Introducing Wind Generation as a Way to Reduce the Seasonal Volatility in Electricity Generation in Georgia

By Giorgi Kelbakiani and Norberto Pignatti*

Introduction

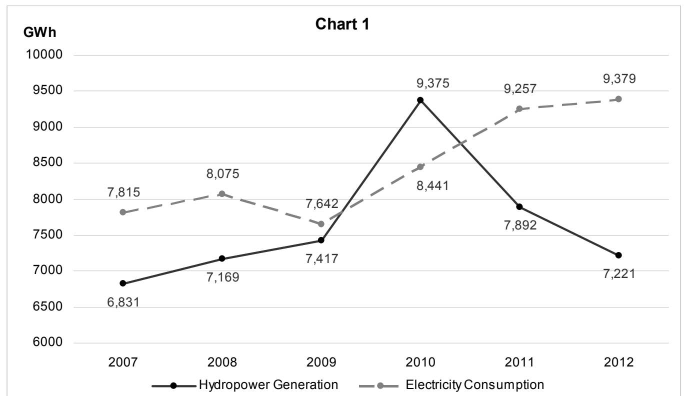
Due to the geomorphological characteristics of its territory and to its geographical location, the Republic of Georgia is rich in hydro resources. According to the Georgian Ministry of Energy and Natural Resources, so far Georgia has exploited only about 20% of its hydro resource potential.

Since 2006 the Georgian government has been planning to utilize these resources to not only meet domestic demand, substituting hydro fully for electricity imports and thermal power plant (TPP) generation (burning imported gas), but also to turn Georgia into a regional provider of electricity.

Initially, thanks to the rehabilitation of existing hydro power plants (HPPs) and to improvements in the regulatory environment of the Georgian electricity sector realized in the wake of the Rose Revolution, this program seemed relatively easy to achieve.

The generation of cheap hydropower did increase and partially substituted for thermal energy generation and electricity imports. After a steady increase from 2007, finally, in 2010, total annual hydropower generation (9 375 GWh) in Georgia exceeded the country's total electricity consumption (8 441 GWh) (chart 1).

Parallel to this the construction of new transmission lines started to increase the export capacity to Turkey and a number of Memoranda of Understanding were signed with investors in relation with the realization of 40 new HPP projects.



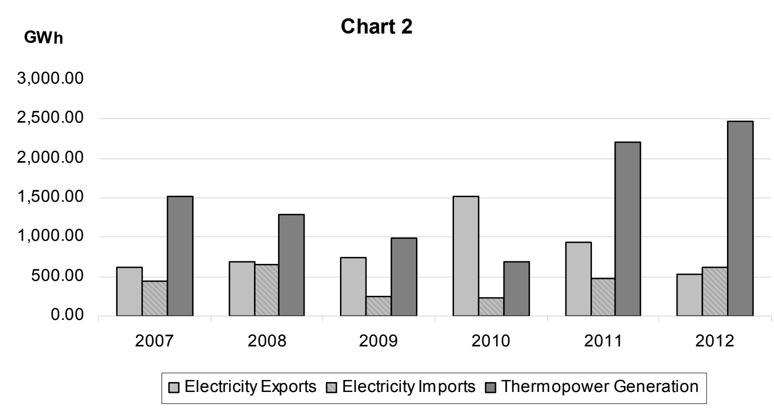
Source: ESCO

The Importance of Seasonality

Despite this promising start, however, the situation did not evolve in the desired direction. Due to adverse climatic conditions the generation of hydropower declined in 2011 and 2012, while consumption kept rising.

As a result, Georgia lost its newfound status as a net electricity exporter in 2012 (chart 2).

Chart 2 allows us also to identify another important aspect that does not appear looking at total hydropower generation and total electricity consumption. Even in the best year (2010) of Georgian hydropower, both thermal power generation and electricity imports stood quite high (683 and 222 GWhs, respectively) due to the monthly distribution of the hydropower generation and the electricity consumption of the country.



Source: ESCO

The seasonal nature of both hydropower generation and electricity consumption created excessive generation in summer months and a gap in the winter of 2010 (chart 3). In other years, the gap was even more pronounced.

