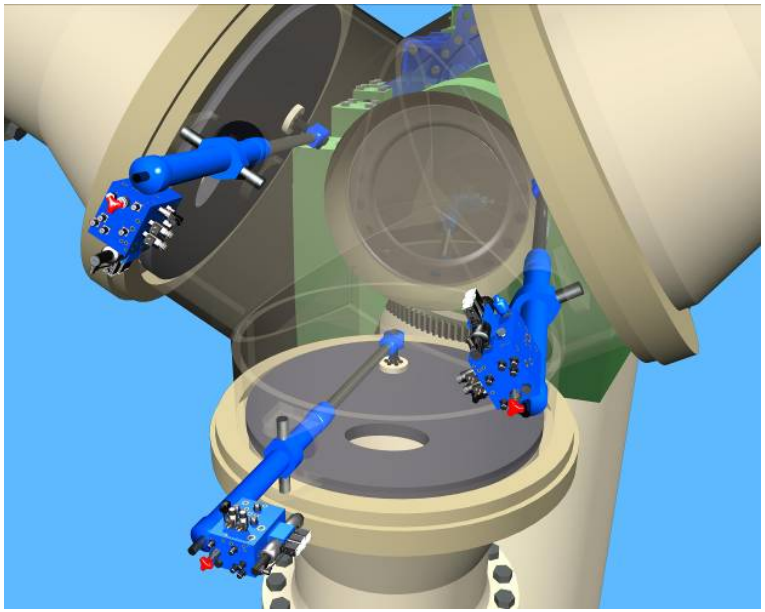
Pitch systems of the future –under all climatic conditions

