

RISK OF ICEFALL

in the international Context

 **Winterwind**
INTERNATIONAL WIND ENERGY CONFERENCE



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- 01 HISTORICAL BACKGROUND**
- 02 RISK OF ICE-FALL IN AUSTRIA
- 03 INTERNATIONAL COMPARISON



Wind Energy in Cold Climates (WECO Study, 2000)

- Investigation of hazard potential through field investigations and observations
- For wind turbines up to 60 m diameter → maximum distances $\leq 100\text{m}$
- Turbines were not switched off → No distinction between ‘ice-throw’ and ‘ice-fall’

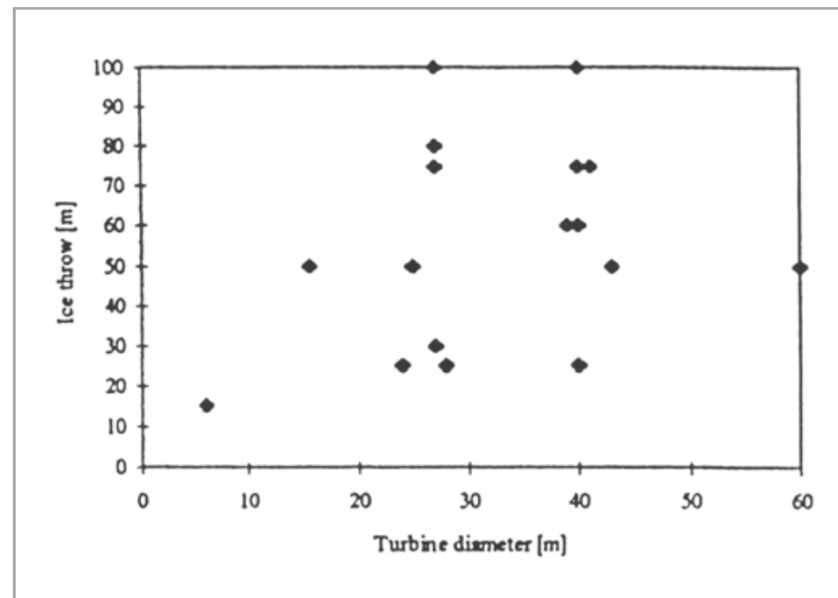


Fig. Source: WECO Study 2000

Fig.: Distance of ice fragments as a function of the diameter of the turbine

DEWI - Risk analysis of Ice-Throw (Seifert, 2003)

- Initial distinction between ‘ice-throw’ and ‘ice-fall’
- Creation of an empirical formulas for the maximum distance based on the result of WECO study and additional observations (Tauernwindfarm)

$$\text{Ice-fall} \rightarrow d = \frac{D+H}{15} * v \qquad \text{Ice-throw} \rightarrow d = 1,5 \times (D+H)$$

- Comparison between empirical calculation using Seifert formula and observations showed an overestimation in the calculation

- Situation described though formulas reflects the worst case scenario during icing conditions
- In fact, detailed risk assessment is required
- Modelling of probability of hits per m² and year (see Figure)

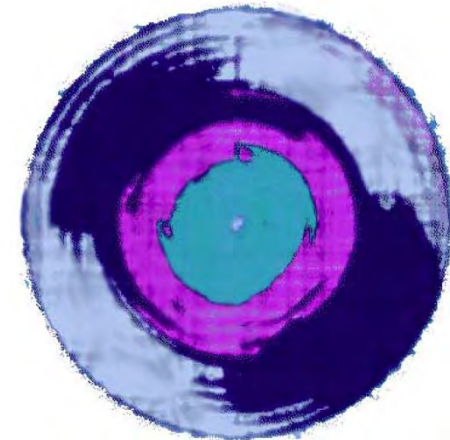


Fig.: Probability of hits per m² and year
Source: Seifert, 2003

Gütsch Study (Meteotest, 2007)

- Investigation of an Enercon-E40 in 2.300 above sea level in Switzerland
- Automatic mode for the de-icing of the rotor blades and restart of the WKA
- No distinction between „ice-throw“ and „ice-fall“ possible
- Observation as to size and weight of ice fragments, distances, direction

