BRUSSELS, JUNE 30 - JULY 1, 2022

SAFETY FORUM

SAFE SUSTAINABILITY

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No contradiction: Safe & efficient flight operation despite renewable power plants near airports

Safety Forum 2022 | Session 2: ANSPs and airports

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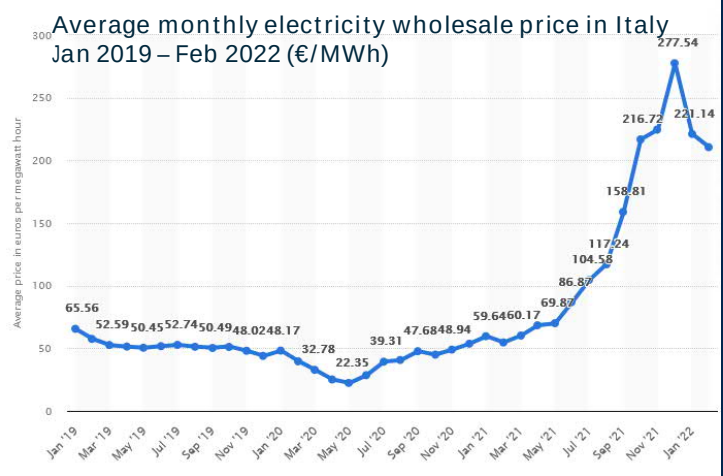
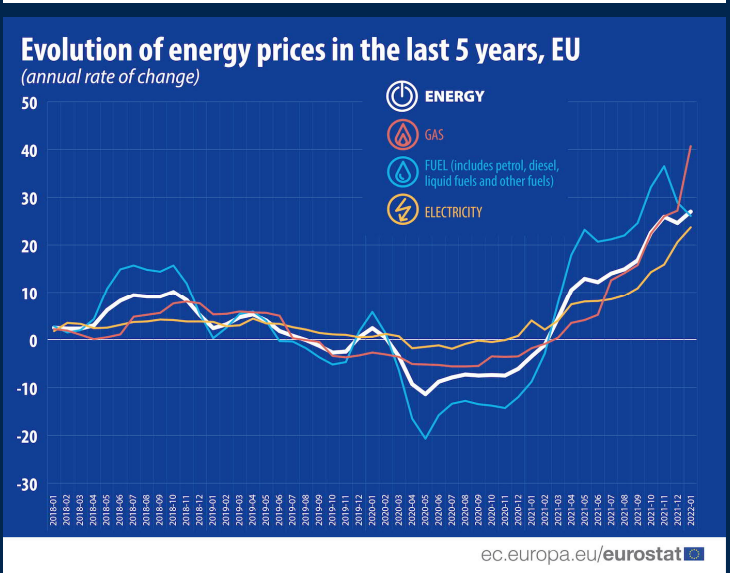
CERTIFIED ISO 9001 QUALITY MANAGEMENT

Motivation in a nutshell
Facilitating the use of renewable energy at airports

The market:

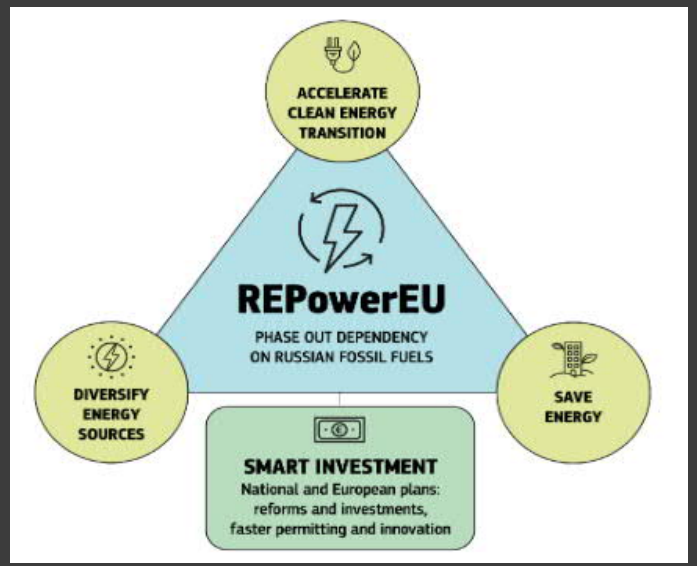




The EU:

'Ambitious but realistic' | EU in solar strategy targets to add 600GW and impose PV rooftop mandate

Brussels, May 18th 2022



… and airports?

- *Dynamic/strong rising energy prices*
  - Independence from external power suppliers & saving electricity costs
- Increasing requirements & strong governmental pressure expected for transition to renewables
  even for airports!

- Support airports to <u>decarbonize</u> energy and electricity supply
- Facilitate renewable energy at airports:
  - <u>Safety assessments</u> for the use of renewable energy sources at/around airports required

Renewables at airports
Top 5 Advantages

I. Support decarbonization at airports

II. Improving carbon footprint (to be recognized by ACA, ISO14001)

III. Provision of self-sufficient power supply (e.g. Power-to-X)

IV. Rent empty airport premises to solar park operators and investors

V. Strengthening public image and improving neighborhood relations

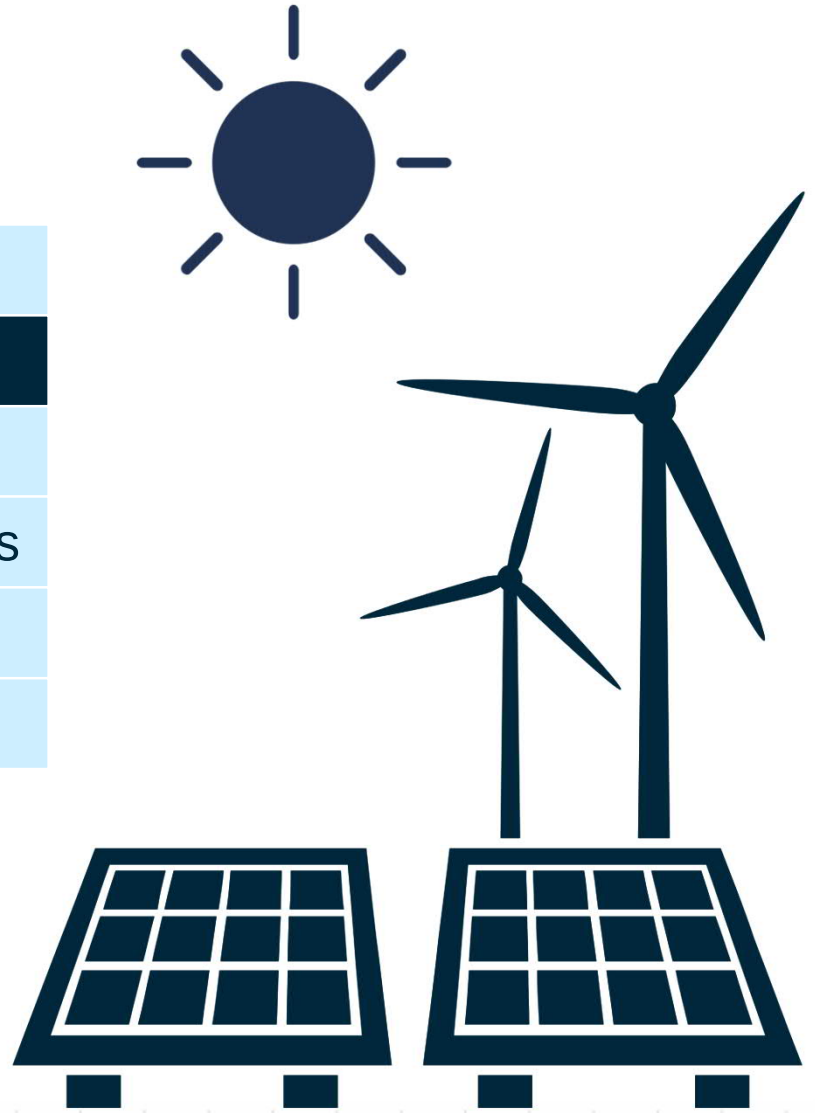
Groningen Airport, NL

Dusseldorf Airport, GER

Solar-powered car park at Abu Dhabi Intl‘ Airport, VAE

Agenda

- Prolog
- Agenda
- *Here Comes The Sun:* Solar farms at airports
- *When the Wind Blows:* Wind turbines in the vicinity of airports
- *Fly Away (green):* Eco-efficient flight procedures
- Epilog



Solar farms at airports

Dusseldorf-Weeze Airport
NRN/EDLV

Big potential for solar energy at airports

For example: Berlin-Brandenburg Airport (BER/EDDB)

Objectives
Planning and assessment process for solar farms at airports

- Technical feasibility studies for solar power plants on airport building roofs and near aircraft movement areas
- Aviation safety risk assessment for hazards arising from solar polar plants near aircraft movement areas
- Only acceptable risks on airport operations from solar power plants

Our Goal:
Maximize PV system output, while maintaining high safety levels at airports

PV specifications
(size, module type, lifetime, tilt/azimuth etc.)

