Definition of a Baseline Rotor for a 25MW Floating Offshore Turbine

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INTRODUCTION AND BACKGROUND

Wind turbine sizes have grown rapidly in recent years with machine ratings of 15-16 MW available from multiple manufacturers of offshore wind turbines.

To aid offshore floating wind R&D, the academic research community has developed several open-source wind turbine reference models at 10 and 15 MW scales; however, the industry is eyeing even larger machines in the 20-25+ MW range.

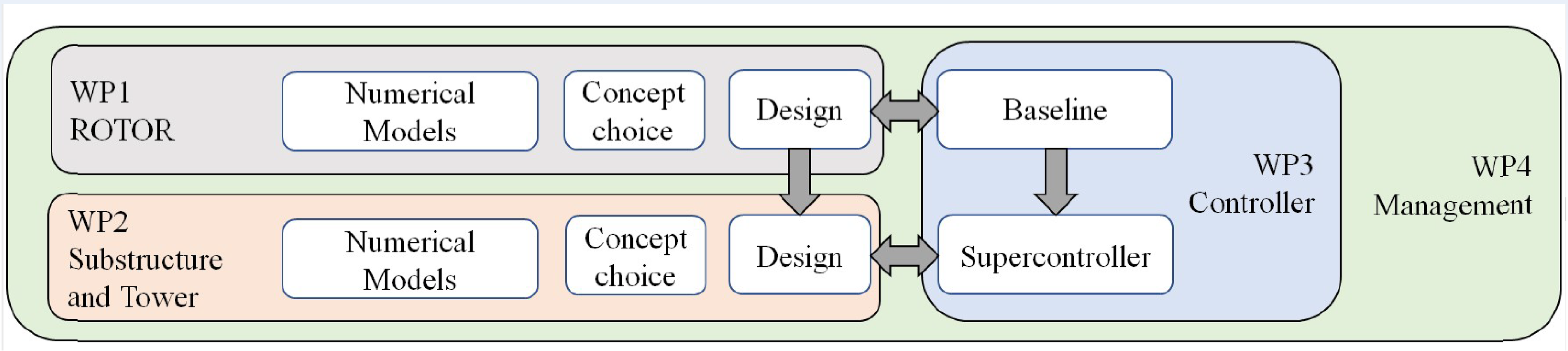
Such reference models are highly valuable to provide early guidance on technology performance and technology limits (or needs) while providing the entire community with common baseline reference designs aimed at evaluating both new turbine technology (e.g., new control systems) along with new floating system designs (e.g., new hull and mooring configurations).

The present study presents the definition for an initial baseline rotor design at 25 MW scale for a floating offshore system, which can serve as a starting point (technology baseline) for future optimization studies.

The team includes partners from IFE, NTNU, and UT-Dallas (University of Texas at Dallas, USA) where efforts have focused on design of a floating 25 MW turbine (3-bladed upwind horizontal axis wind turbine) on a semi-submersible floating system.

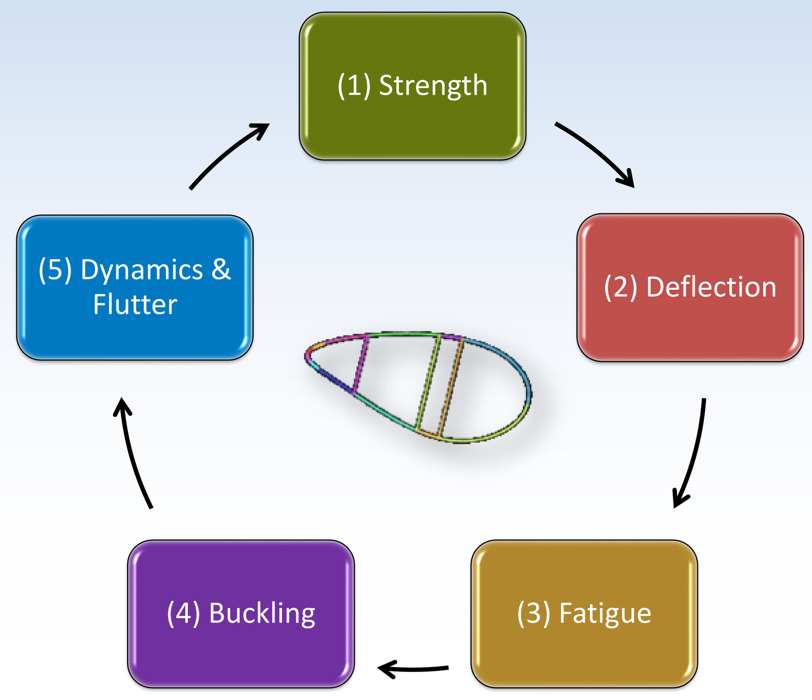
TEAM'S TURBINE DESIGN APPROACH

UPSCALE Project Aim: Holistic design approach aimed to address the need for research to push boundaries.



