# Wind Turbine
## Hazards and Rescue Operations


**Axel Manz**
**Charley Shimanski**


**ICAR Joint AIR-TER Commissions**
**October 2018 – Chamonix, France**

ecms Academy
reaching higher levels

MOUNTAIN RESCUE ASSOCIATION

# Wind Turbine Hazards and Rescue Operations

**PART 1**
**The Wind Turbine Industry**

**PART 2**
**Terrestrial Rescue**

**PART 3**
**Helicopter Rescue**

# Wind Turbine Hazards and Rescue Operations

**PART 1**

**The Wind Turbine Industry**

**PART 2**

**Terrestrial Rescue**

**PART 3**

**Helicopter Rescue**

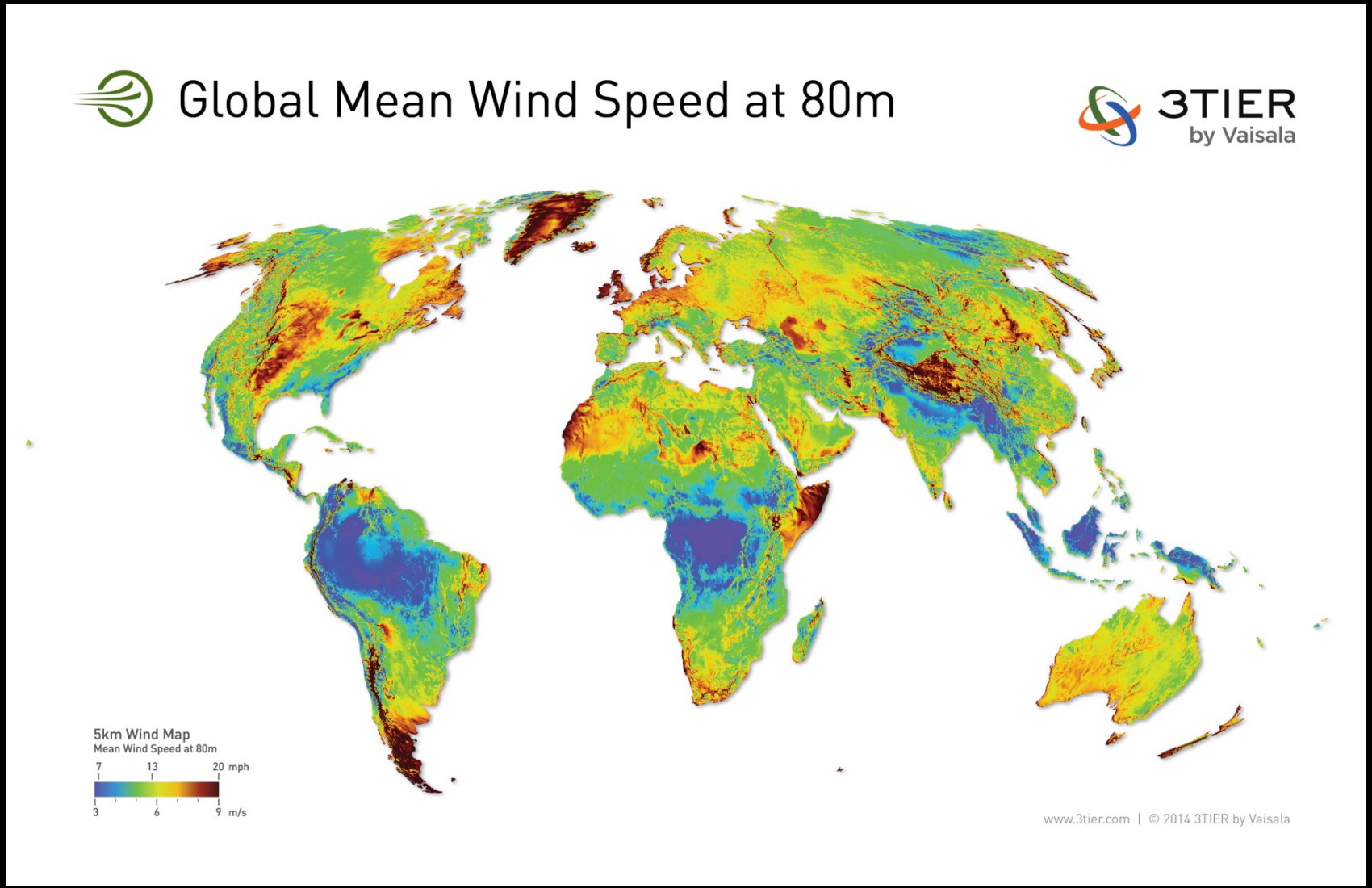
# Wind Turbine Height

- Often rising over 150 meters (500 feet)
- Tallest is 220 meters (722 feet)
- Future turbines will be even taller.

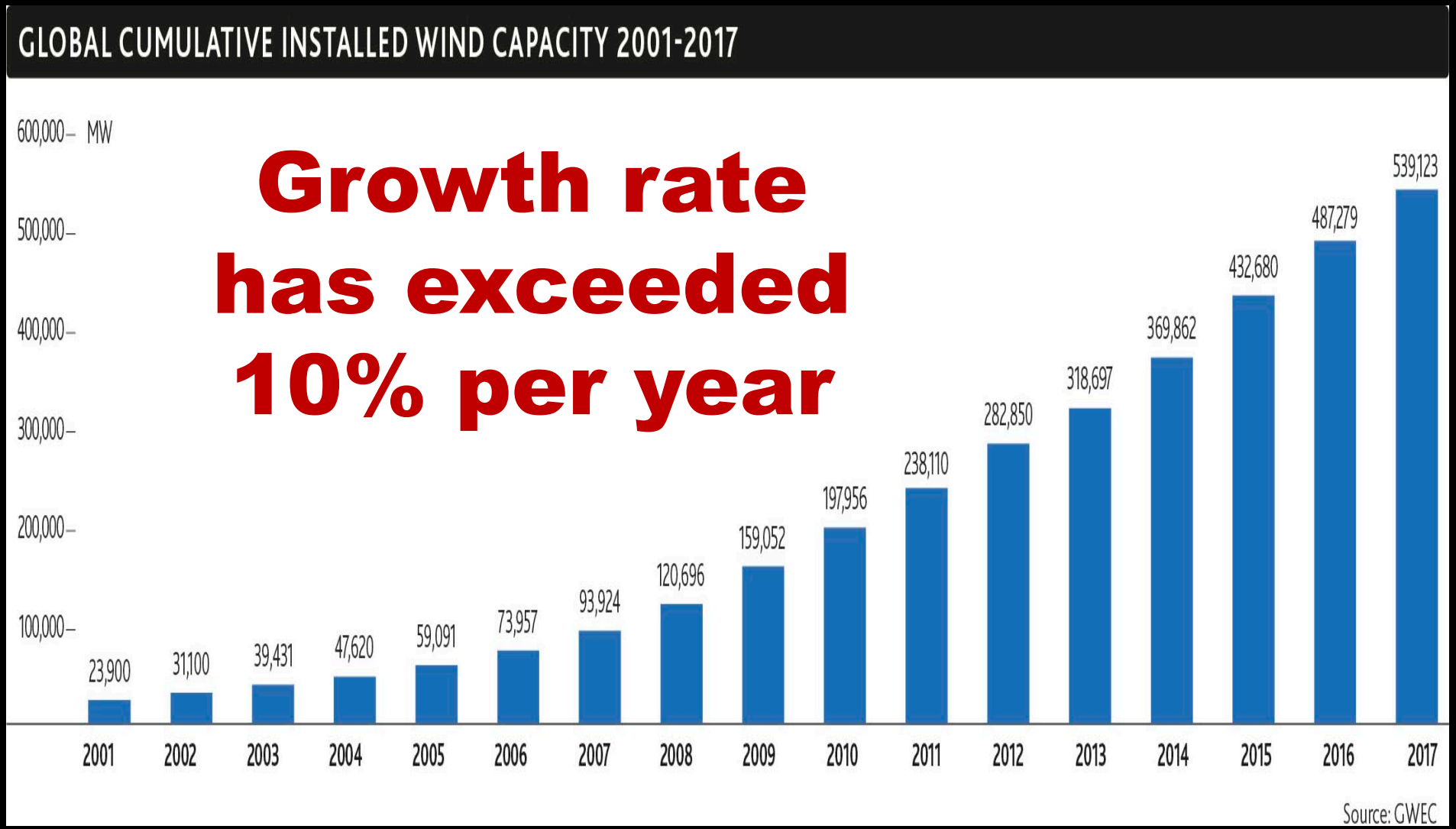
# The Wind Power Industry

- Wind power is present in 90+ countries.
- Germany, UK, France, Belgium, Ireland, India all set new records
- China is the global leader