Wind Power Works

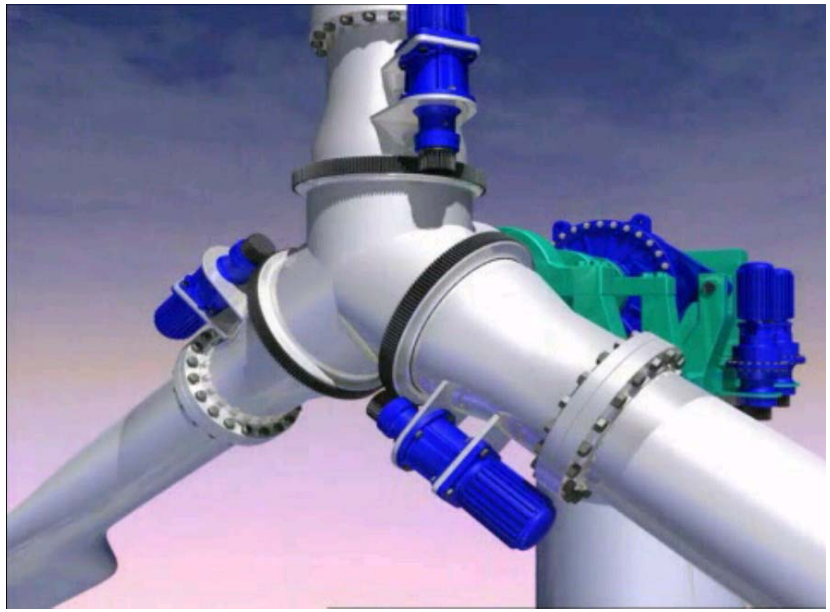
Pitch systems for wind turbines

Pitch Systems of the Future

Rexroth
Bosch Group



Hydraulic



Electric

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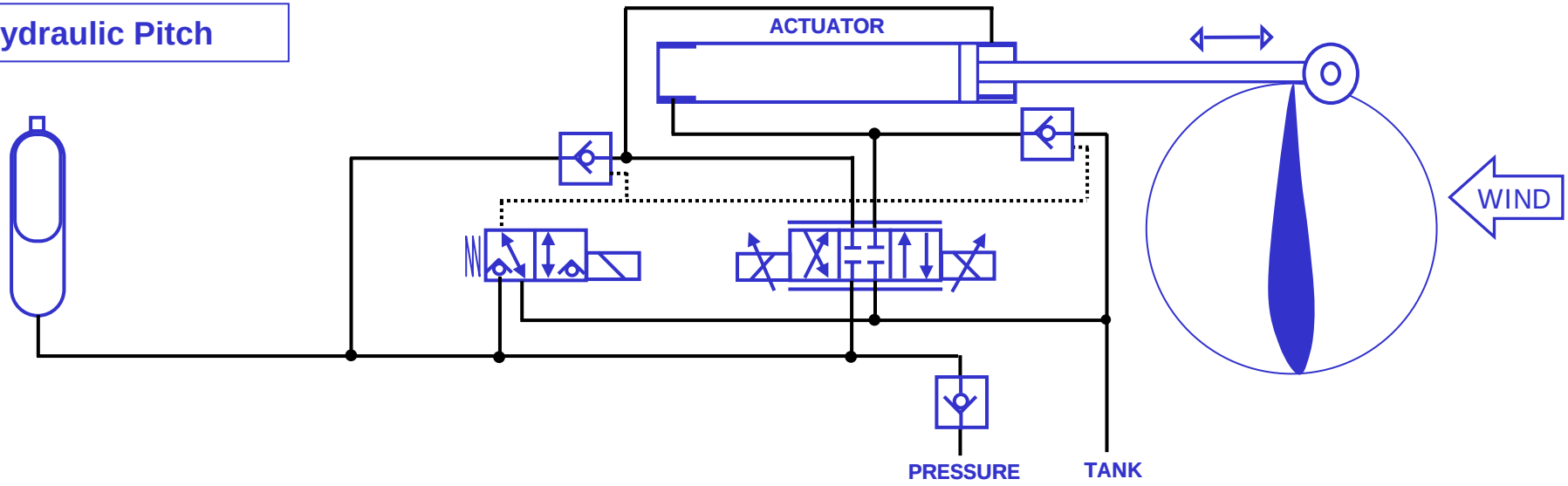
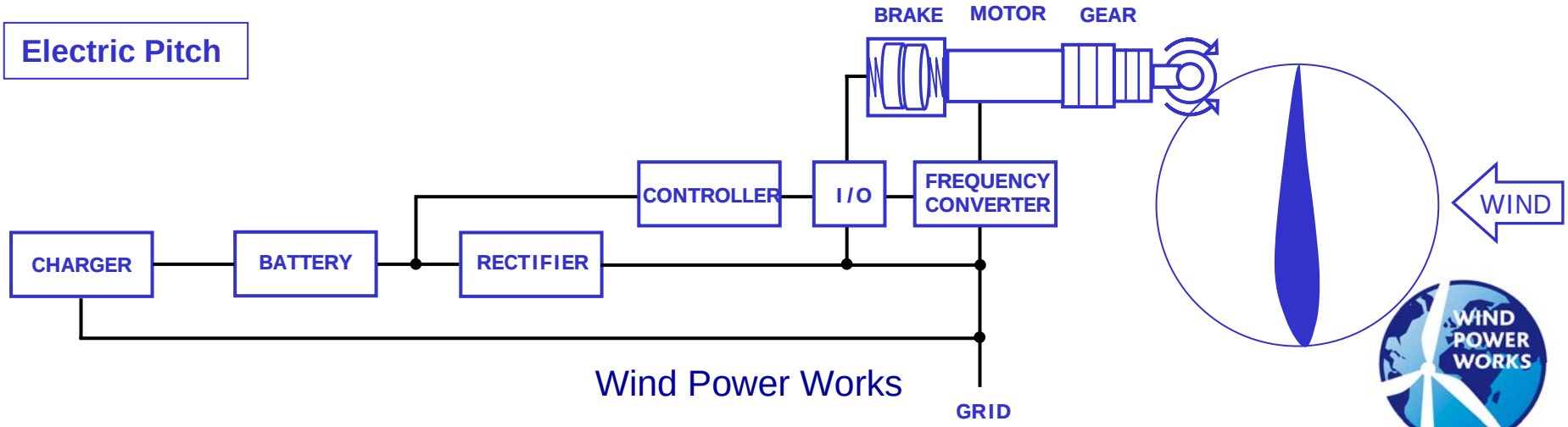
The Fail Safe Principle

