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WIND POWER MADE EASY

To heat or not to heat ?

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XANT company – www.XANT.com

Winterwind

INTERNATIONAL WIND ENERGY CONFERENCE

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- Mid sized wind turbines
  - ✓ 50 - 500 kW
- Applications
  - ✓ On-site generation
  - ✓ Off-grid systems
- ✓ Drivers
  - ✓ Fuel- & battery saver
  - ✓ Hedge against volatile energy prices
  - ✓ Smart-grid enabler
  - ✓ Land mark

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TECHNICAL SPECIFICATIONS

- XANT M-21 / 24
  - ✓ 100 kW
  - ✓ Direct drive
  - ✓ Total height max 50 m
  - ✓ Design DNV-GL certified
  - ✓ Certified power curve 200.000 kWh @ 5.2 m/s
  - ✓ Certified noise curve 39 dB(A) @ 200 m
- XANT L-33
  - ✓ 330 kW
  - ✓ Direct drive
  - ✓ Total height max 55 m
  - ✓ Under Development

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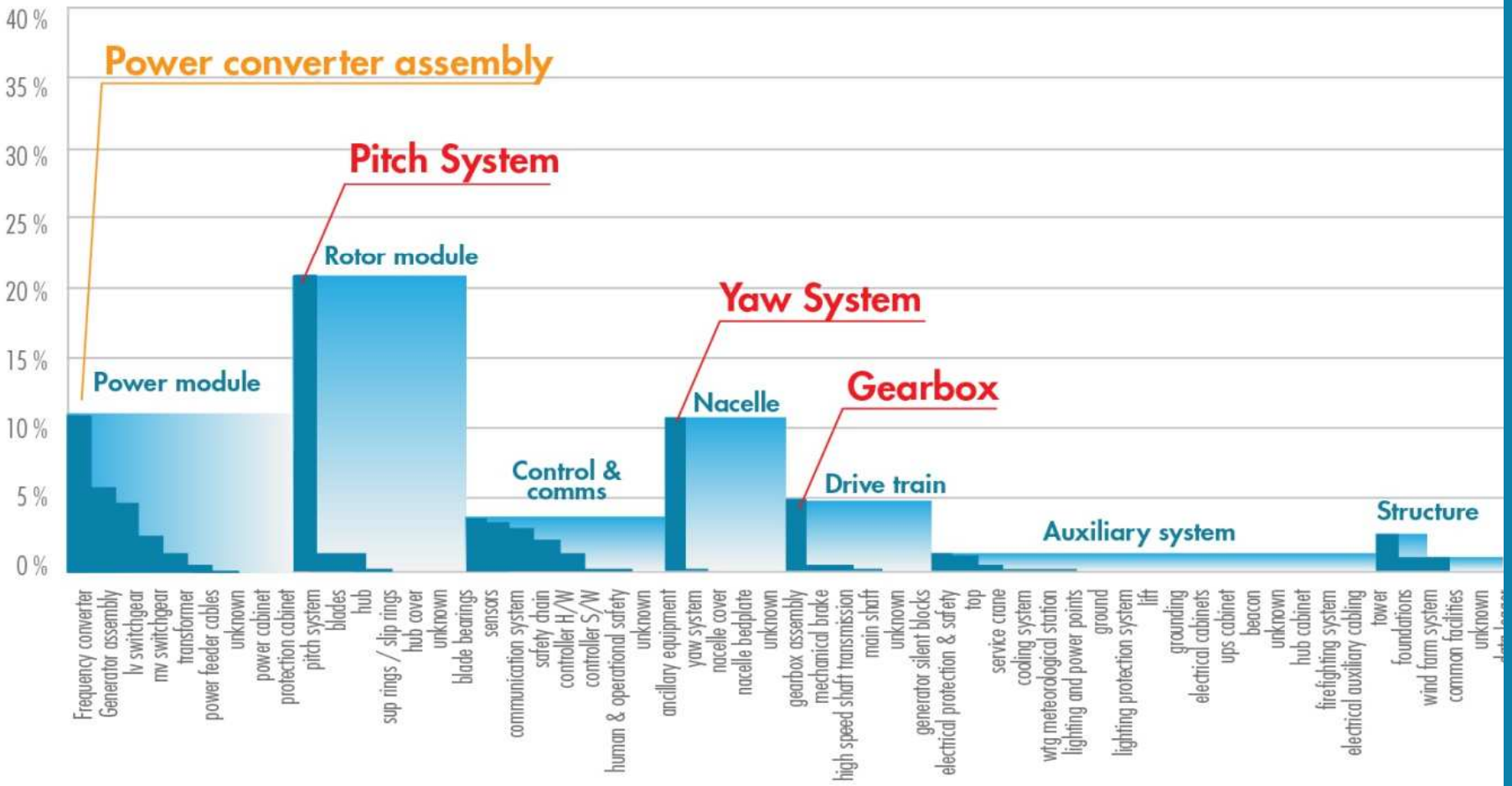
DESIGNED FOR RELIABILITY