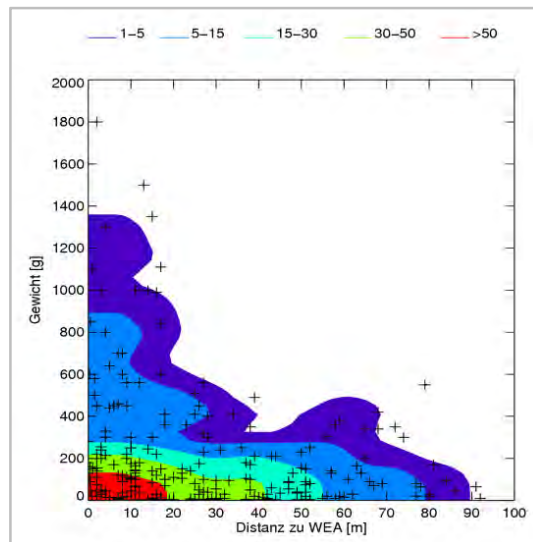


Fig. Source: René Cattin, Meteotest, 2007

Fig.: Weight vs. distance according to the number of ice-pieces

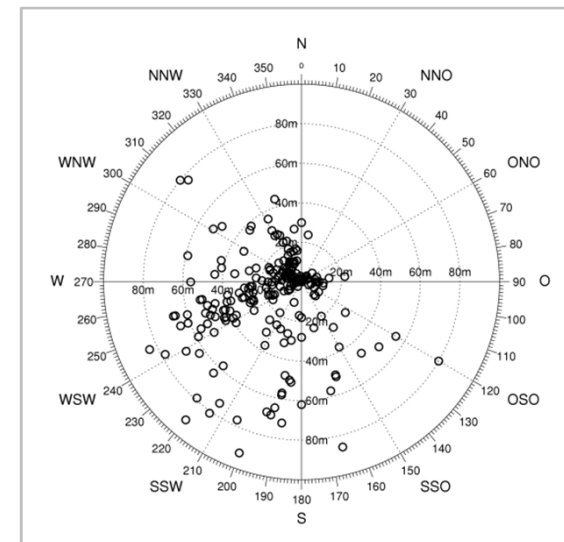


Fig. Source: René Cattin, Meteotest, 2007

Fig.: Distribution of ice throw around the wind turbine

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Permission practice in Austria until 2009

- Condition in the notification of approval: No “Ice-throw”, only “Ice-fall”
- Minimum distance to public roads through Seifert Formula (unless possibility to close)
- Land utilization agreement required only for (horizontally) swept rotor area

Precedent WF Pöttelsdorf in Burgenland

Withdrawal of approval for operation of a SWT (DR = 82m)

- Location with very moderate icing (3-5x events per year)
- Owner of adjacent land plot (~50m away from the turbine tower) argued that he cannot proceed with his farming activities during winter
- Approval from cantonal government in 2009
- In 2010 High Administrative Court: WT has to be dismantled
- Remark: Different decision regarding the installation of a telecom mast



Fig.: WF Pöttelsdorf

Necessity for Risk assessment

- Research Project Energiewerkstatt et al.
 - Comprehensive Observations: Trajectories...
 - Modelling of risk zones
- Probability consideration
 - Parameter to be considered:
 - Size of Turbine
 - Meteorology at the site: Frequency/intensity of icing events, frequency of strong winds, wind rose
 - Danger of ice pieces (i.e. size) for human beings
 - Probability of presence of people in the surrounding
- Comparison of the risk with values of commonly accepted risk
 - 1×10^{-5} (i.e. the risk for death during office works)

