



Winterwind 2019

Technology retrofit and service approach for performance optimization in cold climates

Turning experience into customer value



Globally, Siemens Gamesa has installed over 85 GW around the world in all climates, both onshore and offshore



Over 35 years of experience

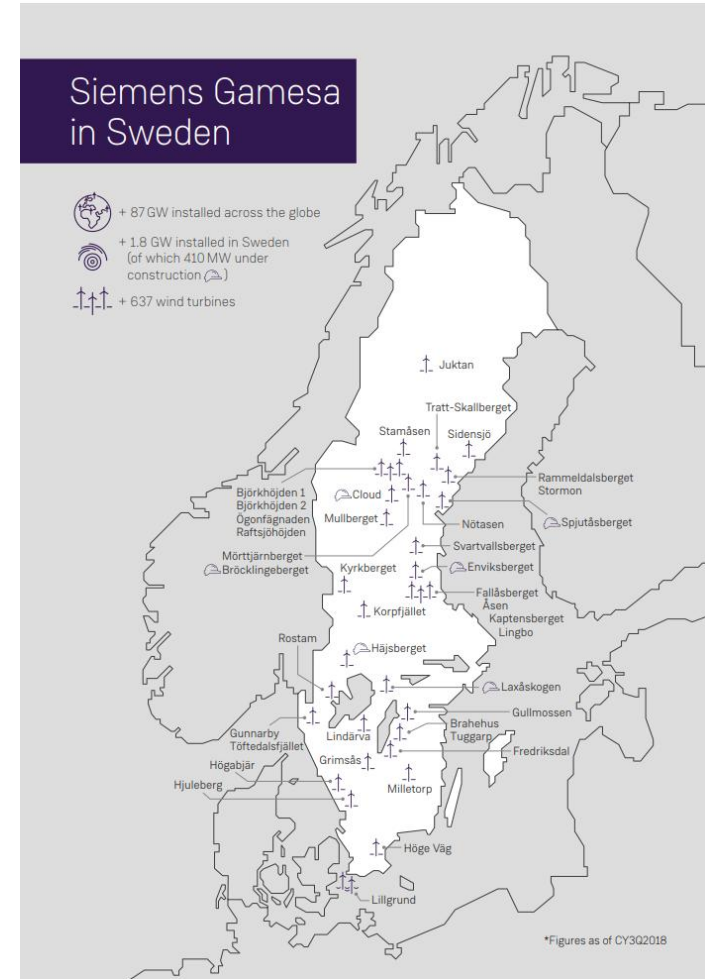
- First cold climate adapted turbine installed in 1986 (Quebec, CA)
- First edition of blade de-icing system installed over 20 years ago
- More recently, introduced first controls based ice mitigation strategy, Operation with Ice (OWI)



In Sweden, Siemens Gamesa has over 1.8 GW installed or under construction

- Over 300 turbines in operation with de-icing and/or OWI

Expertise that helps customers optimize operations and harvest their wind resources in the harshest of climates, maximizing returns throughout the year



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#homesafe: health and safety under icy conditions - The Basics

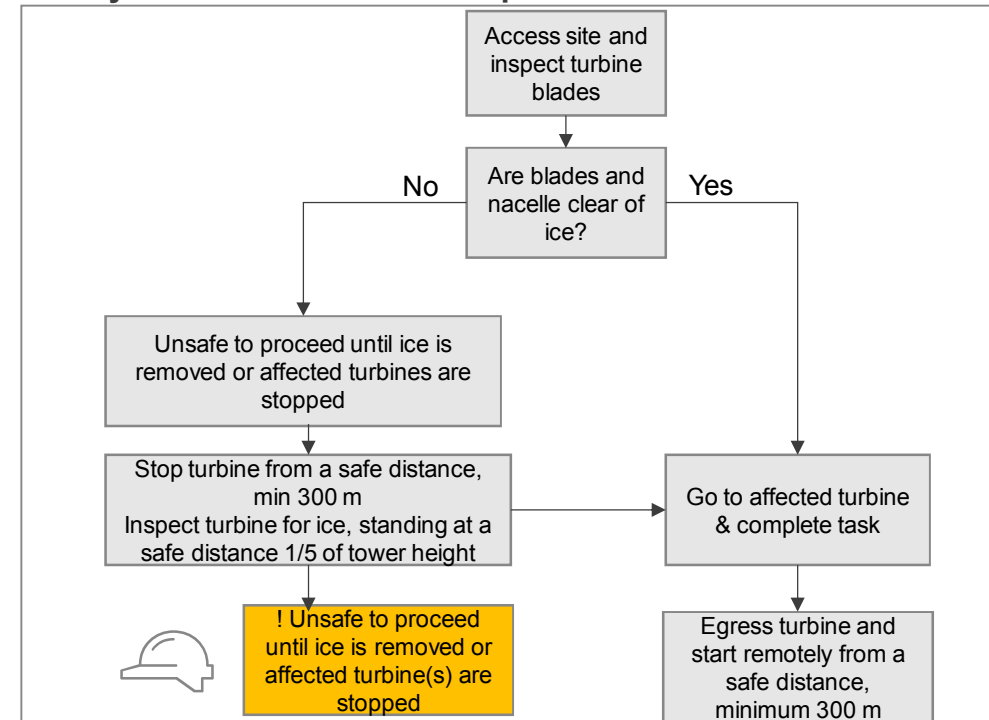
- The risk of ice throw cannot be entirely eliminated by the current technologies within the area of de-icing and anti-icing, as their purpose is to reduce ice buildup primarily on the leading edge.
- The risk of ice throw can be contained by acknowledged guidelines of safe zones, typically in the order of 250 m to 400 m depending on the turbine type.
- The turbine owner is responsible for taking the appropriate risk mitigation measures to protect the public from being exposed to falling ice in accordance with local legislation.
- The site personnel are typically more exposed to ice-throw than the public. Site personnel must, in the event of icing conditions, always follow the health and safety rules and procedures provided by Siemens Gamesa & specific site conditions.