- Just Enough Essential Parts JEEP
- Elimination of most-failure-prone parts

Results - Failure Rate (all downtime events)

Percentage contribution to overall failure rate



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DESIGNED FOR TRANSPORT

- All parts fit in a 40” container
- Lowest transport cost
- Possibility to deliver to remote locations


ap
Satellite
Greenland
Iceland
Finland
Sweden
Norway
Russia
United Kingdom
Poland
Germany
Ukraine
France
Spain
Italy
Kazakhstan
Mongolia
Turkey
China
South Korea
Japan
Iraq
Iran
Afghanistan
Pakistan
Algeria
Libya
Egypt
Saudi Arabia
India
Thailand
Mali
Niger
Sudan
Chad
Nigeria
Ethiopia
DRC
Kenya
Tanzania
Angola
Namibia
Botswana
Madagascar
South Africa
Indonesia
Papua New Guinea
Australia
New Zealand
Canada
United States
Mexico
Venezuela
Colombia
Peru
Brazil
Bolivia
Chile
Argentina
North Pacific Ocean
North Atlantic Ocean
South Pacific Ocean
South Atlantic Ocean
Indian Ocean
Southern Ocean
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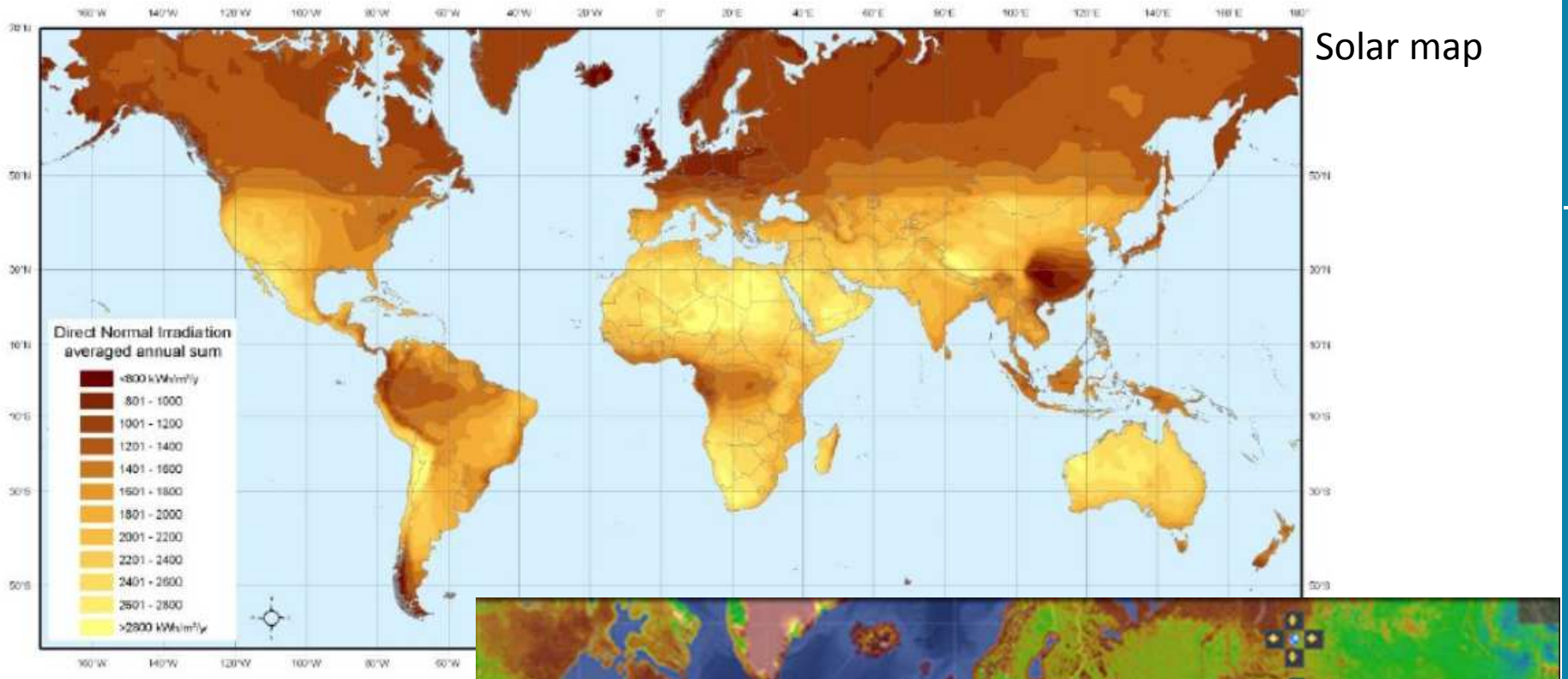
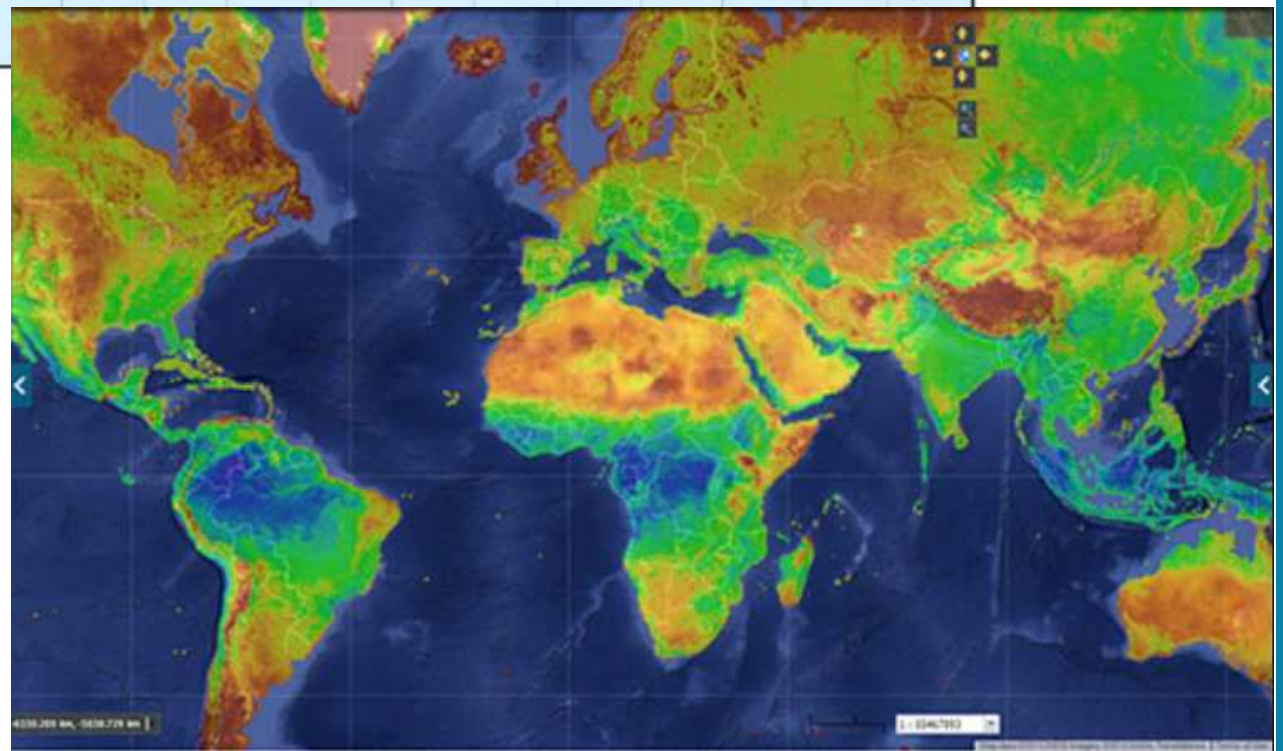
Map data ©2019



