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Improving efficiency under the Energy Efficiency 21 (EE21) Programme: Global Energy Efficiency 21

Global Energy Efficiency 21

Analysis of the development and spread of advanced technologies in energy efficiency and renewable energy within the Global Energy Efficiency 21 project for the countries of Central Asia. National studies for Kazakhstan, Kyrgyzstan, Tajikistan and Uzbekistan

Note by the secretariat

I. Background

1. Rising electricity costs and growing demand have led to an increasing amount of attention being paid in recent years to energy efficiency in the developed and developing countries. In economic terms, increasing energy efficiency is one of the most effective ways of reducing greenhouse gas emissions. Increasing energy efficiency, together with the use of renewable energy sources, also increases energy security by reducing demand for energy resources, including fossil fuels. Together, they have now become a priority in the energy, economic and environmental policies of many countries. Various technological approaches have been adopted to improve energy efficiency and make use of renewable energy resources, which have a distinct potential to alleviate the greenhouse effect and are now at various stages of development in different countries. The adoption of a set of laws to provide certainty to those taking part in the related projects is a precondition for supporting the introduction of the required technology. The Government of the Russian Federation and the United Nations Economic Commission for Europe (ECE) have thus taken the initiative to analyse the development and spread of advanced technologies in energy efficiency and renewable energy within the Global Energy Efficiency 21 project for the countries of Central Asia.

II. Introduction

2. While energy efficiency and renewable energy resources play active roles in the implementation of energy policies in Central Asia, there are differences in approaches between the countries. The countries of the region, with their rich (albeit unevenly distributed) energy resources and existing and planned overland pipelines and electrical power lines, can offer the best possibilities for the delivery of energy with which to ensure their energy security. Energy efficiency and renewable technologies are very important to these countries. An improvement in energy efficiency can reduce domestic energy demand, thus freeing up resources and improving the reliability of deliveries. Additionally, such improvements can help to solve the region's energy problems and become a tool in efforts to combat climate change, protect the environment, overcome energy poverty and increase the competitiveness of the national economies. The region's Governments have recognized the importance of developing and spreading advanced technologies for renewable energies and energy efficiency, but such questions are sometimes not given their full due in master plans for sustainable energy development. These countries face difficulties related to out-of-date technologies and equipment that may not meet environmental and occupational safety requirements and also problems resulting from growing demand for energy. Certain new technologies may often be more competitive in some countries than in others. The development and introduction of such technologies depend on the conditions of the country in question and the means of putting such technologies to use. A new policy should encourage all users (private and State) to introduce energy-saving technologies and all producers to adopt new technical approaches with more efficient and environmentally friendly energy production. An effective technology development policy in one country may have a positive impact on the introduction of technologies in other countries.

3. This document presents the research done at the national level under this project with the aim of:

- Analysing national policy, including the formulation of price tariffs, subsidies and market structures that are obstacles to investment in energy-efficient technologies;
- Considering the challenges and proposals for reform;
- Assessing energy use in each economic sector, with an accent on end users.

III. Kazakhstan

4. Kazakhstan has 57 electric power stations. Their installed capacity on 1 January 2010 was 19.1 thousand megawatts (MW), and their available capacity was 14.8 thousand MW, with capacity disruptions and limitations amounting to 4.3 thousand MW. About 41% of the generating capacity, that is, 40 of the country's 53 thermoelectric plants, have been in service for more than 30 years. Thermoelectric plants account for 88% of the overall energy balance, and hydroelectric plants account for 12%. Hydropower is the second biggest power source in the fuel balance for electricity, surpassed only by coal. An analysis of the installed electric generation capacity shows that the country's energy system is characterized by a prevalence of thermoelectric power stations burning coal (75%), gas (23%) and fuel oil (2%). In 2010, 82.6 billion kilowatt-hours (kWh) of electricity was produced and consumption amounted to 83.8 billion kWh; the electric power generated during the winter peak period represented a shortfall of 790 MW. At that time, new market relations were 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 was set up, with an open, competitive market for electrical power.

