

# ENERGY RESOURCES OF CENTRAL ASIAN REPUBLICS AN ANALYSIS IN MARKET DEMAND

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## **Abstract**

*Energy is one of the Central Asia's crucial resources and the region intends to accelerate and harness this potential, assigning it top priority in developmental planning. The development of energy sector is expected to usher in enormous economic benefits, attract huge investments and strengthen bilateral and multilateral trade with improving regional cooperation. With the increase in hydrocarbons and generation of hydropower in Central Asian republics, the region aims not only to provide domestic energy at affordable cost, but also turn into a net energy exporters in near future which would have a positive impact on the global energy demand. In this backdrop, the present research paper has been buildup with the main objective to highlight that how and to what extent these republics can transform their economies with the proper management of their available resources, particularly, hydrocarbon and hydropower. Moreover, the paper also examine the demand-supply mechanism which can help in regional integration and the benefits accrued thereof.*

## **Keywords**

Energy Potential, Proven Reserves, Probable Reserves, Hydrocarbons, Hydropower, Global Market Demand, Energy Efficiency, Demand-Supply Gap, Production Ratio, Energy Security, Surplus-Deficit Syndrome, Eco-friendly, Environmental Costs.

## **Hydrocarbon Potentials**

As a result of the energy wealth, Kazakhstan, Turkmenistan and Uzbekistan got a prominent space on the hydrocarbon map of the world. Kazakhstan has proven<sup>1</sup> reserves estimated at 30 thousand million barrels (3.9 thousand million tons) of oil and proven natural gas reserves of 45.7 trillion cubic feet (1.3 trillion cubic meters), which constitutes 1.8% and 0.7% of global proven reserves with a reserve to production ratio (R/P)<sup>2</sup> of 47.4 years and 82.5 years respectively.<sup>3</sup> These figures which are reproduced in table 1 and table 2, are self explanatory and reveal the status of CARs in these two important resources.

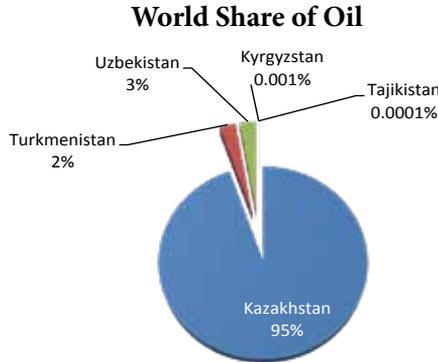
Turkmenistan has proven reserves estimated at 0.6 thousand million barrels (0.1 thousand million tons) of oil and proven natural gas reserves of 618.1 trillion cubic feet (17.5 trillion cubic meters), which constitutes 0.05% and 9.3% of global proven reserves respectively<sup>4</sup> with a reserve to production ratio (R/P) of 7.4 years and more than 100 years respectively.

**Table 1**  
**Proven Reserves of Oil**

(000 millions)

Country	2002	2011	June-2014				
	Barrels	Barrels	Tones	Barrels	Growth Rate	World Share	R/P Ratio
Kazakhstan	5.4	30.0	3.9	30.0	14.7	1.8	47.4
Turkmenistan	0.5	0.6	0.1	0.6	1.46	< 0.05	7.4
Uzbekistan	0.6	0.6	0.1	0.6	0.00	< 0.05	24.0
Tajikistan	0.012	0.012	0.001	0.012	0.00	<0.001	...
Kyrgyzstan	0.04	0.04	0.005	0.04	0.00	<0.0001	...
<b>Total</b>	<b>6.5</b>	<b>31.2</b>	<b>4.1</b>	<b>31.2</b>	<b>13.3%</b>	<b>1.9%</b>	<b>78.8</b>

Source: British Petroleum Statistical Review of World Energy, June 2014, available at [www.bp.com/statisticalreview](http://www.bp.com/statisticalreview)