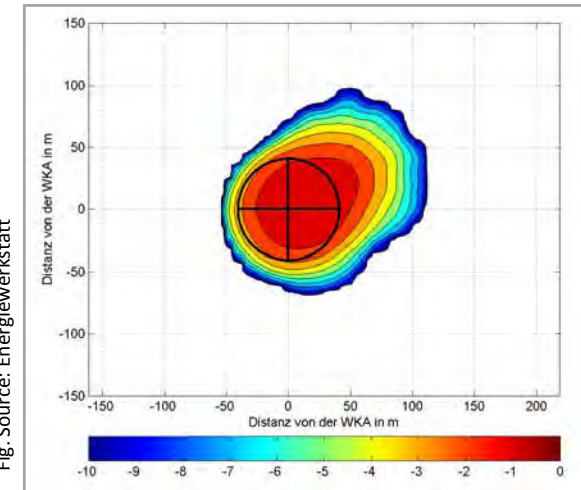


Fig. Source: Energiewerkstatt

Fig.: Example for risk zone

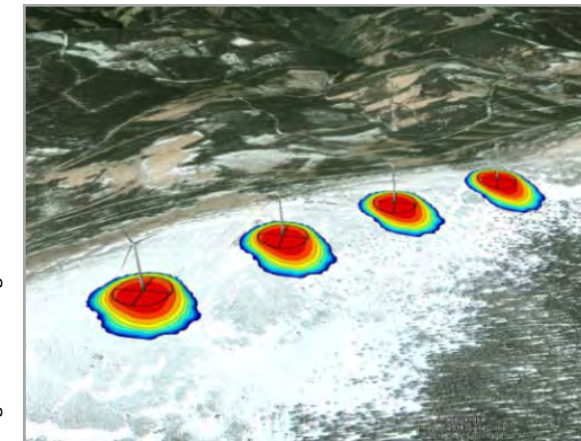


Fig. Source: Energiewerkstatt

Fig.: Example for a risk zone in the Alps

Current legislative requirements

- Land utilization agreements:
 - Necessary distance to next property line: Blade-tip-height + 20%
- Additionally, Risk Assessment for public infrastructure
- Manifold conditions in approval to build
 - Two independent ice detection systems
 - Automatic shut-down of the WT in case of ice accretion
 - Automatic restart is not allowed; visual inspection through wind farm attendant
 - Signposting: Warnings Signs, Flashing Lights...



Photo: Warning sign
Source: Tauernwind

→ Interesting for Austria to have an international comparison!

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Direct Target:

- Working out the different approaches to elaborate overview on the different rules and regulations as to the assessment of the “danger due to ice-fall“

Indirect Target:

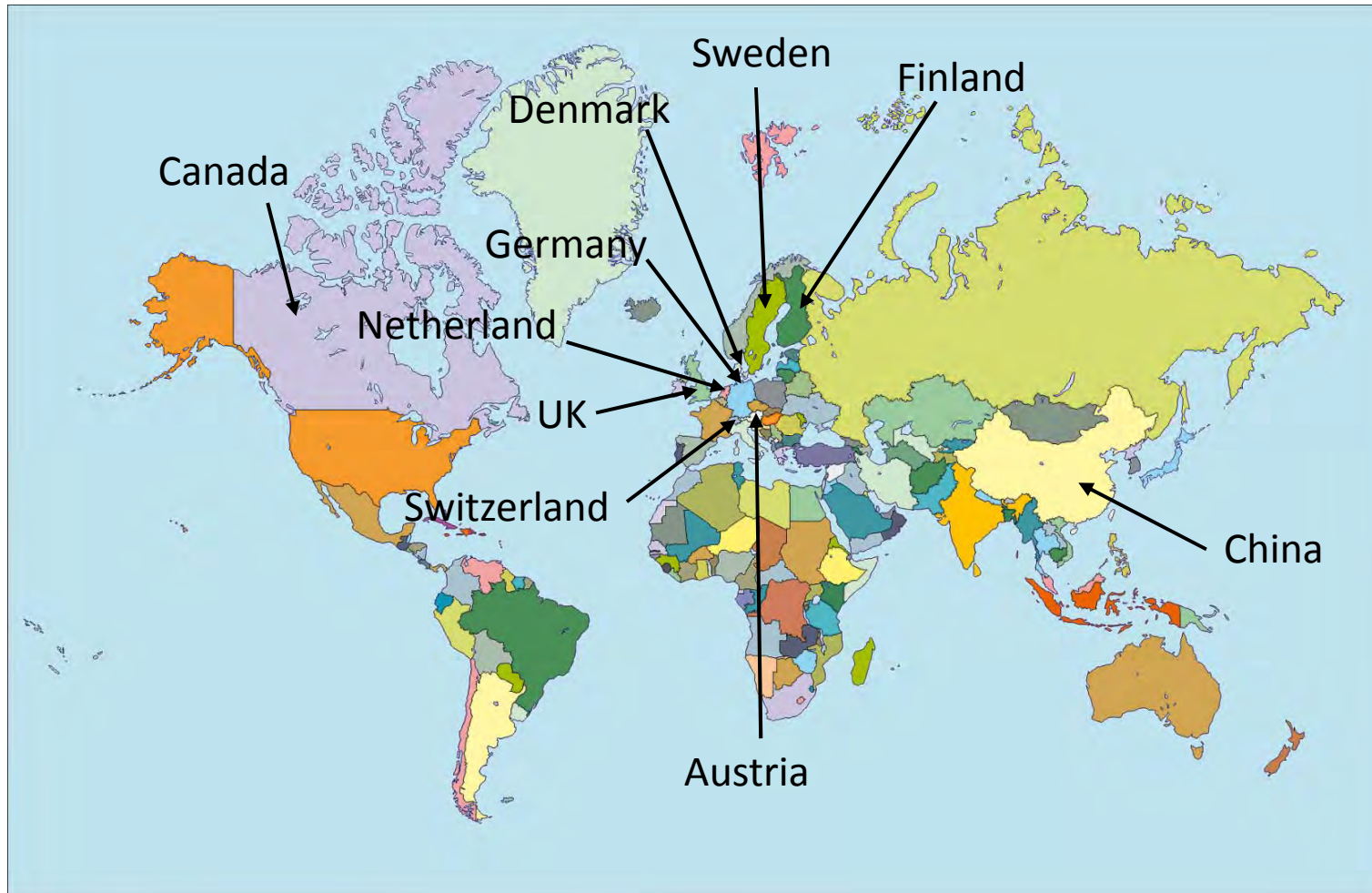
- Paving the way to more transparency
- Common, international standard for ice throw

Method:

- Development of a questionnaire about „Risk of ice-fall“
 - Starting point is the Austrian perspective
- Questions regarding requirements as to:
 - Ice-detection, extent of danger area, operational modes...
- Submitted to the partners in IEA Task 19 ‘Wind Energy in Cold Climates’
- In order to cover different approaches in cantons → asking for three different cases

Return of questionnaires

Thanks for the contributions!



