![eologix sensor technology logo]

Increasing O&M benefits from icing sensors by means of smart data augmentation

Winterwind 2023, Åre, Sweden

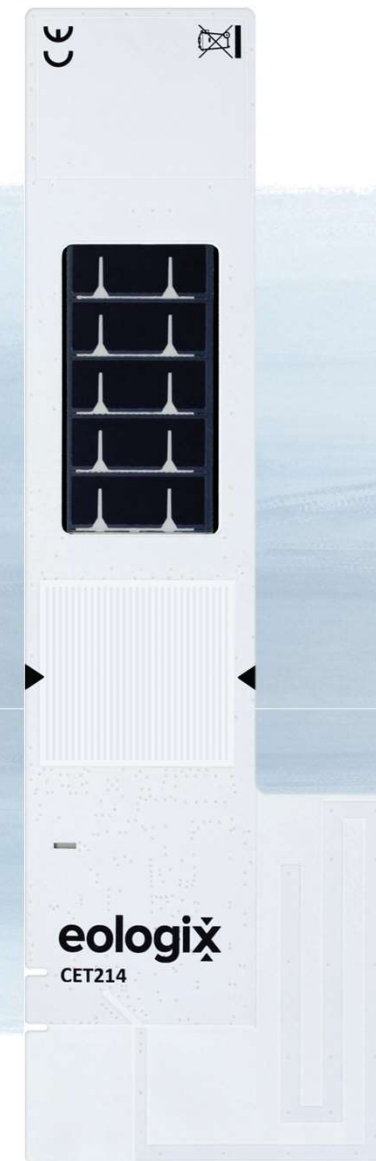Doris Schadler, Michael Moser & Harald Hohlen | eologix sensor technology gmbh

Image: Getty

Kick-off

Situation

You are on your way to work (already late) and there is ice on the windshield of your car.

First thought

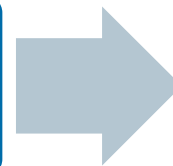If I had known that ice was to be expected on the windshield ...

Possible solutions

1) Take the bus
2) Get up earlier
3) Put a protection on the window

About us

eologix
sensor technology

Innovative sensor systems directly measuring on the blade surface for ice detection, temperature measurement and pitch angle monitoring
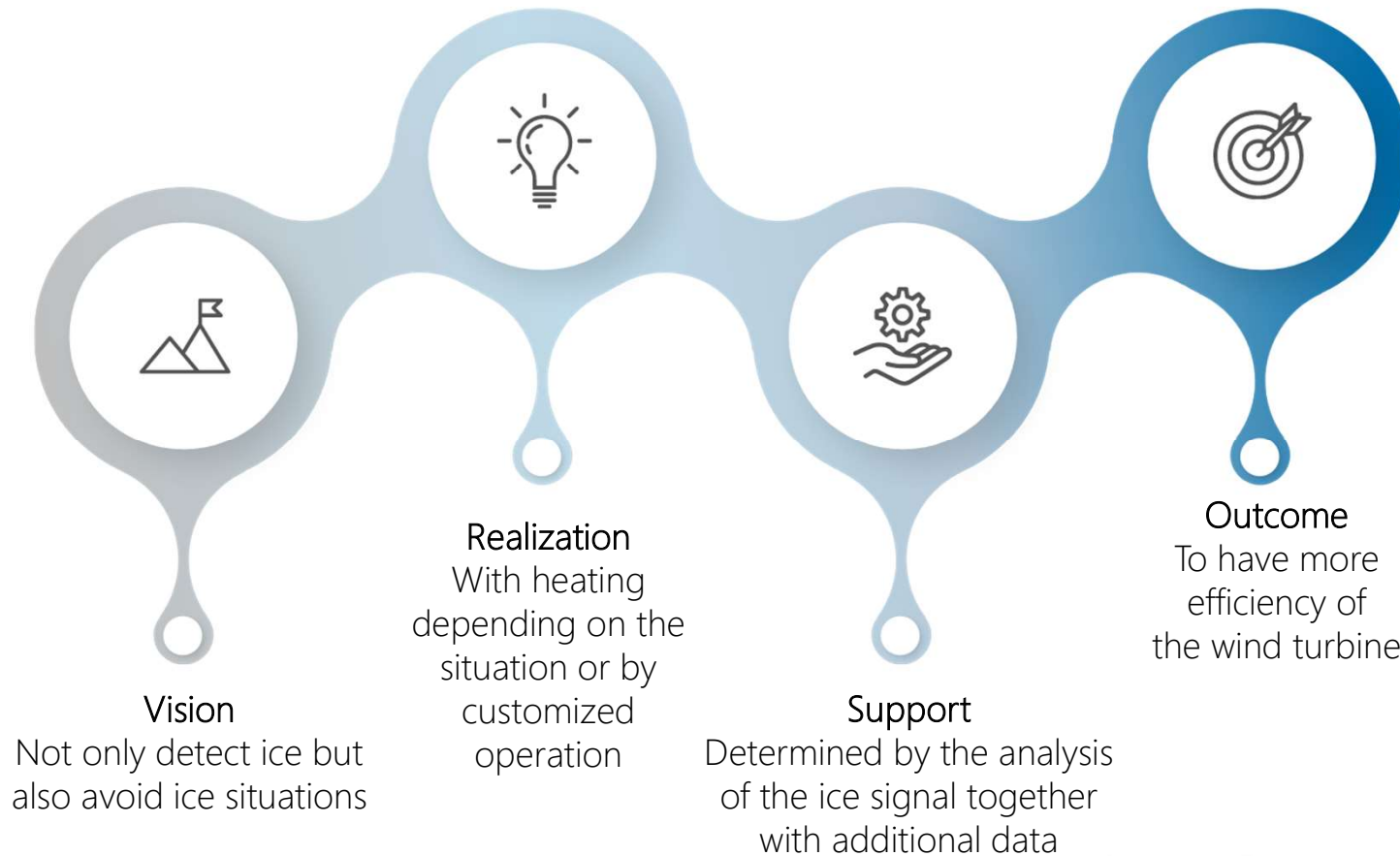
How to improve performance and increase benefit of the user?

