State of the art and research gaps in wind farm control
Results of a recent workshop

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iea wind

FarmConners

Abstract

The promise of advanced Wind Farm Control (WFC) of **increased power and reduced loads** through coordinated control of all turbines in a wind farm has been around for more than a decade. Many groups have worked on different aspects and with different methods to solidify the knowledge about the potentials and control approaches. However, it still is not commercially available. The **International Energy Agency** (IEA) and the EU funded **FarmConners** Coordination Action sponsored a recent Topical Expert Meeting on state of the art and research gaps in WFC.

The first activity of the FarmConners project was a workshop and subsequent paper on the currently available knowledge, both as abstract knowledge and as existing data sets. The workshop (held in Amsterdam on 25 September 2019) was attended by more than 50 experts around the world, of which many are collaborating in FarmConners. Alongside keynote speeches, the results of two online questionnaires and regular talks presenting and summarising the current knowledge and existing datasets for verification, some sessions also discussed a way forward.
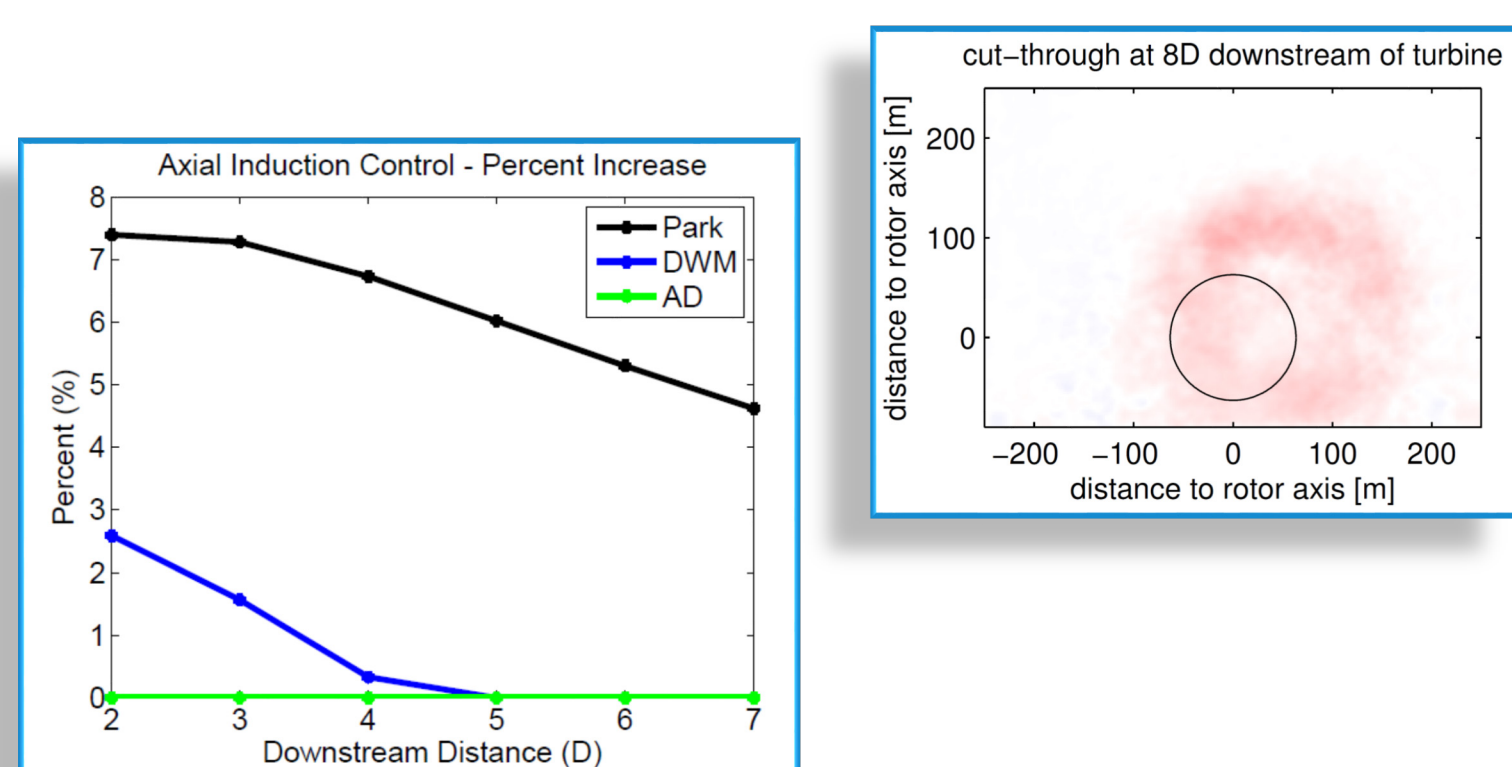
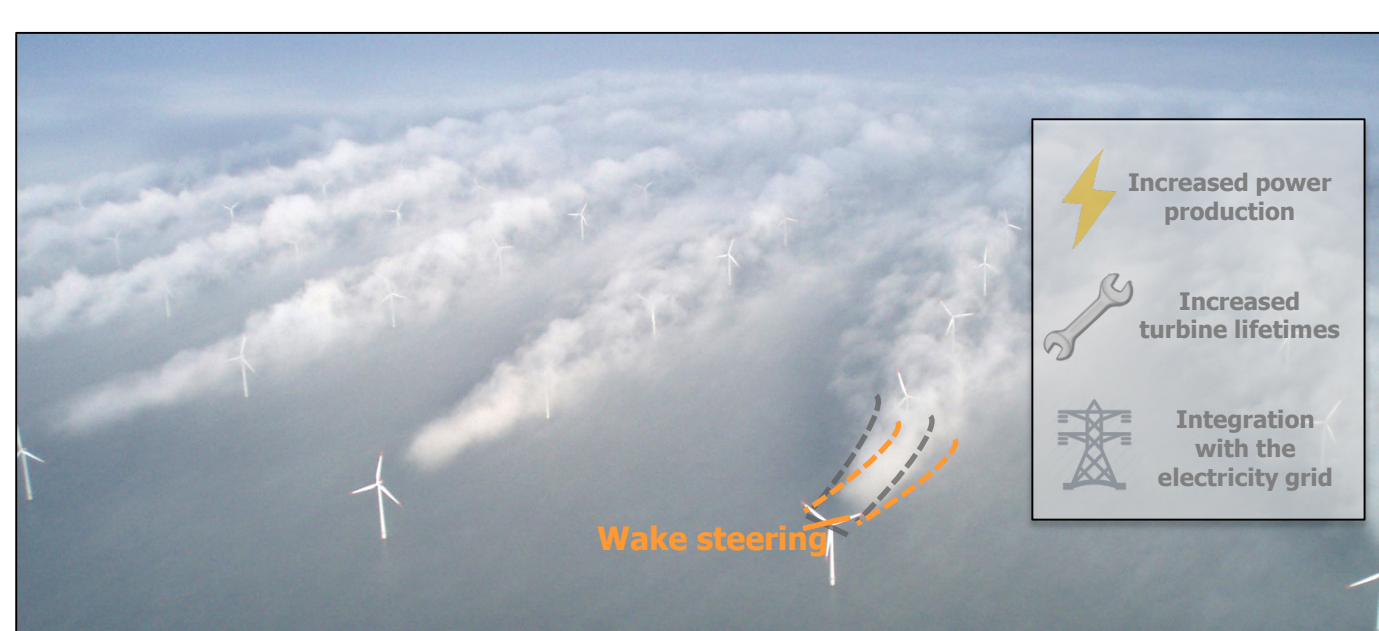## Wind Farm Control State of the Art

Induction control

Status:

On life support for AEP increase:

[2]

Potential for load reduction / rebalancing

[5]

Optimization of loads in cases of externally forced derating

- Scenario:
  – 15m/s free wind speed
  – Wind direction 120deg
  – 30% forced wind farm derating
- Rating of individual WTGs adjusted to obtain lowest possible overall loads while keeping the power target
- Individual turbine derating up to 60-70%
- Load improvement: ~3.5% compared to full-power case