5. Energy-intensive sectors are the foundation of the country's economy, and power production is the primary consumer of primary energy resources. Between 40 and 50% of the overall consumption of primary energy sources is used for the production of electricity and thermal energy. The biggest consumer of electricity is industry, with the greatest consumption in mining and metallurgy. Industry, including the electricity industry, accounts for nearly three quarters of the country's demand for electricity. In 2010 the 15 largest companies accounted for 35.2% of total energy consumption. The majority of industries currently use obsolete technologies and equipment that is already quite worn down. Energy intensity in the country in general is over three times higher than in the European Union, which means that Kazakhstan requires three times as much energy per unit of gross domestic product (GDP). There is thus an enormous need to modernize equipment, as it is in particular obsolete equipment and out-of-date technologies that produce losses of electricity. The ineffective and incoherent use of electrical and thermal power means that it must be produced in greater quantities at thermoelectric power stations; it is thus more harmful to the environment.

6. The magnitude of the problems resulting from the inefficient use of energy resources means that there is an enormous potential to save energy. Energy conservation and increased energy efficiency in all economic sectors are now a priority, and addressing those issues will solve a large number of energy, environmental and economic problems. Energy efficiency must include measures to modernize capital assets, improve management, enhance the qualifications of production staff and attract large-scale investment. It is thus a prerequisite for success to make use of the scientific and technical potential, to adopt a new and innovative way of thinking and to make energy efficiency attractive to investment as a specialized form of activity. The introduction of energy-saving technologies and projects in industry can bring many benefits. Funds invested in energy-saving technologies can be paid back in periods ranging from several months to between five and seven years. Amortizing new generation capacity takes two to three times longer.

7. One of the priorities in the development of the country's electrical energy is the use of renewable energy resources. For Kazakhstan the following types of renewable energy offer the best prospects: wind power; small-scale hydropower units; and solar facilities producing thermal energy and electricity. However, it should not be thought that such resources can fully replace hydroelectric and thermoelectric power plants. All these resources are either geographically specific to a given locality or are dependent on the weather. Thus, the renewable energies can all be used only to supplement the main energy sources; it is not possible to rely on them alone. Conventional sources of energy and nuclear power plants provide the base for the country's electrical production. Renewable facilities remain less profitable and require considerably more investment than those using conventional sources. Production costs for alternative energies are three times higher than for conventional ones. For example, in 2009 the production cost of wind energy was 8–10 tenge per kWh, for solar energy it was 22 tenge and for biomass it was between 6 and 12 tenge. The utility companies are therefore not interested in the use of renewables for production. Furthermore, insufficient thought has as yet been given to the mechanism for supporting the production and use of such resources.

8. A comprehensive plan for increasing energy efficiency in Kazakhstan between 2012 and 2015 has been adopted by a Government decision. It notes that the required reduction in primary energy demand can be achieved through the following measures:

- Reduction of the unit consumption for electricity production from the current 350 grams of coal equivalent per kWh to 300;
- Reduction of the unit consumption for thermal energy from 190 kilograms per gigacalorie (Gcal) to 170;

- Reduction of net electricity loss in the distribution grid from the current rate of 25.9% to 15.1%;
- Reduction of net thermal energy lost in the distribution network from the current rate of 32.8% to 18%;
- Reduction of 10% in absolute demand for electricity by industry, from the current level of 42.1 billion kWh (excluding electricity used to meet the needs of electric power plants themselves, of 6 billion kWh);
- Increase in the amount of energy obtained from renewable resources (0.5 billion kWh) and hydroelectric power stations (1 billion kWh) by 1.5 billion kWh;
- Stabilization of greenhouse gas emissions at their 2008 level (229 million tonnes of CO_2 equivalent).

9. The high GDP energy intensity is attributable largely to the use by Kazakh industry of obsolete, wasteful technologies. In industry, the main efficiency and conservation efforts have concentrated on introducing new, energy-efficient production technologies, reducing losses in electricity distribution by refurbishing the grid, replacing equipment, and fitting variable frequency drives on electric motors operating with variable loads. The work of various units and plants must also be automated, main and subsidiary production must be modernized and the use of low-efficiency and high-consumption equipment has to be abandoned. As industry accounts for over 70% of overall electricity consumption, it is necessary to carry out an energy audit of industrial enterprises to detect “bottlenecks” where the introduction of energy-efficient measures and technologies would be most beneficial.

