Power System and Economic Growth: Twenty Years After the End of the Soviet Era

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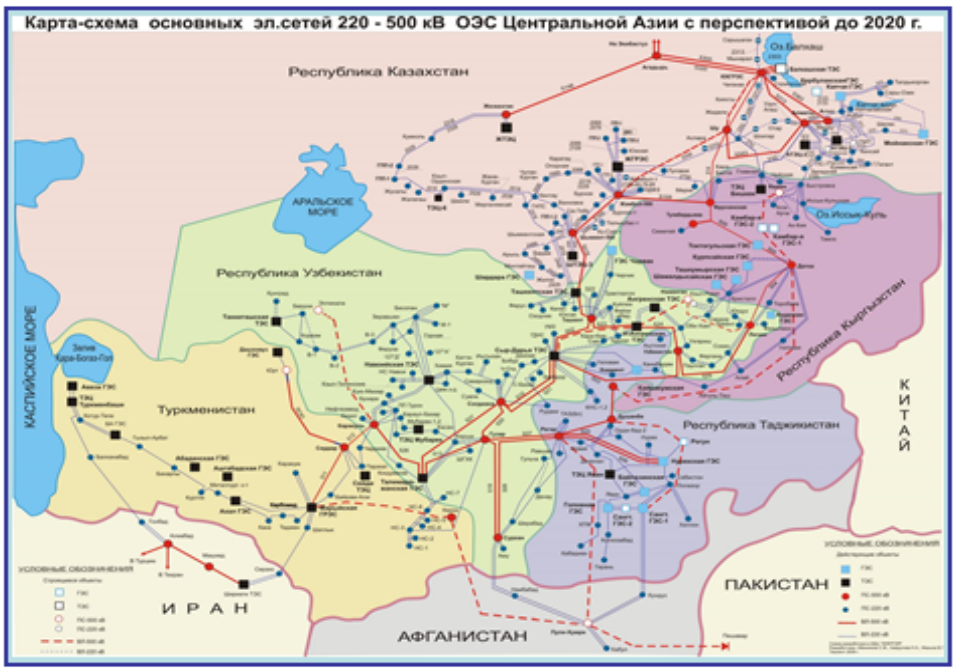
Overview

Twenty years after the end of the Soviet era, the Central Asian electrical power system has come to a very critical stage. The technical conditions of generation and transmission equipment as well as the distribution systems are totally depreciated and cannot satisfy the needs of the growing economy of the region. In the past twenty years, investments to rehabilitate the electrical power systems have been insufficient and many power plants and substations have reached the end of their technical lifetime. Current analysis shows that, in Kazakhstan, 44% of the generation capacity is more than thirty years old, in the Kyrgyz Republic, 64%, and in Tajikistan and Uzbekistan, 74% and 75% respectively. Less than 20% of the power plants are under twenty years old. Thus, the age of the generation equipment is the main risk for the supply of electricity in Central Asia. On the Map of Central Asain Energy System (CAES), (220 -500 HVL) is seen the significant size of the role of the CAES in order to increase the supply of electricity to Afghanistan and Pakistan.



Source: Coordination Dispatch Center of Cenatral Asain energy system "KDC Energiya".

During the Soviet era, the architecture of the electrical power system was designed without considering national boarders, and energy resources in the whole region were shared between the countries. However, more recently, the generation and transmission planning of the individual countries in Central Asia has focused on energy independence from neighboring countries. Turkmenistan and Tajikistan are no longer connected to the Central Asian Power System (CAPS), and only Kazakhstan, the Kyrgyz Republic, and Uzbekistan continue interconnected operations of their electrical power systems. In Northern Kazakhstan, CAPS is connected to the Russian system via IPS (Interconnected Power System) / UPS (Unified Power System of Russian Federation). However, stable operation of the electrical system is becoming increasingly difficult because economic growth in each country is causing violations of agreed generation dispatch, especially in the winter. The main reason is a severe winter power shortage in each country. This is causing the interruption of synchronous operation, partial blackouts, and frequent load shedding.

