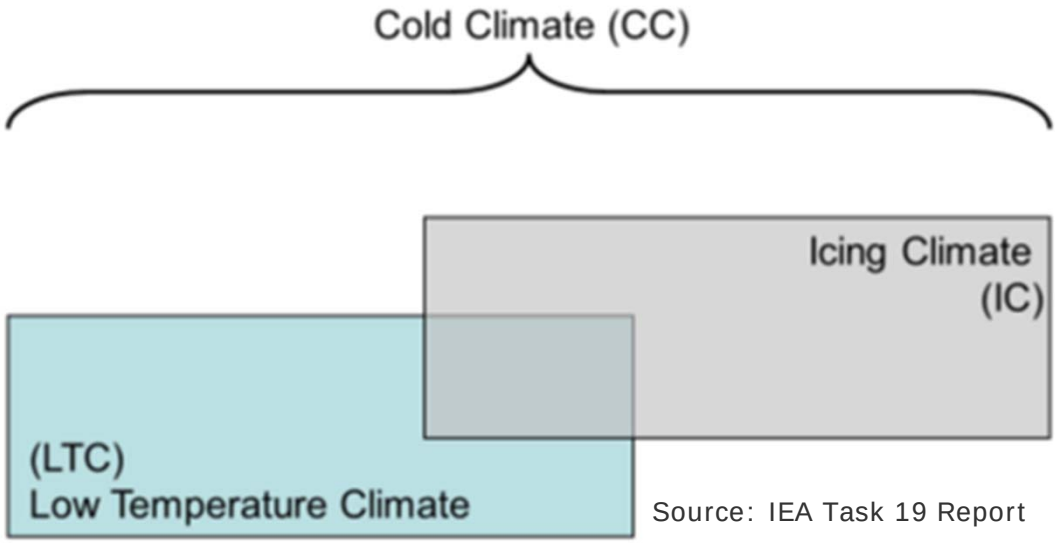
New Recommended Practises for Low Temperature and Icing Climate Conditions

Kai Freudenreich
Michael Steiniger
Gireesh Kumar Vasanta Kumari Ramachandran

DNV GL Renewables Certification

Contents

Cold Climate / Low Temperature Climate / Icing Climate



Source: IEA Task 19 Report

DNVGL-RP-0363
"Extreme temperature conditions for wind turbines"

DNVGL-RP-0175
"Icing of wind turbines"
expected for Q3 / 2017

What is a DNVGL Recommended Practise ?

- DNV GL Recommended Practise (RP):
  - optional supplement to existing standards
  - provide principles and technical requirements for design and certification of wind turbines for certain technical topics
  - define internationally acceptable level of safety, reliability and durability

- Download: https://www.dnvgl.com/energy/generation/renewables-certification/energy-rules-and-standards.html

- Scope of RPs DNVGL-RP-0363 and DNVGL-RP-0175: Safety relevant issues equipment and personnel
  - Extreme temperatures:
    Both cold and hot climate
  - Icing

