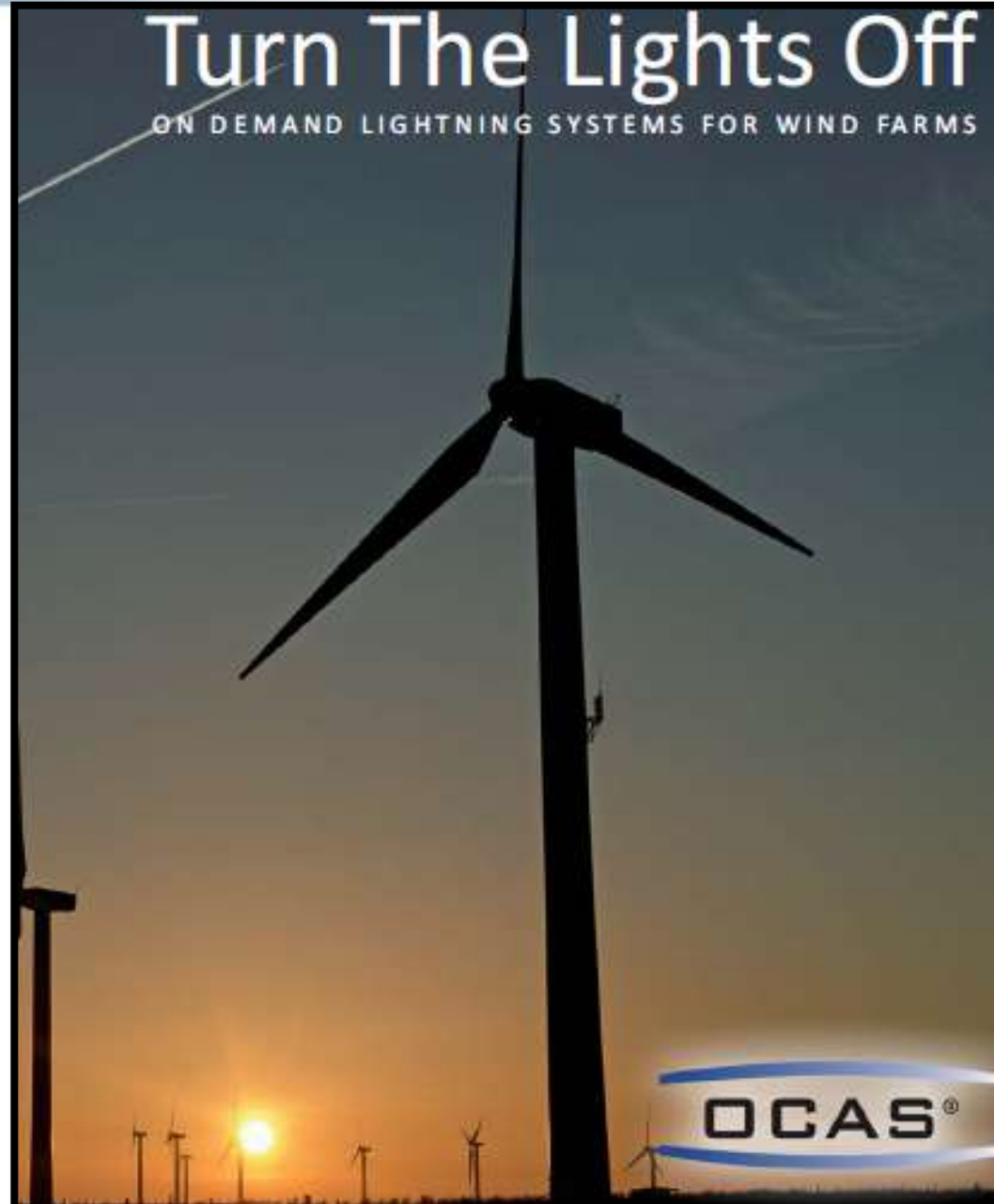


Radar based
On-demand
Lighting System

Winterwind 2011

Knut Vangen



Agenda

Introduction to OCAS

Status

Regulatory issues

Colour marking

Summary

Why choose OCAS

Substantial add-on value for wind parks

- Reduces light pollution and visual impact
- Mitigates public opposition
- Faster permitting processes
- Allows turbines > 150 m for improved yield
- Increasing safety and reducing the risk of litigation