Danish Wind Power Academy

Hydraulic Pitch



Electric Pitch



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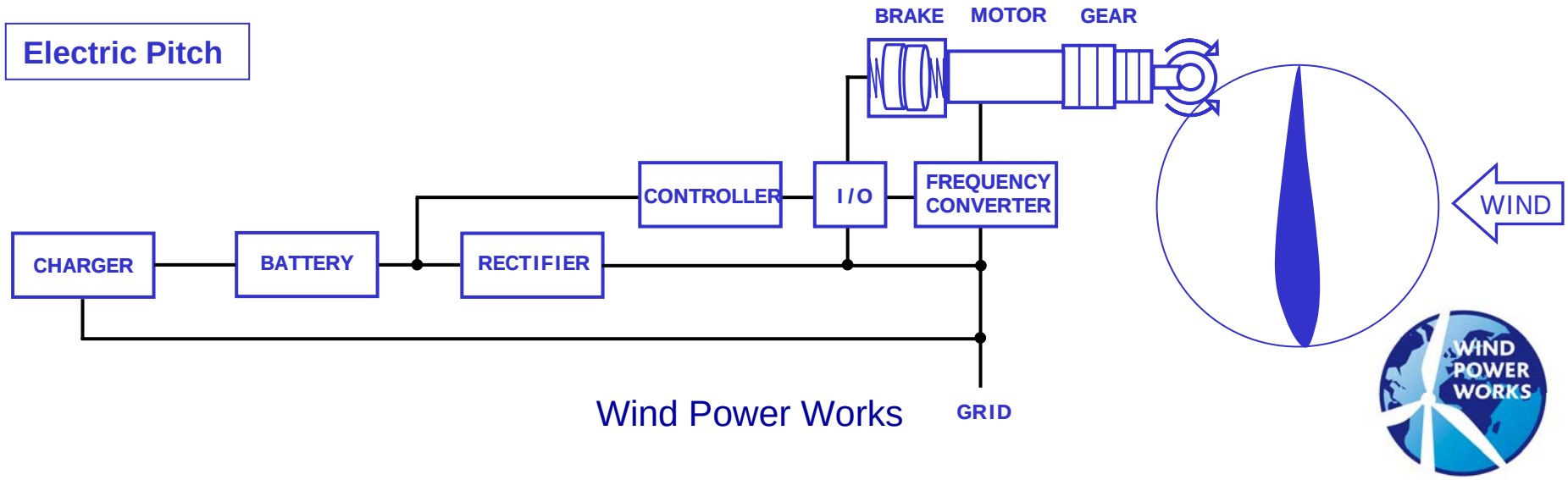
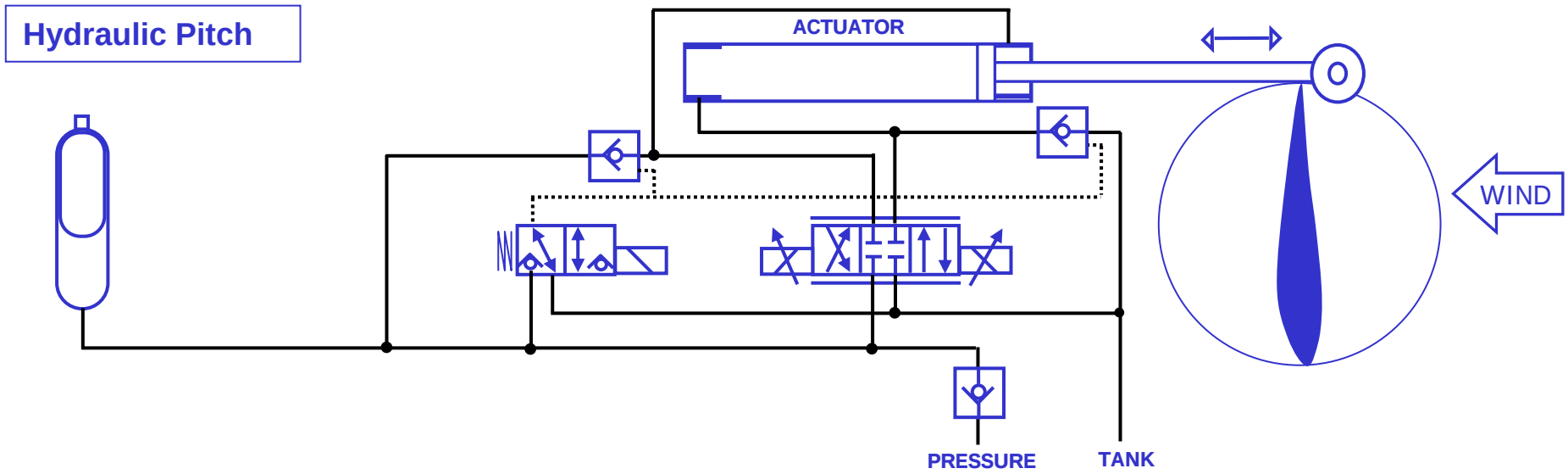
Electric Pitch System – Challenges