UT-DALLAS'S BLADE DESIGN APPROACH

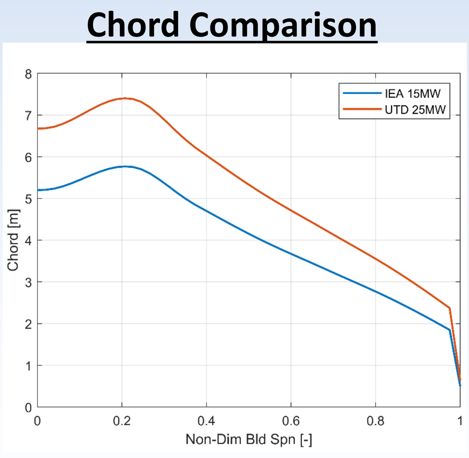
International design standards-based approach for blade design to satisfy a comprehensive set of requirements on strength, deflection, fatigue, buckling, and dynamic stability (resonance and flutter).



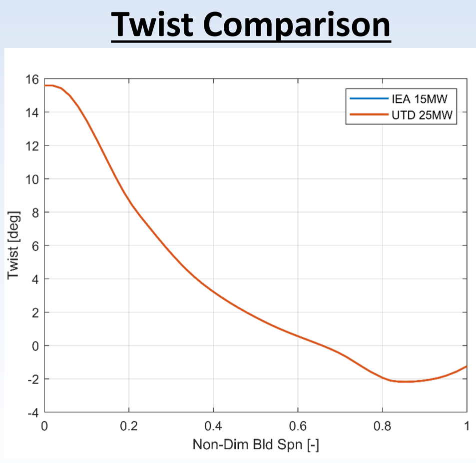
INITIAL 25MW ROTOR BLADE AERO-STRUCTURAL DEFINITION

Baseline aerodynamic design: (1) high efficiency design with max Cp = 0.50, (2) based on upscaling IEA 15MW.