10. Residential energy use is characterized by a high level of network wear and tear and considerable losses in distribution and consumption. Most facilities and networks serving residential users were introduced into service or overhauled over 20 years ago. As the standard service life is 25 years, some 63% of these facilities require a complete overhaul or replacement. To address these problems, the Housing Modernization Programme for the period up to 2020 calls for the modernization, using all sources of funding, of over 81,000 kilometres of the thermal, electrical and gas distribution networks within 10 years. Of this total, some 24,400 kilometres will be upgraded by 2015.

11. The residential sector includes multiple-home residential buildings and individual homes. It currently accounts for about 40% of demand for thermal energy. According to expert estimates, nearly 70% of buildings do not meet modern standards for the thermal performance (especially buildings that date from the 1950s to the 1980s); up to 30% of the thermal power required for heating is thus lost through their envelopes. The significant portion of demand for thermal energy that comes from the residential sector (27.9%) means that further restructuring is required. There are no individual thermal energy consumption meters in homes, so the energy is measured at the provider. The measurement thus includes losses in the distribution systems for heat and hot water, which according to estimates can be as high as 50%. 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 taken in the utilities and residential sector can achieve the following savings (the payback period for such measures is between two and three and a half years):

- Replacement of heat distribution units at local heat distribution stations and distribution adjustment: ~ 20 to 25%;
- Installation of temperature control units and individual consumption meters: ~ 15 to 20%.

12. To increase energy conservation and energy efficiency, the following is required:

- Local governments should be allowed to decide independently whether, to what extent and in what conditions to grant temporary tax breaks to companies adopting energy-efficient technologies;
- At the national level, incentives should be provided for energy conservation and customs duties reduced for companies importing energy-efficient and low consumption equipment;
- A legal basis should be established for special agreements relating to the provision of services for energy conservation in the State sector;
- Mechanisms should be set up to attract private investment in energy conservation in the utilities and residential sector.

IV. Kyrgyzstan

13. Kyrgyzstan has extensive energy resources and can cover its own needs to a significant extent. However, the potential of the fuel and energy sector is currently not being sufficiently exploited, the efficiency of many energy companies has fallen and the sector is facing hard times financially and economically. 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.

14. Expenditure on electric power amounts to some 5% of gross domestic product, 16% of the volume of industrial production and 10% of the income of the State budget. The grid provides access to electricity to practically the entire population. The hydroelectric potential of the country's 252 large and medium-sized rivers has been assessed at 18.5 million kilowatts (kW) of capacity, and over 160 billion kWh of electricity. The hydroelectric potential of small rivers and waterways (small-scale hydro) is between 5 and 8 billion kWh a year, but only 3% of that is actually used. Kyrgyzstan's electrical grid is run by an independent organization that works 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.

15. The electric utilities 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 a failure to pay on the part of consumers have brought about a large financial deficit which adversely affects the power companies, their clients and the tax revenue 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. The current energy pricing policy has to be improved;

(c) Energy consumption accounts. 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 accounting of actual electricity consumption are obstacles to attracting investment and to the 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 conservation and efficiency have to be updated and should be brought into line with international standards.

16. The main consumers in Kyrgyzstan are the residential sector (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; State bodies consume 10.5%; industry, agriculture and commercial consumers consume 29%. There has been a reduction in the use of coal and gas by heavy means of transport, and it is the electricity production sector that has made up the difference. Today, electricity is used for heating, hot water and cooking. While in 1990 the population consumed 1 billion kWh, that figure had risen to 3.64 billion by 2010, with heavy seasonal fluctuations. Consumption in winter is 3.5 times greater than in summer.

17. 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 conservation; 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 State still provides no budgetary support for the development and introduction of energy-saving technologies.

18. 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 oil equivalent (toe). Overhauling and updating the 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.

19. To achieve the basic aims, three development priorities have been identified for energy conservation and energy efficiency. The first priority is aimed at saving 1.2 million toe in the short term through qualitative organizational and management support to develop energy conservation. The second is directed at saving 0.7 million toe 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 toe.