Solar map



Wind map
(average wind speed, 200m high)

NOTHERN REGIONS "MARKET STUDY"

- Remote communities
- Low solar irradiation
- Good wind resources

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COLD-CLIMATE STRATEGY

Distinction between two modes/purposes:

- Operation at low-temperatures (down to -40°C)
- Ice throw mitigation measures
  - Prediction
    - Environmental conditions
  - Detection
    - Ice detector on the blades
    - Under-performance
  - Prevention
    - Dark blades
    - Ice-phobic coating
    - Blade heating

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TEST AT THE OWI LAB (June 2016)

4 test days in June 2016

Purpose

- General behavior of the nacelle + converter
- Identification of the weak points and their possible solutions
- Heating blankets on the brakes
- Blade heating system
- Specific bearing grease
- Specific oil in the yaw gearboxes

TEST AT THE OWI LAB (June 2016) – Setup

- Complete nacelle without blades
- Generator in motor mode (from 30 to 60 RPM)
- Yaw motion
- Converter in the room with the nacelle (conservative setup)
- Heated anemometer

TEST AT THE OWI LAB (June 2016) - Setup

Temperature sensors

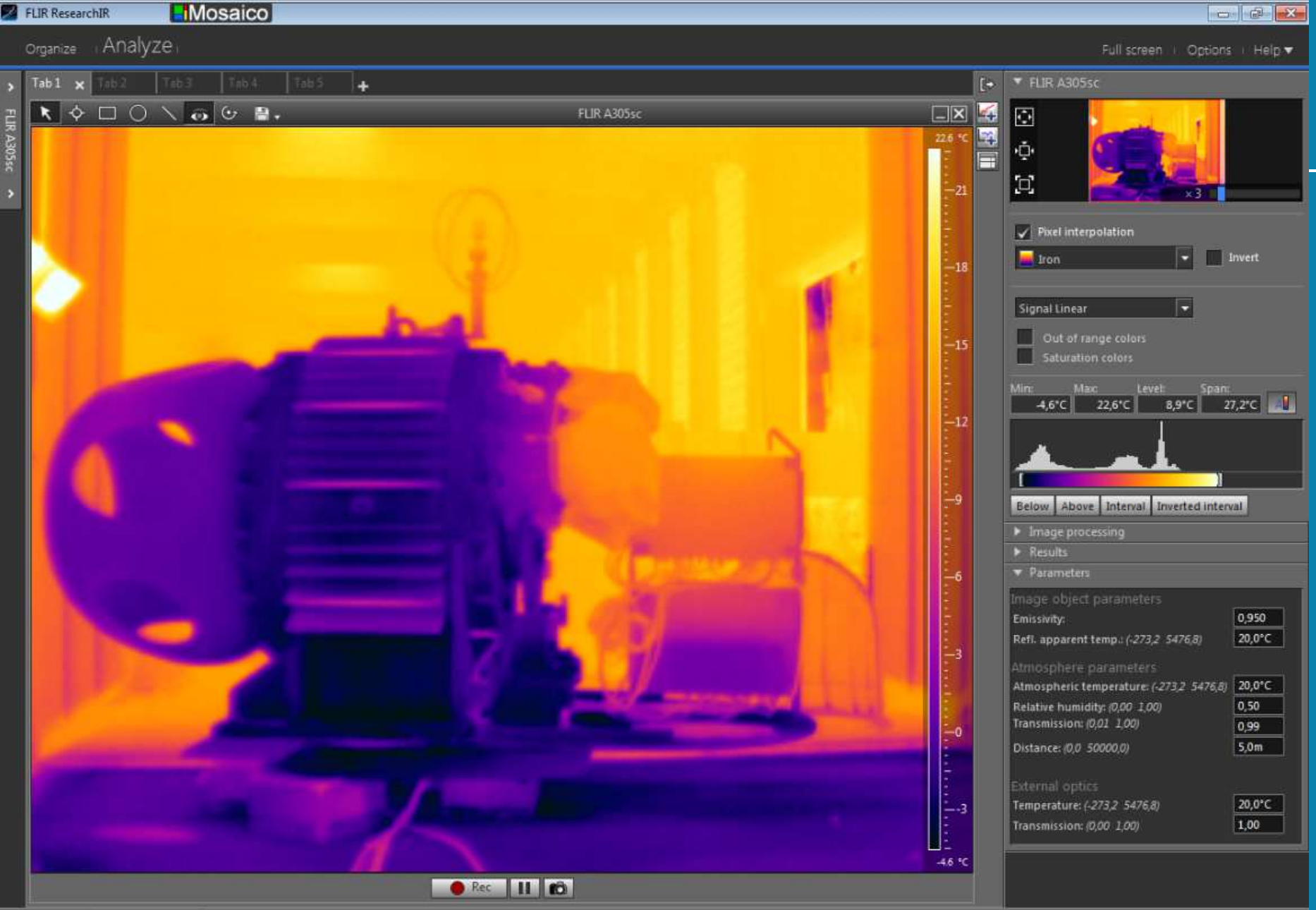
- Both generator bearings
- Yaw gearbox
- Electro-mechanical brakes (inside the blankets)
- Incoming air of the blade heating device
- Outcoming air of the blade heating device
- Incoming air at blade root
- Thermic recording of the nacelle from different point of view
- Converter (several points inside)