| Real-time ice detection | → | Ice prediction or prevention |

Ice prevention on wind turbine blades

eologix sensor technology

Vision
Not only detect ice but also avoid ice situations

Realization
With heating depending on the situation or by customized operation

Support
Determined by the analysis of the ice signal together with additional data

Outcome
To have more efficiency of the wind turbine

Parameter impacting/indicating icing

eologix
sensor technology

| From eologix measurements	From SCADA	From weather (forecasts)
› Degree of icing	› Rotational speed	› Air temperature
› Blade surface temperature	› Electrical power	› Air humidity
› Rotational speed	› Wind speed and direction	› Wind speed and direction
› Accelerations (blades and nacelle)	› Operation mode	› Precipitation
› Angular velocities (blades and nacelle)	› Environmental temperature	› Solar radiation
		› Air pressure

Why choose data from weather?

Combine sensor data of eologix sensors with weather (forecast) data

> ❯ Weather situations / phenomena typical for ice accumulation
> ❯ Independent from a location of a wind energy converter (WEC)
> ❯ Independent from SCADA data
> ❯ Many (open) sources for weather forecasts
> ❯ Many (open) measurements of historical weather data
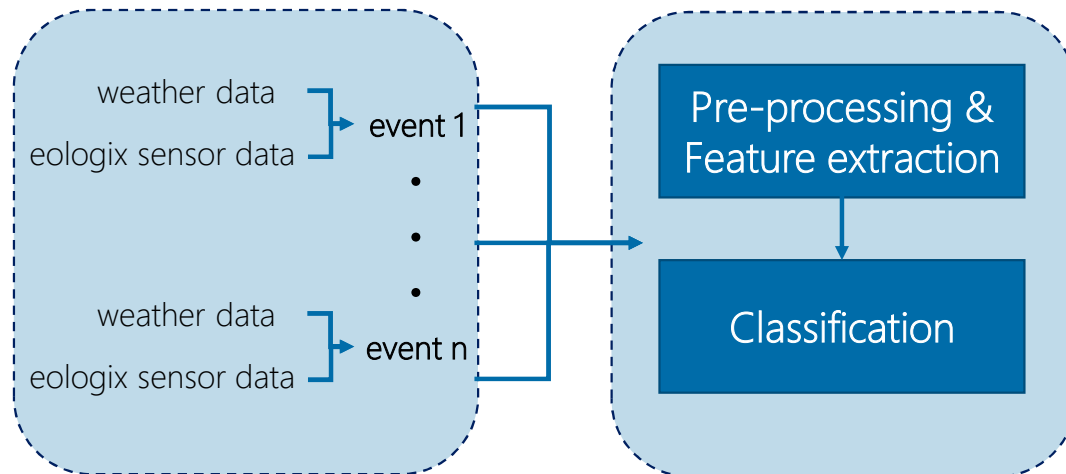
1st step: data labeling