# Industry Growth

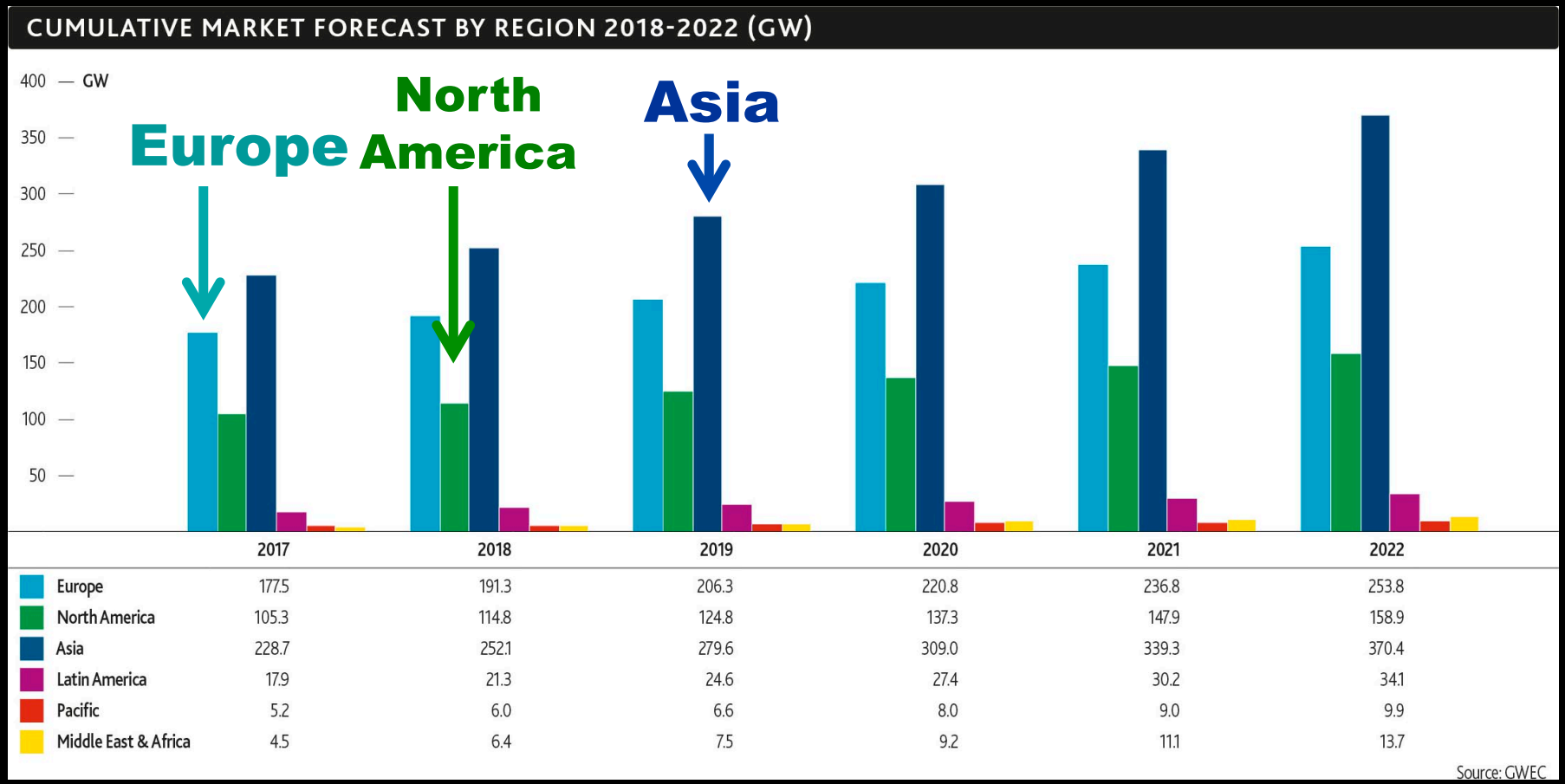


# Industry Growth



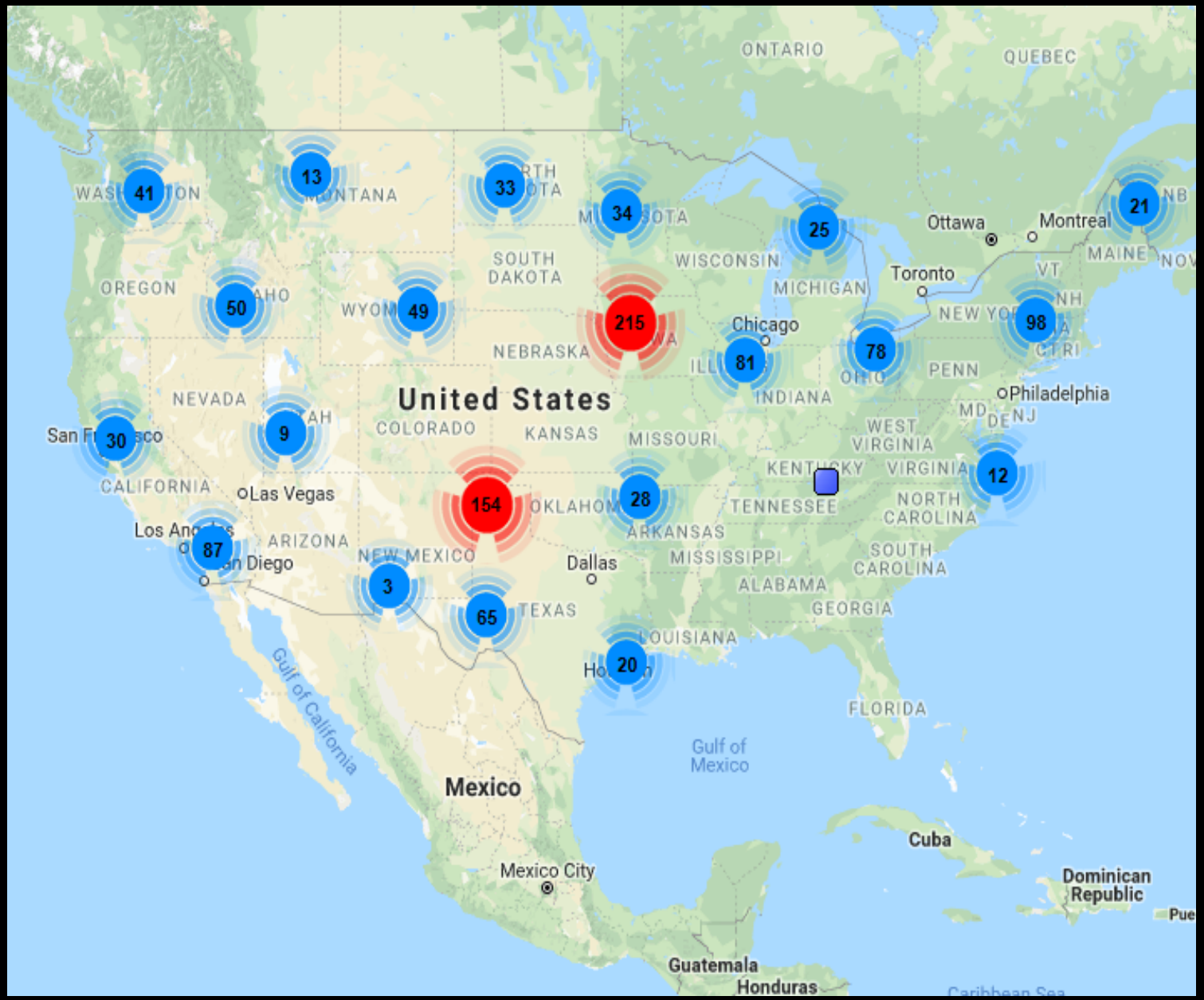
# Industry Growth

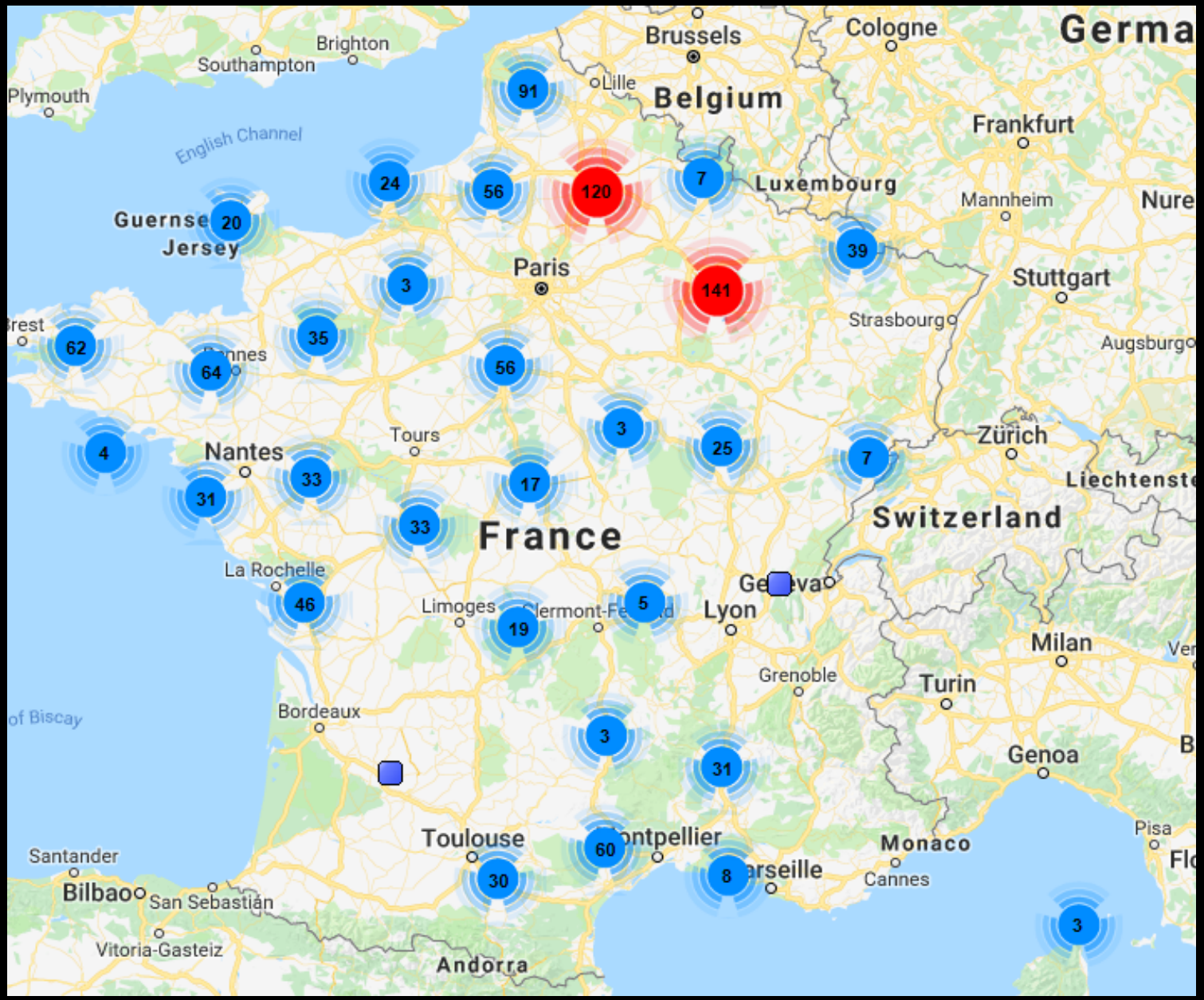
## Europe +43%, North America +55%, Asia +62%,

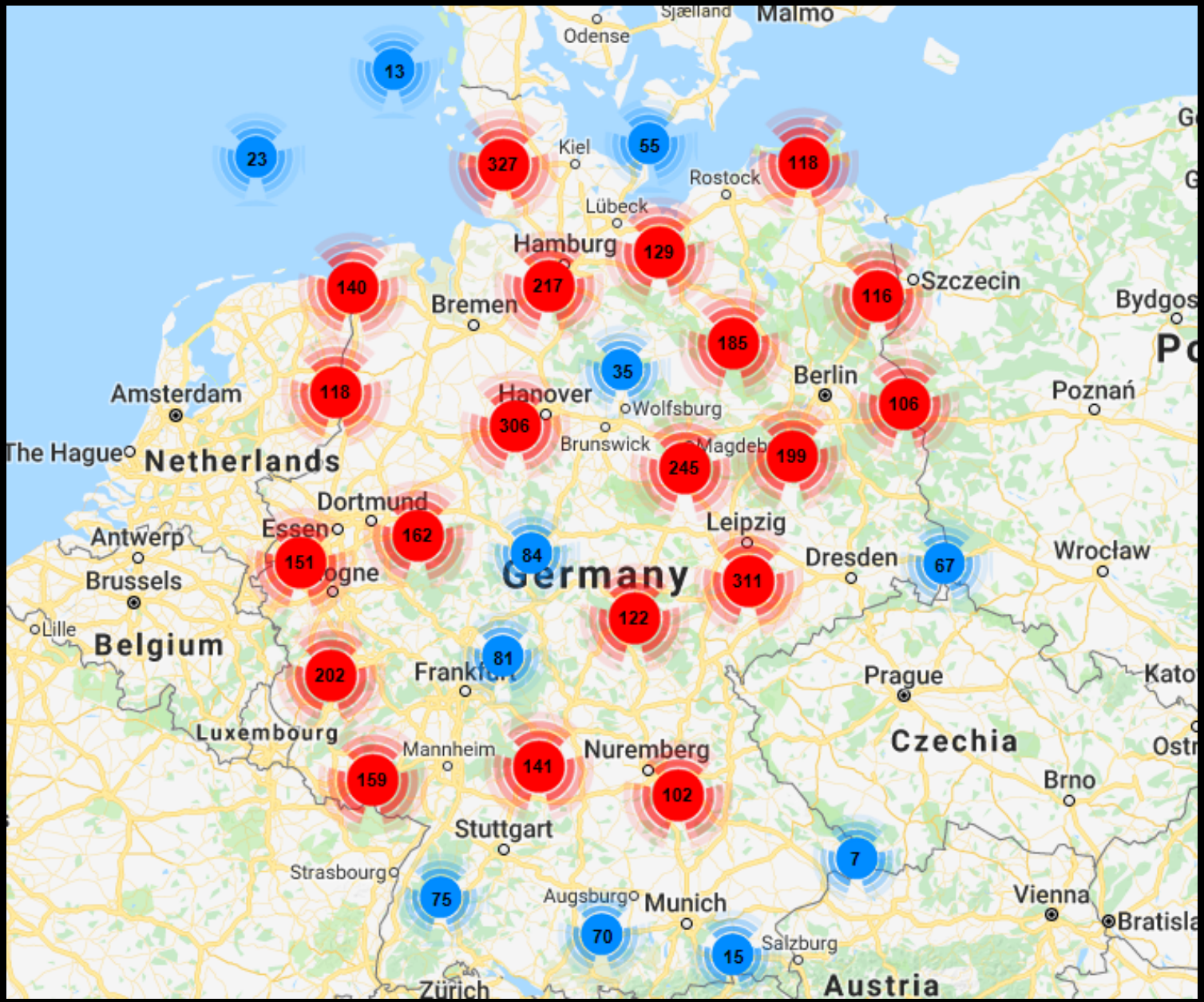


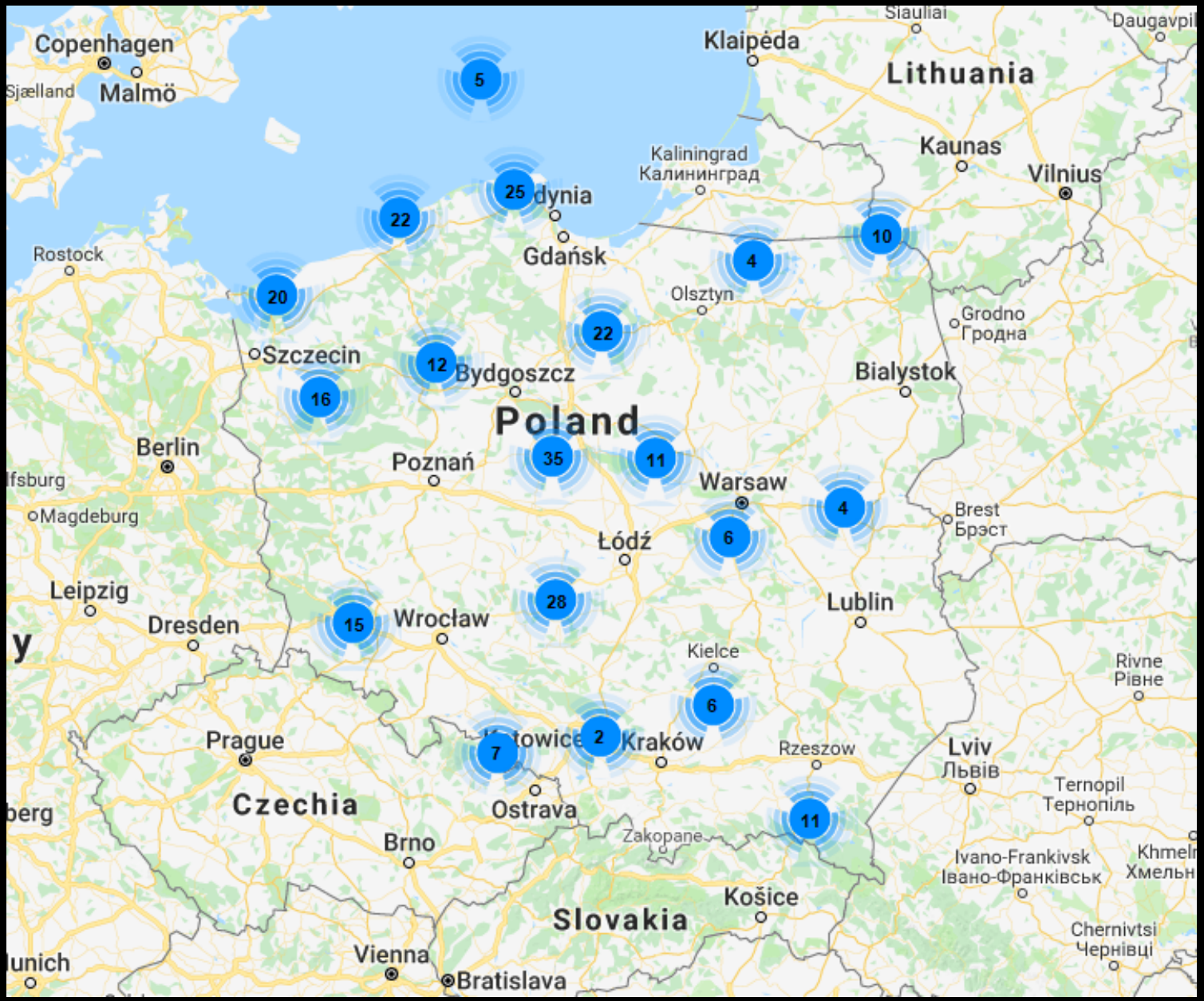

| | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 |
|---|---|---|---|---|---|---|
| Europe | 177.5 | 191.3 | 206.3 | 220.8 | 236.8 | 253.8 |
| North America | 105.3 | 114.8 | 124.8 | 137.3 | 147.9 | 158.9 |
| Asia | 228.7 | 252.1 | 279.6 | 309.0 | 339.3 | 370.4 |
| Latin America | 17.9 | 21.3 | 24.6 | 27.4 | 30.2 | 34.1 |
| Pacific | 5.2 | 6.0 | 6.6 | 8.0 | 9.0 | 9.9 |
| Middle East & Africa | 4.5 | 6.4 | 7.5 | 9.2 | 11.1 | 13.7 |

Source: GWEC


ONTARIO
QUEBEC
41
13
33
34
25
21
Ottawa
Montreal
MAINE
SOUTH DAKOTA
WISCONSIN
MICHIGAN
Toronto
OREGON
50
49
215
98
Chicago
NEBRASKA
81
78
PENN
NEVADA
United States
Philadelphia
INDIANA
30
9
COLORADO
KANSAS
MISSOURI
WEST VIRGINIA
12
CALIFORNIA
Las Vegas
154
28
TENNESSEE
NORTH CAROLINA
ARIZONA
87
ARKANSAS
MISSISSIPPI
SOUTH CAROLINA
NEW MEXICO
Dallas
3
ALABAMA
65
TEXAS
GEORGIA
LOUISIANA
20
FLORIDA
Gulf of California
Gulf of Mexico
Mexico
Cuba
Mexico City
Dominican Republic
Guatemala
Honduras


Germa
Brussels
Cologne
Brighton
Southampton
Plymouth
Lille
Belgium
English Channel
Frankfurt
Luxembourg
Mannheim
Nure
Guernse
Jersey
Paris
Stuttgart
Strasbourg
Augsburg
Tours
Nantes
Zürich
Liechtenste
Switzerland
France
La Rochelle
Limoges
Lyon
Milan
Grenoble
Turin
Bordeaux
of Biscay
Genoa
Pisa
Toulouse
Monaco
Cannes
Santander
Bilbao
San Sebastián
Vitoria-Gasteiz
Andorra
91
24
56
120
7
20
39
3
141
62
35
64
56
4
3
25
7
33
31
17
33
46
5
19
3
31
60
30
8
3


Sjælland
Malmo
Odense
13
23
327
Kiel
55
118
Rostock
Lübeck
Hamburg
129
140
217
Bremen
116
Szczecin
Bydgos
185
35
Berlin
Amsterdam
118
Hanover
Wolfsburg
106
Poznań
306
Brunswick
Magdeb
199
The Hague
Netherlands
245
Dortmund
Leipzig
Essen
Antwerp
162
84
Wrocław
151
Dresden
67
Brussels
Germany
311
122
Lille
Belgium
81
202
Frankfurt
Prague
Luxembourg
Mannheim
Nuremberg
Czechia
Brno
159
141
102
Stuttgart
7
Strasbourg
75
Augsburg
Munich
Vienna
Bratisla
70
Salzburg
15
Zürich
Austria


Copenhagen
Sjælland
Malmö
Klaipėda
Lithuania
Kaunas
Vilnius
Kaliningrad
Калининград
dynia
Gdańsk
Rostock
Olsztyn
Grodno
Гродна
Szczecin
Bydgoszcz
Bialystok
Poland
Berlin
Poznań
Warsaw
Brest
Брэст
Magdeburg
Łódź
Leipzig
Dresden
Wrocław
Lublin
Kielce
Rivne
Рівне
Prague
Kraków
Rzeszow
Lviv
Львів
Ternopil
Тернопіль
Czechia
Ostrava
Zakopane
Brno
Ivano-Frankivsk
Івано-Франківськ
Košice
Slovakia
Chernivtsi
Чернівці
Vienna
Bratislava
5
25
22
10
4
20
22
12
16
35
11
4
6
28
15
6
2
7
11

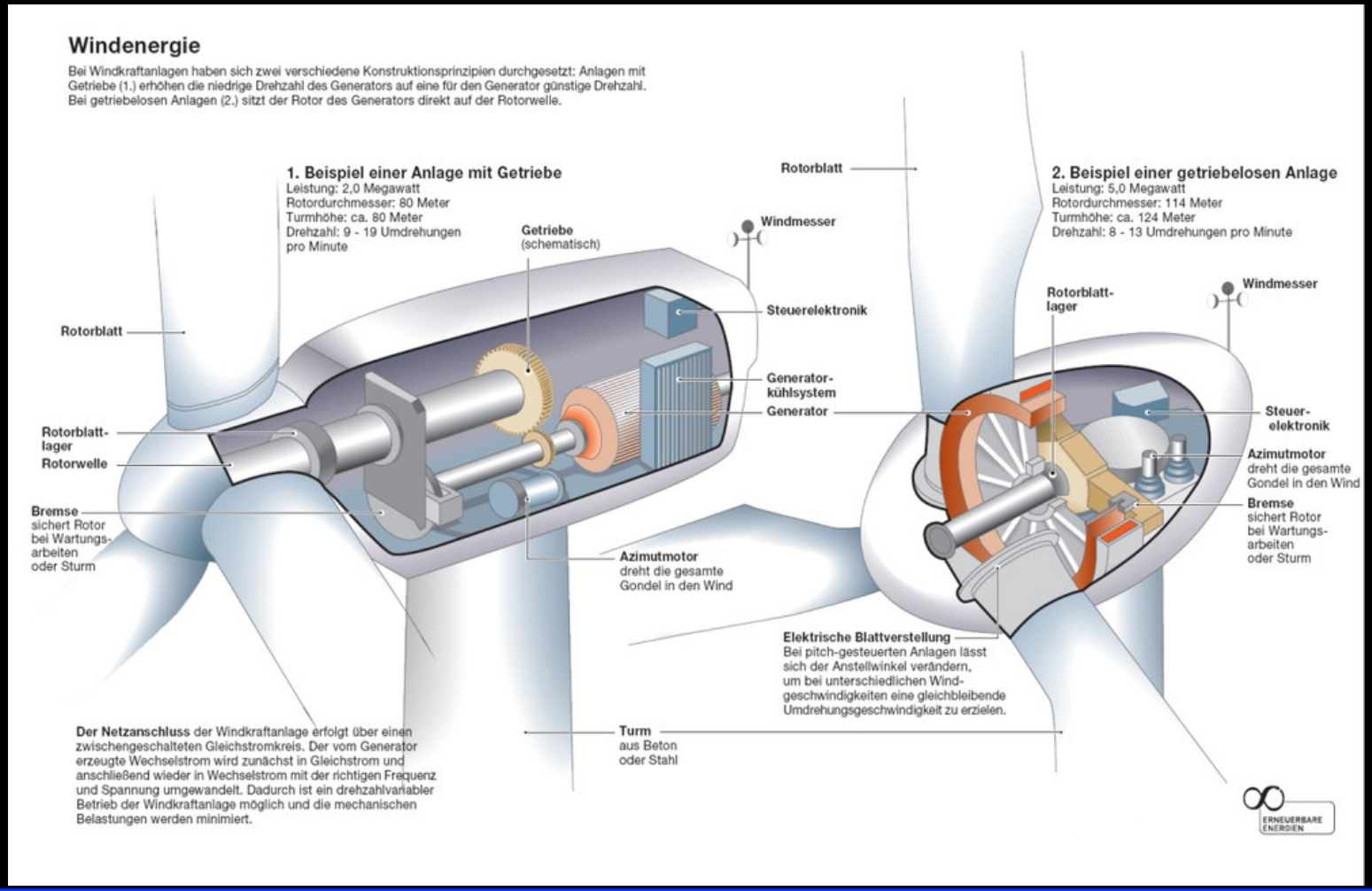
# Wind Turbine Hazards and Rescue Operations

