

October Webinar - Planning and Designing Denmark's Future Energy Islands – a Large Scale 100% Inverter-based Offshore Power System	
Question	Answer
Are synchronous condensers really necessary or 100.00% inverter based resources is able to operate at this large scale?	This is being examined. It would from a cost and maintenance perspective be very attractive to avoid them offshore. Best guess currently, is that we can avoid them, but analysis are still ongoing.
What do you consider as Long Term Energy Storage in terms of hours , What technology are you considering to use to meet long term storage needs ?	The power system is connected to district heating system through CHP plants, electric boilers and large electric heat-pumps. The storage capacity in the district heating system today delivers storage capacity from hours up to a few days. High temperature storage solutions with thermal storage in stones is investigated as a solution for storage within 1-2 weeks (electricity-to-electricity).
How much installed capacity do you believe you will need to meet real time load?	For the longer term storage solutions the strategy is to use Power-to-x units producing hydrogen and derived fuels. These solutions are expected to deliver storage capacity in weeks and even seasonal storage as hydrogen might be stored in large underground salt-caverns. Today we have a capacity of 6 GW, primarily CHP units based on biomass and gas. This will be reduced to 4,5 GW towards 2030. The peak demand is approx 6 GW
A very decisive choice between AC-hub or HVDC multi terminal solution will have to be taken. What is the time window until decision needs to be taken ?	According to the project's timeline, a tender will go out in 2023. It is clear that a full standardized interoperability framework will not be in place, but still several options to ease later expansions will be considered.
What is the other 14% of the clean electricity generation—nuclear? geothermal?	Biomass
Will power-to-X loads be anticipated to require constant electricity supply (24x7)?	The PtX plants are in general expected to be flexible, to benefit from operational hours with low power prices. Furthermore TSO tariff products with "limited grid access" is developed to incentivise flexible operation.
and, could we maybe not see other technologies outcompeted it, with hydrogen network, storage etc?, with a more direct connection to the WF's?	Yes, many alternatives are under investigation. Energinet welcomes all of them.
What is the challenge that you consider that should be more difficult to solve for a 100% inverter system ?	Please refer to slides 20-22, 28 and 33.

<p>What will be the grid code requirements at the energy islands? Will it be developed from scratch or will it be inspired by DK?</p>	<p>In Europe we have common grid codes between all member states. These define a set of minimum requirements. Grid codes are developed for generators, demand and HVDC. National requirements can be added by the national system operator if it is considered necessary. In the current version of the codes, a set of adjusted requirements for HVDC-connected plants are defined. However, there are not large differences compared to the rest of the code's requirements, and it could for sure make sense to investigate this further to see if a "hub-code" should be developed</p>
<p>Please Could you recommend some reports regarding the oscillation that you mention in Germany?</p>	<p>A number of papers are published on the topic. One example would be: "BorWin1 – First Experiences with harmonic interactions in converter dominated grids by Christoph Buchhagen, Christian Rauscher, Andreas Menze, Dr. Jochen Jung TenneT TSO GmbH, Bayreuth, Germany"</p>