High growth market and high political ambitions

- Reduced public opposition is required for progress

Proven and unique technology

- The only technology approved for turning lights off at wind parks
- Advanced 3D radar technology
- Long operational track record
- Fail safe

Strong commitment from current investors

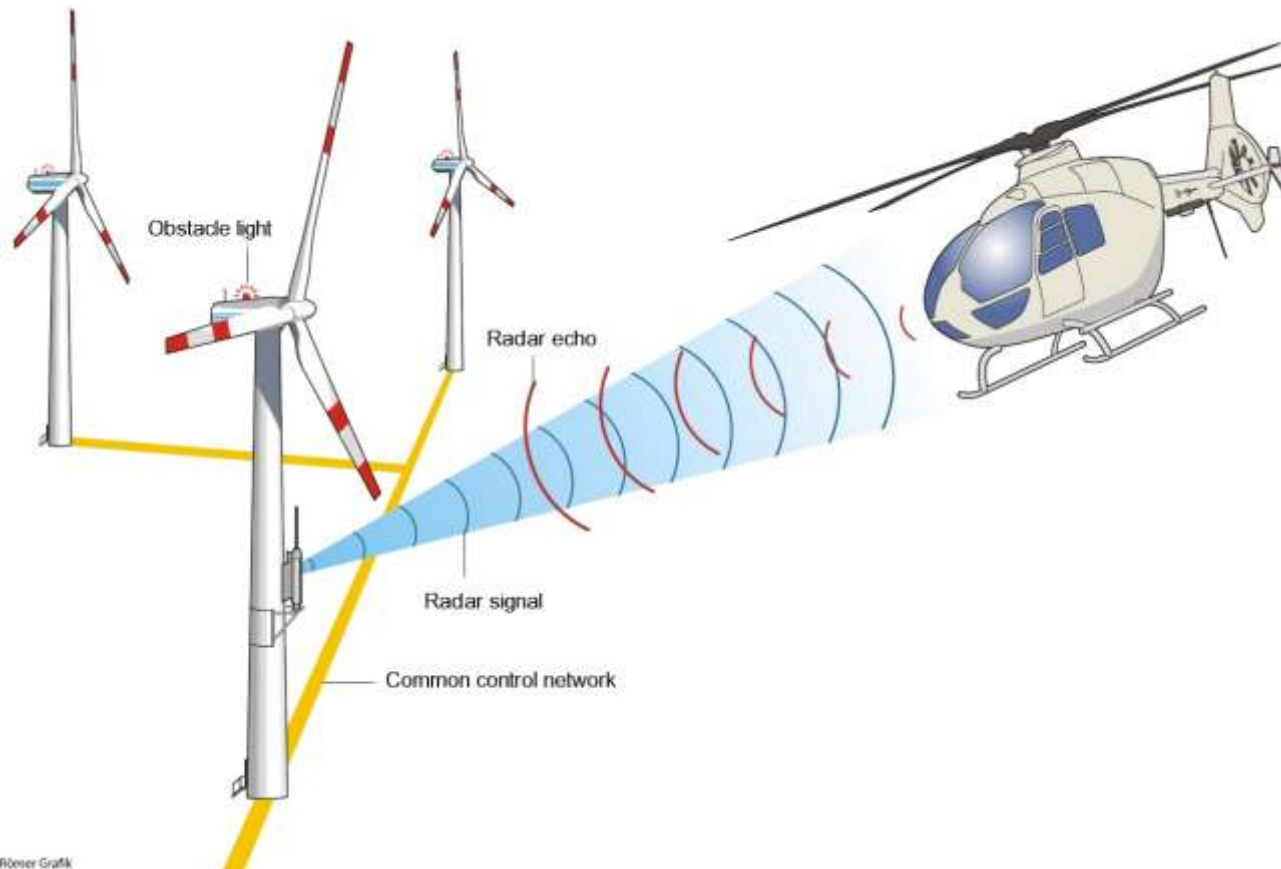


Background



- **Obstacle Collision Avoidance System**
- 2000: OCAS founded by experienced military pilots
 - Friends and colleges collided with power lines
 - Saw the need to improve current marking standards
- Advanced 3D radar research to develop OCAS
- Cooperation and development with:
 - Aviation authorities (FAA, TC and CAA-N)
 - Research organisations
- Product ownership, in-house competence
 - Average industry experience of ~22 years
 - 10 years of product development
 - Aviation experts: test / electronic warfare military and commercial pilots
 - Regulations: aviation, avionics, industrial and military HW & SW, environmental testing
 - Radar and electronics

