

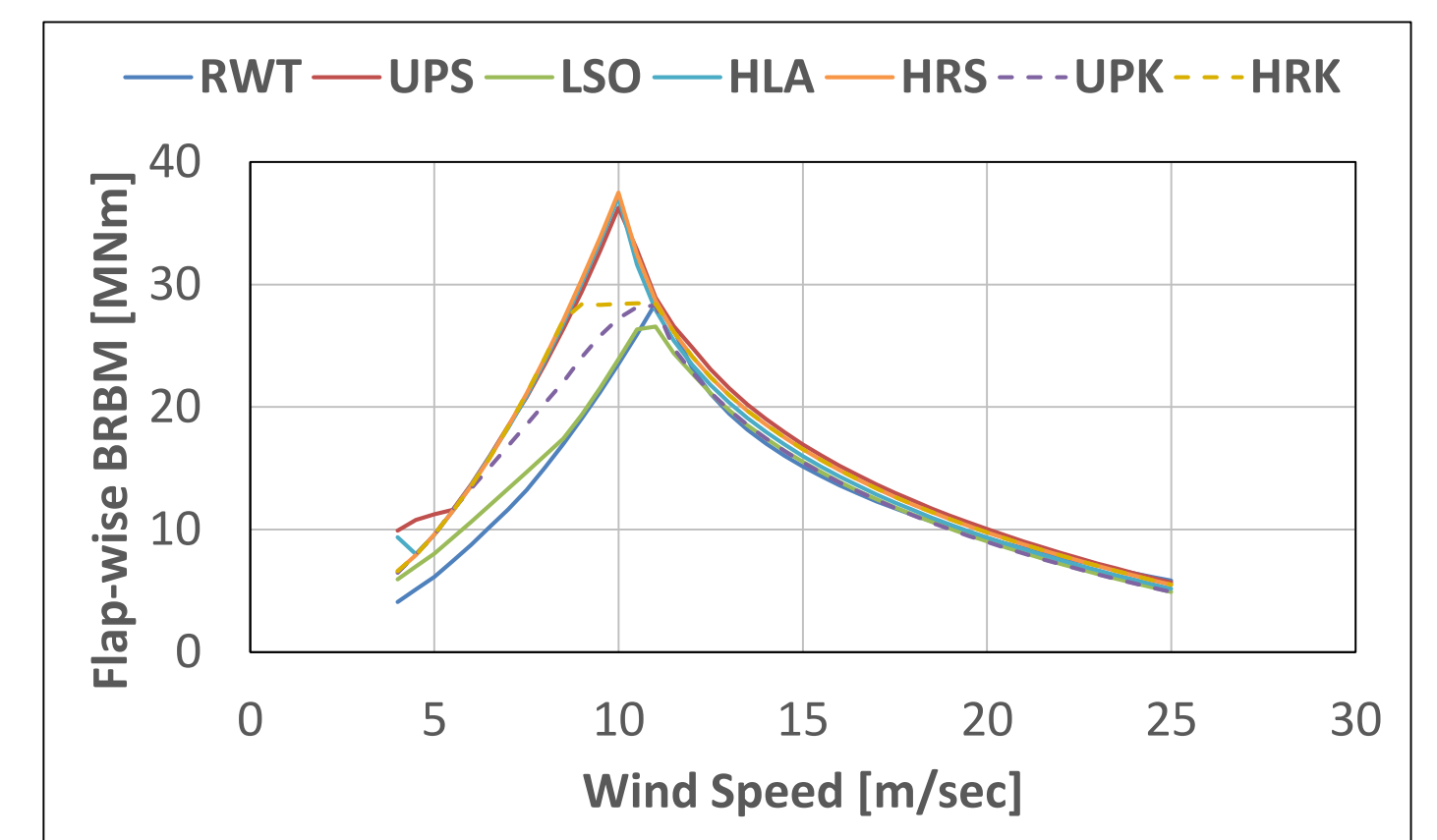
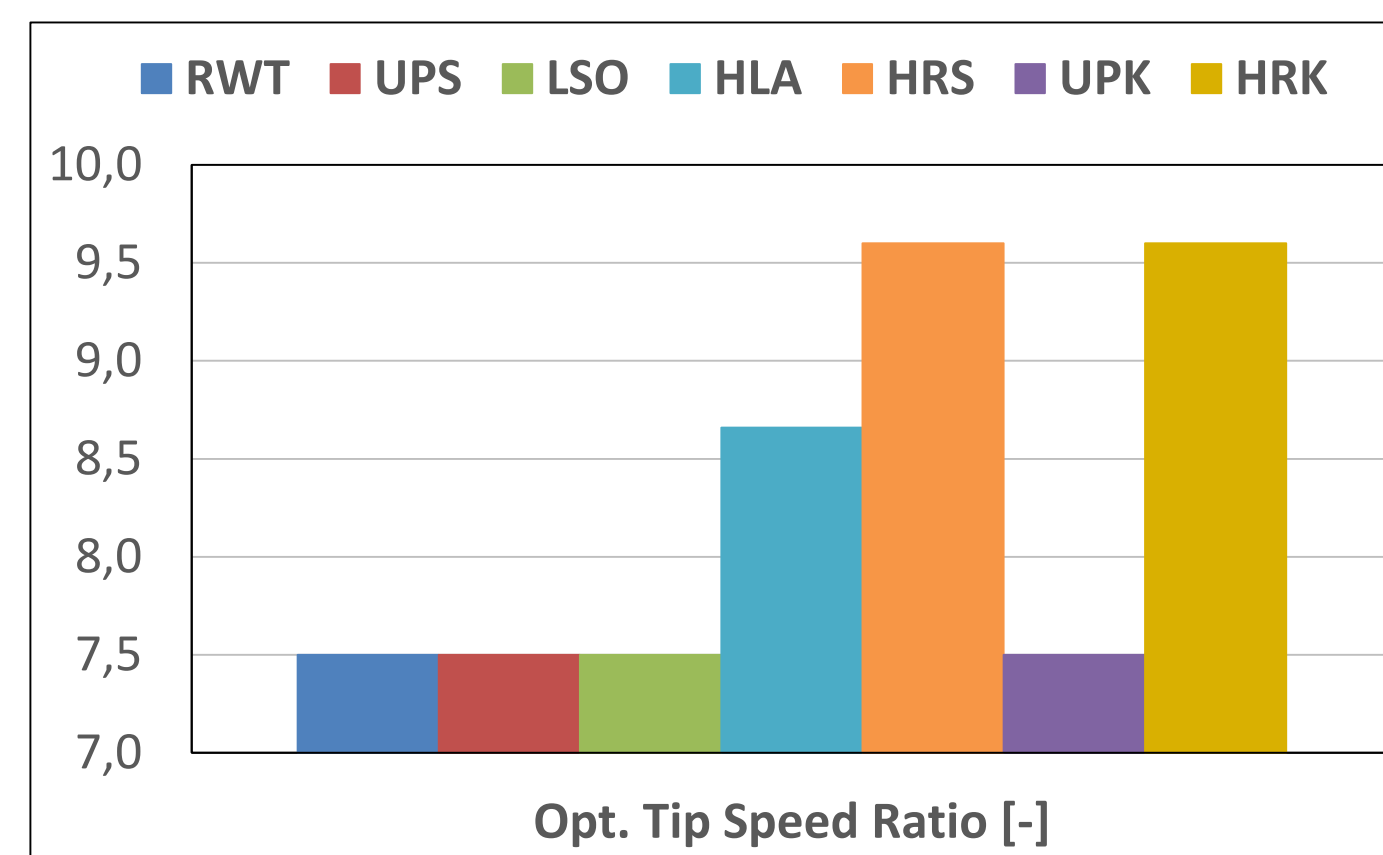
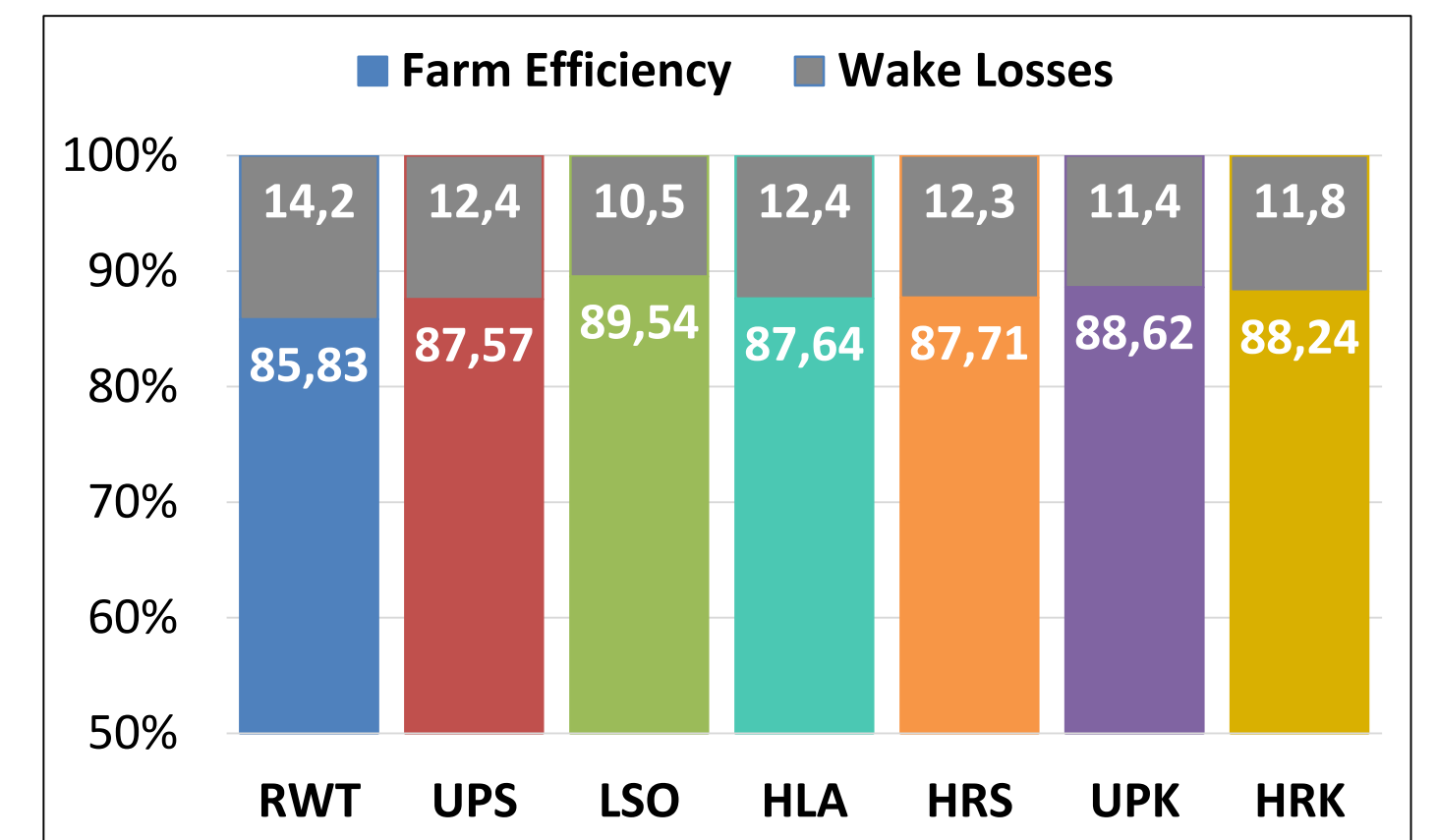
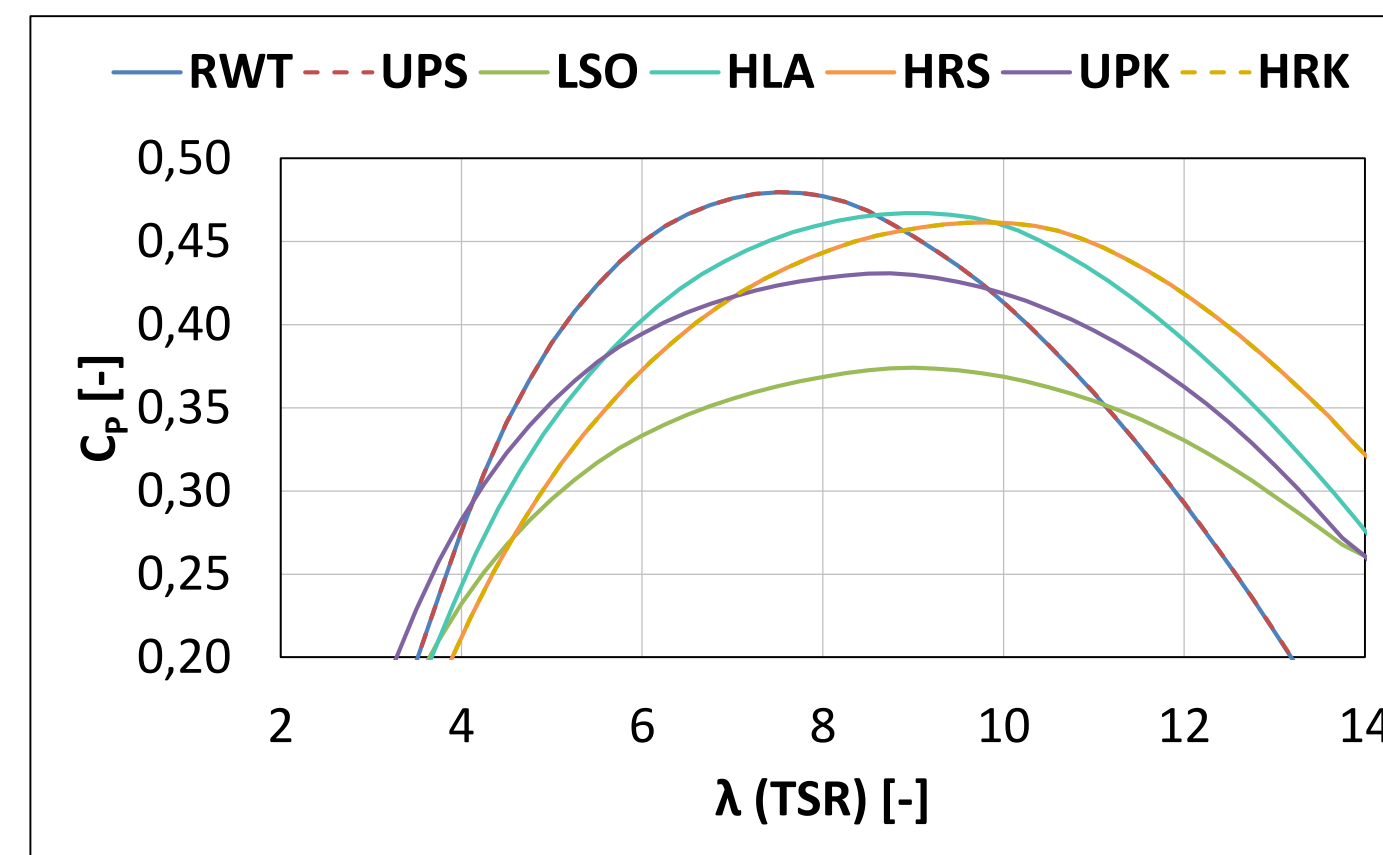
