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Public Workshop 10th December 2020

WFC strategies for providing levelized loading during active power control

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ForWind – Center for Wind Energy Research

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 857844.

Wind turbine loading in a wind farm

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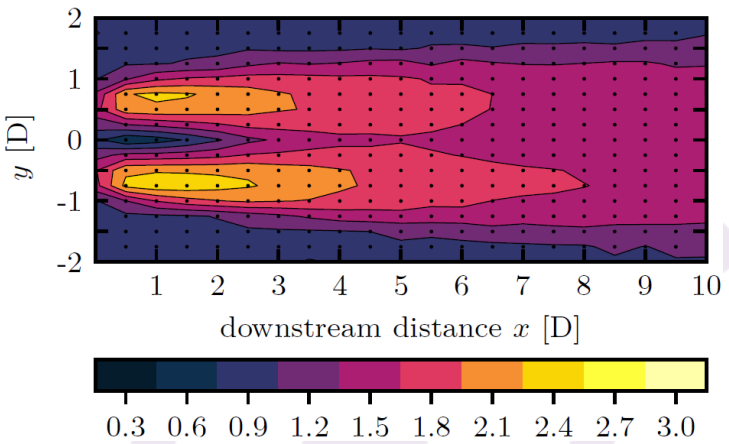
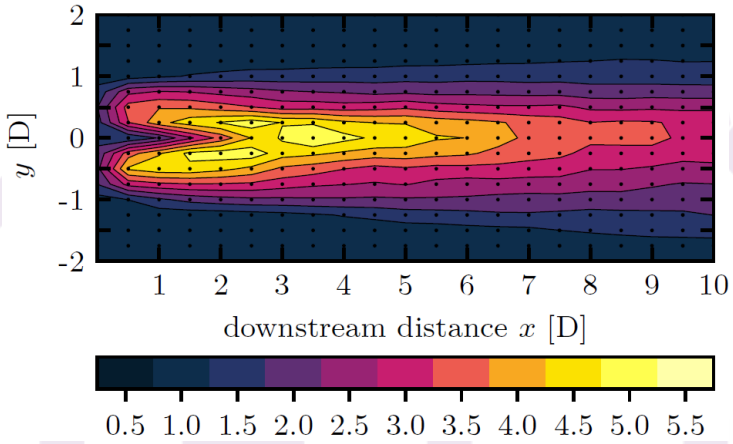
Wind turbine loads are significantly affected by

- wakes from upstream turbines
- wind farm (flow) control strategies
  - ➢ Could loads be reduced by WFC?

Blade root flapwise bending moment



Tower base fore-aft moment



➢ Normalized damage equivalent loads for different downstream and lateral positions of the downwind turbine [Marc Bromm, 2019]

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Active power control

Contribution to the power grid stability by adjusting the produced power

- Power reference defined by the transmission system operator (TSO)

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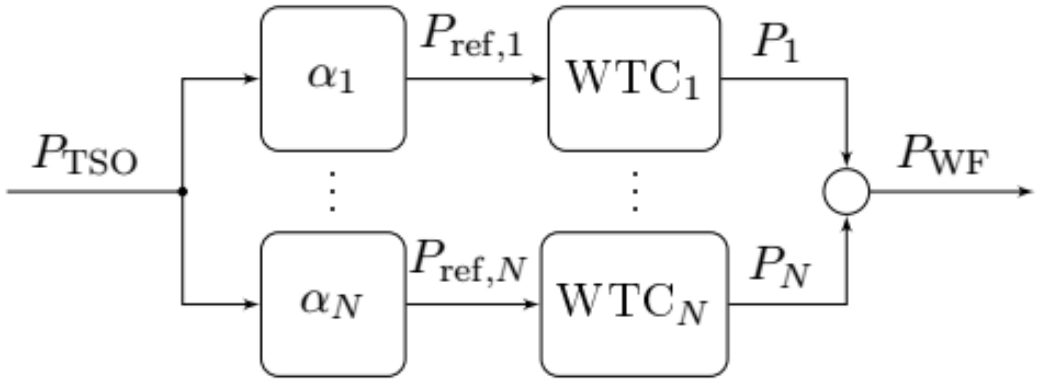

