Reliability and Flexibility for Carbon. Development of power systems of Central Asia

Bakhtiyor Shamsiev
Head of the Power Systems' Electrical Modes Department, CDC ENERGIA

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Perspective development plan of the electrical networks of Central Asia until 2030

<table>
<thead>
<tr>
<th></th>
<th>2023 Install capacity (GW)</th>
<th>CAPS Generation (b*kW*h)</th>
<th>CAPS Demand (b*kW*h)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kazakhstan</td>
<td>24.64</td>
<td>112.90</td>
<td>115.10</td>
</tr>
<tr>
<td>South</td>
<td>4.70</td>
<td>14.05</td>
<td>26.87</td>
</tr>
<tr>
<td>North-West</td>
<td>19.94</td>
<td>98.85</td>
<td>88.23</td>
</tr>
<tr>
<td>Kyrgyzstan</td>
<td>4.00</td>
<td>13.80</td>
<td>17.11</td>
</tr>
<tr>
<td>Tajikistan</td>
<td>5.76</td>
<td>21.85</td>
<td>19.90</td>
</tr>
<tr>
<td>Uzbekistan</td>
<td>19.58</td>
<td>77.95</td>
<td>80.97</td>
</tr>
</tbody>
</table>
Main areas of cooperation

The main areas of cooperation by and between Central Asian Power systems are:

- trade in electric energy and reserve sharing;
- development of interstate power grids;
- joint construction of power plants;
- planning the integrated development of energy systems.
Currently, the process of restoring parallel operation of the energy system of Tajikistan is underway. A network schedule for connecting to the UPS of Central Asia has been drawn up with completion of work in May - June of this year. Tajikistan is planned to connect to the UPS of Central Asian in two stages:

- On the first stage, it should be connected on the **South of Uzbekistan** (by two 500kV OHL “SS Guzar – SS Regar” and “SS Surkhan – SS Regar” and two 220kV lines “SS Regar – SS Zarchop” and “SS Regar – SS Denau”).

- The second stage is the connection of the **Sughd substation** (Tajikistan) to the existing 500 kV overhead line in Uzbekistan according to the “tie-in” scheme. As well as a new 500kV transmission line will be constructed to interconnect New Syrdarya TPP (Uzbekistan) and SS Sughd (Tajikistan). ADB supports the project on linking Tajikistan power system to the CA UPS.
Planning the integrated development of energy systems

- It is necessary to build additional lines between the Central and Eastern parts of the energy system of Uzbekistan.
- Uzbekistan has such plans in the future.
- In the near future, Uzbekistan invited CASA-1000 participants to consider the possibility of connecting the 500 kV Datka-Sugd overhead line to the Uzbekistan SS (2x23 km) and/or to the Lochin SS (2x40 km).

This will allow:

- Increase the capacity of the Center-East interface;
- Significantly increase voltage levels in the Fergana Valley;
- Use the Datka-Sugd overhead line year-round with a higher load;
- Dividing a long line (about 500 km) into 2 or 3 parts will facilitate its operation in normal and repair modes.
Getting the Turkmenistan power system connected to CA UPS is a key issue to be reviewed.

The Turkmenistan energy system currently operates in parallel with Iran. Whereas it operates with CA UPS in an "island" mode using the standalone generators to export the electricity.

At the same time, Turkmenistan has built 500kV transmission lines to the border of Iran and to Afghanistan.

It is planned to use **500/400kV transformer** to get linked with Iran in parallel operation mode which has voltage level 400kV.

Afghanistan planned to operate in parallel with the CA UPS. Hence, Turkmenistan will get connected to Afghanistan with B2B (back to back substation) to be built on the TKM-AFG interface.

We believe that it is more expedient for Turkmenistan to switch to operating in parallel with the CA UPS, while connection with Iran should be made with B2B, which is less costly (1 B2B is cheaper than 1 B2B + transformer).

The role of Turkmenistan as a transit power system will push expanding the Central Asian power trading region to South Asia, to be further extended to West Asia (Iran, Turkey and neighboring Armenia and Georgia)*.
Joint construction of power plants

- Kyrgyzstan, Uzbekistan and Kazakhstan signed a memorandum of intent on the Kambarata HPP-1 construction project. Establishing a joint venture between the parties is in progress.

- Negotiations are progressing between Tajikistan and Uzbekistan and between Tajikistan and Kazakhstan on electricity supply from the Rogun HPP. As lately updated, the stakeholders from Uzbekistan and Tajikistan came to an agreement on this matter.

