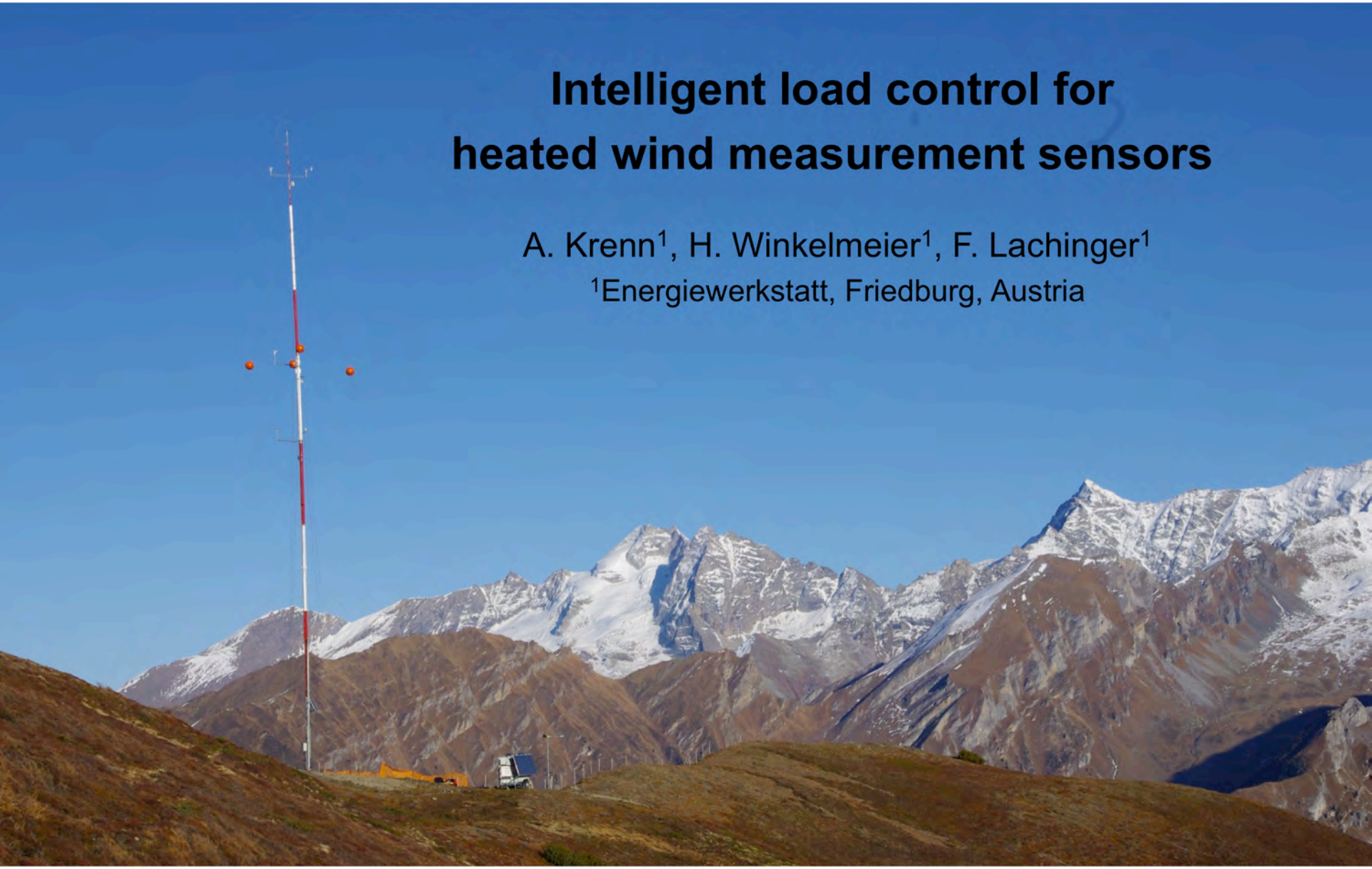

Intelligent load control for heated wind measurement sensors

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[1]Energiewerkstatt, Friedburg, Austria

Company Profile

Wind Energy

- Wind Measurement
- Project Development
- Planning & Implementation
- Training and Education
- Research & Demonstration

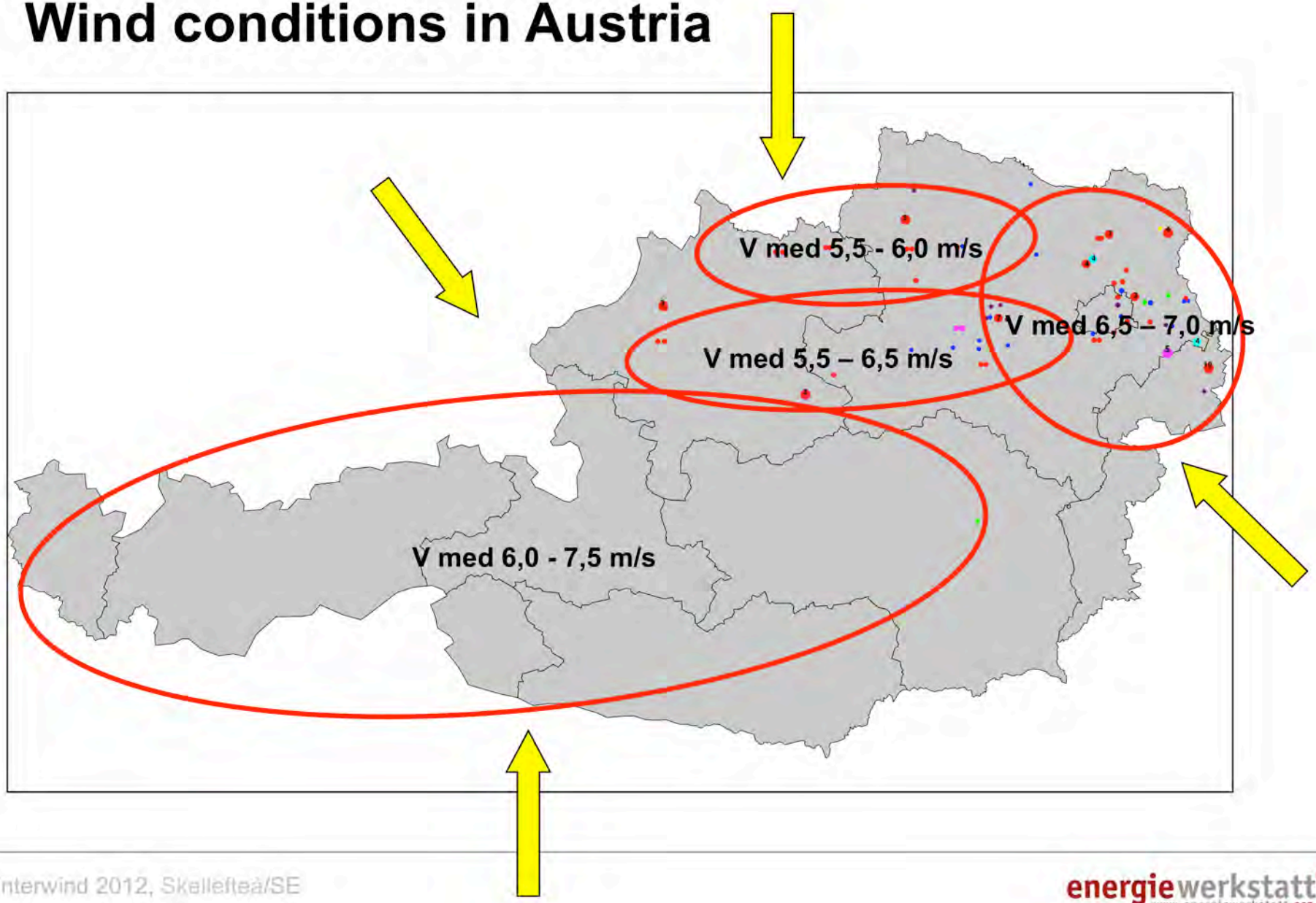
energiewerkstatt
www.energiewerkstatt.org