20. Measures to save energy and to increase energy efficiency in the near future are being implemented as follows:

- Drafts are being produced of legal and standard-setting documents to meet the requirements of the Energy Conservation Act and to increase energy efficiency;
- Existing energy-producing and energy-intensive firms are being refurbished, the energy sector modernized, buildings insulated and new buildings constructed to make more rational use of energy resources;
- Local energy resources are being used;
- The building materials industry is being restructured and energy-saving and insulation materials produced;
- Metering and monitoring equipment and systems for hot water, steam, natural gas and electricity are being developed, produced and installed.

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

22. The renewable applications with the greatest prospects in the conditions prevailing in Kyrgyzstan are the following: decentralized facilities located in remote mountain regions (for instance, for farms and livestock raising, mining and prospecting, road servicing, hydrometeorological, scientific and other observation stations, radio and television relay transmitters, tourist and health resorts, pumping stations and hunting and forest management facilities); and also in regions with centralized power services, for residential buildings, facilities providing social services, trade and consumer services and health facilities (hospitals, resorts, convalescent homes, sanatoriums, hotels and saunas, etc.). The use of renewables should be seen not only in a purely environmental light, but also from the point of view of social and economic problems. Currently, the types of renewables that are technically in the best position for widespread use are solar-powered heating systems and electricity from small-scale hydro projects.

V. Tajikistan

23. 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 currently makes it possible to 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: industry accounts for some 49.2% (excluding the requirements of electricity generating plants and losses); another 9% goes to construction and transport,

11% is used for agriculture and pump irrigation, domestic services account for 26.1% and other consumers use 10.5%.

24. Most of the electricity is used by industry. In 2011, the Tajik Aluminium Company (TALCO) accounted for about 50% of overall electricity consumption, or 6.7 billion kWh. The shortfall of electricity for other industrial sectors amounts to over 800 million kWh. The highest increases in industrial use of electricity are found in industries producing non-ferrous metals (20%), ferrous metals (18.9%), building materials (7.3%) and foods (12.7%). Machine building has remained far behind, with an increase of just 1%.

25. To optimize energy use in industry, the following steps have been taken:

- An "energy-savings management system" has been introduced as a national standard in industrial enterprises;
- Enterprises have been restructured with the primary aim of producing high-tech, competitive products consuming less energy;
- Production facilities have been updated with the introduction of advanced technologies capable of producing significant savings;
- Energy-saving potential has been assessed for all types of energy in use through energy audits and by establishing and periodically updating energy rating certificates for companies;
- The rating of technological equipment in enterprises has been improved and its operation optimized using on-site diagnostic systems;
- The specific standards, rules and regulations for the consumption of energy resources per unit of production have been reviewed and compliance monitored;
- Standards have been established for energy use and limits on energy losses, and to make certification of high-consumption tools and equipment mandatory;
- A domestic energy base has been developed, primarily through the introduction of renewable energy resources;
- Secondary energy resources are being used, as are alternative fuels, including waste fuel from production; effective systems have been adopted for the provision of heat, lighting, ventilation and hot water;
- A modern standard metering service has been established and enterprises have been equipped with modern meters and control mechanisms for all stages of energy consumption;
- Energy use management has been automated and automated control and metering systems introduced to reduce wasteful energy use, optimize use during peak times and draw up energy balances for all types of resources;
- Incentives have been introduced for the development of specialized business activities in the area of energy efficiency and economic actors trained to make the best possible choices in terms of scientific, planning, technological and productive considerations with a view to reducing energy intensity.

26. Electricity use in agriculture is now 25% of its 1990 level. One reason is the low paying capacity in this sector, where electricity price increases have had the effect of reducing consumption. At the same time, the irrigation infrastructure is still very energy-intensive; 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 intakes for individual and collective use must be built.

27. Between 2000 and 2011, electricity use in transport remained constant and 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.