#homesafe: ensuring safety while minimizing downtime

- Conduct site specific risk assessment detailing site responsibilities before construction and within operations.
- Ensure site set-up with correct signage & safe zone identification
- Communicate site access decision making flow chart, guiding the safest course of action
- Daily site communication & planning, having site staff equipped with suitable vehicle, correct high power torches & binoculars.
- Yaw blades away from the turbine access door, considering wind direction and speed so that ice is cast in the correct direction.

Safety is embedded in access procedures



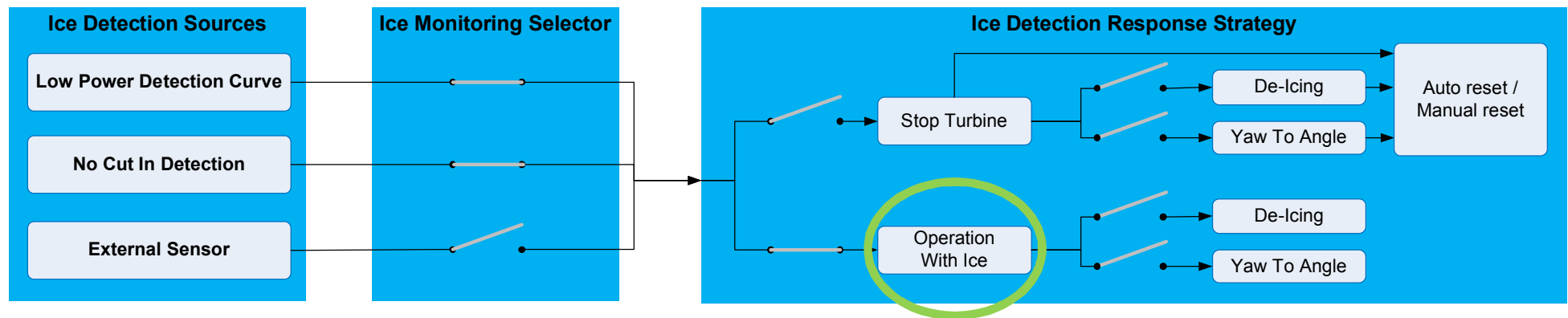


Retrofitting innovation:

Operation With Ice delivers bottom-line results

Flexible turbine configuration for cold climate strategy

- Siemens Gamesa's ice detection and response system offers a functionality that extends the range of operation during ice conditions.
- The configurable options determine how ice is detected and the associated action taken to e.g. comply with building permits
- Default configuration maximizes the power production



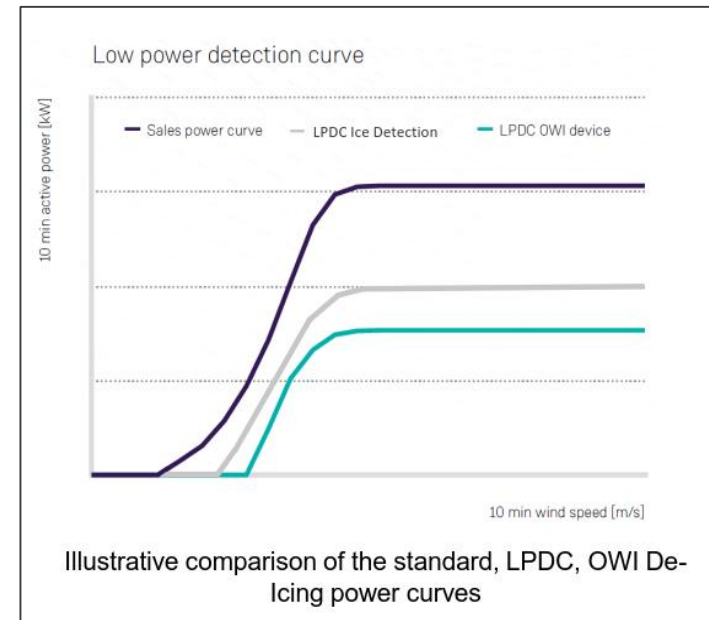
Adaptable control strategy using OWI (Operation With Ice)

Why is this needed?

