G-PST/ESIG Webinar: Ancillary Services from an Energy System with a High Share of Variable Renewable Energy (VRE)	
Question	**Answer**
How do you avoid a situation where hydro generation dominates the ancillary services market?	The AS markets in the Nordics are already dominated by hydro. However, we have worked with both the technical requirements, market design and roles/responsibilities to allow for other technologies to participate as well. We try to make the entire setup as technology agnostic as possible, and we see more technologies entering the markets already. A good example is having asymmetric services, in hourly markets which are cleared in a daily auction. Similarly, transparency on required reliability and penalties if failing to deliver, etc.
how difficult has it been to get people to think in terms of probabilistic forecasts?	We allow for use of point-based forecasting as well. We are only enforcing the reliability target, however you would unlock more capacity by having a probilistic forecasting approach, as a point-based forecasting would introduce unnecessary margins. But we have seen that multiple providers already worked with probabilistic forecasting, and therefore is has not been difficult to introduce it.
What have been any lessons learned about how Energinet coordinates the use of aggregated consumer load with local distribution networks (may use the same load)?	Currently, the DSOs in Denmark do not have any flexibility markets other than time-differentiated tariffs and "interruptible connection agreements". The latter, which gives a discount on the tariff but allows the DSO to reduce the power transfer with the grid, if the grid is locally overloaded. Hence, Energinet allows the units connected at DSO-level to participate equally as all other units, where they of course can't bid to the AS market if the DSO forecasts and warns about local bottlenecks.
I've seen articles promoting geothermal development in Denmark. Is this real and, if so, might it supply significant ancillary services.	We generally support all possible technologies to participate in the AS markets, but I do unfortunately not know the status on geothermal in Denmark. If it is being implemented, and will become flexible, then of course, it should participate in the AS markets.
Have you seen the need for voltage control or adding aditional shortcircuit level or you just need ancillary services related to balancing?	We are currently not developing any market based procurement of other services than active power for frequency stability and balancing. As many other TSOs we foresee an increasing need for non-frequency related ancillary services, because of the increase of converters and loss of synchronous machines. However, we do not have severe increases in the near-future needs - but we are heavily analyzing the needs and potential supply in the longer term.
What software graphing tools do you use for that resolution plots?	I'm not sure which plot that is refered to, but please add a reference and I will get back to you.

FFR services are remunerated?	Yes, in a pay-as-clear market design where the need is forecasted on a daily basis per hour for the coming day (based on inertia-forecast).
Is there any standard for the forecasting? Is 10% Quantile is standard other than 5% Quantile?	It is not a standard, but simply an assessment by Energinet to find balance between realibility and attractiveness for the VRE units to participate in the AS markets. We will evaluate the quantile once every year.
What method is used for the wind power forecasting? What are inputs there?	For the forecasting in Energinet we use weather-data from multiple different sources, and historical and real-time measurements. For the commercial parties, we do not know, as we do not have any requirements for them to share the inputs (we only focus on the output precision in the validation of the forecasts).
what's a "PTX" project?	Powet to X (=anything). When referring to flexibility for the electricity consumption for PtX, we mainly refer to electrolysis (power and water to hydrogen and oxygen), but is of course also interested in other processes like refinement of hydrogen to ammonia or methanol. However, the electricity consumption and flexibility is expected to be larger for electrolysis.
What grid connection requirements do apply for PtX projects? Is Energinet seeing any need to introduce PtX specific grid connection requirements in the future?	We are currently developing requirements for large consumption units, which in short introduces similar requirements as for production units. However, we do not have published drafts yet, but I would be happy to establish contact with the relevant colleagues in Energinet.
How many years of historical data did you use in the forecast?	For prequalification to the AS markets, we require a minimum of 3 months of data. However, many providers have more, or have access to historical data from very similar plants (i.e. another wind farm close by, etc.). We continuously validate the forecasting precision via sample testing, hence we allow for a small amount of historical data.
How do you ensure the plants' compliance with their declared capacity?	Through sample testing. You are also obliged to inform Energinet, if the sold capacity is not available in real-time (forecasting error, forced outage, etc.), then Energinet will replace the lost capacity in an extra-auction (if the amount is significant). The provider which can't deliver will cover the additional cost for the extra-auction, and pay-back for the amount that could not be delivered. If a provider multiple times do not have the full capacity available in real-time, then Energinet can exclude the provider from the market (where a new prequalification is then required).

do you see an increase in reserves coming from neighbouring countries?	In general, we see that the growth of the electrical grids by introduction of more VRE, larger referece incidents, more constrained grids, etc. leads to increase in reserve demand, and also increase in energy activation of the reserves. Germany experience what they call the "German Paradox", where this is not the case. Denmark experience similar development, as we can reduce the need of procurement of reserves with common dimensioning methodologies, sharing agreements, netting of opposite imbalances in real-time, etc. (Large-scale benefits, when balancing larger areas in a common way, instead of individual balancing in smaller areas).
Are all of the reserves required to come from synchronized resources and providing primary frequency response? voltage control?	No, the technical requirements are technology agnostic, and they are additional to the grid-connection requirements. They can be found here: https://en.energinet.dk/electricity/ancillary-services/prequalification-and-test/
are interconnecting wind/solar/batteries required to install with communications to receive a curtailment signal for dispatch? or do they opt in?	They are not obliged to by the connection agreement, but if they want to participate in the AS markets (voluntary participation) we have requirements for communication, metering and logging, etc.
You do not co-optimize energy with reserves. You procure them before the DAM. Are AS paid as bid or do you use marginal pricing like in the US? and why?	We have completely separate capacity and energy activation markets for mFRR in Denmark. Currently for aFRR we have pro-rata activation of procured capacity, however that will change in mid 2024, when DK1 and the Nordics connect to PICASSO (common European aFRR EAM platform). For frequency reserves, the energy contribution is small, hence we will continue to have pro-rata activation of procured capacity. Some reserve capacity markets are pay-as-bid, but will transition to pay-as-clear within the next couple of years, so all the Nordic reserve markets are pay-as-clear.