The OCAS solution



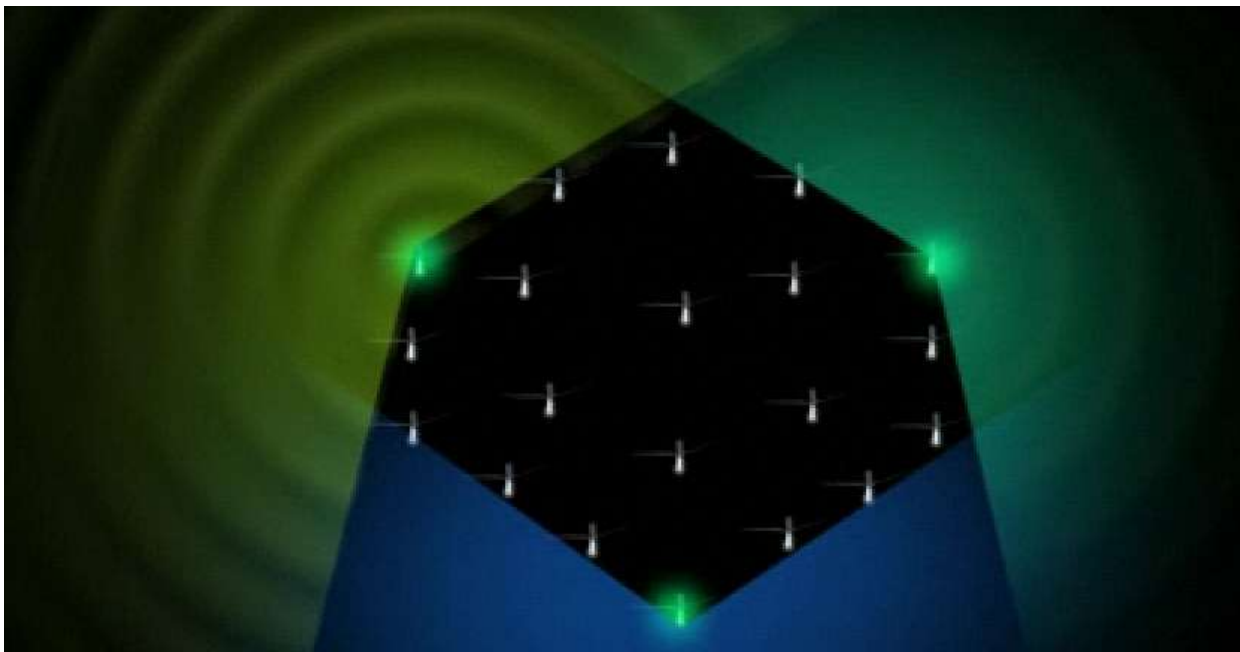
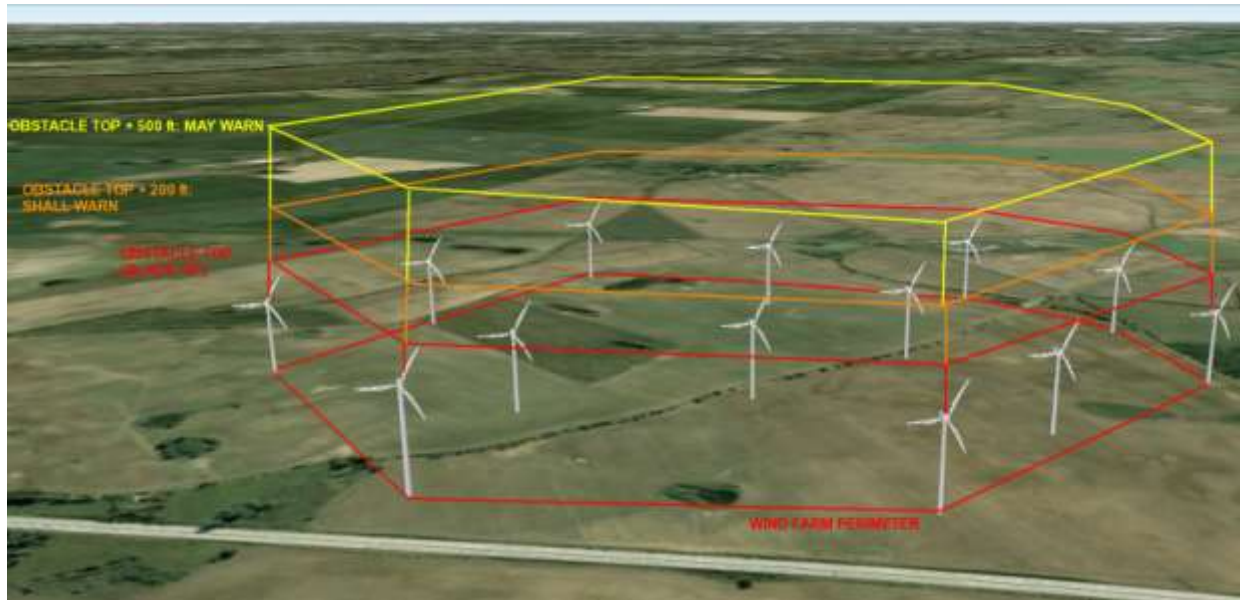
- 3D Radar detects and tracks aircrafts
- Calculates time to potential impact with obstacle
- Activates obstacle lights and optional VHF audio warning when required to enable safe evasive manoeuvre



