



SUB-/SUPERSYNCHRONOUS OSCILLATION ANALYSIS IN AN OFFSHORE GRID MODEL USING RTDS

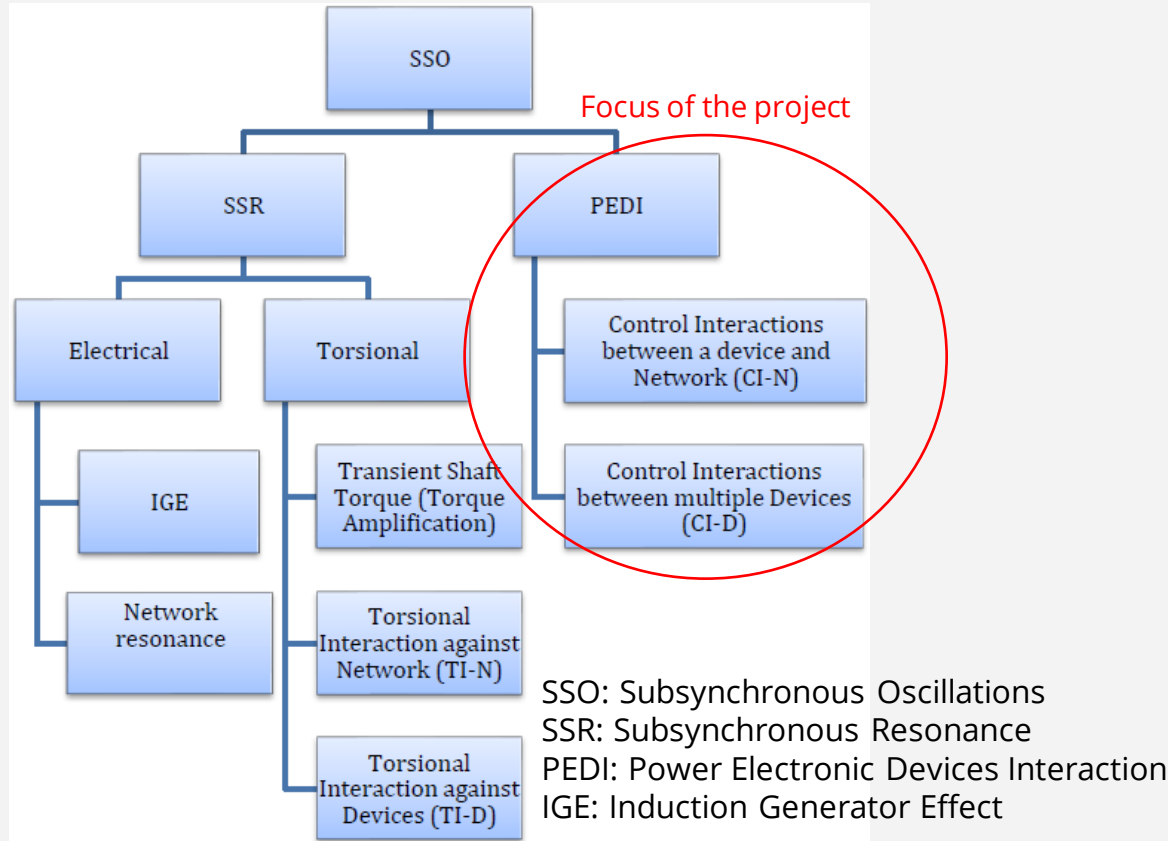
SANDRO KELLERMÜLLER

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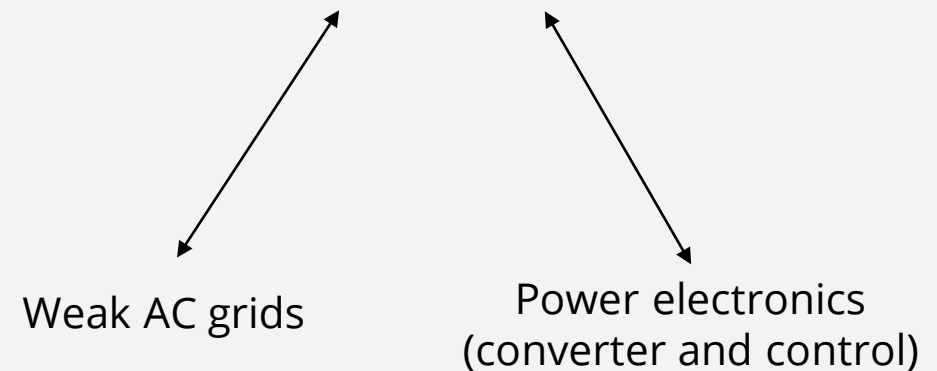
BACKGROUND SUB/SUPERSYNCHRONOUS OSCILLATIONS