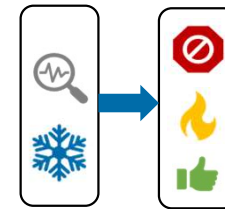Combine data from two different sources and label them with the outcome of the eologix sensor (degree of icing)

weather data ⌐
eologix sensor data ⌐→ event 1

⋅
⋅
⋅

weather data ⌐
eologix sensor data ⌐→ event n
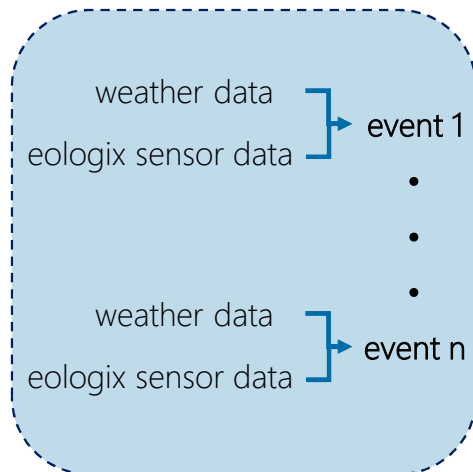
2nd step: pattern recognition

Find pattern in weather data which are typical for ice situations

weather data
eologix sensor data → event 1
·
·
·
weather data
eologix sensor data → event n