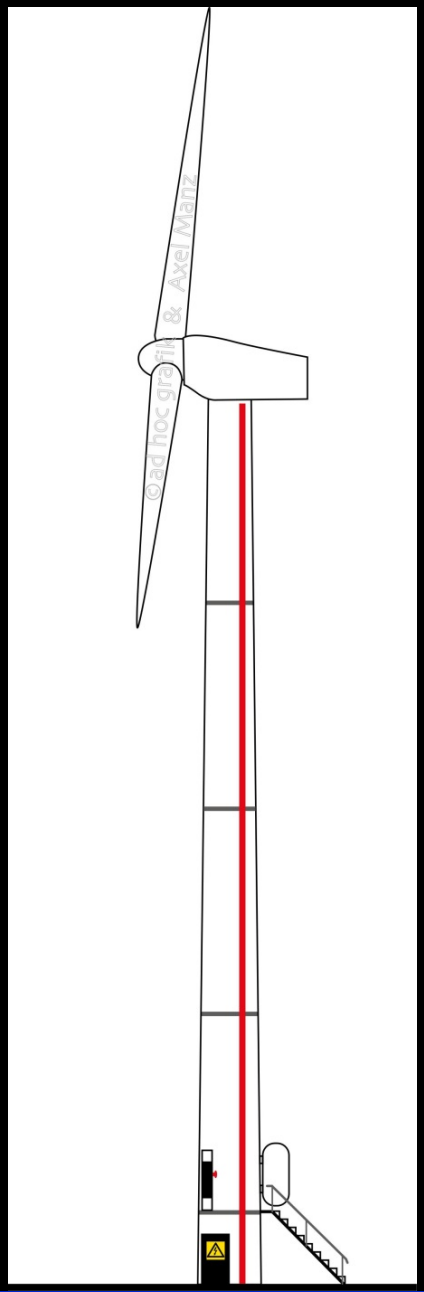
**PART 1**
The Wind Turbine Industry

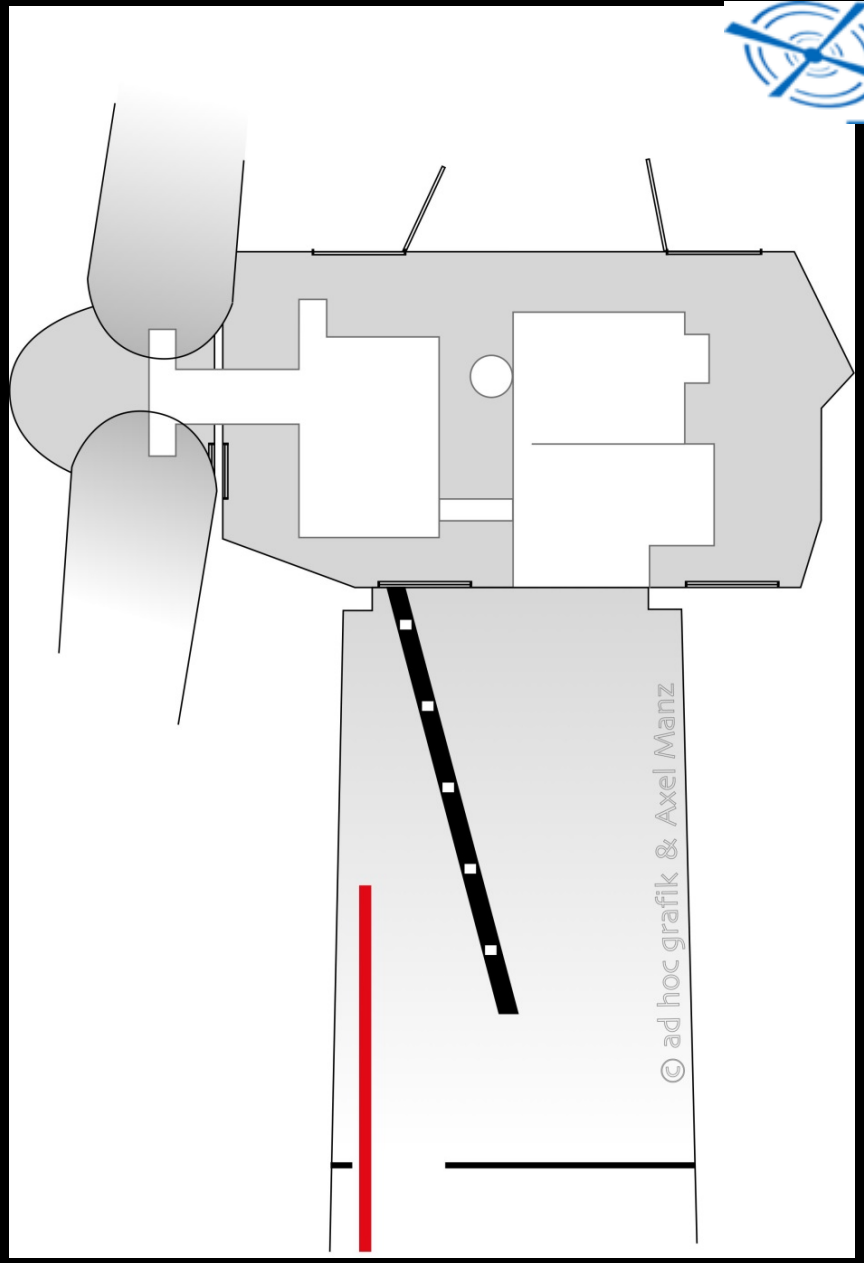
**PART 2**
Terrestrial Rescue

**PART 3**
Helicopter Rescue

# Common nacelle types



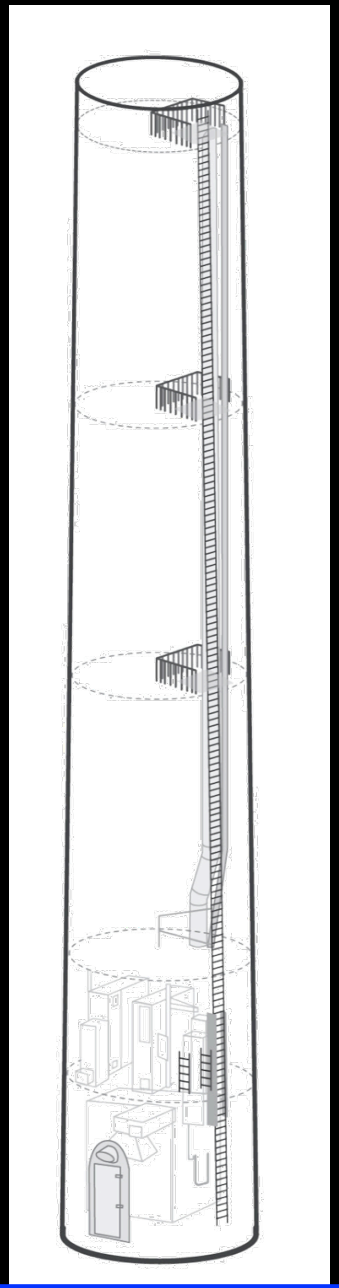


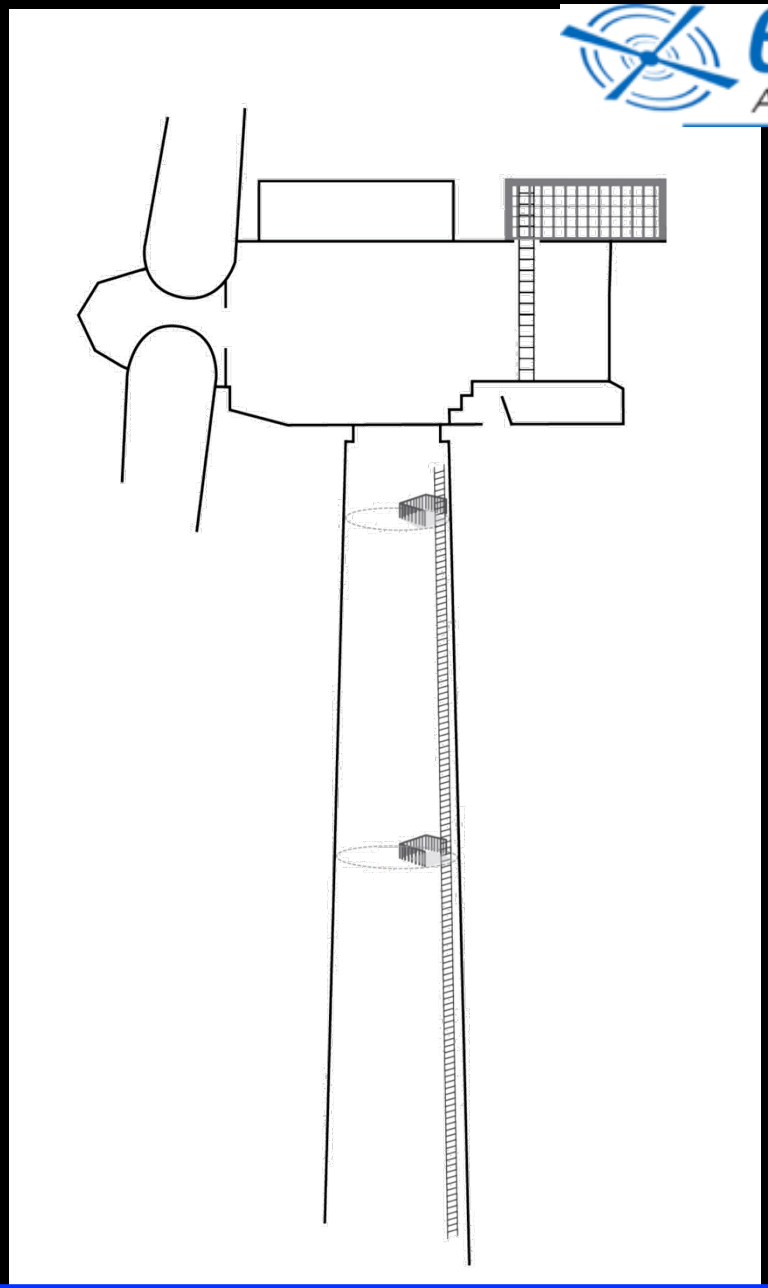




ecms Aviation Systems GmbH

# Tower, platforms, hatches and openings

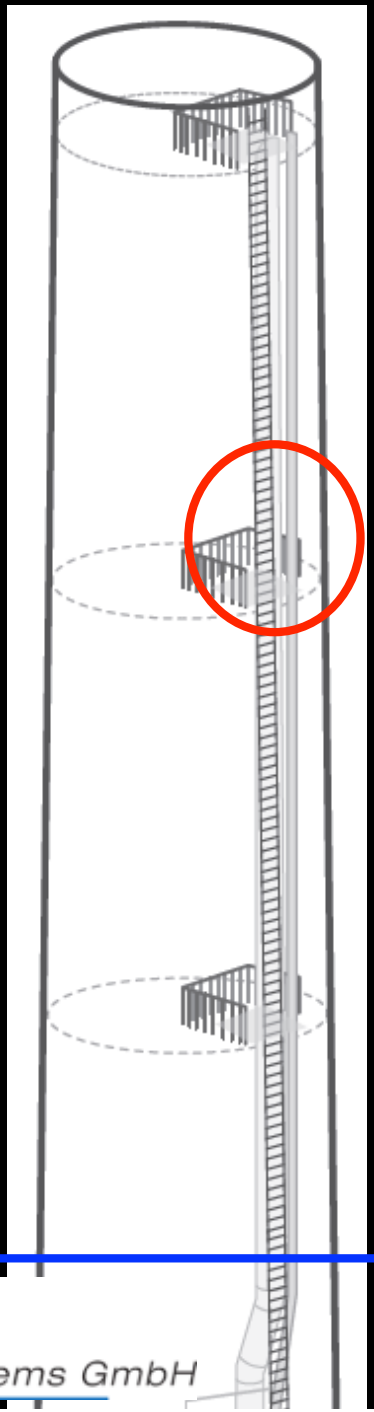
ecms Aviation Systems GmbH





ecms Aviation Systems GmbH

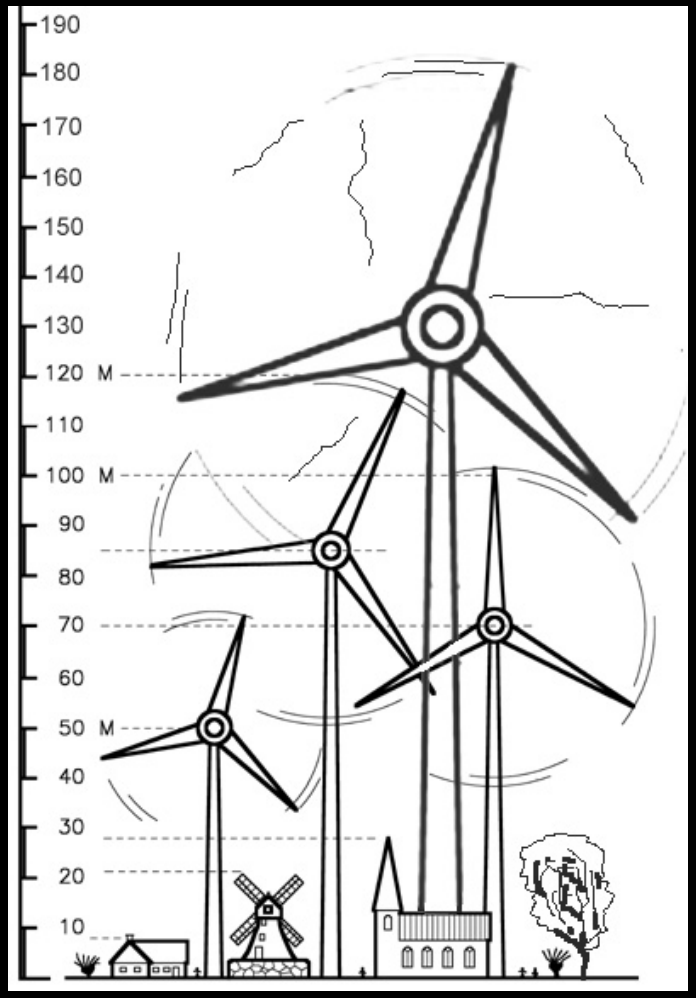
ecms Aviation Systems GmbH



ecms Aviation Systems GmbH

ecms Aviation Systems GmbH

# Common heights




## Common shaft heights:

- Old: 90m-100m
- Actual: 130m-140m
- Ongoing: 160m-200m

## Surprise:

- Ropes shrink in use
- “windsag“

## Conclusion: rope length

- Min. shaft height + 15%


ecms Aviation Systems GmbH

# Access problems

ecms Aviation Systems GmbH

# Examples of real rescues

SCHWER VERLETZT

# Arbeiter stürzt von Windrad

Abgestürzt: Nach Wartungsarbeiten verlor ein Techniker (26) im Turm der Windkraftanlage den Halt, fiel acht Meter tief

**Lichtenau – Er stürzte acht Meter in die Tiefe. Ärzte kämpfen um sein Leben. Horror-Unfall in einer Windkraftanlage bei Lichtenau!**

Zwei Techniker (55, 26) waren vormittags in den Turm der 80 Meter hohen Anlage gestiegen, mussten Wartungsarbeiten vornehmen. Beim Abstieg passierte es. Während der ältere der beiden Männer schon fast festen Boden erreicht hatte, befand sich sein Kollege kurz unterhalb der zweiten Plattform. In 30 Meter Höhe verlor er an einer Leiter plötzlich den Halt, stürzte acht Meter tief, schlug hart auf einer weiteren Etage des Turms auf. Er erlitt zahlreiche Brüche und schwerste innere Verletzungen.