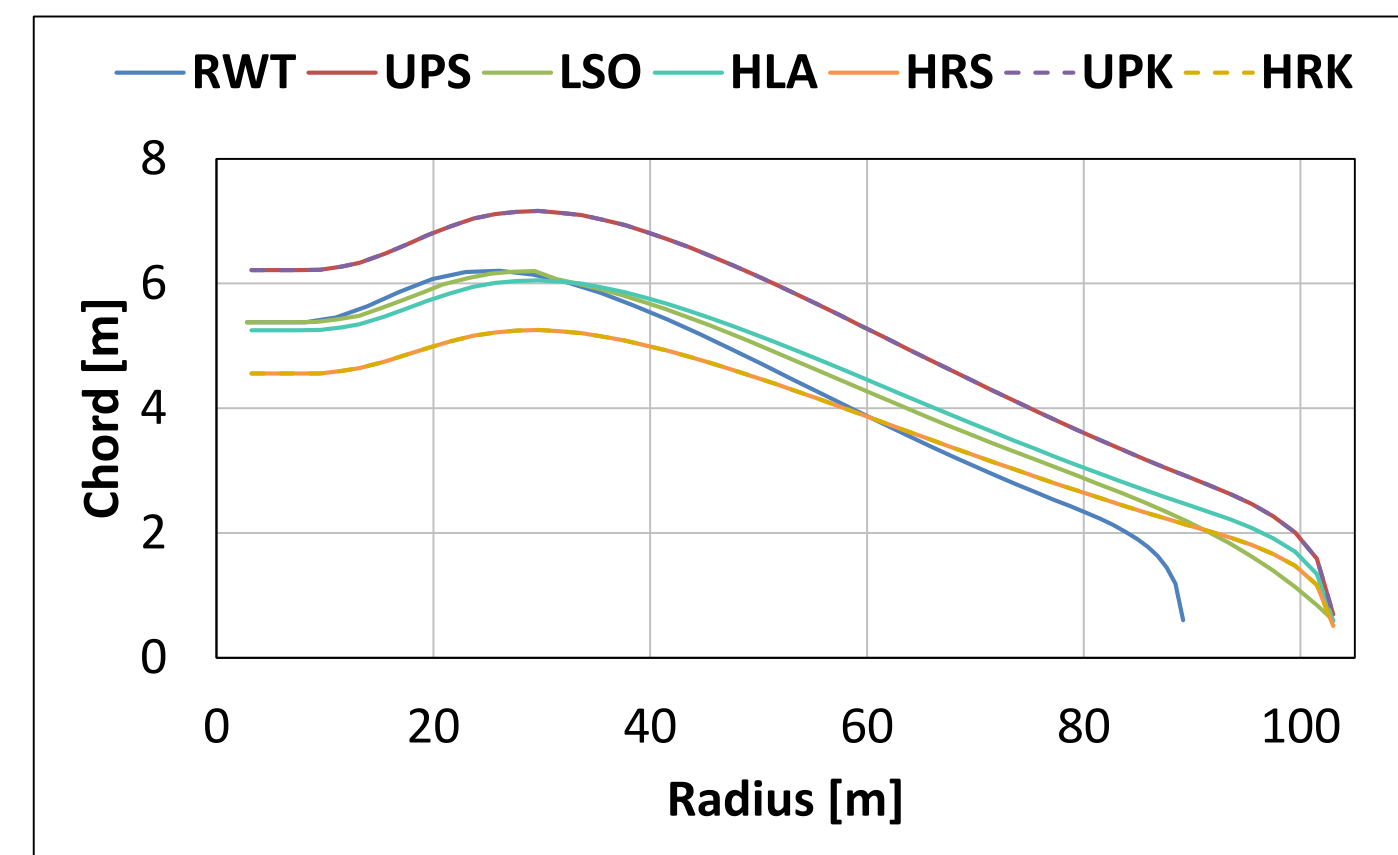
## Objectives

1. Investigate different rotor concepts for the future 10MW offshore wind turbines.
2. Create primary, coherent structural models (i.e. mass, stiffness properties) via the proportional effect of aerodynamic, gravitational and centrifugal loads.