Wind Energy in Austria

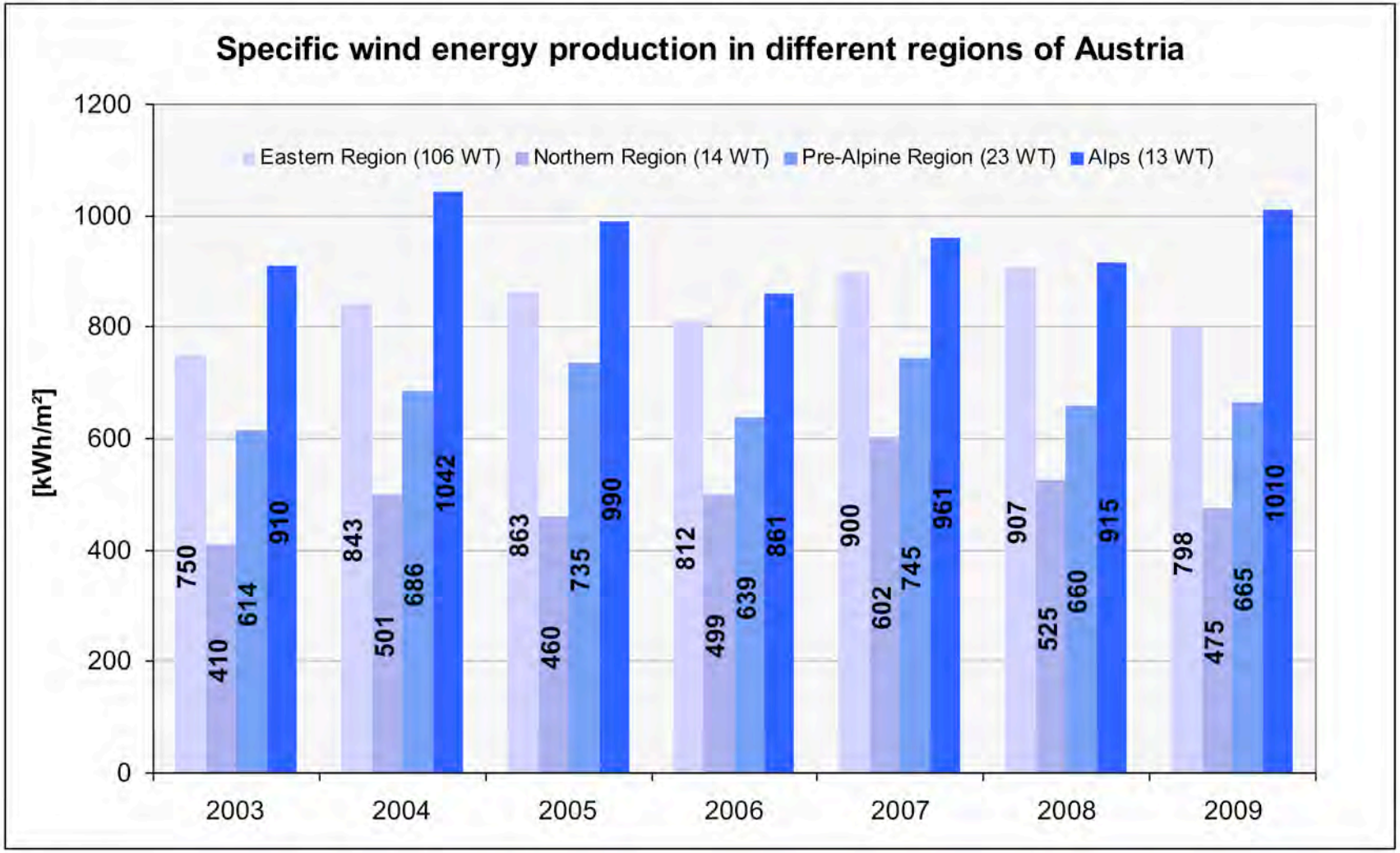
State 31.12.2011

- 650 Wind turbines
- 1.084 MW installed power
- 2,39 TWh electricity generation per year
- 3,6 % of Austrian electricity demand