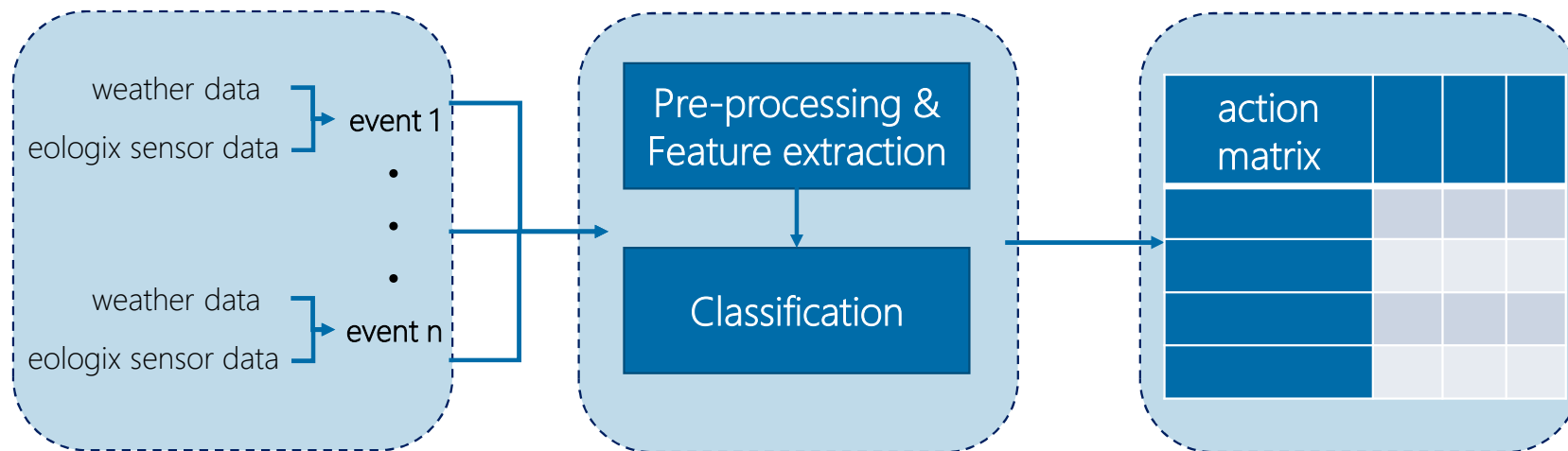Pre-processing & Feature extraction
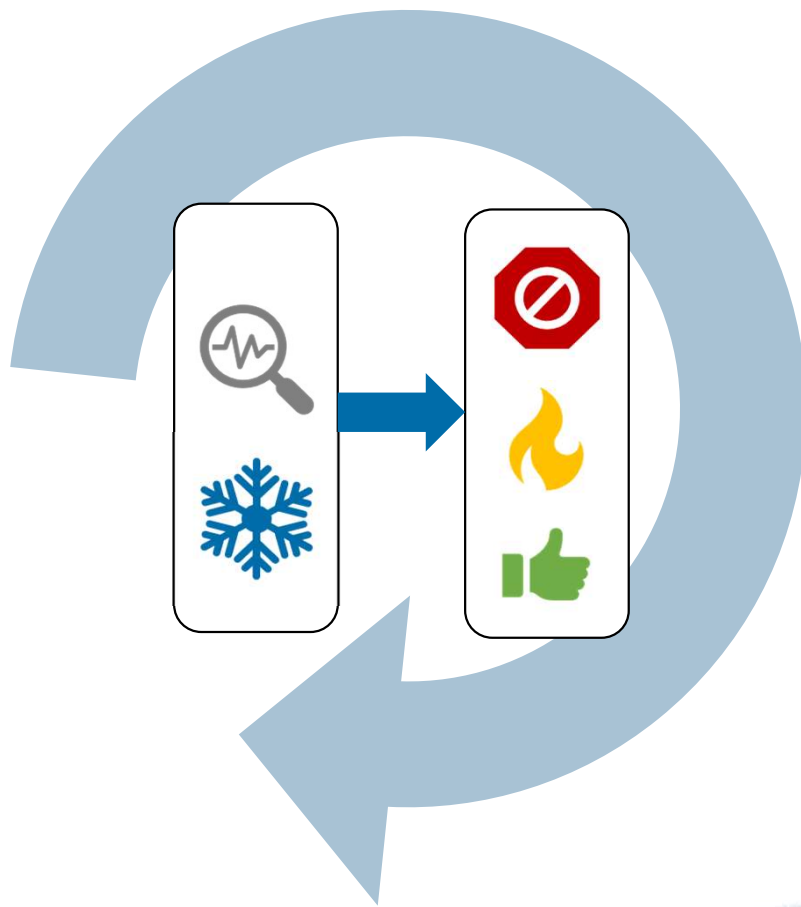
Classification

3rd step: action matrix generation

Use this knowledge, information of the weather forecasts and data of the eologix sensors to decide for one of these actions:

1. stop turbine   2. start heating   3. restart   4. normal operation
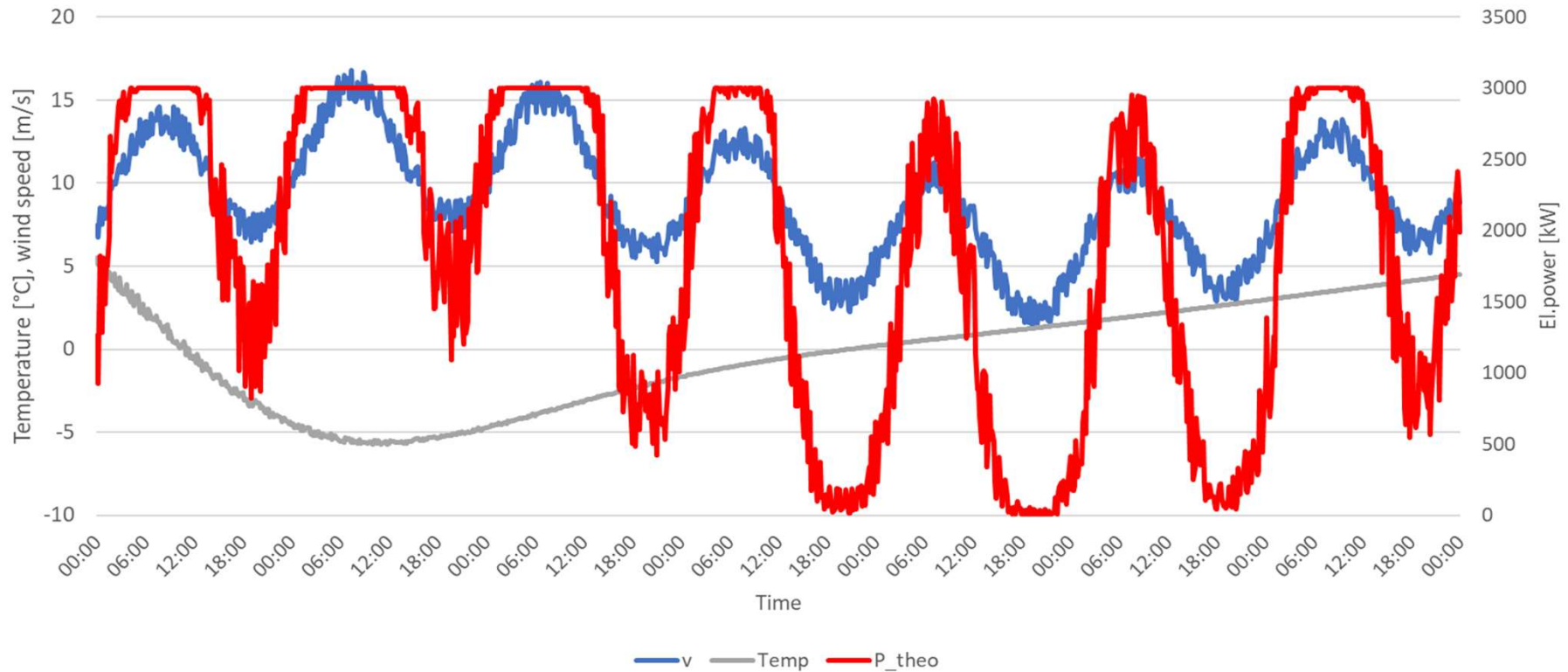
Overall - Continuously learning

Learn continuously with information of weather data and sensor data (labeled data) to

1. find more crucial situations
2. improve forecasts
3. optimize action matrix
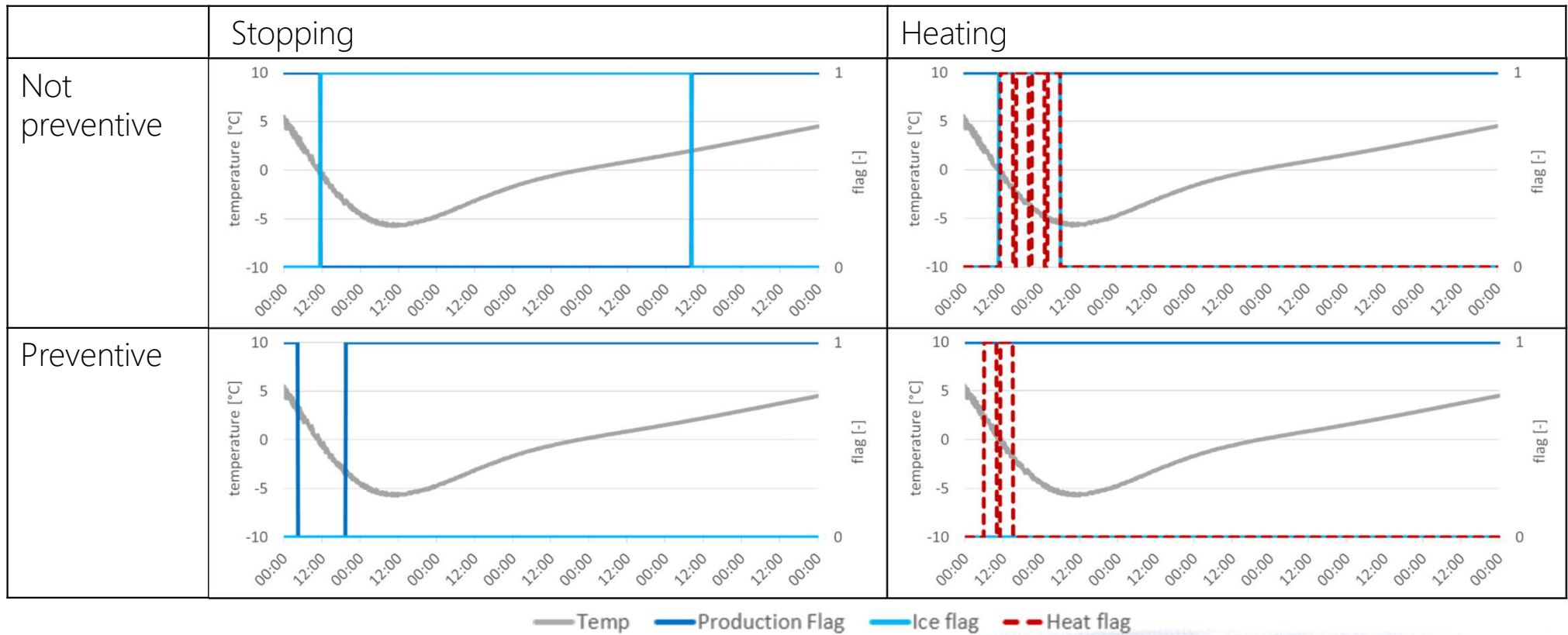
➔ Adapt ice prevention strategy