OCAS radar at Siemens SWT 2.3-101 in Ontario, Canada (Talbot wind park)

OCAS setup

- Defines obstacle 3D volume
- 200 ft (60 m) margin for safe passage
- 300 ft (90 m) added margin for inaccurate flight (i.e. turbulence)
- Dynamic warning zone based to time to impact
- 30 seconds to impact: Lights ON
- Duration typically 1 – 3 minutes.
- 20 seconds: optional VHF warning (12 s)
- Radars outward looking from perimeter of park



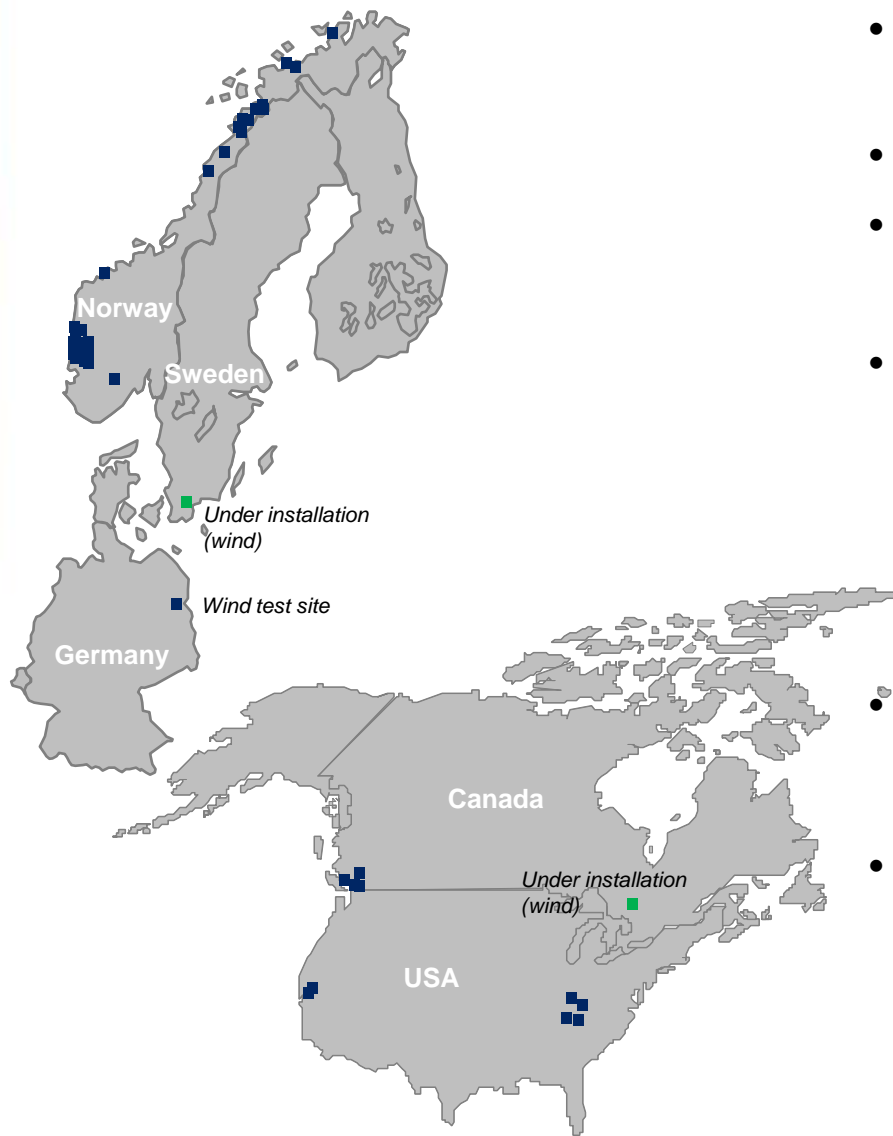
Unique product

- Developed by in-house, highly skilled specialists
- Advanced low cost, 3D radar
- Highly specialised software: Identify only real threats
- Proprietary power saving hardware design (lamp life: >30 years)
- No moving parts
- Failsafe
- No installation in aircraft required – available to ALL and NOW
- NO regulatory changes required



Proven technology

Operational sites around the world