Wind conditions in Austria



Specific wind energy production in Austria

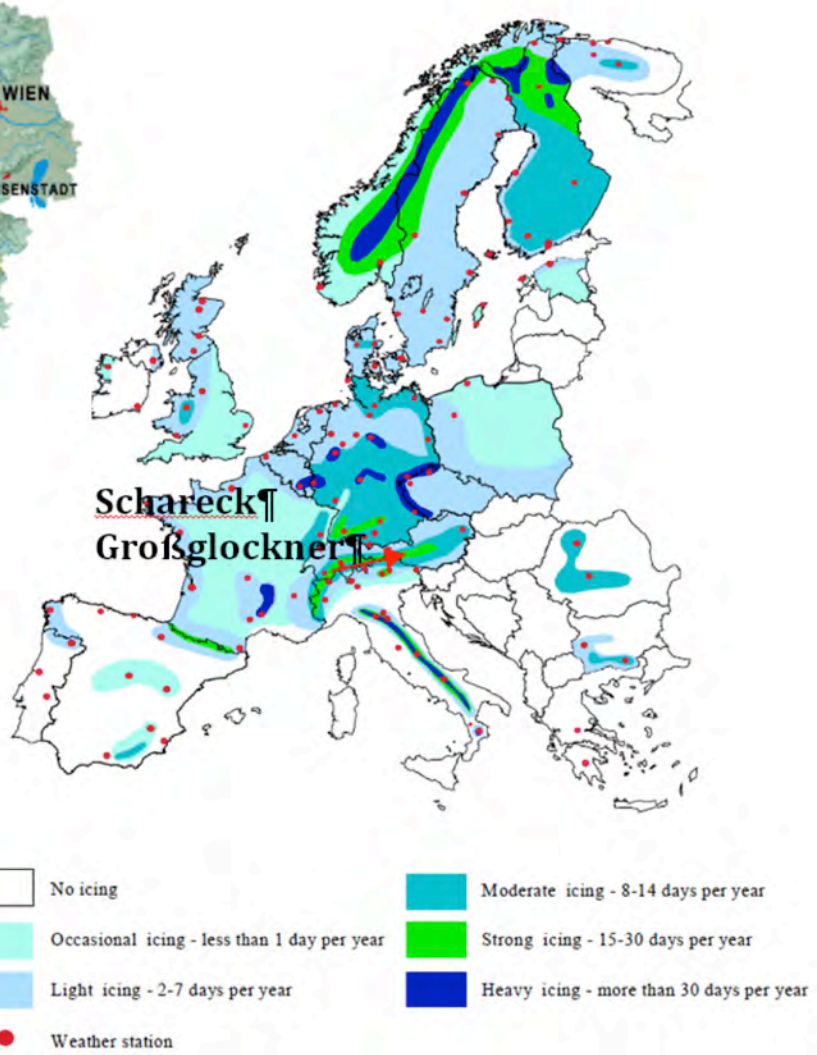


01 Wind Energy in Austria

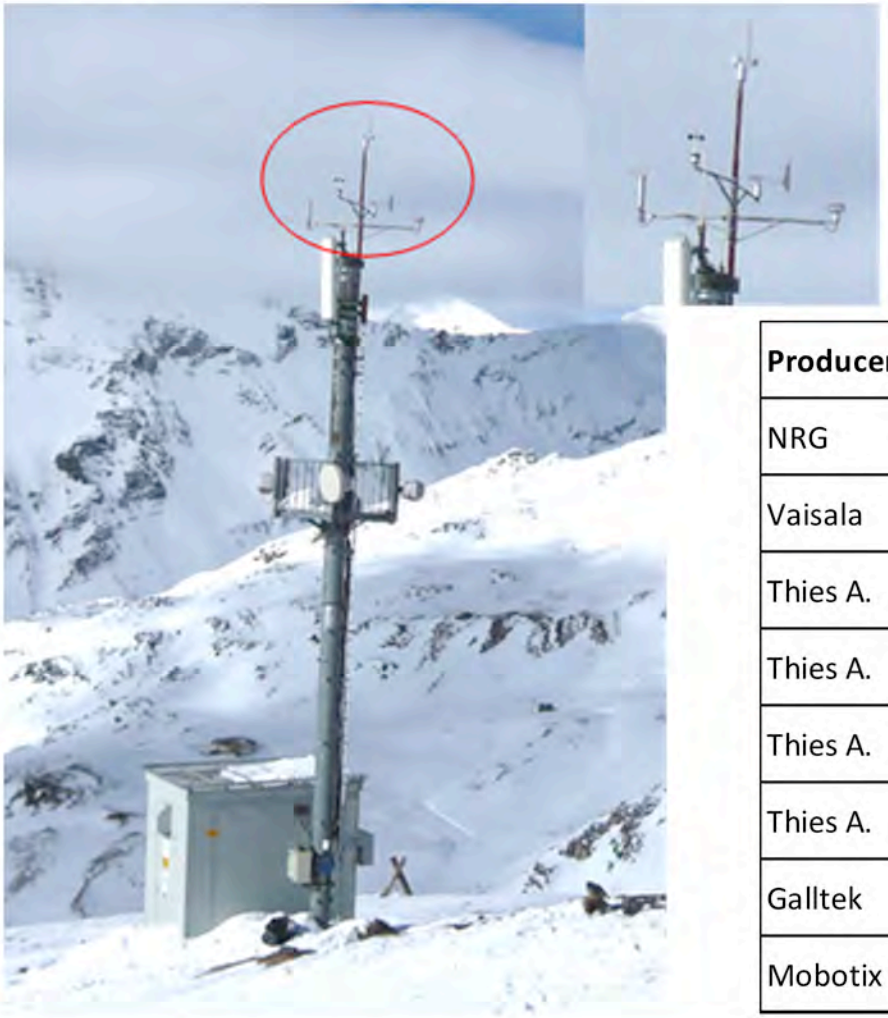
02 Test Rig Schareck / Großglockner

03 Wind Measurement Brenner

Test Rig Schareck



Measurement setup

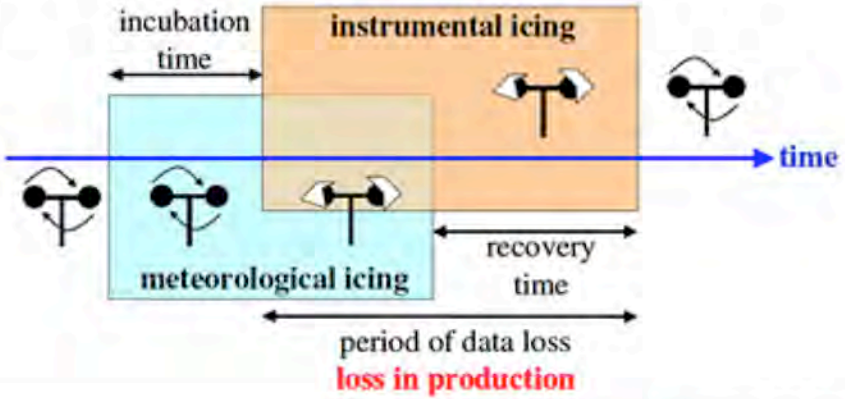


Producer	Type	Operating mode	Power [W]
NRG	Ice Free 3	Heated cup anemometer	96 W
Vaisala	WAA252	Heated cup anemometer	72 W
Thies A.	2D	Heated 2D Ultrasonic	310 W
Thies A.	2D Compact	Heated 2D Ultrasonic compact	250 W
Thies A.	Classic	Unheated cup anemometer	-----
Thies A.	Classic	Wind vane	25 W