Airport site evaluation & safety assessments

Identify solar power potential
(location specific, e.g. via globalsolaratlas.info)

Estimation of PV-capacity and output, CAPEX planning, ...

Our Capabilities
Airport site evaluation and assessment

- Hazard analysis & risk assessment for solar farms at airports
  - Solar PV-panels (ground/roof installation)
    based on proposed location, azimuth/tilt angles of PV-panels, panel material, fixed vs. single/dual tracking)
  - Concentrated solar power (CSP)
    if located in the (greater) vicinity of an airport

Columbia Metropolitan Airport, SC, USA

- Optimization of PV configuration close to / within an airport
  - Identification of the optimum PV panel siting & configuration

  ➔ minimum impact to aviation safety while maximizing system output (= *suitable areas* for PV panels)

- **Near aircraft movement areas**
- **Roof tops of airport buildings**
- **Parking areas**
- **Agri-PV on adjuncted areas and empty airport premises**

Cochin Airport, Kerala, India
1st 100% solar-powered airport in the world

Our Capabilities

Aviation Safety Risk Assessment **Framework** for airport solar farms

Assessment Framework

Two-step approach:

1. Identify *potential areas* for PV-panels
   - = Compliant with safety clearances on ground (acc. EASA CS-DSN-ADR)
2. Perform risk assessments
   - i. Obstacles (OLS)
   - ii. CNS
   - iii. Glint & Glare
   - iv. Runway safety & others

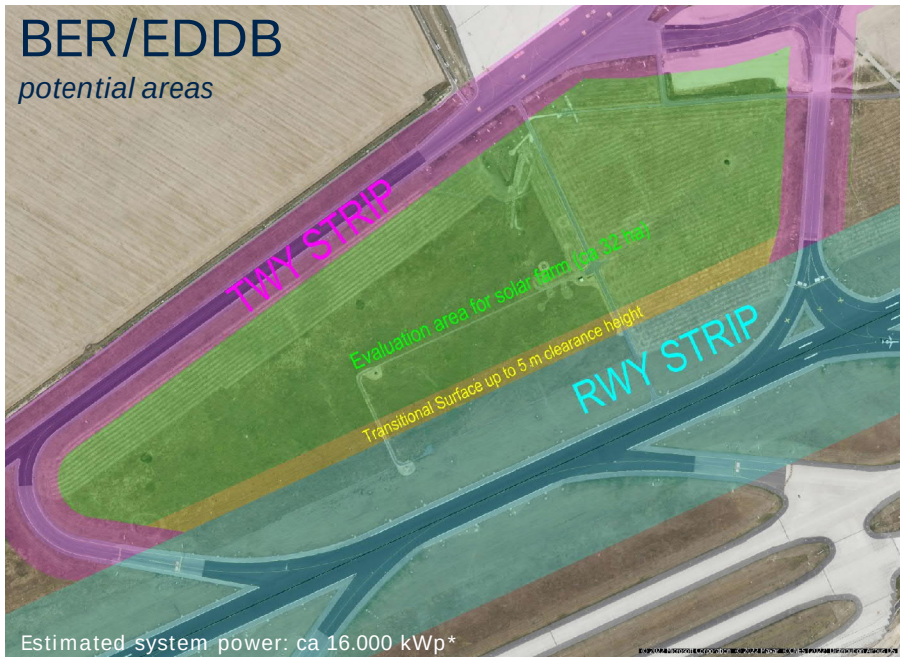
= *Suitable areas* [ha] for PV-panels from safety perspective

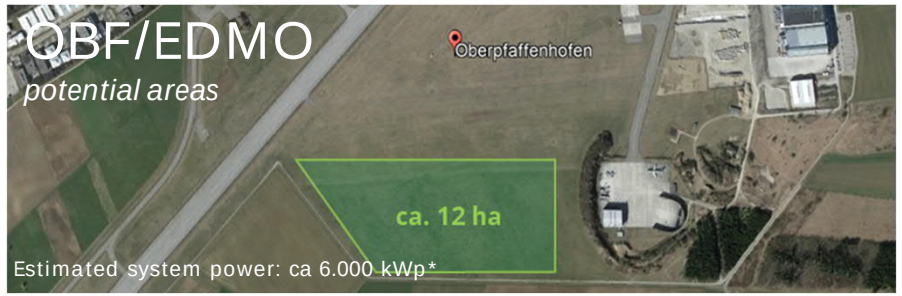
Hazard analysis & risk assessment

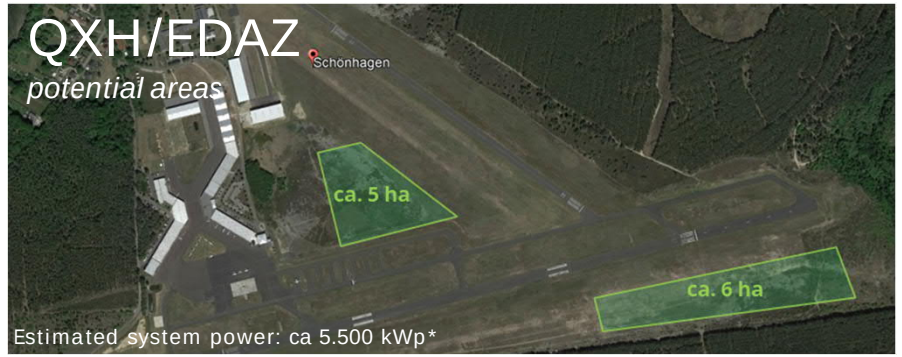
- Safety clearances on ground
- Obstacle assessment
- CNS assessment
- Glint and glare analysis
- o Runway safety (e.g. runway excursions)
- o Impact assessment for Rescue Fire Fighting Services and Emergency Planning & Management

Where to locate?
Key risk areas and premises to be checked

- Near aircraft movement areas
- Roof tops of airport buildings
- Parking areas
- Agri-PV on adjuncted areas and empty airport premises



