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German Economic Team

NEWSLETTER

UZBEKISTAN

Uzbekistan's 2030 electricity system: a least-cost analysis

The Uzbek government has announced ambitious 2030 electricity system plans to meet growing demand, including through the construction of a nuclear power plant, adding significant gas power plants capacity, and increasing solar photovoltaic (PV), wind, and hydropower generation.

Cost optimal modelling and analysis however find that the ideal configuration of the system in 2030 looks different. In a scenario where the nuclear power plant is not built or delayed and increased electricity trade occurs with neighbouring Tajikistan and Kyrgyzstan, Uzbekistan would require over 8.3 GW of wind power, 10.9 GW of solar PV, and 3.1 GW of open cycle gas turbines acting as peakers and reserves. Compared to government plans, this approach would annually save EUR 1.7 bn in costs (14% reduction), as well as 2 bcm of gas (16% reduction), and would reduce emissions by 18%.

Background and methodology

Uzbekistan's government envisages an ambitious ramp up in electricity demand by 2030, driven by an increasing population, as well as forecasted economic growth. To meet these targets, a significant overhaul of the electricity system will be needed to ensure stability and adequacy, and to prevent blackouts which have historically plagued the system. An electricity system modelling exercise assessed government plans, and a cost optimal approach to investigate the best pathways for the Uzbek electricity system to meet stated goals.

The electricity system modelling was conducted in the open-source Calliope model, with subsequent analysis and calculations assessing aggregate and annual investment costs, gas consumption, emissions, and other metrics. The model included all energy assets which are currently either built or in the process of construction, with the decommissioning of old, inefficient assets that the government has announced for closure. Four scenarios were tested:

1) *Central scenario* which closely resembles current government plans,

2) *Cost optimal scenario*,

3) *Central scenario with regional trade*

4) *Cost optimal scenario with regional trade*.

Scenarios 1) and 4) are highlighted in this newsletter.

Results of Central scenario

In the Central scenario, which closely resembles the announced government's 2030 plans, the system constructs the 2.4 GW nuclear power plant, increases hydro capacity to 3.8 GW and builds the announced 5 GW of solar PV and 3 GW of wind power. Some aging and inefficient coal power and old steam turbines are decommissioned. In addition to planned capacity expansions, to maintain adequacy and stability, the government would only have to add 200 MW of combined cycle gas turbines (CCGT) and 1,600 MW of open cycle gas turbines (OCGT) to act as peakers and reserve capacity. By 2030, this would result in 40% of annual generation coming from renewable energy, with aggregate investment costs reaching EUR 35 bn and annual costs reaching EUR 12 bn, with the bulk of variable costs stemming from the gas power sector.

Results of Cost optimal scenario with trade

Cost optimal modelling analysis however finds that the ideal configuration of the Uzbek electricity system in 2030 looks different. Firstly, Uzbekistan should expand trade with Tajikistan and Kyrgyzstan to take advantage of their hydropower projects which should be finished by 2030. This would allow for the import of cheaper electricity in the summer when water flows are higher.

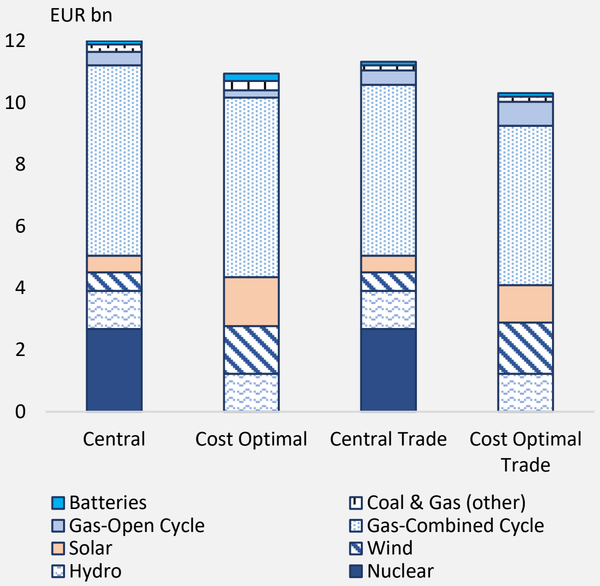
Given the high construction costs of nuclear power plants, the cost optimal configuration prioritises the construction of renewable energy, as well as some additional gas power plant capacity. Uzbekistan's favourable meteorological potential, combined with decreasing costs of renewable energies, leads to a cost optimal configuration with the installation of 10.9 GW of solar PV and 8.3 GW of wind power capacity.

To ensure system adequacy, especially given the high number of installed variable renewable energy sources, an additional 3.1 GW of OCGT are needed to ensure adequacy, acting as peakers and reserve capacity.

Costs, gas consumption and CO_2 emissions

A cost optimal system where electricity trading takes place with Kyrgyzstan and Tajikistan yields substantial economic benefits. Firstly, annual savings are EUR 1.7 bn compared to the Central scenario, a reduction of over 14%. Modelling also shows that given marginal prices of the various dispatchable technologies, Uzbekistan's annual balance of trade in electricity is positive, yielding larger export revenues despite importing more physical electricity.

Annual system costs under the selected scenarios



Source: modelling results, own calculations

Secondly, the cost optimal system leads to reductions in CO_2 emissions as well as gas consumption. Gas consumption under the cost optimal scenario with regional trade is roughly 2 bcm less annually compared to the Central scenario, which allows Uzbekistan's government to divert gas into either domestic value-added products (e.g. in the new gas-to-liquids plant) or for exports through existing pipeline systems to China and elsewhere. At the modelled prices, these reductions would save over EUR 820 m of gas annually, with emissions decreasing by 17.5% compared to the Central scenario.

Gas consumption and emissions under modelled scenarios

Scenario	Consumption (bcm)	CO_2 emissions (MT)
Central	12.7	24.8
Cost Optimal	11.1	22.2
Central Trade	11.2	21.4
Cost Optimal Trade	10.6	20.4

Source: modelling results, own calculations

Conclusions and policy implications

Results of the modelling and analysis show that following a cost optimal pathway means Uzbekistan would have to build very little additional CCGT capacity. Instead, the government should prioritise a greater rollout of both solar and wind power, the construction of more OCGT capacity to cover peaks and act as a reserve and should not build the nuclear power plant due to high capital expenditures. Doing so, while trading electricity with its regional neighbours would decrease costs, gas consumption and emissions. New Uzbek CCGTs and OCGTs should also be constructed to be able to operate on hydrogen, to prepare for future changes in the energy supply, especially if domestic gas supplies decrease.

At the same time, other significant issues (which will be further addressed in future modelling work) must be addressed if the government wants to meet its targets. The low gas pipeline pressure significantly affects ramping and efficiency of gas power plants. An overhaul of the electricity grid will be needed to incorporate renewable sources and to ensure smooth flows. Additionally, many plants currently operate under take-or-pay contracts which prevent optimal dispatch and might incur significant costs on the economy and population.

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A more comprehensive analysis is provided by our Policy Study: How much gas power plant capacity does Uzbekistan need? A 2030 scenario analysis using the government's electricity demand forecast

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**Advisory activities in Belarus are currently suspended.*