Galltek	P63-12	Combined Thermo-/Hygrosensor	-----
Mobotix	M12 Dual Night	Webcam with infrared spotlight	-----

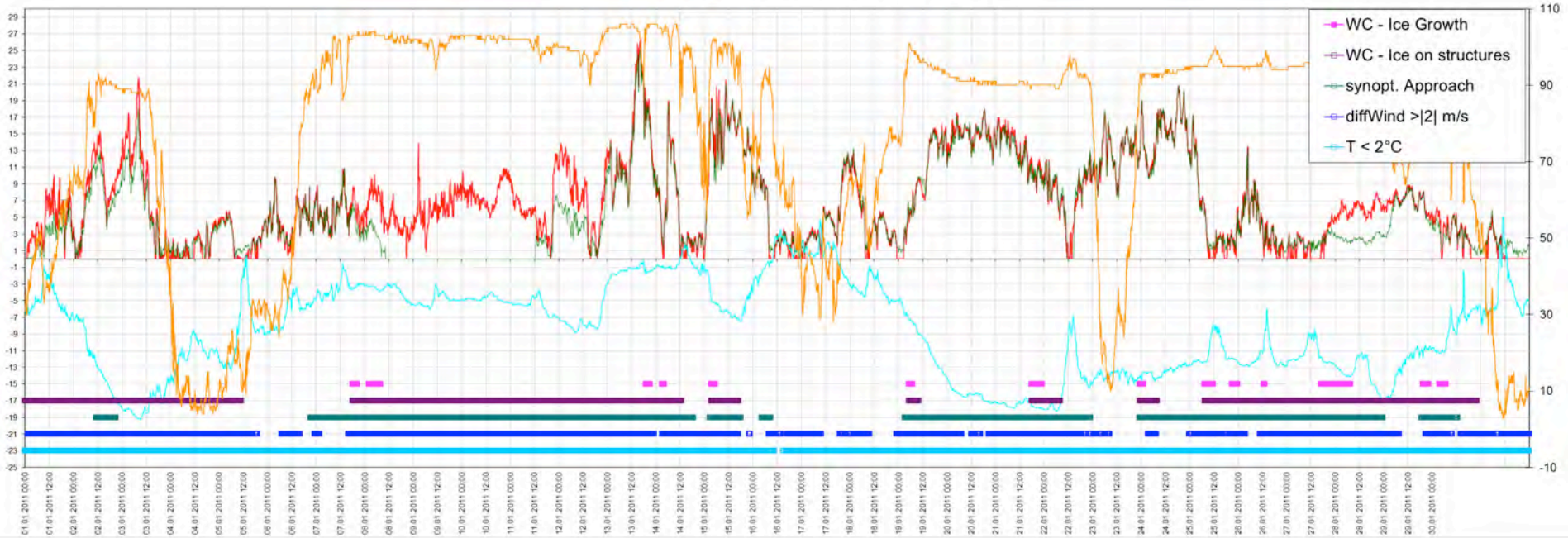
Data evaluation

Comparison of five different scenarios rsp. icing periods:

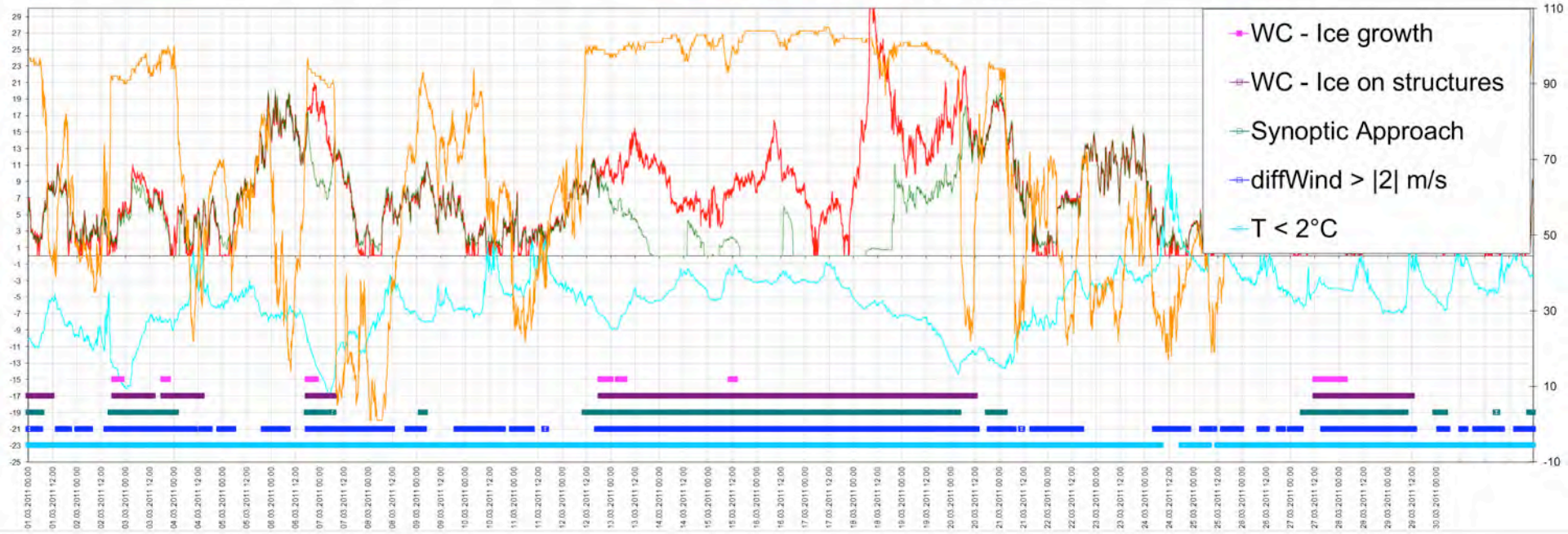
- Actual meteorological icing periods based on webcam evaluations
- Actual instrumental icing periods based on webcam evaluations
- Estimated icing periods according to synoptic considerations
- Estimated icing periods according to comparison of heated and unheated anemometers
- Estimated icing periods according to standard algorithms of heated wind measurement sensors