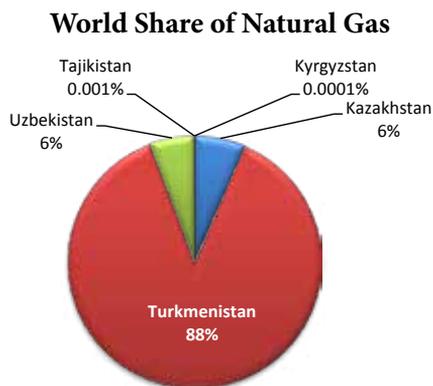


**Table 2**  
**Proven Reserves of Natural Gas**

(trillion c<sup>m</sup>/feet)

Country	2002	2011	June-2014				
	Tcm	Tcm	Tcf	Tcm	Growth Rate	World Share	R/P Ratio
Kazakhstan	1.3	1.3	45.7	1.5	1.15%	0.7%	82.5
Turkmenistan	2.3	17.5	618.1	17.5	17.62%	9.3%	>100
Uzbekistan	1.2	1.1	39.7	1.1	- 0.78%	0.6%	19.7
Tajikistan	0.005	0.005	0.2	0.005	0.00%	<0.002	...
Kyrgyzstan	0.005	0.005	0.2	0.005	0.00%	<0.002	...
<b>Total</b>	<b>2.8</b>	<b>19.9</b>	<b>703.5</b>	<b>20.11</b>	<b>17.08%</b>	<b>10.6%</b>	<b>202.2</b>

Source: British Petroleum Statistical Review of World Energy, June 2014, available at [www.bp.com/statisticalreview](http://www.bp.com/statisticalreview).



Uzbekistan has proven reserves estimated at 0.6 thousand million barrels (0.1 thousand million tons) of oil and proven natural gas reserves of 39.7 trillion cubic feet (1.1 trillion cubic meters), which constitutes 0.05 % and 0.6% of global proven reserves respectively<sup>5</sup> with a reserve to production ratio(R/P) of 24.4 years and 19.7 years respectively. The overall picture of these three republics show that the proven oil and gas reserves are 31.2 thousand million barrels (4.1 thousand million tons), and 664.9 trillion cubic feet (19.9 thousand cubic meters), which represents 1.9% and 10.6% of proven oil and gas reserves of the world respectively.<sup>6</sup> The total reserve to production ratio (R/P) of all the three republics stands at 113 years, 107.4 years and 43.9 years which accounts 281.0 years and in an average the mean life of proved hydrocarbon reserves of all the three republics is 93.66 years.

**Table 3**  
**R/P Ratio and World Share of Proven Hydrocarbon Reserves**

Country	R/P Ratio (Oil)	R/P Ratio (Natural Gas)	Total (R/P Ratio)	World Share (Oil)	World Share (Natural Gas)
Kazakhstan	47.4	82.5	<b>129.9</b>	1.8	0.7
Turkmenistan	7.4	100	<b>107.4</b>	<0.05	9.3
Uzbekistan	24.0	19.7	<b>43.7</b>	<0.05	0.6
Total	<b>78.8</b>	<b>202.2</b>	<b>281.0</b>	1.9%	10.6%
<b>Mean = 93.66</b>				<b>Total = 12.5%</b>	

*Source: Calculation is based on the data given in various reports of British Petroleum Statistical Review of World Energy till June, 2014*

### Hydropower Potential

The gross hydropower potential of Kazakhstan<sup>7</sup> is theoretically estimated 170 billion KWh of which 27 – 30 billion KWh is cost-effective and viable (technically potential)<sup>8</sup> for use while 23.5 billion KWh is economically