Die Feuerwehr Altenbeken-Buke kam mit Höhenrettern, die den Techniker nach einer Stunde aus dem Turm holten. Per Hubschrauber wurde er in eine Bielefelder Spezialklinik gebracht. Unfallursache könnte ein Defekt am Sicherungssystem gewesen sein. Die Polizei und das Amt für Arbeitsschutz ermitteln.

kw

Rettunghubschrauber Christof 13 flog den schwer verletzten Arbeiter in eine Klinik

- **Lichtenau-Asseln (NRW)**
- **2007**

ecms Aviation Systems GmbH

# Emergency doctor climbed up with top belay

ecms Aviation Systems GmbH

ecms Aviation Systems GmbH

# 25m platform

ecms Aviation Systems GmbH

ecms Aviation Systems GmbH

# Passing hatch, casualty becomes unconscious

ecms Aviation Systems GmbH

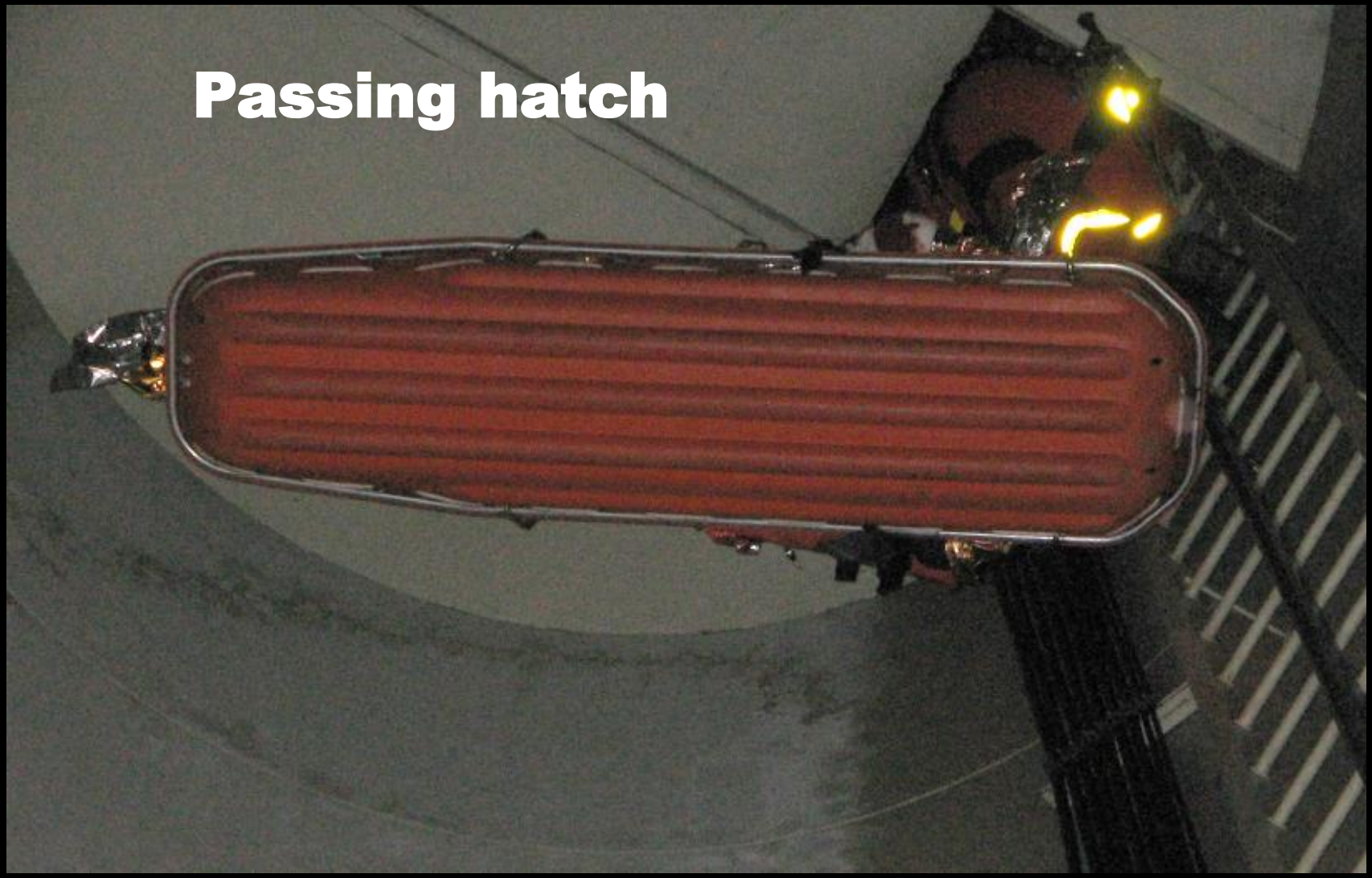
ecms Aviation Systems GmbH

# Passing hatch

ecms Aviation Systems GmbH

ecms Aviation Systems GmbH

# Passing hatch



ecms Aviation Systems GmbH

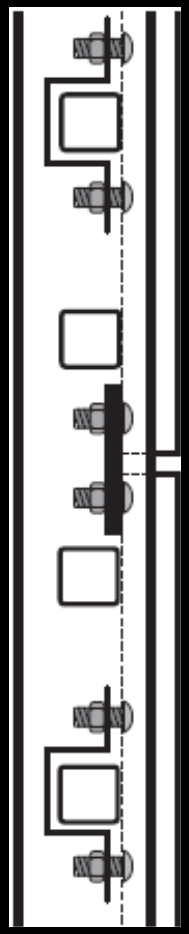
# Passing hatch, casualty becomes unconscious

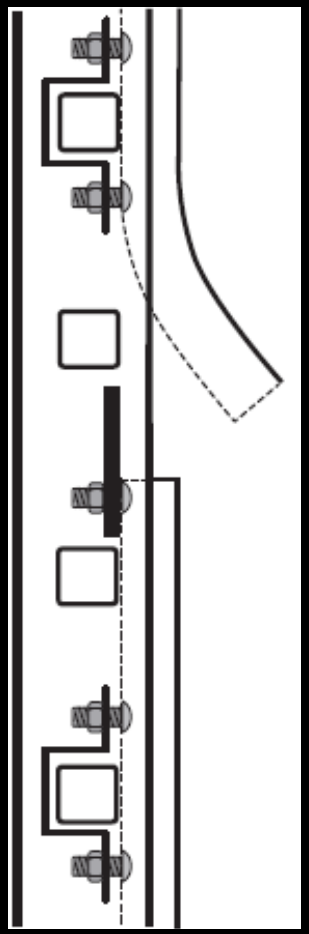
ecms
Aviation Systems GmbH

ecms
Aviation Systems GmbH

# Accident investigation

## Fallarrest rail onsite





# Missing screw on fall arrest rail connector

# Operation after pinched hand

# Operation after pinched hand

# Debrief

- Slightly injured, hand was pinched
- Coworker contacted the rescue team and informed about the need for only a wrench
- No fall arrest rail sliders onsite → 80m lead climb with shock absorbers (about 20 min)
- Casualty unable to act himself, just lowering (rescue triangle) with attendent

# Elevator

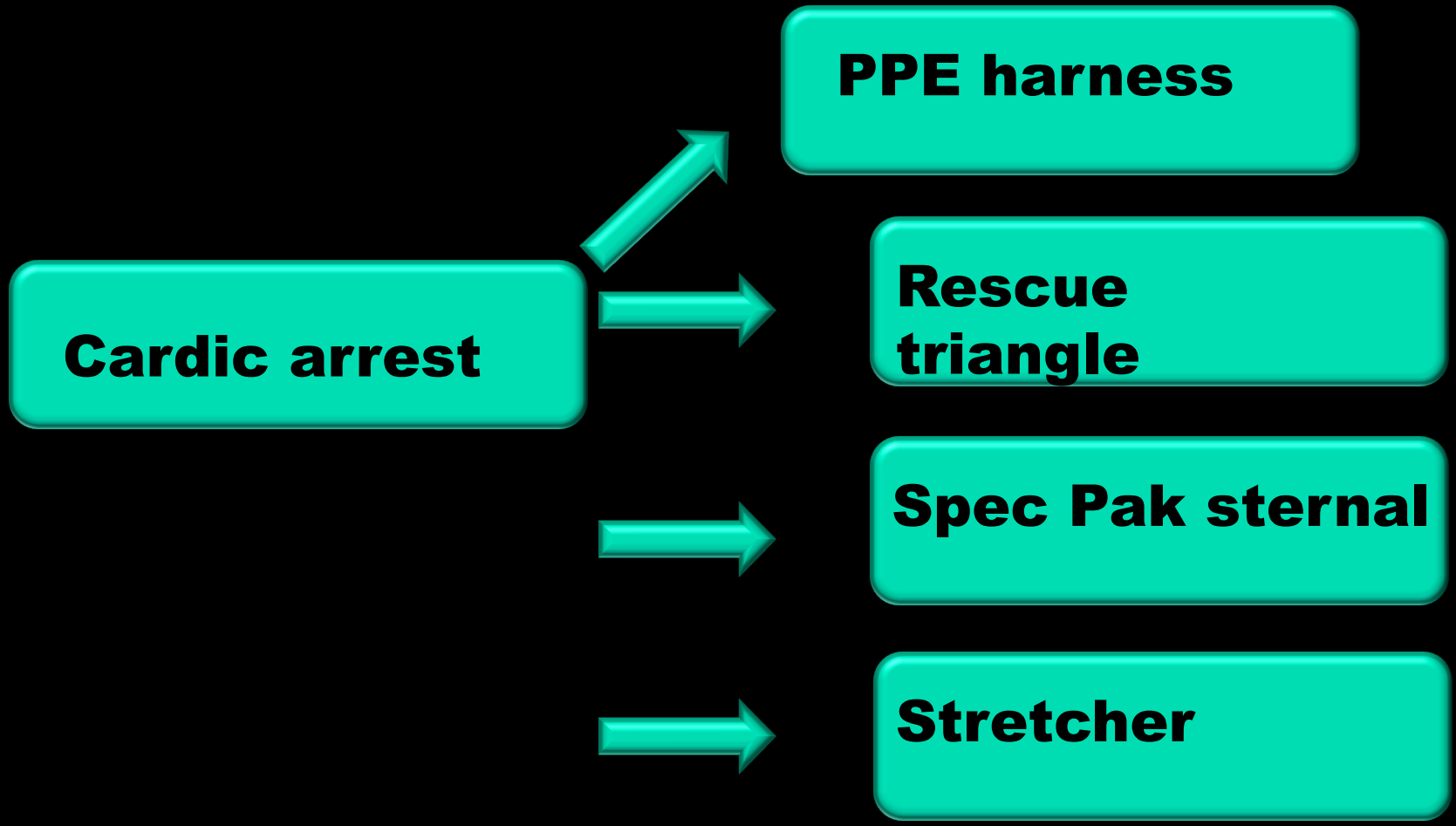
**Spotted:**

- Mostly upstairs
- >10min to get down
- 136m climb with fall arrest sliders around 15min
- Make a decision
  - Elevator vs. climb