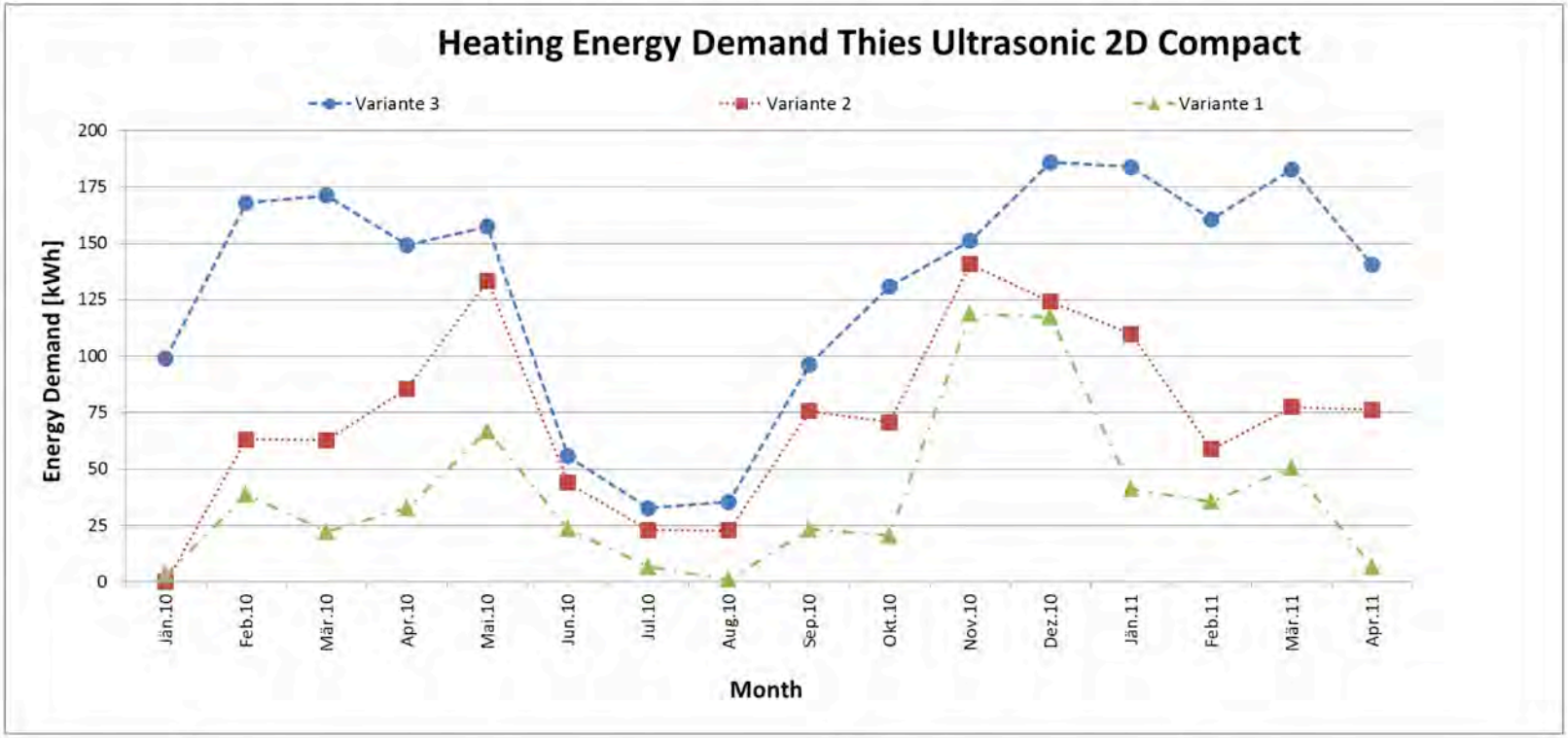
Evaluation January 2011



Evaluation March 2011



Resulting Energy Demand



Scenario	Solution regarding heating control	Used settings	Energy Consumption
1	Standard sensor algorithm	≤ 2°C	100%
2	Comparison heated/unheated sensor	Δvmed > 2 m/s	29%
3	Relative humidity und temperature	≥ 90%; ≤ 1°C	55%

Considerations regarding heating demand

- Theoretically, heating of wind measurement sensors is only necessary during meteorological icing periods
- In case of external power supply units
  - Which energy consumption do we have?
  - How much energy is available?
  - Which data availability do I want to achieve?
- Importance of an advanced load control management
- Possible approaches:
  - Info from webcam, difference betw. heated and unh. sensor not available
  - Synoptic considerations (equivalent to meteorological icing)
    - Overestimation of icing periods, but still ~ 50% saving of energy
  - In future - ice detector: current obstacles (350 W heating demand, costs)