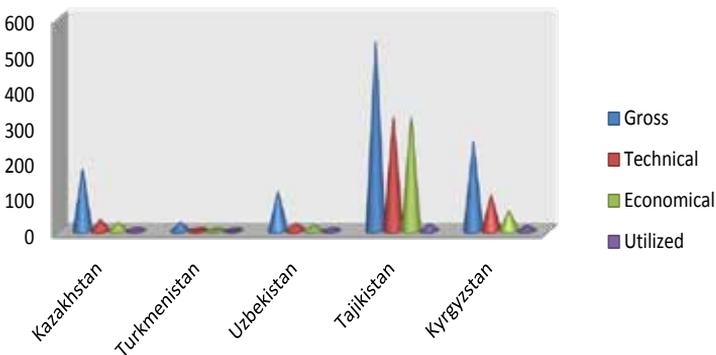
viable which constitutes 5.71% of Central Asian hydroelectricity share.<sup>9</sup> The gross hydropower potential of Uzbekistan is 107 billion KWh of which the technically potential hydropower resources is estimated at 21.1 billion KWh while 15 billion KWh is economically viable which constitutes 3.65% of total share of Central Asian electricity. Turkmenistan has 24 billion KWh<sup>10</sup> of which the technically potential is 5.8 billion KWh while 2 billion KWh being economically viable which constitutes 0.48% of total share of Central Asian hydroelectricity. Tajikistan and Kyrgyzstan are the other two republics of the region which are gifted by nature with large hydropower wealth.

**Table 4**  
**Hydropower Potential Resources**

Country	billion KWh / Annum							
	Gross		Technical		Economical		Utilized	
	Total	Share in CA (%)	Total	Share in CA (%)	Total	Share in CA (%)	Total	Share in CA (%)
Kazakhstan	170	15.8	30	6.3	23.5	5.71	9	17.7
Turkmenistan	24	2.2	5.8	1.2	2	0.48	0.1	0.18
Uzbekistan	107	10	21.1	4.5	15	3.65	8.2	16.12
Tajikistan	527	48.9	317	67.1	317	76.86	19.5	38.4
Kyrgyzstan	249	23.1	99	20.9	55	13.3	14	27.6
<b>Total</b>	<b>1077</b>	<b>100</b>	<b>472.9</b>	<b>100</b>	<b>412.5</b>	<b>100</b>	<b>50.8</b>	<b>100%</b>

Source: United Nations Economic and Social Commission Organization and British Petroleum Statistical Review of World, 'Energy Review,' June 2014/ available at: [www.p.com/statisticalre](http://www.p.com/statisticalre)

**Hydropower Potential**



Tajikistan possesses a total hydropower potential of 527 billion KWh, of which industrial (technical) hydro potential is 317.82 (60.3%) billion KWh and

total potential of small hydropower potential is 184.46 (35.001%) billion KWh and 24.72 (4.69%) billion KWh is economically feasible for construction per year respectively. Taking together all these potentials constitute 4% of global hydropower potential. Given the hydropower potential, it has been estimated that the republic of Tajikistan losses 401.0 million KWh in terms of heat annually.<sup>11</sup> Since, hydropower is the main resource of the country, it, therefore, requires an efficient power potential utilization for the sake of sustainable prosperity of the country. Kyrgyzstan possesses total hydropower potential of 249 billion KWh, of which industrial (technical) and economically hydro potential is 99 (39.75%) billion KWh and total potential of small hydropower potential is 150 (60.24%) billion KWh.<sup>12</sup> These potentials constitutes 2.01% of global hydropower potential.

### **Supply of Hydrocarbon and Hydropower Resources**

In terms of hydrocarbon supply, Kazakhstan stands at 1728 thousand barrels (81.3 million tons) of oil and 19.7 billion cubic meters of natural gas (17.7 million tons of oil equivalent) which constitutes 2.53 % and 0.6 % of global oil and gas supply. Turkmenistan with 222 thousand barrels (11.0 million tons) of oil and 64.4 billion cubic meters of natural gas (57.9 million tons of oil equivalent), which constitutes 0.32 % and 1.91 % of global oil and natural gas production. Uzbekistan has 68 thousand barrels (3.2 million tons) of oil and 56.9 billion cubic meters of natural gas (51.2 million tons of oil equivalent) which represents 0.1% and 1.7% of global oil and natural gas supply per day.<sup>13</sup> Taking these three republics together, the sub-region has 2,018 thousand barrels (95.5 million tons) of oil and 141 billion cubic meters (126.8 million tons of oil equivalent) of natural gas production which constitutes 2.96% and 4.2% of global oil and natural gas production. In terms of hydropower supply, Kazakhstan has 0.67 mtoe, Turkmenistan has 0.01 mtoe, and Uzbekistan has 0.87 mtoe. Tajikistan possesses 1.38 mtoe and Kyrgyzstan has 1.22 mtoe. The total picture of these republics show that they have 4.14 million tons of oil equivalent hydropower supply.<sup>14</sup>