Simulation study
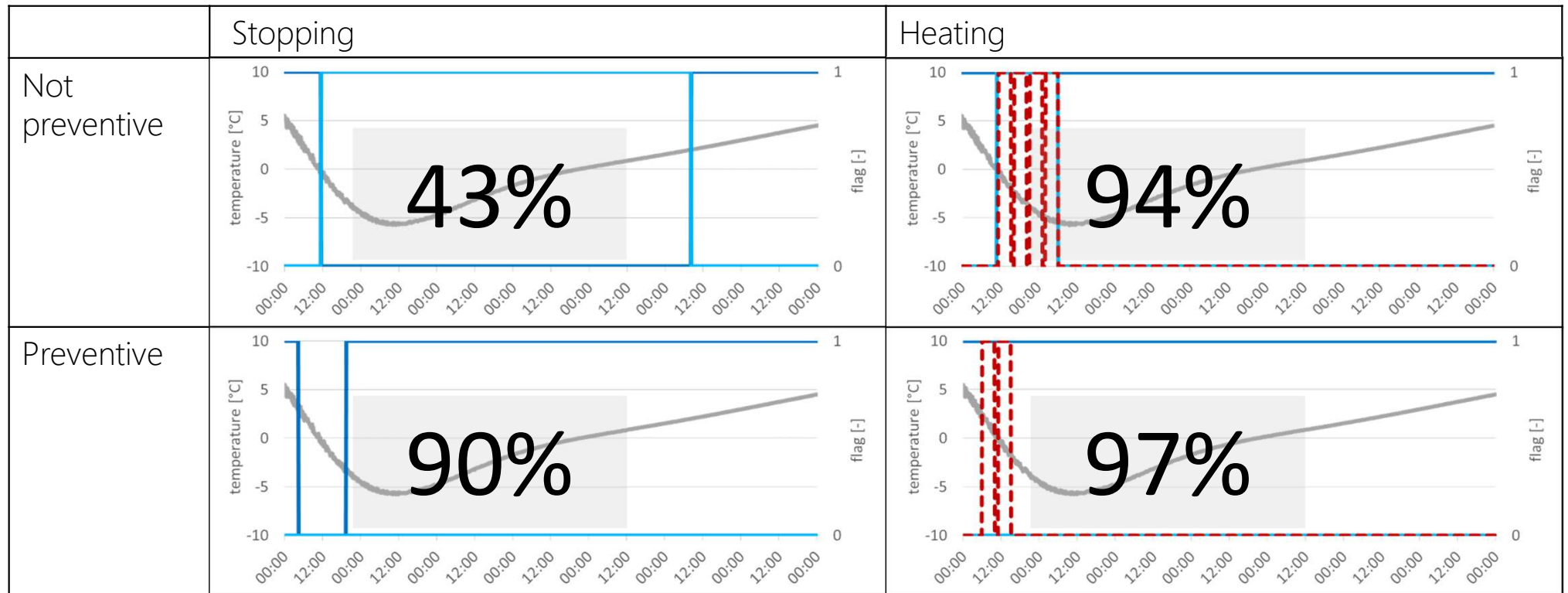
Setting (temperature, wind