Funding factors contribute to the currently unsustainble situation. First, most of the reconstruction and construction of new power plants is financed by international development banks, like the World Bank (WB), Asian Development Bank (ADB), Islamic Development Bank (IsDB), Europian Bank for Reconstration and Development (EBRD) and other donors as separate projects. Although a number of projects, which have been implemented in the past are still at the implementation stage, the support is mostly to maintain the existing level of electrification. Nor are electricity tariffs of any Central Asain countries able to fund the needed expansion. Unfortunately, tariffs do not even cover the cost of electricity generation, transmission, and distribution, and commercial losses (illegal connections, low collection rate, and so on). The system is still operational mainly because of

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extensive maintenance and repair works, for which a large workforce is still available in the utilities. In many cases, however, the countries have not been able to finance the major maintenance and repair works that are usually required. Because of the age of the equipment and a lack of financing for repair works, the available capacity is much lower than figures reported. In addition according to data from CDC (Central Asian Coordination Center) the Kyrgyz Republic is a net exporter of electricity, mainly to Kazakhstan. Uzbekistan and Tajikistan are net importers of electricity, whereas Turkmenistan was also a net exporter of electricity.

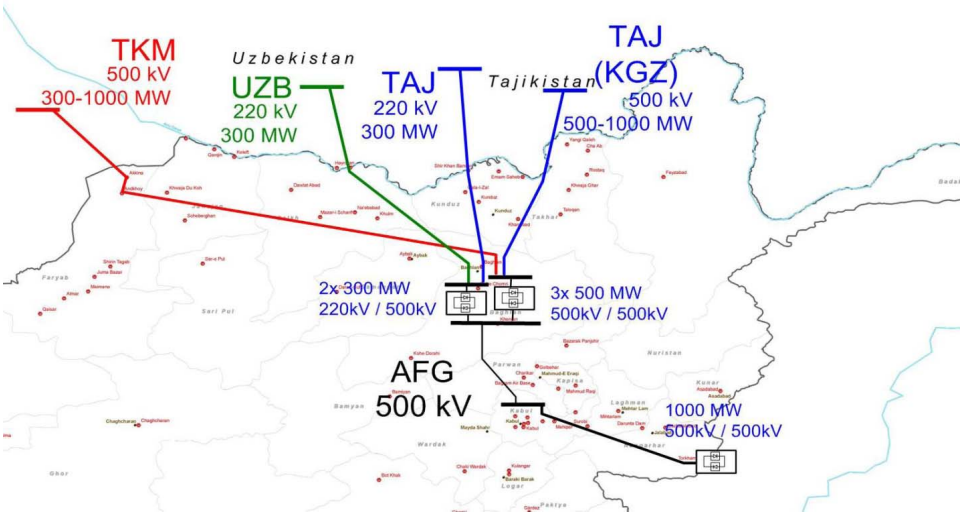
Turkmen power system initiated the construction of 500 kV HVL from Mary TPP to Kerky (Atamyrat) and further to the Afghan-Turkmen border, however, Kyrgyzstan and Tajikistan together with Afghanistan and Pakistan are working on a project called CASA-1000. Harmonization of CASA-1000 project with neighboring countries is pretty hard. The main reason is that the project affects the interests not only of the project participants , but also the entire region of Central and South Asia. In a regional content, CASA 1000 covers only Tajikistan and Kyrgyzstan. At the same time, power supply via this link will be associated with water regimes, which is affecting negatively all countries' economy in the region. The proposed scheme could work 3-4 months a year only and as a result would not contribute to improving the regional energy trade systems of CAPS.

This article overviewes, especially from an economic perspective, the growth of the regional energy system and how to synchronize it with economic growth of each country within the region, as well as regional integration, including part of development the Afganistan

Methods

The corresponding author was a regional senior economist in a team of consultants to develop a Regional Energy Sector Master Plan, financed by Central Asia Regional Economic Cooperation, (CAREC) and an Asian Development Bank program. According to the project goals, this team of experts developed forecasts of load and demand for the Kyrgyz Republic, Tajikistan, Uzbekistan and the southern part of Kazakhstan, that are connected to CAPS. We based our model parameter estimates on a simplified econometric modeling approach and made forecasted from 2011 to 2031. This approach has been selected owing to a lack of data for meaningful econometric analysis. It has been applied by various studies in a similar way before, but this is the first time it has been done for the Central Asian Power energy system. Data for annual electricity consumption in CAPS between 1993 and 2010 has been provided by the “Energy” CDC in Tashkent. Other availble data was the balance of imports and exports between 2000 and 2010 for each country.

