

Design and simulation of 40 MW PM Generator for the CRAFT concept

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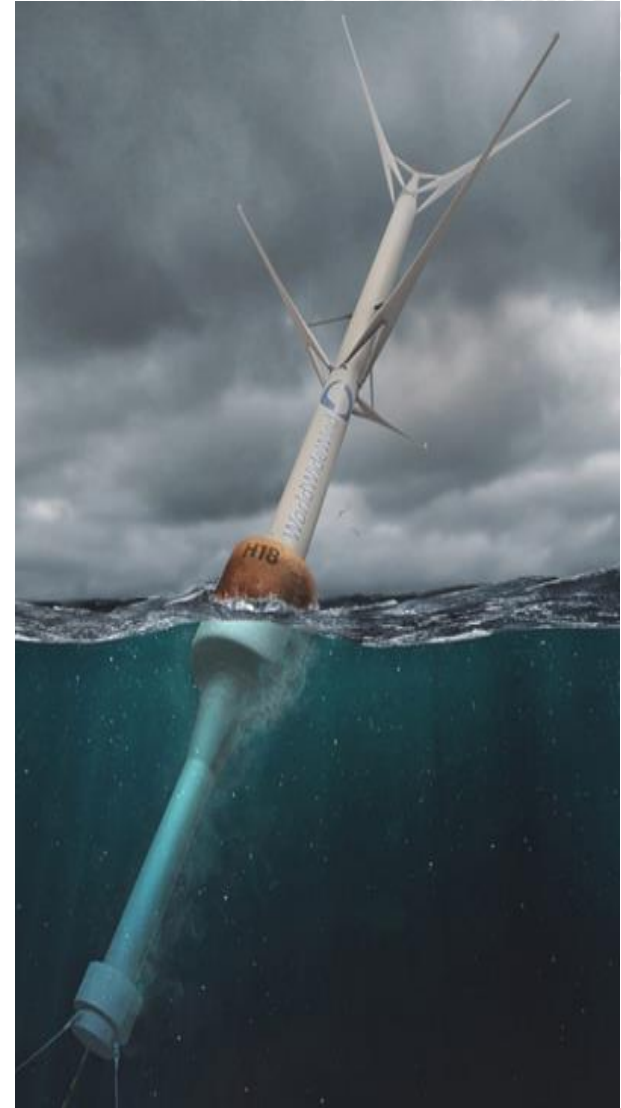
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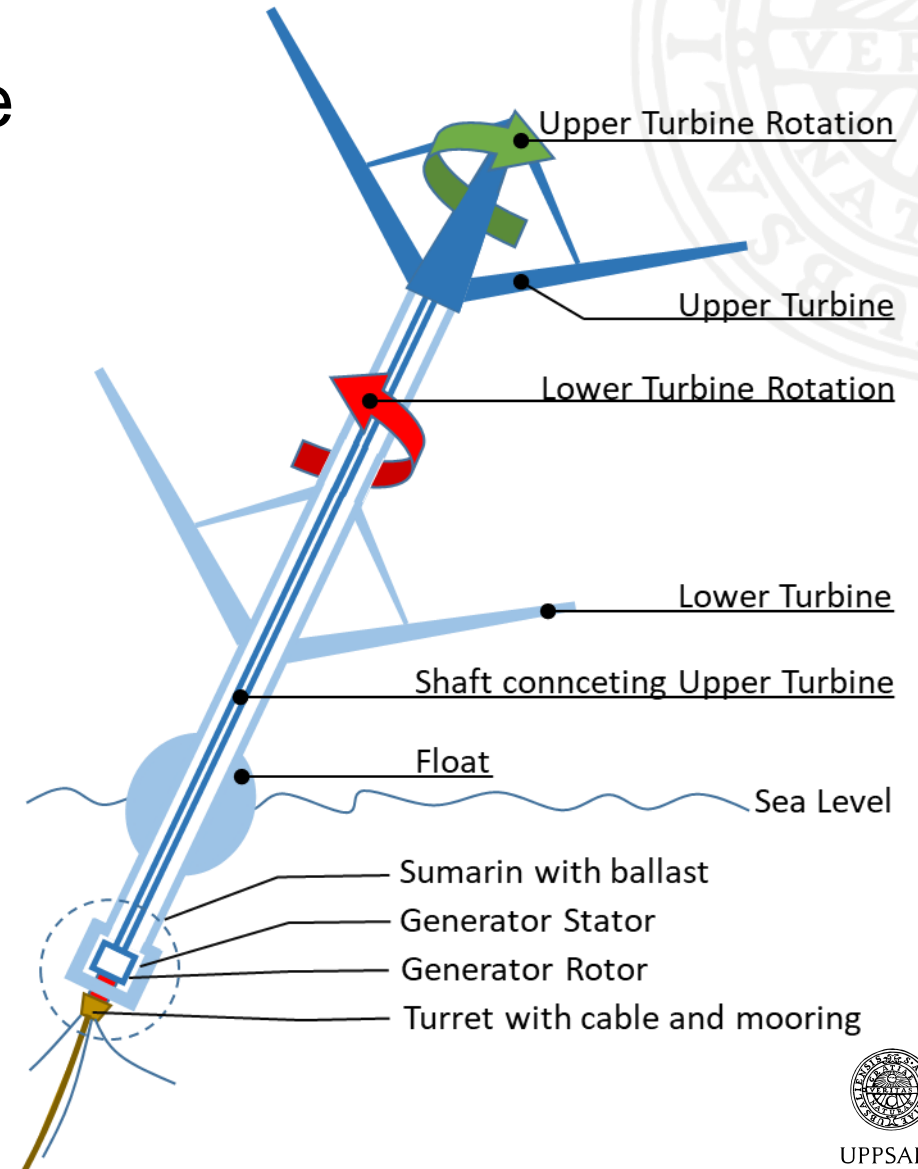
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CRAFT

