate the main and auxiliary production processes.

Since the industry is by far the main energy consumer in the country with over 70% of the total demand, the Kazakhstan authorities initiated and legislatively introduced energy audits of industrial enterprises to identify “bottlenecks” where energy efficiency measures and technologies shall be applied. A set of energy saving measures in the industry includes, among others, optimization of energy consumption modes, introduction of automated electricity metering systems, improvement of auxiliary operations and processes, disposal of reloaded equipment, compensation of reactive power.

Utilities are characterized by a high level of network wear and tear and considerable losses in distribution and consumption. Most the facilities and networks were put into operation or overhauled over 20 years ago. The standard service life is 25 years, and about 63% of these facilities require a complete overhaul or replacement. The key energy saving measure *in this sector* is to rehabilitate heat, electricity and gas distribution networks. To address these problems, the

Utilities Modernization Programme by 2020 calls for the modernization, using all sources of funding, of over 81,000 km of the heat, electricity and gas distribution networks within 10 years. About 24,400 km of them will be upgraded by 2015.

The residential sector includes apartment buildings and individual houses. It currently accounts for about 40% of demand for heat. According to expert estimates, nearly 70% of buildings do not meet modern standards for the thermal performance (especially buildings constructed in 1950s - 1980s); up to 30% of the thermal power required for heating is lost through their envelopes. The significant portion of heat consumption attributed to the residential sector (27.9%) needs further structuring. There are no individual heat meters in homes, so the energy is measured at the heat provider. The measurement thus includes the losses in the heat and hot water distribution systems of up to 40%. Significant heat savings can also be achieved by modernizing the heating and hot water systems and by installing equipment to adjust water temperatures. An analysis has shown that energy efficiency measures in *the utilities and residential sector* could give the following savings:

- up to 20-25% through replacement of heat distribution units at local heat distribution stations and distribution piping adjustment;
- up to 15-20% through installation of temperature control units and individual consumption meters.

Introduction of new civil construction standards and modernization of thermal insulation on the existing buildings are also the key energy saving measures in this sector of Kazakhstan.

In recent years, Kazakhstan has significantly increased emphasis on energy efficiency and energy saving, and the use of RES. In July 2009 Kazakhstan adopted the RES support law and the law amending some legislative acts of the Republic of Kazakhstan regarding RES support. In 2009, to implement the Government policy on rational and efficient use of energy, Kazakhstan developed an energy-saving action plan to 2015. In 2010, Kazakhstan developed a sectoral programme on electric power industry development for 2010-2014. In 2011, the Government approved the comprehensive plan on energy saving. Implementation of this comprehensive plan will provide a reduction in GDP energy intensity by 10%. In December 2011, the Parliament of the Republic of Kazakhstan passed a new energy saving law and increase of energy efficiency. The introduction of advanced energy-efficient technologies and energy saving are related to the priority strategic tasks of the state.

Kyrgyzstan

Kyrgyzstan has extensive energy resources and can cover the domestic needs by large margin. However, the potential of the fuel and energy sector has not been fully exploited, and the efficiency of many utilities has fallen with the sector facing financially and economically hard times. The country is dependent on imports of coal, natural gas and petroleum products. Imports account for more than 50% of the country's fuel and energy balance.

Electric power sector accounts for about 5% of GDP, 16% of industrial production and 10% of the national budget income. The grid provides access to electricity to practically all population. The hydroelectric potential of the country's 252 large and medium-sized rivers has been assessed at 18.5 million kW, and over 160 billion kWh of electricity. The hydroelectric potential of small rivers and waterways (mini hydro) is between 5 and 8 billion kWh a year, but only 3% of that is actually used. Kyrgyzstan's electrical grid operates in parallel with the Central Asian energy system. It includes 18 power stations, with an overall installed capacity of 3,666 MW (16 hydroelectric power plants with an overall capacity of 2,950 MW and two thermoelectric plants with 716 MW). Taking into account the wear and tear on generating equipment, the available capacity is currently 3,135 MW. Average annual electricity production amounts to about 12 billion kWh.

The electric power sector is currently facing the following difficulties:

a) Commercial and technical losses. From January to November 2011, overall losses in the grids of the distribution companies amounted to 1.8 billion kWh, or 21.2% of the electricity delivered to them. Commercial losses came to 0.4 billion kWh, or 5.1%, and technical losses accounted for 1.4 billion kWh, or 16.1%. In 2010 total electricity losses in the grid came to 1.9 billion kWh, or 25.9% of the energy delivered. The losses and poor collection rate have brought about a large financial deficit which adversely affects the power companies, their clients and the tax agencies. The problems in the energy field have grown beyond the sector and are now national in scope;
b) Price tariffs. In today's economy, pricing is one of the main factors in the efficient use of fuel and energy. In Kyrgyzstan, current pricing does not provide producers and consumers with an incentive to reduce energy expenditures. Therefore, the current energy pricing policy has to be improved;
c) Energy metering. Currently, the wear and tear on the grid's basic equipment is around 50%. A large portion of the distribution companies' grids and equipment is unsuitable for further use. The obsolete equipment and inaccurate metering of actual electricity consumption are the obstacles to attracting investment and to development of competition in the energy sector;
d) Uneven distribution of generating capacity. Most hydroelectric power stations are in the country's south, while most consumption is in the north. The installed generating capacity in the south is 2,920 MW, or 79.4% of the overall figure. Small-scale hydroelectric power stations and unconventional energy sources are used very little.
e) Standards for energy saving and efficiency have to be updated and should be brought in line with international standards.

The main consumers in Kyrgyzstan are the residential sector (buildings - 37%), industry (34%) and transport (29%). In fuel and energy consumption, the share of the residential sector has increased markedly, while that of industry and agriculture has declined. Electricity consumption currently stands as follows: the population consumes about 60.5% of the electricity delivered on the domestic market; Government bodies consume 10.5%; industry, agriculture and commercial consumers consume 29%. Reduced use of coal and gas has heavily affected the electricity production sector. Today, electricity is used for heating, hot water and cooking.

In 1990 the population consumed 1 billion kWh; in 2010 that figure had risen to 3.64 billion kWh, with heavy seasonal fluctuations. Consumption in winter is 3.5 times greater than in summer.

Energy consumption and energy efficiency now face the following problems:

- Inadequacies in current technologies and in the legal and financial framework are responsible for the inefficient use of fuel and energy. There are no incentives for energy producers or consumers to reduce expenditures on energy;
- There is little advocacy for effectively saving fuel and energy in production and in everyday life. Places of higher education and vocational schools still do not produce specialists in energy saving; there are no training programmes for them;
- Energy-saving equipment and materials are only rarely imported or produced in the country, and advanced conservation technologies are only introduced very slowly. As a

result, there is a lack of appropriate information. There is no market for energy saving technologies and equipment, and producers and consumers who would potentially benefit from them have no funding with which to buy them. It is very difficult to access loans for innovative projects. The Government still provides no budgetary support for the development and introduction of energy-saving technologies.

At the same time the country has enormous potential for increasing energy efficiency. According to estimates, overall energy consumption in the country's economic sectors could be reduced by 13% in the near future thanks to technical and organizational measures that would not require substantial investments; this would save 550,000 tonnes of coal equivalent. Overhauling and modernizing the power equipment currently used in the energy sector and introducing energy-saving technologies could produce savings of up to 25% for electricity and about 15% for thermal energy.

There are three priorities for energy saving and energy efficiency development. The first priority is aimed at saving 1.2 million of tonnes of coal equivalent in the short term through qualitative organizational and management support to develop energy saving. The second is directed at saving 0.7 million of tonnes of coal equivalent in the medium term by providing incentives for the development and use of energy-efficient equipment, technologies and materials in the production, transmission and consumption of gas and other energy sources. The third priority is aimed, through economic restructuring, at reducing the energy intensity indicators and energy intensity in terms of gross domestic product in the long term, saving up to 1.0 million of tonnes of coal equivalent.

Measures to save energy and to increase energy efficiency in the near future will be implemented as follows:

- Develop draft legal and standard documents to meet the requirements of the Energy Reserves Law and to increase energy efficiency;
- Refurbish the existing energy-producing and energy-intensive firms, rehabilitated energy sector, insulate buildings and construct new buildings with the view of the more rational use of energy resources;
- Use local energy resources;
- Restructure the building materials industry and start energy-saving and insulation materials production lines;
- Develop, produce and install metering and monitoring equipment and systems for hot water, steam, natural gas and electricity.

Kyrgyzstan has a huge potential renewable energy resources, estimated at 840.2 million of tonnes of coal equivalent per year. The main types of renewable energies are solar, mini hydro, wind, geothermal and biomass. However, such resources are currently barely used; they now account for less than 1% of the country's energy mix. There are various reasons for this, the main one being the lack of an effective economic incentive mechanism.

The most promising areas of application of renewable energy in Kyrgyzstan are the following: decentralized facilities located in remote mountain regions (for instance, arable and pastoral farming, geology and mining, road servicing, meteorological, scientific and other observation stations, radio and television relay transmitters, tourist and recreational resorts, pumping stations and hunting and forest management facilities); and residential buildings, social services facilities, trade and consumer services and health facilities in the regions with centralized power services (hospitals, resorts, convalescent homes, sanatoriums, hotels and saunas, etc.). The use of renewables should be considered not only from an environmental perspective, but also from the point of view of social and economic problems. Currently, the most technically mature for widespread use are the solar heating systems and mini hydro projects.

Priority areas in energy efficiency and energy saving sectors in *energy industry and industry* of Kyrgyzstan are:

- modernization of the energy sector by using energy and gas effective facilities, technologies, equipment and materials during generation, transmission and consumption of energy and gas;
- optimization of demand management to ensure a regular and permissible load of the power system;
- installation of state-of-the-art metering and controlling devices for hot water, steam, natural gas, electricity consumption in all economic entities.

The first steps to increase energy efficiency and energy saving through *RES development* in Kyrgyzstan shall be to:

- construct micro and small hydro power plants of various capacities: 5, 16, 22, 30 kW;
- construct stand-alone wind farms using domestic design – double rotor wind turbines BVEU-0.25, stand-alone power sources unit ABIP– 0.5;
- use heat pumps for heating of different industrial, agricultural facilities and private houses and premises with 3, 12 and 15 kW of thermal capacity;
- use biomass in order to generate methane fuel gas. This area was in the focus of many research and, development studies and experiments, which helped designing two types of biogas plants for rural areas and industry (BGP-7 and PBGP-10).
- produce solar panels, assembly solar power plants and install it at consumers, produce solar thermal collectors and solar plants of various types.

Uzbekistan

Uzbekistan has an installed capacity of more than 12.4 million kW including 12.0 million kW of 39 thermal and hydropower power plants belonging to Uzbekenergo state power company. The remaining capacity is managed by Government departments and branches of industry. Up to 90% of power is produced by the company's 10 thermal power stations, which have a total installed capacity of 10.6 million kW. Uzbekistan's power grid fully meets electricity demand of the national economy and the population, and exports electric power to other countries. In 2010, Uzbekistan produced 50.6 billion kWh and 7,790 thousand Gcal of thermal energy. In 2011, the figures rose to more than 51.4 billion kWh and 8,070 thousand Gcal, respectively. The technical losses in Uzbekenergo power grid make about 13%, and include technical losses from electrical production companies, main power lines and regional electricity grids. However, there is no concept of "commercial losses" in the relevant regulations. The mix of primary energy resources used for production of electric and thermal power includes 92% of gaseous fuel, and 4% of oil residual and 4% of coal.

The country's mineral resources include large hydrocarbon reserves. Currently 211 oil fields have been discovered in the country's five oil- and gas-producing regions; 108 of gas and gas condensate fields, and 103 oil and gas, condensate, and oil fields. Over 50% of the production fields are currently being developed, 35% are ready for production, and the remainders are under exploration. Total annual hydrocarbon production in Uzbekistan is approximately 86 million of tonnes of coal equivalent. That figure has increased by over 60% since 1991. Currently the proportion of renewable energy resources (excluding hydropower) is less than 1% of the country's energy balance. However, national potential in RES stands at around 51 billion toe, while the commercial potential is over 17.9 billion toe.

Energy saving is the basis for improving the energy efficiency of the country economy. The main ways of achieving the targets are by:

- Reducing end consumption of the corresponding demand;
- Improving efficiency in energy use, refining each stage of the production-processing-distribution- use chain;
- Replacing expensive finite resources with cheaper renewable ones;
- Adopting promising advanced technologies and improving energy efficiency to comply with environmental standards.

Between 2005 and 2011, electricity demand rose by 10.9%. The largest growth was seen in the utilities and services sector (46.9%), including population consumption (62.6%). Electricity consumption in construction increased by 52.4% but its share still represents a relatively small (between 0.3 and 0.5%) proportion of total consumption. The figure for industry rose by 5.1%. Transport reduced its electricity consumption by 13.1%, as did agriculture, by 11.5%. Because of the obsolete technology and low domestic prices for hydrocarbons, Uzbekistan is one of the most energy-intensive countries in terms of the hydrocarbons used to produce $1 of GDP. This shows the huge potential for improving efficiency in domestic hydrocarbon consumption through the large-scale introduction of alternative energy sources.

Currently, the organizational and technological potential for energy savings in power production is estimated to be between 2.5 and 5 million tonnes of coal equivalent per year, and achieving that is directly linked to the priorities for the development of the electric power industry:

- Reconstruction, technical refurbishment and modernization of power production;
- Reconstruction and further development of the electrical grid;
- Construction of new generating capacities, focusing on optimizing production facilities that use primary fuel with adequate reserves and environmentally friendly renewable sources;
- Training of technically and economically competent energy saving specialists.

It is very important that the demand side is also involved in the process. This implies a range of interrelated actions in all the sectors of the economy aimed at effective energy use and energy saving. Influencing energy demand is preferable to increasing capacity (influencing supply) because the construction of new generation capacity and power lines requires huge investment in the sector. Influencing the demand side requires relatively less investment and finance with significant results; it will help optimize production and consumption of electricity in industry and other areas.

Energy-saving potential can be fulfilled in several areas. To reduce energy intensity in industry and consequently improve energy efficiency, the ineffective, worn-out and outdated equipment must be replaced by modern energy-efficient and energy-saving equipment; and the production process in large and medium-scale factories must be optimized.

For instance in the power sector this means using gas turbines and combined cycle gas turbines; combined heat and power plants; enhanced recovery and more efficient processing and transportation of oil and gas; enrich coal at mine; introducing effective combustion technologies; reduce auxiliary consumption; using controlled electric drives, etc. In the building materials industry, this means changing cement clinker production from dry for wet process technology; producing ceramic bricks with high void ratio; introducing waste-based production (using ash, clinker, etc.), using fuel more efficiently; recycling waste gases, etc. In agriculture, this means using advanced technologies for preparing and farming of land; optimizing water use; improving the machinery, etc. In transport, this means increasing the ratio of light commercial vehicles and diesel motors; using gas as a motor fuel; building hard surfaced roads, etc.

The housing sector includes apartment buildings and individual houses. In Uzbekistan, half of all energy (17 million toe) is used in buildings. Because of the deterioration in the utilities supply system, poor insulation and a series of other problems, energy use in buildings is between 2 and 2.5 times higher than in other countries. The economic potential of introducing energy-saving measures in Uzbekistan is calculated to be more than 8 million toe. This means that the country currently loses USD 1.865 billion in potential income from natural gas exports and USD 250.3 billion to greenhouse gases every year. The total loss due to the lack of modern technology in the utilities and residential sector is USD 2.115 billion. Furthermore, the total annual expenditure necessary to introduce energy-efficient technology is substantially less than the expected benefits.

The key issue preventing any improvement of the low level energy efficiency and restricting the introduction of “green” buildings is the absence of incentives and effective framework for introduction and wide dissemination of the principles of “green” construction. Specifically, the current system of energy management and outdated standards, regulations and approaches to housing construction neither reflect today’s requirements, nor provide adequate incentives for improving energy efficiency, nor prevent excessive energy consumption or significant greenhouse gas emissions. Some of the reasons of the low level of energy efficiency and energy saving in the housing sector include:

- Relatively low pricing of energy resources (prices for natural gas and electricity are one of the lowest in the world);
- Prevalence of non-efficient domestic appliances;
- Inadequate energy metering system (for electricity and natural gas): not all houses are equipped with electricity and gas meters and, when they are, the meters often do not comply with current requirements;
- Misappropriation of electricity; unauthorized illegal connection to the electric grid;
- Inadequate public awareness of energy saving and efficiency related issues, and the use of electricity and natural gas for domestic heating.

The following could be done to improve energy efficiency in the utilities and residential sector: equip all consumers with energy monitoring and metering devices; use improved thermal insulation; decentralize power supplies (where it proves to be economically feasible); introduce heat pump units; use renewable energy sources; use gas discharge lamps (instead of incandescent light bulbs) for lighting; and use energy-efficient household appliances.

Much attention in Uzbekistan is paid to energy-saving technologies. To improve the electricity metering system, to guarantee its accuracy, reliability and exhaustiveness, to reduce losses and ensure energy saving, Uzbekenergo launched a project to introduce automated electricity monitoring and metering systems for all consumers in the country. Introduction of these systems in companies, entities and housing consumers will reduce technical losses and guarantee more accurate metering at all stages in the electricity supply. Optimum performance will facilitate improving sound management of fuel and energy resources. More than 5 million modern metering devices will be installed under the project.

Summarizing the above said we can highlight our findings. The top-priority technologies for *producing electricity* in Uzbekistan are to:

- Introduce modern gas turbines and combined cycle gas for producing heat and electricity (for example the joint project for development of new technologies NEDO (Japan));
- Enrich coal at mine and introduce efficient combustion technologies;
- Use regulated electric drive.

Priorities in energy efficiency and conservation in *industry* are to:

- Increase oil and gas recovery ratio and improve efficiency in their refining and transporting;
- Convert cement clinker production from dry to wet process technology;
- Produce ceramic bricks with higher void ratio;
- Introduce waste-based production (using ash, clinker, etc.);
- Use fuel more efficiently;
- Recycle waste gases;
- Introduce commercial metering system at the enterprises, entities and households.

Priorities in energy efficiency and conservation *in agriculture* are to:

- Introduce of advanced technologies of preparing and farming of land, water use, improved machinery etc.

Priorities in energy efficiency and conservation *at transport* are to:

- Increase the ratio of light commercial vehicles and diesel motors;
- use of gas as a motor fuel;
- construct hard surface roads, etc.

Priorities in energy efficiency and energy saving in *housing and utilities sector* are to*:*

- equip all consumers with energy resource monitoring and metering devices;
- use improved thermal insulation;
- decentralize power supplies;
- introduce heat pump units;

- use renewable energy sources;
- introduce gas discharge lamps (instead of incandescent light bulbs) for lighting;
- use energy-efficient household appliances.

Improvement of energy efficiency and energy saving through the use of *renewables:*

- construction of small HPPs;
- introduction of standalone units for the use of solar and wind energy, solar heat collectors, biogas facilities.

Tajikistan

Tajikistan has considerable reserves of fuel and energy resources. Its hydropower potential is around 527 billion kWh per year, some 202 billion kWh of which is already technically and economically feasible. Yet Tajikistan currently uses only 5% of the overall total of such resources. The overall installed capacity of the country's grid is 5,591 MW; thermoelectric power plants account for 320 MW. Electricity is generally produced from hydropower, and first and foremost by the Nurek hydroelectric power plant, with a capacity of 3,000 MW. The installed capacity of hydroelectric facilities can produce 5 million kWh per day, and annual average electricity production over the past three years has been around 16,256 million kWh. There is very little oil or gas production as Tajikistan has relatively small reserves. Coal reserves are currently estimated at 4.5 billion tonnes, only a very small portion of which is now being exploited (in 2011, only 236,700 tonnes were extracted). Fuel and energy consumption in Tajikistan is currently structured as follows: 49.2% for industry sector (excluding auxiliary supply of electricity generating plants and losses); 9% for civil construction and transport; 11% for agriculture and pump irrigation; 26.1% for housing utilities and 10.5% for other consumers.

The biggest share of the electricity is consumed by industry. In 2011, the Tajik Aluminium Company (TALCO) accounted for about 50% of overall electricity consumption, or 6.7 billion kWh. The shortfall in other industrial sectors amounts to over 800 million kWh. The highest growth rates of electricity consumption are apparent in nonferrous metals (20%), ferrous metals (18.9%), building materials (7.3%) and foods (12.7%). Machine building is far behind with just 1%.

The key steps to optimize energy use in industry are to:

- implement in industry the national "power management system" standard;
- restructure the enterprises aiming primarily at production of less energy-intensive high-tech competitive products;
- renew fixed assets of enterprises in the country on the basis of advanced technology and engineering with high economic effect;
- Assess potential energy savings for all types of energy use through energy audits; develop and periodically update energy certificates for enterprises;
- improve the regulation of the process equipment and optimize operation of equipment including establishment of the in-house technical diagnostics;

- review specific norms, rules and regulations of energy consumption per unit of production and establish the compliance monitoring;
- Establish standards for energy consumption and energy loss limits; introduce mandatory certification of energy consuming devices and equipment;
- Develop domestic generation facilities using mainly renewable energy sources;
- Use secondary energy resources and alternative fuels including fuel waste; use efficient heating, lighting, ventilation, hot water supply systems;
- Organize modern in-house metrology functions; introduce modern technical metering and monitoring devices in companies at all levels of energy consumption;
- Introduction of automated power management systems to reduce the wastage of energy resources, optimize their consumption in peak hours; form balances of all types of energy resources;
- Encourage development of energy performance contracting business and energy service companies.

Electricity consumption in agriculture is 4 times lower than in 1990. One of the reasons is the low purchasing power in this sector; thus higher electricity price had entailed reduction in consumption. At the same time, the irrigation is one of the most energy intensive infrastructures; it is the sector with the third highest energy intensity in the country's economy. The average annual consumption of electricity for pump irrigation is 1.5 billion kWh. In order to reduce the system's energy intensity, the existing water supply facilities have to be refurbished with high-efficiency equipment and small, medium-scale and local irrigation systems and water wells for individual and collective use shall be built.

Between 2000 and 2011, electricity consumption in transport was flat at a very low level, accounting for just 0.07% of overall consumption. In this sector, the main consumer was the trolleybus company, which consumed over 18 million kWh per year.