speed, theoretical power)
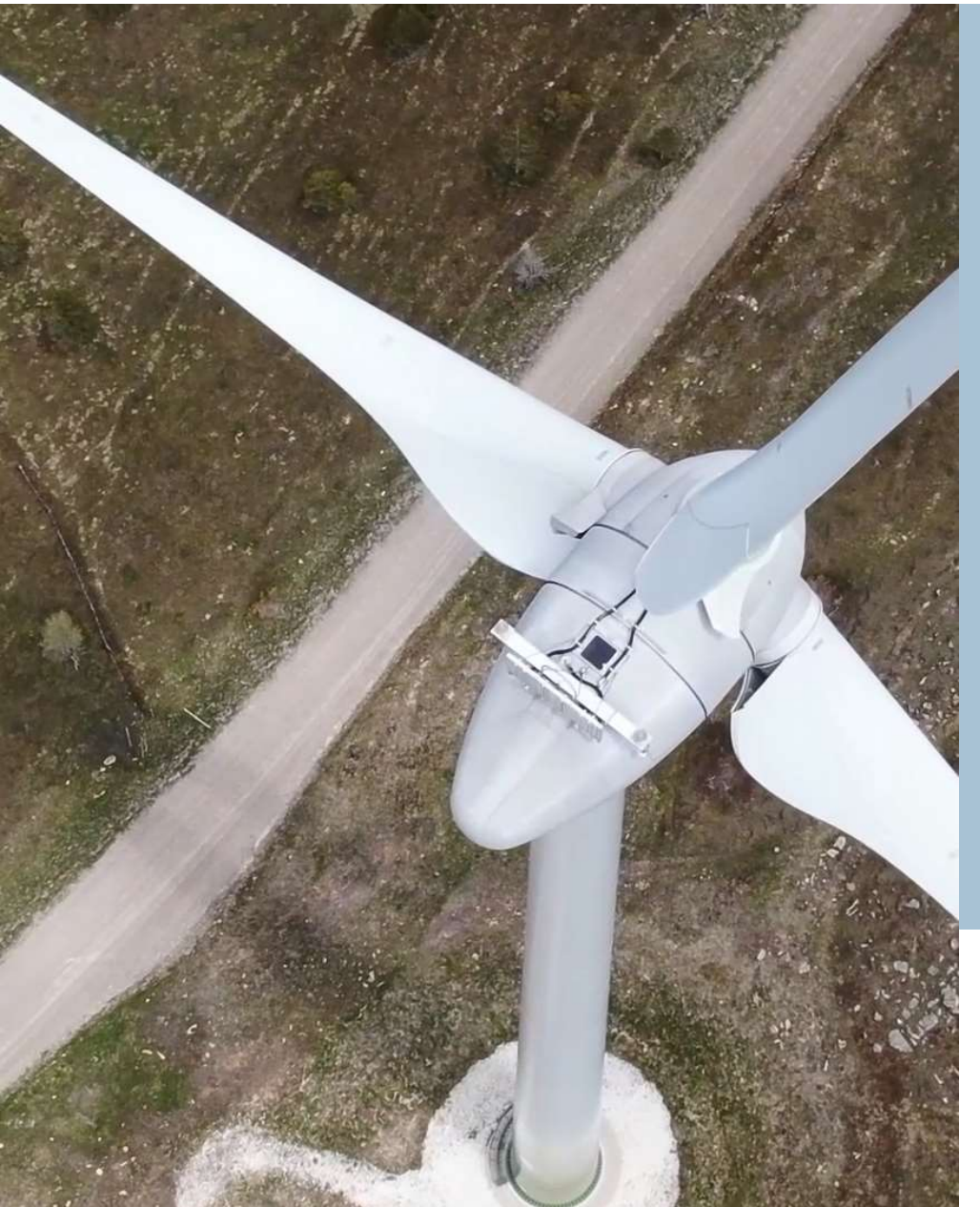
Simulation study