3. Evaluate the rotor concepts both in wind turbine level and in wind farm level with a simple cost model.

## Rotor Concepts

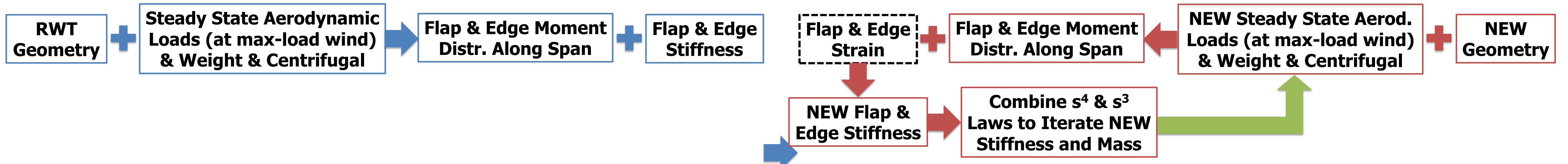
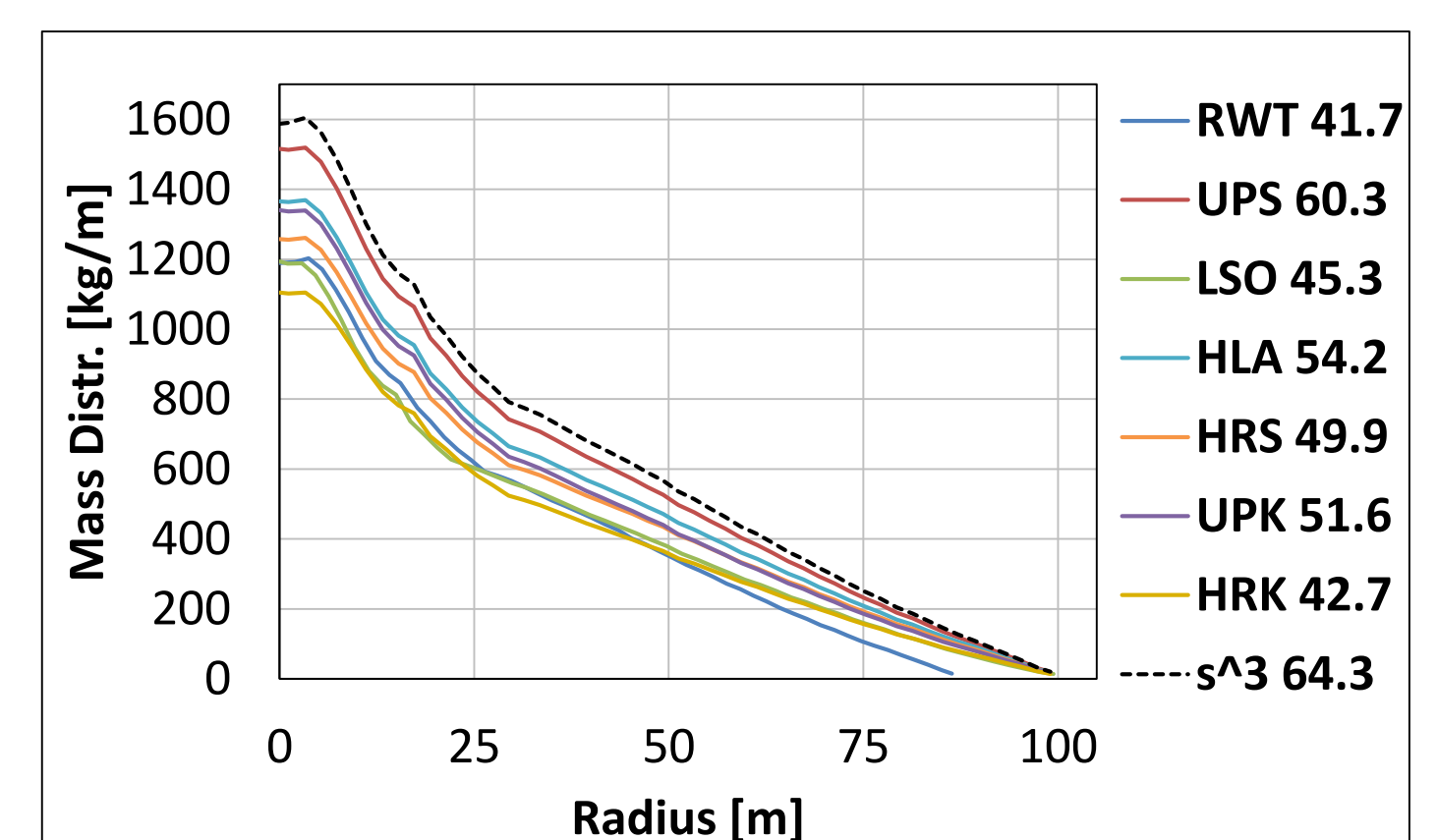
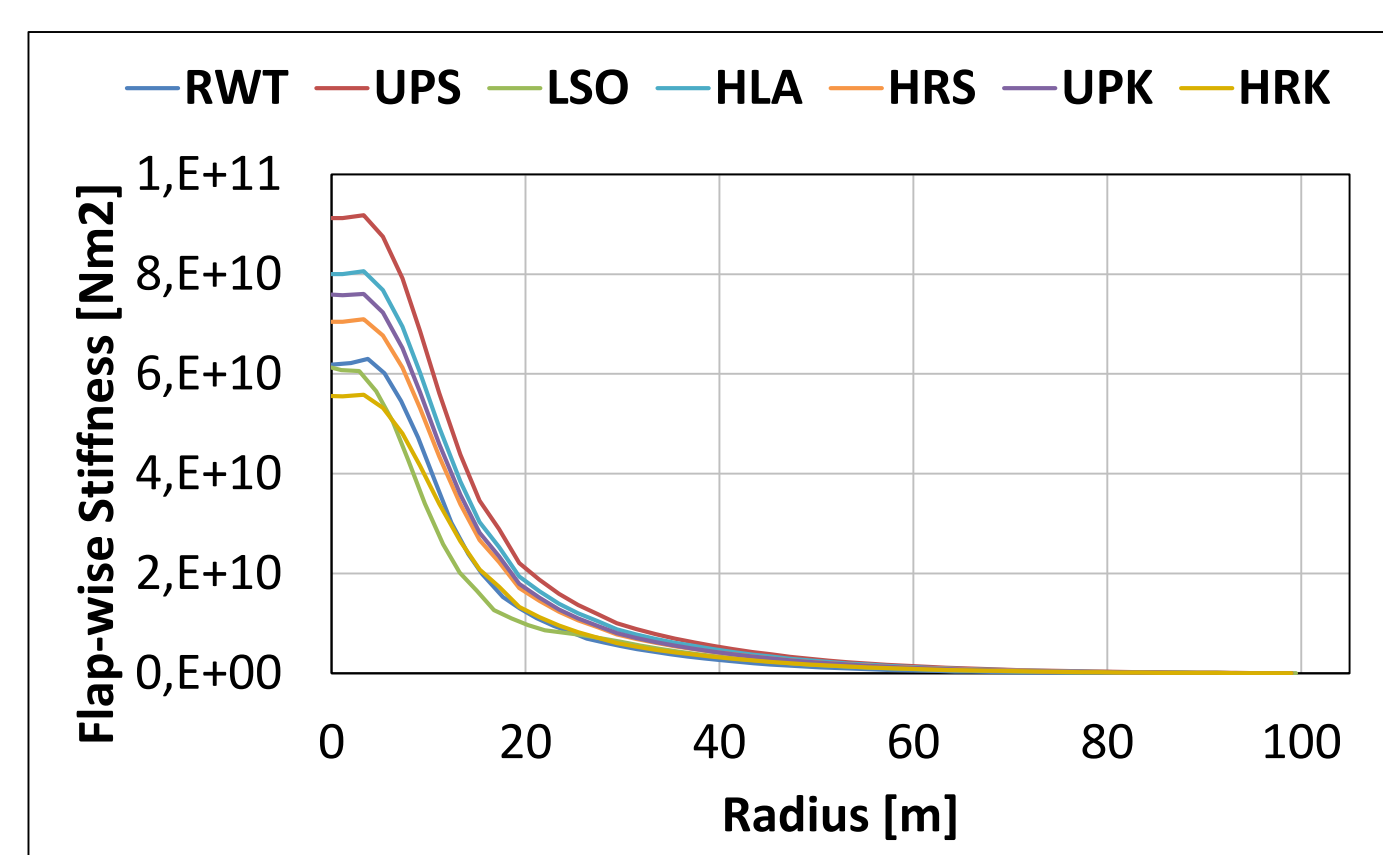
1. Reference Wind Turbine **RWT**
2. Upscale (geometrical) **UPS**
3. Low Solidity **LSO**
4. Higher Lambda **HLA**
5. Higher Rotor Speed **HRS**
6. Upscale w/ Peak Shaving **UPK**