Electricity consumption in residential buildings and in services sector has increased by 14% since 1990 to 3,603.8 billion kWh in 2011. The trend of electricity consumption is mainly dependent on the population growth rate. The population increased by 11% in 10 years. However when household electricity consumption increased significantly after 1990 because of interruptions in supply of natural gas and petroleum products, the consumption in the service sector hardly increased at all. And in the period from 2000 to 2011, the service sector developed rapidly. In that sector the main factors contributing to increased use of electricity were growth in volume and restructuring. The structural changes were brought about by continuing growth in the number of power consuming enterprises, including large hotels or resorts, trade centres, banks, cafes and restaurants. Prospects in residential electricity consumption will depend on paying power of the population vs. energy costs ratio; the higher rate of electronic appliances integration and future conditions of electricity and heat supply. The main indicator that can be used to benchmark energy efficiencies for government organizations is the rate of energy used annually per square metre of space (expressed in kWh per square metre per year). In this area, there is little interest in reducing energy consumption. The existing legislation provides no incentive for government employees to follow energy saving policy.

Energy resources saving at the national level could be broken down into types and larger classes of energy-saving techniques. These include:

- Equipment for energy audits, for saving heat, electricity, water and fuel; for reactive power compensation; reduced-voltage start and speed control of motors;
- Use of renewable energy sources;
- Automation of technological processes, motors, buildings, comfort systems and data centres.

The following steps can also be taken to increase energy efficiency in the grid:

- Increase efficiency and reliability of energy systems (advanced energy-saving technologies, equipment, facilities, materials and automatic regulation systems);
- Replace obsolete transformers with new ones;
- Replace obsolete electric motors with new, energy-efficient ones;
- Replace electric radiators with heat accumulating radiators that consume power only at night, when electricity price is low, and release it during evenly the day;
- Use cold outdoor air for compressor intakes.

The use of energy-efficient technologies shall in general reduce energy consumption by 30-40%. For example, at industrial enterprises the motors account for up to 65% of energy use. The use of frequency converters on induction motors in engineering systems reduces electricity consumption by 30%, and introducing automated control mechanisms increases the savings to 50%. Lighting in buildings accounts for 20-40% of energy consumption; the installation of building automation systems (for example, using multifunctional motion, lighting and temperature sensors, lighting regulators, twilight sensors, wall-mounted control panels and blinds and rolling shutters) can reduce electricity consumption by 30-40%. The electricity supply and cooling systems for data centres account for 10-50% of the energy used; the potential reduction here is 10-40%.

Around 90% of residences in Tajikistan were built according to out-of-dated standards, and these buildings account for most of the consumption (3.6 billion kWh). It is thus now important for the country not only to build energy-efficient housing, but also to bring old housing up to modern building standards by insulating and installing up-to-date heating systems. Mitigation of heat loss and electricity wastage in buildings may include the following: use of solar elements in building design; apply thermal insulation of buildings; refurbish roofing; seal building joints and use plastic windows; install new generation of radiators with heat regulator; install automatic door closers for entryways; replace lamps with energy-efficient, sensor-controlled lighting units in public spaces; install solar collectors to heat water and solar panels to provide electricity.

In Tajikistan, the following renewable energies are deemed the most promising: mini hydropower plants, solar installations generating heat and electricity, wind power and biogas facilities. Unfortunately at this stage not all of these technologies are economically viable. Therefore, the concept of economic potential is used to assess the possibilities offered by renewables. In Tajikistan the economic potential of renewable energies amounts to about 5%. In other words, up to 800 million kWh per year of the overall energy requirement can be obtained from renewable resources using commercially available technologies.

New, energy-efficient technologies are required in the energy sector in Tajikistan, but numerous problems have emerged in this regard, specifically:

- Fuel and energy companies are heavily reliant on imported energy technologies and equipment;
- Fuel and energy companies are unable to meet modern technical requirements;
- Fuel and energy companies have limited R&D potential and lack innovative structures (such as energy efficiency and saving research centres, innovative technological centres, technical industrial parks and advanced training centres encouraging innovative approaches).

To improve energy efficiency and use of renewable energies Tajikistan shall address the following challenges: renew and develop the national scientific and technical potential; establish energy efficiency and conservation research centres; modernize scientific and technical information system and experimental base; create a framework of government support and incentives to encourage energy companies to develop and implement investment projects aimed at innovative development in the country's fuel and energy sectors; develop international cooperation to import the best technological advances in the world; maintain and develop human resources and the existing scientific base; and integrate science, education and innovative activities.

Thus the priorities in energy-efficient and energy-saving *electricity production and transmission* in Tajikistan are to:

- ➢ improve efficiency and security of power system (use of advanced energy saving technologies, equipment, devices, materials, automatic control systems);
- ➢ replace obsolete power and measuring transformers;
- ➢ optimize low-voltage transformers burden.

Measures to reduce electricity production losses are to:

- ➢ convert boiler houses to combined heat and power plants using alternative energy sources;
- ➢ construct gas turbine power plants
- ➢ replace outdated boilers with energy-efficient ones;
- ➢ introduce and improve new technological and commercial losses metering and reduction systems;
- ➢ apply thermal insulation on outdoor heat pipelines;
- ➢ replace water cooling towers with steam injectors, introduce circulation water system.

Priorities in energy efficiency and conservation in *industry* are to:

- ➢ apply harmonic filtering, eliminate peak overvoltage;
- ➢ introduce instrumentation for energy audits, saving thermal energy, electricity, water and fuel;
- ➢ compensate reactive power to increase the active power;

- replace obsolete electric motors;
- use reduced-current start system and variable frequency motors;
- automate processes to control engineering and electricity supply systems (for example, using multifunctional motion, lighting and temperature sensors, dimmers, twilight sensors, wall-mounted control panels and blinds and rolling shutters);
- replace electric radiators with heat accumulating radiators;
- use cold outdoor air for compressor intakes;
- redesign of boiler house into small combined heat and power plant with gas turbine installation;
- introduce new energy-efficient lighters;
- hermetically seal buildings; heat housing air intake by waste gas.

Priorities of energy efficiency and conservation in *agriculture* are to:

- rehabilitate the existing irrigation infrastructure through modernization of water supply systems and construction of small, average and local systems using high-performance energy equipment;
- adhere to all modern construction standards and requirements in terms of thermal insulation for agricultural buildings and communications, designing of ventilation and light;
- apply temperature control in agricultural buildings, heating systems and water heating-up;
- use energy saving and LED lamps;
- use controlled electric drive.

Measures minimizing heat loss and electricity wastage in *buildings* are to:

- use of solar architecture in building design;
- apply thermal insulation to building facades and walls;
- replace roofing, seal building joints and install plastic windows;
- install the new generation of radiators with regulators;
- install automatic door closers for entryways;
- replace lamps with energy-efficient, sensor-controlled lighting units in common spaces;
- install solar collectors to heat water and of solar panels to provide electricity.

Measures improving energy efficiency and energy saving *at transport* are to:

- modernize vehicle fleet reducing costs for motor fuel and improving management system of vehicle park and transportation;

- introduce advanced high-end technologies and equipment, optimize technological processes parameters via sound use of fuel and energy resources;
- introduce fuel monitoring systems in transport organizations and improve energy resources rationing arrangements;
- enhance operation and maintenance of existing railway and motor roads;
- optimize routes for cargo and passengers transportation;
- develop traffic management in the large cities of the country;
- replace the existing obsolete power supply equipment with the new energy saving one.

Enhancement of energy efficiency and saving through development of *renewables*:

- construction of small HPPs;
- installation of solar collectors to warm up water and solar panels to supply electricity and heat water, using of domestic solar cookers;
- wind generators for independent consumers;
- production of combustible biogas out of waste liquids and solids from stock breeding complex, using domestically produced biogas generator (digestion tank).

Turkmenistan

Having enormous reserves of natural gas (15—20 trillion m^3) and oil (1.5—2.0 billion tonnes), Turkmenistan is one of significant exporters of fuel resources to the world energy market. However difficulties in transportation and exploration impede the development of this economy sector which makes about 70 % of gross national product. Total hydrocarbon reserves reach 45.44 billion tonnes of coal equivalent. In 2012, above 69 billion m^3 of natural gas and 11 million tonnes of oil and gas condensate was produced in Turkmenistan. Limited privatization mainly covered the sector of services. The industry, agriculture, power industry, transport and communications are still in the hands of the government. As a result, many state services remain free and depend on subsidies. In 2009, Turkmenistan gross domestic product was USD 16.24 billion. The main industry branches include refining of oil and natural gas; production of glass and fabric (mainly, cotton) and clothes; food industry. In 2008, the number of man power was 2.3 million. 48 % of all employed people are involved in agriculture, 14 %, in industry, and 38 %, in the sector of services.

The system of TurkmenEnergo State Electric Energy Corporation under the Ministry of Electric Power and Industry of Turkmenistan includes ten (10) government power plants with total installed capacity 4104.2 MW (nine gas-fired plants and one HPP). In 2009, 15.61 billion kWh were produced. The Turkmen electric power industry has excessive capacity; it fully covers the national electricity demand and can export power to other countries if needed. All power plants use domestic natural gas. As a backup fuel they use residual oil and diesel fuel of own oil refineries.

According to the resolution of the President of Turkmenistan dated 1993, the population is provided with free electricity, gas and water. In 2006 this social benefit was extended to 2030. Despite the growing performance, the electric power industry is not profitable. Balance sheet profit in the industry was generated mainly through the exchange rate difference over the last years. The main share of electricity is consumed domestically. Electricity prices are regulated by the government and set below the cost of production. Free electricity for population is covered from the national budget.

The electric power industry is a key consumer of fuel (natural gas, residual oil, diesel fuel) and one of the most important economy sectors in Turkmenistan. It accounts for 87% of industrial consumption of gas in the country. Rehabilitation of electricity production equipment save a considerable amount of natural gas which can be exported thus improving economic position of Turkmenistan. Energy-efficiency measures in the electric power industry requires political support at the government level. It is required because construction of 1 MW simple cycle gas turbine plants cost about USD 0.6 million, and their conversion to combined cycle will cost USD 1.5 million for 1 MW, i.e. 2.5 times cost overrun. However, these costs could be recovered in 5-6 years only due to export of the saved gas.

Turkmenistan has favourable climatic and natural conditions for renewable energy sources producing electricity, heat and cold. Estimated annual potential of solar energy is about 110 billion tonnes of coal equivalent. Wind energy potential is estimated at 5.5 billion tonnes of coal equivalent per year. However availability and low cost of conventional energy sources for all social groups hinder wide use of the renewables despite their high potential.

In the long term the renewable development programmes shall solve a series of priority challenges of power supply to different consumer categories:

- Local energy problems in the remote regions distant from the national power system;
- Improvement of sustainable development in agricultural regions in desert and mountain areas;
- Improvement of living standards and employment of local population;
- Mitigation of human environmental impact.

The feasibility of using of renewable energy in the energy mix of different types of consumers should be determined based on competiveness of renewables in comparison with the widely used conventional energy technologies, including comprehensive assessment of energy efficiency, economic viability and environmental safety. Currently, it is rather difficult to evaluate the market potential of the renewables in this regard, since there is no background information which can serve as a basis for appropriate calculations and assessments. For instance there is no energy saving law, and this fact do not allow assessing the ways and amounts of energy waste reduction, and the share of alternative methods for energy production. Conditions of government support of development of renewable energy are not determined through appropriate regulatory documents which should determine and secure such conditions. All this complicates the development of investment programs for the creation and implementation of systems and renewable energy systems for the near future.

Priority energy efficiency areas and corresponding technologies *at electricity production* include:

- Withdrawal from operation of obsolete and physically worn out equipment;
- Rehabilitation of generation units at the existing power plants;
- Conversion of gas turbine plants from simple to combined cycle;
- Efficiency upgrading of units at Seýdi CHPP through construction of cooling towers.

Energy efficiency and energy saving could be improved through deployment of *renewable energy sources* as follows:

- Solar powered watering points in wild pastures;
- Energy-saving solar houses for rural areas;
- Power supply of farms;
- Solar boiler-houses for housing and public utilities;
- Night lighting of main transport routes (using renewables);
- Wind and solar power plants for power supply to remote villages.

4.2 Inventory/database for new and emerging technologies for energy efficiency and renewable energy sources applied in Central Asia

Application of any given existing and emerging technologies for energy efficiency in the countries of Central Asia (CA) depends on availability of fossil fuel (gas, coal and oil) and renewable energy sources (water, wind and sun), and development of industry branches subject to availability of certain resources, transport, construction sector and agriculture in these countries.

CA countries are rich in fuel resources and top-ranked globally in coal, oil and gas reserves and water resources. Kazakhstan has the biggest coal and oil reserves, Uzbekistanis and Turkmenistan are rich in gas. Kyrgyzstan and Tajikistan are rich with water resources. The trend of fossil fuel use for electricity and heat production will remain in a long-term. In this case, the key areas in energy efficiency improvement involve new technologies of fossil fuel combustion, use of high-efficiency combined cycle and gas turbine installations, recovery of associated gases for electricity production. All high-efficiency technologies described in sub-section 3.1 for coal and gas power plants has a commercial potential in the region.

At the same time, thanks to geographic location the CA countries could use the renewables for electricity and heat production. The new technologies and renewables can be used both in stand-alone (mini hydro and wind installations, solar collectors) and for large installations (HPP, wind and solar power plants). Application of all these technologies described in sub-sections 3.4 - 3.8 depends on the nature of the renewable source, location of the specific project (how are it is from its consumer and from the transmission infrastructure) thus affecting its economic characteristics. Practically all the listed above new technologies and equipment using renewable energy sources can be applied in CA.

The potential improvement of energy efficiency in industrial enterprises in CA countries is enormous, and is primarily associated with the modernization of obsolete equipment at all stages of the preparation and processing of raw materials and production of finished products, the introduction of automation and control systems (control and energy metering systems, automation systems, climate heating, ventilation , air conditioning, lighting and automation control systems of buildings), the use of modern materials (insulation, lubricants). Industry is represented by the following main sectors:

- Non-ferrous industry;
- Ferrous industry;
- Chemical, oil refinery and petrochemical industry;
- Machine building;
- Paper and pulp industry;
- Industry of construction materials;

All countries of this region has developed railway, motor and air transport which facilitates the use of commercially available energy-efficiency technologies in this sector in all CA countries.

All considered Central Asian countries in the recent past were a part of one country with uniform standards in the building and housing sector. Therefore, the problems they face in housing and communal services and building and construction are similar. The same is true for energy efficiency technologies that are used or recommended for use for existing and new buildings (see Section 3.3).

Agriculture is another developed sector in all CA countries. The issues of improvement of energy efficiency and energy saving in the sector as well as applied technologies (irrigation systems, agricultural buildings and structures, applied specialized machinery and specific technological processes) are similar in all the countries of the region.

Databases for energy-efficiency technologies and their application

The global experience of deployment of energy-efficiency and resource-saving technologies is also applicable in the countries of Central Asia. The existing databases for energy-efficiency and resource-saving technologies for different industry sectors, transport and agriculture are invaluable for the experts in the region.

According to surveys of Lawrence Berkeley National Laboratory (USA), the new areas of energy efficiency improvement in industry in general are to improve compressor control system, use of new lubricants, application of variable frequency motors and switched-reluctance drives, application of dry sheet forming (in pulp and paper industry), application of inert anode/ wetted cathode technologies (aluminium production) and anaerobic waste water treatment[20].

The best energy efficiency indicators of modern industry technologies (production of steel, iron, aluminium, cement, pulp and paper production, chemical industry) for which one should strive, are given in *Best Practice* (2007), Lawrence Berkeley National Laboratory[21].

Based on experience of EU countries, Norway and Croatia, ODYSSEE database was created; it contains data on energy efficiency indicators in industry branches, agriculture and transport and can be found at http://www.odyssee-indicators.org/database/database.php.

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[20] http://www.rmi.org/RFGraph-Emerging_energy_efficient_technologies

[21] http://ies.lbl.gov/node/393

The new energy efficiency technologies for industry are developed in many countries. The web-site of Washington State University Extension Energy Programme http://e3tnw.org/ represents database which includes the following key application areas of energy-efficiency technologies: building insulation, compressors, electricity distribution (SMART grids), energy management, cooking, air conditioning control, irrigation, lighting, electric motor, cooling and water heater.

Use of renewable energy sources and emerging technologies are given in detail at the web-site of National Renewable Energy Laboratory (USA) - http://www.nrel.gov/science_technology/.

Analysis of energy efficiency technologies (existing and future) used for power supply (supply of primary energy sources, transportation and distribution, production of electricity and heat) and consumption (industry, transport and utilities) is given at the web-site of Energy Technology Systems Analysis Program, International Energy Agency:http://www.iea-etsap.org/web/E-TechDS/Technology.asp. There is a brief review of status of technological processes, production and costs, potential and scopes of application (global, local, national and regional) for new technologies.

For example, studies and review of energy-efficiency technologies are given at the web-site of International Energy Studies Group (Lawrence Berkeley National Laboratory (USA)) - http://ies.lbl.gov, at multifunctional public internet portal Energy-efficient Russia of the Russian Energy Agency - http://energohelp.net/articles/. List of energy-efficiency technologies is being prepared by the Russian Union of Industrialists and Entrepreneurs http://www.rspp.ru/simplepage/481.

Let's consider the presented experience in terms of its use in the countries of Central Asia.

Cement production

The production process includes raw material preparation, fuel preparation, clinker making, cooling and grinding. Efficiency can be improved at each stage of production. For example:

- Use alternative raw materials, i.e. replacement of limestone by materials which do contain CO2; this will allow to reduce CO2 emissions and fuel consumption for calcination. This includes blast furnace or carbide slag, lignite, fly ash, asphalt-bearing shale, crushed sand from stone cutting, lime sludge from sugar processing etc.;
- Use alternative fuels, i.e., partially or fully replace hard coal or lignite which have high specific CO2 emission values of combustion, with fuels having lower specific emission values, for example: gas, petrochemical wastes, paper waste etc.; fuel management;
- Use high efficiency vertical roller mills, classifiers/separators for more precise separation, mixers;
- Use high-efficiency cooling systems (clinker coolers) and heat recovery systems;
- Improve insulation and application of multistage pre-heater stages for clinker preparation.

General recommendations regarding energy efficiency improvement of cement production cover preventive inspections/ maintenance, use of high-efficiency variable frequency drives and motors, optimise compressed air and fan system, lighting control and transition to LED lighting[22].

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[22] For more details see: http://www.ietd.iipnetwork.org/content/cement; http://ies.lbl.gov/node/451

Metallurgy and machine building

Production of iron and steel includes numerous processes. The main processes are coke making, sintering, smelting in blast furnace, casting and steel rolling.

Power consumption can be reduced through application of various technologies including dry coke quenching, recovery of exhaust gas of coke ovens to heat the raw materials, coal pulverisation, gas injection, heat recuperation from air heaters, coal moisture control, top pressure recovery turbines, increased blast furnace top pressure, emissions optimized sintering, application of new insulating materials, flameless burners, thin slab casting and many others.

General recommendations regarding energy efficiency improvement cover preventive inspections/ maintenance, establishment of energy management, use of variable frequency drives on pumps and fans, optimisation of motors[23].

Heat-treatment machinery and industrial furnaces are one of the most considerable consumers of energy (gas and electricity) and resources (refractory products, heaters, electrodes, copper, gas, oil, water etc.) at metallurgic and machine building enterprises. Therefore, energy consumption could be reduced by application of energy-saving technologies, new materials and design of new furnaces, efficient high-temperature and heat insulation materials, and rehabilitation of the existing thermal facilities.

Key energy-saving measures in machine building and metallurgy include[24]:

- Application of fibre high-efficiency refractory and heat-insulation materials for lining of industrial furnaces;
- Application of thyristor frequency converters in metal induction heating for forging and thermal treatment process;
- Transition from hot pressing to stamping and cold pressing;
- Application of advanced gas burner units. Application of recuperative, flat-flame and impulse burners;
- Application of efficient heat carrier routing (counterflow, U-shaped furnaces with recuperation zones, forced convection, flame and thermal curtains, recycling of combustion products);
- Application of recuperative and reclamation devices;
- Expansion of powder metallurgical technique use;
- Heating process automation in furnaces of various applications.

Energy-saving technologies requires application of special materials. Currently, high-efficiency refractory and heat-insulation materials are applied to secure reliable and durable operation of furnaces at the following temperatures of long-term application (fibrous materials from basalt and multisiliceous fibres, foam material):

- Up to 750 °C – basalt fibre slabs and boards with density from 140 up to 220 kg/m^3;

[23] More details on applicable and design energy-efficiency technologies during production of iron and steel are available at: http://www.ietd.iipnetwork.org/content/iron-and-steel; http://www.iipnetwork.org/databases

[24] http://basaltfm.com/ru/energo/technology.html

- Up to 875 °C – perlite and ceramics, foam diatomite and vermiculite, density up to 350 kg/m^3;
- Up to 1200 °C – multisiliceous materials: felting and coiled materials, density up to 200 kg/m^3;
- Up to 1500 °C – multisiliceous materials, felting, slabs at high-temperature binders.

Chemical and petrochemical industry

These industries have various technological processes producing and consuming a lot of heat. Coal, oil and gas are used both as fuel and raw material. However a great portion of the processed energy resources can cover 50% of auxiliary heat demand. This problem requires development and implementation of combined energy technology system integrating energy and thermal power systems to provide higher economic efficiency in achieving target of energy and technology production[25].

A large potential of energy saving could be found in recycling of waste energy (heat of high grade gas emissions) and application of waste heat recovery boilers for production of steam and hot water.

Key areas in improving energy efficiency through energy saving are to:

- Install recuperators for water heating;
- Use direct heating gas burners instead of steam heating of fire-resistant fluids;
- Efficiency improvement in distillation process due to use of heat pumps, activity increase and catalyst selectivity.

Energy saving and energy efficiency improvement at chemical enterprises is oriented at improvement of the existing technology processes and equipment in production of calcined and caustic soda; deployment of large installations for methanol production; use of gas-phase ethylene polymerization in polyethylene production; upgrading and enlargement of unit capacity of plants in production of chemical fibre; development of membrane technology for separation of fluid and gaseous mediums; development and deployment of production of chlorine and caustic soda in membrane sell; increase in share of orifice method in production of caustic soda; application of high-activity catalysts; production of ethyl aldehyde through direct oxidation of ethen by oxygen; wide deployment of technological process automation.