- ~1,000,000 operative hours since Q3 2006
- > 3,000 flight tests since 2003
- Average operative up time > 99,8%
- 52 approved and operational systems in Norway, Canada and USA
 - 40 different sites
 - 15 different customers
- 3 systems installed +13 under installation for wind parks
- Robust design with low maintenance cost

OCAS is approved in the US, Canada and Norway

Approvals



FAA



Approved



TC



Approved



Luffarts-
tilsynet



Approved



Transport
-styrelsen



Under approval



BMVBS



Under approval

*OCAS is the first
Audio Visual
Warning System to
be installed, tested,
and approved by
aviation authorities*

Approved by International Dark Sky Association

OCAS approach

Wind park characteristics

Wind turbine height > 100 / 150m

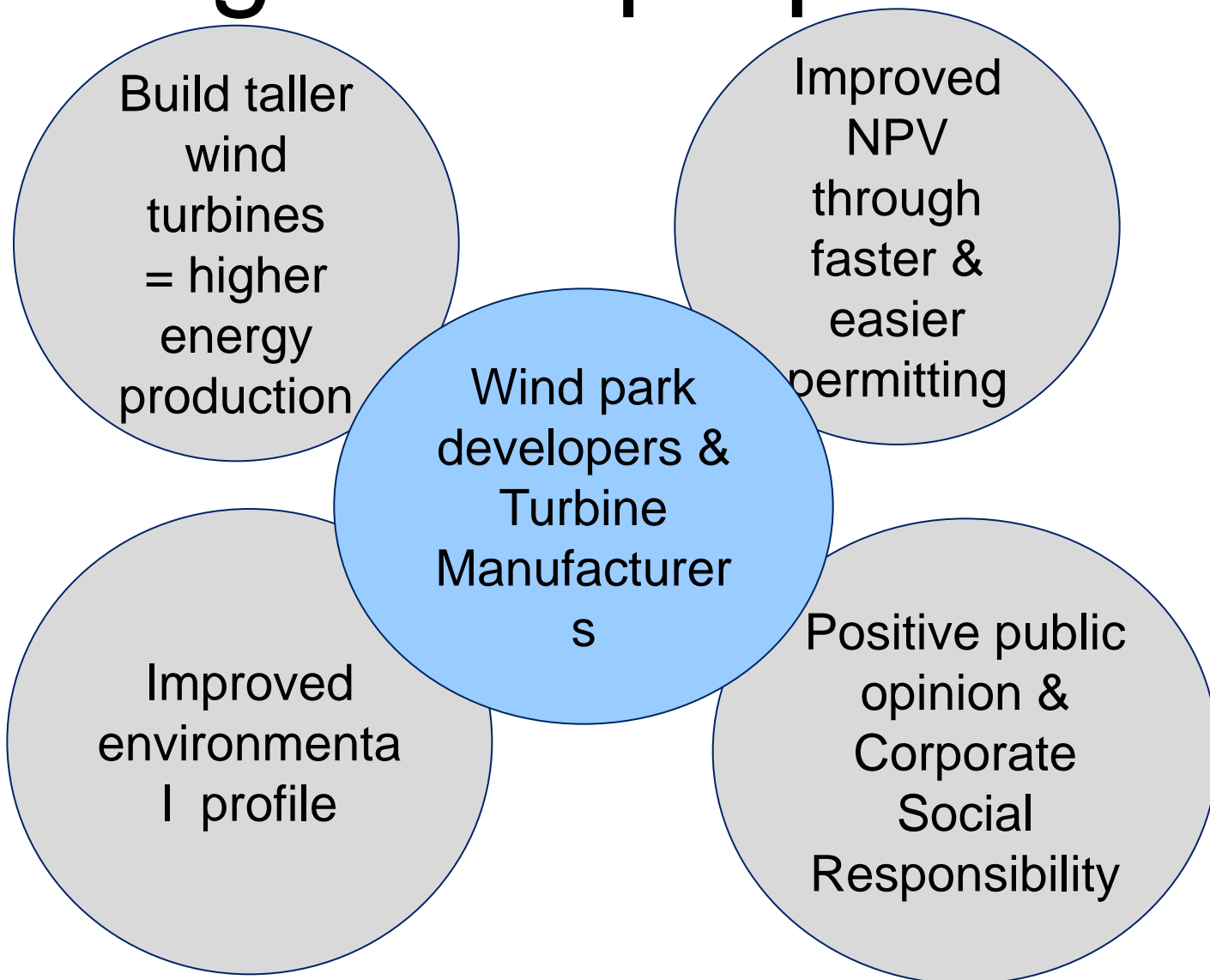
Locations where hub height > 150 m gives more than 10 % increased production, including optimised layout