- **Open loop approach (baseline)**

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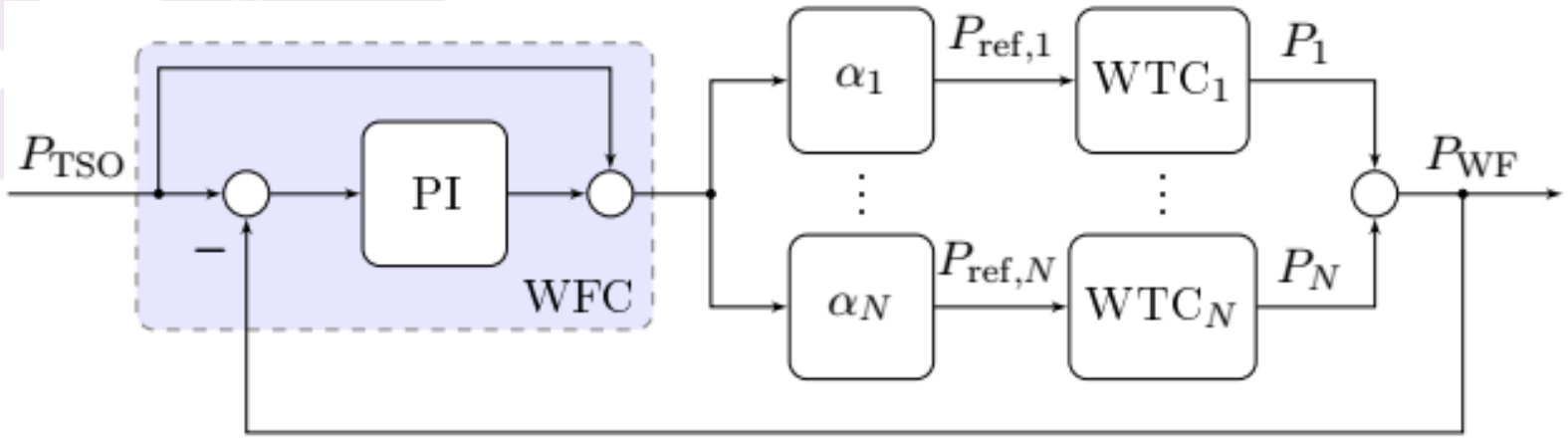

- Open loop approach (baseline)
- **Closed loop approach (Ref. APC)**

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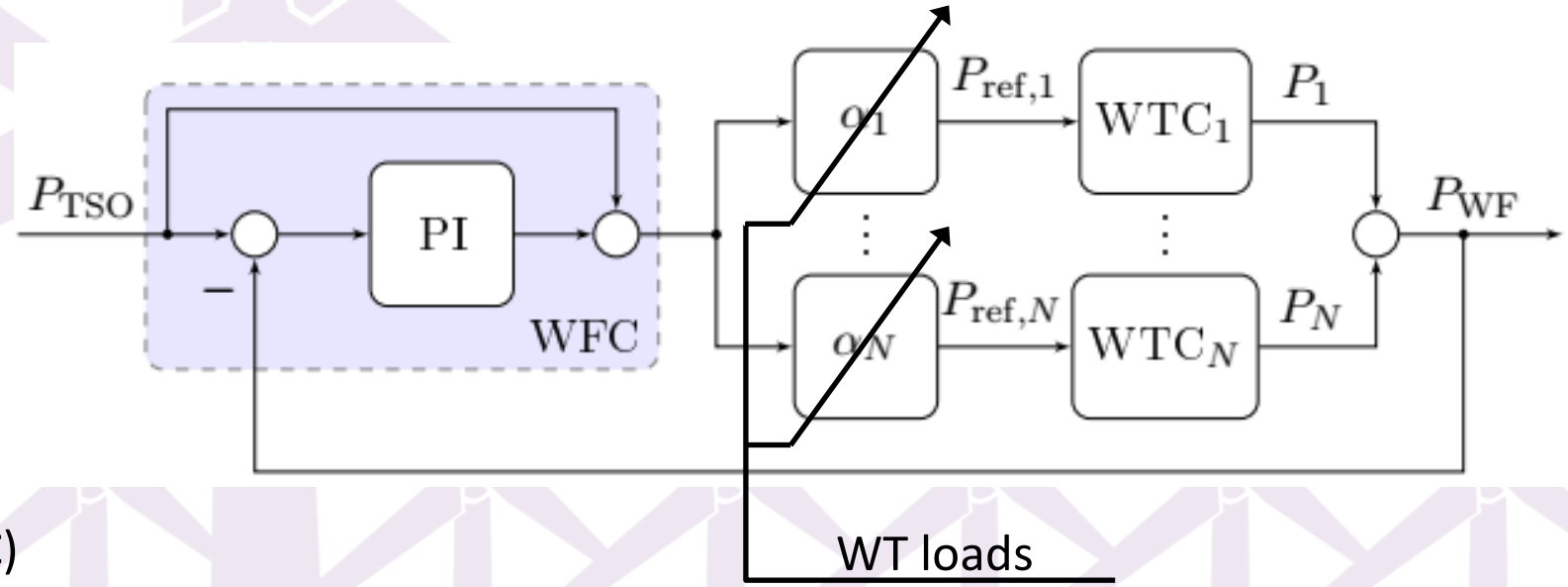