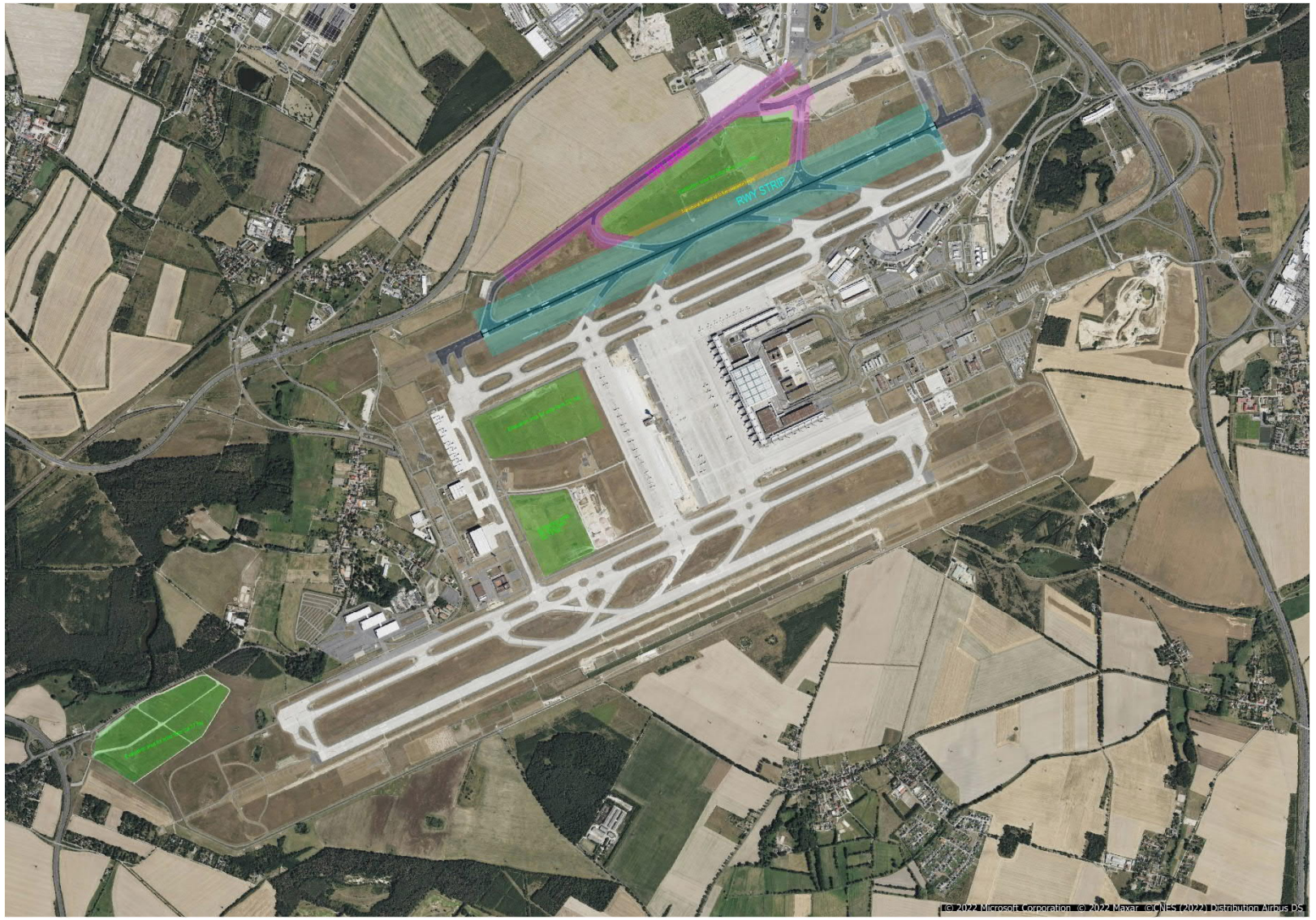




* Based on 500 kWp/ha (DUS solar system)

Big potential for solar energy at airports

Berlin-Brandenburg Airport (BER/EDDB)

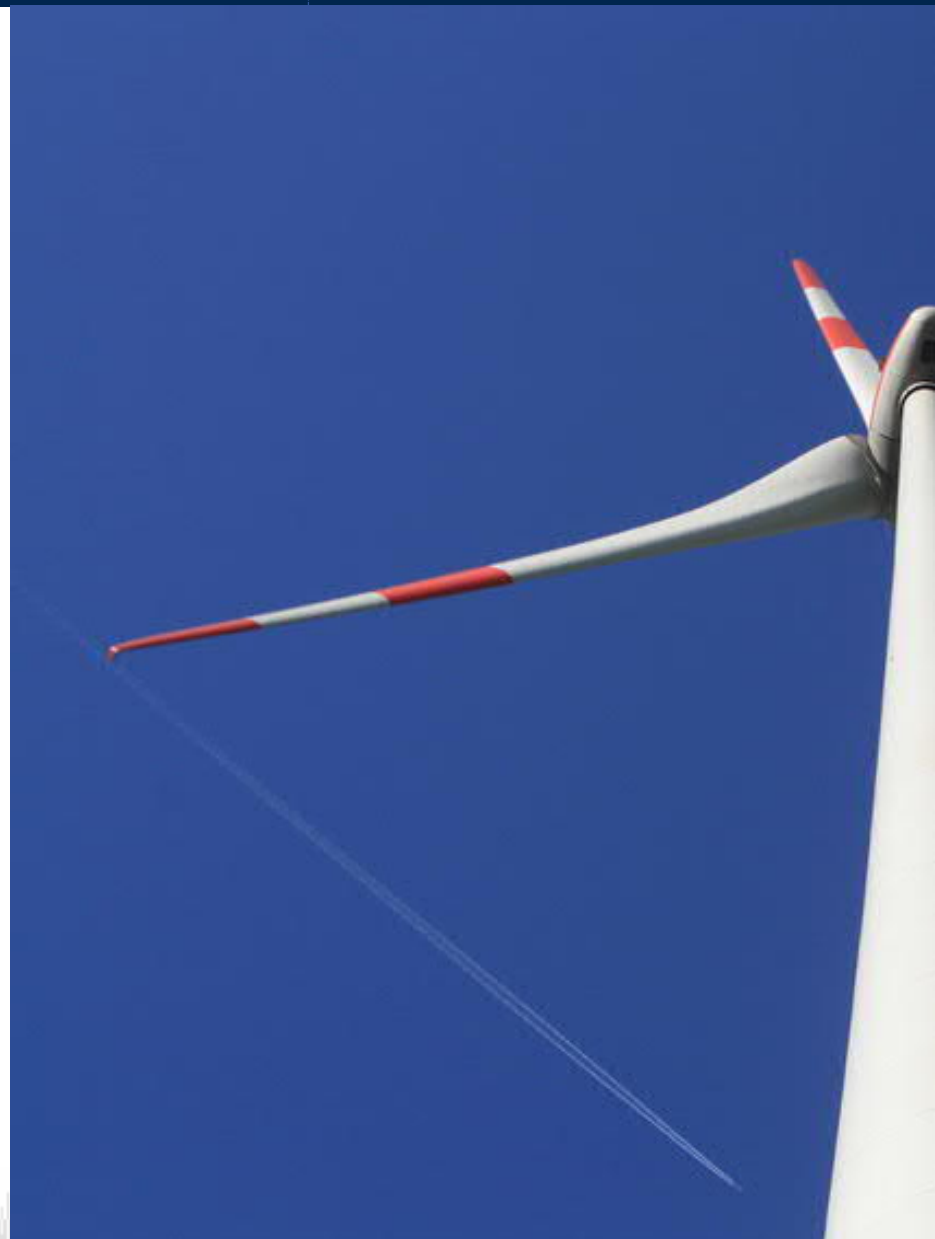


Wind turbines in the vicinity of airports

Objectives
Assessment elements for wind turbines near airports

- Aviation safety risk assessment for hazards arising from wind turbines near
  - Airports
  - Airfields
  - Glider airfields and heliports

- Safety assessments for
  - Visual & Instrument Flight Procedures
  - Obstacle Limitation Surfaces (OLS)
  - Airspace
  - Turbulences / aerodynamic effects
  - CNS equipment (e.g. DVOR)