7. Higher RPM w/ P. Shav. **HRK**

- Airfoils and the distribution of them are kept the same.
- Power density drops from 400W/m<sup>2</sup> to 300W/m<sup>2</sup>. Tip speed, RPM, TSR vary.
- Tower structure and hub height (119m) are kept the same.
- Higher loads in **UPS, HLA, HRS**; in **LSO, UPK, HRK** almost the same by design.



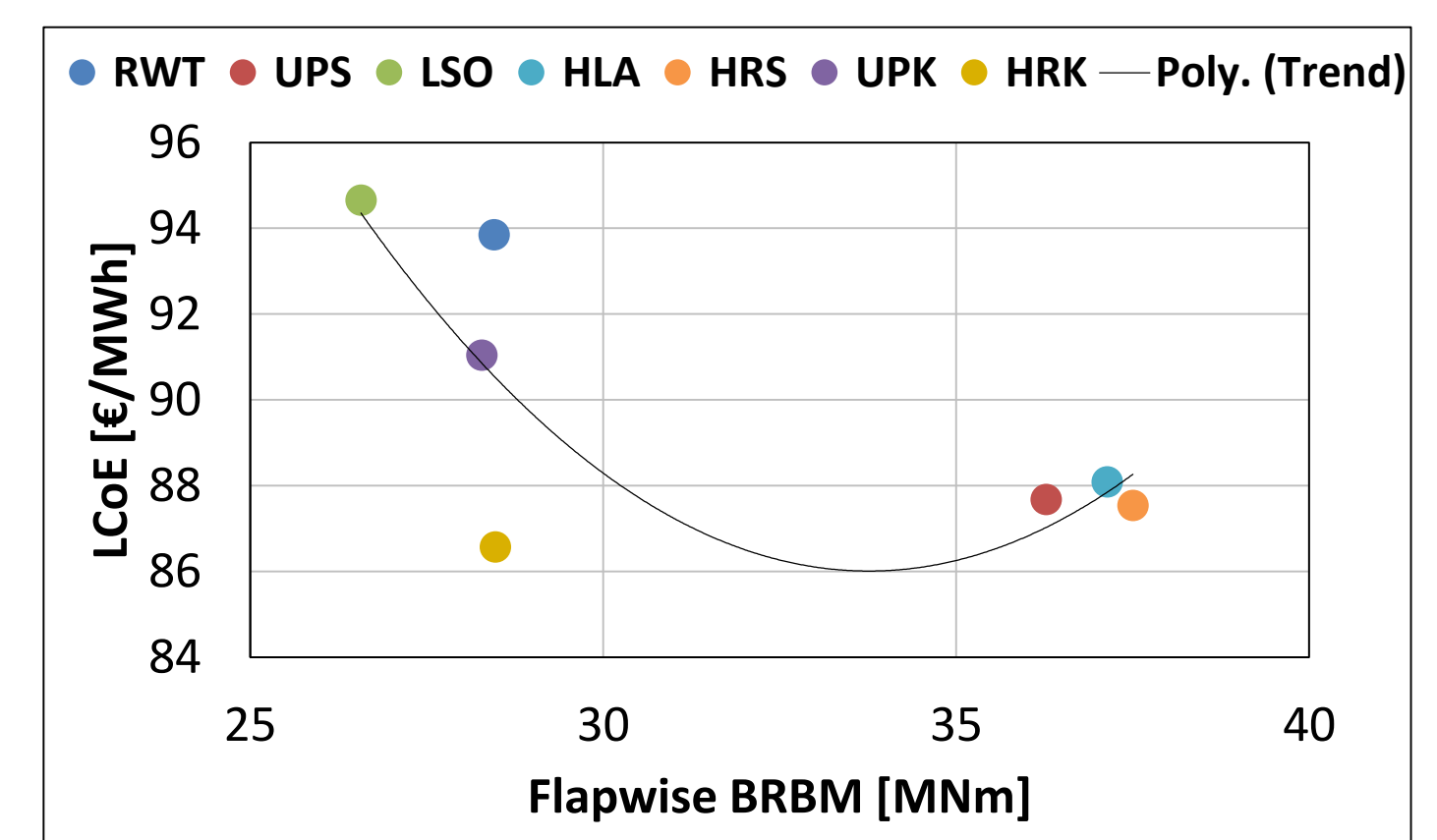
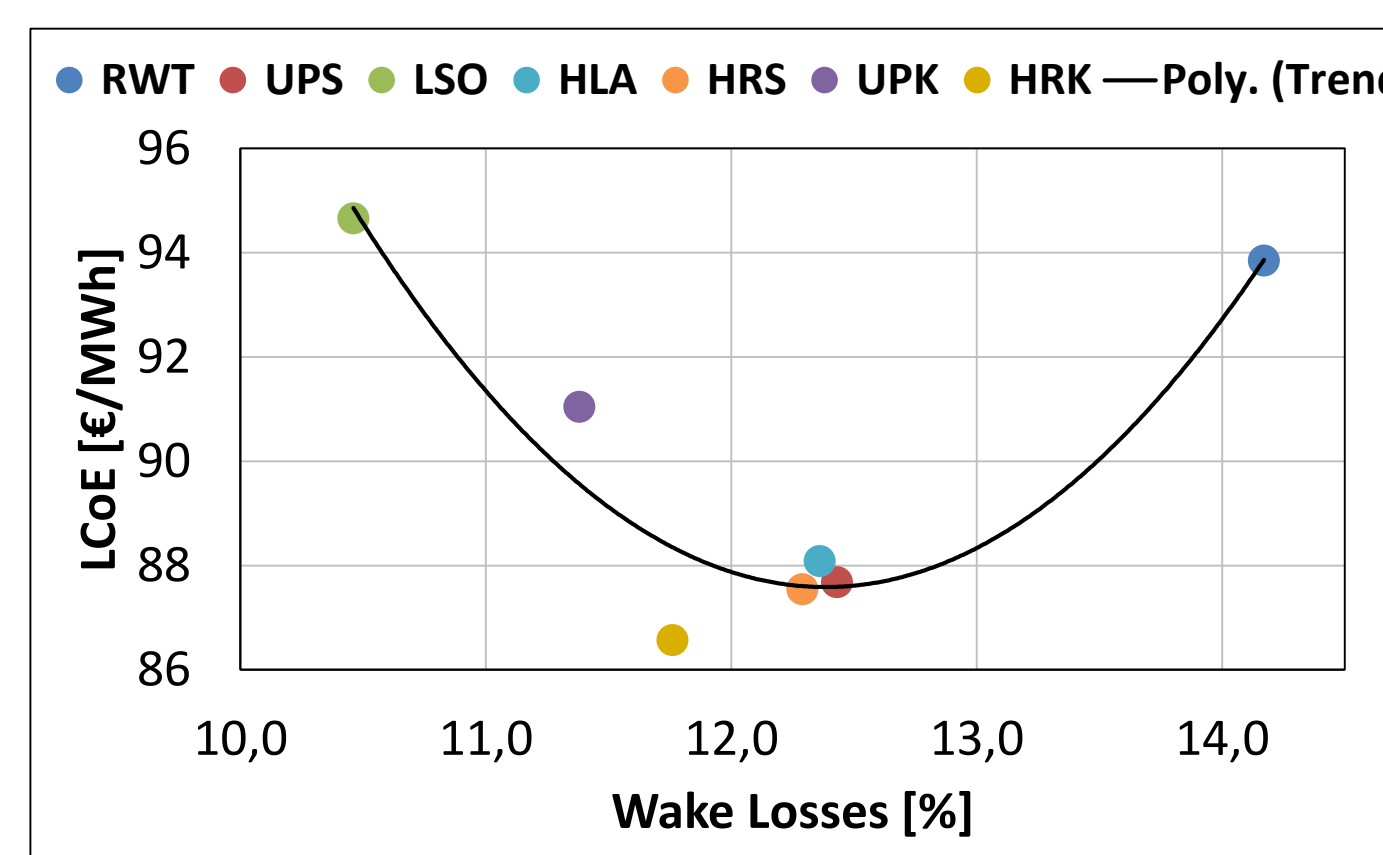