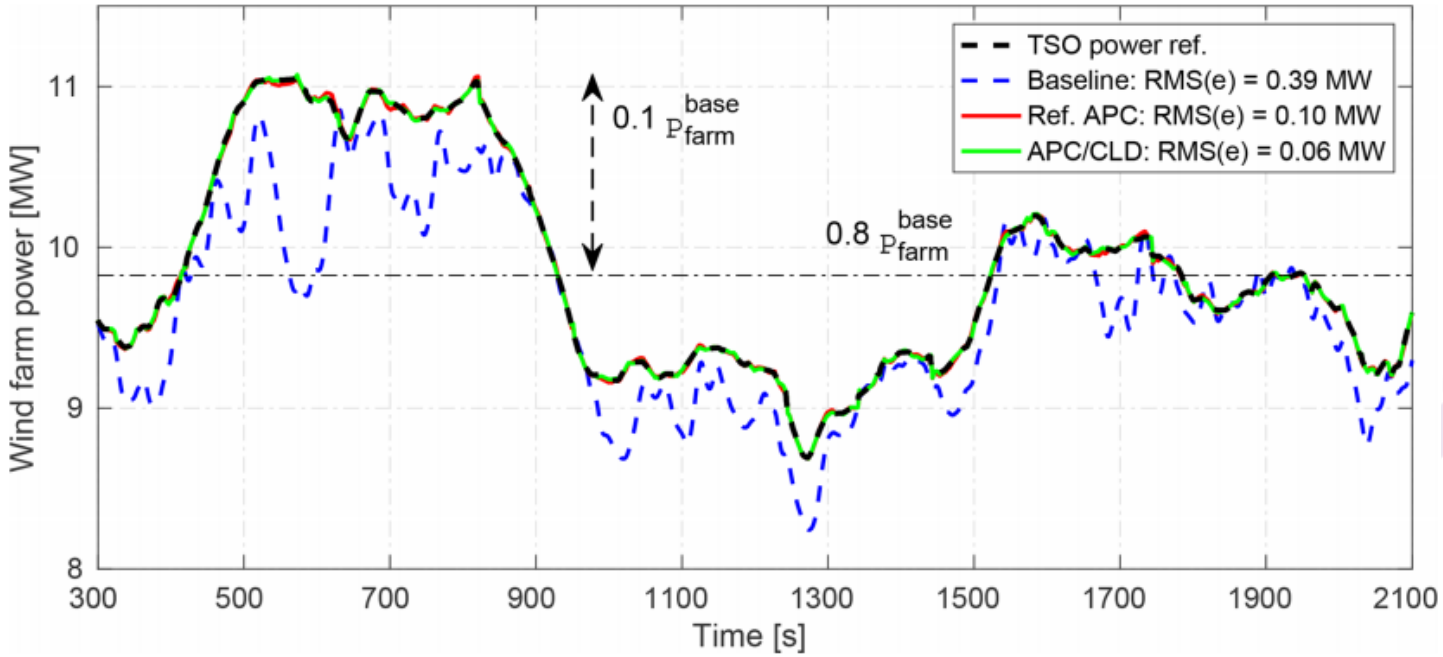
- Open loop approach (baseline)
- Closed loop approach (Ref. APC)
- **Closed loop approach with coordinated load distribution (APC/CLD)**