28. Electricity consumption increased by 14% between 1990 and 2011 in homes (residential buildings) and in services, rising to 3,603.8 billion kWh in 2011. The main base index used for analysing electricity consumption in homes is trends in population growth. The population increased by 11% in 10 years. While home electricity use increased significantly after 1990 owing to interruptions in deliveries of natural gas and petroleum products, consumption in the service sector hardly increased at all. 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 the volume of production and structural shifts. The structural changes were brought about by continuing growth in the number of enterprises with technical capacity, including large hotels or resorts, trade centres, banks, cafes and restaurants. Prospects for change in residential electricity use will depend on the relationship between increases in income and energy costs, the level at which homes become saturated with electronic appliances and future conditions for the provision of electricity and heat. The main indicator that can be used to compare energy efficiencies for State organizations is the rate of energy used annually for a square metre of space (expressed in kWh per square metre per year). In this area, there is little interest in reducing energy consumption. The legislation in force provides no incentive for State employees to carry out a policy aimed at saving energy.

29. If we look at the economics of energy resources at the national level we can identify not only types but also entire classes of energy-saving techniques. These include:

- Equipment for carrying out energy audits, for saving thermal energy, electricity, water and fuel and for volt-amperes reactive compensation, reduced-voltage starts and electric motor revolution frequency regulation;
- Use of renewable energy sources;
- Automation of technological processes and motors, buildings, comfort systems and data-processing centres.

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

- Increase the 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 a lower electricity rate is in effect, and release it during the day;
- Use cold outdoor air for compressor intakes.

31. The use of energy-efficient technologies will on the whole make it possible to reduce energy consumption by between 30 and 40%. For example, at industrial enterprises, motors account for up to 65% of energy use. The use of variable frequency inverters on induction motors set up in engineering systems reduces electricity consumption by 30%, and introducing automated control mechanisms increases the savings to 50%. In buildings, lighting accounts for between 20 and 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 between 30 and 40%. The electricity supply and cooling systems for data-processing centres account for between 10 and 50% of the energy used; the potential reduction here is between 10 and 40%.

32. Around 90% of residences in Tajikistan were built according to standards which are now out-of-date, and it is these buildings that 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. The measures to minimize heat loss and electricity wastage in buildings may include the following:

- Use of solar architecture in building design;
- Thermal insulation of building facades and walls;
- Replacement of roofing, insulation of building joints and installation of plastic windows;
- Installation of the new generation of radiators with heat transfer regulators;
- Installation of automatic door closers for entryways;
- Replacement of lamps with energy-efficient, sensor-controlled lighting units in common spaces;
- Installation of solar collectors to heat water and of solar panels to provide electricity.

33. In Tajikistan, the following renewable energies have the best prospects: small-scale hydropower, 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 economically accessible means.

34. 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 scientific and research potential and lack innovative structures (such as energy efficiency and conservation research centres, innovative technological centres, technical industrial parks and advanced training centres encouraging innovative approaches).

35. Improved energy efficiency and the use of renewable energies will only be achieved through: the renewal and development of the country's scientific and technical potential; the establishment of energy efficiency and conservation research centres; modernization of the scientific and technical information system and experimental base; the creation of a system of State 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; the utilization of international cooperation to make use of the best technological advances in the world; maintenance and development of human resources and the existing scientific base; and the integration of science, education and innovative activities.

VI. Uzbekistan

36. Uzbekistan has an installed capacity of more than 12.4 million kWh, of which 12.0 million kWh are accounted for by 39 thermal and hydropower stations belonging to the Uzbekenergo State power company. The remaining capacity is managed by Government departments and branches of industry. Most — up to 90% — of the power is produced by the company's 10 thermal power stations, which have a total capacity of 10.6 million kWh. The country's power grid fully meets the demand of the national economy and the population, and is able to export 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. The technical losses from the Uzbekenergo power grid stood at about 13%, and included losses from electrical production companies, main power lines and regional electricity grids. However, there is no concept of "commercial losses" in the relevant regulations.

37. The country's mineral resources include large hydrocarbon reserves. Currently 211 production fields have been opened in the country's five oil- and gas-producing regions; 108 of them produce gas and natural gas liquid, and 103 produce oil and gas, natural gas liquid, and oil. Over 50% of the production fields are currently in operation, 35% are ready for production, and the remainder are under prospection. Total annual hydrocarbon production in Uzbekistan is approximately 86 million toe. 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 stands at around 51 billion toe, while the technical potential is 17,982.3 million toe.