### **Demand for Hydrocarbon and Hydropower Resources**

In terms of hydrocarbon demand, Kazakhstan has been consuming 265 thousand barrels (12.8 million tons) of oil and 9.5 billion cubic meters (8.5 million tones oil equivalent) of natural gas which constitutes 0.3% and 0.5% of global hydrocarbon demand per day.<sup>15</sup> Turkmenistan is consuming 100 thousand barrels (4.8 million tons) of oil and 23.3 billion cubic meters (20.9 million tons of oil equivalents) of natural gas which constitutes 0.1% and 0.7% of global hydrocarbon demand per day respectively.<sup>16</sup> Uzbekistan is consuming 82 thousand barrels (3.9 million tons) of oil and 47.9 billion cubic meters (43.1 million tons of oil equivalents) of natural gas which constitutes 0.1% and 1.4% of global hydrocarbon demand per day respectively. The three republics have 447 thousand barrels (21.5 million tons) of oil and 80.7 billion cubic meters (72.5 million tons of oil equivalent) of natural gas which constitutes 0.5% and 2.4% of global hydrocarbon demand per day respectively.<sup>17</sup> In terms

of hydroelectricity, Kazakhstan's demand has been 6.97 million tons of oil equivalent, Turkmenistan has 1.08 million tons of oil equivalent, Uzbekistan 4.11 million tons of oil equivalent. Tajikistan's 1.17 mtoe and Kyrgyzstan's 0.78 mtoe constituting respective figures of 2.9%, 0.5%, 2.3%, 1.02% and 0.05% of the global hydroelectricity consumption. Taking as a whole, the total hydroelectricity consumption is 14.11 million tons of oil equivalent which constitutes 3.55 % of global hydroelectricity consumption per day.

On the basis of calculations, the total primary energy<sup>18</sup> demand in Kazakhstan, Turkmenistan and Uzbekistan has been 58.1 million tons<sup>19</sup>, 34.0 million tons and 50.5 million tons of oil equivalent respectively. On per capita basis, the total primary energy demand of these republics on an average has been 2.2 tons of oil equivalent which stands higher as compared to world energy demand of 1.8 tons of oil equivalent, meaning, thereby, that the compound average annual growth rate of energy demand was estimated to increase by 1.7% in 2035.<sup>20</sup> It indicates that these republics are energy intensive republics and would result in the production of the highest share of carbon emissions that estimated 1.4%, 1.6% and 1.2%, in Kazakhstan, Turkmenistan and Uzbekistan respectively. The issue of energy resources in the Central Asian republics as well as in the world is of very crucial concern. Thus, taking together both the reserve to production ratio (R/P) and energy consumption, the CO<sub>2</sub> emissions of the Central Asian republics, there is a need to rethink about the life of hydrocarbon reserves for their management, otherwise the region will have to face the energy crunch in the near future. Because the global demand<sup>21</sup> for hydrocarbon resources is increasing fast which will lead to decrease in the reserve to production ratio (R/P) from the present mean life of 93.66 years of their reserve base and at the same time these republics are energy intensive economies as evident from their energy demand pattern with respect to the world benchmark. Keeping in view their proven oil and natural gas reserves, the three hydrocarbon resource – rich republics of Central Asia has no alternative, but to bring efficiency in energy consumption in order to save their economies and to go for alternative renewable options.