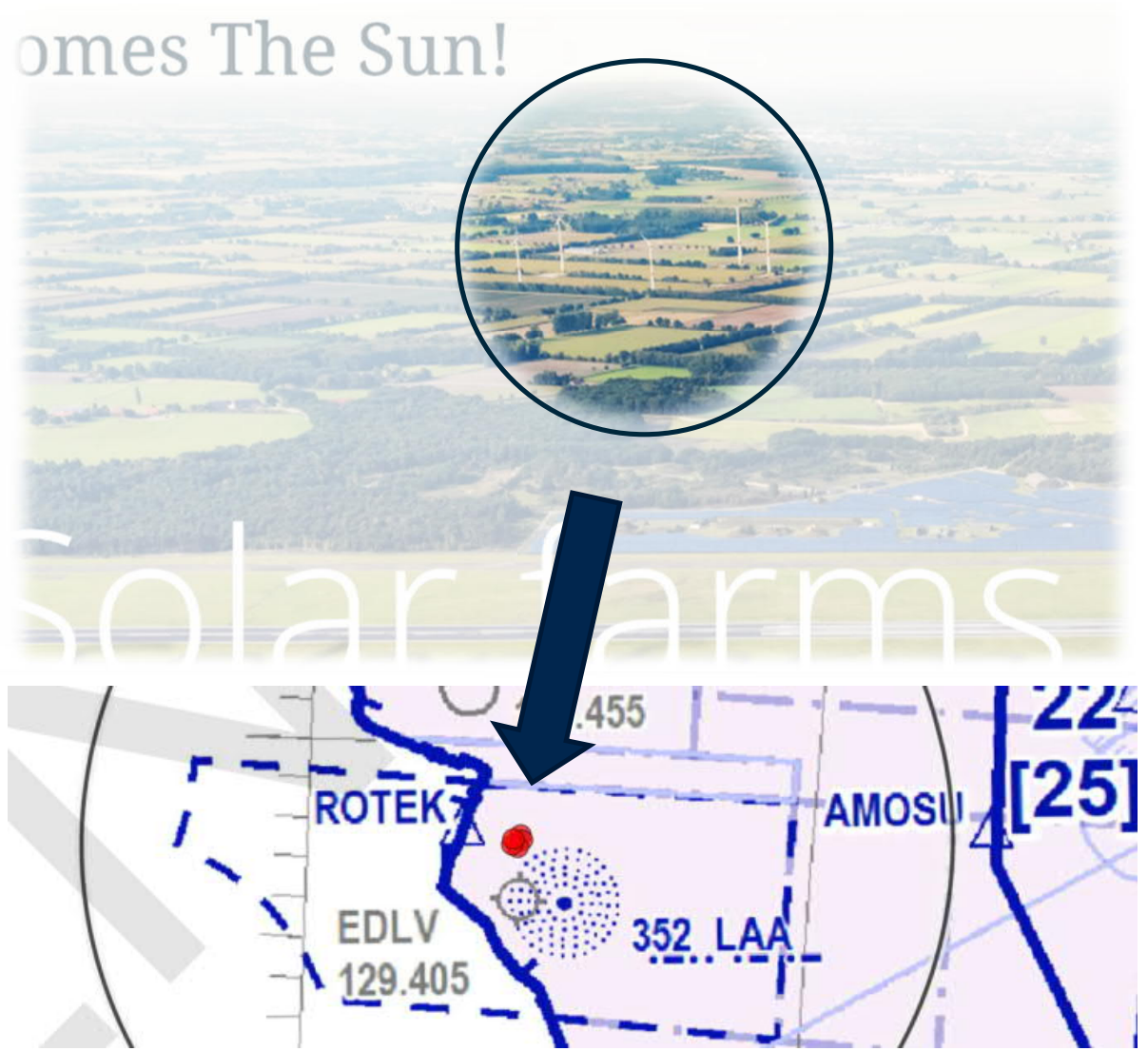


Objectives
Initial assessments for wind turbines in the vicinity of airports

Aeronautical study

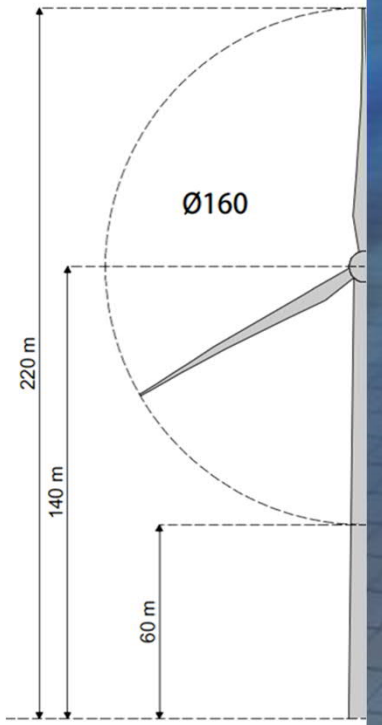
Implementation of an Aircraft Detection Lighting Systems (ADLS) for wind turbines during night

- Transponder-based detection system (Mode S, 3/A)
- Special recognition for detection capability of departing aircrafts from the airfield
- Distance to the airport: 2.4 km (1.3 NM)
- Line-of-Sight analysis for the detection of blind spots/shadowing of transponder signals
- Conclusion (i.a.)
  - Aircrafts departing from the airport have to be detected by the wind turbine mounted detection system



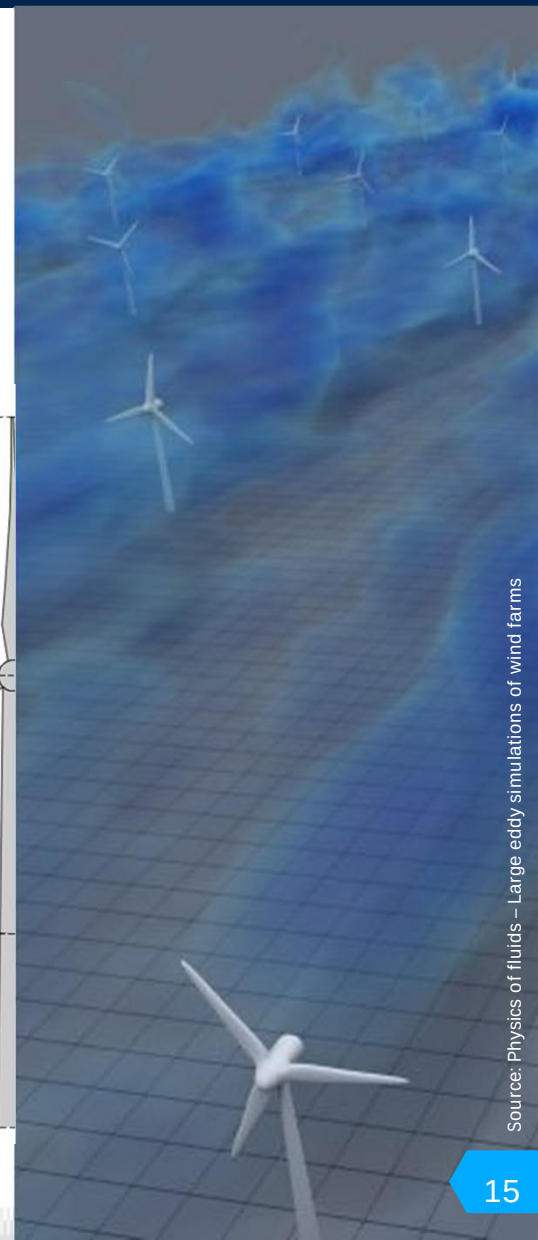
Safety assessment of wind turbines
Special consideration: Turbulences as dymanic obstacles

- Protection volumes around wind turbines due to turbulences
  - *No ICAO/EASA rules for minimum distances to wind turbines based on turbulence*
  - UK: “5D” – 5x diameter of wind turbine[1,2]
    (e.g. 80 m rotor length → 800 m protection diameter)
  - Other recommendation
    (e.g. TU Delft, FH Aachen University of Applied Science):
    “7D” – 7x diameter of wind turbine
    (e.g. 80 m rotor length → 1.200 m protection diameter)



- Effects of turbulence on flight paths in strong dependence on wind direction and intensity

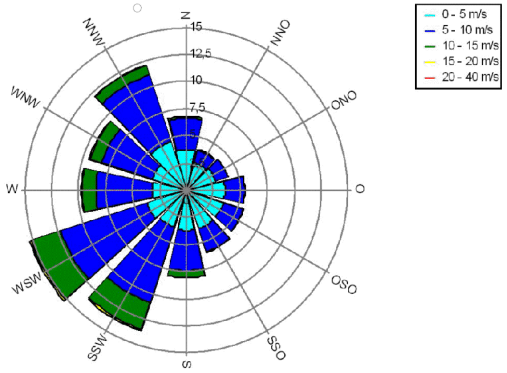
[1] CAP 764 – CAA Policy and Guidelines on Wind Turbines (February, 2016)
[2] Wind Turbine Wake Encounter Study, University of Liverpool (March, 2015)