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

- Reducing spending on final energy while meeting the same volume of demand;
- Improving efficiency in energy use, refining each stage of the supply-processing-distribution-use system;
- Substituting cheaper renewable sources of energy for expensive finite sources;
- Adopting promising advanced technologies and improving energy efficiency while complying with environmental standards.

39. Between 2005 and 2011, demand for electricity rose by 10.9%. The largest growth was seen in the utilities and services sector (46.9%), including domestic consumption (62.6%). Construction saw an increase of 52.4% but its demand 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 use of obsolete technology and the 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.

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

- The reconstruction, technical refurbishment and modernization of power production;
- The reconstruction and further development of the electrical grid;

- The construction of new generating capacity, focusing on optimizing production facilities that use primary fuel with adequate reserves and environmentally friendly renewable sources;
- The training of technically and economically competent energy conservation specialists.

41. It is very important to influence demand for energy. This implies a range of interrelated actions in all the sectors of the economy aimed at effective energy use and energy conservation. Influencing energy demand is preferable to increasing capacity (influencing supply) because the construction of new production capacity and power lines requires huge investment in the sector. Influencing demand requires relatively less investment and finance, but can produce significant results, and will help optimize electricity production and consumption in industry and other areas, as well as its efficient use.

42. Energy-saving potential can be realized in several areas. To reduce energy intensity in industry and consequently improve energy efficiency, 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. In the power sector, that means gas turbines and combined heat and power plants, enhanced oil and gas recovery, more efficient processing and transportation, coal enrichment at the mine, the introduction of effective combustion technologies, reduced losses on domestic needs, variable frequency drives, etc. In the construction materials industry, it is the substitution of dry for wet process technology for cement clinker production, the production of ceramic bricks with a higher proportion of voids, waste-based production (using ash, clinker, etc.), more efficient fuel use, use of waste gases, etc. In agriculture, it means advanced technologies for preparing and working land, water use, improved machinery, etc. In transport, greater numbers of small vehicles, a larger proportion of diesel motors, the use of gas as a motor fuel, construction of hard surfaced roads, etc.

43. The housing sector includes apartment buildings and individual detached 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 US$ 1.865 billion in potential income from natural gas exports and US$ 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 US$ 2.115 billion. Furthermore, the total annual expenditure necessary to introduce energy-efficient technology is substantially less than the expected benefits.

44. The key issue preventing any improvement in the low level of energy efficiency and restricting the introduction of “green” buildings is the absence of incentives and effective mechanisms for the introduction and wide dissemination of the principles of “green” construction. Specifically, the current system of energy use management and the outdated standards, regulations and approaches to housing construction do not take full account of today’s requirements, are an inadequate stimulus for improved energy efficiency and, consequently, contribute to excessive energy consumption and significant greenhouse gas emissions. The low level of energy efficiency and of energy conservation in the housing sector is also linked to the following:

- The relatively low price of energy resources (prices for natural gas and electricity are some of the lowest in the world);
- The prevalence of non-energy-efficient domestic appliances;

- The 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, unauthorized illegal connection to the electric grid;
- Inadequate public awareness of issues related to energy conservation and efficiency, and the use of electricity and natural gas for domestic heating.

45. The following could be done to improve energy efficiency in the utilities and residential sector: equip all consumers with energy resource monitoring and flow devices; use panels with improved thermal protection; decentralize power supplies; introduce heat pump units; use renewable energy sources; introduce high intensity discharge lamps (instead of incandescent light bulbs) for lighting; and use energy-efficient household appliances.

46. Increased attention is being paid to energy-saving technologies in Uzbekistan. To improve the electricity metering system, guarantee that it is accurate, reliable and comprehensive, to reduce losses and ensure that energy is saved, Uzbekenergo has a project to introduce automated electricity monitoring and metering systems for all consumers in the country. The introduction of these systems in companies and for economic operators and domestic consumers will reduce the technical losses and guarantee more accurate metering at all stages in the electricity supply. Optimum performance will make it possible to improve the sound management of fuel and energy resources. More than 5 million modern metering devices will be installed under the project.