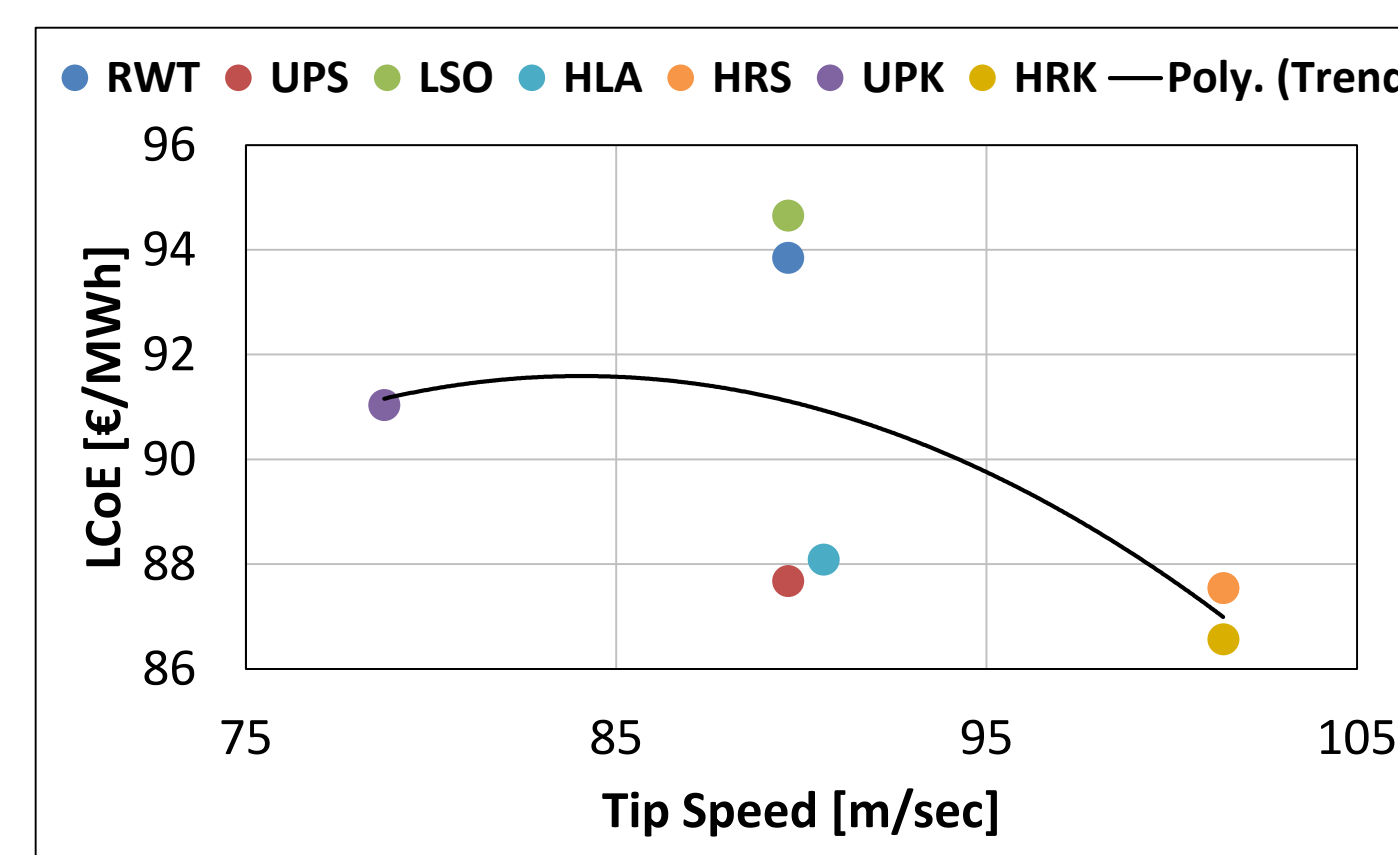
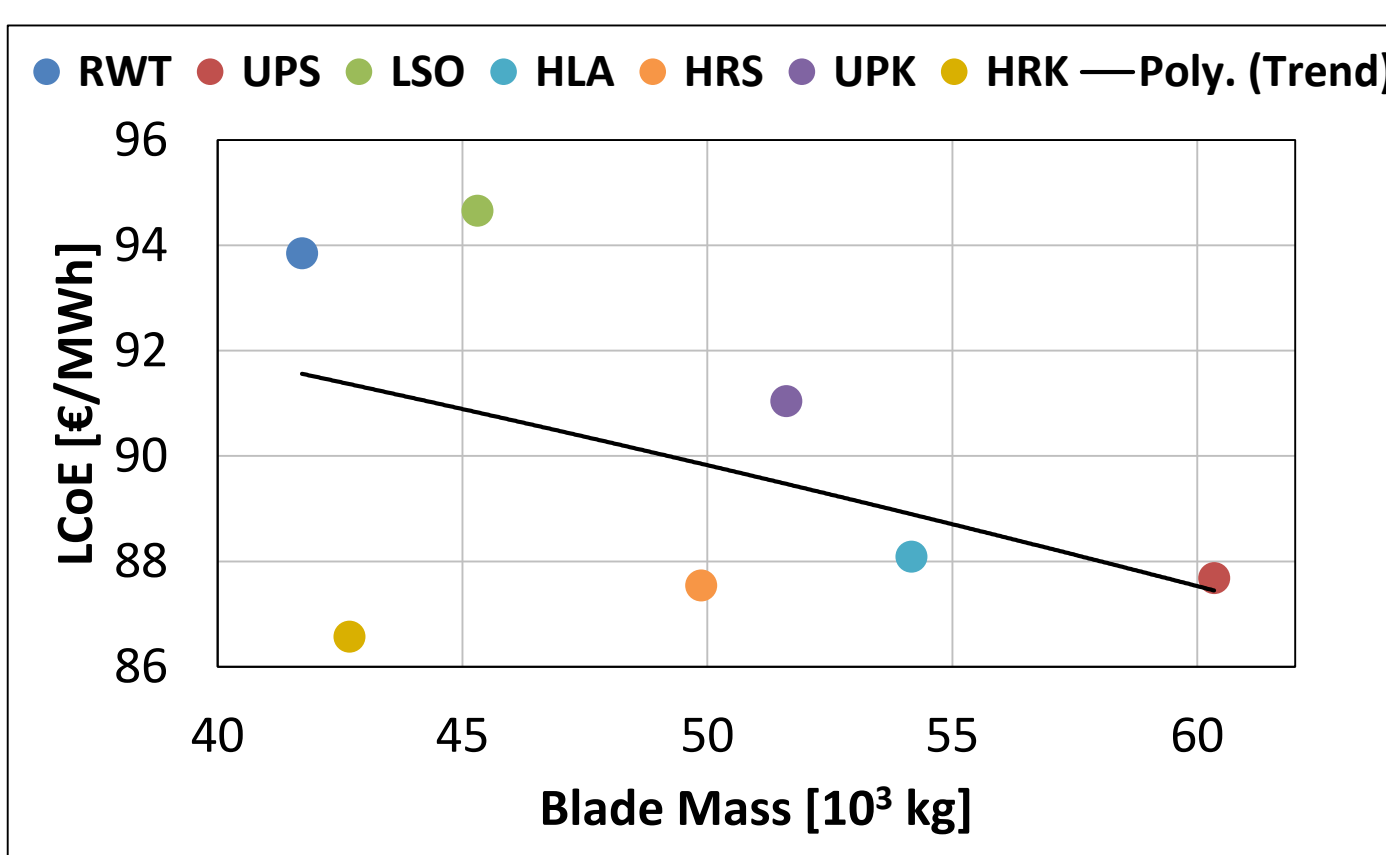
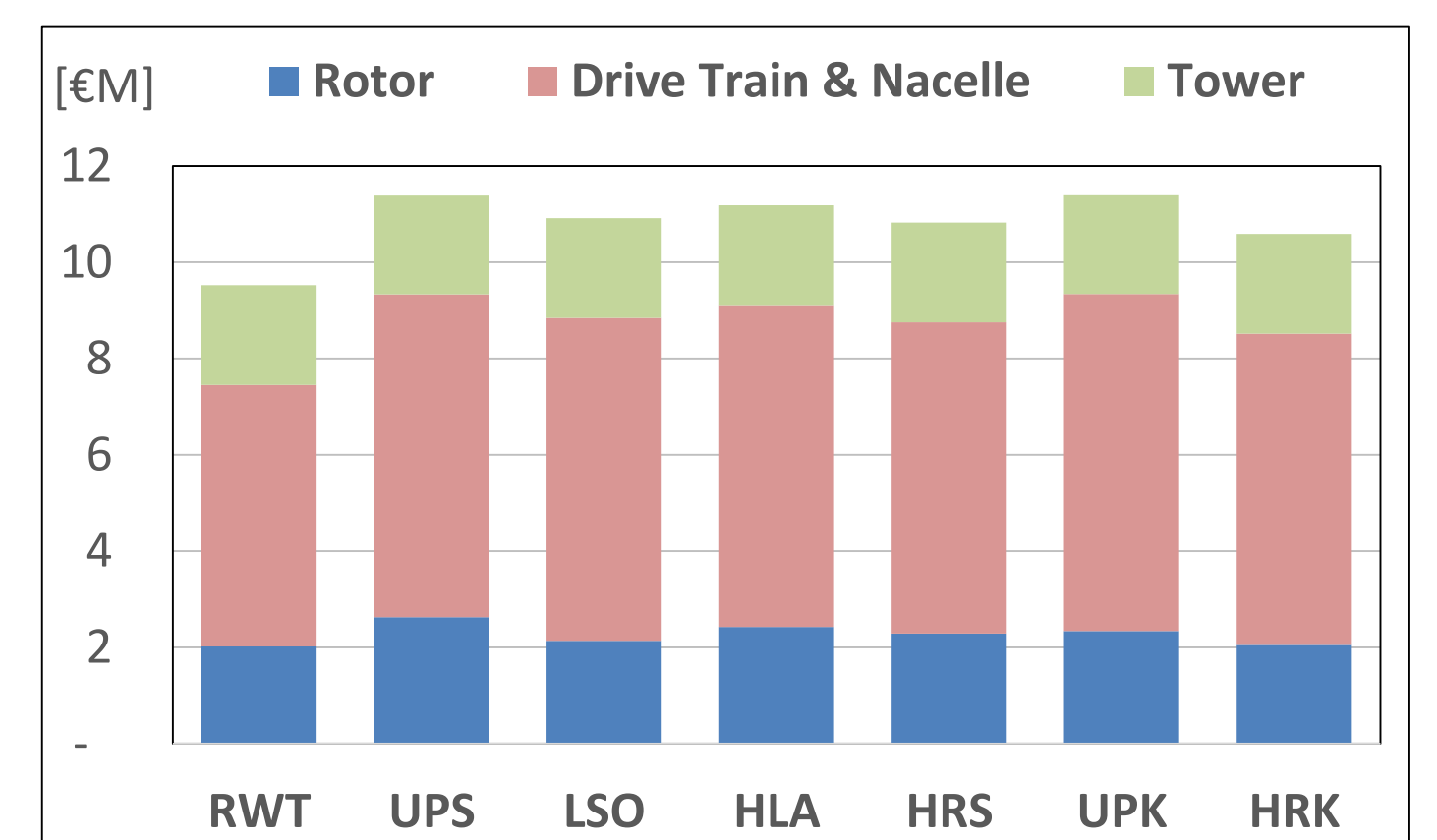
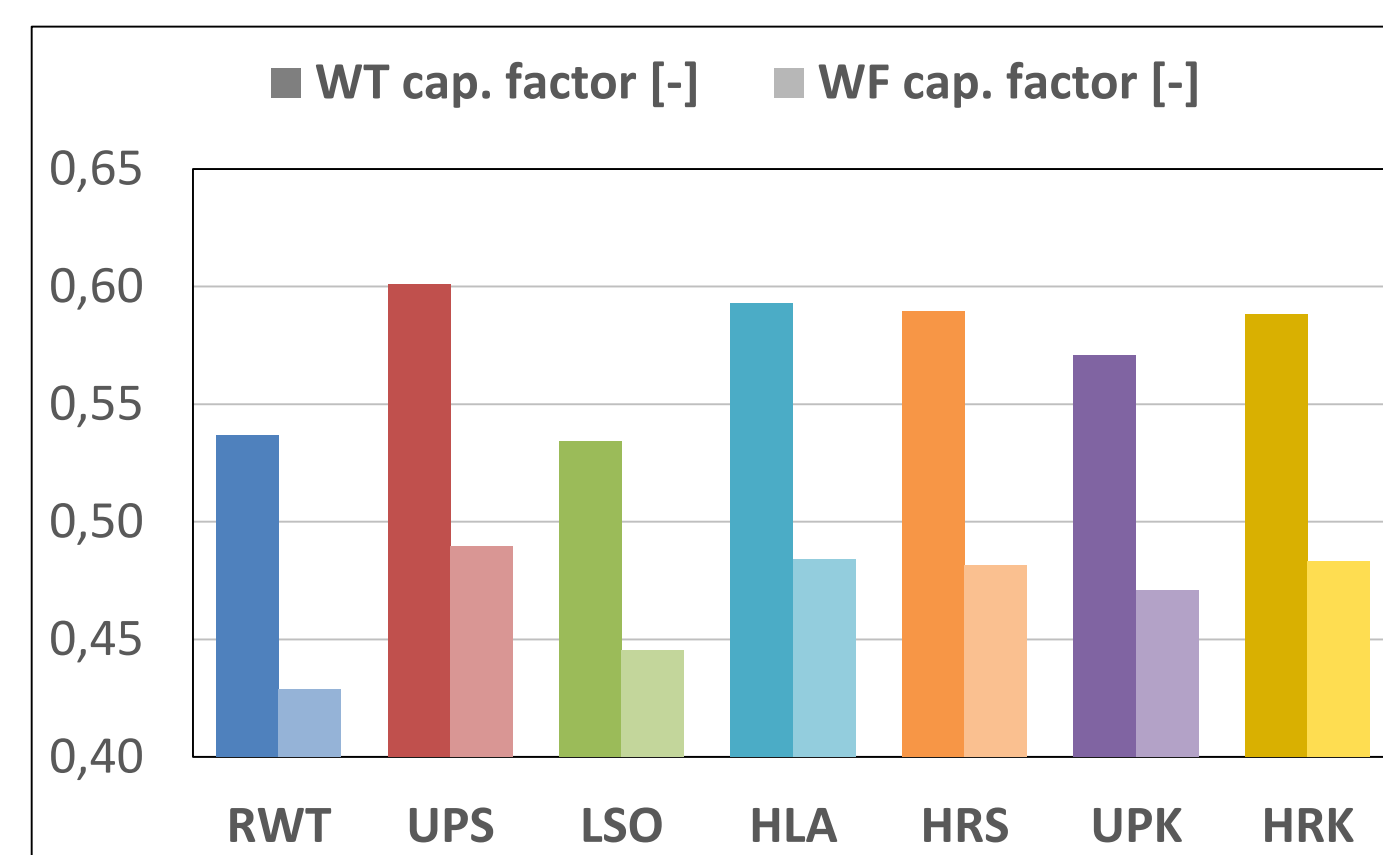
## Methodology

- 3-axis independent up-scaling to reflect geometric changes.
- Done at maximum-load (ca. rated) operating point, based on strains.
- Iterations to calculate blade mass (smaller than linear law  $s^3$ ).
- Aeroelastic Analysis with Focus6 package (PHATAS and BLAEMODE).



## Cost Modelling

- INNWIND cost model is used.
- Component costs depend on operating and physical parameters (power, torque, masses etc.).
- Up-scaled from the UpWind 5MW wind turbine.
- Incorporates site conditions, certain O&M and BoP costs and losses.
- An 800MW farm considered based on Horns Rev conditions and simulations.



## Conclusions

- An LCoE reduction (ca. 6-8%) can be achieved at the wind farm level despite blade mass and single WT cost increase.
- Wake losses need to be taken into account for cost calculations since they influence the costs significantly.
- LCoE is driven by the combination of many factors at the same time. Therefore, wind farm design should be done integrally including the turbine.

## Acknowledgements

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