  Main goal here: levelized tower base moments from individual turbines

Numerical validation

Wind farm with 12 turbines (3x4) simulated in large eddy simulation code PALM

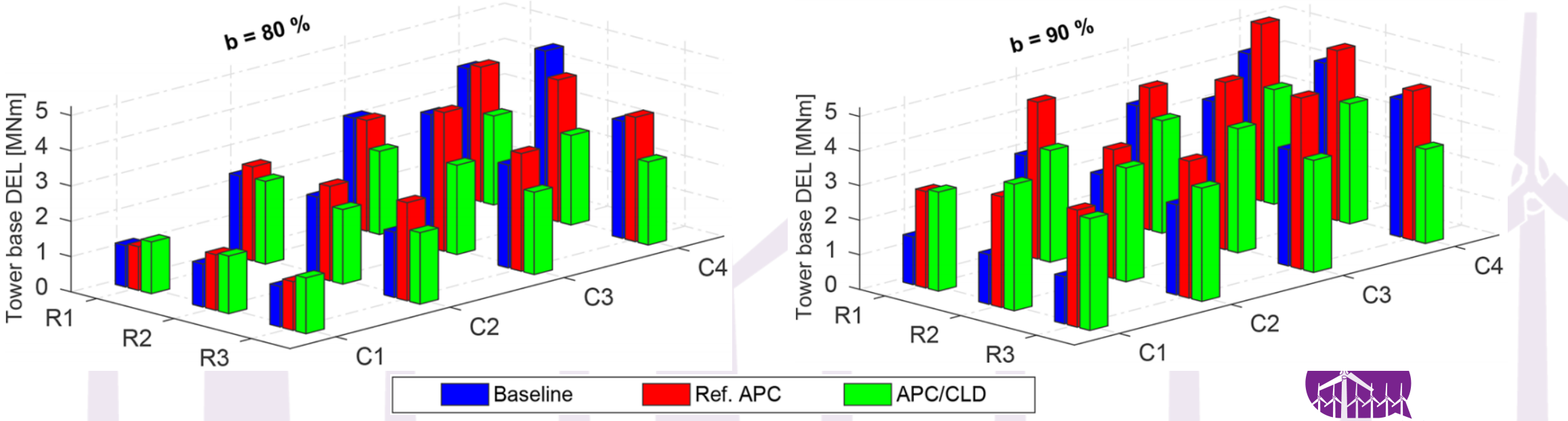
- ADM extended with a simplified tower loading model



Numerical validation – tower loads

Comparison of tower base DELs for different power reserves

- Loads of the downwind turbines decreased
- Loads of the upwind turbines increased