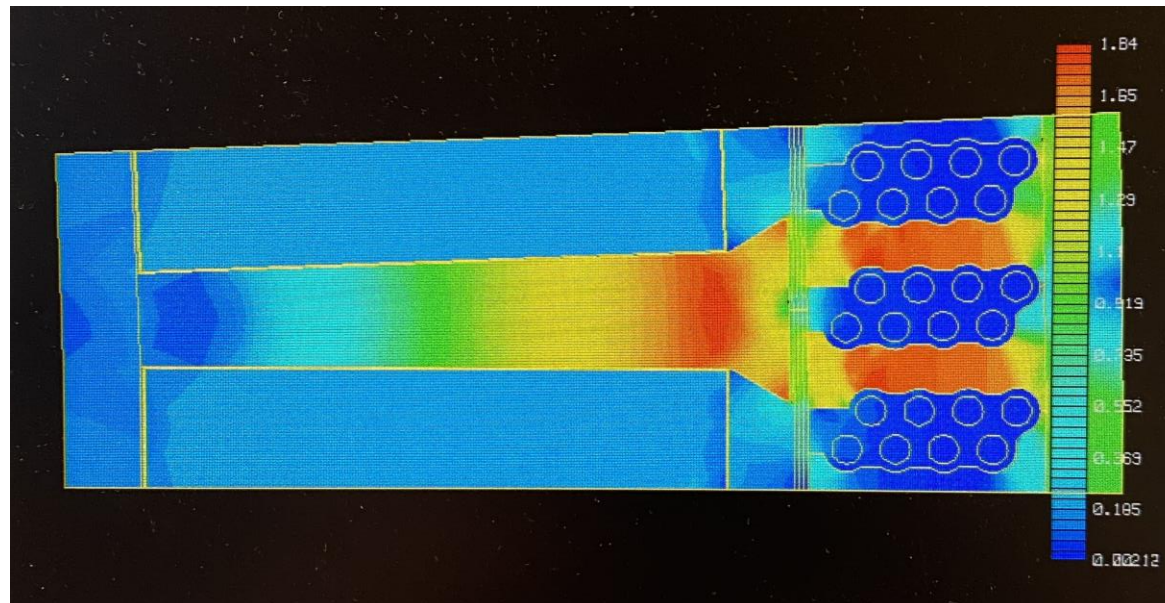
Counter Rotating Axis Floating Turbine

- A new concept from World Wide Wind AS.
- Utilizing counter rotating turbines. One turbine is rotating the stator and one the rotor.
- Generator acts as ballast in submerged housing "Sumarin".
- Two 3-bladed turbines on 1 tower, 1 generator and 1 spar buoy.
- Full electric control of rotational speed.
- Active electric stall control of power capture.
- Designed from first principles for a fully integrated floating system.



Generator Simulation and Calculations

- Full physics finite element method (FEM) and dynamic simulations.
- Generated power from time series expected in the North Sea.
- The cogging of the generator is analyzed.



Generator results

- Stator winding consists of circular cables.
- Rotor consists of buried ferrite PM.
 - + Cheaper.
 - + Weight contributes to stability.