New parks with permitting problems due to light issues

Parks visible from populated and recreational areas

Repowering, Expansion or existing parks with light issues

Strong value proposition



Market status

Customer	Status
Enertrag, Germany	Pilot project 3 radars installed February 2010
RES (Renewable Energy Systems) Canada	Contract April 2010 10 radars under installation
Leading turbine manufacturer Leading energy provider Sweden	Purchase Order July 2010 3 radars under installation
Zephyr Eyphelwind, Germany	Letter of Intent September 2010 3 radars
JP Vind, Sweden	Letter of Intent November 2010 7 radars
Wind Park Developer, USA	Letter of Intent December 2010 4 radars
	Total 30 radars for wind parks

OCAS status in Sweden

REGULATORY

- 2009-12: First presentation for Transportstyrelsen
- 2010-02: Spectrum agreement for OCAS radar with Forsvarsmakten
- 2010-08: Formal application for OCAS in first wind park in south Sweden
- 2010-10: 2nd meeting with Transportstyrelsen
- 2010-11: Supplemental documentation submitted
- 2011-01: 3rd meeting with Transportstyrelsen and Forsvarsmakten
- 2011-02: Supplemental details submitted
- 2011-03: Expected response / approval

COMMERCIAL

- 2010-02: Live demonstration at test wind park in Germany: 13 x V90, 3 radars
- 2010-08: Submitted first application for wind park
 - Southern Sweden: Order received, delivery in progress
- 2010-10: Live demonstration with Vindbruk Halland
 - OCAS radar installed at MET tower with high intensity LED light
- 2010: Sales activity in Sweden, multiple LOI's signed
- 2011: OCAS AB established
- 2011: Nordic sales manager employed
- 2011-06: First wind park in Sweden with OCAS approved

International regulations: ICAO annex 14 vol 1

4.3.2 Recommendation.— *In areas beyond the limits of the obstacle limitation surfaces, at least those objects which extend to a height of 150 m or more above ground elevation should be regarded as obstacles, unless a special aeronautical study indicates that they do not constitute a hazard to aeroplanes.*

6.1.9 Recommendation.— *Obstacles in accordance with 4.3.2 should be marked and lighted, except that the marking may be omitted when the obstacle is lighted by high-intensity obstacle lights by day.*

6.4 Wind turbines

6.4.1 A wind turbine shall be marked and/or lighted if it is determined to be an obstacle.

Note.— *See 4.3.1 and 4.3.2.*

Markings

6.4.2 Recommendation.— *The rotor blades, nacelle and upper 2/3 of the supporting mast of wind turbines should be painted white, unless otherwise indicated by an aeronautical study.*

Sweden: TSFS 2010-155 (09/2010)