# Cardiac Arrest, winch rescue in PPE Harness


# Prospective analysis regarding rescue devices

# Special demands based upon injury



# Rescue Device based upon injury

Rescue triangle

Electric shock/ burning

Stretcher, maybe under CPR

# Special demands based upon injury

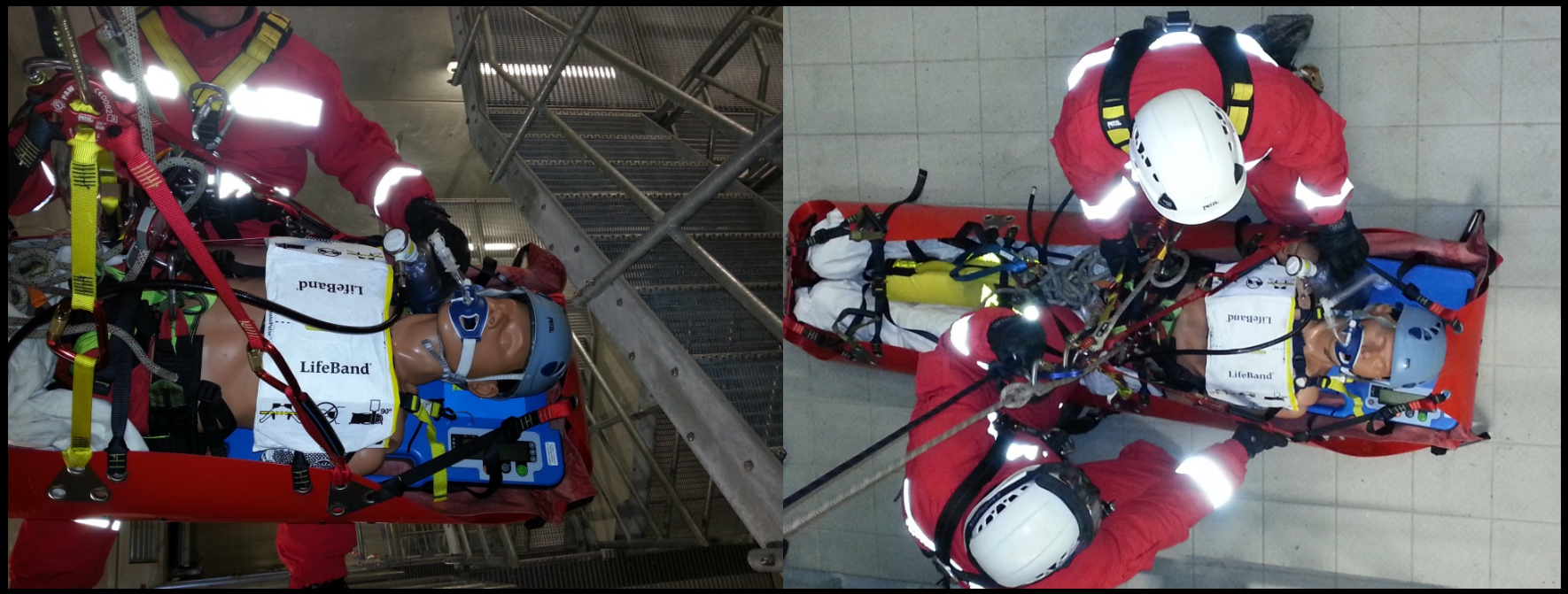
Neck collar/
pelvic collar

Fractures

Spineboard vs.
vacuummatress

Stretcher

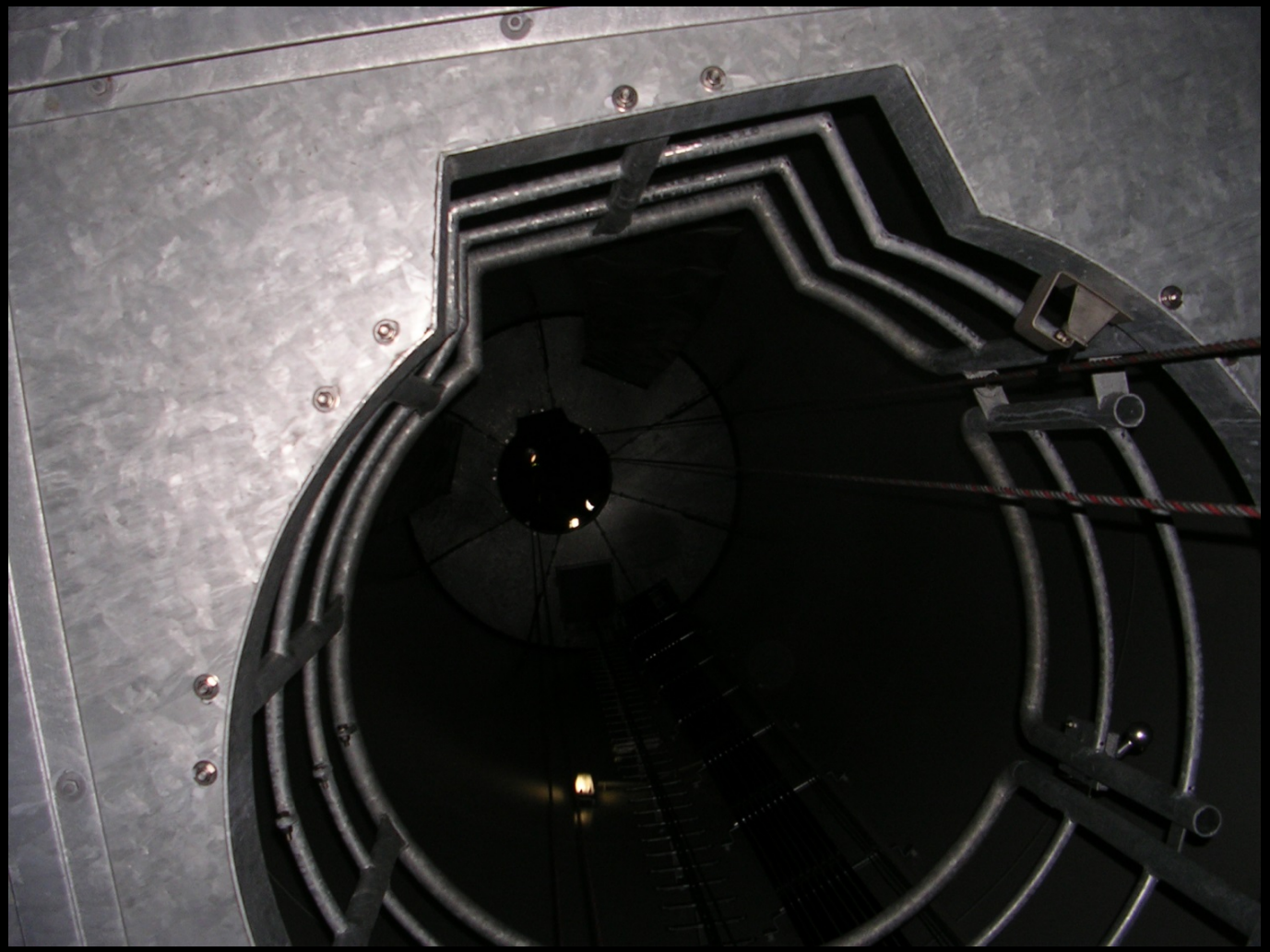
# Special medical demands




## Rescue under CPR

# Difficulties with casualty pathway

# Passing hatch single time

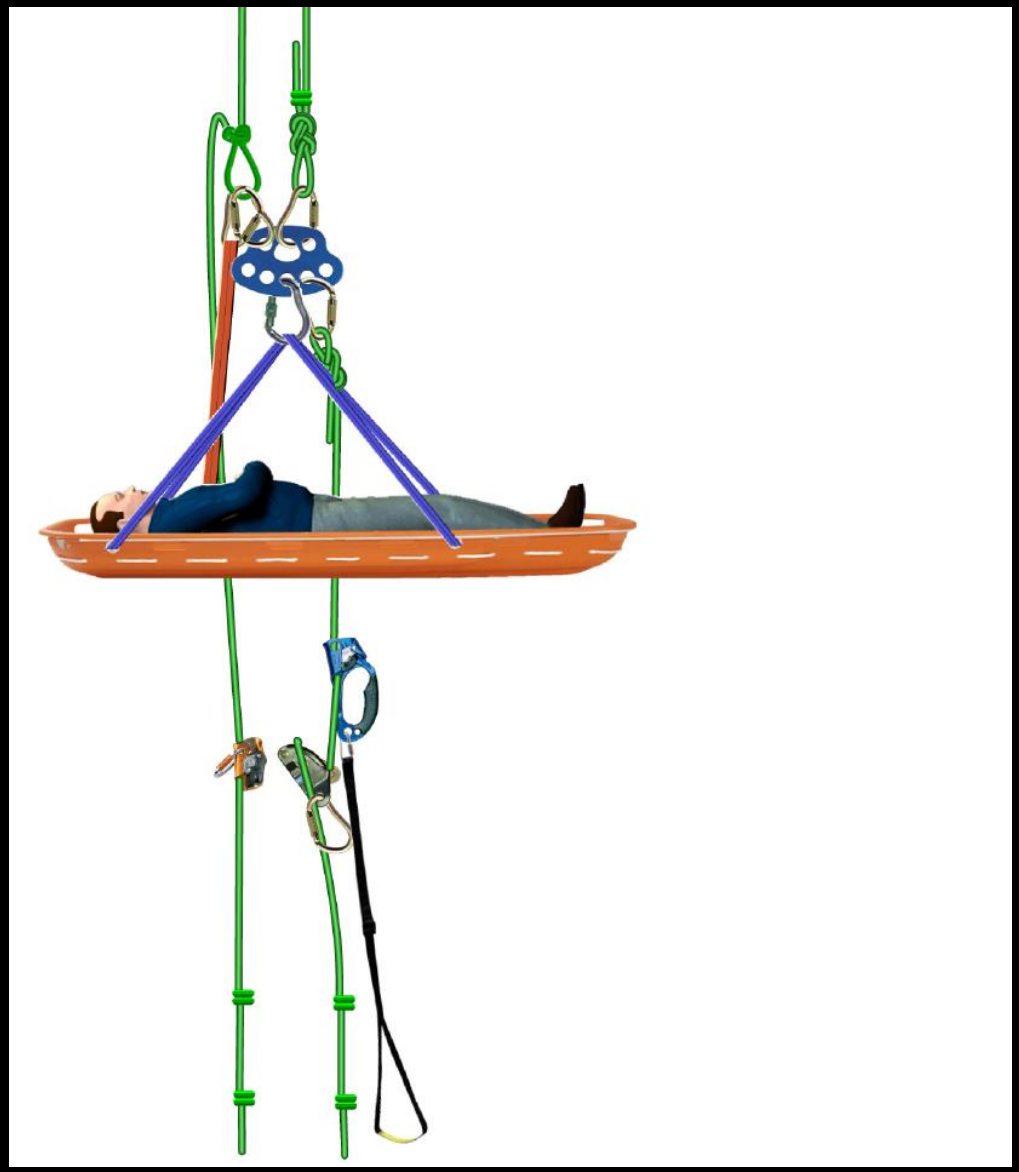


# Passing hatches multiple times

ecms Aviation Systems GmbH

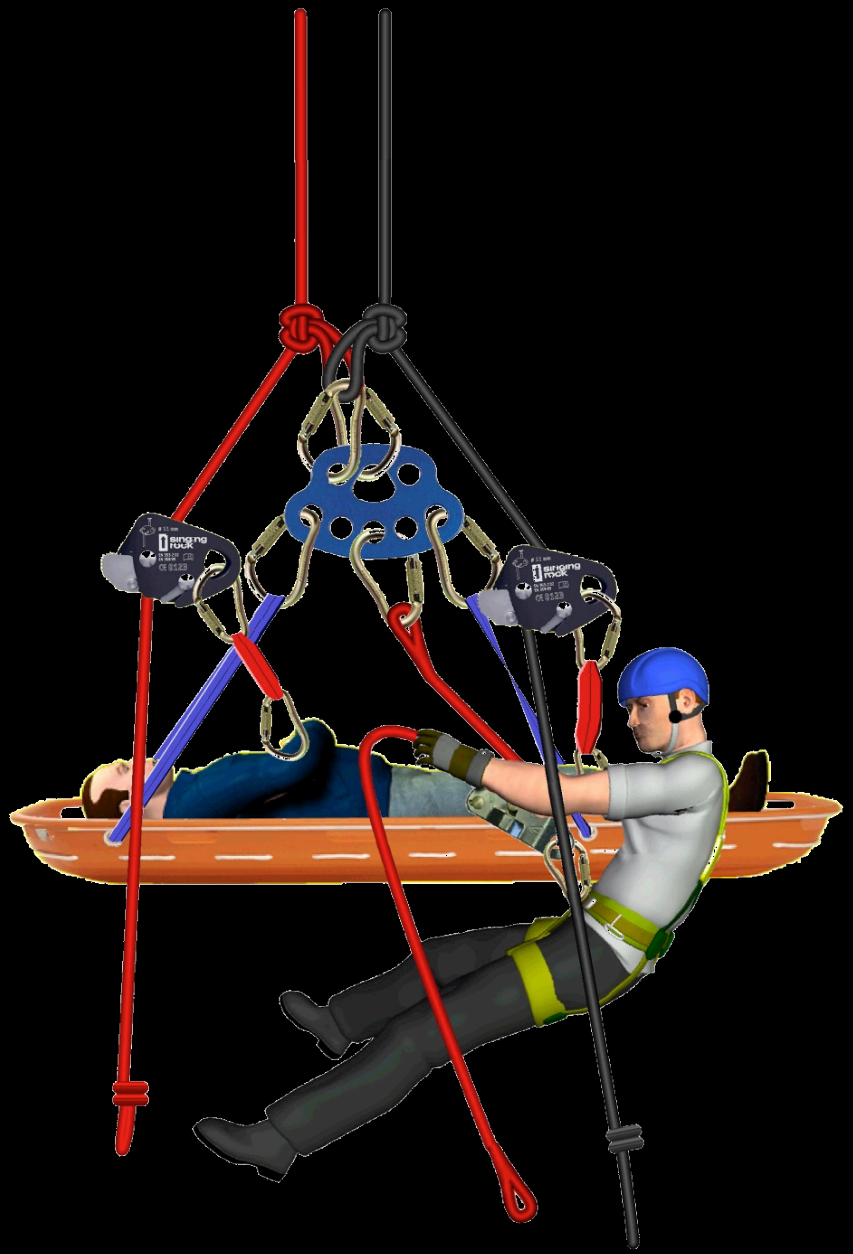
# Passing hatches multiple times

ecms Aviation Systems GmbH



**Definition: Rescue central point**

- **Passive lowering with attendant**
- **Attendant hands free**
- **Compact setup required**