- Currently, Tajikistan and Uzbekistan are jointly working on a project for constructing two hydropower plants of total capacity of 320 MW on the Zarafshan River in the Sughd Region (Tajikistan). The countries have established “TAUZ Hydro” JSC, which is responsible for project management.
RES integration into UPS of Central Asia

The UPS of Central Asia stakeholders have been integrating the renewable energy sources along with the modernizing and retrofitting the traditional generating facilities and commissioning highly efficient combined cycle gas turbine plants and modernizing the hydro power plants. Mainly solar photovoltaic plants and wind power plants are put into operation.

There are already 2,600MW of RES in Kazakhstan's energy system, including 1,200MW of solar and 1,400MW of wind. The Ministry of Energy announces about 16 GW of RES-based generation to be commissioned by 2030.

Kyrgyzstan announced a plan to introduce about 3-4GW of RES within 2-3 years.

In Tajikistan, two SPP with a total capacity of 60 MW are expected to be commissioned in 2024 and around 700 MW are planned to be implemented by 2030.

Uzbekistan currently has a total capacity of 1,520MW of SPP and 100MW of WPP. At the same time, 8.64GW of SPP and 17GW of WPP, as well as 7GWh of BESS are planned to be implemented by 2030.
Renewable energy projects of Uzbekistan

**Solar PV projects of Uzbekistan**
- Contracted: 6 447 MW
- Emission reduction: 6.9 Mtons
- 2030 plans: 8 640 MW

**WG projects of Uzbekistan**
- Contracted: 4 200 MW
- Emission reduction: 6.2 Mtons
- 2030 plans: 17 000 MW

**BESS projects of Uzbekistan**
- Contracted: 1 440 MW
- Capacity: 2 251 MWh
- Emission reduction: 900 MW
- 2030 plans: 3 000 MW
- 2030 plans: 6 000 MW
Example of an energy system with a high share of renewable energy sources, (Spain), 02/06/2023

- Renewable energy sources generation 63% during the day, 40% at night

- The unevenness of the schedule created by the solar plants is compensated by unloading:
  - Wind PP – 5 GW (37%);
  - HPPs with Reservoirs – 3.6 GW (74%);
  - Hydro pumped plants
    - from 2.8 GW to -1.5 GW (147% day time.)
    - to -2.8 GW (200% at night.)
  - TPP (gas) – 5 GW (60%);
  - TPP (coal) – 0.65 GW (63%).

The maximum rate of ramping (down) in Solar generation - from 17:00 to 18:00 is 4.5 GW/hour. This is compensated by increasing the generation by:
- HPP 1.4 GW,
- Hydro pumping 1 GW,
- TPP(gas) 1.5 GW.

~ 4GW
Ways to effectively integrate renewable energy sources

- Coordinated efforts to develop a market for regulatory capacity and reserve trading.

- Development of principles of emergency automation for effective integration of renewable energy sources at the regional level.

- Implementation of regional Centralized Emergency Control System (CECS).

- Implementation of regional Automatic Generator Control (AGC) system.
Currently, the RES share is growing and the load in increasing in Kazakhstan, Uzbekistan, Kyrgyzstan and Tajikistan. Hence, the power imbalance will increase on the border between Kazakhstan national power grid and CA UPS.

At the same time, due to parallel operation with the Russia’s power system which performs the centralized frequency control of CIS power grid, the power imbalance of CA UPS will be reflected on the Kazakhstan and Russia interface and *North-South* Kazakhstan transit capacity can be overloaded.

Large power surges from CA UPS, which are not evitable if RES is widely introduced, may lead to increased deficit in CA UPS and unacceptable frequency reduction which would cause shutting down RES and CCGT facilities. All these may result in "frequency collapse" and blackout.

To avoid switching off the extremely loaded North-South transit of Kazakhstan, the Kazakhstan stakeholders are investigating the issues of constructing HVDC from Ekibaztu GRES-1 to Zhambyl.

Energia CDC proposes an alternative option - transition from parallel operation to joint operation by and between Kazakhstan power system and CA UPS via B2B, which will exclude the power surges from CA UPS to the North-South transit of Kazakhstan. This means that CA UPS will independently regulate frequency. This proposal anticipates participation of 3 power systems, i.e. the proposed project is a region-wide.
THANK YOU!