10. Evaluation of the Uruguayan system and recommendations based on Danish experiences

Uruguay has an electricity system with great dynamic potential, which today is only utilized to a very small extent. If the planned amount of wind power should be integrated without loss of operational stability, Uruguay should change from a deterministic system where all production is scheduled and planned well ahead to a system with stochastic wind production. Wind production cannot be perfectly planned. Uruguay has much hydro power and few constraints on thermal production units. This can provide the production flexibility to supplement wind power.

The electricity system in Uruguay has no physical constraints that would make it difficult to implement wind power. However, Uruguay needs to change their operating procedures to be more flexible, so they can frequently change their schedule in accordance with updated wind forecasts. The accuracy of wind forecast increases, the closer one gets to the operating hour. The more wind power installed, the more important it becomes to have operational flexibility close to the operating hour. Therefore, Uruguay needs to operate at a higher time-resolution. Production schedules should be made for every hour. The forthcoming AGC will help on this flexibility issue.

In addition, more flexible exchange agreements with Argentina and Brazil would be highly beneficial, when the fluctuating wind power is installed. This may increase the possibilities of making the most beneficial use of the wind power production. Ideally, it should be possible to adjust the use of the interconnections close to the operating hour. Denmark is heavily interconnected with its neighboring countries and wind power benefits from the strong interconnections, because wind power can be exported when wind power production is very high.

The Danish experience is that good wind power forecasts are essential. UTE has an agreement with a university to develop the wind power forecast model. In 2011, the first forecast model for the wind power forecasts was developed which is nowadays in process of calibration. UTE should continue improving the wind power forecast along with the introduction of new wind power capacity. Energinet.dk recommends that both time series models and numerical models with weather input data are used.

A probable issue in Uruguay might be rolling reserves, because large power plants have to deliver ancillary services and voltage adjustment. When the wind power is fully implemented, some hours Uruguay will have very high wind power production, but some ancillary services are still needed and have to be delivered by power plants or by a synchronous condenser. Short-circuit power might also be a problem in the Uruguayan electricity system.

In the long-term Uruguay should be aware of the capacity situation, i.e. is there enough reliable capacity to cover peak demands? The introduction of wind power decreases the economic conditions for conventional production units which are needed during peak demands when the wind does not blow. Wind

power is fluctuating and unreliable, and there has to be enough capacity from reliable production units or interconnectors to cover the demands. Energinet.dk's experience is that both static and dynamic (Monte Carlo) methods to assess the capacity situation are relevant.

Uruguay should have focus on formulating appropriate grid codes for wind turbines. The Danish experience is that grid codes are essential for the success of integrating wind turbines. Grid codes should be detailed, but at the same time transparent and stable. A stable long-term framework is a prerequisite for attracting potential investors. The use of ancillary services from wind parks should be specified in the tender. Otherwise it will be difficult to use the ancillary services.

Energinet.dk also recommends that Uruguay finds inspiration in our procedures of grid analysis, which are described in part 7-9.

Grid-wise we identify a present weakness in the northern part of the grid where many biomass power plants will be installed. This may be solved by the expansion of the domestic grid in the Northern region and the new connection to Brazil. Furthermore, focus on the critical line length for the new 217 km 150 kV connection and 283 km 500 kV connection is important.