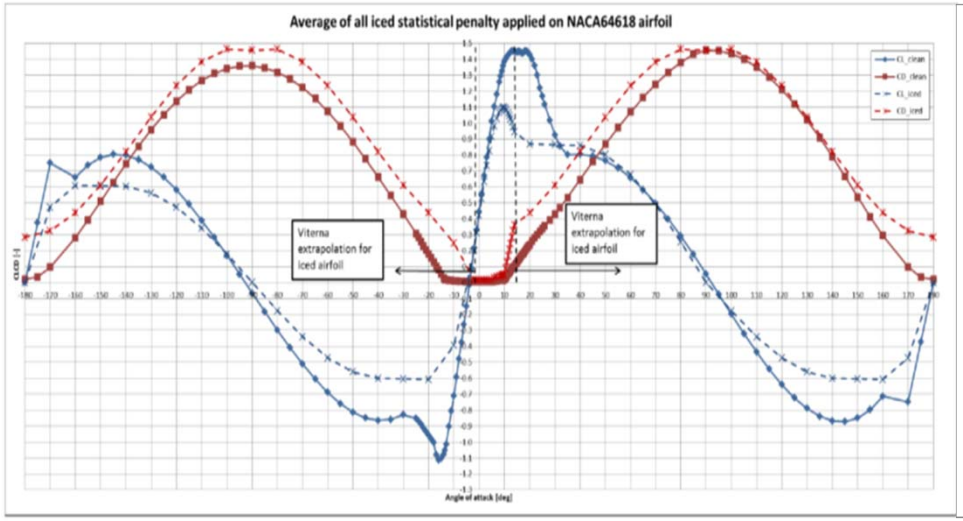
Definition of external conditions

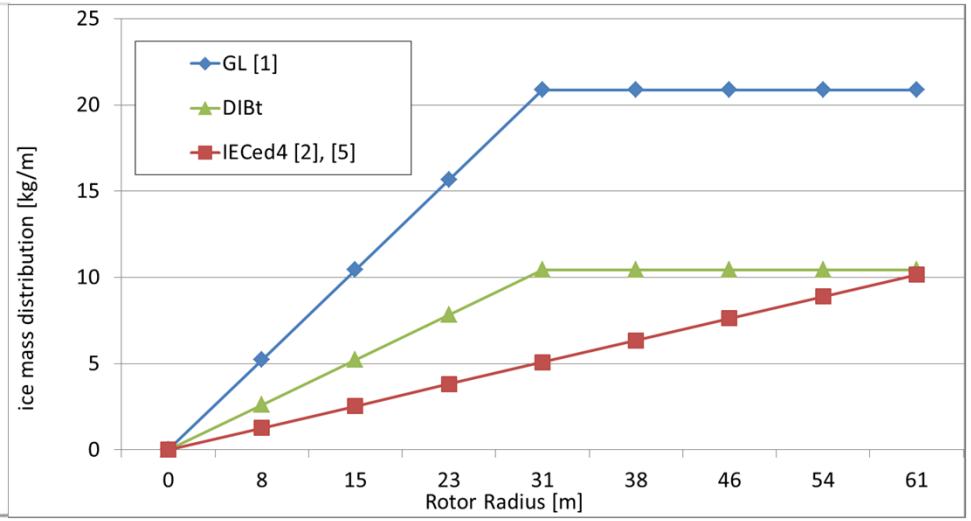
- Extreme temperatures:
  - criterion > 9 days per year
    below -20°C / above +50°C on hourly basis
  - mostly air density for loads & controller
  - temperatures for material properties
  - requirements for heating and cooling systems

- Icing:
  - main criterion: > 168 hour/year blade icing
  - rotor icing duration for fatigue loads
  - icing intensity for extreme loads on rotor and exposed components
  - relation to other standards, e.g. ISO 12494

Icing model

- new rotor icing model
  - based on IcedBlades results, research project 2012-16 (presented at Winterwind)
  - rotor aerodynamics (changed coefficients) + rotor ice mass along blade





  - similar to IEC 61400-1 edition 4
  - describes also aerodynamic and mass imbalance
- ice mass on non-rotating parts
- spray ice acc. to NORSOK N-003

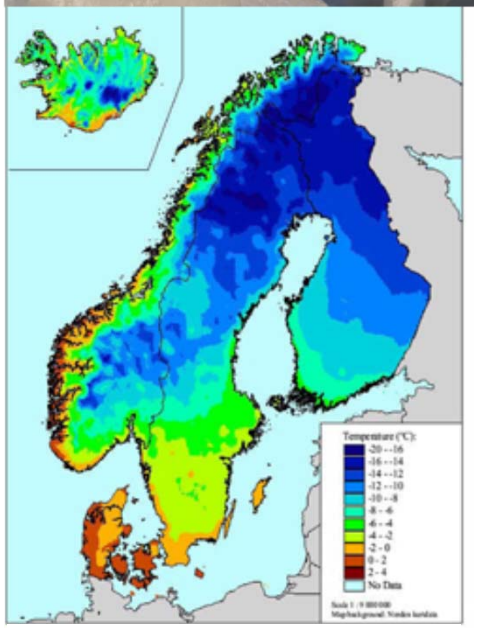
New Ice Class and Loads

	Ice class I	Ice class S
Rotor icing duration for fatigue	750 hours per year	To be defined by manufacturer
Extreme icing for exposed structures	30 mm acc. to ISO 12949	
Spray ice	linear from 80 to 0 mm	

- covers load relevant effects of large number of typical icing sites
- rotor icing duration approximately IEA Ice class 3
- criteria for application of ice class listed, e.g.
  - sites with more than 168 hours icing per year and/or
  - controller is sensitive to blade icing and/or
  - tower designs prone to ice induced vibrations