Source: Physics of fluids – Large eddy simulations of wind farms

Safety assessment of wind turbines

Case Study: Wind turbine protection zones (VFR) due to turbulences



Wind distribution for airfield in case study

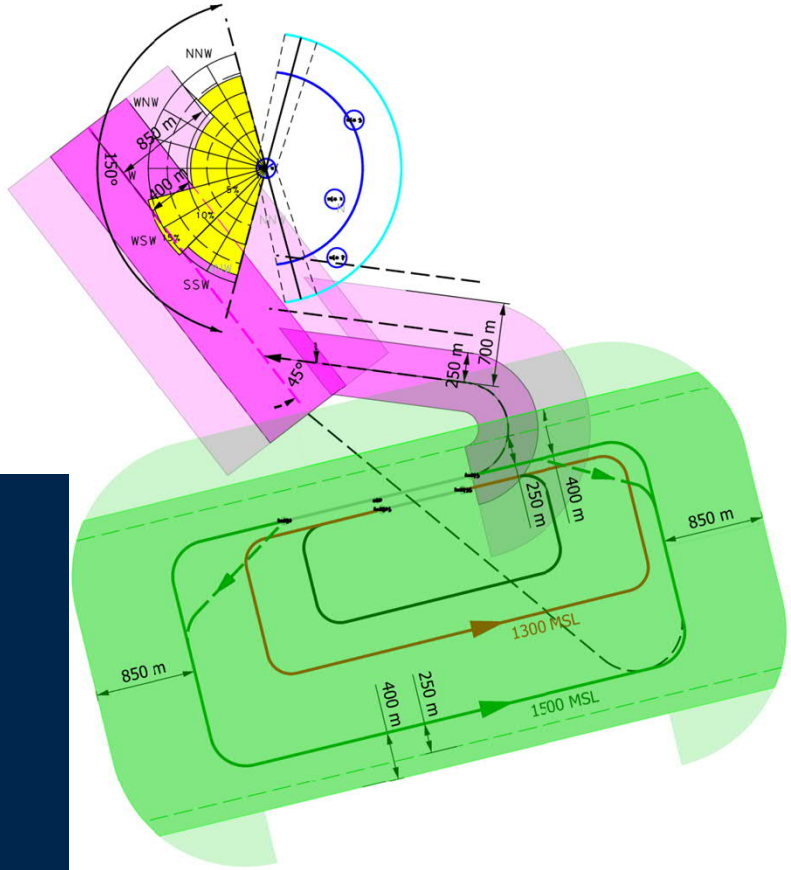
Aeronautical study

Safety assessment of wind turbines in the vicinity of an airfield (VFR)

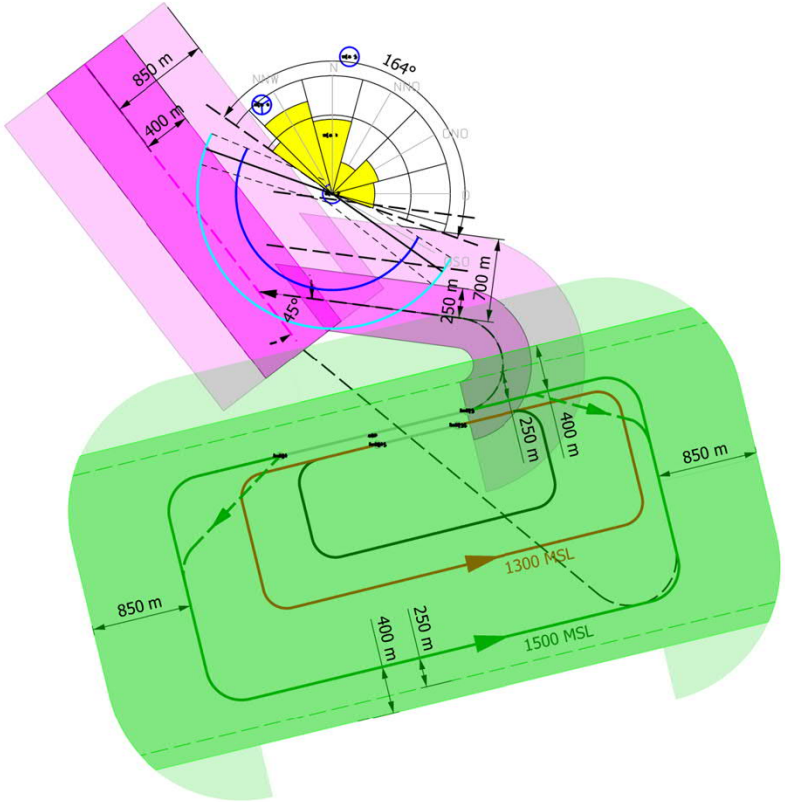
- Special recognition for turbulences from wind turbines

Conclusion (i.a.)

- Rise awareness for pilots
- Relocating certain wind turbines
- Shutdown of certain wind turbines for critical wind direction



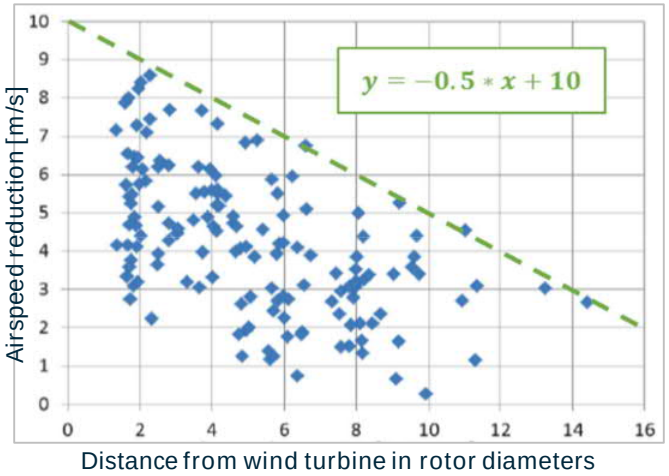
- *Main wind direction (15.2%):* only penetration of „secondary“ protection zone