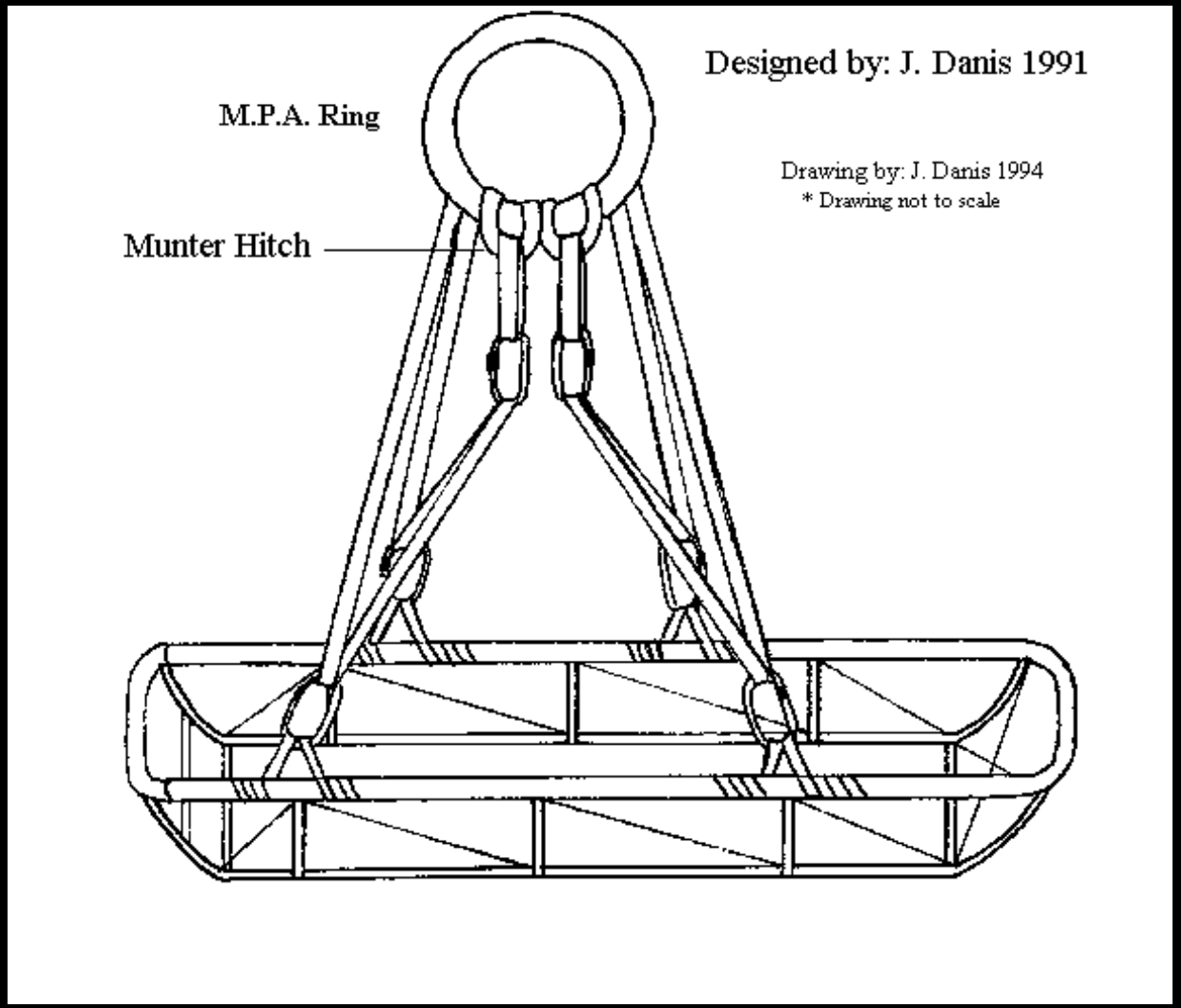
# Butterfly, two ropes

ecms Aviation Systems GmbH

# Compact setup

ecms Aviation Systems GmbH

# Missing rigidity




# Changeover stretcher orientation

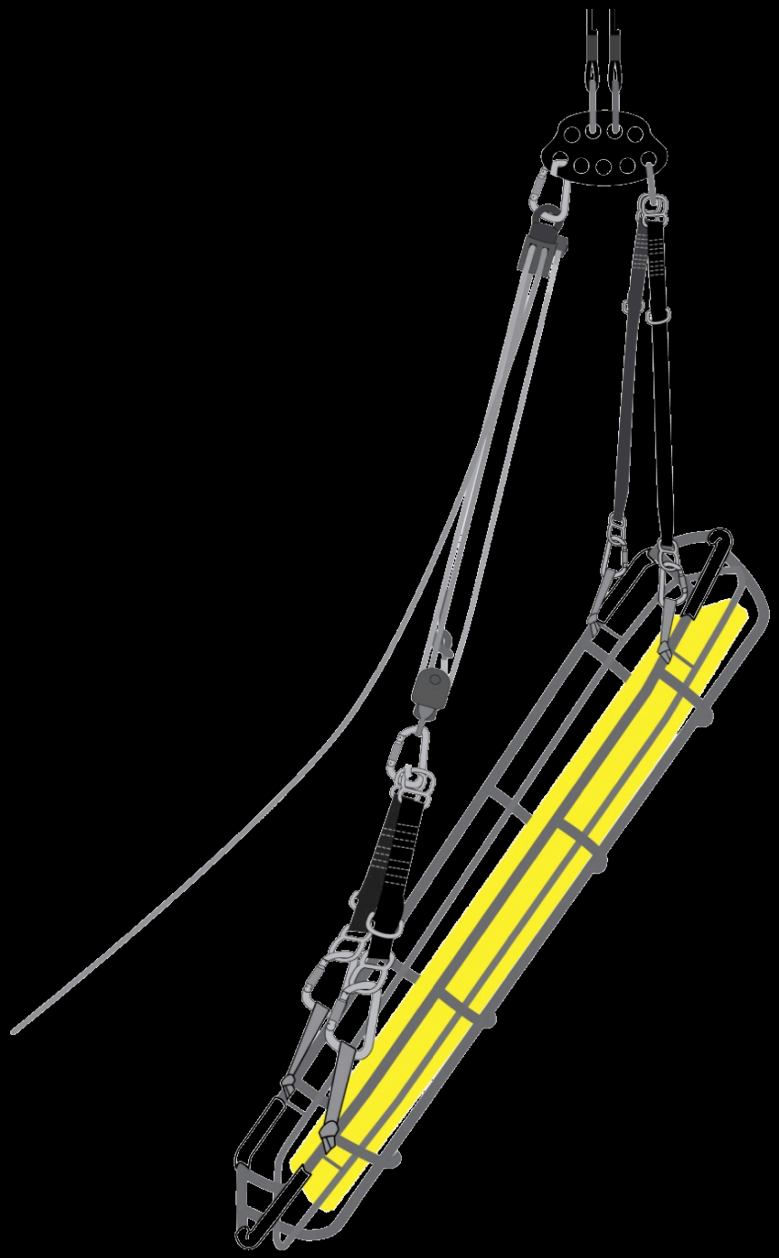
# Nearby accident Grimpday 2011

# Nearby accident Grimpday 2011

ecms Aviation Systems GmbH

# Nearby accident Grimpday 2011

ecms Aviation



# Solution with basket stretcher and Aztek

ecms Aviation Systems GmbH

# Solution with basket and Aztek

ecms Aviation Systems GmbH

ecms Aviation Systems GmbH

# Problems with aluminium frame plastic litters

ecms Aviation Systems GmbH

ecms Aviation Systems GmbH

# Solution with Skedco and Aztek

ecms Aviation Systems GmbH

# Problems

# Rollup, Balance, automatic CPR

ecms Aviation Systems GmbH

# Hatch nacelle, Rollup balance

ecms Aviation Systems GmbH

ecms Aviation Systems GmbH

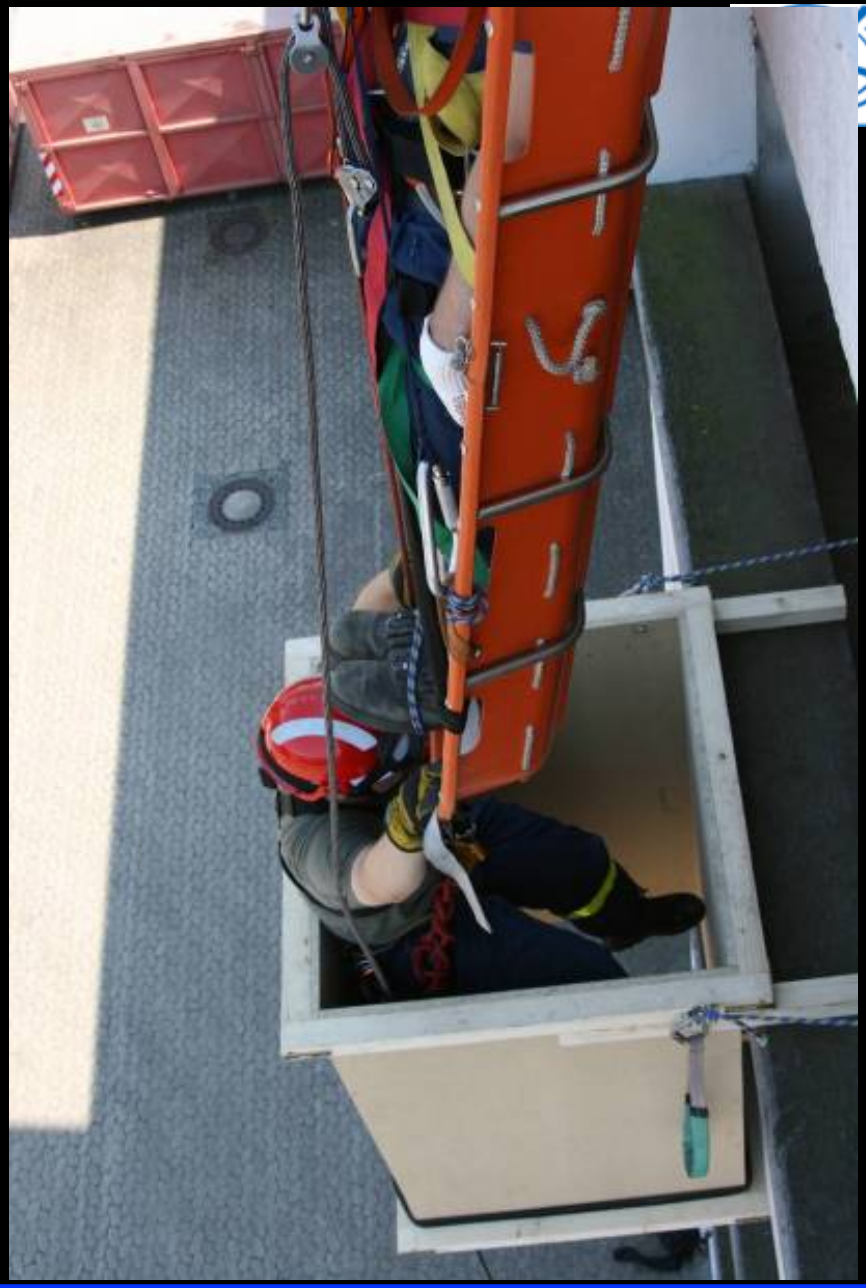
# Hatch nacelle, Rollup balance

ecms Aviation Systems GmbH

ecms Aviation Systems GmbH

# Passing hatches in the tower

ecms Aviation Systems GmbH



# Training box

# Rotating Incident

# Rescue out of the hub/blade

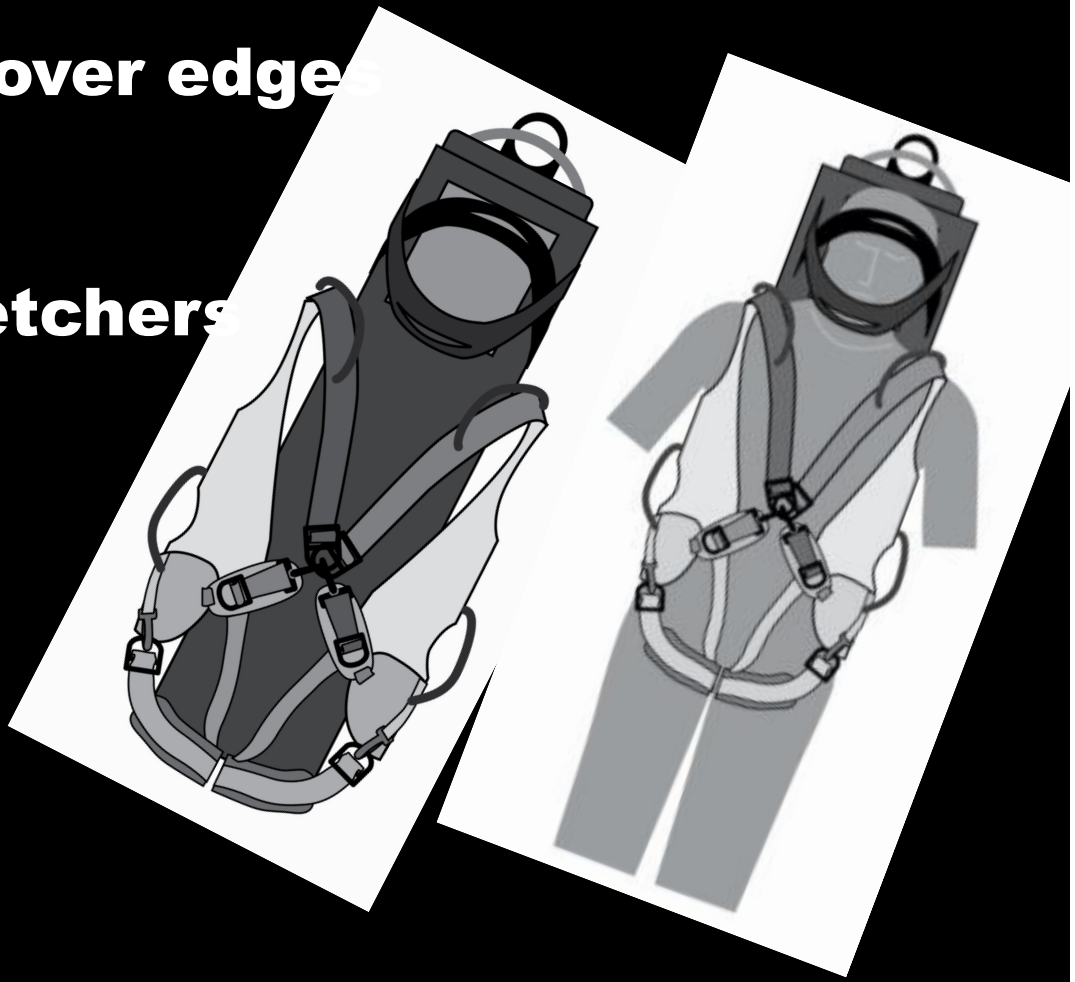
- **Rotation video here?**

# Hub/blade rescue

- Rescue out of the hub can require Confined Space Rescue Operations
  - Maybe toxic atmosphere
  - Detailed look on accident mechanism
    - Worker unconscious → high alert
    - Due to time
      - Rescue vs. Recovery
- Actually no experience with CSR operation on wind turbines
- CSR Operation not very common in Europe
  - This needs to be improved

# Spec-Pak

- Ridgity for dragging over edges
- Vertical use
- Semi vertical use
- Compatible with stretchers



ecms Aviation Systems GmbH

# Hub/blade rescue

ecms Aviation Systems GmbH

# Hub/blade rescue

# Hub/blade rescue

# Hub/blade rescue

# Terrestrial Support for Air Rescue (Onshore)

ecms Aviation Systems GmbH


# Air Rescue Onshore

ecms Aviation Systems GmbH

ecms Aviation Systems GmbH


# Air Rescue Onshore

ecms Aviation Systems GmbH

ecms Aviation Systems GmbH

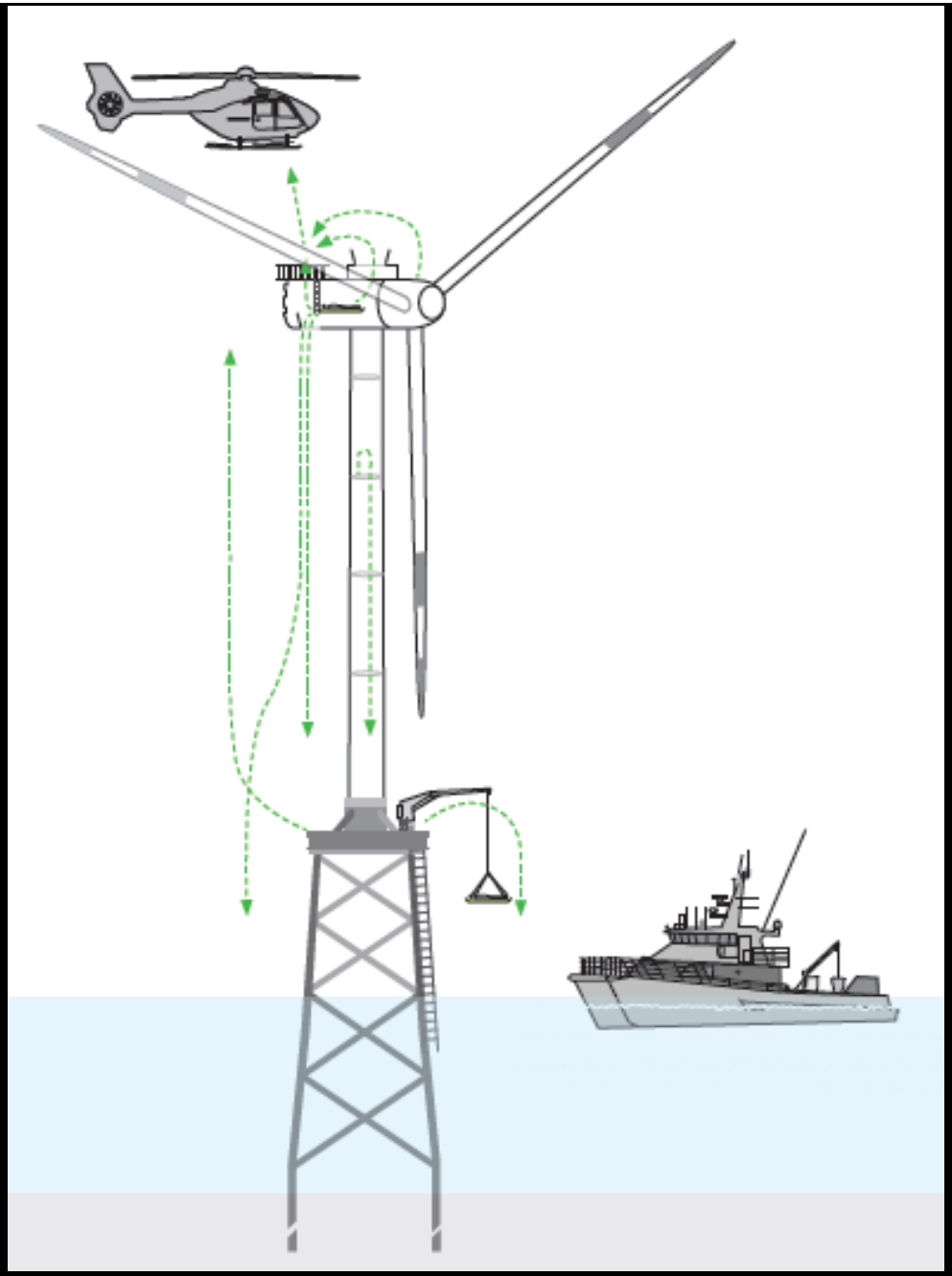
# Air Rescue Onshore

ecms Aviation Systems GmbH

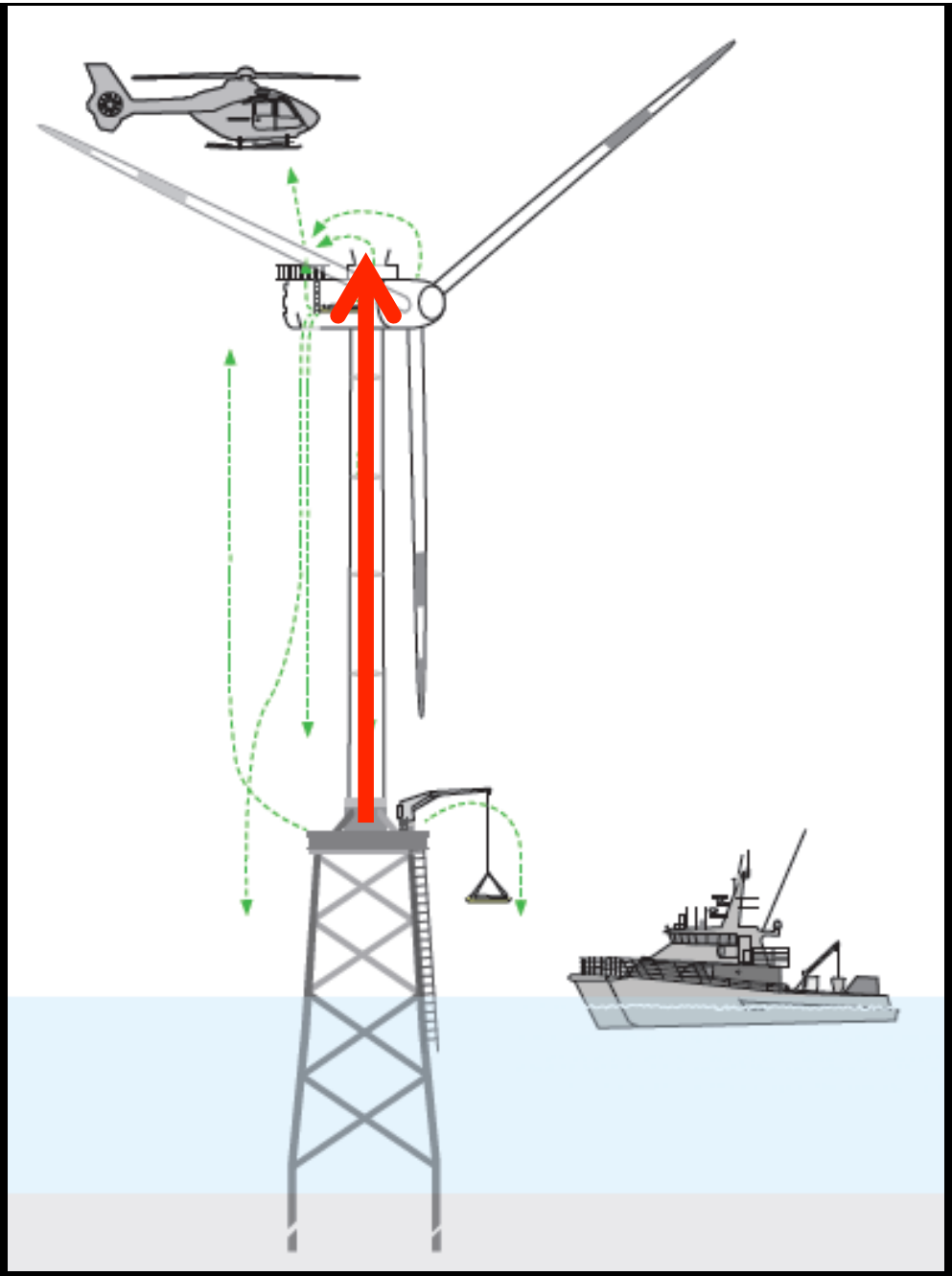
ecms Aviation Systems GmbH

# Air Rescue (Offshore) North/baltic sea

ecms Aviation Systems GmbH



- **Nacelle → water (Evac in case of fire)**
- **Nacelle→Heli hoist**
- **hub→Heli hoist**
- **Tower→Transition piece**
- **Transition piece → ship**
- **Tower/transition piece → helicopter**