- Batteries - difficult to monitor, low power at low temperature and a frequent need for replacement
- Lubrication of pitch gear is difficult due to small movements
- Complex solution; many components and thus difficult to understand and service
- Backlash between the gears may be a problem



Hydraulic Pitch System – Challenges



- During service and replacement of parts a high degree of cleanliness must be obtained
- Maintenance of the accumulators can be a little difficult
- Leakages can occur, but with the right selection of components and proper service and maintenance this can be avoided

Comparing the two Commonly Used Technologies

SUPPLY

Electric

- Mounting method, casting of the hub
- Servo motor with brake
- Gear box
- Electric switches
- Mechanical end stop
- Gear wheel on blade bearing
- Gear wheel on gear box
- Lubrication system for pitch gear wheel
- Electric batteries
- Bracket for batteries
- Monitoring system for batteries
- Electric cables in the hub
- Heating system (for cold weather)
- Servo motor controller
- Pitch controller
- Through gear box assembly (TGA)
- Slipring (high power for motors)

- Operation of pitch lock
- High speed brake control
- Yaw brake control
- Hatch opening
- Operation of internal crane
- Operation of rotor lock

Hydraulic

- Mounting method, casting of the hub
- Hydraulic actuator
- Linear transducer (build into actuator)
- Rod end bearing for actuator
- Bearing system for actuator
- Pitch manifold including valves
- Distribution system (manifold)
- Bracket for distribution system
- Accumulators
- Bracket for accumulators
- Hoses and fittings in the hub
- Pitch controller
- Electric assembly boxes
- Through gear box assembly (TGA)
- Slipring (low power)
- Rotation union
- Pitch power pack
- Hoses and fittings in the nacelle

- Operation of pitch lock
- High speed brake control
- Yaw brake control
- Hatch opening
- Operation of internal crane
- Operation of rotor lock

Dimensions & Working Conditions of Wind Turbines

BOEING 767

Wing span	51,9 m
Total length	61,4 m
Operation	Less than ÷ 40 °C
Survival	even lower

2 - 3 MW class

Diameter blades	90 m
Tower height	65–105 m
Overall height	110–150 m
Operation	÷ 30 °C
Survival	÷ 40 °C

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Reliability – is it Important?

- As for aircrafts, reliability in wind turbines is important because:
  - If a failure happens, the turbine must be brought to a controlled position – again and again
  - Failure means loss of production
  - Failure means extra service costs

Danish pitch hydraulics work in wind turbines

The Danish Solution

- Majority of hydraulic driven pitch control use Danish pitch technology
- 99% of all OFF SHORE turbines use Danish pitch technology
- Danish pitch technology have more than 25 years of experience
- From the very beginning all Danish wind turbine manufactures have taken advance of Danish pitch technology

Climate Conditions – How to Handle them?