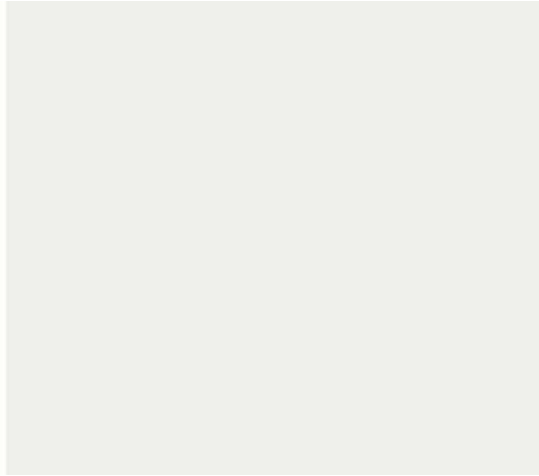
- Wind turbines and wind parks
 - 45 .. 150 m height
 - Daytime: White or light grey colour
 - Twilight: Red 20 flashes per minute (FPM), medium intensity (2000 Cd)
 - Night: Red 20 FPM medium intensity (200 - 2000 Cd)
 - Above 150 m height
 - Daytime: White or light grey colour
 - Twilight: White 40 – 60 FPM high intensity (20.000 – 100.000 Cd)
 - Night: White 40 – 60 FPM high intensity (2000 Cd)
 - Wind parks: perimeter and high points marking
 - Below 150 m height: 450 m distance between perimeter lights (~ all)
 - Above 150 m height: ~ 1200 m distance between perimeter lights
 - Low intensity lights at intermediate turbines, inside park and intermediate levels for tall objects

Undantag

33 § Transportstyrelsen kan medge undantag från dessa föreskrifter.

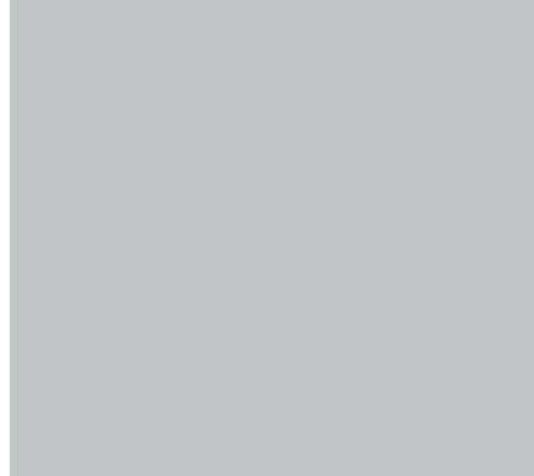
Allowed marking colors in TSFS 2010:155

RAL 9003: traffic white



RGB 238, 238, 235

RAL 7035: light grey



RGB 195, 195, 198

RAL 7038: Agate grey



RGB 177, 179, 172

- Color and surface texture affect icing properties?
 - Black / dark antennas are known to accumulate less ice
- Color may affect attraction to insects (which then attract birds and bats)
- Reduced visible impact to people (blend into background, reduced reflections)

White or grey daytime marking

- Uncertain in fog and winter and twilight
- Unsafe with winter (white – grey) background



Color marking versus light marking



- White and grey turbines daytime visibility: < 1000 m (winter: fog / snow)
- Picture shows German W red (100 Cd): < 1000 m visibility in fog

Why do wind parks need OCAS?

Drivers for wind parks to buy OCAS

Mandatory requirement for low / no visual impact of obstruction lights and daytime colour marking

Faster or easier permitting = Increased NPV

Build higher parks = higher incremental energy production

Public opinion

Corporate Social Responsibility / Environmental profile

Technology innovation image

- All wind parks are required to comply with national aviation obstacle marking regulations, including obstacle lights
- Awareness and opposition against visual impact of obstacle lights is increasing in populated areas

"Utilizing the OCAS technology emphasizes RES Canada's commitment to delivering projects with an environmentally neutral footprint"

Andrew Fowler, Vice President RES Canada.

"We want to try this, as we are looking at building turbines that are higher than 150m"

Anders Lundberg, Vindbruk Halland, Sweden

"To protect the environment, we are trying out new technology, like this revolutionary radar control system"

Werner Diwald, CEO, Enertrag, Germany

OCAS advantages

- Minimize negative visual impact of wind farms
 - Light marking night
 - Light marking daytime – possible alternative to paint marking
- Ensures maximum aviation safety
- Facilitates for increased possible energy production and park earnings
- Increased probability for project realization

Questions?

Knut Vangen
Development manager
OCAS AS

Turn The Lights Off

ON DEMAND LIGHTNING SYSTEMS FOR WIND FARMS