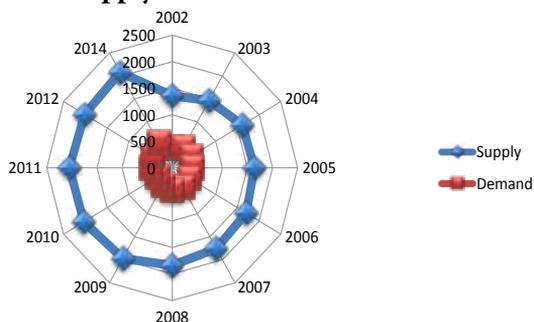
### **Energy Resources: Demand – Supply Dynamics**

The total demand – supply gap of all the Central Asian republics in oil has been 1535.78 thousand barrels in June 2014 with an annual growth rate of 4.49% from 2002 to June 2013, in which Kazakhstan has the potential to export 1498 thousand barrels with an annual growth rate of 5.2% and Turkmenistan 94 thousand barrels with an annual growth rate of -0.73%; but all other three republics namely Uzbekistan, Tajikistan and Kyrgyzstan have been importing oil resources from other two republics such as Turkmenistan and Kazakhstan.

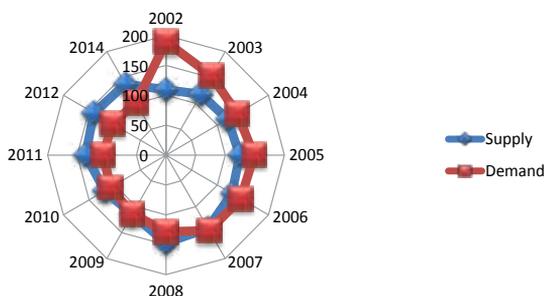
The total demand – supply gap of all the Central Asian republics in natural gas has been 35.68 billion cubic meters in June 2014 with an annual growth rate of -7.19% from 2002 to June 2013, in which Kazakhstan has the potential to export 7.1 billion cubic meters with an annual growth rate of 29.54% and Turkmenistan 40 billion cubic meters with an annual growth rate of 1.07% and Uzbekistan 10.0 billion cubic meters with an annual growth rate of 23.02%. But other two republics, namely, Tajikistan and Kyrgyzstan have been importing

natural gas resources from Turkmenistan, Kazakhstan and Uzbekistan. In case of hydropower consumption except Tajikistan and Kyrgyzstan, other three countries have been depicting hydropower deficit. Thus, the total hydropower deficit of all the Central Asian republics has been estimated at 10.2 million tons of oil equivalent in June 2014 with an annual growth rate of -2.95% from 2002 to June 2013, in which Kazakhstan has the deficit of -6.4 mtoe with an annual growth rate of -4.85% and Turkmenistan -1.09 mtoe with an annual growth rate of -4.06% and Uzbekistan -3.51 mtoe with an annual growth rate of -0.50% but other two republics, namely, Tajikistan and Kyrgyzstan have been exporting hydropower at 0.20 mtoe and 0.57 mtoe with an annual growth rate of 4.70% and 5.94%. A consolidated picture of demand-supply gap of hydrocarbons and hydropower within CARs from 2002 to 2013, as reproduced in table 5, shows some interesting equations and inferences.

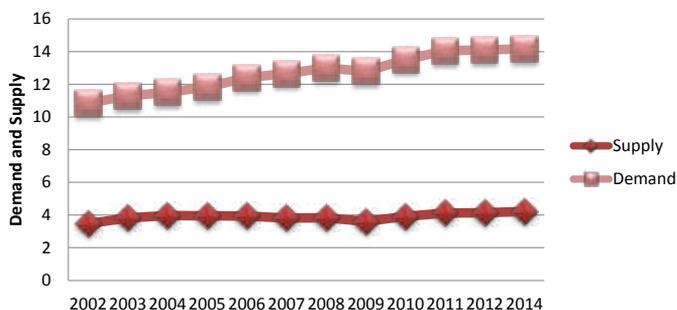
### Supply and Demand of Oil



### Supply and Demand of Natural Gas



### Supply and Demand of Hydropower



**Table 5**  
**Demand-Supply Gap (DSG) in Hydrocarbons and Hydropower**  
(Oil: 000 barrels, Gas: billion m<sup>3</sup>, Hydrocarbon: million tons oil equivalent)