Comparison of operation & heat strategy

Simulation study

Comparison of operation & heat strategy

|	Stopping	Heating
Not preventive	43%	94%
Preventive	90%	97%

100% relates to total theoretical energy production (based on P_theo)

Benefits

> Sensor data is already rich in content
>> Less additional data is needed

> Forecasts can improve with sensor data
>> Reliably labeled data is available

> Forecasts are combined with the ice detection system
>> False negatives do not affect the safety of the system
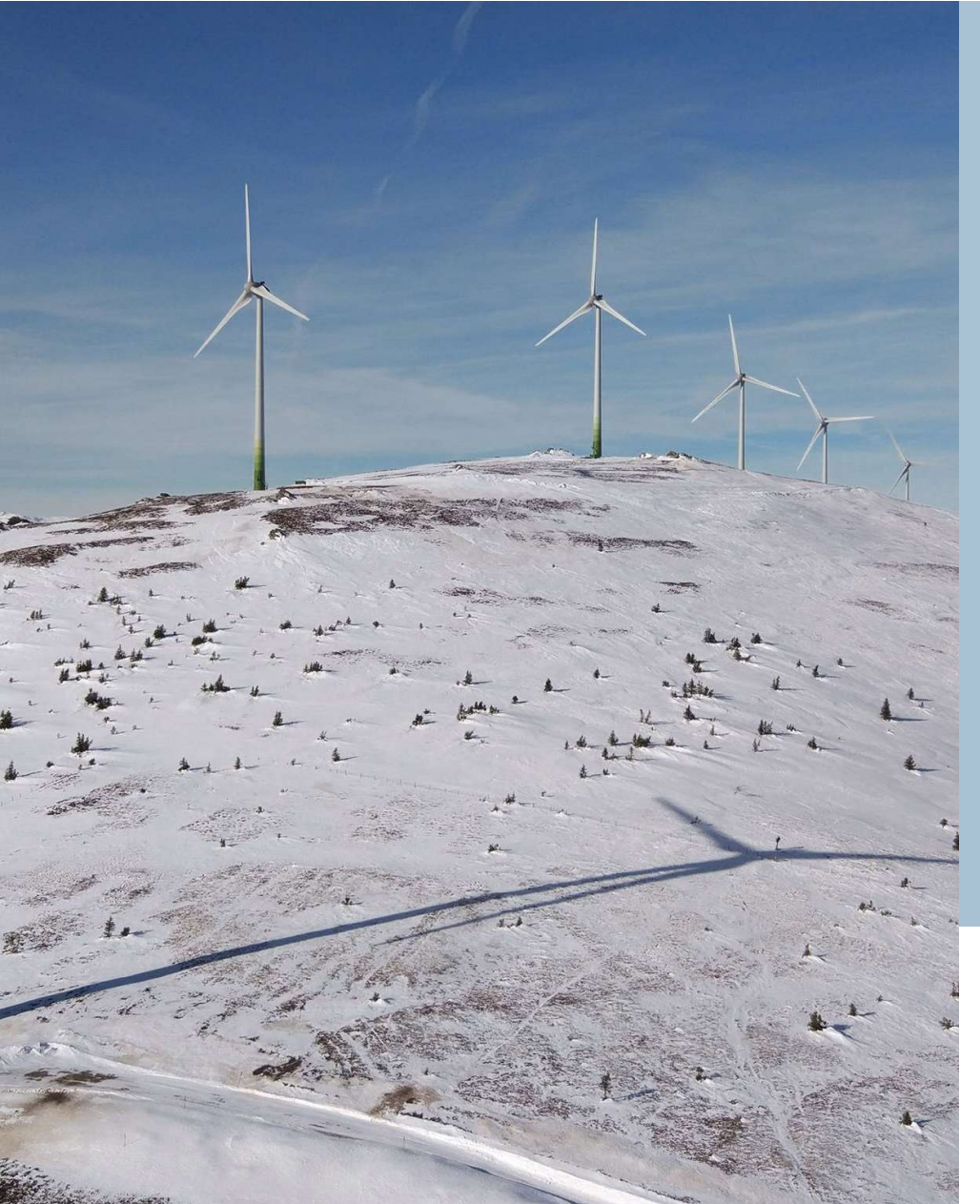
Challenges

› Accurate local forecasts (microclimate) are required

› Algorithm needs time to train and improve

› Action matrix can become arbitrarily complex

› Generation of positive use cases

ANY QUESTIONS?

Get in touch with us.
We are here for you.

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Visit us at booth #8
here at Winterwind

Image: Getty