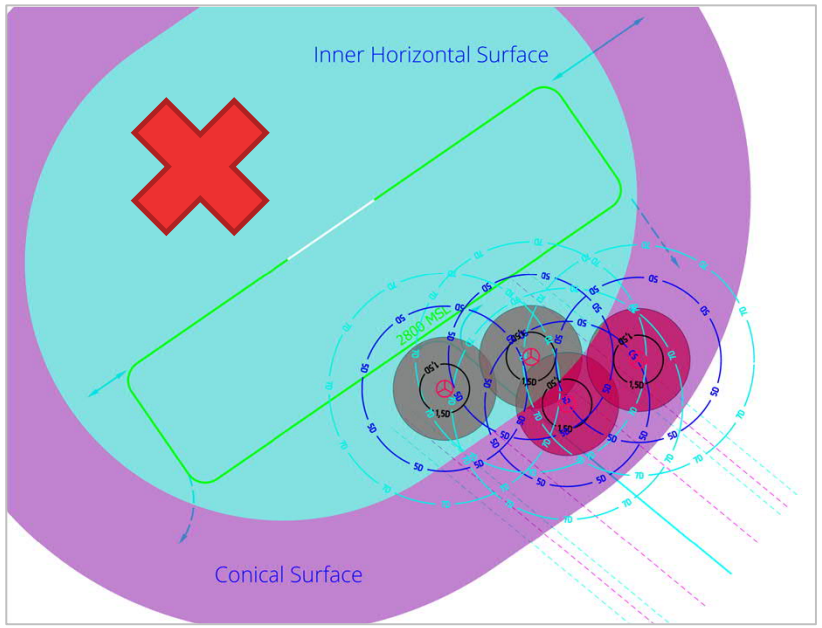


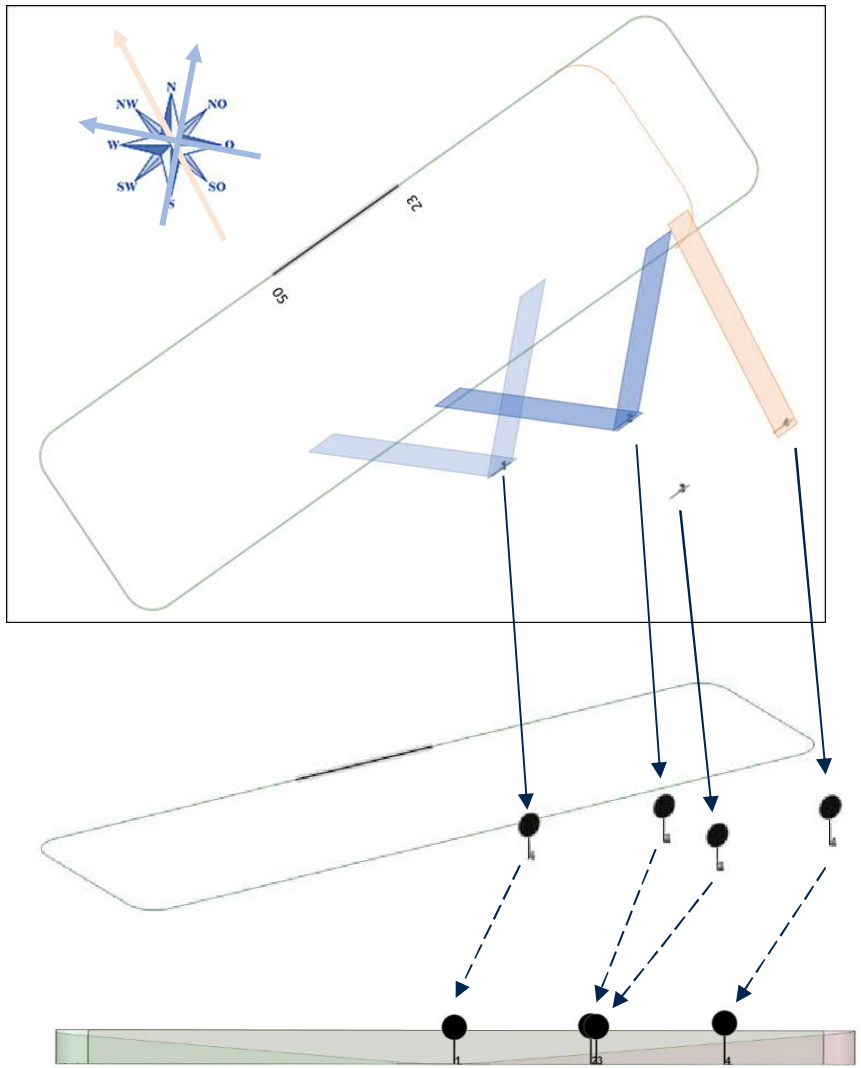
- *Critical wind direction (12.1%):* penetration of “primary” protection zone

Safety assessment of wind turbines

Case Study: Wind turbine protection zones (VFR) due to turbulences







Aeronautical study

Analysis of aerodynamic effects in the downwind of wind turbines using *CFD*

- Hazard potential due to aerodynamic effects (wind deficit/shears)
- Windshear potential for straight (90°) and inclined (e.g. 45°) flights

Conclusion (i.a.)

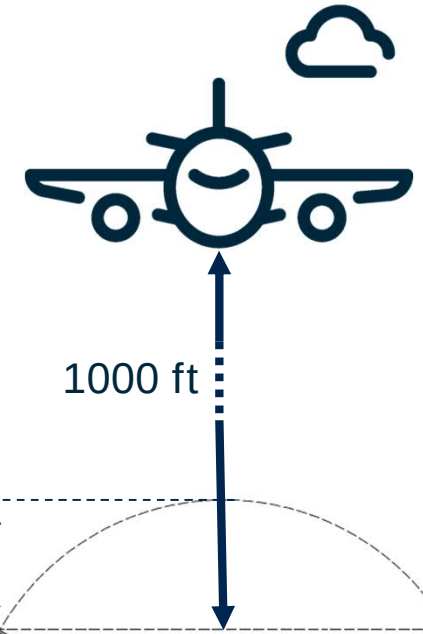
- Inclined flights downwind the wind turbine with increased risk for wind shears (= potential for stalling!) for eastern/southern wind directions
- No operation of wind turbines for wind directions between 75° and 215° and wind speeds above 6 m/s

CFD – Computational Fluid Dynamics

Safety assessment of wind turbines
Special consideration: Y-Position of wind turbines

- Move and lock turbine blades *temporarily* in Y-Position
  - e.g. during cold temperatures
  - On-demand, when flights occur in the vicinity of an airfield