Site Assessment

- lists required site data
- different possible sources, as
  - measurements: reliable sensors + power supply !
  - existing data bases, e.g. temperature or icing maps
  - numerical analyses
- required corrections:
  - spatial
  - long-term
  - rotor height (especially for incloud icing)
- recommendations given for correlation rotor icing vs. instrumental/meteorological icing
- site specific evaluation either by
  - comparison of external conditions site vs. design
  - site specific load calculation



Source: viavasterbotten.se

Control and Protection System

- sensor reliability
- possible controller instability due to changed air density and / or icing
- supervision of
  - heating systems
  - cooling systems
  - ice protection systems
  - power supply + cold start procedures
- different strategies for icing:
  - ice protection mode (anti- / de-icing)
  - switch to ice operation mode (adapt operating parameter)
  - turbine stop

Source: WinWind, Winterwind 2012

Ice protection

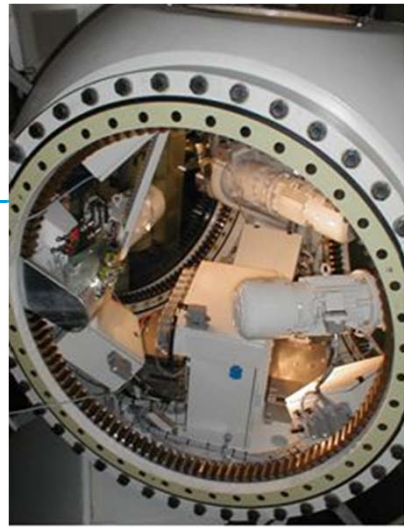
Source: WinWind, Winterwind 2012

- de-icing or anti-icing
- variety of methods already existing and possibly still expanding
- mostly temperature, coating, vibration effects
- incorporation into control and protection system to
  - switch on / off
  - prevent undesired effects, as e.g. overheating, excessive vibrations etc.
- effects on load definition e.g. by reduced icing duration or extreme icing
- functionality to be shown in field tests

Components

- load / structural effects
- temperature / material effects
- heating / cooling requirements
- power supply requirements
- cold start requirements