Can it be made to work anyway? Can we combine wake steering and induction control, depending on wind direction?
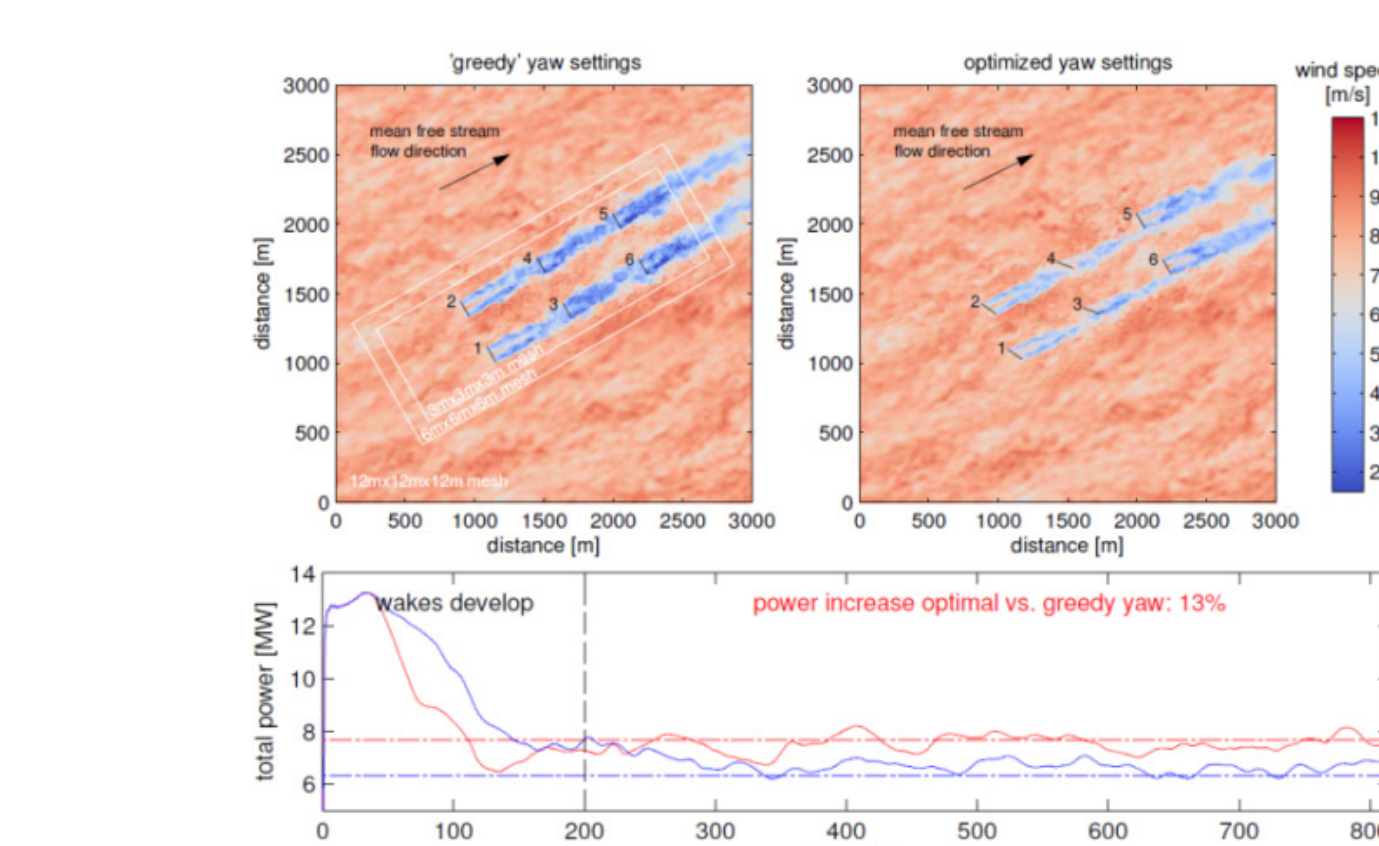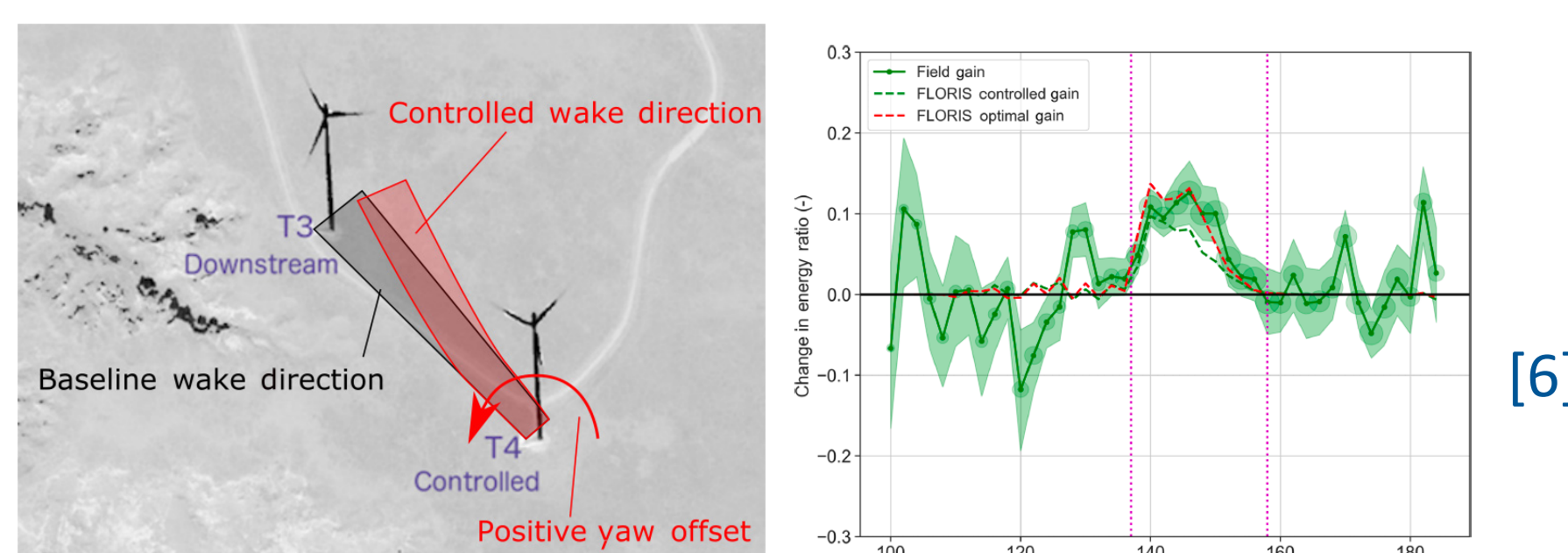
Wake steering