- Sub/supersynchronous oscillations are typically in the range $f_{sub} < f_n < f_{sup} < 2f_n$
- Classification according to CIGRE (TB 909, 2023)

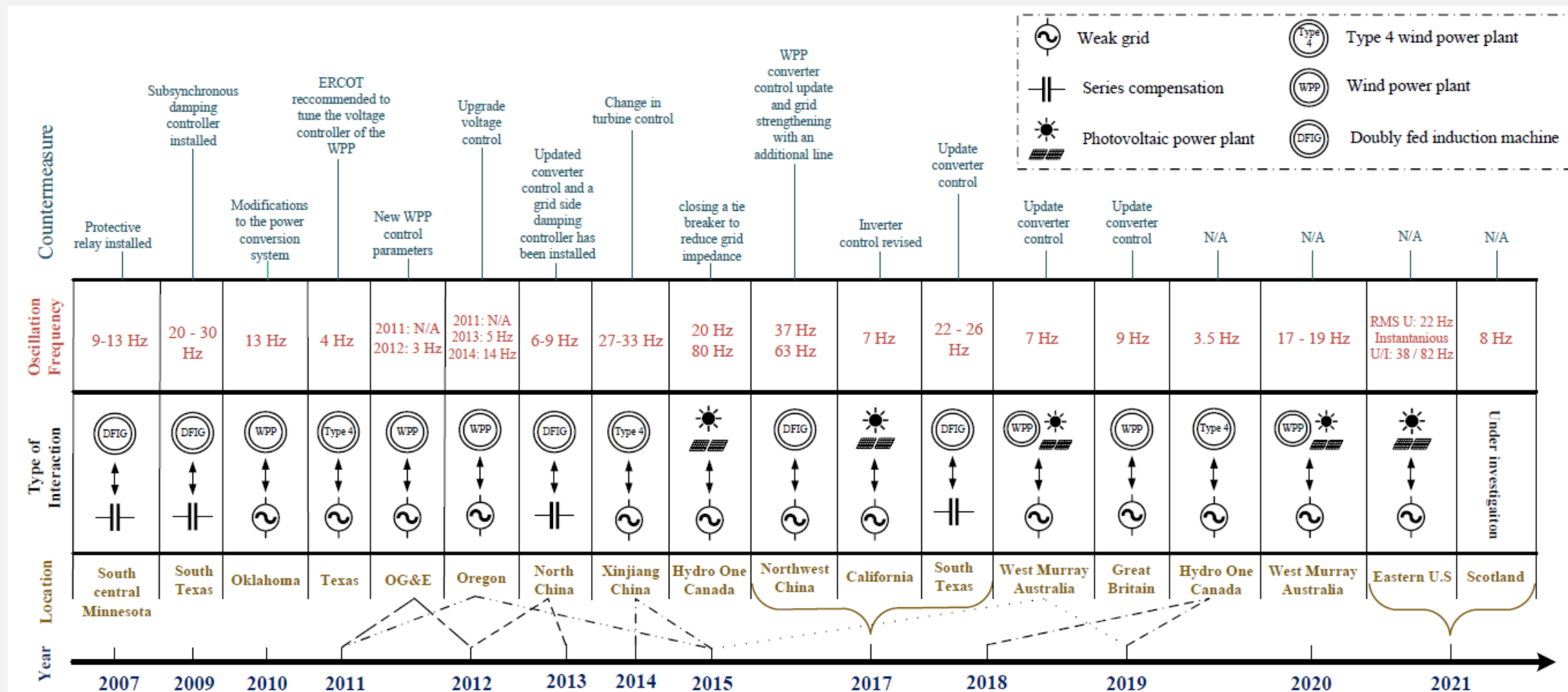


Interacting components PEDI:

Power electronics (converter and control):
 WTG Type 3/4, IBR, HVDC, FACTS, SVC



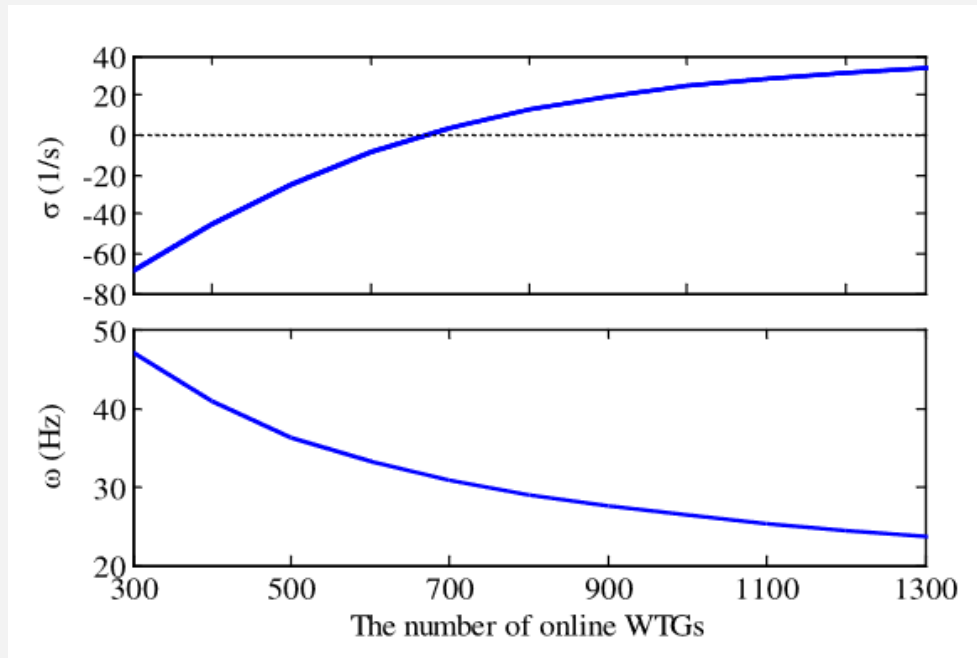
DOCUMENTED EVENTS



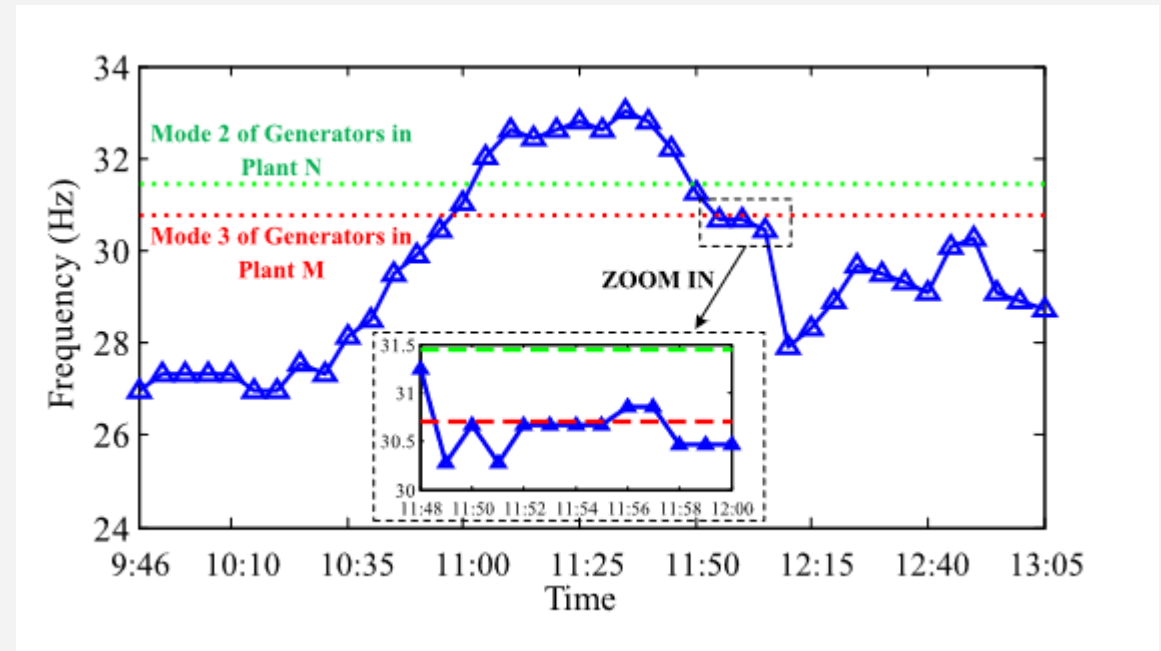
CHALLENGES SUB/SUPERSYNCHRONOUS OSCILLATIONS IN OFFSHORE POWER SYSTEMS