Geometric design parameters	12 m	15 m
Rotational speed [rpm]	10	10
Number of poles	156	168
Number of slots per pole and phase	1/1	1/1
Stator inner diameter [mm]	12 000	15 000
Stator outer diameter [mm]	12 400	15 440
Generator length [mm]	6690	4367



Generator characteristics

Electromagnetic design parameters	12 m	15 m
Power [MW]	40	40
Line-to-line voltage [kV] rms	48	48
Current [A] rms	481	481
Electrical frequency [Hz]	13	14
Cogging [%]	22	22



Generator results

	12 m	15 m
Total weight [ton]	842	826
Efficiency [%]	97,5	97,8
Electromagnetic losses [kW]	1045	886
Copper losses [kW]	688	506
Iron losses [kW]	357	379

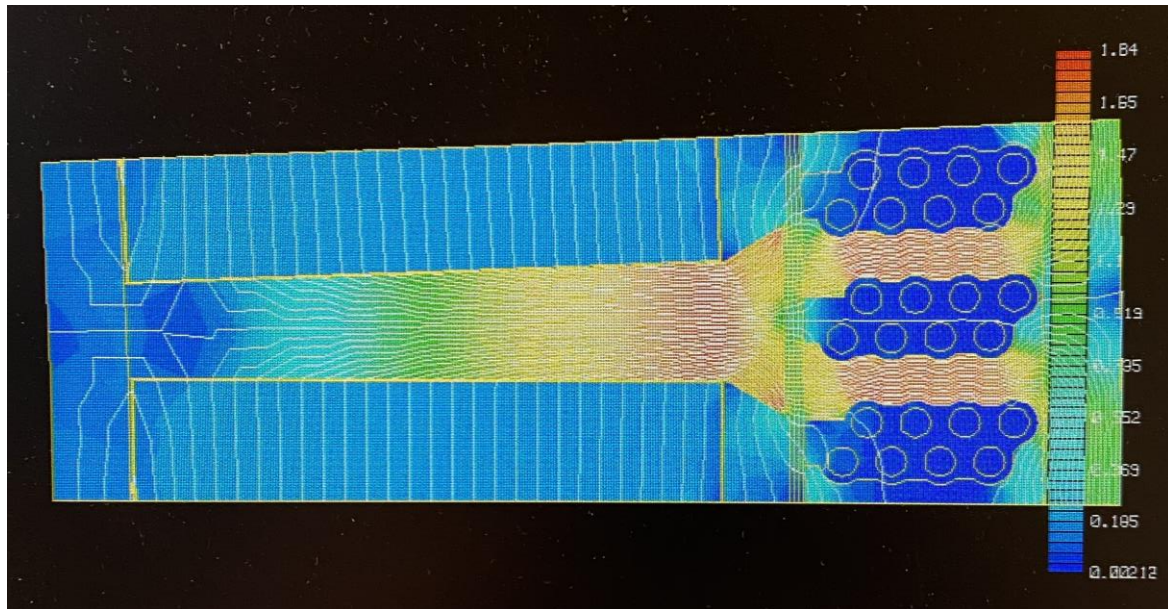


Electromagnetic field

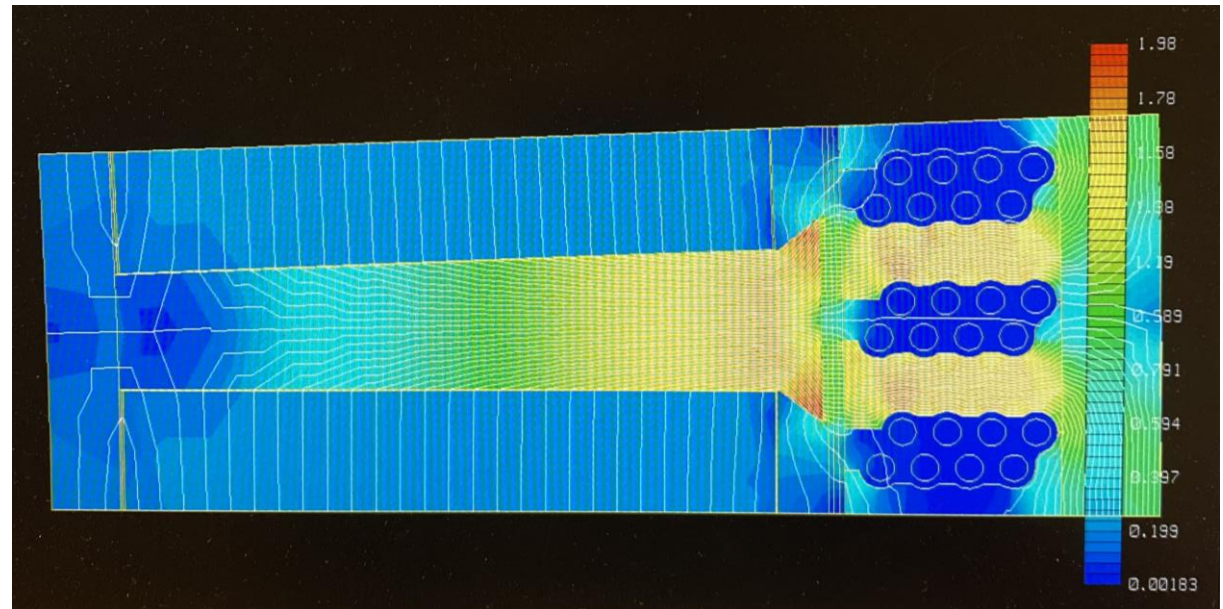
- The magnetic flux with field lines for one pole
- B-field intensity
- Rotor and stator for both machines