➢ Guarantee obstacle clearance



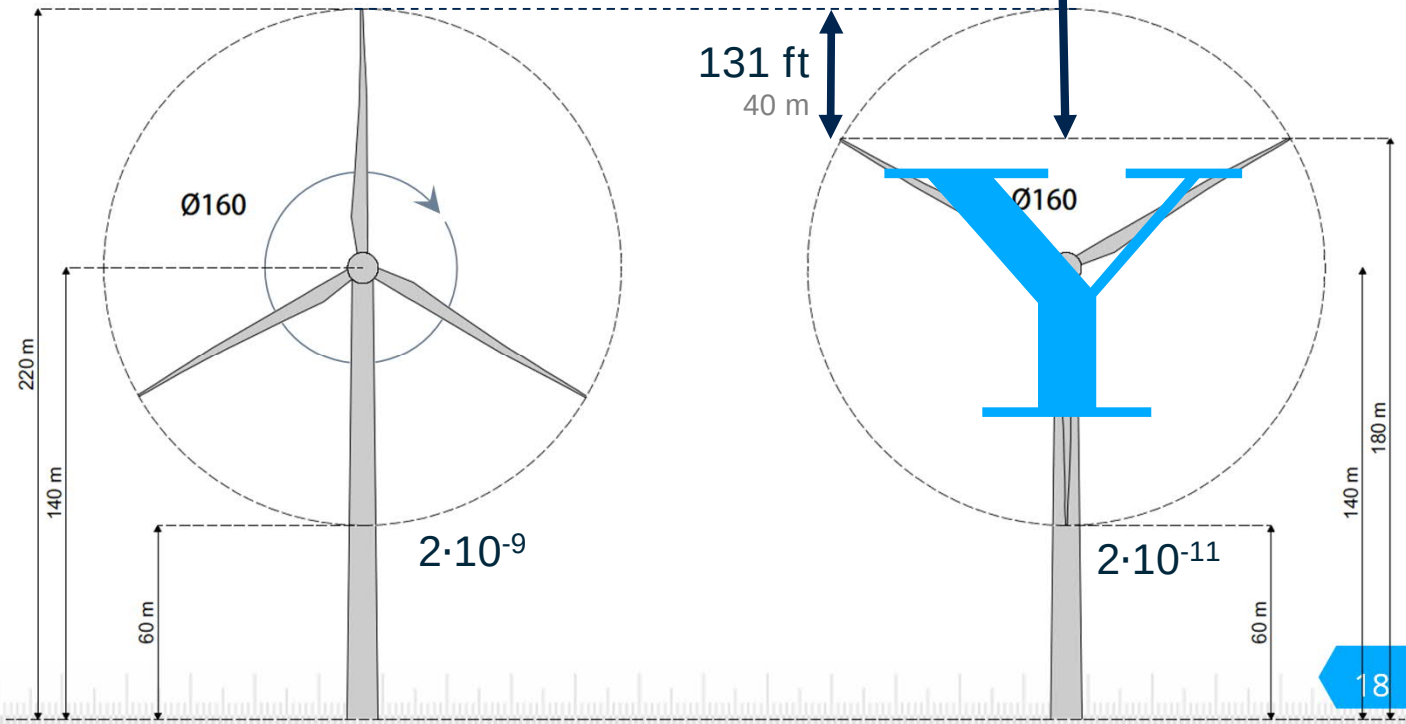
Aeronautical study

Risk assessment for flight operation arising from the Y-Position

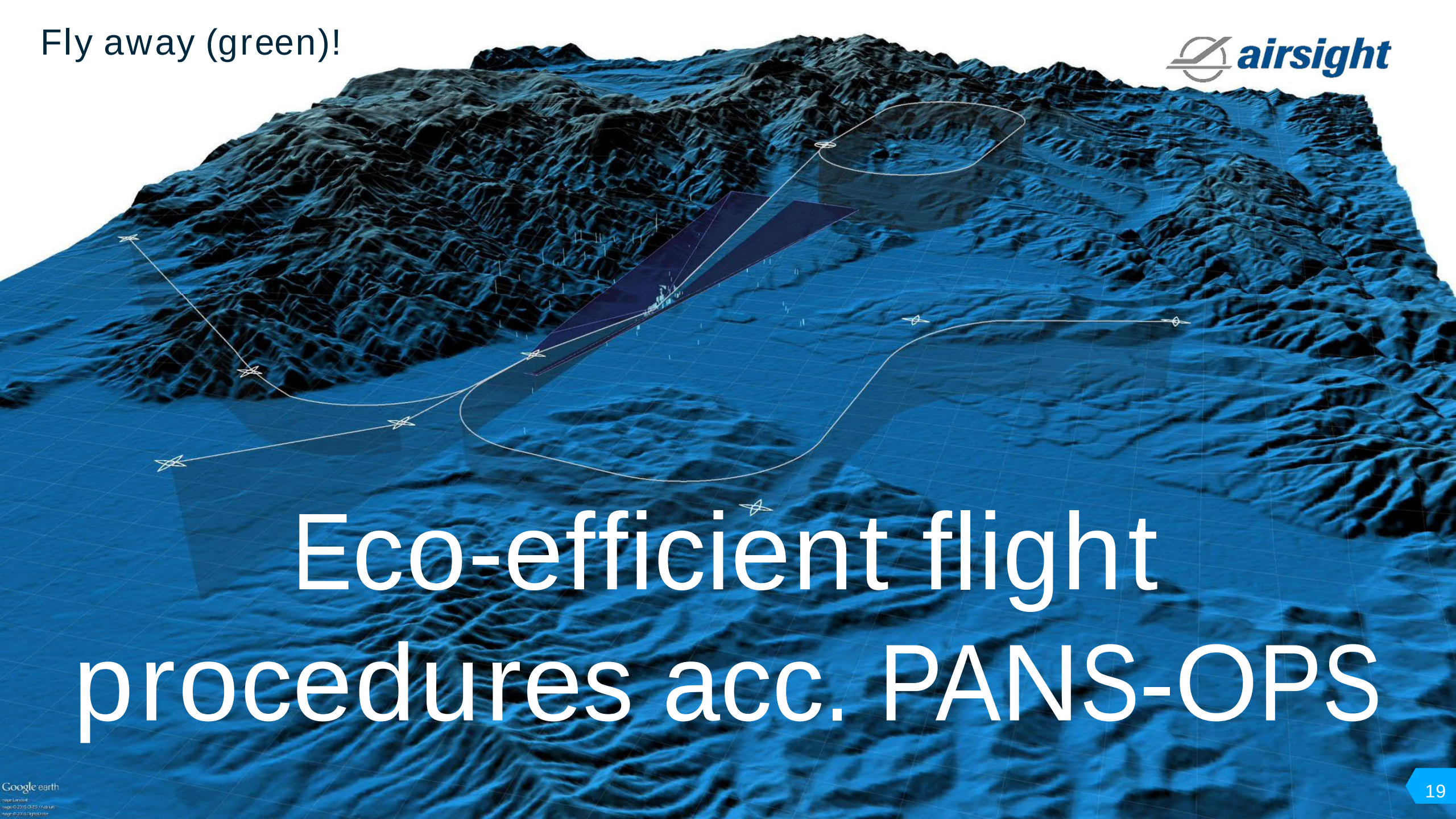
- Special recognition for cold temperatures and flights close to MVA
- Risk assessment using bayesian networks

Conclusion (i.a.):

- Probability of catastrophic event (ICAO A level) (collision aircraft vs wind turbine blade): $3 \cdot 10^{-11}$
- Below the ICAO TLS of $2 \cdot 10^{-9}$



Fly away (green)!



Eco-efficient flight procedures acc. PANS-OPS

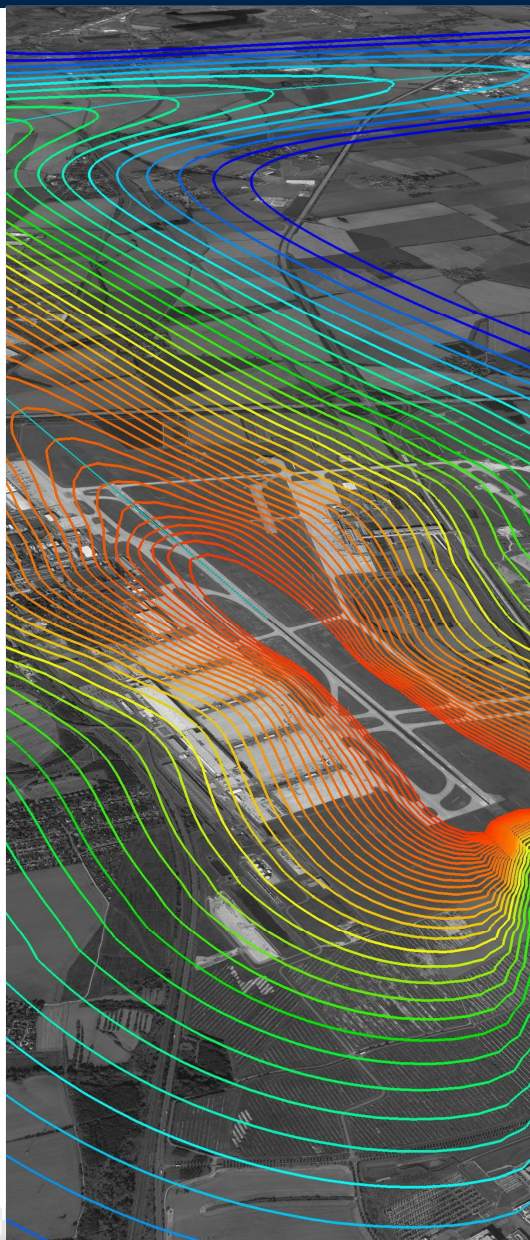
Eco-efficient flight procedures

Framework for development/assessment of eco-efficient flight procedures

- Optimization w.r.t to aircraft noise, fuel and CO2 & Non-CO2
- Stakeholder support within the framework of EUROCONTROL Collaborative Environmental Management (CEM)

Input data analysis
Redesign of flight procedures acc. ICAO PANS-OPS (Doc 8168)
Stakeholder engagement: Consultation/workshops
Aircraft noise/emission calculation and assessment
Fly away (green): Eco-efficient Flight Procedures
Validation

Necessary not only to reduce noise and CO2 pollution from flight operations, but also to improve relations with the neighborhood *while maintaining high safety levels*



Epilog
Take home messages

1. Solar power yield at airports can be massively increased if areas between aircraft movement areas are used in compliance with regulatory requirements and based on a tailored aviation safety risk assessment framework for solar farms at airports

2. Wind turbines close to airports can be installed after a site-specific risk evaluation and related mitigation measures (if appropriate) indicates neglectable impacts on aviation safety.

3. Flight procedures acc. ICAO PANS-OPS (Doc 8186) based on eco-efficient criteria is one of the corner stones of an eco-friendly airport system.

4. Public acceptance needs to be considered when sustainable solutions are being developed without comprising aviation safety:
   e.g. implementation of Aircraft Detection Lighting Systems (ADLS) for wind turbines during night

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Thank you for your attention!

Do you have any questions?

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Solar farms at airports enter the market!

In Ukraine too!

Eco-efficient Flight Procedures
Backup

- Optimization w.r.t to aircraft noise, fuel and CO2 & Non-CO2
- Stakeholder support within the framework of EUROCONTROL Collaborative Environmental Management (CEM)

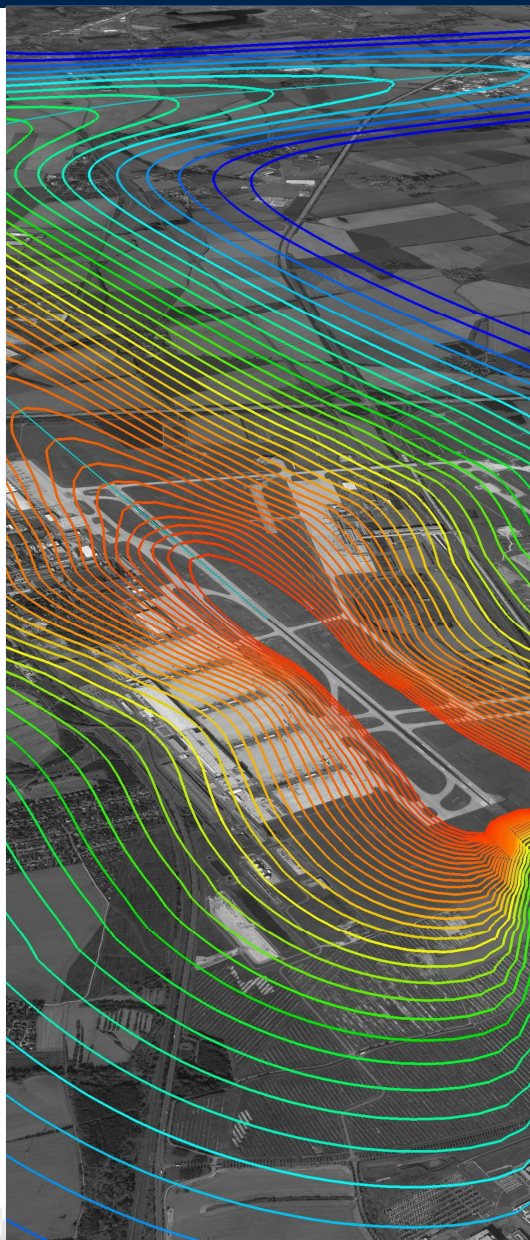
Analysis of ...
- Flight tracks and vertical profiles (ADS-B, MLAT, radar)
- Airport noise measurements