Current

- Generator
- Yaw drives

TEST AT THE OWI LAB

Experimentation phases



- Continuous operation in decreasing outside temperature (staircase profile)
- Operation @ -40°C
- Short stop @ -40°C
- Cold start @ -40°C
- Icing

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TEST AT THE OWI LAB (June 2016)

Lessons learnt

- Power consumption of about 12 kW (balanced by additional yield due to more dense air)
- Cold start at -40°C is the most demanding
  - Yaw gearboxes were blocked
  - Brittle cables
  - Power converter didn’t start (hair dryers to increase its temperature at -20°C)
  - Generator bearings were ok
  - …
- Heating blankets is the best power consumption/heating benefit ratio
- Sonic anemometer must be heated
- Stator heater in the generator

TEST AT THE OWI LAB
October 2017

2 days in October 2017

Purpose

- To identify the icing patterns on the blades
- To precisely define the best location of the ice-detection sensor
- Test of the ice-detection sensor operation

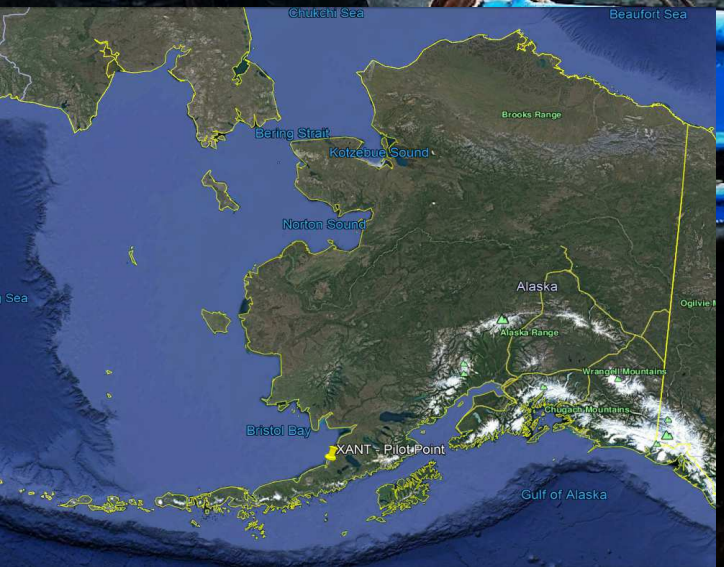
PILOT POINT I & II
Alaska - USA

100 kW

287.000 kWh

100 kW

287.000 kWh



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TEST IN THE FIELD
Since October 2018

Installation in Alaska during fall 2018

- Two XANT M-21 ETR
- Tilt-up execution

TEST IN THE FIELD
Since October 2018

Experimental process:

- ✓ Test of the blade heating system at different power levels
- ✓ Test of the heating blankets
- ✓ Test of the icing sensor system
- ✓ Test of the heated anemometer

→ 96% availability since commissioning end of October

Next steps:

- Effect of the ice-phobic coatings on the de-icing timing (both at OWI-Lab and in the field)

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