- Frequency and damping of the SSO can vary depending on the wind speed, number of operating WTGs, network topology, converter controller parameters of the converters

Modal analysis:



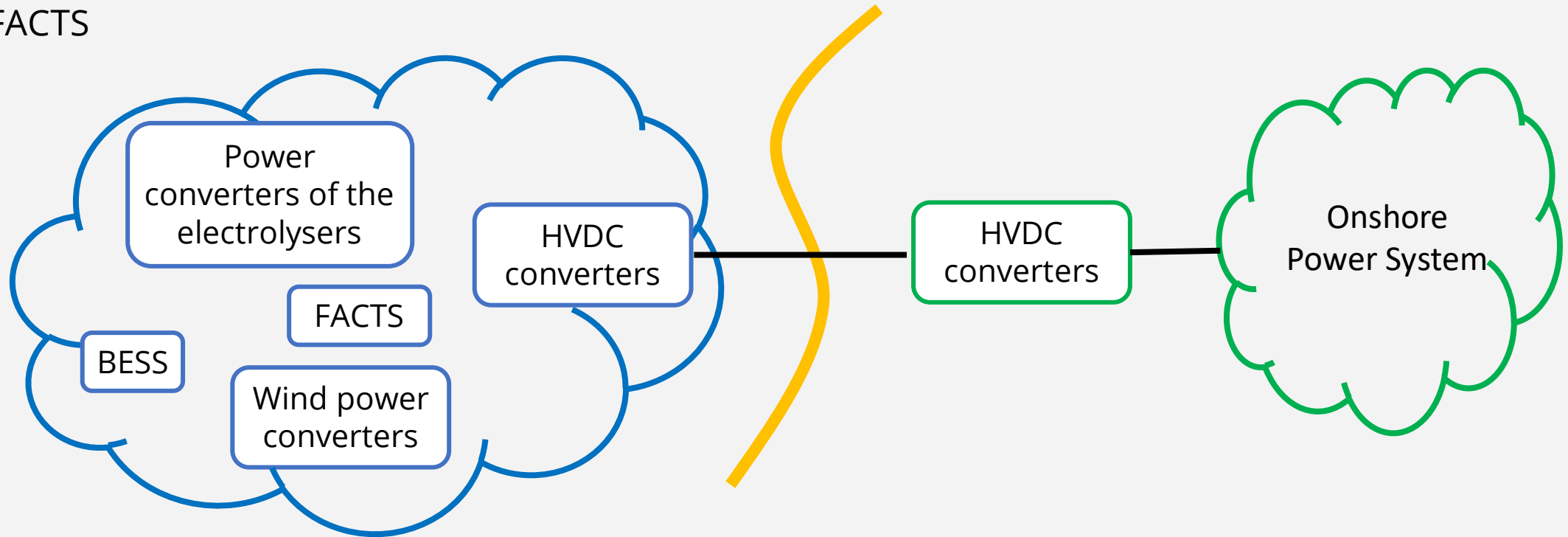
SSO frequency of a recorded event 2014 in China:



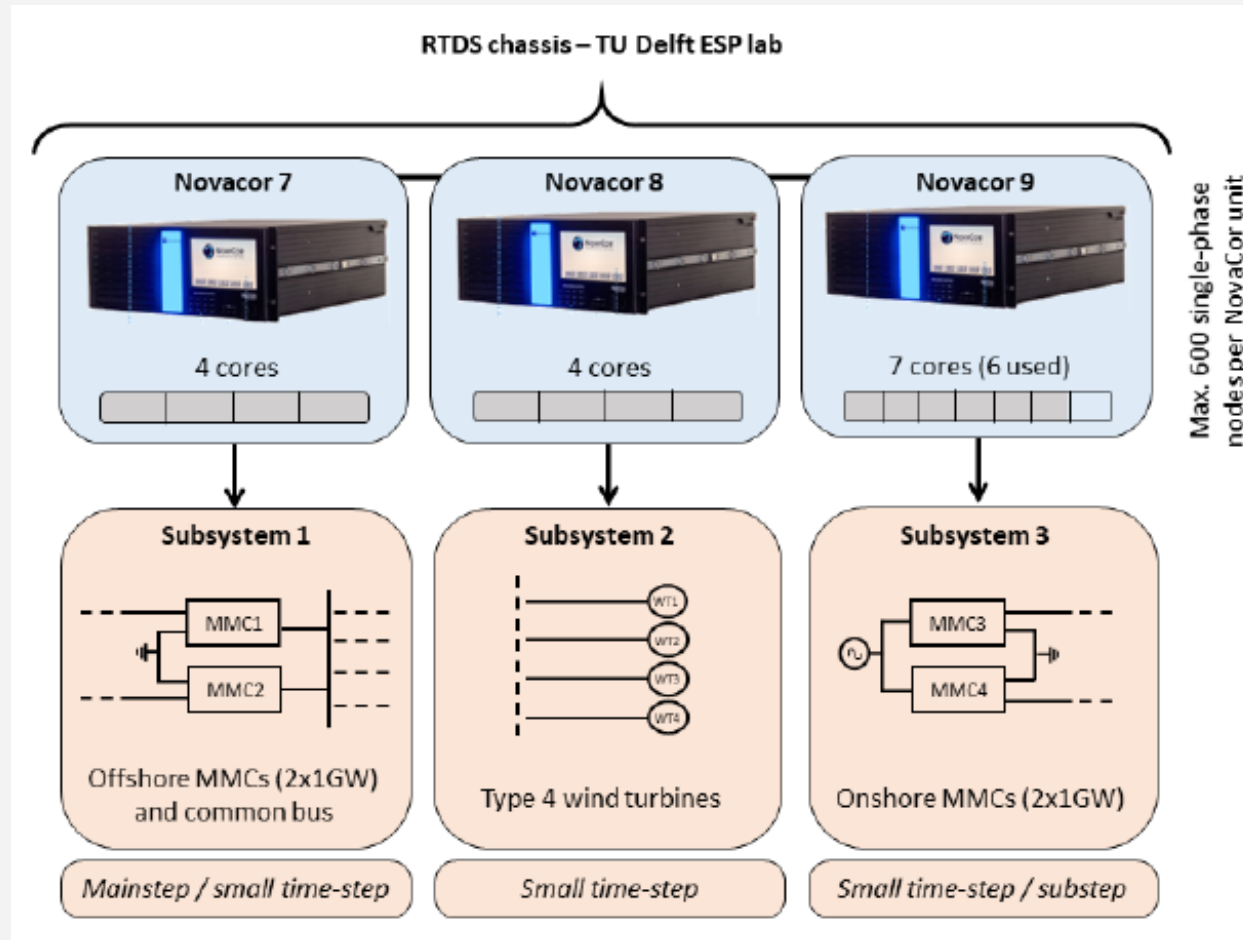
Source figures: H. Liu *et al.*, "Subsynchronous Interaction Between Direct-Drive PMSG Based Wind Farms and Weak AC Networks," in *IEEE Transactions on Power Systems*, vol. 32, no. 6, pp. 4708-4720, Nov. 2017

MULTI-GW AC/DC OFFSHORE ENERGY SYSTEM

- Wind power
- Hydrogen production equipment (electrolysers)
- HVDC / Multiterminal HVDC
- Energy storage (BESS, supercaps)
- FACTS



INITIAL MODEL IN RTDS USED AS STARTING POINT



- Aggregated PMSG wind power
- Bipolar HVDC link connection

FUTURE WORK – (P)HIL TESTBED