01 Wind Energy in Austria

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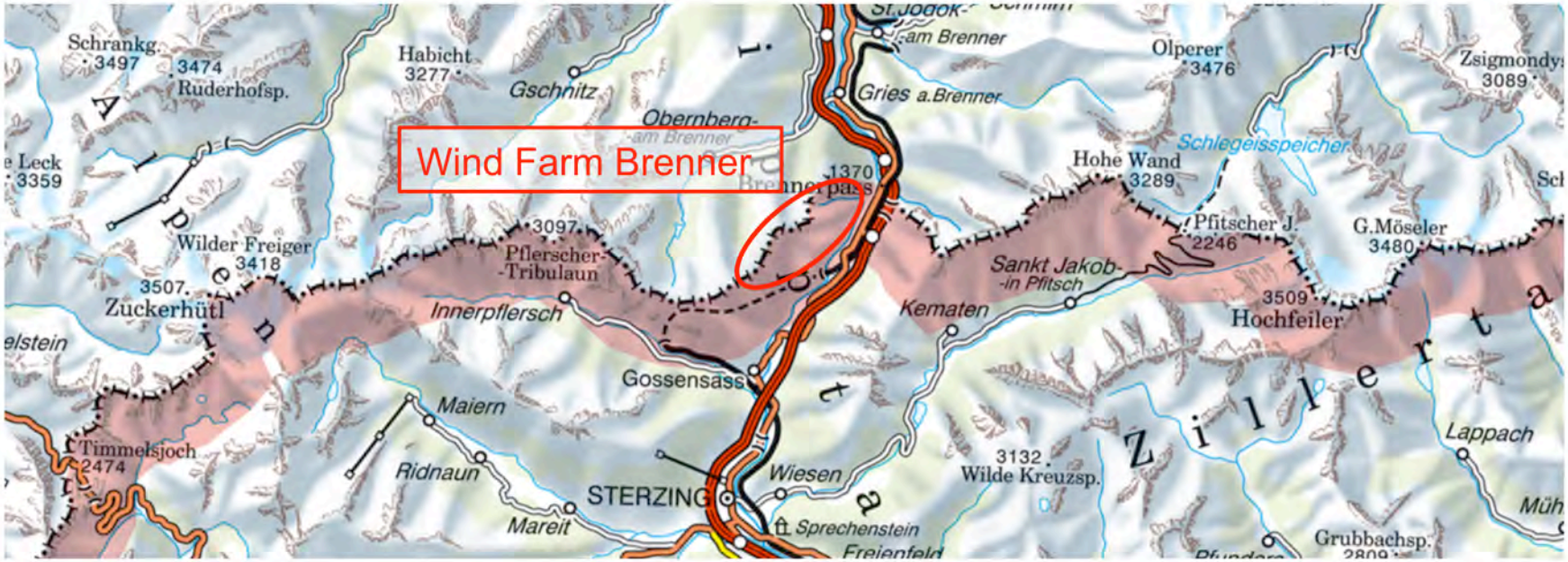
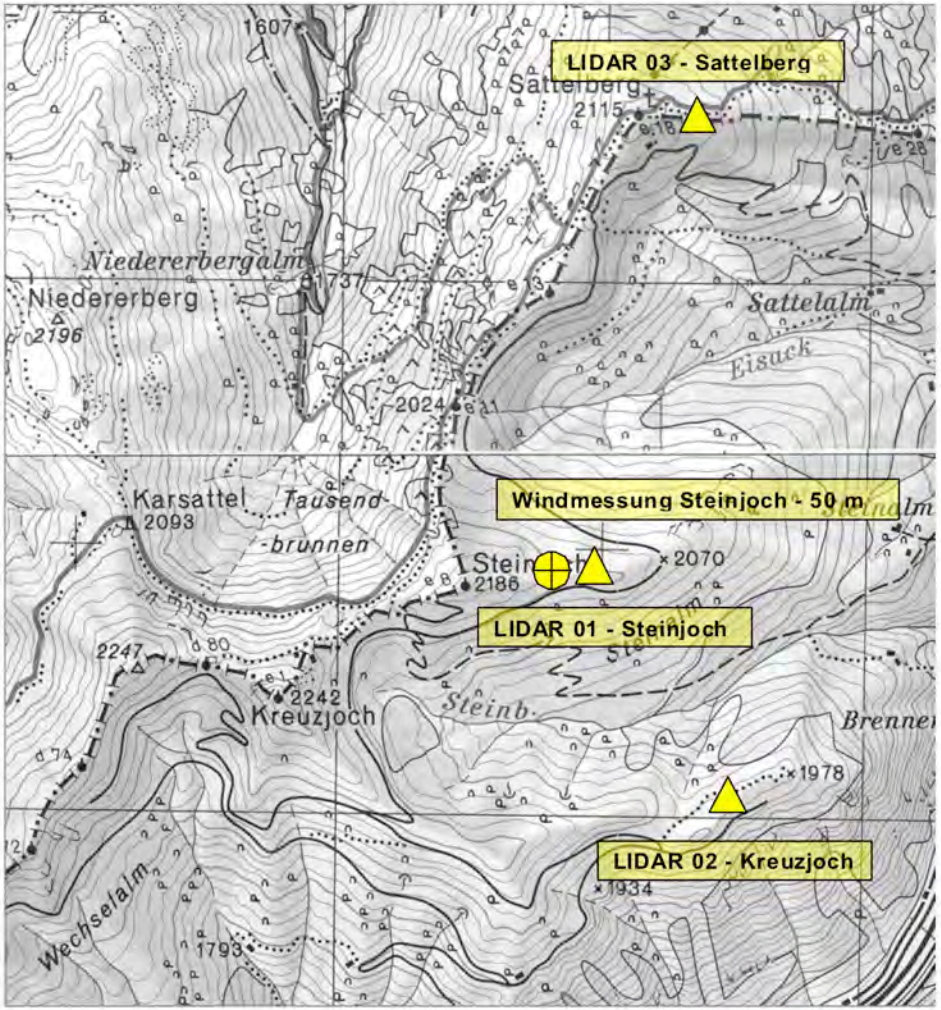
Wind farm Brenner