This seasonal pattern can also help explain another reason why hydropower generation has not been increasing as fast as hoped: sluggish investment. From the investors' point of view the excess of supply during summer months is problematic. In this period, in which new HPPs would generate the highest amount of electricity, they are going to meet very tough competition domestically from the already existing HPPs (old, large, often fully amortized, which are operating at very low costs). This lowers the expected profitability of investments in new HPPs (which could be increased only by a substantial increase in the demand for Georgian electricity in the region) and might explain the slower than expected realization of the planned investments, despite the signed memoranda.

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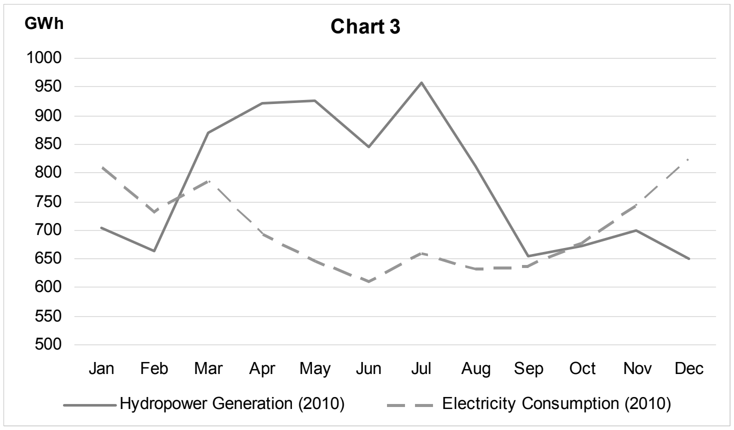
Source: ESCO

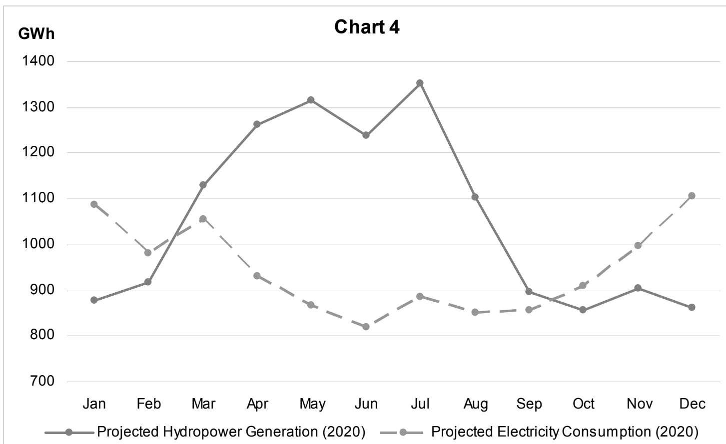


Source: ESCO

Even putting aside the concerns about the profitability of new power plants, additional investments in new hydro power plants seem not to be an effective way to close the gap in winter, especially considering the steadily growing consumption.

Chart 4 shows a simple projection for 2020: The prospective generation of three large HPP projects (Khudoni, Namakhvani Cascade and Faravani with total potential installed capacity of 1661 MW) is added to the hydropower generation of the year 2010 and is compared to the projection of electricity consumption in 2020 (assuming 3% growth per annum).

This scenario is quite optimistic: First of all, we are assuming that existing hydropower will maintain the 2010 level of production (the highest so far recorded). Secondly, the assumed growth rate of electricity consumption (3%) is slightly lower than the growth rate observed in the period 2007-2012. Interestingly enough, despite these assumptions, the predicted winter gap is increasing, as well as the excess generation in summer.



Source: ESCO

New small HPPs will not be able to make much difference as far as the winter gap is concerned. Without the ability of collecting water in dams, their generation capacity in winter months is reduced even more sharply than in the case of large HPPs with dams.

The persistence (and the potential increase) of a gap between generation and consumption in winter and the volatility in the generation of electricity during the year, in absence of an integrated regional electricity market capable of absorbing excess production and to cover for the winter gap in a reliable way and at reasonable prices explains why the Georgian government seems to be starting to consider a number of alternative ways to achieve its goals.