12 m generator



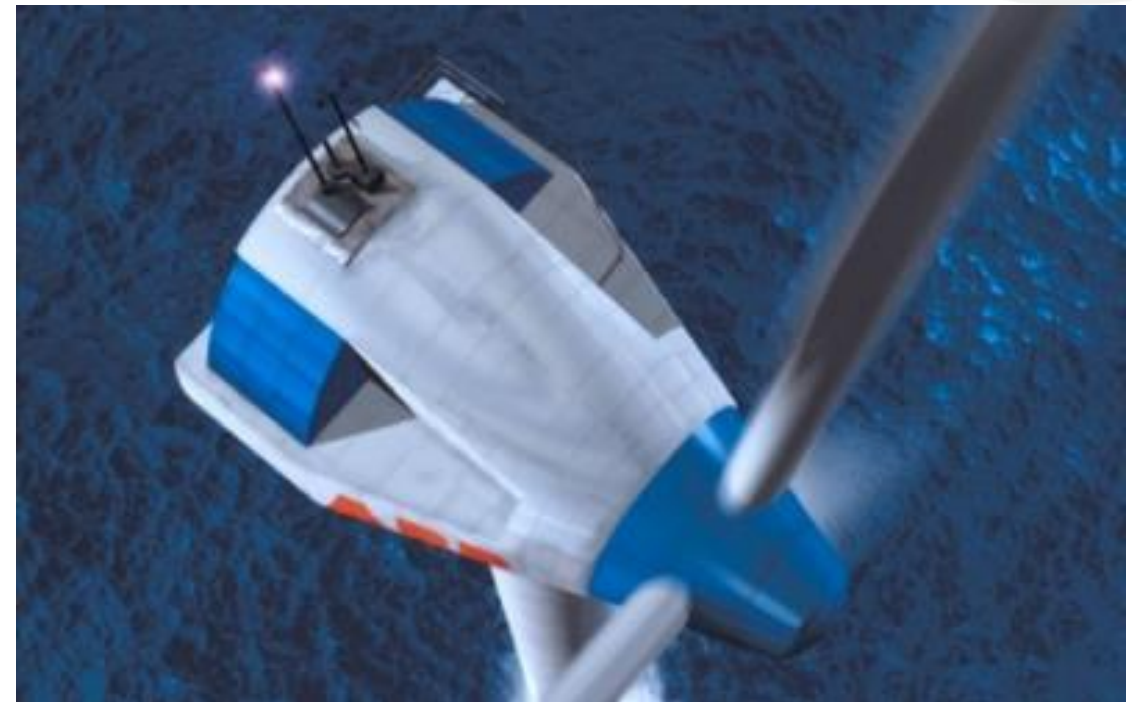
15 m generator



Bench-marking

- Comparing to a direct drive solution (no counter rotation)
- Reducing the rotational speed by half for the 12 m generator
- Both direct drive and ferrite magnets

	12 m CR	12 m DD
Total weight [ton]	842	1700
Length [mm]	6690	13 554



<https://library.e.abb.com/public/a0f92a52ff5b843ec1256f2c0050f23d/31-37%20M153.pdf>

Conclusions

- Design of two 40 MW generator for the CRAFT have been performed and both have successfully been simulated.
- The generator with smaller airgap diameter will have lower material costs due to smaller frame but higher due to use of more active materials.
- For a comparison to a direct drive by reducing the rotational speed by half, i.e. not using counter rotation, would render the generator much larger and heavier.





Thank you!

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for
ENERGY

WorldWideWind 

The logo for WorldWideWind, consisting of a blue circle with a white stylized 'C' shape inside, resembling a wind turbine or a circular arrow.

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