Pulp and paper production

Pulp and paper production is a very energy intensive industry where the most of energy saving potential relates to the improvement of the cellulose (chemical or mechanical) preparation process, steam generation and heat power recovery systems, drying and bleaching systems. The energy efficient technologies applied in the industry can be found on the web-sites([26]).

[25] http://www.ingenerstvo.ru/774

[26] http://www.ietd.iipnetwork.org/content/pulp-and-paper; http://eex.gov.au/industry-sectors/manufacturing/pulp-and-paper/

The need for heat at the pulp and paper mills[27] is two or more times higher than the need for electricity. It is particularly high at the stage of paper drying. The main areas where the heat demand could be reduced are: 1) infrared radiation; 2) high frequency and microwave heating; 3) heat pumps. However, they require large investments, and therefore the preference is given to less capital intensive measures to decrease the fuel and energy resource consumption. Such measures include:

Electricity saving:

- Increase of initial steam pressure of the turbines of in-house heat and power plants;
- Shift energy consumption as far as possible to the off-peak hours;
- Install compensating devices to reduce electricity losses;
- Increase electric motor load factor;
- Utilize more efficient equipment for pulp cooking;
- Replace wood pulp with wastepaper.

Steam saving:

- Utilize steam boilers at the ultimate performance; timely maintain and monitor their operation using computer-aided techniques;
- Prevent steam leaks;
- Monitor steam demand;
- Apply heat insulation to steam pipes, fittings and tanks;
- Limit steam consumption to the preset maximum level;
- Utilize the bleed steam of the turbine;
- Decrease of steam pressure in boilers.

Heat saving:

- Recover condensate to heat the boiler feed water;
- Recycling of hot wash water;
- Prevent of overdry;
- Utilise waste heat of boiler exhaust gases;
- Utilise waste heat of the air above the paper machines;
- Clean dryers to increase heat transfer efficiency.

[27] http://www.ingenerstvo.ru/778

Glass production

The main glass production stages, which are the most attractive for improvement of energy efficiency, include batch preparation, melting and refining, conditioning and forming. The energy efficiency potential in this industry sector includes improvement of process management, higher rate of scrap glass recycling, increased size of furnaces, use of waste heat in the batch and scrap glass preheating systems or for steam generation, use of oxy-fuel. Description of technologies aimed at energy saving and enhancing energy efficiency in the industry can be found on the corresponding web-sites([28]).

Transport

Energy efficiency of transport (air, rail, motor) is first of all the efficient fuel consumption. The solution lies in further reducing of the weight of design, improving of the aerodynamic performance of vehicles, using of alternative fuels (combined use of fuels), improving of the fleet, and improving of management and logistics.

These issues are described in details on the corresponding web-sites([29]). The key ways of enhancing the energy efficiency of *transportation* include are to[30]:

- Use less energy intensive fuel (primarily, it is liquefied or non-liquefied compressed gas), and develop new types of efficient fuels;
- Use fuel injection, air feed and improved combustion technologies in gasoline engines;
- Use compressed air (compressors) to decrease the size of vehicles and enhance the efficiency of fuel consumption;
- Reduction vehicle weight through replacement of metal with polymer, and thus reducing fuel consumption and ensuring better vehicle safety (according to the European Automobile Manufacturers' Association the vehicle weight reduced by 100 kg saves up to 160 litres of fuel per year);
- Reduce fuel consumption by using high-efficiency engines;
- Use green tyres which reduce the rolling resistance, improve road adherence and save up to 10% of the normally consumed fuel;
- Adopt electric vehicles;
- Hybrid electric vehicles which combine a conventional internal combustion engine (gasoline, diesel or an alternative fuel driven) and electric engine (ICE hybrid).

The key areas of reducing energy consumption in the *railway industry* are to:

- Electrify railways;

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[28] http://www.ietd.iipnetwork.org/content/glass; http://eex.gov.au/industry-sectors/manufacturing/chemical-manufacturing/

[29] http://eex.gov.au/industry-sectors/transport/; http://www.railway-energy.org/tfee/index.php?ID=200

[30] http://www.energo-pasport.com/wordpress/energosberezhenie-na-transporte-osnovnye-meropriyatiya.html; http://solex-un.ru/energo/reviews/avtomobilnyy-transport/obzor-2/obzor-21; http://www.exxonmobil.ru/Russia-Russian/PA/energy_e_eff_trans_brk.aspx

- Replace petroleum fuels with the liquefied natural gas;
- Use advanced locomotives with better efficiency engines,
- Reduce energy losses at railway electric substations;
- Upgrade heat supply to railway stations.

Construction, housing and utilities[31]

The following energy saving technologies are used to enhance energy efficiency in the construction sector: heat insulation of buildings and windows, manufacture of energy saving wall panels, "cold roof" technologies (use of retroflecting white roofing, planting) in hot climate zones, optimisation of heat supply, conditioning and ventilation systems.

The new energy efficient technologies in the housing and utilities sector are represented by metering and management systems of heat and electricity consumption; lighting; use of new equipment; new heat insulating materials; upgrading of heat supply and distribution systems using the quality heat insulation; polymer pipes and advanced pumping equipment; transition from radiator hot water heating to various air heating systems[32].

The below list represents only a few of the measures that allow improving energy efficiency in the housing and utilities sector[33].

Fuel saving during thermal and electric power generation.

- Recuperative and regenerative burners (allow heating the air fed to the combustion chamber through utilization of the heat of waste gases);
- Automation of combustion modes (maintaining an optimal fuel-air balance);
- Flameless combustion. HiTAC technology.
- Fluidized bed combustion of solid fuels;
- Heat recovery from the waste gas exhaust system. Heating of source water or induced air;
- Minimised boiler blowdown;
- Upgrade hot water and steam boilers with combined cycle technology;
- Magnetostrictive cleaning of the boiler inner surface scale;
- Sealing air inflow in the gas ducts and brickwork;
- Recovery of condensate to boilers;
- Economizers for preliminary heating of feed water in de-aerators;
- Recycling of vented steam of generator boilers. Use of steam-jet-injectors;

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[31] Data bases: http://www.krug2000.ru/news/55/1234.html

[32] http://www.gisee.ru/building/

[33] http://portal-energo.ru/articles/details/id/40

- Reasonable reducing of medium heat temperature;
- Recovery of energy released when reducing the pressure of main pipe gas to produce electric and thermal power;
- Cogeneration. Combined heat and power generation;
- Upgrading of boiler houses of small cogeneration plants through a build-up gas turbine unit;
- Trigeneration. Combined heat, power and cooling;
- Reactive power compensation at a facility level.

Enhancing energy efficiency of heat supply networks

- Optimization of pipe size during upgrade of the pipeline;
- Pipe-in-pipe installation with polyurethane foamed insulation;
- Replacement of mineral wool insulation with polyurethane foamed insulation and metal reflectors;
- Electrical and chemical protection of metal pipes;
- Use of remote pipeline diagnostics systems;
- Use of reasonable conditions for reduction of medium heat temperature;
- Prevention of groundwater and waste water inflow to underground heating mains;
- Installation of heat meters at central heating stations;
- Replacement of low-efficient tube-in-shell heat exchangers at central heating stations with plate-type heat exchangers;
- Installation of variable frequency drives to maintain an optimum pressure in the networks (20-25% electricity saving and reduction of accident rate);
- Shutdown of low-efficient and non-loaded boilers;
- Optimisation of thermal conditions of central heating station and recycling of the heat from the system return water and exhaust ventilation;
- Energy efficient lighting;
- Installation of controlled valves at the heat supply to the high loaded sections of the heating mains;
- Use of mobile measurement systems for diagnostics of heat supply and conditions, as well as for regulation of heat supply;
- Installation of heat meters at the heat entrances to buildings;
- Introduction of clustered systems of automatic control equipment for central heating stations;
- Integrated hydraulic balancing of heat supply networks.

Enhancing energy efficiency of electric power networks and lighting systems

- Prevention of transformer under-loading (less than 30%);
- Prevention of transformer over-loading;
- Prevention of overloading at the long sections of distribution networks;
- Installation of reactive power compensators by consumers;
- Introduction of a distributed grid for the reactive power compensation;
- Prevention of current leak at the underground main lines;
- Timely replacement of insulators at OHTLs;
- Improvement of the electric power quality (use of shielding, FORCE energy saving system);
- Increasing of the loading of asynchronous motors (loading shall be over 50%);
- Use of automatic switches from delta connection to Y-connection in light-load conditions;
- Replacement of asynchronous motors for synchronous motors;
- Use of variable speed drives in the ventilation systems of power facilities;
- Automated adjustment of lighting level using power supply regulators for fluorescent lamps;
- Replacement of fluorescent mercury lamps with sodium vapour lamps and metal halide lamps;
- LED lamps for external and emergency lighting;
- Efficient electrical components for the lamps;
- Lighting fittings with reflectors;
- Lighting level selective switching;
- Automated circuit breakers for emergency lighting;
- Use of fibre optic light guide for lighting of dark premises.

Enhancing energy efficiency of water supply systems

- Variable frequency drives at the pumps of heating stations, pump station;
- Replacement of metal piping for polyethylene pipes (reduction of the losses resulting from maintaining of the excessive pressure in pipelines);
- Steel pipeline cathodic protection;
- Optimization of water supply systems. Dispatching and automation of network management;
- Installation of detectors and pressure valves in the network taps;

- Modification of the centralized hot water supply from the circulating supply to a circulating-boosting supply.

"Non-conventional" ways of energy saving in the housing and utilities sector

- Recovery of produced water heat and geothermal sources for heating and hot water supply purposes;
- Solar collectors for additional hot water supply and heating of buildings;
- Creation of seasonal and daily heat storage system;
- Steam-jet-injector as an efficient heat exchanger for disposal of the low temperature heat from waste steam;
- Steam-jet-injectors instead of circulating pumps;
- Heat pumps for heating and hot water supply and recovery of heat from:
    - ✓ sewage and industrial water discharge;
    - ✓ building basement;
    - ✓ solar collector;
    - ✓ exhaust ventilation system;
    - ✓ return water of the heating system network;
    - ✓ sea water and surface water.
- Gas generation units instead of natural gas and for heat supply;
- Coalmine methane;
- Production of pellets, peat briquette and their use for gas generation and heating;
- Distributed grids for heat supply to communities;
- Waste incineration plants in the distributed grids;
- Heat from the network return water for snow melting machines.

Agricultural sector[34]

There are several energy resources utilized in the agricultural sector: heat, fuel and lubricants, gas and electrical power. Nowadays specific measures are implemented to improve energy saving for each of these energy resources.

Electricity saving in the agricultural sector. A considerable portion of electricity consumption can be reduced by using energy saving lamps and scheduling of electrical appliances operation, using energy saving machines instead of obsolete equipment, and increasing of the portion of secondary energy resources in the agricultural sector. Energy costs can be reduced through the use of bio-fuel made of rapeseed oil. Such fuel is a very good alternative to diesel fuel which is used for farming

[34] http://www.energo-pasport.com/wordpress/energosberezhenie-v-selskom-xozyajstve.html

machinery in agricultural sector. Besides of the less cost compared to diesel fuel the rapeseed oil is environmentally safe and non-toxic. Furthermore, such fuel increases the service life of engines, and therefore reduces the expenditures for accessory equipment for machinery.

Use of combined machinery. Energy saving in the agricultural sector could be achieved by using the combined machinery for tillage works. This allows reducing labour and fuel costs (POL) due to reduced number of machinery runs along the fields, for instance tillagers ERA-P, harvesters ERA-U, are able to substitute nearly the entire conventional machinery fleet.

Water saving. As the water is vital for people and plants, drip irrigation systems are used to supply water directly to the base of the plants and therefore allow water saving. Such saving is measured as two or three times reduction of water consumption.

Main areas of energy saving and energy efficiency enhancement in the agricultural sector alongside the new machinery include the following:

- Improvement of grain and seed drying technology, methods of using mineral and organic fertilizers;
- Introduction of the systems of animal wastes utilization for the energy generation purposes (biogas plants) and for production of fertilizers and feed additives;
- Utilization of the heat of ventilation emissions of livestock houses for heating of water and premises.

Due to specific character of agricultural business (seasonal) and remote location from the main energy sources, the use of renewable energy is the most promising option for heat and electricity supply to the isolated consumers (small HPP, wind turbines, solar heat collectors, and biogas units).

Below Table 4.1 represents the database of renewable energy technologies. Table 4.2 represents the list of manufacturers/distributors of renewable energy technologies. Table 4.3 represents the energy efficient technologies by industries, manufacturers/developers of which operate or have their representative offices close to or in the Central Asia.

Table 4.1 Database of commercial and prospective Renewable Energies Technologies

	RE Source	Technology	Output product / use	State of development	Available Power capacity per unit	Average Costs (*)	Technical potential
Electricity Production	Wind Power						
		Large centralised	Electricity	Commercial	2 MW - 8 MW	USD 2,000 / kW	Onshore and offshore
		Small decentralised (vertical axis and horizontal axis)	Electricity in DC current	Commercial	200 W - 15 kW		Buildings integrated or stand alone
	Concentrated Solar Power						
		Parabolic Trough	Electricity	Commercial	farms of 50 MW - 250 MW	USD 3100 - 9300 / kW	Greenfield
		Power Tower	Electricity	Commercial	farms of 1.5 MW - 400 MW	USD 6400 - 10700 / kW	Greenfield
		Linear Fresnel Reflector	Electricity	R&D / Commercial	farms of 50 MW - 250 MW	USD 3100 - 9300 / kW	Greenfield
	Solar Photovoltaics						
	Cristalin Silicon (C-Si)	Monocristalin	Electricity in DC current	Commercial	200 Wp - 300 Wp per module	USD 880 - 1140 / kW	BIPV or ground mounting; rigid
		Polycristalin	Electricity in DC current	Commercial	200 Wp - 300 Wp per module	USD 880 - 1140 / kW	BIPV or ground mounting; rigid
		Ribbon Sheets/ String Ribbon	Electricity in DC current	Commercial	250 Wp - 280 Wp per module	USD 880 - 1140 / kW	BIPV or ground mounting; rigid

	RE Source	Technology	Output product / use	State of development	Available Power capacity per unit	Average Costs (*)	Technical potential
	Thin film	Cadminum Telluride (CdT)	Electricity in DC current	Commercial	~80 Wp per module	USD 770 - 1000 / kW	BIPV or ground mounting; rigid
		Amorphous Silicon (a-Si)	Electricity in DC current	Commercial	Any size (flexible)	USD 650 - 750 / kW	BIPV or ground mounting; flexible or rigid
		Copper Indium/gallium Diselenide/disulphide (CIS, CIGS)	Electricity in DC current	Commercial	Any size (flexible); ~145 Wp (rigid)	USD 770 - 1000 / kW	BIPV or ground mounting; flexible or rigid
	Concentrated Solar Photovoltaics	Cells with concentrating lens	Electricity in DC / AC current	Commercial	~20 kW - ~60 kW per array	USD 3100 - 4400 / kW	Ground mounting
	Organic solar cells	Oligomer solar cells	Electricity in DC current	R&D / Demonstration	Any size	not available yet	Multiple applications (electronic oligomers)
		Polymer solar cells	Electricity in DC current	R&D / Demonstration	Any size	not available yet	Multiple applications (electronic polymers)
		Dye-sensitized solar cells	Electricity in DC current	R&D / Demonstration	Any size	not available yet	Multiple applications (electronic inks)
	Inverters	Central, string or micro	Electricity in AC current	Commercial	not applicable	USD 0.25 / Watt peak	PV farms
	Balance of System (BoS)	Cables, wires, peripherical installation	Installation supporting peripherials	Commercial	not applicable	USD 820 - 1660 / kW	PV installations

	RE Source	Technology	Output product / use	State of development	Available Power capacity per unit	Average Costs (*)	Technical potential
	Trackers	1 Axis, 2 Axis	Follow apparent sun movement to increase productivity	Commercial	not applicable	20% of investment cost of solar system	PV farms
	Hydro Power						
		Run-of-river	Electricity	Commercial	less than 100kW - 10 MW	USD 500 - 3500 / kW	Small rivers, sensitive environment
		Dam	Electricity	Commercial	few MW - 900 MW	USD 1000 - 3500 / kW	Any rivers in non-sensitive environmental areas
		Capacity adding	Electricity	Commercial	site dependant	site dependant	Already existing hydro plants
	Geothermal Power						
		High temperature	Electricity	Commercial	300 kW - 100 MW	USD 1500 - 5500 / kW	High temperature resource available
	Biomass						
	Solid Biomass (wood, forest residues, pellets, etc.)	Combined Heat & Power and boilers	Electricity and heat (hot water, hot air, vapour)	Commercial	few kW - hundreds MW	USD 600 - 1400 / kW	Domestic, services and industry

	RE Source	Technology	Output product / use	State of development	Available Power capacity per unit	Average Costs (*)	Technical potential
	Gaseous Biomass (Bio methane from waste + waste water)	Combined Heat & Power and boilers	Electricity and heat (hot water, hot air, vapour)	Commercial	few kW - hundreds MW	USD 600 - 1400 / kW	Landfills, waste water treatment plants, farms, etc.
Heat & Fuels Production	Solar Thermal Collectors						
		Flat plate solar collectors	Sanitary hot water, appliances, space heating	Commercial	Available at any size	USD 500 / sq.m	Rooftop, ground mounted, domestic, industrial, services
		Evacuated tubes solar collectors	Sanitary hot water, appliances, space heating	Commercial	Available at any size	USD 500 / sq.m	Rooftop, ground mounted, domestic, industrial, services
	Geothermal Heating and Cooling						
		Geothermal heat pumps	Space heating & cooling	Commercial	Available at any size	USD 2000 - 5000 / kW	Domestic and services
	Biomass						
	Solid Biomass (wood, forest residues, pellets, etc.)	Wood stoves, boilers, high efficiency fireplace inserts, etc.	Space heating	Commercial	Available at any size	USD 400 - 700 / kW	Domestic, industrial and services

	RE Source	Technology	Output product / use	State of development	Available Power capacity per unit	Average Costs (*)	Technical potential
	Liquid Biomass (biodiesel, bio ethanol)	Combustion engines (vehicles and stationary)	Fuels (alone or mixed with oil products)	Commercial	not applicable	not applicable	Transports and stationary combustion engines

(*) - The indicated costs are average estimates and depend on the location, size and structure of the installation. The estimated costs includes equipment, installation, BoP systems, land and permits.
Concentrated solar power does not include the cost of storage facilities.

Table 4.2a Database of commercial and prospective Renewable Energies Technologies. List of Manufacturers and developers

Wind Power		Concentrated Solar Power		
Large	small decentralised	Parabolic Trough	Power Tower	Linear Fresnel Reflector
www.enercon.de www.vestas.com www.suzlon.com www.sinovel.com www.goldwindglobal.com www.gamesacorp.com www.ge-energy.com www.energy.siemens.com	www.urbangreenenergy.com www.helixwind.com www.windspireenergy.com www.evancewind.com	www.flagsol.com www.abengoasolar.com www.solarmillenium.de www.saint-gobain-solar-power.com	www.abengoasolar.com www.saint-gobain-solar-power.com www.wilsonsolarpower.com www.brightsourceenergy.com www.solarreserve.com	www.areva.com www.novatecsolar.com

Table 4.2b Database of commercial and prospective Renewable Energies Technologies. List of Manufacturers and developers

Solar Phototvoltaics				Hydropower
C-Si	Thin film	CPV	OPV	
www.upsolar.com	CdT	www.amonix.com	www.plextronics.com	www.alstom.com
www.yinglisolar.com	www.firstsolar.com	www.arimaeco.com	www.heliatek.com	www.voith.com
www.trinasolar.com	www.antec-solar.de	www.soitec.com	www.polyera.com	www.andritz.com
www.schueco.com	www.ge-energy.com	www.cyriumtechnologies.com	www.solarmer.com	www.newmillsengineering.com
www.rcssolar.com	a-Si	www.isofoton.com		www.gugler.com
www.ldksolar.com	www.unisolar.com	www.opelsolarinc.com		www.hydrolink.cz
www.jinkosolar.com	www.anwell.com	www.pyronsolar.com		www3.toshiba.co.jp
www.isofoton.com	www.kaneka-solar.com	www.semprius.com		www.canyonhydro.com
www.goldigreen.in	www.moserbaer.com	www.soitec.com		
www.everenergy.com.tw	CIS-CIGS	www.solfocus.com		
www.conergy.com	www.nanosolar.com	www.solergyinc.com		
www.s-energy.com	www.solarion.net	www.spectrolab.com		
www.sharp-solar.com	www.solyndra.com			
www.q-cells.com	www.xsunx.com			
global.kyocera.com	www.ascentsolar.com			
www.suntech-power.com	www.heliovolt.net			
panasonic.net/energy/solar/	www.miasole.com			
www.mitsubishielectric.com	www.solarion.net			
www.motechsolar.com	www.soltecture.com			
www.schott.com	www.wuerth-solar.com			
nl.sunpowercorp.be				
www.shenzhensolarpanel.com				

Table 4.2c Database of commercial and prospective Renewable Energies Technologies. List of Manufacturers and developers

Geothermal	Biomass	Solar Thermal		Geothermal Heat Pumps
		Flat Plate Collector	Evacuated Tube Collector	
www.ormat.com	solid biomass Boilers	www.solarhart.com	www.rittersolar.de	www.bosch.com
www.hotrockltd.com	www.baxi.co.uk	www.sun-master.com	www.apricus.com	www.climatemaster.com
www.chevron.com	www.ashwellbiomass.com	www.shueco.com	www.australiasunenergy.com	www.gogogeo.com
www.rockenergy.no	www.windhager.co.uk	www.bosch.com		www.geothermalgenius.org
	www.andritz.com			www.nibe.eu
	www.energy.siemens.com			www.china-heatpump.com
	Biogas biolers			www.waterfurnace.com/
	www.viessmann.com			
	www.dws.be			
	www.dalkia.com			
	www.dresser-rand.com			
	www.schmitt-enertec.com			
	www.cat.com			
	www.cumminspower.com			
	www.ge-energy.com			
	cogeneration.tedom.com			
	www.wartsila.com			

Table 4.3 Database of commercial and prospective Renewable Energies Technologies. Energy efficiency technologies manufacturers

