Baptiste Domps

Research Topics

Background

Degreane Horizon VINCI group

Wind energy and VINCI Énergies

Degreane Wind Profiler

System overview Wind remote sensing with rad

Wind Potential

Generalities

Issues with classical instruments Wind Assessment with Wind Profil

Summary

Appendia



Hands-On with Degreane Horizon PCL-1300

Baptiste Domps*, J. Marmain, C. Melnotte and T. Pugliesi

Degreane Horizon – Radar and Scientific Applications Department

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Specialist Meeting on Electromagnetic Waves and Wind Turbines École Nationale de l'Aviation Civile, 5-6 Dec 2019



1/14





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Research Topics

Background

Degreane Horizon

VINCI group

Wind energy and VINCI Énergies

Degreane Wind Profiler

System overview

Wind remote sensing with radar

Processing overview

Wind Potential

Generalities

Issues with classical instruments Wind Assessment with Wind Profil

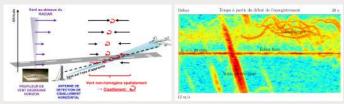
Summary

Appendix

Research Topics

Degreane Horizon Wind Profiler: measures wind speed and direction on a vertical axis (meterological agencies, airports)

Our 'usual' research topic: wind shear detection



Our 'wind energy' research topic: wind assessment using radar system

2/14

- Early stages
- Marketing studies, requirements





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Research Topics

- Background
- Degreane Horizon
- VINCI group
- Wind energy and VINCI Énergies

Degreane Wind Profiler

- System overview
- Wind remote sensing with radar
- Processing overview

Wind Potential

- Generalities
- Issues with classical instruments Wind Assessment with Wind Profile
- Summary
- Appendi

Outline

Research Topics

Background

- Degreane Horizon
- VINCI group
- Wind energy and VINCI Énergies

2 Degreane Wind Profiler

- System overview
- Wind remote sensing with radar
- Processing overview

Wind Potential Assessment

- Generalities
- Issues with classical instruments
- Wind Assessment with Wind Profiler

3/14

4 Summary

Appendix





Baptiste Domps

Research Topics

Background

Degreane Horizon

VINCI group Wind energy and VINCI Énergies

Degreane Wind Profiler

System overview

Wind remote sensing with radar

Processing overviev

Wind Potential

Generalities

Issues with classical instruments Wind Assessment with Wind Profil

Summary

Appendi

Degreane Horizon

- Based in Toulon (French Riviera)
- 70 people, sales: €10m

Our expertises





4/14







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Research Topics

Background

Degreane Horizon

VINCI group Wind energy and VINCI Énergies

Degreane Wind Profiler

System overview Wind remote sensing with rad

Wind Potential

Generalities

Issues with classical instruments Wind Assessment with Wind Profil

Summary

Appendi

Degreane Horizon

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- 70 people, sales: €10m

Our expertises





A full range of worldwide-trusted weather sensors, e.g.:









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Research Topics

Background

Degreane Horizon

VINCI group Wind energy and VINCI Énergies

Degreane Wind Profiler

System overview Wind remote sensing with ra

Wind Potential

Generalities

Issues with classical instruments Wind Assessment with Wind Profile

Summary

Appendix

Degreane Horizon

- Based in Toulon (French Riviera)
- 70 people, sales: €10m

Our expertises





Defence



Space surveillance radar

Air-droppable met system



Underwater acoustics





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Research Topics

Background

Degreane Horizon VINCI group

Wind energy and VINCI Énergies

Degreane Wind Profiler

System overview Wind remote sensing with re

Wind Potential

Generalities

Issues with classical instruments Wind Assessment with Wind Profile

Summary

Appendi

Degreane Horizon

- Based in Toulon (French Riviera)
- 70 people, sales: €10m

Our expertises





Energy/transport

Remote alarm systems, Data transmission, Remote control, Galvanic Isolation Devices

4/14







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Research Topics

Background

- Degreane Horizon
- Wind energy and VINCI Énergies

Degreane Wind Profiler

System overview Wind remote sensing with r

Wind Potential

- Generalities
- Issues with classical instruments Wind Assessment with Wind Profil

Summary

Appendix



Degreane Horizon

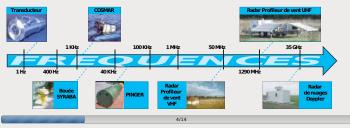
- Based in Toulon (French Riviera)
- 70 people, sales: €10m