blades



power back-up

heating / cooling systems

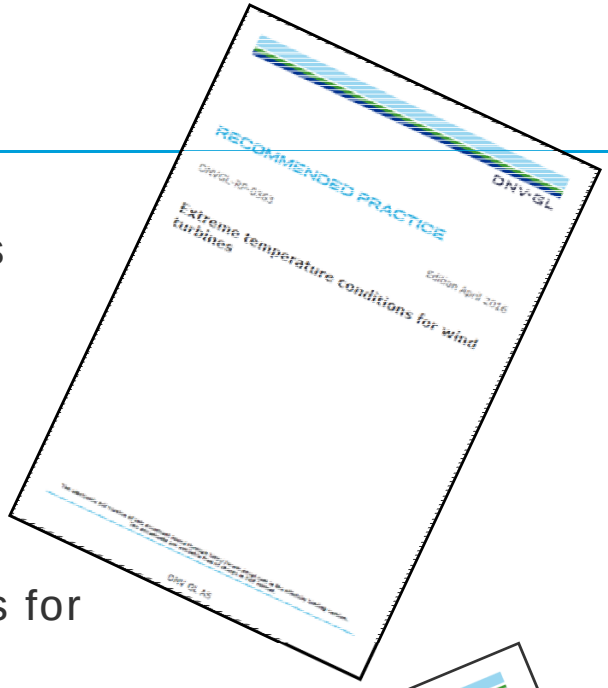
met masts

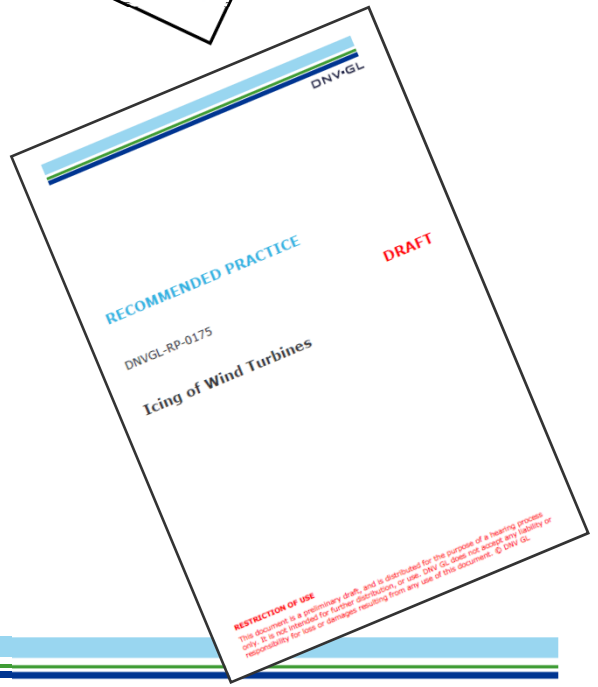
exposed structures

Source: Fassmer

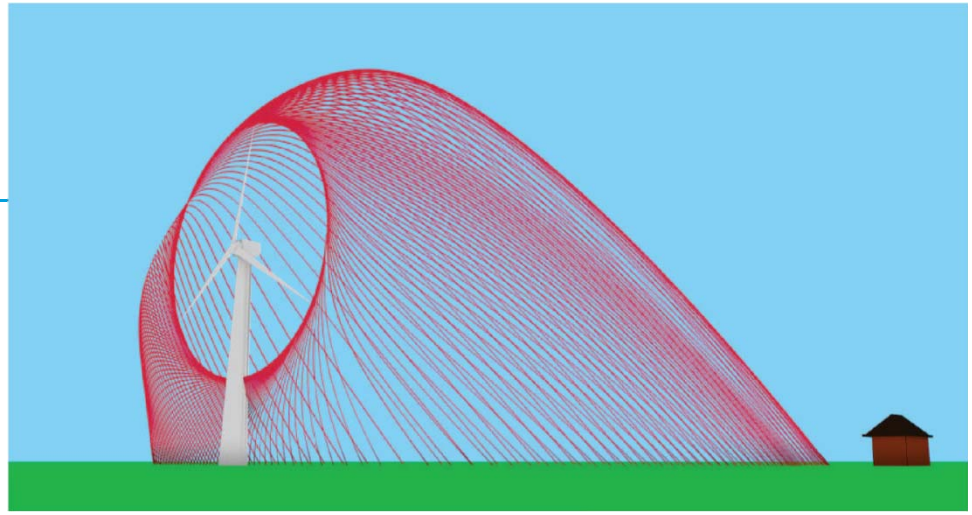
Conclusions

- two DNVGL recommended practises (RP) serve as basis for design and certification of wind turbines
- to be used as supplement to existing standards
- DNVGL-RP-0363 “Extreme temperature conditions for wind turbines” is already published
- DNVGL-RP-0175 “Icing of wind turbines” expected for Q3 / 2017
- download: https://www.dnvgl.com/energy/generation/renewables-certification/energy-rules-and-standards.html