Conclusions and outlook

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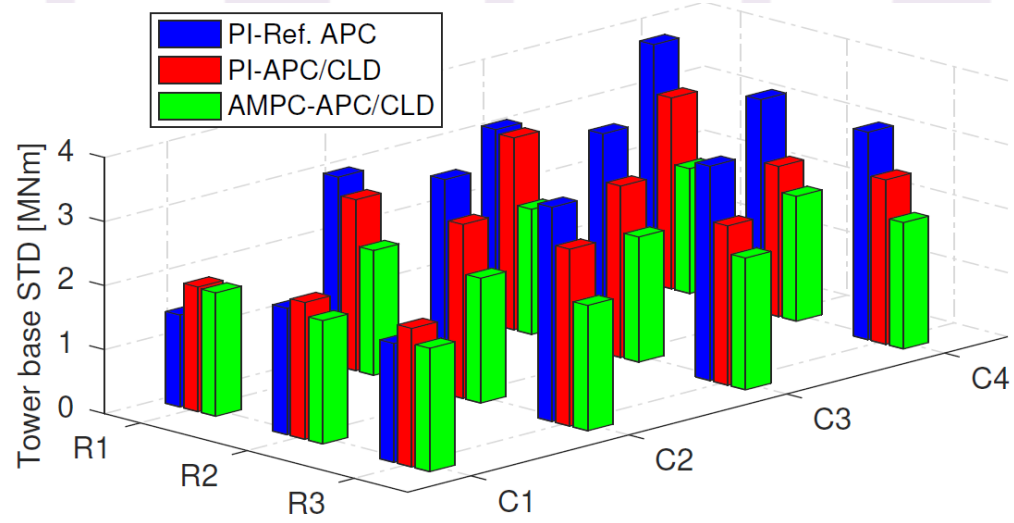
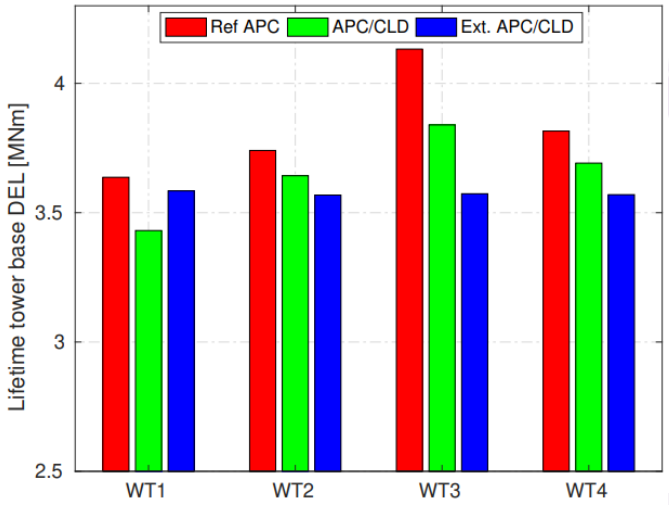
- Active power control allows for load reduction
- A simple PI-based controller achieves:
  - high quality power tracking
  - “fairer” load distribution in a wind farm

Ongoing work

- Detailed load analysis in aeroelastic simulations
- Model predictive control for APC/CLD



- Lifetime extension through APC/CLD



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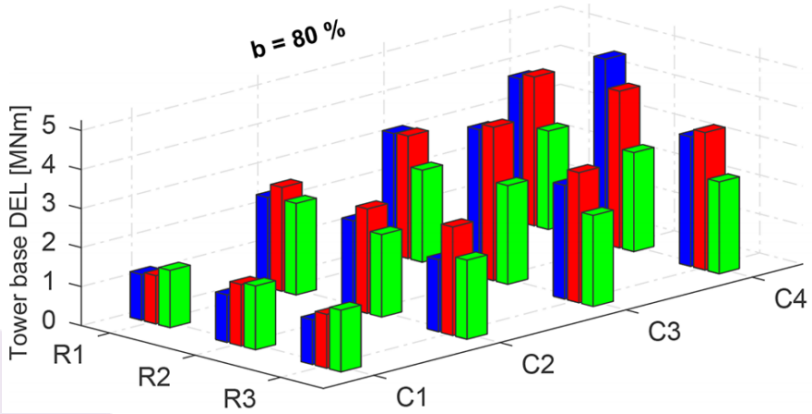
Thank you for your attention!



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Funding received from:

Federal Ministry for Economic Affairs and Energy

Federal Ministry for Economic Affairs and Energy according to a resolution by the German Federal Parliament (project WIMS Cluster)

Ministry for Science and Culture of Lower Saxony through the funding initiative Niedersächsisches Vorab (project ventus efficiens)

European Union's Horizon 2020 research and innovation programme under the grant agreement No. 857844 (project FarmConners)

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