Status:

Current best option for AEP increase

Potential for load reduction / rebalancing

Tested in several places, usually with good results, but often with single turbine only
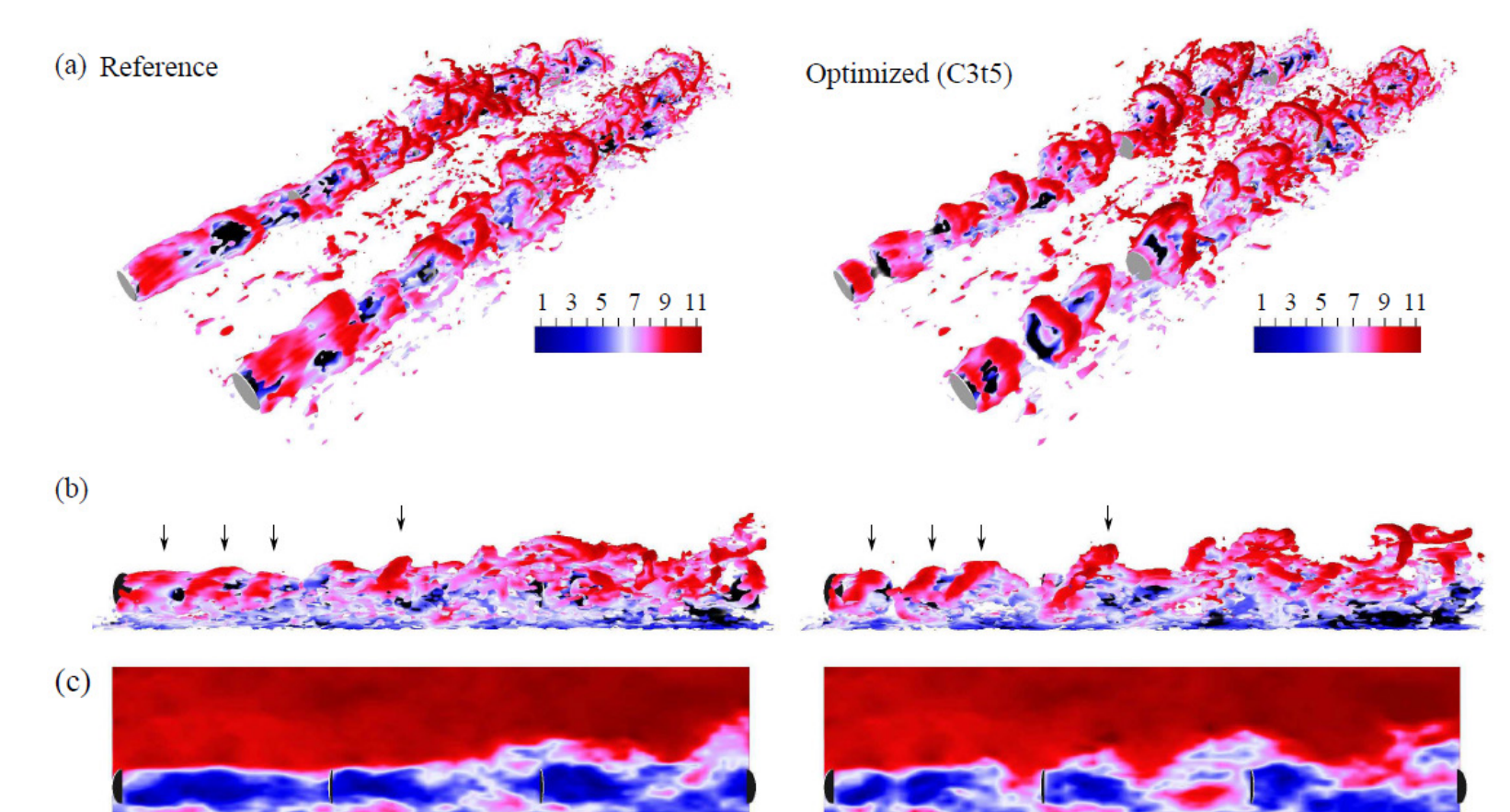

[6]

Are load impacts believable?

Other

Dynamic Induction Control:

Shows potential for AEP increase [11, 12]

Unclear for load reduction / rebalancing

Increase tip speed in wake:

Novel concept, untested [13]

Potential for AEP improvement

Wake steering through individual pitch:

Debunked [9, 14]

Control of electrical system to reduce losses:

Worked on e.g. in TotalControl

Wind farms designed for WFC:

Allows densification of wind power [7]

Anything we overlooked?

Except provision of Ancillary Services, which for most AS is established already.

Research Gaps

Result of expert solicitation [10] (questionnaire) in advance of the workshop. The scale shows how many people of about 50 participants prioritised which topic. **Validation campaigns** are missing most. Understanding **load impacts** comes second.

FarmConners Solutions

Benchmarks:

'Synthetic' Dataset high-fidelity simulations **+** Wind Tunnel experiments Including dynamic yawing **+** Wind Farm Field data 'normal' and controlled operation

Position papers:

Certification, Standardization and other Regulatory issues

Value proposition:

Showcase of WFC in various electricity market scenarios; compliance and revenue including Economic benefits of WFC in design phase

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