Our expertises





A wideband knowledge



On the use of Radar Wind Profiler Data for Wind Farm Site Selection



Forward

VINCI

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Research Topics

Background

Degreane Horizon

VINCI group

Wind energy and VINCI Énergies

Degreane Wind Profiler

System overview

Wind remote sensing with radar

Processing overview

Wind Potential

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Generalities

Issues with classical instruments Wind Assessment with Wind Profi

Summary

Appendia

VINCI group

Global player in concessions and construction

Degreane Horizon is part of VINEL , itself part of VINCI group



5/14

- Investor, builder and operator of buildings and infrastructure
- Worldwide business (≈ 100 countries)
- At the heart of today's challenges









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Research Topics

Background

Degreane Horizon

VINCI group

Wind energy and VINCI Énergies

Degreane Wind Profiler

System overviev

Wind remote sensing with radar

Processing overview

Wind Potential

Generalities

Issues with classical instruments Wind Assessment with Wind Profile

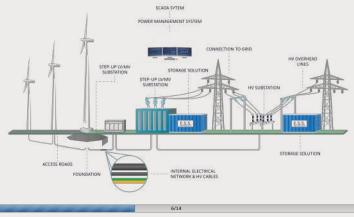
Summary

Appendia

Wind energy and VINCI Énergies

Dedicated brand for energy transition: **OMEXOM**

- 21k people, 33 countries
- Power (wind & solar), transmission, substations, distribution, territories





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Research Topics

Background

Degreane Horizon VINCI group

System overview

Wind remote sensing with radar Processing overview

Wind Potential Assessment

Generalities Issues with classical instruments Wind Assessment with Wind Prof

Summary

Appendi

System overview

Degreane Horizon Wind Profiler: measures wind speed and direction on a vertical axis

- L-band (pprox 1,3 GHz)
 - 3 to 5 arrays of dipoles
 - Range from 75 m to 5 km
 - 75 m max resolution
 - 2 min temporal resolution
- Deployed on > 50 sites worldwide, many references in the meteorological literature as a reliable instrument

7/14

• Optional temperature profile with RASS system



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Research Topics

Background

Degreane Horizon

Wind energy and VINCI Énergies

Degreane Wind Profiler

System overview

Wind remote sensing with radar Processing overview

Wind Potential

Generalities

Wind Assessment with Wind Profile

Summary

Appendi

System overview

Setup example



(hard or mobile installation)

Remote Data Analysis

- Custom-setup: hard or mobile
- Turnkey solution (including civil engineering if needed)

7/14

- Robust system with autonomous and continuous operation under all weather conditions
- Remote data analysis
- Life span > 10 years, low operating costs



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Research Topics

Background

Degreane Horizon

VINCI group

Wind energy and VINCI Énergies

Degreane Wind Profiler

System overview

Wind remote sensing with radar

Processing overview

Wind Potentia

Generalities

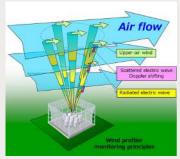
Issues with classical instruments Wind Assessment with Wind Profil

Summary

Wind remote sensing with radar

Detection of irregularities of the refractive index of particle-free clear air

These irregularities are caused through variations in the temperature, pressure and moisture that affect the propagation of electromagnetic waves and backscattering



Japan Meteorological Agency

- Doppler Beam Swinging technique to compute wind vector
- Applications: Aeronautic safety, Meteorological forecasting, Study of atmosphere's dynamic, etc.





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Research Topics

Background

Degreane Horizon

VINCI group

Wind energy and VINCI Énergies

Degreane Wind Profiler

System overview

Wind remote sensing with radar

Processing overview

Wind Potential

Generalities

ssues with classical instruments Mind Assessment with Wind Profil

Summary

Appendix

Wind remote sensing with radar Case study: Wind Shear & Wind Barb display (3 min sampling, 7 hours data)

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Time vs Altitude





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Research Topics

Background

Degreane Horizon

VINCI group

Wind energy and VINCI Énergies

Degreane Wind Profiler

System overview

Wind remote sensing with radar

Processing overview

Wind Potential

Assessment

Generalities

issues with classical instruments

Summary

Appendix

Network Control **Profiler Signal** Profiler Profiler Processor Center Data Processor Coherent integration Fuzzy Logic ·FFT **Profiler Data** Processor InCoherent Integration Running .Ground Clutter **Data Archive** Consensus Rejection Multiple Peak Moments Calculation Statistical Dissemination OC. Weber-Wuertz OC Spectrum Wind, Temp. Date Humidity Profiles

• Own software tailored to customer's requirements

Local Site

• Full quality control functionality is provided at all stages of signal and data processing

Processing overview

Wind, Temp, Humidity Profiles



Met Building



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Research Topics

Background

Degreane Horizon

VINCI group

Wind energy and VINCI Énergies

Degreane Wind Profiler

System overview

Wind remote sensing with radar

Processing overview

Wind Potentia

Assessment

Generalities

Issues with classical instruments Wind Assessment with Wind Profil

Summary

Appendi

Generalities about Wind Potential Assessment

- One of the first step when designing a Wind Farm Project
- Ensures economic viability of the farm:

Identification of wind site (mesoscale wind atlases);

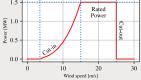
- 2 preliminary evaluation;
- assessment of site and micrositing.