Blowing Wind into the System

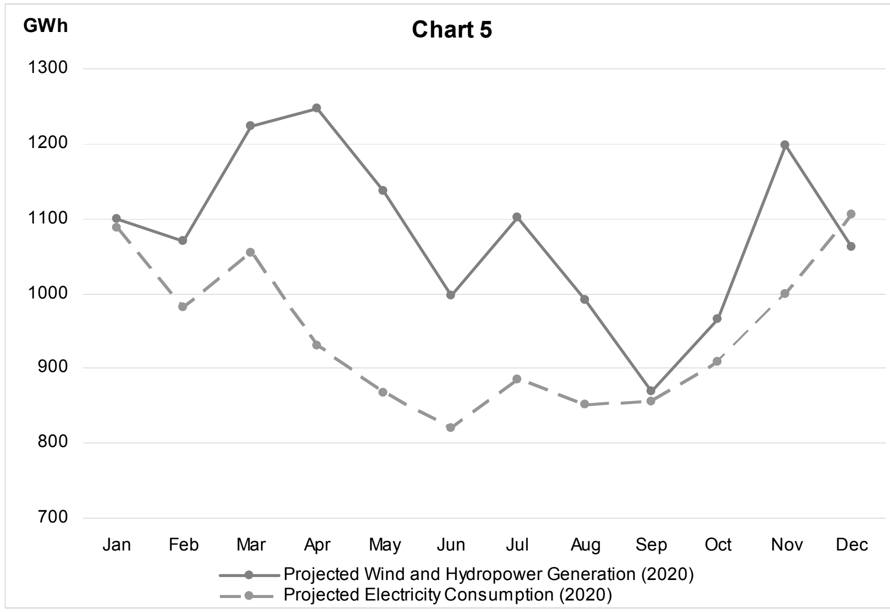
Considering the points raised above, a possible solution seems to be the identification of a renewable energy source with a pattern of generation complementary to that of hydropower generation, able to generate electricity mostly in winter. Wind power, at this stage, appears to be the most promising alternative.

According to the Wind Atlas data produced by the Karenergo (a Wind Energy Scientific Center based in Tbilisi), Georgia has considerable wind energy generation capacity. The strongest argument in favor of wind energy, however, is that in a majority of the most promising wind sites winds are blowing harder in winter, when the excess demand and electricity prices are the highest. Consequently, optimally placed wind farms can fill the gap in green energy production, contributing in a more effective way to the government's long term objective to reduce country's dependence on electricity imports and thermo power (which itself depends on imported gas).

To demonstrate the potential benefit of wind power in terms of electricity sector independence, we produced chart 5 based on our calculations. In contrast to the chart 4, chart 5 shows what could happen if Georgia built appropriate wind farms (with total potential installed capacity of 1270 MW) instead of HPPs (total installed capacity of 1661 MW). All other projections are similar to those from chart 4.

Investing in wind generation might have one more potential benefit. At some point Georgia might want to start building "pumped-storage" reservoirs for some of its dams. These devices are storing excess (otherwise non-storable) electricity produced by variable renewable sources (such as wind) by using it to pump the water up into the reservoirs when demand is low. In this way, the same water can be used when the demand is high. So far, the "pump-storage" technology has not been utilized in Georgia since excess electricity produced by small HPPs in summer months could not be stored for lack of spare storage capacity (water reservoirs are quite full in summer). This technology could instead be easily employed to store excess wind electricity (e.g., at night) when reservoirs are half empty during the winter. The result would be higher daily production by both HPPs and wind farms.

Clearly, wind energy development faces many technical challenges such as variability, dispatch-ability and storability. However, the global trends in wind energy generation provide evidence that these challenges can be successfully addressed even in countries where wind accounts for a relatively large share of total electricity production.



Source: ESCO

So far the main reasons for the lack of investment in wind generation in Georgia have been the high level of startup costs and the lack of support from the government. Yet, considering global trends in wind energy technology and the evolution of the Georgian electricity market it may be high time to prepare for tomorrow by investing in relevant education, experimental wind farms, and pump storage facilities.

This seems, indeed, to be the direction taken by the Georgian government. At a press conference on July 17 the Minister of Energy, Kakha Kaladze, announced the intention of the government to embark on the construction of wind power plants; a new step in the path that should lead Georgia to independence in the electricity sector and become a major electricity exporter in the region.