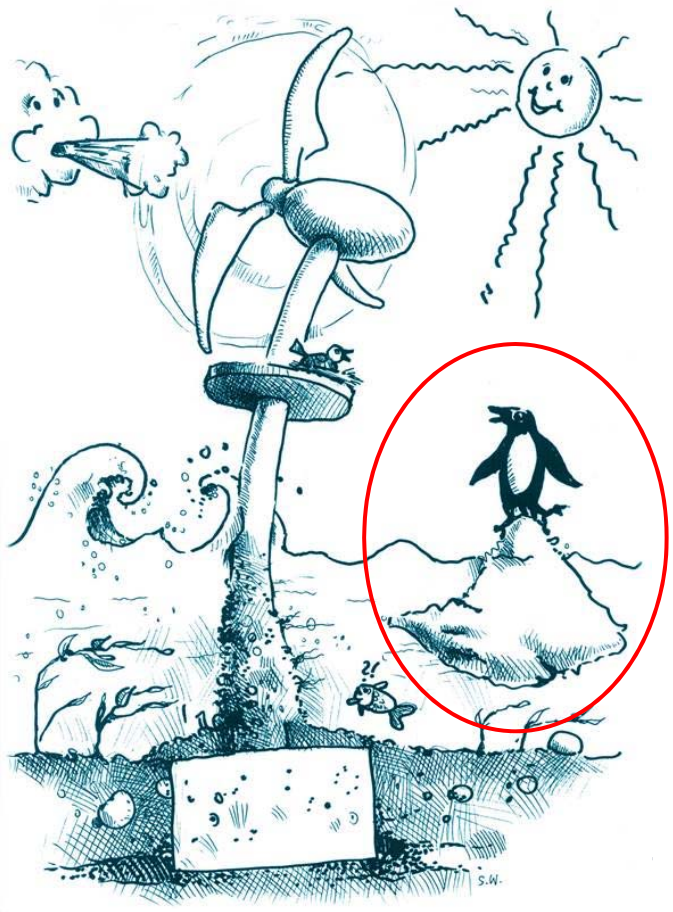
Future Work



- RP Extreme Temperatures:
  - Issued - / -

- RP Icing:
  - Ice throw:
    possibly to be included in next revision

  - Sea ice:
    additional RP considered

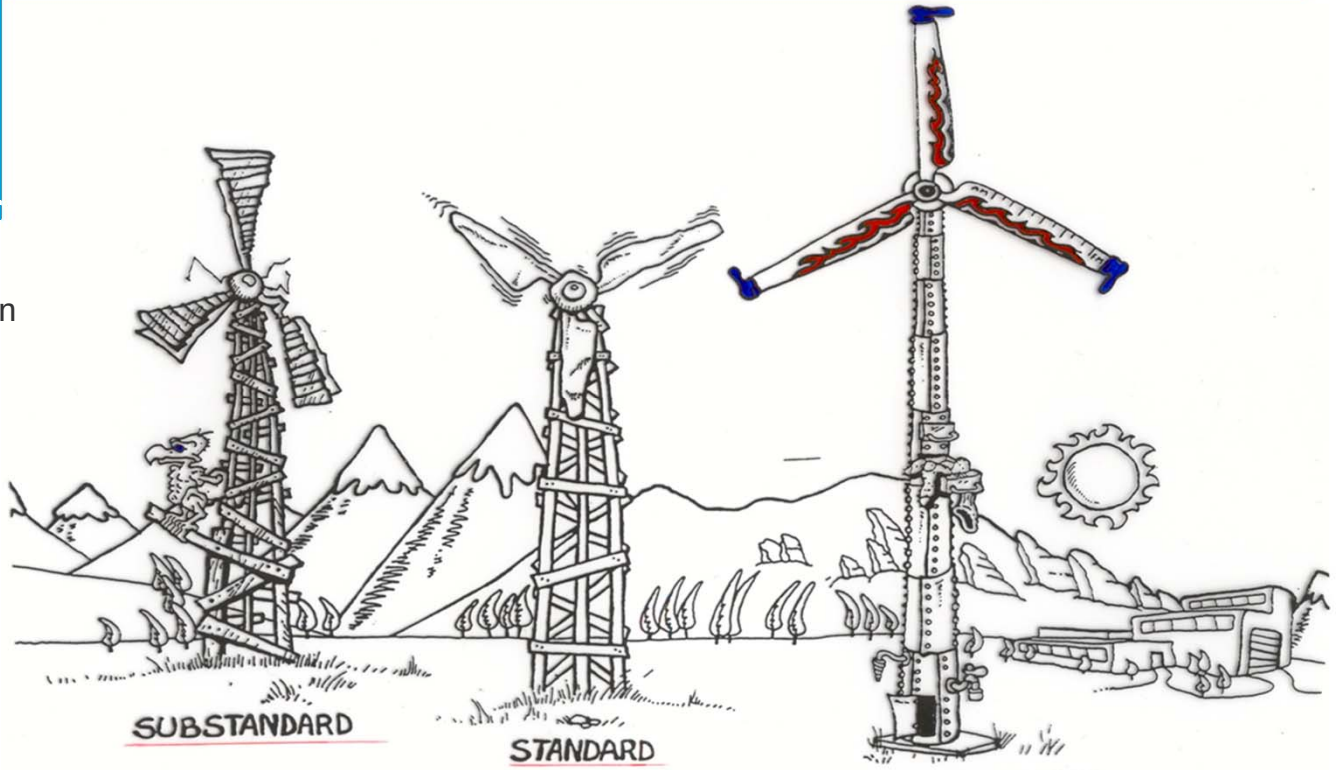


Any questions ? Thank you !

Kai Freudenreich
DNV GL Renewables Certification
kai.freudenreich@dnvgl.com

www.dnvgl.com

SAFER, SMARTER, GREENER



Source: NREL