Winterwind 2014

OVERVIEW MATRIX		Moderate icing			Varying icing				Strong icing		
		DENMARK	NETHERLAND	UNITED-KINGDOM	GERMANY	CHINA	SWITZERLAND	AUSTRIA	FINLAND	CANADA	SWEDEN
Response-options		130	495	257	229	140	193	102	18	3	23
Population density per km ²											
Assessment of the icing frequency and intensity of the location	Not at all										
	By synoptic consideration										
	Comparison heated/ unheated anemometer										
	Ice Sensor										
	Ice Map										
Definition of the extent of the danger zone for icfall/ icethrow	Any other										
	Not at all										
	Empiric formula										
	Risk assessment										
	Any other										
Which implications/ restrictions arise for the danger zone?	No restrictions										
	Signpostings										
	Confirmation for affected private land										
	Agreement to close public roads										
	Any other										
Is it allowed to operate the turbines with iced-up blades?	Yes										
	No										
	Both										
Is an automatic restart allowed after de icing or is an verification at the site required?	Yes										
	No										
	Not specified										
Which requirements are stipulated as to the detection of ice on the turbine	None										
	Manufactor solution (ice sensor, power curve)										
	Solution during standstill										
	Redundant system										
	Not specified										
Do authorities dictate/ prescribe the utilisation of a blade heating?	Yes										
	No										

Disclaimer: Completeness of the information and data provided in the given cases and evaluations is excluded. Other cases and examples are feasible.

Countries with moderate icing conditions

- Denmark (1 questionnaire)
 - Necessity for risk assessment (despite of only moderate icing)
 - Report (Risø-R-1788): Treats risk assessment of siting WT close to highways
 - No restrictions as to safeguarding of danger areas (e.g. confirmation for affected private land plots, agreement to close public roads)
 - No restrictions as to ice detection during operation
- Netherland (1 questionnaire)
 - Assessment of icing frequency or intensity with CFD-Model (Meso scale data)
 - Necessity for risk assessment (despite of only moderate icing)
- United Kingdom (1 questionnaire)
 - Assessment of the danger area is not required
 - No restrictions as to safeguarding of danger areas
 - Not allowed to operate the turbines with iced-up blades

Countries with diverse icing conditions

- **Germany** (3 questionnaires)
 - No assessment of icing frequency or intensity
 - Definition of the danger area through empiric formulas (Seifert)
 - No land utilization agreement necessary with neighbours
- **China** (1 questionnaire)
 - Necessity for risk assessment
 - Assessment of icing frequency or intensity by the use of sensors or synoptic considerations
 - Turbines need to be shut-down in case of iced-up blades
- **Switzerland** (1 questionnaire)
 - Different approaches as to assessment of site-specific icing conditions (incl. ice map)
 - Risk assessments and empiric formulas
 - Allowance to operate WT with iced-up blades

Countries with strong icing conditions

- **Finland** (1 questionnaires)
 - Ice sensors and ice map to assess the site-specific icing conditions
 - Definition of the danger area through empiric formulas (H_{bladetip} + safety margin)
 - Allowance to operate WT with iced-up blades, if not very close to houses or roads
 - Utilisation of a blade heating system is prescribed, if public roads are in the risk area
- **Canada** (1 questionnaire)
 - Utilization of empiric formulas for the definition of the danger area
 - Tailor-made solution as to operational mode (different approach for WT near settlements than for more remote ones)
- **Sweden** (1 questionnaires)
 - Definition of the danger area through empiric formulas (Seifert), recommendation to do a further risk assessment, if people live there
 - General recommendations as to the safeguarding of the danger zone
 - Requirement to detect icing on the WT in a reliable way.

Conclusions

- Results from the survey:
 - Far away from a uniform licensing practice in the evaluated countries (huge differences even in between different cantons)
 - No interrelation visible in between legislative requirements, population density and icing conditions
- Next steps:
 - Awareness among the authorities
 - Further improvement of technical solutions and meteorological models
 - WT manufacturers have to assume their responsibilities

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Thanks for your Attention.