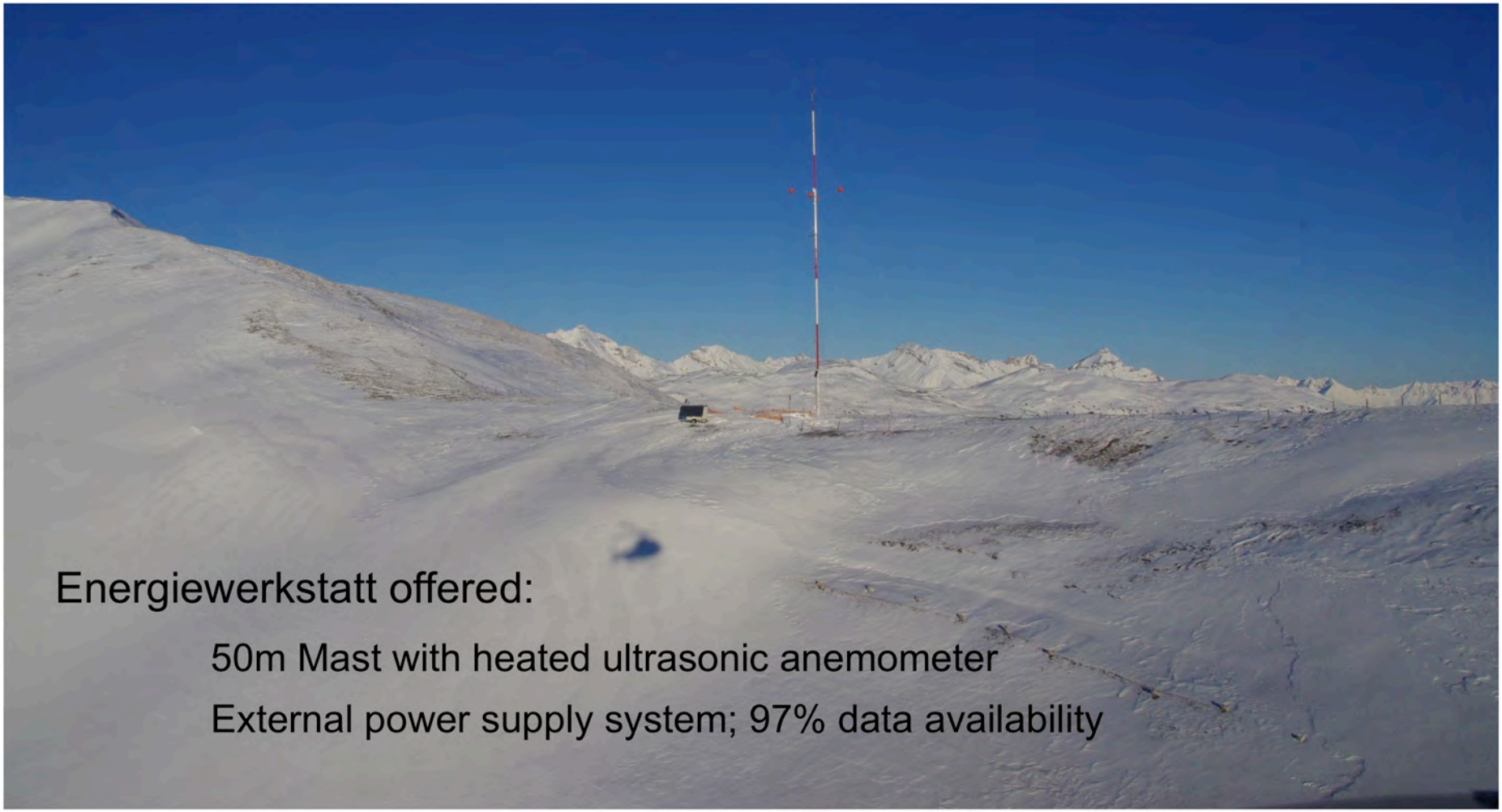
- 2.100 – 2.200m above sea level
- 600 W/m^2 at hub height (estimated)
- 40 days per year icing (estimated)
- 19 Wind turbines approved (LTW70 – 2.0 MW)



Measurement concept



Wind measurement mast Steinjoch



Energiewerkstatt offered:

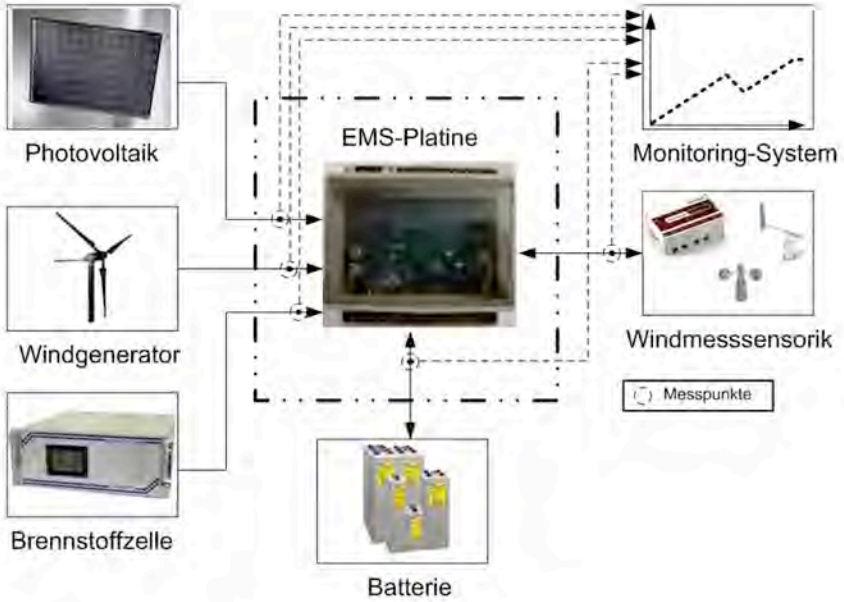
- 50m Mast with heated ultrasonic anemometer
- External power supply system; 97% data availability

External power supply system

Power demand Ultrasonic: **250 W (periodically)**
Power demand LIDAR: **40 W (100 W) (continuously)**

Technical specification:

PV generator:	4 x 180 W
Wind generator:	2,40 m diameter / 900 W
Fuel cell:	300 W (as backup)
Hydrogen store:	6 bottles à 50 litres
Battery storage:	600 Ah / c100
Data storage:	Ammonit Meteo 32
Dimensions:	1.10 / 2.20 / 1.80
Operat. control:	EMS Energy management system