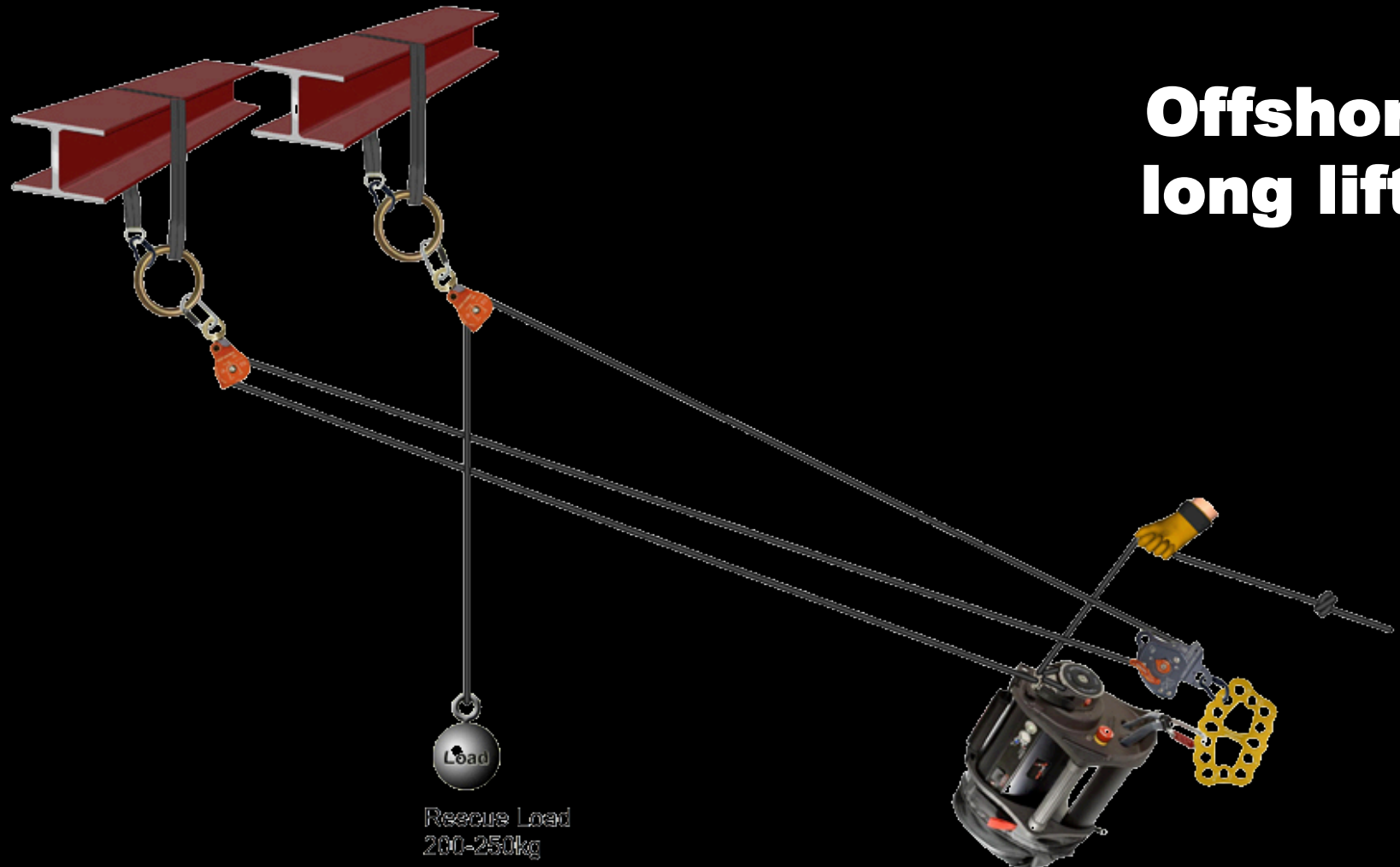


- Long lifts required
- Comparison winch rope reel style vs. capstan style
- Conclusion only capstan style winch
- Winch operation indoor, risk assesment prohibits usage of gas powered winch
- Winches can shut down
  - Technical problems
  - Problems with rechargeable battery
    - Empty
    - cold

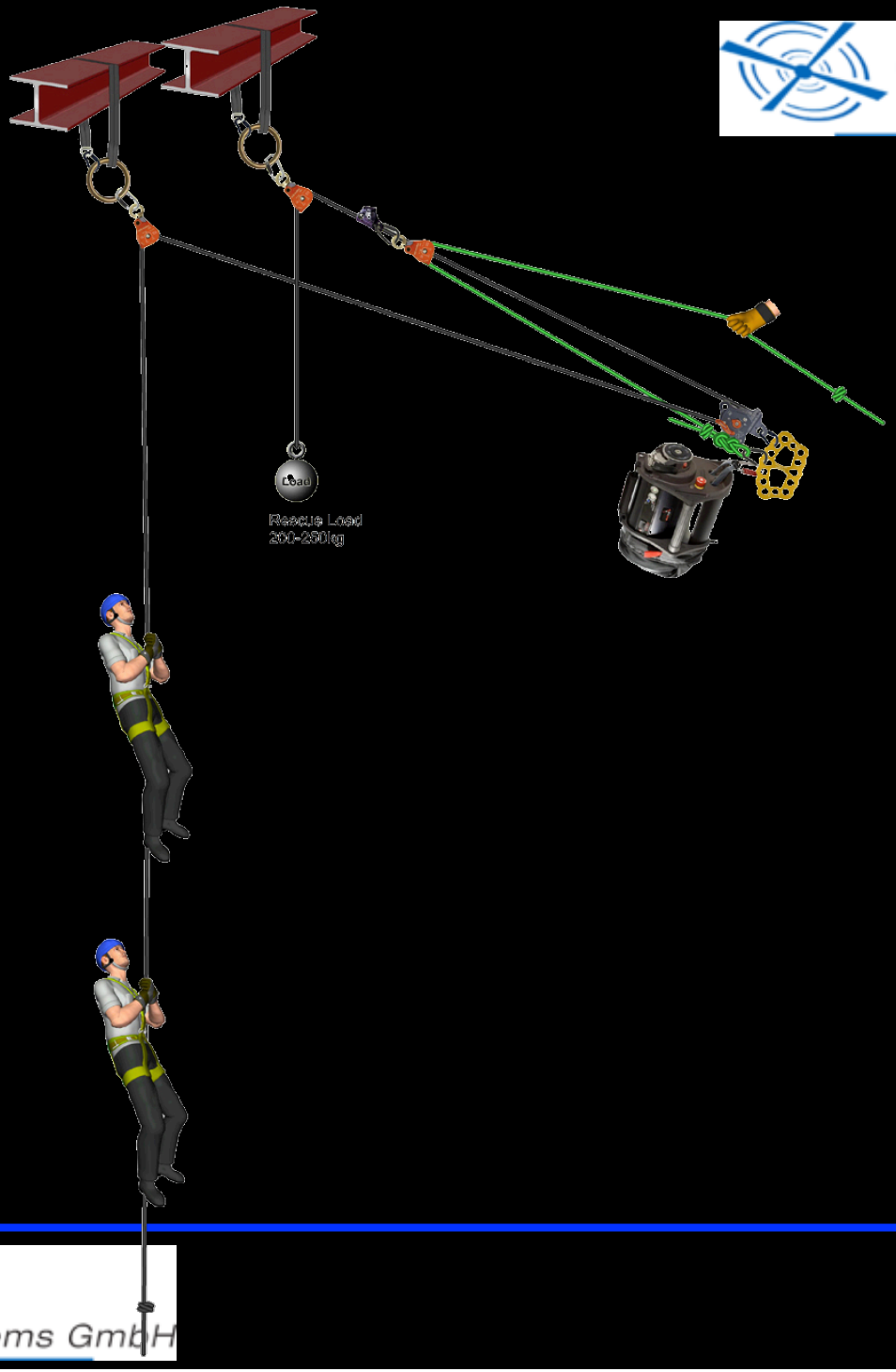
# Offshore/long lifts

ecms Aviation Systems GmbH

# Offshore long lifts




ecms Aviation Systems GmbH




# Offshore long lifts

ecms Aviation Systems GmbH

# Offshore winch issue

ecms Aviation Systems GmbH

# Wind Turbine Hazards and Rescue Operations

**PART 1**
The Wind Turbine Industry

**PART 2**
Terrestrial Rescue

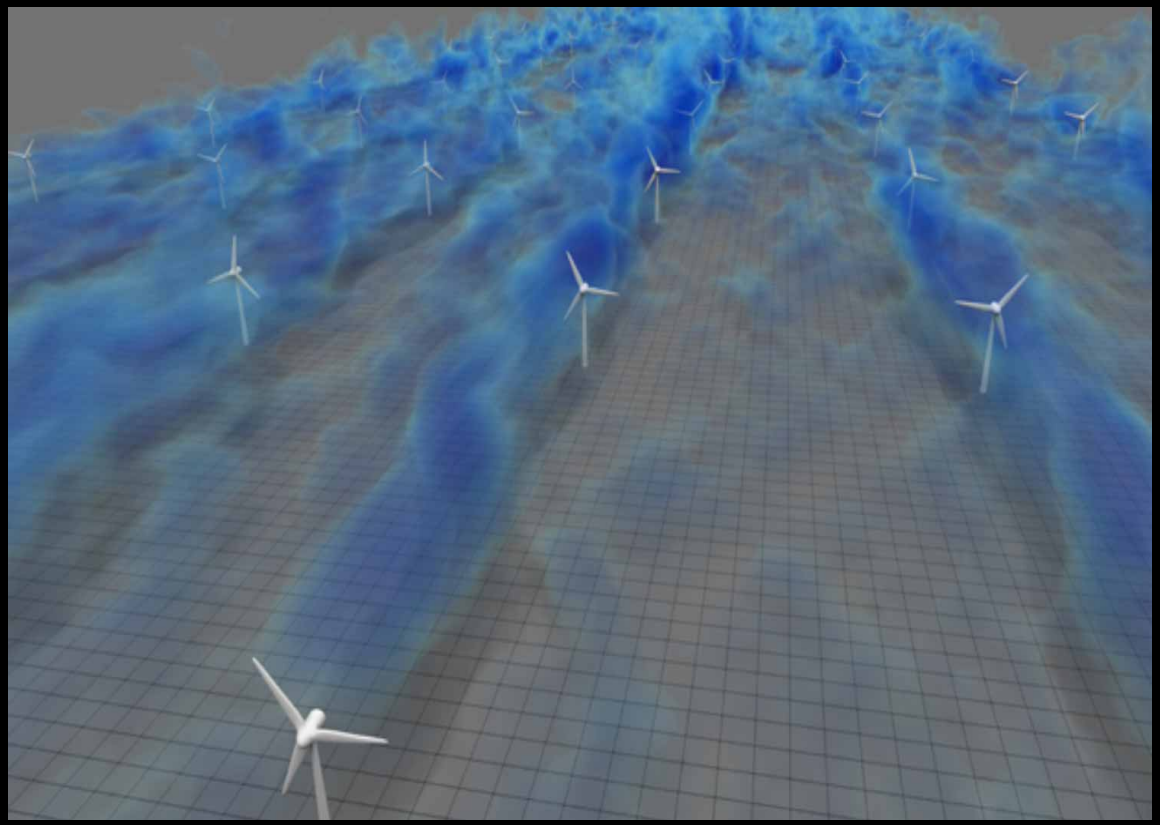
**PART 3**
Helicopter Rescue

# Helicopter fleets projected to triple in size in 5 years

- In support of worker transport
- In support of Search and Rescue

# HAZARD IN FLIGHT OPERATIONS #1:

## Wake vortices and turbulent flow *behind* a Wind Turbine




*Journal of Renewable and Sustainable Energy*,

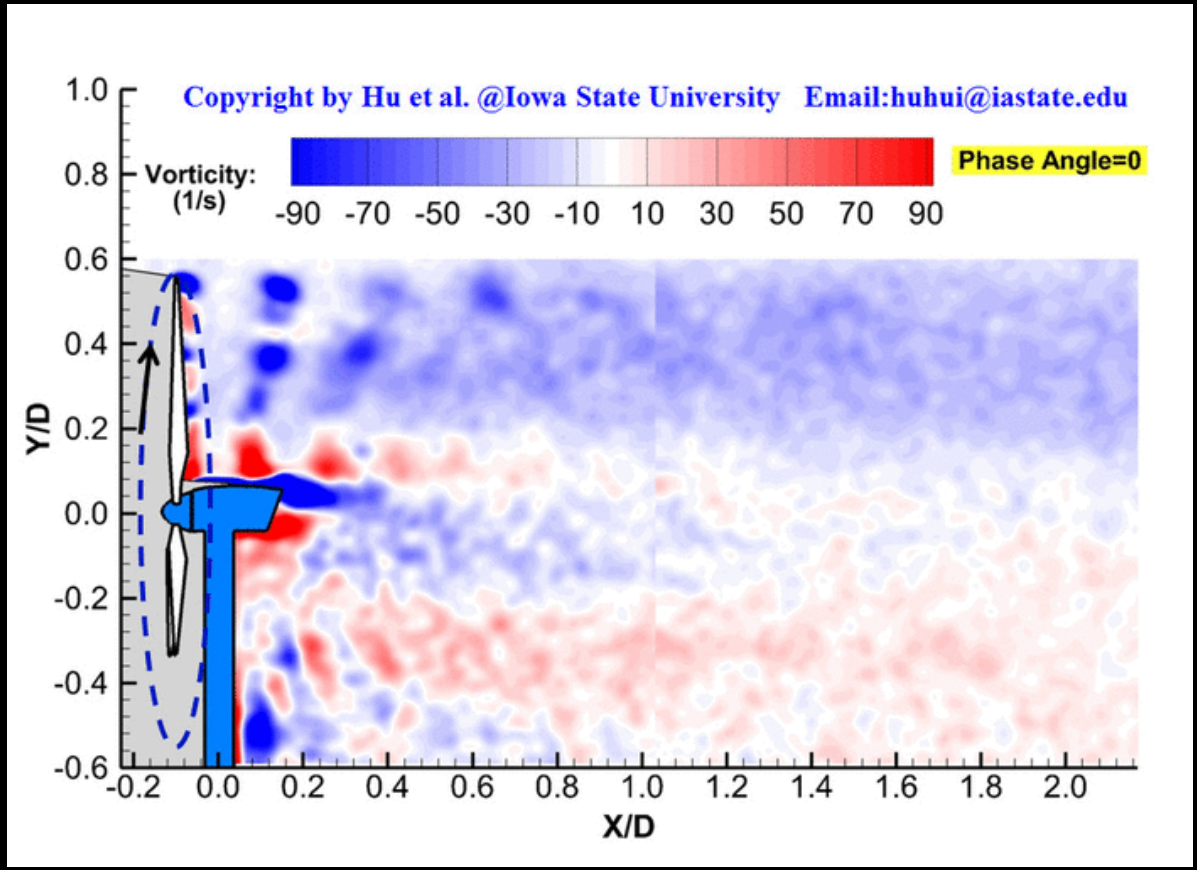
***Helicopters may be affected*** **by airflow disturbances.**

**They produce turbulence for some distance behind them.**

# HAZARD IN FLIGHT OPERATIONS #1:

## Wake vortices and turbulent flow *behind* a Wind Turbine

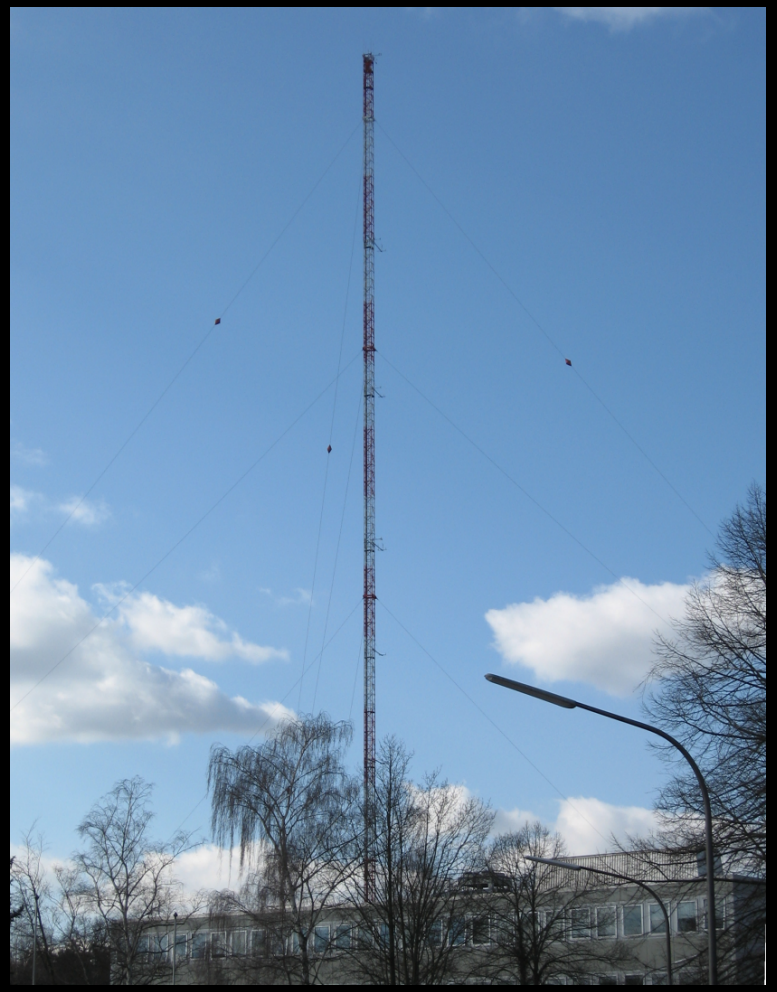
**This can be as much as *five times the rotor diameter*.**



# HAZARD IN FLIGHT OPERATIONS #2:

## Meteorological Evaluation Towers
## (aka “Measurement Tower”)

- **Very difficult to see**
  - **Can be 60+ meters tall**
  - **Can be installed quickly — sometimes within hours —**
- **In the USA, many METs fall below the 60 meter federal law or markings.**