Sectors	Scope	Technologies	Status	Manufacturer/developer	Reference
Power industry and heat power industry	**Fuel**	Coal gasification	Commercial	ARCON Technology, Russia	http://www.arcontechnology.ru/reasyngas.html
			Commercial	YONGMAO, China	http://www.rigell.com.ua/ugolnyi-gazifikator.html
	Electricity production	Coal fired power plants using the technologies of supercritical steam parameters	Commercial	Russian National Heat Engineering Institute, Russia	http://www.spsl.nsc.ru/news-item/v-chitalnom-zale-4-otkrylas-tematicheskaya-vystavka-gazifikaciya-uglya/ http://www.startbase.ru/knowledge/articles/164/
		Coal combustion in circulating fluidized bed	Commercial	CMI Energy, Alstom, Harbin Boiler factory	http://www.cmigroupe.com/en/p/energy http://www.alstom.com/russia/ru/activities/power-generation/alstom-power-/
		Cocurrent combustion of pulverised coal	Commercial	Group of ProEnergoMash and KPK, Russia	http://www.kotelprom.tehnodoc.ru/gazifik_util.php
		Atmospheric and pressurised fluidized-bed coal combustion	Commercial		http://www.eprussia.ru/tech/articles/138.htm http://www.bikz.ru/presscenter/publication/articles/tehnologiya_szhiganiya_tipa_kipyawij_sloj/ http://www.atit-group.ru/tag/szhiganie-uglya-v-kipyashhem-sloe/

Sectors	Scope	Technologies	Status	Manufacturer/developer	Reference
		Coal combustion in a slag-tap furnace	Commercial		http://www.vemiru.ru/index.php?r=48&sid=995 http://www.smartgrid.ru/content/stacionarnyy-kotel-s-zhidkim-shlakoudaleniem/
		Combustion of water, coal and fuel suspensions	Commercial		http://www.cotes.ru/696 http://b-3.su/stati1/poleznaya_informaciya/vtoraya_zhizn_burogo_uglya/
		Combined cycle coal technologies	Commercial	SIEMENS	http://w3.siemens.ru/energy-efficiency/energy-efficiency.html?stc=ruccc020019
		Integrated coal gasification combined cycle (IGCC) plant	Pilot projects	Russian National Heat Engineering Institute, Russia	http://www.startbase.ru/knowledge/articles/164/
		Recovery of associated gases for electricity production	Concept	Russian Academy of Natural Sciences, Russia	http://www.wikipravda.ru/economy/enegy/351-iskusstvennyy-tornado-vihrevoy-vetrogenerator-dlya-vyrabotki-elektroenergii-razrabotan-akademikom-raen.html
			Commercial	Caterpillar	http://energyland.info/analitic-show-104933

Sectors	Scope	Technologies	Status	Manufacturer/developer	Reference
	Heat and electricity production	Installation of back pressure turbine in standard boiler-house and transforming it to mini district heating unit	Commercial	NPVP Turbokon and Kaluga Turbine Works, Russia	http://www.rusdem.org/library/brochure/
		Combined cycle plant	Commercial	SIEMENS	http://w3.siemens.ru/energy-efficiency/energy-efficiency.html?stc=ruccc020019
		High-efficiency boiler-houses and mini thermal power plants	Commercial	Ural Energy-saving Company Koral, Russia	http://www.koral.ru/products
		Annular gas combustion niche burner technology in boiler furnaces at CHPP (SNG type)	Commercial	Burning technologies are protected by Ukrainian patent No. 51844 and have priority in Eurasia	http://www.elitcovka.ru/shmoad/unonau329ud/index.shtml
	Electricity transmission	Aluminium Conductor Composite Core	In prospect (manufacturing plant is being	Simross-Lamifil JV	http://www.startbase.ru/knowledge/articles/199/

Sectors	Scope	Technologies	Status	Manufacturer/developer	Reference
		cable	built)		
		A high-voltage, direct current (HVDC) electric power transmission and development of smart grid	Commercial	SIEMENS	http://w3.siemens.ru/energy-efficiency/energy-efficiency.html?stc=ruccc020019
		Resonance methods of electric power transmission	Research and development	Institute of rural electrification, Russian Academy of Natural Sciences	http://www.unido-russia.ru/archive/num5/art5_14/
	Reduction of losses in electric networks	Static reactive power compensator	Commercial	Ansaldo-VEI JSC, Research and Development Center for electric power industry, Russia	http://www.ansaldovei.ru/rus/18/ http://www.fsk-ees.ru/innovation/intelligent_network/new_types_of_power_equipment_of_substations_and_overhead_power_lines/static_compensator_statcom/
		Controlled shunt reactors			-

Sectors	Scope	Technologies	Status	Manufacturer/developer	Reference
		Static frequency converters			http://www.abb.ru/industries/db0003db004333/ea0ce931de76ec32c125797400278ab3.aspx
		Capacitor units	Commercial	Russia, Kazakhstan	http://www.khomovelectro.ru/catalog/kondesatornye-ustanovki/
					http://elcom-energo.ru/ http://www.ukkz.com/
					http://policond.ru/
		Ice melting devices for power transmission lines	Commercial	Federal Grid Company of Unified Energy System	http://elektroas.ru/oao-fsk-ees-ispytyvaet-upravlyaemoe-ustrojstvo-plavki-gololeda
	Rehabilitation of high-voltage equipment	High-voltage equipment	Commercial	Siemens	http://www.siemens-rca.com/countries/kazakhstan/
				ABB	http://www.kz.abb.com/
				Alstom	http://www.alstom.com/power/
		Optic current and voltage transformers	Commercial	Profotech CJS, Russia	http://www.startbase.ru/innovations/61/

Sectors	Scope	Technologies	Status	Manufacturer/developer	Reference
	Energy storage system	Kinetic energy storage system	Prototype model	Russian Superconductor, Russia	http://www.startbase.ru/innovations/41/
	Renewable energy sources				-
	Solar energy	Solar water heaters	Commercial	ALTESCOM, Kazakhstan	http://altescom.kz/water-heaters/solar/?tracking=15
		Solar installations for rural population: cover daily needs in electricity, hot water and, partially, heating (electric power – 0.4 kW, peaking heat power – 0.2 kW, hot water - 315 K at 1 L/min.)	Commercial	Kazakh Research Institute of Power Engineering named after Sh. Ch. Chokin, Kazakhstan	http://ru.convdocs.org/docs/index-138626.html
		Solar photo panels produced on equipment of American and European manufacturers:	Commercial	VITASVET - official partner of Schneider Electric, Russia	http://www.vitasvet.ru/

Sectors	Scope	Technologies	Status	Manufacturer/developer	Reference
		Xantrex (Schneider Electric), OutBack, TBS Electonics, to supply electricity to autonomous facilities and industrial consumers			
		Polycrystal thin-film materials and devices, efficiency output 17-20%	Research and development	National Renewable Energy Laboratory (NREL), USA	http://www.nrel.gov/pv/thinfilm.html
		III-V multijunction photocell	Research and development	National Renewable Energy Laboratory (NREL), USA	http://www.nrel.gov/pv/multijunction.html
		Helio-furnaces	Research and development	Design Bureau of Alternative Energy "VoDOmet" (Omsk).	http://www.saveplanet.su/tehno_588.html
		Solar concentrator technologies	Research and development	Russia and Switzerland	http://www.strf.ru/material.aspx?CatalogId=21731&d_no=48832
					http://greenevolution.ru/2013/02/04/shvejcarskaya-kompaniya-razrabotala-effektivnyj-koncentrator-solnechnoj-energii/

Sectors	Scope	Technologies	Status	Manufacturer/developer	Reference
	Wind power	Small wind electric systems: 2, 5, 10, 20 and 100 kW for power supply to separate facilities based on Bolotov vertical axel wind energy turbine	Commercial	SPE ENECSIS	http://www.enecsis.ru/index.htm
		Diagonal wind turbines with vertical rotor	Research and development	ABS Innovations	http://abs-innovation.ru/?p=153
		Wind turbines with wind concentrators	Patent	Samara State Academy of Architecture, Building and civil Engineering	http://www.ntpo.com/patents_electricity/electricity_2/electricity_529.shtml

Sectors	Scope	Technologies	Status	Manufacturer/developer	Reference
	Low-grade heat use	Generating plant for recovery of low-grade heat -1 kW (the study is financed by Siemens AG).	Prototype model	ABOK – Russian association of Engineers for Heating, Ventilation, Air-Conditioning, Heat Supply and Building Thermal Physics – a non-government public organisation	http://www.abok.ru/for_spec/articles.php?nid=5147
	Alternative energy sources	Low head horizontal straight-flow turbines	Commercial	Firma MAGI-E, Russia	http://www.magi.ru/prjamotochnaja-trubnaja-gitroturbina.html
		Biofuel	Commercial	Shangqiu Haiqi Machinery Equipment Co., Ltd., China	http://russian.alibaba.com/product-gs/200kw-biomass-gasification-equipment-499777430.html
		Production of hydrogen fuel from food waste	Research and development	University of Pennsylvania	http://www.energosystem.spb.ru/hydrogen.php

Sectors	Scope	Technologies	Status	Manufacturer/developer	Reference
		Production of hydrogen based on heat energy from nuclear high-temperature reactors	Research and development	OKBM Afrikantov, Russia	http://www.okbm.nnov.ru/russian/hydrogen
		Storage batteries of a new type	Prototype model	Northwestern University (State of Illinois, USA)	http://samou4ka.net/page/novyj-tip-akkumuljatora-bystraja-zarjadka-i-medlennaja-razrjadka
		Biofuel from agricultural products (rape)	Commercial		http://www.rae.ru/forum2012/13/560
		Installations using agricultural waste biogas for local application	Commercial	Center EcoRos, Russia	http://www.teploved.ru/menu11_3.html http://transgaz-holding.ru/bioenergeticheskie_ustan
		Production of bio fuel and acids using cyanobacteria	Research and development	National Renewable Energy Laboratory (NREL), USA	http://www.nrel.gov/docs/fy13osti/55974.pdf

Sectors	Scope	Technologies	Status	Manufacturer/developer	Reference
Industry	Electric motors	Series of energy-efficient industrial motors -7 AVE	Commercial	RUSELPROM Russian Electrotechnical Concern	http://www.ruselprom.ru/about-company/energysafe.html
		Installations with asynchronous and synchronous variable frequency drive of vehicles and machinery	Commercial	RUSELPROM Russian Electrotechnical Concern	http://www.ruselprom.ru/mechatr.html
		Brushless DC electric motor	Commercial	RITEK Innovative Technology Center, Russia	http://ritek-itc.ru/ritek/more/ritek-itc-2010.pdf
	Energy saving ventilation systems	Heat recovery air handling units	Commercial	VENTS, Kazakhstan	http://blog.vents.ua/exhibitions/energosberegayushhie-texnologii-vents-v-kazaxstane.html
	Industrial production automation and control	Digital industrial processes, establishment of Digital Factories	Commercial	SIEMENS	http://w3.siemens.ru/energy-efficiency/energy-efficiency.html?stc=ruccc020019#industry-technologies
		SIMATIC	Commercial	SIEMENS	http://w3.siemens.ru/energy-efficiency/energy-

Sectors	Scope	Technologies	Status	Manufacturer/developer	Reference
		automation systems			efficiency.html?stc=ruccc020019#industry-technologies
	Metallurgy industry	Energy efficiency technologies in ferrous metallurgy	Commercial	digest	http://bestpravo.ru/rossijskoje/pt-zakony/z1a.htm
		Use of ESKAT-M fuel catalyst in Martin furnace	Commercial	Gurevsk Metallurgical factory, Russia	http://www.metall-russia.ru/sitenews/action/view/cur_mon/2012-02/news_id/1725/
	Oil production	Innovative pumps for oil production	Prototype model	Mechanica, Russia	http://www.startbase.ru/innovations/76/
Construction	Structure and building insulation, thermal insulation in road construction	Thermal insulating materials produced by URSA, KNAUF INSULATION, TechnoNocol, IZOMIN, GEXA	Commercial	TERMIKO GROUP, Russia	http://termikogroup.ru/
		Cellular rubber substance	Commercial	Termoplex, Russia	http://www.termoplex.ru/kaiflex.php?table=kaiflex_main http://ssi-ent.com/thermal_insulator/rubber
					http://teploprok.com/katalog-produkcii/category/475/vspenenniy-kauchuk.html

Sectors	Scope	Technologies	Status	Manufacturer/developer	Reference
		Insulating paint	Commercial	Thermal - Coat (USA)	http://www.tcceramic.ru/index.php?id=19
				Alliance – Stroitelnye Tekhnologii	http://fibroblok.ru/catalog/astratek
		SUPER THERM reflecting coating	Commercial	SPV, Russia	http://www.startbase.ru/innovations/84/
		Thermal insulation of exterior walls using multilayer thermal insulating system (Synteco, TERMOKREPS)	Commercial	KREPS, Russia	http://www.abok.ru/for_spec/articles.php?nid=135 http://www.eebt.ru/index.php?option=com_content&view=frontpage&Itemid=1
					kreps.ru/
		External thermal insulation composite systems (ETICS)	Commercial	EnergoSovet.ru – energy-saving, energy efficiency and energy-saving technologies for 2006-2013	http://www.energosovet.ru/bul_stat.php?idd=11
			Commercial	Xella, Germany	http://www.ytong.ru/ru/content/nav1_1425.php

Sectors	Scope	Technologies	Status	Manufacturer/developer	Reference
		Construction of air-tight houses	Commercial		http://stroimsvoy-dom.ru/ekonom-energo/index.php
		Low-e glass with film coating reducing heat losses in buildings and structures	Commercial	GUARDIAN, Sibir Glass Company	http://www.okna-git.ru/stati/energoeffektivnye-okna.html http://www.guardian-russia.ru/ru/ http://www.sibglass.ru/produce/top/
Transport	Transport (motor and railway transport)	Hybrid engine for urban transport, municipal vehicles and motor car	Commercial	RUSELPROM Russian Electrotechnical Concern	http://www.hybrid-drive.ru/
		On-board reactive power compensation units at railway transport	Prototype model	OCV jointly with VElnii, Russia	http://www.zeldortrans-jornal.ru/publik/spezproekt/2005/september-05-09/krivnoy.htm
		Regeneration braking at electrified railway sections	Commercial	RVR, Demikhovo Machine building factory, Russia	http://www.rvr.lv/ru/3_1_2.html http://www.dmzavod.ru/products/

Sectors	Scope	Technologies	Status	Manufacturer/developer	Reference
		Resource and energy saving technologies at railway transport and underground implemented with using energy storage	In prospect	Moscow State University of Communication Lines	http://knu.znate.ru/docs/index-410432.html
	Heat consumption: control, accounting and automation	Heat metering systems by Danfoss, Kamstrup, DASU	Commercial	EnKom-St, Kazakhstan	www.enkom.kz www.heating.danfoss.kz
		Water meters by Minol, Arzamas Instrument Plant, Lianozovo Electromechanical Plant			
		Danfoss, Samson and IMI control equipment			
		Danfoss heat exchange			

Sectors	Scope	Technologies	Status	Manufacturer/developer	Reference
		equipment			
		Grundfos, Wilo pumping equipment			
		Danfoss, Naval, Onninen, Vexve shutoff and control valves			
		Altais metal-reinforced plastic pipe and fittings			
		Kermi steel radiators			
		Heat-reflective screens behind heating radiator	Commercial	STIZOL, Russia	http://www.energosovet.ru/entech.php?idd=29 http://www.izotermo.ru/radiator.html
		Integrated control and information system of housing and public utilities based on KONTAR software and	Commercial	Moscow factory for heating automation	http://www.mzta.ru/mzta/items/540-kompleksnaya-upravlyayushche-informatsionnaya-sistema-zhkkh-na-baze-ptk-kontar

Sectors	Scope	Technologies	Status	Manufacturer/developer	Reference
		hardware system			
		Gearless drive for elevators	Commercial	RUSELPROM Russian Electrotechnical Concern	http://www.ruselprom.ru/about-company/energysafe.html
		Heat pumps for energy-efficient life support system for buildings and structures	Commercial	Innovative Group of Companies INSOLAR, Russia	http://www.insolar.ru/index.htm
		Automated process control system in the area of fuel and energy resources consumption	Commercial	Moscow factory for heating automation	http://www.energoeffekt21.ru/archive/iv_kongress_2012/spb_2012/sbornik_materialov_iv_kongressa_spb/
		Equipment and systems for efficient management of infrastructure, industry, office buildings and	Commercial	Schneider Electric	http://www.yahont.com.ua/page422/article3.html

Sectors	Scope	Technologies	Status	Manufacturer/developer	Reference
		shopping centres, as well as hotels of various categories – building management system TAC Vista, equipment Merten for lights control			
		Condensation gas-fired boilers	Commercial	Viessmann	www.viessmann.ru
	Lighting	Energy-saving lamps	Commercial	Aktei-Energosberezhenie	http://www.1econom.ru/production/
				VITASVET - official partner of Schneider Electric, Russia	http://www.vitasvet.ru/
				Catalogue of goods (Kazakhstan)	http://www.kz.all.biz/lampy-energosberegayushchie-bgg1069913
				Viled svetotronika, Russia	http://viled.net/

Sectors	Scope	Technologies	Status	Manufacturer/developer	Reference
	Energy-efficient technologies in housing and public utilities	Energy-efficient technologies in housing and public utilities (review)		Kazakhstan Housing and Utilities Reform Centre JSC	http://zhkh-center.kz/www.zhkh-center.kz/www.zhkh-center.kz/?page_id=152
		Buildings Energy Efficiency in Central Asia and Armenia – BEECA	Commercial	web-site	http://kz.beeca.net/
		Individual accounting system for energy resources consumption and control	Commercial	Pribor factory, Russia	http://www.priborplant.ru/ru/production/gkx
		Smart home system	Commercial		http://vsegdadoma.ru/ http://www.i-dom.ru/
		Energy-efficient windows	Commercial	GUARDIAN, Sibirian Glass Company	http://www.guardian-russia.ru/ru/ http://www.sibglass.ru/produce/top/

Sectors	Scope	Technologies	Status	Manufacturer/developer	Reference
				Okna-Git	http://www.okna-git.ru/stati/energoeffektivnye-okna.html

Section 5: Major sources of financing

There are several reasons to improve energy efficiency and deploy renewable energies in developed and developing countries. Energy efficiency represents the best option towards finding the ways to do more (or the same) with less energy content. Therefore, by reducing energy bills, financial sources are made available to other purposes and consequently contribute to economic growth. Moreover, it is a cost effective solution to carbon emissions reduction. Renewable energies form ways of producing electricity and heat power through sustainable means.

Energy efficiency and renewable energies potential are not yet realised in full because of several existing barriers. End-user electricity and gas prices subsidized, misaligned financial incentives, high upfront investment costs, long simple pay-back time of some investments, as well as the non-internalisation of the carbon costs, form the economic and financial barriers to a further deployment of these technical and technological solutions.

Governments play an essential role in enhancing the deployment of energy efficiency and renewable energies, namely through the establishment of regulatory, planning instruments and market facilitation and public information and participatory approaches. However, governments have also a crucial influence on economic and financial instruments made available to the further implementation of energy efficiency and renewable energies.

Various financial instruments are available at disposal of governments and private sector in order to finance energy efficiency and renewable energy projects, using best available technologies. The main options available are through public or private capital budgets (direct investment, subsidies, and grants), debt financing (loans, lease, and guarantees), Energy Services Companies (ESCOs) and carbon financing. To stimulate private investors, various economic instruments are also provided by governments as price incentives.

The purpose of this chapter is to provide an overview of the most applicable financial and economic instruments to disseminate energy efficiency and renewable technologies in Central Asian Countries, with focus on the opportunities provided by the International financial institutions and donor's programmes.

National financing – the role of Government

Governments can have an important role in catalysing private investments and in facilitating energy efficiency renewable technologies dissemination. Financial incentives and grants funded by public budgets are often used to support the upfront cost and increase the rate of return of investments. By provision of different incentives for public and private sector, governments can stimulate and facilitate the investment in energy efficiency measures and renewable energy. Options include subsidies in the form of grants, concessional loans, direct public investment, tax reliefs and benefits and feed-in tariffs. Economic instruments can also be used to increase the amount of finance available or to improve financing terms for example through reduced interest rates, provision of guarantees, dedicated credit lines.

The public sector can also play a leadership role by demonstrating the potential of energy efficiency to reduce energy consumption and showcasing new technologies and energy management. Elsewhere significant potential exists in the public sector to improve energy efficiency by deploying advanced technologies, however very often the small size of energy efficiency projects and long term payback time are a major barrier for the implementation.

Government should stimulate and support different solutions like bundling of similar projects (e.g. schools, hospitals, etc) in order to attract large scale financing providers. Introduction of specific rules governing the public procurement of energy are often a good instrument promoting energy efficiency and renewable energies, as the purchase of new efficient equipment and services can play significant role. Introduction of regulatory frameworks that can attract additional financial cash flow are also commonly used, for example energy saving obligation schemes for utilities and green and white tradable certificates.

Public funds can be invested in energy efficiency and renewables R&D as part of economic stimulus programmes and the national green growth strategies. Such investments are likely to bring multiple benefits as supply of energy technologies, increasing employment, and cost saving. Removing barriers to private sector investments is another way for government to provide support.

Energy Service Company (ESCO) and Energy Performance Contracting (EPC)

An ESCO is a company that offers energy services which may include implementing energy-efficiency projects (and also renewable energy projects). The payment of those services is based on energy savings achieved, sometimes also on other criteria agreed in the Energy performance contract and accepts some degree of financial risk in doing so.

ESCOs can provide a variety of services, including financing in some cases, but most importantly will guarantee energy savings of a certain amount. As the guarantor of the savings, the ESCO remains involved in measuring and verifying the savings during the debt repayment period. ESCOs and energy performance contracting are mainly found in the public sector, however numerous examples exist in the industrial sector and commercial buildings.

The success of the ESCO concept depends on numerous factors, and there is a variety of success stories in implementing EPC in different countries. The EU Joint Research Center in its report “ESCO market in Europe” identifies several major barriers for the success operation of ESCO including:

- Ambiguities in the legislative framework, including the public procurement rules remain one of the most important barriers;
- Low and subsidised energy prices decrease the economic potential for energy savings;
- The lack of reliable energy consumption data makes it difficult to establish baselines and hence provide reliable data on actual savings.