Energy management system

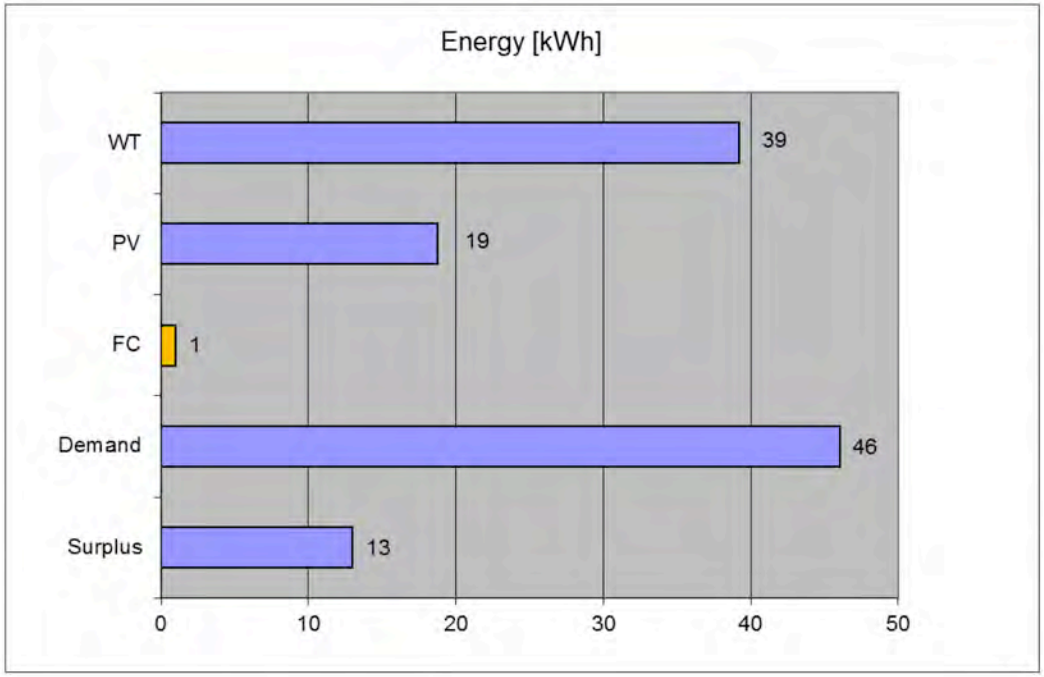
Controlling of the system

- **Load management**: Managing the power demand of the sensors according to the actual conditions
- **Production management**: Intelligent interplay of the components
- **Thermal management**: Intelligent provision of the required thermal conditions (for battery pack and fuel cell)
- Provision of a **remote control** system, which allows permanent control and a remote changing of the settings

Experience from first months

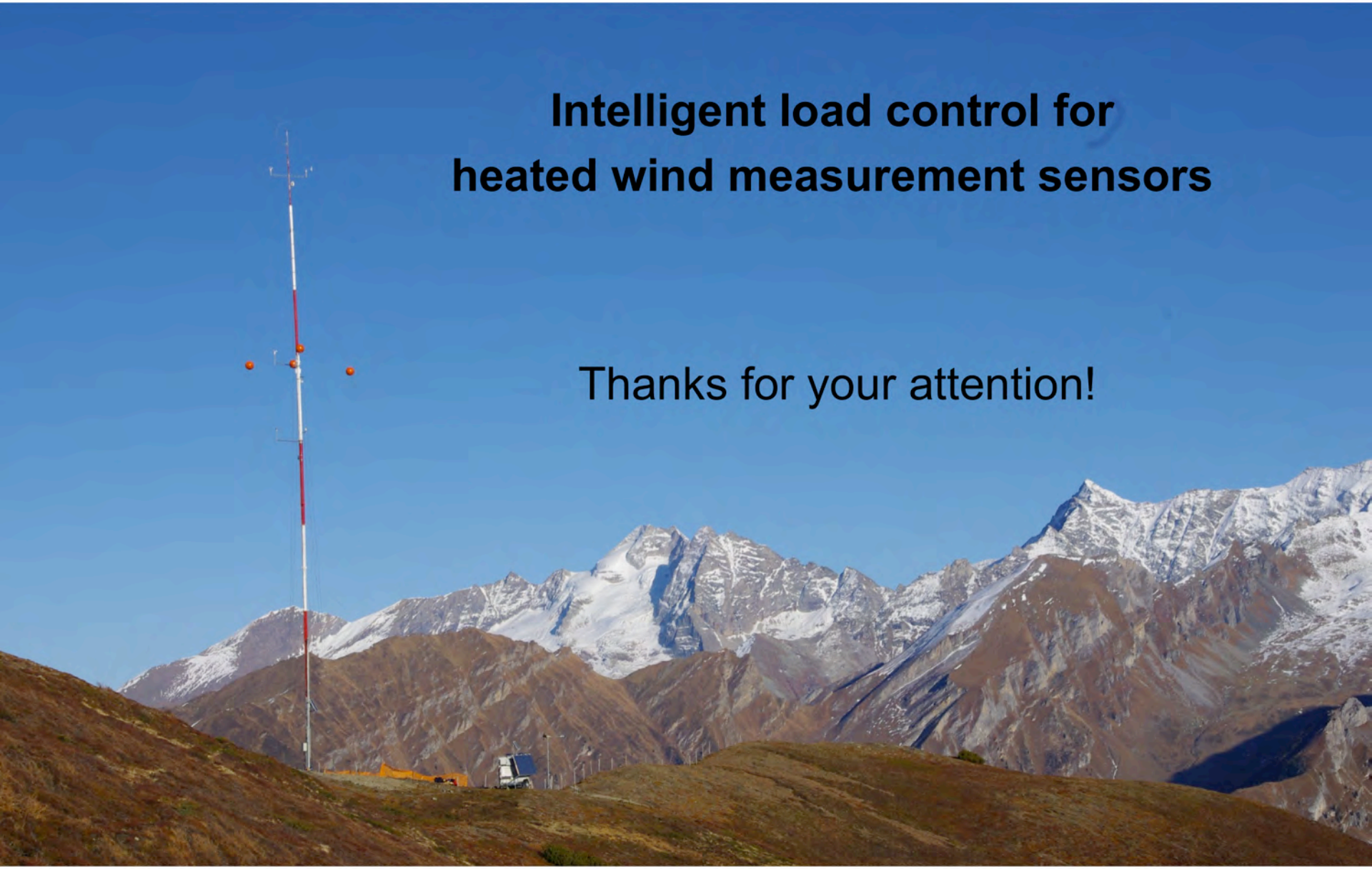
Extreme conditions

- Mean wind speed: 12 m/s in 23 m height
- Wind gusts (10min mean): > 30 m/s
- Ice accretion: Up to 8 cm (all-round)



Evaluation of 1 ½ months

- Surplus of ~30%
- No demand for FC (only self consumption)
- Data availability of ~97%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heated wind measurement sensors
Thanks for your attention!