Country	Resource	2002	2007	2013	AAGR (2002-2013)
Kazakhstan	Oil	852	1220	1948	5.2%
	Gas	0.4	5.8	7.1	29.54%
	Hydropower	-3.78	-5.27	-6.4	-4.85%
Turkmenistan	Oil	102	104	94	-0.73%
	Gas	35.5	44.1	40	1.07%
	Hydropower	-0.7	-0.94	-1.09	-4.06%
Uzbekistan	Oil	22	10	-7	-9.79%
	Gas	1	13.2	10	23.02%
	Hydropower	-3.32	-3.28	-3.51	-0.5
Tajikistan	Oil	-25.09	-39.32	-14.48	-4.82%
	Gas	-50.2	-44.06	-6.64	-16.64%
	Hydropower	0.12	0.22	0.2	4.7%
Kyrgyzstan	Oil	-8.5	-13.36	-34.74	-13.5%
	Gas	-70.8	-26.76	-14.78	-13.15%
	Hydropower	0.3	0.41	0.57	5.94%
<b>Total (Oil)</b>		<b>942.41</b>	<b>1281.3</b>	<b>1535.78</b>	<b>4.49%</b>
<b>Total (Gas)</b>		<b>-84.1</b>	<b>-7.72</b>	<b>35.68</b>	<b>-7.19%</b>
<b>Total (Hydropower)</b>		<b>-7.38</b>	<b>-8.86</b>	<b>-10.2</b>	<b>-2.95%</b>

*Source: Calculations based upon various relevant sources*

### Energy Saving / Conservation Potential

From the above figures analyzed, it has been observed that energy efficiency and energy conservation is vital and improvement in energy efficiency could contribute to enhance energy security of all the Central Asian republics. Improving energy efficiency, simultaneously, is the best way to meet the sustainable development goals in these republics and could reduce their negative environmental impacts, including greenhouse gas emissions etc. It has been estimated that potential of energy conservation of all Central Asian republics is 35-40% of energy consumption of which total energy conservation potential, the fuel and energy complex and manufacturing industry account 60%, housing and utilities 20-25%, transportation 7-8%, agriculture 6-7%. It has been inferred that 30% of energy conservation could be achieved through organizational, economic and operational measures while 70%<sup>22</sup> could be obtained through transition to energy efficient technologies in economic sectors.

Over the past two decades, Central Asian republics have taken various steps to address some of the extremely inefficient and wasteful energy practices and technologies that had become entrenched during the Soviet era. But these efforts have proved less effective and considerable potential remains for improving energy efficiency and curbing emissions of greenhouse gases

and other pollutants. The potential for reducing the amount of energy used for district heating is particularly large. Consumption of primary energy in all these republics as a whole could be cut by more than 100 million tons of oil equivalent (mtoe) which is one half of the level in June 2014. The energy – saving potential in both absolute and percentage terms is greater in Kazakhstan, where energy use could, in principle, be lowered by more than one – half, mainly in the industrial, residential and commercial sectors. The saving potential is also very large in Turkmenistan especially in the services and residential sectors, as well as in distribution systems and in Uzbekistan, where about half of the over consumption is related to inefficient industrial energy use.<sup>23</sup> The energy efficiency potential in the economy of Tajikistan is about 2 million metric tons<sup>24</sup> of oil equivalent of which 30-35% exists in the fuel and energy sector and in industry, 20-25% in the housing and utilities sector, 7-8% in transport, and 6-7 % in agriculture respectively. Given the hydropower potential, it has been estimated that the republic of Kyrgyzstan losses 101.01 million KWh in terms of heat annually. In this scenario, the republic of Kyrgyzstan needs to conserve energy and for this efficiency in energy is inevitable. The energy efficiency (saving) potential in the economy of Kyrgyzstan is about 0.5 million metric tons of oil equivalent. The energy resource-rich countries of Central Asia have enough scope to save more and more resources of energy by adopting efficiency in their energy consumption pattern. The energy efficiency potential of Kazakhstan has been calculated 46 million metric tons of oil equivalent. Turkmenistan with 32 million metric tons of oil equivalent, Uzbekistan 22 million metric tons of oil equivalent, Tajikistan 2 million metric tons of oil equivalent and Kyrgyzstan 0.5 million metric tons of oil equivalent. Given the predominant position of energy in the fuel balance of the region, improvements in energy efficiency generally will lead to planned energy consumption. Such a trend would enable the energy rich republics of Central Asia to export the surplus (saved) energy and earn foreign reserves. It will save these republics from the pressure arising out of the current account position and would easily meet their growing budgetary needs, so that they can carry out their developmental plans smoothly.