To overcome these barriers, Governments need to introduce supportive policies and legislation, as well as introduce cost-reflective energy price as one of the main factors influencing the demand of energy efficiency investments. The liberalisation of the energy markets is also considered an important enabling factor in order to create the right market conditions for ESCOs to operate.

International Financial Institutions (IFIs) and regional and bilateral donors

IFIs and donors are often playing a key role in setting up different financial mechanisms for energy efficiency and renewable energy projects. This is done in several ways – by providing technical assistance to governments to improve regulatory and investment frameworks in order to attract investments in the sector and by direct involvement in the design and the financing of specific mechanisms.

In the past the main efforts of IFIs and donors in Central Asian countries was focused in improving reliability of energy supply, reduce losses and rehabilitate power generation plants and electricity transmission and distribution lines. For example ADB has provided $34 million loan to Tajikistan for the Power rehabilitation projects and $122 million grant for expansion and modernisation of the electricity transmission system. Similar examples can be found in the table bellow for the other countries as well.

However as seen by reviewing the IFIs strategies for the next 2-3 years, their priorities for the region are moving towards providing support to demand side energy efficiency as well as to stimulate investments in renewable energy. IFC has introduced Central Asia Resource Efficiency program in order to facilitate investment in recourse efficient technologies and best practices. EBRD launched Sustainable energy financing facility in Kyrgyzstan in 2013 to support investment as in modern technologies and equipment.

Table 5.1 below provides detailed overview of the main regional and bilateral donors and IFIs, which are involved in different financial schemes and projects in the area of energy efficiency and renewable in the five Central Asian Countries.

Table 5.1: Available and potential financial sources for energy efficiency and renewable energy projects in Central Asian countries

Donor/IFI	Past/Ongoing projects	Future priorities in donor's/IFI's strategy
	Tajikistan	
ADB	Support provided mainly within Post conflict Infrastructure Program for: • Power Rehabilitation Project ($34 million loan) - rehabilitation and reinforcement of power transmission and distribution facilities in the capital Dushanbe and the Khatlon region; • $54.77 million grant for the Nurek 500-kilovolt Switchyard Reconstruction Project; • $122 million Regional Power Transmission grant - expansion and modernization Tajikistan's electricity transmission system.	Tajikistan: ADB's country partnership strategy (CPS) for 2010–2014 aims to help Tajikistan tackle its most critical development constraints and create a basis for higher and more sustainable economic growth. This is to be achieved by supporting improvements in energy and transport infrastructure, and facilitating reforms. According to the Country Operations Business plan (COBP) for 2013-2014, Tajikistan is currently eligible only to receive grants from the Asian Development Fund (ADF). The indicative investment program for ADF resources agreed with the government under the COBP, 2013–2014 comprises $59 million each year in 2013 and 2014. Tajikistan may receive additional ADF resources for projects with regional importance. The technical assistance (TA) pipeline for 2013–2014 is expected to total about $3.4 million. The energy sector activities will focus on Electric power generation, transmission, and distribution; demand and supply-side energy efficiency; retail competition; operations performance and the resources allocated amount to $96 million for 2013–2014.
IFC	Since 1997, IFC has invested $81 million to support 32 private sector projects in the financial sector, hydro power, retail, tourism and manufacturing sectors. A significant portion of the program has been focused on the energy sector, as well as in agribusiness and financial markets	IFC works with private sector clients, government, and civil society to bring the benefit of global expertise to Tajikistan through its advisory services and selected investment projects. IFC also assists the Tajik government in furthering the nation's development, especially efforts to develop the private sector. As of June 30 2012, IFC's portfolio in Tajikistan stands at $30 million, with investments in financial markets,

Donor/IFI	Past/Ongoing projects	Future priorities in donor's/IFI's strategy
		manufacturing, and services sectors. Currently IFC is also supporting the Europe and Central Asia Resource Efficiency Program, which aims to stimulate investment into uptake of resource efficient technologies and best practices; to improve management processes and operational practices in industry across all sectors; and to raise awareness among policy makers and financial institutions.
World Bank	Since 1996, the World Bank has provided approximately US$843 million in IDA grants and trust funds to Tajikistan. Around 34 percent of these funds have been committed for agriculture and rural development sector. Other major sectors for IDA support since 1996 are economic policy and public sector (17 percent), energy (15 percent), water and urban development (15 percent), health and social protection (9 percent), and education (10 percent). The World Bank and Government of Tajikistan cooperation in the energy sector comprises six projects valued at US$70 million dollars over the past decade. These focus on new generation energy projects (the Pamir Energy public-private partnership), urgent supply shortages (the Emergency Energy project), energy loss reduction, and actions to put the energy sector on a sound financial footing. A major focus in the electricity and gas sectors was on implementing a loss reduction program. The World Bank project has helped finance procurement and installation of around 170,000 electricity meters in Dushanbe and over	The World Bank Country Partnership Strategy (CPS) for 2010-2013 has a two-fold objective: i). reducing the negative impact of the crises on poverty and vulnerability; and ii). paving the way for post-crisis recovery and sustained growth. Investment projects and technical assistance under the CPS are aimed at assisting the Government in realization of its Poverty Reduction Strategy objectives, such as improvements to public administration and governance, enhancing the investment climate and private sector growth, as well as supporting human development. According to the CPS The World Bank Group and the Government of Tajikistan energy partnership will focus on: (a) electricity loss reduction, (b) improving energy system efficiency and security, and (c) development of hydropower resources of the country, including for the purpose of export. 47,000 electricity meters will be purchased and installed under the Additional Financing for Energy Loss Reduction Project that was approved by the World Bank Board of Directors in 2012. Reducing commercial losses in the electricity and gas sectors, in combination with more effective metering and higher collections, will lead to better accountability of revenue flows and improve the financial viability of the

Donor/IFI	Past/Ongoing projects	Future priorities in donor's/IFI's strategy
	128,000 gas meters in various regions of the country. This resulted in an increase in billed consumption by around 50 percent within the last two years. Billed revenue for electricity sales in Dushanbe increased by almost five times in the same period.	electricity and gas sectors.
Islamic Development Bank	n.a.	n.a
Aga Khan Foundation	The Aga Khan Development Network (AKDN) works towards the vision of an economically dynamic, politically stable, intellectually vibrant and culturally tolerant Tajikistan. AKDN supports the establishment of programmes and institutions that allow the Government, private sector and civil society to play complementary roles in increasing prosperity and creativity within a pluralistic society. As part of its approach to economic development, AKDN makes long-term investments in Tajikistan in areas where essential infrastructure is lacking. In 2002, the Network and its partners founded the PamirEnergy Company. Under a public private partnership agreement signed with the Government of Tajikistan, the company is managing the operation of all power generation, transmission and distribution facilities of the Gorno-Badakhshan Autonomous Oblast (GBAO) for a 25-year concession period. PamirEnergy has invested more than US$ 37 million since 2002 to repair electrical infrastructure, expand hydroelectric capacity and establish	n.a.

Donor/IFI	Past/Ongoing projects	Future priorities in donor's/IFI's strategy
	a metering system in the region. Following its rehabilitation, over 85 percent of the population of GBAO now has access to electricity and the total capacity of the Pamir 1 hydropower plant has increased to 44 Megawatts (MW), from 33 MW in 2002.	
UNDP-GEF	The UNDP's Energy and Environment programme portfolio is aimed to contribute towards reduction of widespread poverty in Tajikistan by: promotion of income-generating end-use applications of renewable energy sources, ensuring sustainable natural resource management, and educating and involving diverse national and local stakeholders in addressing environmental issues within the country.	UNDP is currently implementing a project "Technology Transfer and Market Development for Small-Hydropower in Tajikistan". The project has a particular focus on improving access to renewable energy in rural regions for the purpose of poverty reduction and triggering economic development. Through its activities the projects assists in the implementation of policies, legislation and regulations that improve market conditions for renewable energy development; demonstrates sustainable delivery models and financing mechanisms to encourage small-scale renewable energy projects; develops viable end-use applications of renewable energy; and conducts training on proper management of renewable energy systems (e.g. tariff collection) to strengthen local ownership and sustainability.
European Investment Bank	The Republic of Tajikistan entered into a Framework Agreement with the EIB on 10 February 2009, establishing the legal framework for EIB activities in the country. This was followed by the signing of the first EIB loan in Central Asia in June 2011 for financing the rehabilitation of electricity distribution networks in the Sugd region.	The EIB received political approval from the Council of EU Ministers to become active in Central Asia (Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan) in late 2008. The EIB will support the EU policy objectives of diversification of energy resources, by focusing its financing on projects in energy supply and energy transport, as well as on the protection of the environment. In addition, Central Asian countries are eligible under the Bank's own risk Energy Sustainability & Security of Supply Facility (ESF) for investment grade projects in renewable energy, energy efficiency, carbon capture, transportation or storage projects aiming specifically to

Donor/IFI	Past/Ongoing projects	Future priorities in donor's/IFI's strategy
		reduce greenhouse gas emissions and projects contributing substantially to security of EU energy supply.
EBRD	One of EBRD priorities in Tajikistan is Improve the quality of energy supply, regulation and energy efficiency, which is vital for all sectors of the economy as well as for the quality of life of Tajik citizens.	According to EBRD country strategy 2012-2015, the Bank will continue to selectively finance the rehabilitation of the energy sector infrastructure, and will support energy efficiency measures at Barki Tojik, subject to satisfactory progress with restructuring and with covenanted reform. Investment priorities will be coordinated with state authorities and other IFIs and donors. The adoption of further reforms in this key sector, in particular the creation of an independent energy sector regulator, would help to unlock significant EBRD investments in the sector. To create the conditions for private sector involvement in energy, the Bank will consider supporting small private sector generation investments should the authorities develop the appropriate regulatory framework.
European Commission	Tajikistan is getting the main share of the EU bilateral assistance (€66 million for 2007-2010) in support to sector programmes, technical assistance and grants. Cooperation focuses on social protection, health and private sector development, underpinned by public finance management. The EC also provides ad hoc support (such as in the aftermath of the energy crisis in 2008).The total value of EC assistance disbursed to Tajikistan since 1992, adding up all the instruments, is over €500 million.	European Commission through its Directorate–General (DG) Development and Cooperation – EuropeAid is providing various grants and contracts. Relevant information for ongoing call for grants and contracts are also published on the website of the EU Delegation in Tajikistan - http://eeas.europa.eu/delegations/tajikistan/funding_opportunities/contracts/index_en.htm
Deutsche Gesellschaft	No current projects in the energy sector.	n.a.

Donor/IFI	Past/Ongoing projects	Future priorities in donor's/IFI's strategy
für Internationale Zusammenar beit (GIZ	Since 1995 GIZ is supporting the economic and social rebuilding of Tajikistan. Currently the focus of cooperation is on support for sustainable economic development and the health system. On behalf of the German Federal Ministry for Economic Cooperation and Development (BMZ), GIZ is working with 18 bilateral and regional projects and programmes in the two priority areas and in the fields of education, sustainable natural resources management and tourism, in development-oriented emergency and transitional aid and in legal and judicial advisory services.	
USAID	In the energy sector, USAID assists with regulatory and institutional requirements and helps reduce operational and management inefficiencies, with the ultimate objective of closer economic integration among Central Asian Republics and between Central and South Asia. An energy efficiency project, financed by USAID promotes energy efficiency measures in Dushanbe's residential sector. The project aims to demonstrate the potential for available energy efficiency and renewable energy technologies for improved heating services. The total amount of financing is 630,000 USD.	An energy efficiency project, financed by USAID promotes energy efficiency measures in Dushanbe's residential sector. The project aims to demonstrate the potential for available energy efficiency and renewable energy technologies for improved heating services. The total amount of financing is 630,000 USD
	Uzbekistan	
ADB	ADB is already supporting energy-efficient generation plants in Uzbekistan. In addition, it is assisting development of the country's solar power potential to	Industrial modernization, infrastructure development, integrated rural development, and private sector mobilization are prioritized as main areas of economic development and welfare improvement over the

Donor/IFI	Past/Ongoing projects	Future priorities in donor's/IFI's strategy
	reduce its carbon footprint, through improving the policy and regulatory framework and establishing a solar energy institute. Assistance is provided for improved electricity metering and increasing the reliability of power supply for businesses and households.	coming years in the ADB Country Partnership Strategy (CPS), 2012–2016 for Uzbekistan. ADB will provide support for energy efficiency enhancement as this is closely aligned with Uzbekistan's emphasis on promoting energy security and affordability, and reducing energy intensity. Support for new transmission and generation projects will be provided to boost the capacity and efficiency of the power sector. Capacity development and institutional improvement of sector agencies is also foreseen to strengthen service delivery and promote private sector participation. The Country Operations Business Plan (COBP) 2013-2014 envisages an assistance package of $2.4 billion. Solar power development, Advance electricity metering, Power modernization are among the projects, included in the Indicative Assistance Pipeline of COBP. Technical assistance grants totalling $12.3 million will be extended for project preparation, demand-led reforms, capacity development, and knowledge management.
IFC	In Uzbekistan IFC invested $88.2 million to support over 20 private sector projects in the financial, agribusiness and food sector. As of June 30 2012, IFC's portfolio in Uzbekistan stood at $17.1 million with investments in the financial and general manufacturing sectors.	(IFC in Uzbekistan maintains its focus on private sector development through a combined investment and advisory approach, by focusing on direct investments in the real sectors, such as general manufacturing, services, and agribusiness; strengthening access to finance for private sector through banks, especially by strengthening privately owned banks; and encouraging private sector participation in infrastructure. Currently IFC is also supporting the Europe and Central Asia Resource Efficiency Program, which aims to stimulate investment into uptake of resource efficient technologies and best practices; to improve management processes and operational practices in industry across all sectors; and to raise awareness among policy makers and financial

Donor/IFI	Past/Ongoing projects	Future priorities in donor's/IFI's strategy
		institutions.
World Bank	Since Uzbekistan joined the World Bank in 1992, the Bank has provided commitments for 24 projects financed by the International Bank for Reconstruction and Development (IBRD) and the International Development Association (IDA). Currently, the World Bank Group priorities include support increasing the efficiency of infrastructure and support for human development and social inclusion. Support for the government's industrial competitiveness and economic diversification agenda, where government and Bank perspectives differ, will be limited initially to analytical and advisory services.	Over the 4-year period of fiscal years 2012 to 2015, the Bank's provisional lending program comprises fifteen operations, of which eleven will support reforms and investments for achieving sustainable growth, including more efficient energy use and diversification of exports. The total financial commitment will be about US$1.3 billion, i.e. commitments averaging about US$325 million annually. The Bank's in 2010 established US$25.00 million Energy Efficiency Facility for Industrial Enterprises, aiming to improve the energy efficiency of industrial enterprises and establish mechanisms to finance energy-efficiency projects; the US$110.00 million Talimarjan Transmission Project, aiming to improve the reliability of the electricity supply to residential and business consumers in South-Western Uzbekistan and strengthen the power transmission network; and the US$180.00 million Advanced Electricity Metering Project, focused on reducing commercial losses in Uzbekenergo's three regional power distribution companies, Tashkent City, and the Oblasts of Tashkent and Syrdarya, by improving their metering and billing infrastructure, and their commercial management systems. Activities of the WB group will support sustainable growth through increased efficiency of energy, transport, and water resources management. In addition to completion of three ongoing operations—Enterprise Energy Efficiency phase I, Talimarjan Transmission, and Ferghana Valley Water Resources Management-Phase 1—the Bank plans to initiate new lending and associated analytical activities in electricity metering and distribution, in transport, and in water resources management.

Donor/IFI	Past/Ongoing projects	Future priorities in donor's/IFI's strategy
Islamic Development Bank	n.a	n.a
UNDP-GEF	UNDP Environment and Energy Unit in Uzbekistan provides assistance to local communities as well as Governmental agencies by building institutional capacities and promoting effective and sustainable approaches in the conservation of biodiversity, achieving sustainable land management, piloting the renewable energy technologies to increase the awareness of and access to affordable energy services and mitigating the consequences of climate change. The assistance provided by UNDP is channelled through the joint projects and programs executed by the respective Governmental agencies collaborating with Environment and Energy Unit. Thus the Unit works closely with Governmental partners to develop national strategies in the areas of waste management, promotion of renewable energy sector, and preparation of plans to improve national capacities for environmental management.	"Promoting energy efficiency in public buildings in Uzbekistan" is a joint project of United Nations Development Programme, Global Environment Facility and State Committee for Architecture and Construction of the Republic of Uzbekistan. The project aims to support the Government in improving energy efficiency of public buildings, thus contributing to national reduction of carbon dioxide emissions. The project is revising and strengthening the norms and regulations applicable to both new and re-constructed buildings, "building in" efficiency into design. Two health clinics located in Tashkent and Navoi regions and four schools located in the Republic of Karakalpakstan, Kashkadarya and Fergana regions have been selected to carry out retrofitting works to introduce and demonstrate new technical solutions that contribute to promoting energy efficiency in public buildings. More than 50 national architects and building designers and constructors benefited from training workshops on promoting energy efficiency in buildings. Study Tour to Denmark with participation of 10 decision-makers– representatives of national partner organizations ensured that the project utilizes world's best experience on energy efficiency and energy management. Tashkent State Technical University and Tashkent Architecture and Construction Institute were assigned with development of new state educational standards and academic modules for further introduction of new educational programmes on energy efficiency into the curricula of these institutes that train future specialists in this area.

Donor/IFI	Past/Ongoing projects	Future priorities in donor's/IFI's strategy
European Investment Bank	The EIB received political approval from the Council of EU Ministers to become active in Central Asia (Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan) in late 2008.	The EIB will support the EU policy objectives of diversification of energy resources, by focusing its financing on projects in energy supply and energy transport, as well as on the protection of the environment. Central Asian countries are eligible under the Bank's own risk Energy Sustainability & Security of Supply Facility (ESF) for investment grade projects in renewable energy, energy efficiency, carbon capture, transportation or storage projects aiming specifically to reduce greenhouse gas emissions and projects contributing substantially to security of EU energy supply.
EBRD	EBRD in Uzbekistan supports private sector investment and entrepreneurship provided that there is no direct or indirect link to the Government or Government officials. For the development of SMEs and micro-business, the Bank channels its resources to the sector through its credit lines to local financial institutions. Since 1999 Business Advisory Services (BAS) and the Enterprise Growth Programme (EGP) have been improving the competitiveness and level of sophistication of the SME sector in Uzbekistan. BAS completed 756 projects in Uzbekistan and received a total of €6.3 million in donor funding from Switzerland, Japan and EBRD Shareholder Special Fund. BAS also undertook 28 market development activities such as Annual exhibition of consulting companies "Consult Expo" , series of training to raise the professional level of consultants in rural area, and Capacity building and development of local association of business consultants and its global integration into ICMCI. EGP	EGP assistance will focus in the next few years on improving organisational and management skills, business planning, marketing skills and exposing management to international best practices - the main impediments faced by Uzbek SMEs. In terms of sectors, textiles, agricultural machinery, fertiliser production, food processing (juices in particular), construction materials, automotive and car-parts industries will be targeted as these have been identified as most in need of international industrial expertise and technological know-how. The BAS grant will remain a key component of BAS assistance, thus helping financially constrained enterprises to access consultancy services. BAS Uzbekistan will provide the maximum size of subsidies for consultancy projects in the following areas: • To promote agribusiness related projects: land management for better crops, livestock farming, irrigation and melioration, plant cultivation, poultry farming; • To improve environmental management: energy efficiency, environmental management, biogas and renewable energy related

Donor/IFI	Past/Ongoing projects	Future priorities in donor's/IFI's strategy
	completed 33 projects in Uzbekistan and received a total of €2 million from Japan, Early Transition Countries (ETC) Fund, the European Union and other BAS and EGP donors.	projects.
European Commission	In 2011 EU and Uzbekistan signed Memorandum of Understanding on cooperation in the field of energy and the EU established its diplomatic representation in Tashkent.	According to the signed Memorandum of understanding in the field of energy, Uzbekistan and EU agree among others to cooperate in research and development; support industrial cooperation with special attention to energy efficiency, energy saving and renewable energy; support the capacity of service sector in the area of energy efficiency and energy saving services to the Uzbek SMEs and business sector. European Commission through its Directorate–General (DG) Development and Cooperation – EuropeAid is providing various grants and contracts. grants and contracts on. Relevant information for ongoing call for grants and contracts are also published on the website of the EU Delegation in Uzbekistan - http://eeas.europa.eu/delegations/uzbekistan/funding_opportunities/grants/index_en.htm
Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ	No current projects in the energy sector Within the framework of international cooperation, GIZ is supporting reforms in the economy, health and education sectors in Uzbekistan, and also focuses on the protection of natural resources and the promotion of social and cultural integration. Sustainable economic development is a priority area of development cooperation between Uzbekistan and Germany. The health sector has now become a further priority area in accordance with the	n.a.