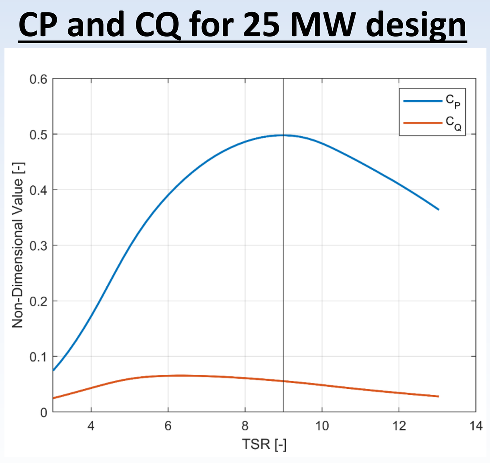
Chord Comparison



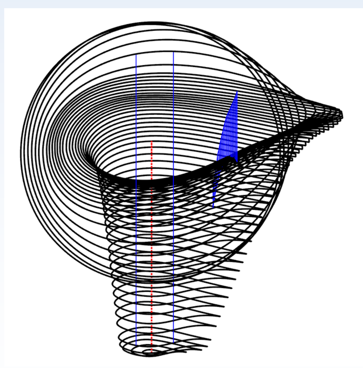
Twist Comparison

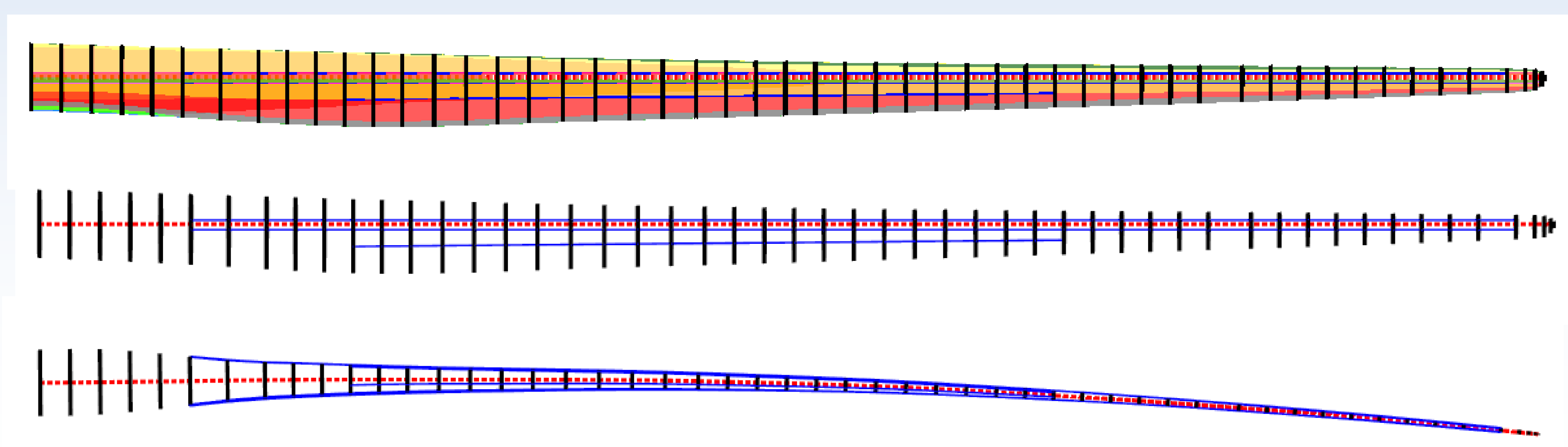


CP and CQ for 25 MW design

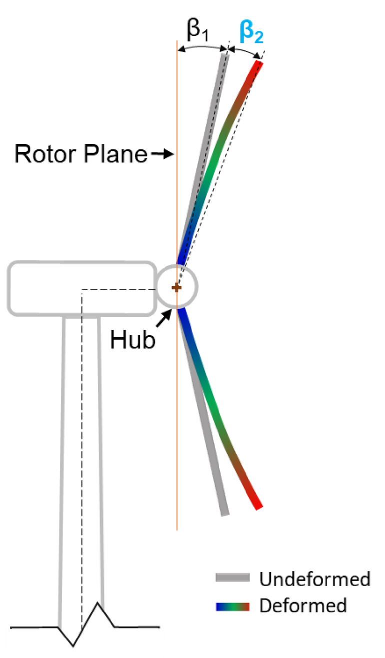


Baseline structural design: (1) Detailed geometry and composite layup definition using NuMaD software, (2) iterations performed to minimize blade mass while meeting design standards structural requirements noted above.





ASRS (Aero-Structural Rapid Screening) is a design approach developed at UT-Dallas that allows fast and detailed evaluation of new blade design concepts. Goal is to speed up process to evaluate new concepts while including all relevant disciplines (aerodynamics, structures, control, and cost).



ASRS Methodology:

1. Create aerodynamic rotor designs
2. Select blade pre-cone and flexibility (this is new) and calculate loads by emulating controller
3. Optimize blade structure
4. Evaluate LCOE

$$\beta_{Total} = PreCone(\beta_1) + Passive\ Cone\ (\beta_2)$$

		Before ASRS	Initial Baseline	Future Design
Structural Iteration #		S25	s27 (ASRS)	TBD
Controller		Peak-Shaving	Peak-Shaving	TBD
Blade Mass	metric tons	163	146	TBD
Blade Material Cost	$ M	2.150	1.68	--
1st Flap Frequency (0 RPM)	Hz	0.339	0.351	--
1st Edge Frequency (0 RPM)	Hz	0.434	0.494	--
Allowable RootMyb	kNm	3.80E+05	3.80E+05	--
Allowable RootMxb	kNm	3.79E+05	3.79E+05	--
Max. Root Mxb (OpenFAST)	kNm	1.01E+05	8.79E4	--
Max. Root Myb (OpenFAST)	kNm	2.41E+05	2.44E5	--
Max. Tip Deflection (OpenFAST)	m	22.2 (21 % margin)	27.6 (22% margin)	--
DLC 1.2 AEP*	$/GWhr	127.6	127.4	--

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