Wind Potential depends on *w*:

$$P_W = \frac{1}{2}\rho A w^3$$

 $f(w) = \frac{k}{\lambda} \left(\frac{w}{\lambda}\right)^{k-1} \exp\left(-\frac{w}{\lambda}\right)^{k}$





Power Curve is non-linear

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Goal: Find the most realistic (λ ; k) parameters



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Research Topics

Background

Degreane Horizon

VINCI group

Wind energy and VINCI Énergies

Degreane Wind Profiler

System overview Wind remote sensing with

Processing overview

Wind Potential

Generalities

Issues with classical instruments

Wind Assessment with Wind Profiler

Summary

Appendi

Issues with classical instruments

Masts

- 3 different Meteorological Towers:
 - Site Selection: 40 m, 2 years data, 1/site
 - Measures Wind direction & speed, humidity, temperature
 - Verify Wind Atlases Data
 - Wind at the rotor's height is **estimated** with the Wind profile power law
 - Ø Micrositing: 100 m, 2 months, 1/Wind Turbine
 - Validation of Wind Turbine position
 - Operation: 100 m, during all Wind Farm's life, 1/site
 - Met Monitoring

Expensive, Civil engineering required, No errors permitted, Height limitation



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Research Topics

Background Degreane Horizon VINCI group

Degreane Wind Profiler

System overview Wind remote sensing with rada Processing overview

Wind Potential Assessment

Generalities

Issues with classical instruments

Wind Assessment with Wind Profile

Summary

Appendi



Issues with classical instruments





There are even offshore met masts! FINO-1: 80 m

D. Muñoz-Esparza, F. Miceli





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Research Topics

Background

Degreane Horizon

VINCI group

Wind energy and VINCI Énergies

Degreane Wind Profiler

System overview

Wind remote sensing with radar

Processing overview

Wind Potentia

.

Issues with classical instruments

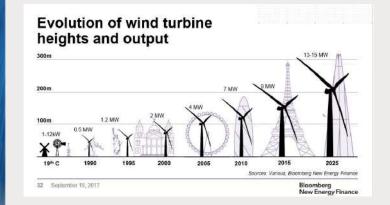
Wind Assessment with Wind Profiler

Summary

Appendix

Issues with classical instruments

Masts are becoming too short



• WTG's rotor is now outside the radar's blind zone



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Research Topics

Background

Degreane Horizon VINCI group Wind energy and VINCI Énergies

Degreane Wind Profiler

System overview Wind remote sensing with rad

Wind Potential Assessment

Generalities

Issues with classical instruments

Summarv

Appendix

Issues with classical instruments

Anemometer/Lidar/Radar

Anemometer mounted on Met Masts: sensitive to Aerodynamics Effects because of the mast

Pros for Lidar Very high radial resolution for low altitudes Cons for Lidar Expensive, Mechanical parts

Pros for Radar All-weather, Reliable, Temperature & Humidity with RASS

Cons for Radar Lower resolution, Blind zone near ground



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Research Topics

Background

- Degreane Horizon
- VINCI group
- Wind energy and VINCI Énergies

Degreane Wind Profiler

System overviev

Wind remote sensing with radar

Processing overview

Wind Potential

Assessmen

Generalities

Issues with classical instruments Wind Assessment with Wind Profiler

Summary

Appendi

Wind Assessment with Wind Profiler

Reduce the blind zone:

- First gate at 75 m
- Ground noise and fixed-echoes issues

Ø Better resolution:

- Resolution depends on Pulse Width: $r = \frac{c\tau}{2}$
- Present shorter Pulse Width is au= 0.5 $\mu {
 m s}$
- Faster switching: less transmit power



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Research Topics

Background

Degreane Horizon

VINCI group

Wind energy and VINCI Énergies

Degreane Wind Profiler

System overview Wind remote sensing with r

Wind Potentia Assessment

Generalities

Issues with classical instruments Wind Assessment with Wind Profil

Summary

Appendix

Summary

- Promising alternative to met masts
- Wind speed & direction but also temperature with RASS
- I would be happy to discuss further ^(C)



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Research Topics

Background

Degreane Horizon

VINCI group

Wind energy and VINCI Énergies

Degreane Wind Profiler

System overview

Wind remote sensing with rada

Processing overview

Wind Potential

Generalities

Issues with classical instruments Wind Assessment with Wind Profile

Summary

Appendix

Signal Processing Appendix