Donor/IFI	Past/Ongoing projects	Future priorities in donor's/IFI's strategy
	protocol signed at the recent intergovernmental negotiations.	
USAid	No current projects in the energy sector	n.a.
	Kyrgyzstan	
ADB	The Power Sector Improvement Project helped bringing more reliability, transparency, and accountability to the energy sector. In 2012, $45.0 million (including $30.0 million from the regional ADF allocation) was allocated for the Power Sector Rehabilitation Project.	Future ADB projects may continue to support energy sector reforms and urgent needs for the rehabilitation of generation, transmission, and distribution facilities. For 2013, the Power Distribution Company Reform Project for $15.0 million is included as standby at the government's request. The government is finalizing an energy sector strategy and an action plan. Both include reform of the distribution companies as a priority
IFC	IFC promotes private sector growth in the Kyrgyz Republic by providing a wide range of advisory services, by increasing access to finance for micro, small and medium enterprises, by strengthening local financial institutions, and by providing credit lines to local banks and microfinance institutions	IFC also seeks opportunities to increase its direct investments in microfinance, banking, energy, mining, and agribusiness in Kyrgyzstan. IFC is supporting the Europe and Central Asia Resource Efficiency Program, which aims to stimulate investment into uptake of resource efficient technologies and best practices; to improve management processes and operational practices in industry across all sectors; and to raise awareness among policy makers and financial institutions.
World Bank	Since the Kyrgyz Republic joined the World Bank in 1992, commitments have reached over US$ 1 billion for 49 International Development Association (IDA)-funded projects, out of which US$ 908 million have been disbursed. To date, 32 operations for US$ 739.5 million have been completed and closed, and 17 projects for US$	The Bank supports the energy sector through the US$35 million energy component of the ongoing Emergency Recovery Project that funds essential repairs, rehabilitation, and fuel to keep the system running As a result, • The connection of 19,000 households to the electric power network in the cities of Jalalabad and Osh has been restored. • Heat supply from Osh Central Heating Plant started on November 3, 2011 for

Donor/IFI	Past/Ongoing projects	Future priorities in donor's/IFI's strategy
	349.5 million are ongoing. The Bank Interim Strategy Note (ISN), which covers the period from August 2011 to June 2013 focuses on the country's recovery and stabilization needs, while paving the way for support for long-term development. The ISN will be followed by a full Country Assistance Strategy, based upon the national development strategy.	the 2011–12 winter. The total 2011–12 winter heat supply was 153 percent of the 2009–10 winter supply. The Bank is also preparing an investment operation to reduce losses and revenue leakages through the establishment of a transparency and accountability framework in the largest distribution company.
-Islamic Development Bank	n.a	n.a
UNDP-GEF	During 2009-2011, UNDP implemented a project "Energy Efficiency in building" aiming at reducing energy consumption and associated GHG emissions in Kyrgyzstan building sector by 30-40%. The project activities included: adopting and enforcing mandatory building energy performance codes, standards and labels (the Energy Pass) in line with internationally recognized best-practices; demonstrating feasibility and viability of an integrated design approach for energy efficiency in public buildings; building capacity of building and construction professionals to implement new building regulation; and establishing a system to monitor energy consumption and CO_2 emissions in Kyrgyzstan building sector.	UNDP provides assistance to Kyrgyzstan in response to requests submitted by the country's government. This arrangement is laid out in the Standard Basic Assistance Agreement (SBAA) between UNDP and the Government of the Kyrgyz Republic, which was signed on September 14, 1992. SBAA lays the legal foundation for cooperation between UNDP and the Government of the Kyrgyz Republic. The technical framework, however, is described in multi-year Country Cooperation Framework (CCF) agreements prepared jointly by the Government of the Kyrgyz Republic and UNDP and approved for funding by the UNDP Executive Board.
European Investment Bank	The EIB received political approval from the Council of EU Ministers to become active in Central Asia (Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan) in	Central Asian countries are eligible under the Bank's own risk Energy Sustainability & Security of Supply Facility (ESF) for investment grade projects in renewable energy, energy efficiency, carbon capture,

Donor/IFI	Past/Ongoing projects	Future priorities in donor's/IFI's strategy
	late 2008. The EIB will support the EU policy objectives of diversification of energy resources, by focusing its financing on projects in energy supply and energy transport, as well as on the protection of the environment.	transportation or storage projects aiming specifically to reduce greenhouse gas emissions and projects contributing substantially to security of EU energy supply.
Sustainable EBRD	EBRD conducts policy dialogue in Kyrgyzstan to address remaining issues in the investment climate, to further its efforts to strengthen the regulatory and legal basis for energy efficiency investment and to improve the macro-prudential environment for local currency finance.	Sustainable Energy Financing Facility in Kyrgyzstan (KyrSEFF) was launched by the EBRD in early 2013. It will support investments in modern technology, equipment or material reducing energy consumption in the residential and commercial building sectors and in almost all industrial sectors through: • A USD 20 million credit line provided to Kyrgyz participating financing institution for on-lending to the residential and industrial sector; • Grants from 10 to 35% funded by the Investment Facility for Central Asia (European Union); • Consulting services providing technical assistance and advice to sub-borrowers on the optimisation of energy consumption and on choosing the best technical solution. Typical investments focus on the replacement of old machinery and equipment mainly in commercial companies and in existing commercial and residential buildings. However parts of new buildings might be also be financed through a KyrSEFF loan.
European Commission	The European Union and the Kyrgyz Republic have been partners since the country's independence in 1991, sharing a political and economic dialogue which has continually expanded. In the early years of cooperation this dialogue	European Commission through its Directorate–General (DG) Development and Cooperation – EuropeAid is providing various grants and contracts. Relevant information for ongoing call for grants and contracts are also published on the website of the EU Delegation in

Donor/IFI	Past/Ongoing projects	Future priorities in donor's/IFI's strategy
	initially focused on trade and investment, but since 2002 many important issues have been included, such as regional security, energy and water issues as well as human rights.	Kyrgyzstan - http://eeas.europa.eu/delegations/kyrgyzstan/funding_opportunities/grants/index_en.htm
Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)	No current projects in the energy sector In accordance with Kyrgyzstan's Country Development Strategy (CDS), GIZ's activities in Kyrgyzstan focus on the priority area of sustainable economic development. Education is a further priority area. GIZ is implementing several projects to promote vocational training. Various regional projects aim to improve schooling in Central Asia and support the delivery of management training. GIZ is implementing several projects in the south of the country which focus on development-oriented emergency and transitional aid (DETA). Other projects and programmes focus on the health sector, drug action and measures to combat drug trafficking, legal and judicial reform, the German minority in Kyrgyzstan, the transboundary dialogue on water resources management, and the sustainable use of natural resources.	n.a.
USAID	In Kyrgyzstan priority areas for USAID operations include economic policy reforms to strengthen fiscal management, tax administration, and decentralization; improvements of regulatory and administrative environment for business; reduction of trade barriers and expanded access to market information; strengthening of agricultural productivity; land market development. USAID's Central Asian Energy	n.a.

Donor/IFI	Past/Ongoing projects	Future priorities in donor's/IFI's strategy
	Efficiency Support Program (CAEESP) aims to assist in reducing greenhouse gas (GHG) intensity and emissions by stimulating investment in energy efficiency technologies...	
Kazakhstan		
Asian Development Bank	Until 2013 the ADB has only supported development projects in Kazakhstan targeting finance, transport and water sectors. ADB has yet to finance an energy sector loan in Kazakhstan. This is due in part to high oil prices, which have reduced the country's need for foreign borrowings. However, ADB has been in recent discussions with the government about financing possible projects in the sector, including those for energy efficiency, transmission, and new technologies.	ADB will consolidate its resources to support synergized investments in energy, transport, finance, and the urban sectors. These will be complemented by governance, gender equity, regional cooperation and integration, public–private partnership, private sector development and operations, and mitigation of the effects of climate change. Priorities are: -extending and augmenting the country's transmission grid to link demand and supply centres and improve energy security is a government objective that ADB can support through project investments. -The government is also evaluating renewable energy power generation projects, which may require financing from ADB and other development partners. -Improved energy efficiency is an important priority, and provides an opportunity for ADB to help the government assess energy efficiency options, and provide support for ensuing supply and demand-side projects. ADB has completed a diagnostic study to assess energy efficiency in Kazakhstan and is identifying potential projects for investment. -ADB can play an active role in encouraging regional cooperation in the

Donor/IFI	Past/Ongoing projects	Future priorities in donor's/IFI's strategy
		energy sector for the mutual benefit of Kazakhstan and CAREC countries. ADB also has a role to play in promoting international best practices. Capacity building in the areas of new energy technologies can be also supported. Planned key activity areas: - Energy efficiency (60% of funds): Energy audits of government buildings - Electrical power transmission (40% of funds): 700 kilometres of transmission lines rehabilitated.
IFC	Europe and Central Asia Resource Efficiency Program (2010-2015) Supported with funds from the Federal Ministry of Finance of Austria and IFC. The Program aims to stimulate investment into uptake of resource efficient (REF) technologies and best practices; to improve management processes and operational practices in industry across all sectors; and to raise awareness among policy makers and financial institutions.	IFC's strategy in Kazakhstan supports growth led by the private sector, particularly in the non-extractive sectors and frontier regions. IFC wants to further stabilize and diversify the banking sector, helping establish best international practices, corporate governance, and a sound regulatory environment. IFC also facilitates, when possible, investments to promote development of small and medium enterprises, as well as investments in manufacturing, infrastructure, and the services sector. IFC will support advisory work and investment projects with strong demonstration effect. IFC also aims at supporting the energy efficiency agenda as a cross-cutting theme in its activities. For further information please see strategy bellow under World Bank. IFC is supporting the Europe and Central Asia Resource Efficiency Program, which aims to stimulate investment into uptake of resource efficient technologies and best practices; to improve management processes and operational practices in industry across all sectors; and to raise awareness among policy makers and financial institutions.

Donor/IFI	Past/Ongoing projects	Future priorities in donor's/IFI's strategy
World Bank	Since 1999, the Bank's support has focused on a large-scale modernization and extension of the high-voltage transmission sector through four projects: (i) Electricity Transmission Rehabilitation Project; (ii) North-South Electricity Transmission Project; (iii) Moinak Electricity Transmission Project; and (iv) Alma Electricity Transmission Project. Under the first two operations (now closed), major transmission sector reforms were successfully carried out, including transmission tariff rationalization, the adoption of a modern grid code, and the establishment of an organized spot market. Meanwhile, the state owned Kazakhstan Electricity Grid Operating Company (KEGOC) has become a financially strong company as a result of a series of institutional capacity-building measures introduced with World Bank assistance. North-South Electricity Transmission Project The project consists of: construction of a new electricity lines, installation of fibre optic Communication Line; expand the existing substations, consulting services for procurement and project management for the construction of the electricity lines and further reforms of the transmission sector, including transmission pricing (zonal tariffs) and establishment of a real time balancing market. Alma Transmission Project The objective of the Project is to improve the reliability and quality of electricity supply to consumers in the Almaty region in an environmentally responsible and financially	World Bank and IFC Strategy for the Republic of Kazakhstan 2012-2017 determines the following: Continued emphasis will be given to sustainability and impact of Bank's operations by retaining an appropriately diverse portfolio. Over the coming period needs in infrastructure sector are great (in particular in transport and energy efficiency). *Outcome 6*: Improving energy transmission to poor areas. Bank assistance through knowledge and large-scale lending for transmission lines has led to the development of a modern grid, transmission tariff rationalization and the establishment of a spot market for electricity. The CPS will build on investments in transmission, focusing on the development and integration of the county's vast renewable energy resources (in particular wind and hydro power) into the national grid, and strengthening key regional power interconnections to alleviate severe network bottlenecks (especially between Kazakhstan and Kyrgyzstan). The indicative program envisages a possibility of a third north-south electricity transmission line project. The Bank will continue to assist the electricity grid operating company to enhance corporate governance and financial standards to international best practice and to play a greater role in regionally coordinated planning and operation of the central Asia power system. Environmental protection, improved energy efficiency and low carbon strategy are ranked as high priorities in Kazakhstan and essential to sustain growth. To support government's efforts in these areas, the WBG assistance would initially focus on supporting efforts to pilot benchmarking technologies in selected industries with best available practices and provide recommendations on reform of environmental

Donor/IFI	Past/Ongoing projects	Future priorities in donor's/IFI's strategy
	sustainable manner. The main components of the project are the construction of transmission lines and technical services for the selection and approval of the overhead transmission line route including support for selection of the transmission routes, conduct of engineering surveys and engineering supervision of the turn-key contracts during construction. Kazakhstan Moinak Electricity Transmission Project The objective of the Project is to increase and improve the supply of electricity to business enterprises and households in southern Kazakhstan in an economically and environmentally sustainable manner. The components of the project are: the construction of transmission lines, modernization of substations and consulting and technical services including support for selection of the transmission routes, conduct of engineering surveys and engineering supervision of the turn-key contracts during construction. No current or past projects under energy efficiency in heat and power sectors.	permit systems and monitoring and enforcement systems. Bank assistance will further focus on rehabilitation of selected industrial contaminated sites while facilitating efforts to broaden and deepen the implementation of Energy Efficiency agenda and water resource management. The Bank will also continue the advisory assistance to Kazakhstan on reducing gas flaring to broaden and deepen the benefits of the existing gas utilization program. *Outcome 13*: Raising energy efficiency. JERP assisted with analysis of options for raising energy efficiency (EE) from current low levels (Kazakhstan ranks among the top ten of the most energy intensive economies in the world). Encouragingly, this agenda has recently been set by the Government among top development goals (with a targeted 25 percent reduction in energy inefficiency by 2020) and a new legislation is under discussion in parliament. The Bank will provide technical assistance for the establishment of a dedicated energy efficiency finance facility to support the development of viable projects as part of a Swiss TF-funded Energy Efficiency Project of which the primary objective is implementation of EE demonstration projects in selected sectors with high social impact, and quantified energy savings. The Bank will initiate a dialogue with the authorities on the potential for adopting clean coal technologies for electricity generation, given the abundance of low cost coal in the country. Private sector interest in establishing thermal generation plants is strong and could be leveraged into clean coal technologies provided the frameworks for tariff setting and PPPs are put in place. The Bank will also continue the advisory assistance to Kazakhstan on reducing gas flaring and developing the existing gas utilization program, while IFC may support power generation projects based on associated gas. The Bank led Global Gas

Donor/IFI	Past/Ongoing projects	Future priorities in donor's/IFI's strategy
		Flaring Reduction Partnership will provide technical assistance and help draft further changes to oil and gas sector legislation. IFC considers improving energy efficiency to be a cross-cutting priority across all of it operations in Kazakhstan. To this end, it will focus on real sector investments where resource use efficiency and energy efficiency can be increased, provide targeted credit lines to banks for on-lending to industrial enterprises, and carry out advisory work, if needed, to facilitate energy efficiency lending in the private sector. In the infrastructure sector, IFC may explore opportunities in improving efficiency in the utilities sector, especially focusing on the distribution part of the district heating. Investments in the waste management sector at the municipal sector will be considered by engaging private investors directly or through PPP structures. FY 2012-2017 also targets: Comparative energy consumption in targeted public and residential sectors reduced by at least 10 percent between 2012 and 2017 (baseline will be established as part of the project preparation). Collaboration with: Swiss TF: Energy Efficiency Proj. (FY12-16); IFC Investments: Credit lines to banks for Energy Efficiency loans; IFC Advisory: Resource Use Efficiency; Partners: EBRD.
Islamic Development Bank	There were no energy focused projects ever supported by the Bank for the period (1975-2011).	Objectives of the Member country Strategy Increased competitiveness of Kazakhstan: to be among the top 50 most competitive economies by 2020 IDB Group will support this goal through investments in infrastructure modernization. Based on growth multiplier considerations, investment in transport and energy sectors will help to reduce production and

Donor/IFI	Past/Ongoing projects	Future priorities in donor's/IFI's strategy
		transaction costs which will improve national competitiveness and boost exports. Increasing country`s competitiveness through infrastructure modernization (transport - to reduce transaction costs and boost regional trade and energy capacities - to ensure sustainable energy generation and supply) and development of R&D capacities. Work Program proposes to focus in the following three areas within the energy sector: i. Participate in the construction of a new 500 kV transmission line that will connect the north region of the country, where the power plants are located, with the south region. The transmission line will significantly improve the reliability of the electricity in the south and enable the achievement of a zero second downtime and eliminate electricity shortages by 2018. ii. Participate in the rehabilitation of existing power plants in order to increase the available capacity from 15.7 GW to 16 GW by 2015. IDB Group will also mobilize additional resources from the Arab Coordination Group and conduct joint appraisal missions during 2012. The rehabilitation of the existing power plants will improve the plants efficiency which will reduce the cost of electricity production. iii. Support the Government goal to increase the share of renewable energy sources from 9.5 percent in 2010 to 11.5 percent in 2014 through construction of hydropower power plant and mini hydropower plants and wind farms, which might be more suitable for rural communities away from the national grid.

Donor/IFI	Past/Ongoing projects	Future priorities in donor's/IFI's strategy
UNDP-GEF	Wind Power Market Development Initiative (2011) The project aimed to promote the development of the wind energy market in Kazakhstan by removing the existing barriers to and reducing the implementation costs of wind energy projects by: (a) assisting the government to formulate a cross-sectoral national wind energy program; (b) providing information for and building the local capacity to develop wind energy projects and to organize financing for them (including site "mapping" and expansion of the wind speed measurement program); (c) facilitating the construction of the first "demonstration" wind farm to prepare ground for and reduce the risks of further investments; and (d) monitoring, evaluating and reporting the experiences and lessons learned during the implementation of the project. Removing Barriers to Energy Efficiency in Municipal Heat and Hot Water Supply (2011) The project worked to remove all the main barriers to the implementation of selected energy efficiency measures. And undertook an overall assessment of heat and hot water supply and demand in the sector. Reducing GHG Emissions through a Resource Efficiency Transformation Programme (ResET) for Industries in Kazakhstan (2010) The proposed project faciliated the adoption of more efficient technologies and processes in industries in	The GEF-5 climate change strategy will promote a broad portfolio of environmentally sound, climate friendly technologies to achieve large GHG reductions in the GEF-recipient countries in accordance with each country's national circumstances. The portfolio will include technologies at various stages of development in the innovation chain, with a focus on the stages of market demonstration, deployment, and diffusion. GEF support will involve a combination of technology-push and market-pull interventions. The climate change mitigation strategy for GEF-5 will consist of six objectives: 1. Promote the demonstration, deployment, and transfer of innovative low-carbon technologies 2. Promote market transformation for energy efficiency in industry and the building sector 3. Promote investment in renewable energy technologies 4. Promote energy efficient, low-carbon transport and urban systems 5. Promote conservation and enhancement of carbon stocks through sustainable management of land use, land-use change, and forestry 6. Support enabling activities and capacity building

Donor/IFI	Past/Ongoing projects	Future priorities in donor's/IFI's strategy
	Kazakhstan. Sustainable Transport in the City Of Almaty (2009) Main activities included: 1) improving the management of public transport and air quality in Almaty; 2) building capacity in Almaty to holistically plan and implement improvements in the efficiency and quality of public transport; 3) building capacity to holistically plan and implement integrated traffic management measures in Almaty city; and 4) implementing a demonstration project that raises awareness and increases knowledge on sustainable urban transport. Energy Efficient Design and Construction in Residential Sector (2010) Increase energy efficiency in new residential buildings in Kazakhstan, thereby reducing greenhouse gas emissions. LGGE Promotion of Energy Efficient Lighting in Kazakhstan (2010) To goal was to achieve energy savings and avoided GHG emissions via transformation of the lighting market in the Republic of Kazakhstan (RK), including implementation of a phase-out of incandescent lamps, while ensuring product quality and cost-effectiveness as well as safe disposition of spent mercury-containing lamps.	
European Investment	The EIB received political approval from the Council of EU Ministers to become active in Central Asia (Kazakhstan,	The EIB will support the EU policy objectives of diversification of energy resources, by focusing its financing on projects in energy supply and

Donor/IFI	Past/Ongoing projects	Future priorities in donor's/IFI's strategy
Bank	Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan) in late 2008. Until now there are no projects already financed by the EIB.	energy transport, as well as on the protection of the environment. In addition, Central Asian countries are eligible under the Bank's own risk Energy Sustainability & Security of Supply Facility (ESF) for investment grade projects in renewable energy, energy efficiency, carbon capture, transportation or storage projects aiming specifically to reduce greenhouse gas emissions and projects contributing substantially to security of EU energy supply. Projects to be financed: KAZAGRO CLIMATE LOAN FOR SMES MIDCAPS AND MSMES (under appraisal, 2013) The loan will focus on financing projects contributing to climate change adaptation, such as resource efficiency (e.g. water efficiency, irrigation) projects, protection of soil erosion schemes (buffer zones, river bank fencing), improved logistics and grain elevators, forestation of degraded land, and possibly climate mitigation (e.g. biomass energy projects). DBK LOAN TO SMES & MIDCAPS (under appraisal, 2013) A first part of the loan will finance SMEs, in line with Kazakhstan's government objectives to support the growth of the SME sector in the country, diversify the economy and lower its dependence on the oil and gas extraction sectors. A second part will focus on financing projects contributing to climate change mitigation and adaptation.
Sustainable Energy Initiative –	The Government of Kazakhstan and the EBRD launched a Sustainable Energy Action Plan (SEAP) in June 2008 to promote the conservation and rational use of energy	The Bank's strategy for this vital sector, which is still suffering from a number of transition gaps, is underpinned by Sustainable Energy Action Plan (SEAP), the main components of which comprise institutional

Donor/IFI	Past/Ongoing projects	Future priorities in donor's/IFI's strategy
EBRD Sources: Ebrd.com	resources as well as the efficient and sustainable supply of power and energy. EBRD has been supporting the development of several energy efficiency and renewable energy projects since already for some years. The projects focus namely district heating facilities, electricity grid expansion and rehabilitation, substations refurbishment, etc. Also projects in the transport sector are being developed and are of direct impact in the energy efficiency performance of the sector. CAEPCO Energy Efficiency Project (2013) The proposed project will support one of the few private companies in Kazakhstan in implementation of its investment program which will enhance energy efficiency and result in carbon emissions reduction going beyond existing standards. Installation of modern metering systems in the electricity distribution grids of the Company will be the first of this level in the sector in Kazakhstan and will promote best practices in the sector. Aktobe District Heating (2012) The project aims to rehabilitate and modernise the district heating production facilities and the main networks operated by the Company. This would result in enhanced energy efficiency, reduction in technical and commercial losses and improvements in environmental standards. Shardara HPP Modernization Project (2012)	development, sector reform, and adoption of best practices as a basis for the Bank's financial involvement, including: • Review and improvements of draft legislation • Strengthening of regulatory agencies and specialized bodies • Tariff levels, metering and methodology improvements • Focus on priority investments and financings While pro-actively seeking to help bridge regional energy imbalances and alleviate endemic power shortages in the country, the Bank will be thus selective in its investment strategy, and will channel financial investment into projects that comply with SEAP and support the transition to a low carbon economy by meeting the following key selection criteria: • Utilise the best available technique (BAT) structured to meet EU environmental and energy efficiency performance for new and existing coal fired power plants with strong industry sponsors • Utilise associated gas, reduce gas flaring and improve efficiency of gas-fired power plants beyond current standard practice in the sector; • Target significant efficiency improvements and power supply reliability through rehabilitation of existing plants or construction of new plants; • Reduce commercial and technical losses, and improve efficiency in electricity and gas transmission and distribution networks • Support renewable energy generation, namely mini-hydro and wind projects. Activities in the area of renewable energy and climate change will form