Consultation/workshops
- Neighborhood
- Stakeholder (airlines, ANSP, airport, authorities)

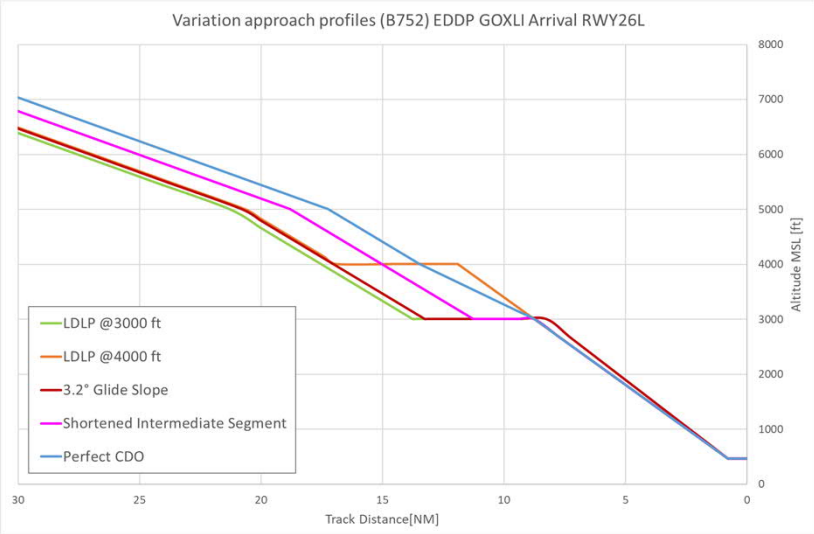
Redesign of flight procedures acc. ICAO PANS-OPS (Doc 8168)
- Deployment of the PBN concept (e.g. curved approaches, RNP)
- Continuous climb/descent operation
- Adjustment of procedure design gradients (PDG)

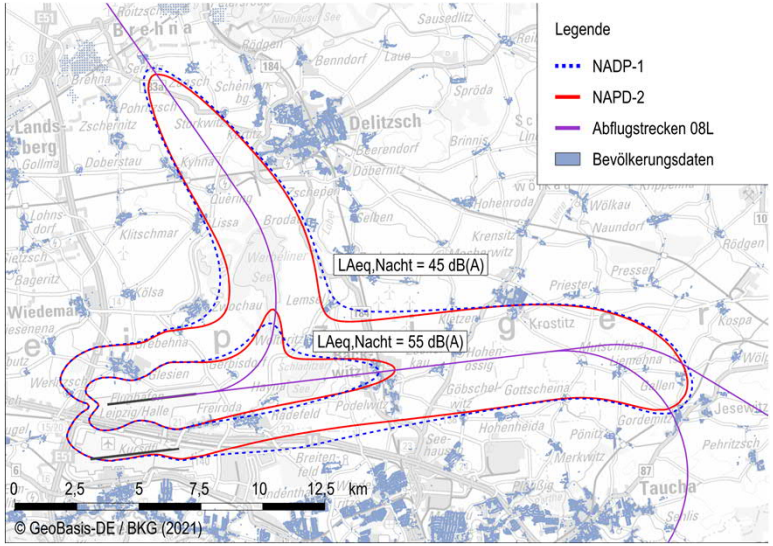
Aircraft noise/emission calculation and assessment
- e.g. AEDT/IMPACT
- Exposure-Response-Function

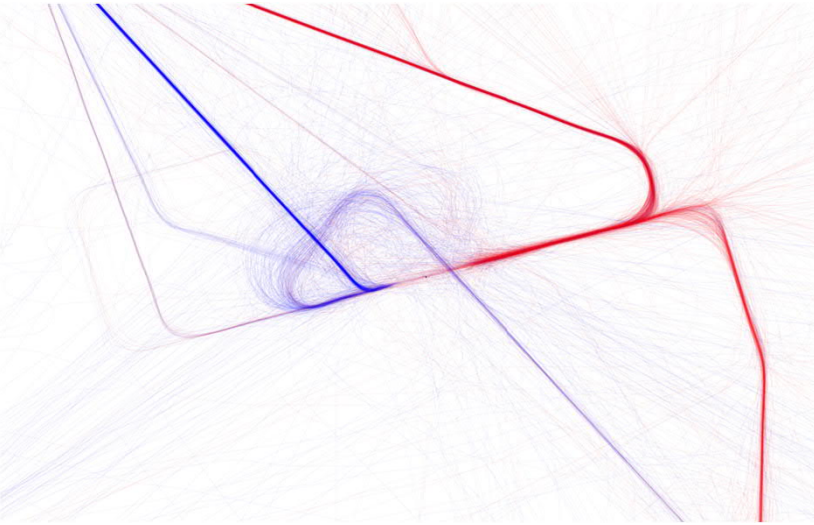
Validation
- Full flight simulator
- Flight testing

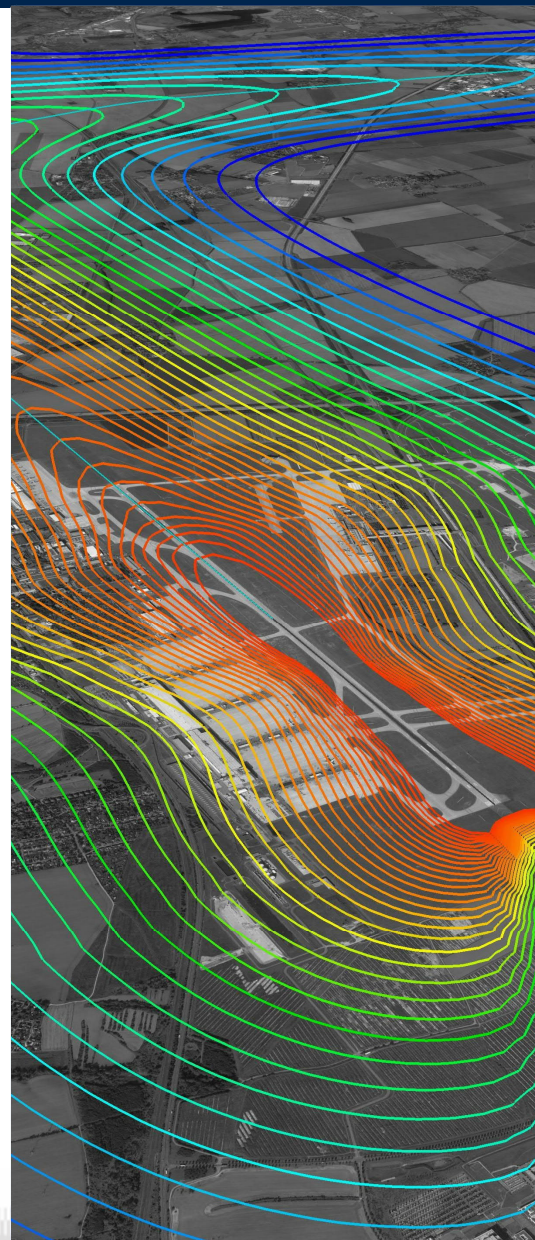


Eco-efficient Flight Procedures
Backup









Latest case study by airsight: [Assessment of eco-efficient flight procedures at Leipzig/Halle Airport (case study)]