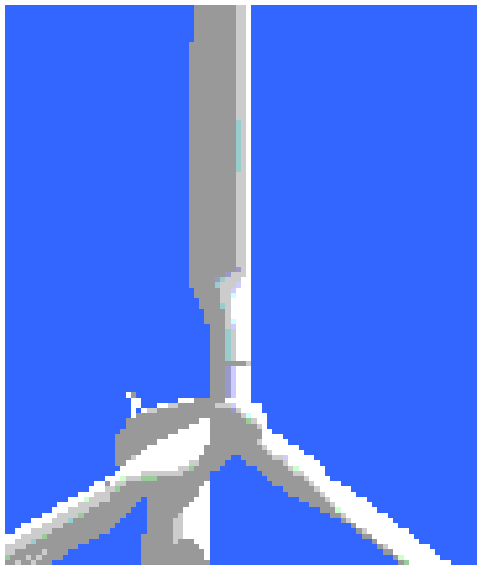
- Normal operation to 30 degrees below zero without any extra heating
- Survival to 40 degrees below zero
- Startup – heating included in the design
- No lubrication or grease is required in hydraulic pitch systems

Flexibility – is it Important?

- Simulation assists in the design phase
- Hydraulics offer easy fine tuning of the prototype through zero series to final serial production
- Before installation:
  - The installation environment may be different than expected
- When installed – fine tuning of the pitch system may be necessary:
  - Extra power may be needed to stop the turbine
  - Extra speed may be required to perform a safe emergency stop

Pitch in Operation

- With hydraulic pitch you meet the requirements for:
  - Accuracy and torque
  - Speed in pitch operation
  - Protection against high wind loads
  - Optimization of power production
  - Limiteded maximum power
  - Performing cyclic pitch (large turbines)
  - Complying with the modern grid demands from the utilities world wide



Response – are we Fast Enough?

- When using a hydraulic pitch system speed is not a problem:
  - The response time from the valves and the hydraulic accumulators is measured in milliseconds
- The necessary torque to turn the blade is proportional to the pressure in the system:
  - The pressure over the necessary stroke can easily be adjusted and it depends mainly on the size of the accumulators installed

A Crucial Failure in the Pitch System may Cause a “Lost” Turbine

Emergency Stop – is it Safe?

Hydraulic emergency stop

- The hydraulic accumulators store sufficient power to bring the turbine to a safe stop under all wind and temperature conditions
- Only a few valves must de-activate and the turbine perform an emergency stop
- No electrical power is required to perform an emergency stop

Extra feature:

- Short start up time after shut down (1 – 2 minutes), especially important if the grid is weak or many grid failures occurs

Lightning – does it Matter?

All turbines need lightning protection

- The hydraulic system is by nature less sensitive because of the mechanical design
- Only a few electric components can be damaged because of lightning
- If electric components are damaged the result is a full emergency stop

Condition Monitoring – is it Required?

Condition monitoring is also required for the large wind turbines in the future

- Hydraulic components offer standard solutions for condition monitoring:
  - PT100 sensors are already installed
  - Pressure transmitters are already installed
  - Position transducers are already installed
  - Proportional valve reference is already installed
  - Filter monitoring is already installed
  - Easy online particle counting

Hydraulics is the obvious choice for condition monitoring

Hydraulic Maintenance – Key Issues!

Important:

- Education of R&D and service people
- Clean system in operation and during service

Hydraulics offer:

- Easy trouble shooting due to simple setup
- Easy access to spare parts
- Reliable system reduces down time for service

Total Cost of Ownership (TCO) – is it Important?

- Lower overall costs improve return on investment
  - Initial cost (purchase)
  - Service and maintenance cost
  - Costs for unexpected stops (loss of production)
  - Environmental costs
  - Scrapping costs

PITCH – Why do we Recommend Hydraulics?

- Suitable for all climate conditions
- Flexibility in design; e.g. redundancy
- Emergency stop without electrical power
- Few components to protect against lightning
- Condition monitoring is made easy
- A hydraulic system is service friendly
- We believe that total cost of ownership is important
- Hydraulics offer a cheaper lifetime solution

PITCH – Why do we Recommend Hydraulics?

- The more often and more powerful pitch movements are required, the more hydraulic pitch is suitable

- A hydraulic system is a safe and proven technology and have been used for a far longer period than other systems

AVN Energy, Fritz Schur Energy and Windsyn

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