Donor/IFI	Past/Ongoing projects	Future priorities in donor's/IFI's strategy
	Financing of Shardara HPP rehabilitation project to replace old equipment and improve efficiency of this hydropower plant. Supporting sustainable energy and redressing energy imbalances shortages through investment is one of the EBRD's priorities in Kazakhstan, as defined by its Sustainable Energy Action Plan in the country. Aktau District Heating (2011) The Project is aimed at replacement of parts of the obsolete district heating networks operated by the Company with pre-insulated modern technology pipes in order to reduce energy and water losses, increase reliability and quality of provided heat and hot water services, reduce maintenance and operation costs as well as reduce the negative environmental impact, both locally and globally. KTZ Energy Efficiency Loan (2011) Co-finance KTZ's energy efficiency programme, which is expected to include a number of components (upgrade of lighting system and electric infrastructure, heat pumps, solar water heaters, space heating and energy efficiency in buildings). Implementation of the programme will result in reduced energy consumption across KTZ operations (Project). KAZREFF: Kazakhstan Renewable Energy Financing Facility (2011) Establishing a Kazakhstan Renewable Energy Financing	an integral part of the Bank's energy strategy and its operations across all sectors. The Bank will seek to support projects in renewable energy, primarily in mini-hydro and wind projects, which have the biggest potential in Kazakhstan. Recognising that many of the renewable energy projects are likely to be relatively small, the EBRD will use energy efficiency credit lines and may develop financing instruments under a framework facility similar to the Direct Lending Facility used in ETC countries or in Western Balkans. The Bank will continue to work with its partner banks to expand their participation in the Kazakhstan Sustainable Energy Financial facility (KazSEFF), which is targeted at energy efficiency elements in projects in such sectors as GI, agribusiness, natural resources as well as small renewable energy projects. Seeking to yield tangible benefits for Kazakhstan's from its recent ratification of the Kyoto Protocol, the Bank will work to develop Carbon Finance investment projects if Kazakhstan becomes eligible to host such projects. The Bank will aim to bring about additional incentives to save energy, such as creating financing structure for investments in public buildings to save energy and creating markets for energy efficiency companies. The Bank will work to launch ESCO's in Kazakhstan, for which purpose it has already engaged consultants. The Bank will seek opportunities to utilise concessional funds under the Clean Technology Fund (CTF), under which USD 250 million is available for Kazakhstan, to leverage private financing of sustainable energy projects in a non-distortionary way. Implementation of the institutional component of SEAP will continue to form the basis for the policy dialogue in the sector, and will be supported by technical assistance. Thus the Bank will focus on

Donor/IFI	Past/Ongoing projects	Future priorities in donor's/IFI's strategy
	Facility which would provide the Bank with an instrument to extend financing for renewable energy projects in Kazakhstan. The two main objectives of the Facility will be: to provide financing and technical assistance for the realisation of early renewable energy projects, which will demonstrate the benefits of utilisation of renewable energy sources; to encourage and support policy dialogue and institutional capacity building in respect of renewable energy, in order to foster the development of a favourable environment for the implementation of such projects in Kazakhstan. The Facility will consider all forms of renewable energy generation project including hydro, wind, biomass and solar. KEGOC Ossakarovka Restructuring Loan (2011) Rehabilitation of the Ossakarovka electricity transmission line to contribute to the overall system reliability and support development of the Akmola region, enabling electricity supply from Central Kazakhstan to the Astana city and Akmola oblast (region). CAEPCO District Heating – PAVLODAR (2010) Invest in the district heating subsidiaries of CAEPCO, a private energy company in Kazakhstan. The projects will finance priority investment programmes in Pavlovdar, Ekibastuz and Petropavlovsk aimed at rehabilitation and improving energy efficiency of existing heat distribution networks in these cities. The investments are expected to	strengthening regulatory agencies, such as appointment of an independent sector regulator, and will continue to champion adoption of viable tariffs via tariff methodology improvements. The Bank will continue to assist in the development of the renewable Energy Law and Energy Efficiency Law, support development of a framework for thermal power plants rehabilitation, and sponsor a least-cost study for generating companies. The Bank will support strengthening regulations and policies that support market penetration of best available techniques in the power sector. In the area of climate change, the EBRD will seek to contribute to the development of the Carbon Finance Framework under the Kyoto Protocol, following which it will move to help Kazakhstan establish national carbon finance legislation. The Bank will seek to disseminate examples of best practices between its partners through sponsoring work-shops and roundtables. Cooperation with other International Organizations is also foreseen as complementary work.

Donor/IFI	Past/Ongoing projects	Future priorities in donor's/IFI's strategy
	yield significant reductions in heat losses, CO_2 emissions and coal savings, and contribute to market transformation towards sustainable energy use in the district heating sector in Kazakhstan. Almaty Development Of Electric Transport (2010) Finance the purchase of up to 200 new energy efficient low-floor trolleybuses for the Company, allowing to replace the existing worn-out trolleybus fleet. Additionally, the Project will provide a sector benchmark to the private sector and will complement the EBRD's previous loan in trolleybus infrastructure signed in 2009. The Project aims at increasing the capacity and standards of public transport services as an alternative to car usage and to provide an overall balanced approach to urban mobility with viable travel choices for users through integrating various transport modes into one properly functioning City transport system. AES Sogrinsk CHP (2010) Investment in Sogrinsk CHP in Eastern Kazakhstan (Ust-Kamenogorsk), aimed at improving the availability and utilisation factor of the CHP, enhanced energy efficiency, reduction in losses and improvements in environmental standards. The scope of the project includes replacement of turbine-generator, modernisation and reconstruction of boilers, auxiliary systems and other energy efficiency investments at the power plant. The loan will be used to	

Donor/IFI	Past/Ongoing projects	Future priorities in donor's/IFI's strategy
	finance replacement of one turbine of the Sogrinsk CHP. CAEPCO (f. Northern lights) (2009) Investment in Central-Asian Electric Power Corporation (CAEPCo), a private energy holding of power utility companies in Pavlodar, Petropavlovsk, Ekibastuz and Astana, to finance major rehabilitation investments aimed at enhancing energy efficiency and improving the environmental standard of power generation and distribution assets.	
European Commission	In Kazakhstan, EC cooperation focuses on social and economic development and support for state and administrative reform, while regional programmes prioritize cooperation in the field of energy and transport, environment, education, security and stability. Strengthening the energy and transport links is one of the major six goals of the EU and Central Asia Partnership. The EU will support the exploration of new oil, gas and hydro-power resources and the upgrading of the existing energy infrastructure. To enhance EU security of energy supply, the EU will also support the development of additional pipeline routes and energy transportation networks. Project: Energy Saving Initiative in the Building Sector in the Eastern European and Central Asian countries (ESIB) (2009-2013) – The objective is to assist the INOGATE Partner Countries in ensuring improved control	Based on the objectives laid down in the Baku Initiative the EU will focus cooperation with Central Asian States in particular supporting sustainable energy development, including the development of energy efficiency, renewable energy sources and demand side management; supporting the development of comprehensive action programmes aiming at the promotion of energy saving, energy efficiency and renewable energy, notably with a view to meeting commitments in the framework of the Kyoto protocol; and Supporting the 'Global Energy Efficiency and Renewable Energy Fund' initiative. European Commission through its Directorate–General (DG) Development and Cooperation – EuropeAid is providing various grants and contracts. Relevant information for ongoing call for grants and contracts are also published on the website of the EU Delegation in Kazakhstan - http://eeas.europa.eu/delegations/kazakhstan/funding_opportunities/grants/index_en.htm

Donor/IFI	Past/Ongoing projects	Future priorities in donor's/IFI's strategy
	of their energy consumption in the building sector by promoting and developing EE, and, where applicable, the use of RE. Location : Armenia, Azerbaijan, Belarus, Georgia, Moldova, Ukraine, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan.	
Deutsche Gesellschaft für Internationale Zusammenar beit (GIZ)	GIZ is supporting the Kazakh Government in the fields of sustainable economic development, education and vocational training, good governance, the environment and climate, and health. There are no current or past projects developed in the energy sector.	n.a.
US Agency for International Development (USAid)	Kazakhstan is a strategic U.S. partner in Central Asia. The country is becoming increasingly influential in the region and the world as its economy stabilizes as the result of targeted economic reforms. The Asian Credit Fund (ACF) was established in 1997 as a micro and small business lending program in Kazakhstan. It also provides microfinance services to rural households. As part of its technical assistance services and emphasis on household energy efficiency, ACF sought to provide a credit line for home improvements but didn't know how to evaluate energy efficiency loan requests. As part of its technical assistance services and emphasis on household energy efficiency, ACF sought to provide a	USAID Policy Framework 2011-2015 defines that: USAID clean energy funding will emphasize countries with high and/or potentially high emissions levels, high potential for renewable energy development and greater energy efficiency, and a high potential to be a clean energy leader in the region.

Donor/IFI	Past/Ongoing projects	Future priorities in donor's/IFI's strategy
	credit line for home improvements but lacked knowledge and expertise on how to evaluate energy efficiency loan requests. Through its Central Asian Energy Efficiency Support Program (CAEESP), USAID provided a $1 million portable guarantee to ACF in 2011 for energy efficiency loans in rural households. From August to December 2012, ACF made close to 100 loans for energy improvements valued at approximately $317,000. The loan amounts averaged between $2,000 and $3,000 per household. Roughly half of the loans were used to add insulation and half were used for heating system improvements, including boiler replacements. This work will continue through 2013 to help reduce greenhouse gas intensity and emissions by stimulating investment in energy efficiency technologies and projects.	
	Turkmenistan	
Asian Development Bank	The Asian Development Bank (ADB) has been striving to enhance its development interventions in Turkmenistan since the country joined ADB in 2000. ADB's interim operational strategy for the country has focused on securing improved basic services for the population, maintaining and upgrading the human resource base, building capacity to improve public sector management, improving production efficiency and related policies in agriculture, and ensuring better environment	Since Turkmenistan joined the Central Asia Regional Economic Cooperation Program in 2010, the priorities have been to help the country integrate with regional economies, markets, and regional supply chains; and to exploit economies of scale from expanded markets. ADB's interventions for the foreseeable future are subject to the newly designed interim country partnership strategy (CPS). The strategy will focus on (i) the development of transport and energy infrastructure enhancing regional connectivity; and (ii) policy and advisory, and capacity building technical assistance in areas ranging from clean

Donor/IFI	Past/Ongoing projects	Future priorities in donor's/IFI's strategy
	management. Project: Afghanistan and Turkmenistan: Regional Power Interconnection Project (2011) The Regional Power Interconnection Project will address electric supply needs in Afghanistan (AFG) and electric infrastructure development and export plans in Turkmenistan (TKM). The Project will meet AFG needs as (i) development partners have advised plans for investment in transmission and distribution which will increase the low electrification rate thereby increasing demand (ii) development of new domestic generation is not expected to meet forecast demand, (iii) existing interconnections cannot fill the supply gap, and (iv) electric imports from TKM can meet new demand in a cost effective manner while increasing security by diversifying import sources. The Project will allow TKM utilize its gas reserves for electric exports by adding additional gas fired generating plant. The project's impact will be increased regional cooperation and optimized use of regional energy resources. In TKM, the outcome will be increased overall generation efficiency through the addition of modern high efficiency power plant a new gas-fired 300MW combined cycle power plant. In AFG, the project includes new transmission lines and substations in its western region including a connection from the TKM/AFG border to the existing 220kV grid.	energy to finance sector development. The CAREC agenda is one of the driving forces behind ADB's operations in the country.
World Bank	The World Bank does not have any recent project	The World Bank Group and the Government of Turkmenistan are

Donor/IFI	Past/Ongoing projects	Future priorities in donor's/IFI's strategy
	Turkmenistan.	currently working on the preparation of an Interim Strategy Note (ISN) that will serve as a platform for expanded cooperation covering up to a two-year period (FY14–15). Once finalized, the Strategy document is expected to be presented to the World Bank Board of Executive Directors by mid-2013 for its consideration.
Islamic Development Bank	There were no energy focused projects ever supported by the Bank for the period (1975-2011).	Strategy not available for Turkmenistan
UNDP-GEF	Improving the Energy Efficiency of the Heat and Hot Water Supply (2011) Reducing GHG emissions by removing the existing barriers to the improvement of the heat and hot water supply systems in Turkmenistan. LGGE Improving Energy Efficiency in the Residential Building Sector (2006) The project will reduce greenhouse gas emissions by improving energy management and reducing energy consumption in the residential sector in Turkmenistan.	The GEF-5 climate change strategy will promote a broad portfolio of environmentally sound, climate friendly technologies to achieve large GHG reductions in the GEF-recipient countries in accordance with each country's national circumstances. The portfolio will include technologies at various stages of development in the innovation chain, with a focus on the stages of market demonstration, deployment, and diffusion. GEF support will involve a combination of technology-push and market-pull interventions. The climate change mitigation strategy for GEF-5 will consist of six objectives: 1. Promote the demonstration, deployment, and transfer of innovative low-carbon technologies 2. Promote market transformation for energy efficiency in industry and the building sector 3. Promote investment in renewable energy technologies

Donor/IFI	Past/Ongoing projects	Future priorities in donor's/IFI's strategy
		4. Promote energy efficient, low-carbon transport and urban systems 5. Promote conservation and enhancement of carbon stocks through sustainable management of land use, land-use change, and forestry 6. Support enabling activities and capacity building
European Investment Bank	The EIB received political approval from the Council of EU Ministers to become active in Central Asia (Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan) in late 2008. Central Asian countries are eligible under the Bank's own risk Energy Sustainability & Security of Supply Facility (ESF) for investment grade projects in renewable energy, energy efficiency, carbon capture, transportation or storage projects aiming specifically to reduce greenhouse gas emissions and projects contributing substantially to security of EU energy supply.	The EIB will support the EU policy objectives of diversification of energy resources, by focusing its financing on projects in energy supply and energy transport, as well as on the protection of the environment. In addition, Central Asian countries are eligible under the Bank's own risk Energy Sustainability & Security of Supply Facility (ESF) for investment grade projects in renewable energy, energy efficiency, carbon capture, transportation or storage projects aiming specifically to reduce greenhouse gas emissions and projects contributing substantially to security of EU energy supply. There are currently no projects ready to be financed by EIB in Turkmenistan.
EBRD	There are no energy projects being financed by the Bank.	The Bank will work together with private sector investors, the Turkmen authorities and other IFIs and donors to address modernisation of infrastructure, which constrains private sector development and operates under below-cost prices and non-transparent practices. Commercialisation and energy efficiency improvements are necessary to ensure long-term sustainability. Promotion of energy efficiency across selected commercial sectors of the economy particularly in its highly inefficient manufacturing and

Donor/IFI	Past/Ongoing projects	Future priorities in donor's/IFI's strategy
		infrastructure sectors. Support for development of legal and institutional framework and the introduction of economic incentives for energy efficiency improvements and exploitation of renewable energy sources.
European Commission	A Memorandum of Understanding on Energy, signed in May 2008, promotes in particular the energy relations with regard to energy security and enhancing industrial development including the development of renewable energy sources. Project: Technologies and Methodologies for Reducing Gas Losses of the Central Asian Gas transit system (2009) The overall objective of this project was to enhance the safety and security of the main gas transit infrastructures in Central Asia through reducing gas losses.	Regional Cooperation is of Strategic importance to Central Asian the countries face several challenges that require a coordinated response. These common challenges include combating drug trafficking, modernising border management, addressing cross-border environmental issues and developing an integrated transportation system. One of the main sectors supported at regional level is the sustainable regional development (Energy, environment and business cooperation networks). EU programmes contribute to the increased security, reliability and efficiency of energy supplies, and facilitate energy cooperation. With regard to the environment, the EU's activities are dedicated to environmental protection and management of water resources. EU programmes have also been strengthening economic relations, trade and transport communications, and key infrastructure investments. European Commission through its Directorate–General (DG) Development and Cooperation – EuropeAid is providing various grants and contracts.
Deutsche Gesellschaft für Internationale Zusammenar	No presence in Turkmenistan	n.a.

Donor/IFI	Past/Ongoing projects	Future priorities in donor's/IFI's strategy
beit (GIZ)		
US Agency for International Development (USAid)	There are no energy projects being supported by USAID.	USAID Policy Framework 2011-2015 defines that: USAID clean energy funding will emphasize countries with high and/or potentially high emissions levels, high potential for renewable energy development and greater energy efficiency, and a high potential to be a clean energy leader in the region.

Other Potential financing sources:

Organisation	General priorities	Specific country priorities
Japan International Cooperation Agency (JICA)	The key aspects of JICA's support in the energy and power sector are, 1) support for sustainable economic growth through the stable supply of electric power, 2) promoting the reduction of greenhouse gas (GHG) emissions by implementing optimal technologies, and 3) promoting rural electrification in view of reducing poverty. As the global community steps up efforts to reduce GHG emissions, developing countries have also started to increase the use of renewable energy sources such as solar, wind, and geothermal power generation, and high-efficiency thermal generation technologies. With extensive knowledge in these fields, Japan responds to calls to help developing countries reduce GHG emissions in their energy sectors. JICA provides assistance for the training of energy management technicians in order to support energy conservation efforts using sophisticated Japanese technologies.	Offices established in Tajikistan, Uzbekistan and Kyrgyzstan, however no projects currently are implemented in the energy sector.
The Norwegian Agency for Development and Cooperation (NORAD)	n.a. Focus on Africa	n.a. Focus on Africa
Australian Government's Overseas Aid program (AUSAid)	n.a. Central Asia countries not among priority countries	n.a. Central Asia countries not among priority countries

Organisation	General priorities	Specific country priorities
Danish Development Assistance (DANIDA)	Danish development cooperation encompasses the countries bordering the EU to the east and the south east in the form of the Neighbourhood Programme as well as countries of Central Asia. Denmark works for stability and the strengthening of the democratisation process. Long-term stability and peace in Central Asia presupposes regional cooperation. Denmark is working to strengthen democratic values and institutions in the region. This is to safeguard the representation of the Central Asian populations and the peaceful resolution of conflicts. Between 2009 and 2012 the Danish government is concentrating its development activity in the Central Asian states on human rights and democracy interventions and on conflict prevention. Approximately DKK 6 million is granted every year to support minor projects in Central Asia. In the coming years Denmark will intensify its bilateral development activity in Central Asia. The intention is to emphasise the promotion of respect for human rights, democratisation and good governance.	Current cooperation activities Kazakhstan, Kyrgyzstan, Tajikistan, but in other sectors than energy.
Dutch Development Policy	The Government's 4 new spearheads for bilateral development are security and the legal order, water, food security, and sexual and reproductive health and rights. All are areas in which Dutch businesses, civil society organisations, and knowledge institutions can offer expertise and add special value. The government wants to be more selective when	On the basis of their scores, the World Bank, the UN Development Programme (UNDP) and the UN Children's Fund (UNICEF) will remain central to Dutch international development efforts. The assessment also showed that some organisations provide more value for money when implementing Dutch development policy. Examples include the African and Asian development banks (AfDB and AsDB), the International Fund for Agricultural Development (IFAD), the

Organisation	General priorities	Specific country priorities
	providing development assistance via international organisations such as the United Nations and the World Bank.	Global Fund to Fight AIDS, Tuberculosis and Malaria, the UN Refugee Agency (UNHCR) and the World Food Programme (WFP).
Swedish International Development Cooperation Agency	n.a. Central Asia countries not among priority countries	n.a. Central Asia countries not among priority countries
Swiss Agency for Development and Cooperation (SDC)	In all Central Asian states Switzerland supports water resource management. In Kyrgyzstan Switzerland also focuses on the priority areas health, public sector reforms and private sector development, in Tajikistan on health, rule of law, access to drinking water and private-sector development. Uzbekistan is receiving support both for improving access to drinking water and in implementing their national development strategies in cooperation with other donors.	The main goal for Swiss cooperation for 2011-2015 is to assist Central Asian countries in sustainable development, transition from authoritarian rule and central planning to pluralism and market economy. The projects in Central Asia are developing in five main domains: - Public institutions and services - Basic infrastructure (water and energy) - Private sector development - Water management and disaster risk reduction - Health care reform

Section 6: Conclusions and recommendations

The applicability of various existing and cutting-edge energy efficiency technologies in Central Asia depends on the availability of fossil fuels (gas, coal, oil) and renewable energy resources (water, wind, solar) in the Central Asian countries, as well as the level of development of various industries based on the available natural resources, transport infrastructure and development of the construction, housing, utilities and agricultural sectors.

Electricity generation:

Policies that are in favour of closing old and inefficient coal combustion plants need to be maintained and further developed by the governments of the Central Asian countries. Enhancing regulatory means and incentives (e.g. carbon pricing mechanisms) could facilitate the coal-to-gas switch in order to meet national CO_2 reduction targets. Governments should consider a combination of policies that halt the deployment of less efficient units, reduce CO_2 emissions and ensure measures are also applied to reduce emissions of non-GHG pollutants.

International cooperation is necessary in order to reduce the resources and time necessary for spreading the deployment of advanced technologies in power plants. HELE technologies are available, however further R&D efforts are needed to I) reduce the cost and lower the risk of certain technologies; II) make them commercially available; and III) develop more advanced combustion and gasification technologies.

Priority new energy efficient technologies which can potentially be used in coal-fired power generation in Central Asia include: supercritical steam technology (SC), ultra supercritical steam technology (USC), integrated gasification combined cycle (IGCC), and technologies based on fluidized systems (especially for combined heat and power plants). For gas-fired power generation they include: use of efficient open cycle gas turbines (OCGT) and combined cycle gas turbines (CCGT), and combined heat and power generation.

Energy efficiency in the power generation sector in Central Asia can be improved significantly by upgrading and improving efficiency in the existing power plants through advanced energy saving equipment, instruments, materials and automatic control systems; converting direct fuel combustion boilers to combined cycle installations; using new technologies of coal preparation; optimizing demand management to flatten the load curve and secure reasonable loading in the grid. Significant reduction of transmission losses can be achieved through the upgrade and replacement of outdated and worn-out power and switching equipment at substations, the use of up-to-date dispatch control systems, relay protection and automation, and reactive power compensation and control systems.