### **References & Notes**

- 1 Proven reserves are defined as oil and natural gas deposits that are considered 90 percent probable and possible reserves are defined as oil and natural gas deposits that are considered 50 percent probable.
- 2 R/P (Reserve to production) ratio is defined as the reserves remaining at the end of any year when divided by the production in that year, the result is the length of time that those remaining reserves would last if production was to continue at the similar rate.
- 3 *British Petroleum Statistical Review of World Energy*, 2011, 2012, 2013, 6–20, [www.bp.com/statisticalreview](http://www.bp.com/statisticalreview).
- 4 Ibid.
- 5 Ibid.
- 6 Calculated from various reports of *British Petroleum Statistical Review of World Energy*, 2014, [www.bp.com/statisticalreview](http://www.bp.com/statisticalreview).

- 7 The total installed power generating capacity of Kazakhstan is 19,892.1, 17,252.4 MW from thermal power plants (TPP) (86.7%) and 2,639.7 MW from hydropower plants (HPP) (13.3%), including small HPP and other renewable energy resources. 70% of the total volume of electricity is generated by local coal. There are gas turbine power plants operating in the west and south of the country as well. Kazakhstan is facing a deficit of electricity, which is covered by Russia's balanced market. The reduction and subsequent elimination of the deficit is planned and being carried out by constructing new power plants and modernizing existing ones. Electricity production in 2010 reached 82.26 billion KWh.
- 8 Technical hydropower potential is that part of gross hydropower potential that can be used by modern technology to meet the requirements of socio – environmental nature which constitutes 6.3% of total share of Central Asian electricity.
- 9 Yasinskiy et al. (2013): "Energy Security and Water Resources Management in Transboundary River Basins in Central Asia," Advanced Functional Economic Cooperation, EDB, *Eurasian Integration Yearbook*, 5.
- 10 The gross hydropower potential of 24 billion KWh constitutes 2.2 percent of total share of Central Asian hydroelectricity.
- 11 United Nations Economic and Social Commission for Asia and the Pacific (2011): "Eco-efficient and Sustainable Urban Infrastructure Development in Asia and Latin America – A Case Study, Advantages of Energy Efficient Design of New and Modernization of Existing Buildings in Dushanbe, Tajikistan," 22
- 12 United Nations Economic Commission for Europe (2011): "Increasing Energy Efficiency to Secure Energy Supplies in the CIS Region," Moscow, 30, <http://www.caresd.net>.
- 13 Op.cit., 3, pp. 8-10.
- 14 The data has been calculated and converted from KWh to mtoe from the World Bank sources.
- 15 Op.cit., 3, pp. 9-24 and see also IEA Report of 2013.
- 16 Ibid.
- 17 Ibid.
- 18 Primary energy comprises commercially traded fuels which including modern renewable sources.
- 19 Comprises 12.8 million tons of oil, 8.5 million tons oil equivalent of natural gas, 35 million tons of coal and 6.97 million tons of oil equivalent electricity.
- 20 International Energy Agency (2013): *World Energy Outlook*, 471, [www.iea.com](http://www.iea.com).
- 21 According to forecasts of OPEC secretariat, world oil outlook for the period 2010-35, the primary energy demand will increase by 54 percent.
- 22 Valentina Kasymova (2011): "Report for the United Nations Economic and Social Commission for Asia and the Pacific," *Study on Central Asian Energy Efficiency Potential*, 30.
- 23 Op.cit.,20, p. 473.
- 24 United Nations Economic Commission for Europe (2013): "Increasing Energy Efficiency to Secure Energy Supplies in the CIS region", Moscow, 45.