# HAZARD IN FLIGHT OPERATIONS #2:

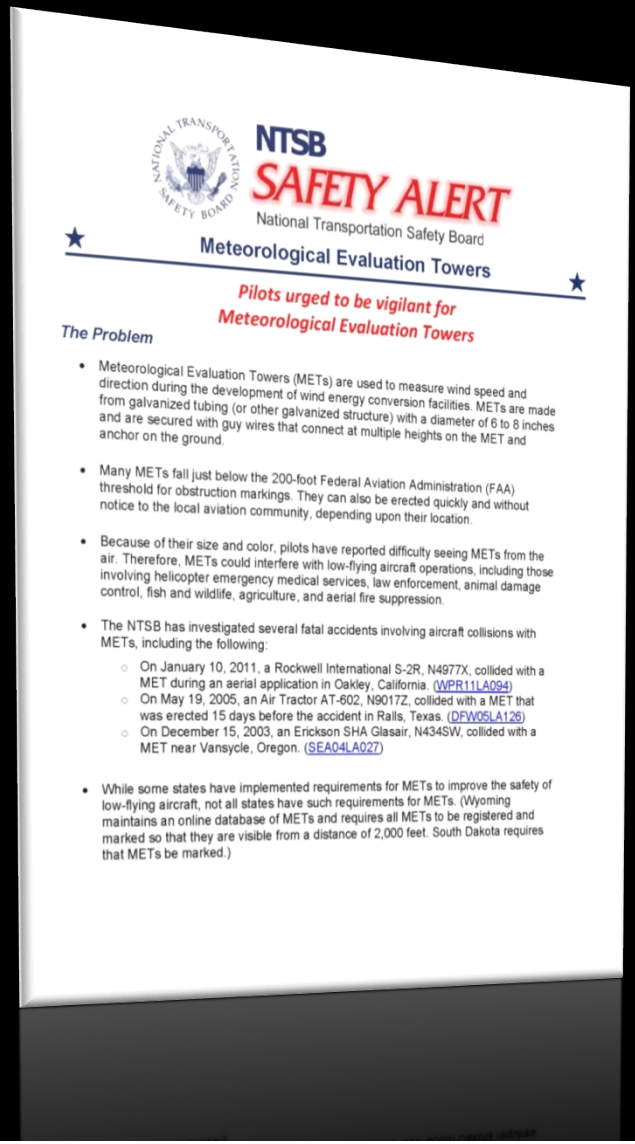
## Meteorological Evaluation Towers
## (aka "Measurement Tower")

- **In March 2013, taking the FAA's "voluntary" marking and rejection of a national database into account, the National Transportation Safety Board (NTSB) issued a Safety Recommendation directed at States**
- **The NTSB recommended that States and territories:**
- ***"Enact legislation requiring that meteorological evaluation towers erected in your State or territory are marked and registered in a directory."***

# HAZARD IN FLIGHT OPERATIONS #2:

## Meteorological Evaluation Towers (aka “Measurement Tower”)

- **IN USA, only “voluntary” marking and NO national database for less than 60 meters**
- **the National Transportation Safety Board (NTSB) issued a Safety Recommendation directed at States**
- **Companies can install towers just under 60 meters to conceal their location from competitors — but also, unfortunately, from aviators.**



NTSB
SAFETY ALERT
National Transportation Safety Board

**Meteorological Evaluation Towers**

*Pilots urged to be vigilant for Meteorological Evaluation Towers*

*The Problem*

- Meteorological Evaluation Towers (METs) are used to measure wind speed and direction during the development of wind energy conversion facilities. METs are made from galvanized tubing (or other galvanized structure) with a diameter of 6 to 8 inches and are secured with guy wires that connect at multiple heights on the MET and anchor on the ground.
- Many METs fall just below the 200-foot Federal Aviation Administration (FAA) threshold for obstruction markings. They can also be erected quickly and without notice to the local aviation community, depending upon their location.
- Because of their size and color, pilots have reported difficulty seeing METs from the air. Therefore, METs could interfere with low-flying aircraft operations, including those involving helicopter emergency medical services, law enforcement, animal damage control, fish and wildlife, agriculture, and aerial fire suppression.
- The NTSB has investigated several fatal accidents involving aircraft collisions with METs, including the following:
  - On January 10, 2011, a Rockwell International S-2R, N4977X, collided with a MET during an aerial application in Oakley, California. (WPR11LA094)
  - On May 19, 2005, an Air Tractor AT-602, N9017Z, collided with a MET that was erected 15 days before the accident in Ralls, Texas. (DFW05LA126)
  - On December 15, 2003, an Erickson SHA Glasair, N434SW, collided with a MET near Vansycle, Oregon. (SEA04LA027)
- While some states have implemented requirements for METs to improve the safety of low-flying aircraft, not all states have such requirements for METs. (Wyoming maintains an online database of METs and requires all METs to be registered and marked so that they are visible from a distance of 2,000 feet. South Dakota requires that METs be marked.)

# HAZARD IN FLIGHT OPERATIONS #3:
## Radar Signals

- A wind turbine farm can cause problems with radar signals,
- ***Weather radar***
  - Turbine shows as a non-weather-related "false echo."
  - Turbine can block the radar signal and "hide" true precipitation behind it, including thunderstorms.
- ***Air Traffic Control Radar***
  - similar concerns about false targets and the hiding of real targets.

# HAZARD IN FLIGHT OPERATIONS #3:
## Radar Signals

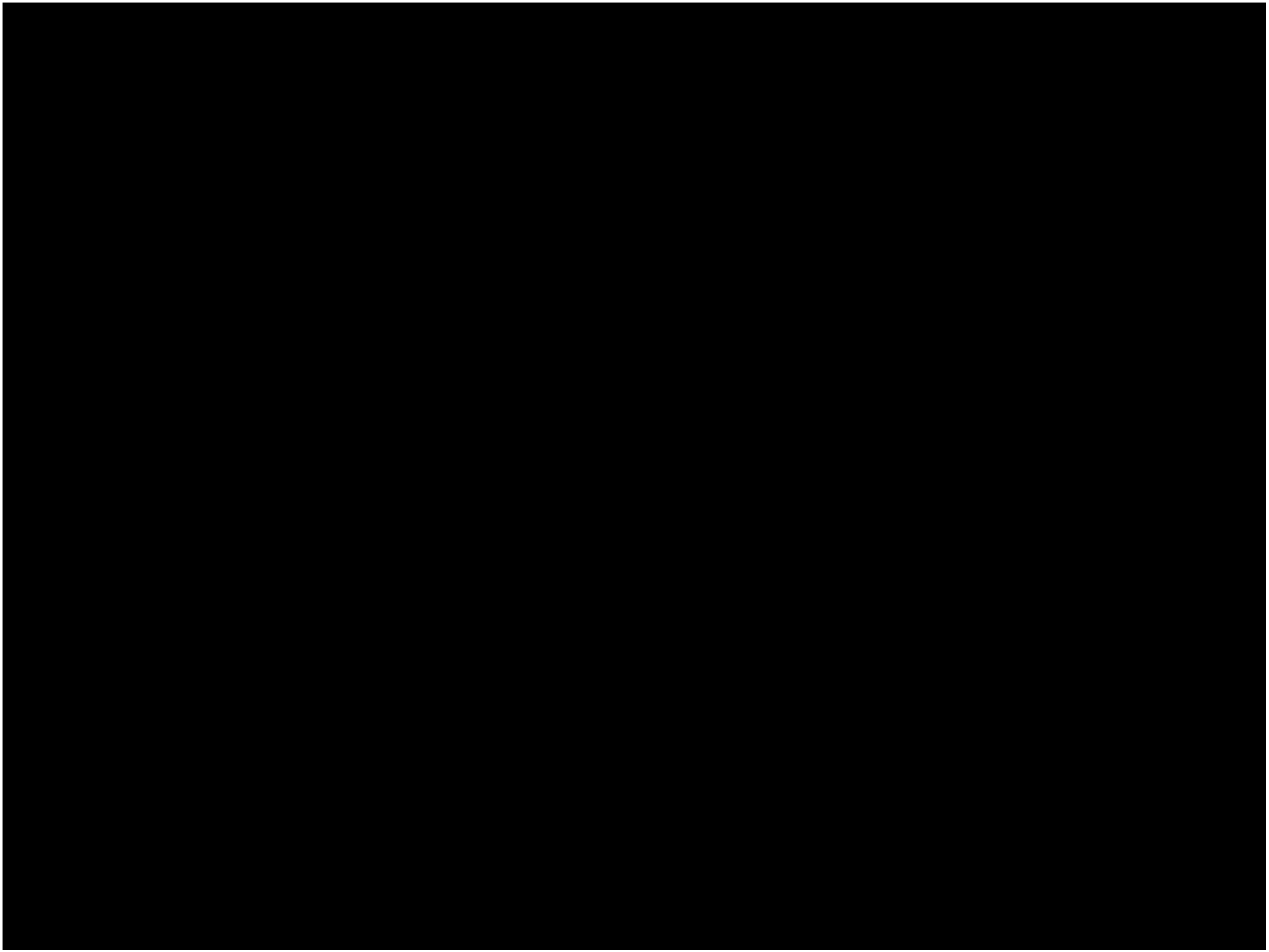
- The U.S. has determined 4 zones of impact, from significant negative impact to unlikely significant impact.
- Canadian government are involved with approvals that could disrupted Air Traffic Control and Weather Radars.
- In Europe, Eurocontrol also designates requirements on planned wind turbines.

# Offshore Wind Farms

**Offshore represents <10% of the global market, but *that will increase substantially* in the coming five years.**

# Industry Promotion of helicopters

**The offshore wind turbine industry is promoting helicopters as an asset – recognizing the utility of aircraft during high seas**



# HeliOffshore


**HeliOffshore has a new *Wind Farm Group* with 3 sub-groups**

- **Safety strategy**
- **Helidecks**
- **Search and rescue (SAR)**
  - **Accident reports on HeliOffshore website**

# HeliOffshore

**The companies involved in the group so far are:**

- **Leonardo Helicopters**
- **Bell**
- **Airbus Helicopters**
- **Wiking Helikopter Service**
- **CHC Helicopter Bristow Group**
- **Heli Service International**
- **HTM Helicopters**
- **KN Helicopters**
- **NHV**
- **Era**
- **Equinor**
- **and wind turbine manufacturers**

# HeliOffshore


**The new group's first meeting is THIS WEEK at the 9th annual Offshore Wind Event.**

**It will publish new guidelines in 2019.**

Offshore Wind Event, 2018.

# Helicopter Rescue Operations

**Offshore, the easiest exit point will be the winch zone on the top of the nacelle.**

**Anti-rotation is critical - Rotation can lead to rotation trauma, or unconsciousness**

# Helicopter Rescue Operations

© Wiking Helicopters

## Dangers of tag lines

- Risk of the tag line being snagged in the railing, and not releasing via break away link.

**An anti rotation rudder should be used so that there is no need for a tag line.**

# Video of Anti-Rotaton Rudder

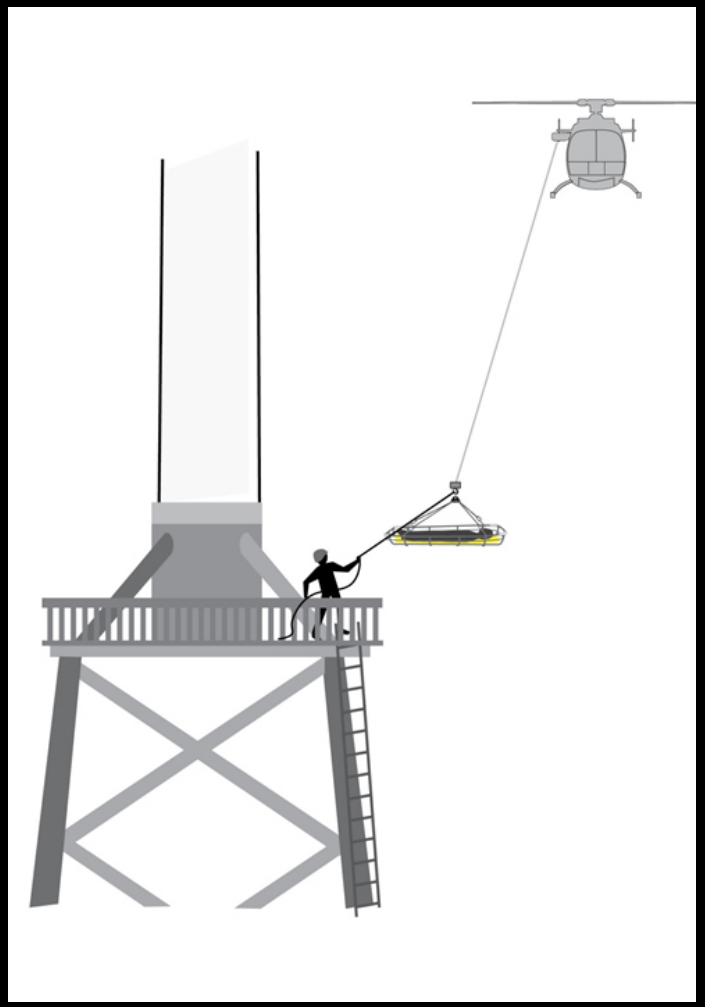
Video courtesy Wiking Helicopters

# Video of Rescuer Extrication from the Nacelle

**Offshore extrication of a rescuer or crewmember from the main platform**


Video courtesy Uni-Fly Helicopters

# Rescuer Extrication from the Transition Piece



Drawing courtesy Axel Manz

- The main rotor must have enough clearance tower.
- Too low? The angle of the winch cable is out of the manufacturer's limits.
- Therefore, you need
  - clearance for rotor
  - enough height for the right angle.

# Video of Rescuer Extrication from the Transition Piece

**Training for an offshore extrication of a rescuer or crewmember from the Transition Piece using an onshore training facility**




Video courtesy Wiking Helicopters

# Video Example #2 of Litter Rescue


© Wiking Helicopters

**Airlift simulation – for practice of litter rescues from the transition piece.**

- Using an attendant and anti rotation rudder
- Using an unattended litter

Video courtesy Wiking Helicopters

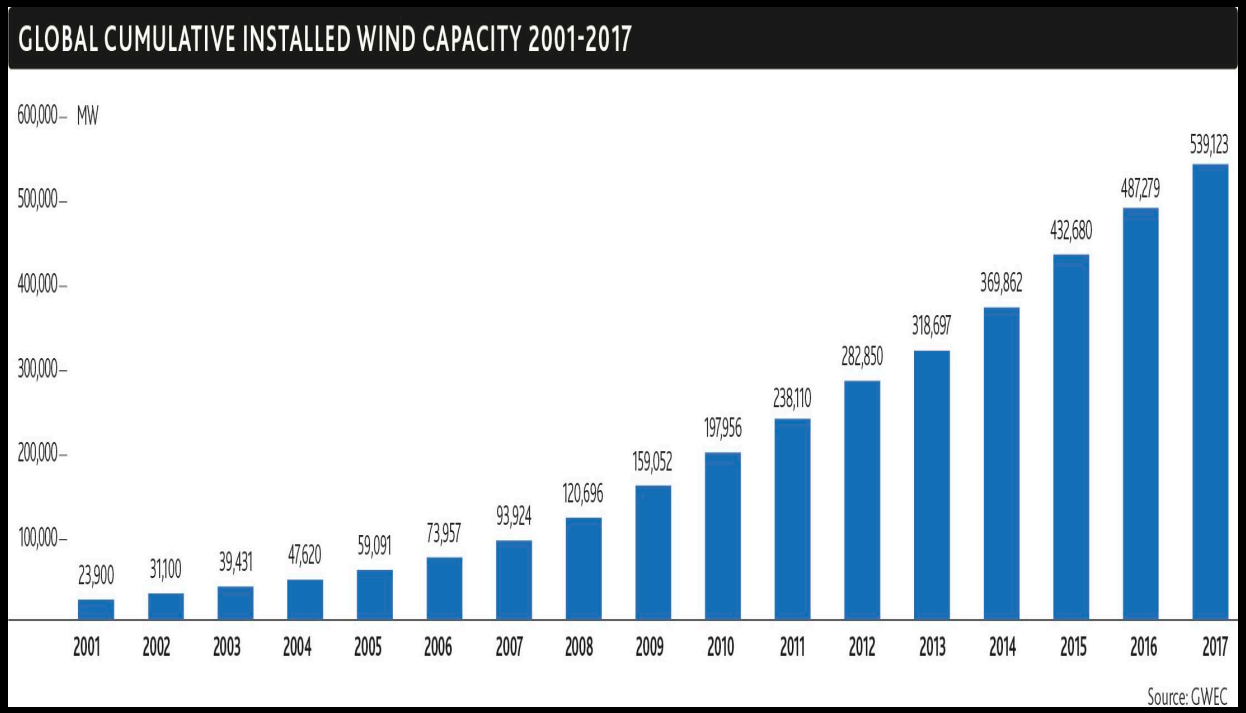
# Video Example #3 of Litter Rescue




- **Airlift of litter from the top winching platform.**
  - **Using an attendant and anti rotation rudder.**

Video courtesy Wiking Helicopters

# Wind Turbine Hazards and Rescue Operations




**Wind turbine industry growth will have a great impact on the rescue community worldwide.**

***Let's prepare for it.***

# Wind Turbine Hazards and Rescue Operations

**Merci,**
**thank you,**
**danke, grazie.**

**Questions or comments?**


ecms Aviation Systems GmbH

axel.manz@ecms-gmbh.de

MOUNTAIN RESCUE ASSOCIATION

Charley.shimanski@gmail.com