Industry:

The potential improvement in energy efficiency in industrial enterprises in Central Asian countries is enormous, and is primarily associated with the modernization of obsolete equipment at all stages of the preparation and processing of raw materials and the production of finished products, the introduction of automation and control systems (control and energy metering systems, automation systems, climate heating, ventilation, air conditioning, lighting and automation control systems of buildings), and the use of modern materials (insulation, lubricants).

A large part of applicable energy efficient technologies is determined by specific branches of industry. The well developed areas in Central Asia include: ferrous and non-ferrous metallurgy; chemical, oil refining and petrochemical industries; machine engineering; pulp and paper production; construction materials production, food and light industry and other industrial sectors. Special attention shall be given to energy saving technologies used in electric motor driven systems (EMDS) which are the main consumers in the industrial sector.

A set of energy saving measures in industry includes, among other things, optimization of energy consumption modes, improvement of auxiliary operations and technological processes, loss reduction in the owned electricity grids through rehabilitation and replacement of equipment, and reactive power compensation.

In addition to various efficient technologies available for different types of industries, governments have a wide range of voluntary or mandatory policies to enhance industrial energy efficiency to be introduced regardless of the type of industry. Such policies include: I) introducing energy management for industries (including identification of existing potential, mandating energy audits and energy managers, setting energy performance benchmarks), thereby facilitating the market for energy performance contracting; II) introducing mandatory minimum energy performance standards for energy-using equipment (electric motors, pumps, compressors, distribution transformers etc.); III) facilitating the market; IV) removing energy subsidies and encouraging investment in energy efficiency measures through financial incentives (tax reduction, loan guarantees, low-interest loans).

There are technologies available to reduce the electricity consumption of motor systems, however the saving potential has not yet been realised in the Central Asian countries. The main actions to be undertaken in order to achieve the savings include: I) the use of appropriately sized energy efficient motors; II) the use of adjustable speed drives; III) system operation optimization to achieve minimum energy losses.

Construction, housing and utilities:

All of the considered Central Asian countries were in the recent past part of a single country with uniform standards in the building and housing sector. Therefore, the problems they face in construction, housing and utilities are similar. The same is true for energy efficiency technologies that are used or recommended for use in existing and new buildings.

Development and enforcement of strict building codes for new and existing buildings is a fundamental step in increasing the energy performance of buildings. Additional measures and complementary policies might include the introduction of financial incentives, building certificate schemes, schemes that support zero or nearly-zero building construction, etc.

Significant energy savings in the construction sector can be achieved through the use of up-to-date and advanced technologies and materials such as building envelope materials, windows, shading, air filtration, heating, ventilation and cooling systems, hot water, automation, etc.

Various commercially available energy efficient building technologies are already used in Central Asia for heating, cooling and ventilation, lighting, appliances and energy-using equipment. Advanced technologies for heating and cooling are available in Central Asia, e.g. active solar thermal, application of heat pumps for heating and cooling and co-generation in buildings, however the pace of their deployment is low mainly due to their high investment cost.

Key measures to improve energy savings in the utilities sector include modernization of heating and electricity supply systems. Significant results can also be achieved through replacement of heat distribution units at local heat distribution stations and distribution piping adjustment, and installation of temperature control units and individual consumption meters. The basic task in introducing energy efficient technologies is to equip all consumers with energy monitoring and metering devices.

Energy-using products:

Policies to limit or phase out inefficient products are crucial for faster deployment of energy efficient products and equipment. Such policies need to be properly enforced as well as complemented by measures to provide information and increase public awareness (e.g. labels) to ensure maximum take-up of the most efficient products.

Transport:

Energy efficiency in transportation (by air, rail and road) is first of all obtained through efficient fuel consumption. The solution lies in further reducing the weight of vehicle designs, improving aerodynamic performance, using alternative fuels (combined fuel use), improving the fleet, and improving management and logistics.

Key areas of energy efficiency improvement in the railway industry include: railway electrification; use of liquefied natural gas instead of petroleum fuels; use of advanced locomotives with more efficient engines; reduction of energy losses at railway electric substations; upgrading of railway station heat supply.

Agricultural sector:

Agriculture is another developed sector in all Central Asian countries. The issues of energy efficiency improvement and energy saving in the sector as well as applied technologies (irrigation systems, agricultural buildings and structures, applied specialized machinery and specific technological processes) are similar in all the countries in the region. Energy efficient management can be achieved through the use of combined machinery for tillage operations, energy efficient pumping equipment for irrigation systems, improvement of the machinery fleet, adoption of systems using animal waste for energy generation (biogas units), and utilization of exhaust air heat from the ventilation of livestock houses to heat water and premises.

Renewable energy sources:

The use of renewable energies for energy supply is at a very modest stage of development in Central Asia. Nevertheless, the technical potential to use renewable energies is quite high as the resources are widely available in the region (namely hydro, solar and wind), and technological developments together with a plunge in associated costs make a favourable basic context for investment.

The presence of sizable fossil fuel resources (namely coal, oil and gas) in most of the Central Asian countries is a factor hindering the development of renewable energies.

The pollution associated with the exploitation of fossil fuel resources in Central Asia is certainly a factor contributing to the high carbon intensity of the region, something that enhanced renewable energy use could improve.

The challenges facing renewable energies development in Central Asia are large and include basic energy sector reforms and the establishment of an institutional framework in order to attract investment and encourage improvements in the carbon efficiency with which energy is generated, distributed and used.

First of all, in order to stimulate the use of renewable energy sources in the region it is reasonable to promote the construction of mini hydropower plants, the construction of low capacity standalone wind power plants to supply electricity to isolated consumers, the construction of moderate capacity wind farms to supply electricity to remote communities, the installation of solar collectors for water heating, the use of low capacity heat pumping plants to supply heat to various industrial and agricultural facilities and private households and premises, and the use of biogas units. Further into future this may include the construction of wind farms with high capacity equipment to be used in the synchronized power systems, and the construction of solar photovoltaic systems.

Energy efficiency and renewable energy potential are not yet sufficiently realized in Central Asia because of several existing barriers. Subsidized end-user electricity and gas prices, misaligned financial incentives, high upfront investment costs, long basic pay-back time of some investments and the non-internalization of carbon costs from the economic and financial barriers to a further deployment of energy efficiency and renewable technologies.

Various financial instruments should be used by the governments of the Central Asian countries in order to finance energy efficiency and renewable energy projects, using the best available technologies. The main options that should be used include public or private capital budgets (direct investment, subsidies and grants), debt financing (loans, leases and guarantees), energy services companies and carbon financing. To stimulate private investors, various economic instruments should also be used by governments as price incentives.

The public sector should play a leadership role by demonstrating the potential of energy efficiency to reduce energy consumption and showcasing new technologies and energy management. Governments should stimulate and support different solutions such as bundling of similar projects (e.g. schools, hospitals, etc.) in order to attract large scale finance providers. Introduction of specific rules governing the public procurement of energy and introduction of regulatory frameworks that can attract additional financial cash flow should also be widely used (e.g. energy saving obligation schemes for utilities and green and white tradable certificates). Removing barriers to private sector investments should be another way for governments to provide support.

Governments need to introduce supportive policies and legislation, as well as introduce cost-reflective energy prices as one of the main factors influencing the demand for investments in energy efficiency. The liberalization of energy markets in Central Asia is another important enabling factor in order to create the right market conditions for energy services companies to operate.

At present, international financial institutions and donors play a key role in setting up different financial mechanisms for energy efficiency and renewable energy projects. This is done in several ways, including the provision of technical assistance to the governments in the region to improve regulatory and investment frameworks in order to attract investments in the sector, and by direct involvement in the design and the financing of specific mechanisms and projects.

As can be seen by reviewing the international financial institutions' strategies for the next few years, their priorities for the region are moving towards the provision of support for demand-side energy efficiency as well as to stimulate investments in renewable energy.

ANNEX I: Links to existing policies, legislation and plans

1. European Union

European energy policy

A POLICY FOR ENERGY

A strategy for competitive, sustainable and secure energy
http://europa.eu/legislation_summaries/energy/european_energy_policy/en0024_en.htm

European Energy Programme for Recovery
http://europa.eu/legislation_summaries/energy/european_energy_policy/en0012_en.htm

Energy Security and Solidarity Action Plan
http://europa.eu/legislation_summaries/energy/european_energy_policy/en0003_en.htm

An Energy Policy for Europe
http://europa.eu/legislation_summaries/energy/european_energy_policy/l27067_en.htm

Green Paper: A European strategy for sustainable, competitive and secure energy
http://europa.eu/legislation_summaries/energy/european_energy_policy/l27062_en.htm

MARKET-BASED INSTRUMENTS

Greenhouse gas emission allowance trading scheme
http://europa.eu/legislation_summaries/energy/european_energy_policy/l28012_en.htm

Community framework for the taxation of energy products and electricity
http://europa.eu/legislation_summaries/energy/european_energy_policy/l27019_en.htm

RESEARCH AND INNOVATION

SET-Plan for the development of low carbon technologies
http://europa.eu/legislation_summaries/energy/european_energy_policy/en0019_en.htm

Sustainable power generation from fossil fuels
http://europa.eu/legislation_summaries/energy/european_energy_policy/l27068_en.htm

Demonstration of the capture and storage of CO2
http://europa.eu/legislation_summaries/energy/european_energy_policy/l28203_en.htm

FINANCIAL INSTRUMENTS

Competitiveness and Innovation Framework Programme (CIP) (2007-2013)
http://europa.eu/legislation_summaries/energy/european_energy_policy/n26104_en.htm

Seventh Framework Programme (2007 to 2013)
http://europa.eu/legislation_summaries/energy/european_energy_policy/i23022_en.htm

A COMPETITIVE INTERNAL MARKET

Agency for the Cooperation of Energy Regulators
http://europa.eu/legislation_summaries/energy/internal_energy_market/en0013_en.htm

Internal market for natural gas
http://europa.eu/legislation_summaries/energy/internal_energy_market/l27077_en.htm

Internal market for energy (until March 2011)
http://europa.eu/legislation_summaries/energy/internal_energy_market/l27005_en.htm

Internal market in gas (from March 2011)
http://europa.eu/legislation_summaries/energy/internal_energy_market/en0017_en.htm

Internal market in electricity (from March 2011)
http://europa.eu/legislation_summaries/energy/internal_energy_market/en0016_en.htm

Transparency of gas and electricity prices
http://europa.eu/legislation_summaries/energy/internal_energy_market/en0028_en.htm

Prospection, exploration and production of hydrocarbons
http://europa.eu/legislation_summaries/energy/internal_energy_market/l27007_en.htm

Greenhouse gas emission allowance trading scheme
http://europa.eu/legislation_summaries/energy/internal_energy_market/l28012_en.htm

AN INTERCONNECTED INTERNAL MARKET

Green Paper - Towards a secure, sustainable and competitive European energy network
http://europa.eu/legislation_summaries/energy/internal_energy_market/en0004_en.htm

Trans-European energy networks
http://europa.eu/legislation_summaries/energy/internal_energy_market/l27066_en.htm

Community financial aid to trans-European networks
http://europa.eu/legislation_summaries/energy/internal_energy_market/tr0031_en.htm

Priority Interconnection Plan (PIP)
http://europa.eu/legislation_summaries/energy/internal_energy_market/l27081_en.htm

Conditions for access to the gas transmission networks
http://europa.eu/legislation_summaries/energy/internal_energy_market/l27078_en.htm

Conditions for access to the network for cross-border exchanges in electricity (up until March 2011)
http://europa.eu/legislation_summaries/energy/internal_energy_market/l27041_en.htm

Natural gas transmission networks (from 2011)
http://europa.eu/legislation_summaries/energy/internal_energy_market/en0015_en.htm

Cross-border exchanges in electricity (from 2011)
http://europa.eu/legislation_summaries/energy/internal_energy_market/en0014_en.htm

Smart Grids
http://europa.eu/legislation_summaries/energy/internal_energy_market/en0031_en.htm

PUBLIC PROCUREMENT

Public procurement in the water, energy, transport and postal services sectors
http://europa.eu/legislation_summaries/energy/internal_energy_market/l22010_en.htm

Remedies mechanisms: water, energy, transport and postal services sectors
http://europa.eu/legislation_summaries/energy/internal_energy_market/l22006b_en.htm

TAXATION

Community framework for the taxation of energy products and electricity http://europa.eu/legislation_summaries/energy/internal_energy_market/l27019_en.htm

Energy efficiency

POLICY ORIENTATIONS

Energy Efficiency directive

Energy Efficiency Plan 2011 http://europa.eu/legislation_summaries/energy/energy_efficiency/en0029_en.htm

Energy efficiency for the 2020 goal http://europa.eu/legislation_summaries/energy/energy_efficiency/en0002_en.htm

Action Plan for Energy Efficiency (2007-12) http://europa.eu/legislation_summaries/energy/energy_efficiency/l27064_en.htm

Competitiveness and Innovation Framework Programme (CIP) (2007-2013) http://europa.eu/legislation_summaries/energy/energy_efficiency/n26104_en.htm

The Global Energy Efficiency and Renewable Energy Fund http://europa.eu/legislation_summaries/energy/energy_efficiency/l27063_en.htm

DELIVERING ENERGY EFFICIENCY

Energy performance of buildings http://europa.eu/legislation_summaries/energy/energy_efficiency/en0021_en.htm

Energy end-use efficiency and energy services http://europa.eu/legislation_summaries/energy/energy_efficiency/l27057_en.htm

Cogeneration http://europa.eu/legislation_summaries/energy/energy_efficiency/l27021_en.htm

Product energy consumption: Information and labelling (from July 2011) http://europa.eu/legislation_summaries/energy/energy_efficiency/en0022_en.htm

Tyre labelling http://europa.eu/legislation_summaries/energy/energy_efficiency/en0005_en.htm

Ecodesign for energy-using appliances http://europa.eu/legislation_summaries/energy/energy_efficiency/en0018_en.htm

Energy efficiency of office equipment: The Energy Star Programme (EU - US) http://europa.eu/legislation_summaries/energy/energy_efficiency/l32053_en.htm

Hot-water boilers http://europa.eu/legislation_summaries/energy/energy_efficiency/l21019_en.htm

Renewable energy

POLICY ORIENTATIONS

Promotion of the use of energy from renewable sources http://europa.eu/legislation_summaries/energy/renewable_energy/en0009_en.htm

Renewable Energy Road Map http://europa.eu/legislation_summaries/energy/renewable_energy/l27065_en.htm

"Intelligent Energy for Europe" programme (2003-2006) http://europa.eu/legislation_summaries/energy/renewable_energy/l27046_en.htm

ELECTRICITY

Renewable energy: the promotion of electricity from renewable energy sources http://europa.eu/legislation_summaries/energy/renewable_energy/l27035_en.htm

Support for electricity from renewable energy sources http://europa.eu/legislation_summaries/energy/renewable_energy/l24452_en.htm

HEATING AND COOLING

Biomass Action Plan http://europa.eu/legislation_summaries/energy/renewable_energy/l27014_en.htm

BIOFUELS

EU strategy for bio fuels http://europa.eu/legislation_summaries/energy/renewable_energy/l28175_en.htm

Motor vehicles: use of bio fuels http://europa.eu/legislation_summaries/energy/renewable_energy/l21061_en.htm

WIND ENERGY

Promotion of offshore wind energy http://europa.eu/legislation_summaries/energy/renewable_energy/en0001_en.htm

2. Japan

Laws

Basic Act on Energy Policy

http://www.asiaeec-col.eccj.or.jp/eng/pdf/e2101basic_law.pdf (PDF)

Act Concerning the Rational Use of Energy (Energy Conservation Law)

http://www.asiaeec-col.eccj.or.jp/law/revised/rue_2.pdf(May 2008 Revised Version) (PDF)

Law for Energy Conservation and Recycling Support

http://www.asiaeec-col.eccj.or.jp/databook/2007e/pdf/01.pdf (PDF)

Chronicles of Energy Conservation Laws

http://www.asiaeec-col.eccj.or.jp/chronicle/index.html

Basic Policies

National Strategies and Plans http://www.asiaeec-col.eccj.or.jp/nsp/index.html

Energy Conservation Policy & Measures in Japan http://www.eccj.or.jp/summary/local0703/eng/index.html (2007)

Energy Conservation Policies of Japan http://www.enecho.meti.go.jp/policy/saveenergy/save01/genjo_English.pdf (Agency for Natural Resources and Energy, METI, 2011) (PDF)

Standards of Judgment under the Ordinance

Standards of Judgment for Factories etc. on the Rational Use of Energy http://www.asiaeec-col.eccj.or.jp/law/fac_e.html

Guidelines for Preparing Medium- and Long-Term Plans in the Manufacturing Industry http://www.asiaeec-col.eccj.or.jp/law/fac1_e.html

Standards of Judgment for Construction Clients and Owners of Specified Buildings on the Rational Use of Energy for Buildings http://www.asiaeec-col.eccj.or.jp/law/ken1_e.html

Standards of Judgment for Specified Equipment (Top Runner Program) http://www.asiaeec-col.eccj.or.jp/top_runner/index.html

Financial Assistance Measures

Financial Support with Loan System http://www.asiaeec-col.eccj.or.jp/brochure/pdf/fs-measures.pdf (PDF)

Financial Support with Taxation System http://www.asiaeec-col.eccj.or.jp/brochure/pdf/qanda.pdf (PDF)

Financial Support with Subsidy http://www.asiaeec-col.eccj.or.jp/brochure/pdf/fs-subsidy.pdf (PDF)

Measures to Cope with Global Warming

Japan's Policies to Deal with Global Warming http://www.asiaeec-col.eccj.or.jp/laws/g-warm/jpnpolicy.pdf (PDF)

International Efforts to Counter Global Warming http://www.asiaeec-col.eccj.or.jp/laws/g-warm/itnefforts.pdf (PDF)

Industrial Sector

Energy Conservation Measures in the Industrial Sector http://www.asiaeec-col.eccj.or.jp/eng/e3101enegy_conserv.html

Important check points concerning technical energy conservation measures http://www.asiaeec-col.eccj.or.jp/databook/2007e/pdf/07.pdf(PDF)

Energy Audit Program http://www.asiaeec-col.eccj.or.jp/sector/com-resident/eneauditprog.pdf (PDF)

Keidanren Voluntary Action Plan on the Environment http://www.asiaeec-col.eccj.or.jp/eng/e3104keidanren.html

Commercial and Residential Sector

Top Runner Program http://www.asiaeec-col.eccj.or.jp/top_runner/index.html

Energy Saving Labeling Program http://www.asiaeec-col.eccj.or.jp/databook/2007e/pdf/09.pdf (PDF)

Energy Star Program http://www.energystar.jp/index_esu.html

Energy Efficient Water Heaters http://www.asiaeec-col.eccj.or.jp/databook/2007e/pdf/10.pdf (PDF)

Standby Power Consumption http://www.asiaeec-col.eccj.or.jp/databook/2007e/pdf/11.pdf (PDF)

Accreditation System of Energy Efficient Product Retailing Promotion Store http://www.asiaeec-col.eccj.or.jp/databook/2007e/pdf/12.pdf(PDF)

Home Energy Management System (HEMS) http://www.asiaeec-col.eccj.or.jp/databook/2007e/pdf/13.pdf (PDF)

Building Energy Management System (BEMS) http://www.asiaeec-col.eccj.or.jp/databook/2007e/pdf/14.pdf (PDF)

ESCO (Energy Service Company) http://www.jaesco.or.jp/english/ [JAESCO]

Energy Audit Program http://www.asiaeec-col.eccj.or.jp/sector/com-resident/eneauditprog.pdf (PDF)

Transportation Sector

Top Runner Program http://www.asiaeec-col.eccj.or.jp/top_runner/index.html

Promotion of Eco Driving http://www.asiaeec-col.eccj.or.jp/eng/e3105promo_ecod.html

Efficiency in Logistics & Traffic http://www.asiaeec-col.eccj.or.jp/databook/2007e/pdf/18.pdf (PDF)

Regulation for Consigners and Transportation Companies http://www.asiaeec-col.eccj.or.jp/databook/2007e/pdf/19.pdf (PDF)

Cross-Sector

ENEX http://www.asiaeec-col.eccj.or.jp/eng/e3401enex.html

Awarding Programs http://www.asiaeec-col.eccj.or.jp/sector/cross/awarding.pdf (PDF)

Smart Life http://www.asiaeec-col.eccj.or.jp/eng/e3404smart_life.html

Energy Conservation Education http://www.asiaeec-col.eccj.or.jp/eng/e3405education.html

Technology Strategy http://www.asiaeec-col.eccj.or.jp/databook/2007e/pdf/21.pdf (PDF)

3. China

Government of the People's Republic of China (2011) China's Twelfth Five-Year Plan (2011–2015) (full English translation prepared by the Delegation of the European Union in China), http://cbi.typepad.com/china_direct/2011/05/chinas-twelfth-five-new-plan-the-full-english-version.html http://cbi.typepad.com/china_direct/2011/05/chinas-twelfth-five-new-plan-the-full-english-version.html

Information Office of the State Council of the People's Republic of China (2011) China's Policies and Actions in Responding to Climate Change, White Paper released Nov 2011, Beijing, http://www.gov.cn/english/official/2011-11/22/content_2000272.htm

Chinese national standards

GB/T 6422 -2009
Testing Guide for Energy Consumption of Equipment

用能**设备能量测试导则**

English Version http://china.lbl.gov/sites/china.lbl.gov/files/GB_T_6422_2009_(EN)_Final.pdf

GB/T13234 -2009
Calculating Methods of Energy Saved for Enterprises

企**业节能量计算方法**

English Version http://china.lbl.gov/sites/china.lbl.gov/files/GB 13234 -2009.EN_.pdf

GB/T 2589-2008
General Principles for Calculation of the Comprehensive Energy Consumption

综合能耗计算通则

English Version http://china.lbl.gov/sites/china.lbl.gov/files/GB_T_2589-2008_(EN)_Final.pdf

GB/T 13471-2008
Methods for Calculating and Evaluating the Economic Value of Electricity Saving Measures
节电技术经济效益计算与评价方法

English Version http://china.lbl.gov/sites/china.lbl.gov/files/GB13471-2008.EN_.pdf

JC/T 733-2007
Methods for the Measuring of Heat Balance of Cement Rotary Kiln
水泥回转窑热平衡测定方法

English Version http://china.lbl.gov/sites/china.lbl.gov/files/Heat balance standard.2007.pdf

GB 16780-2007
The Norm of Energy Consumption per Unit Products of Cement
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