The approach, which has been applied for Electricity Demand Forecast is confined to two main explanatory variables, which are (i) the development of the GDP of a country, and (ii) the development of the average tariff of electricity (in real terms). The link in the model is then established through the income elasticity of demand and the price elasticity for electricity demand. While the future income elasticity is estimated at between 0.5 and 0.8, depending on the country and the period, price elasticity is assumed to range from -0.1 to -0.2, mainly depending on the degree of the tariff increase in a year. The values of income elasticities mostly decrease over time. Such development reflects the potential for the implementation of Demand Side Management (DSM) measures. In addition, the forecast takes into account expected improvements in technical and commercial losses, unserved energy, and modifications in the load factor.



Results

We find that gross electricity consumption (or “electricity sent out to the grid” as it is also known) is expected to increase in Central Asia from 95,748 GWh to 162,644 GWh between 2011 and 2031 in the base case scenario. This is an increase of 66%, or 2.6% per annum, on average over the period. If we compare the expected gross consumption

in 2031 with actual consumption in 2009, which allows us to take unserved energy into account, the gross electricity consumption increases by 82%, or 2.8% per annum. Growth rates of future gross energy consumption, however, differ between the countries and over time. Apart from Southern Kazakhstan, growth rates in the second decade of the forecasting period are expected to be higher than in the first decade.

The forecasting exercise also develops low and high scenario cases. The low scenario is based on lower future growth rates and lower income elasticities, whereas the high scenario assumes higher economic growth rates, higher income elasticities, and in some cases, a deferred tariff adjustment process. Total gross consumption is expected to reach 208,976 GWh in the high scenario and 124,039 GWh in the low scenario in 2031. The development and growth of the peak load is marginally different from the development of gross consumption, due to minor modifications of the load actor in various countries. Analysis shows that expected development of peak load in the region from 2011 to 2031 requires an increase of sector capacity from 17,537 MW to 29,557 in 2031 (in the base scenario), which will increase consumption by 69%, or 2.6% per annum; while in the low scenario, peak load is expected to reach 22,573 MW in 2031, compared to 37,963 MW in the high scenario.

In this project, as a part of Regional Energy Sector Master Plan, the consultant team suggested an alternative scheme, named as a "Project TUTAP" (Turkmetinstan, Uzbekistan, Tajikistan Afganistan & Pakistan). This solution should suppose all countries to be part of the power trade system between the countries of Central and South Asia. The ADB and CAREC programs would like to support this development in order to obtain cooperation between all regional countries' power systems . Proposed new option suggested to organize the interface between the substation of Puli Khumri through the converter-inverter system of substations in Afghanistan which will be supported by construction the 500 kV HV lines and could be valuable basis for the United Energy System of Afghanistan also.

Conclusions

Demand Side Management (DSM) should be a critical part of the region's strategy for expansion planning of the power system. DSM saving could reduce the growth of power demand on the consumer side in order to reduce required installations of new power generation capacities on the supply side. DSM should mainly be based on three types of measures: load management, increasing energy efficiency, and changing behavior of consumers. As analysis shows, a major part of future demand growth of the Central Asian states comes from the residential sector. This growth will run parallel to the economic growth of the region. Together with economic growth, the prevalence of electricity consuming appliances and, therefore, their consumption will increase.

Implementing a standards and labeling policy may avoid excessive growth of electricity demand. The consumption of refrigerators and air conditioners, in particular, can be addressed by means of a standards and labeling policy, as a label displaying the consumption of a fridge enables the consumer to choose a more efficient product. The economic criterion of the DSM assessment is to identify measures on the consumer side that can be realized with lower long-run marginal costs compared to those of investments for new power generation capacities on the supply side. Similar situations, with classification of the Central Asian republics into hydro resources and water suppliers (the upper riparian states of the Kyrgyz Republic and Tajikistan) and water users (the lower riparian states of Kazakhstan, Uzbekistan, and Turkmenistan), the Central Asian republics can be classified as producers of hydropower and producers of power by fossil fuels respectively. The pattern of power energy usage can be seen jointly with the assessment of water supply systems

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