- Ice accretion varies from year to year, sometimes light, sometimes heavy
- When ice builds up on the blades,
- Aerodynamic performance decreases, and
- Power production decreases

How does it work?

- Ice is detected by low power production or by ice detection sensor
- Turbine changes control strategy to avoid stops, improve power production and keeps operating
- Turbine leverages operational data and adapts to the most optimum controller setting

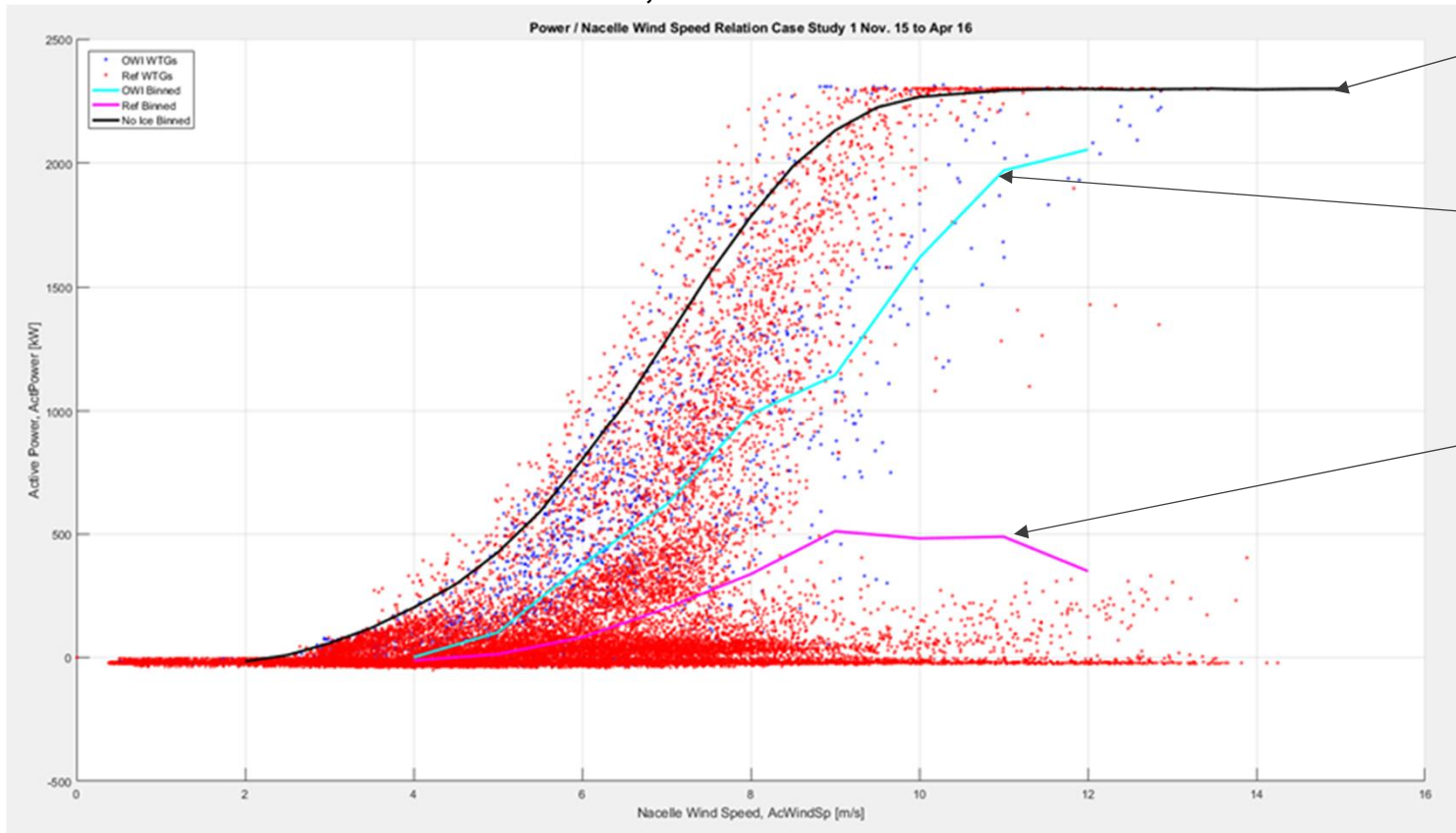


Easily retrofitted: no additional hardware



Winter data shows improved performance with OWI

Test case: 2 turbines retrofitted with OWI, balance of turbines without



Active power – no ice

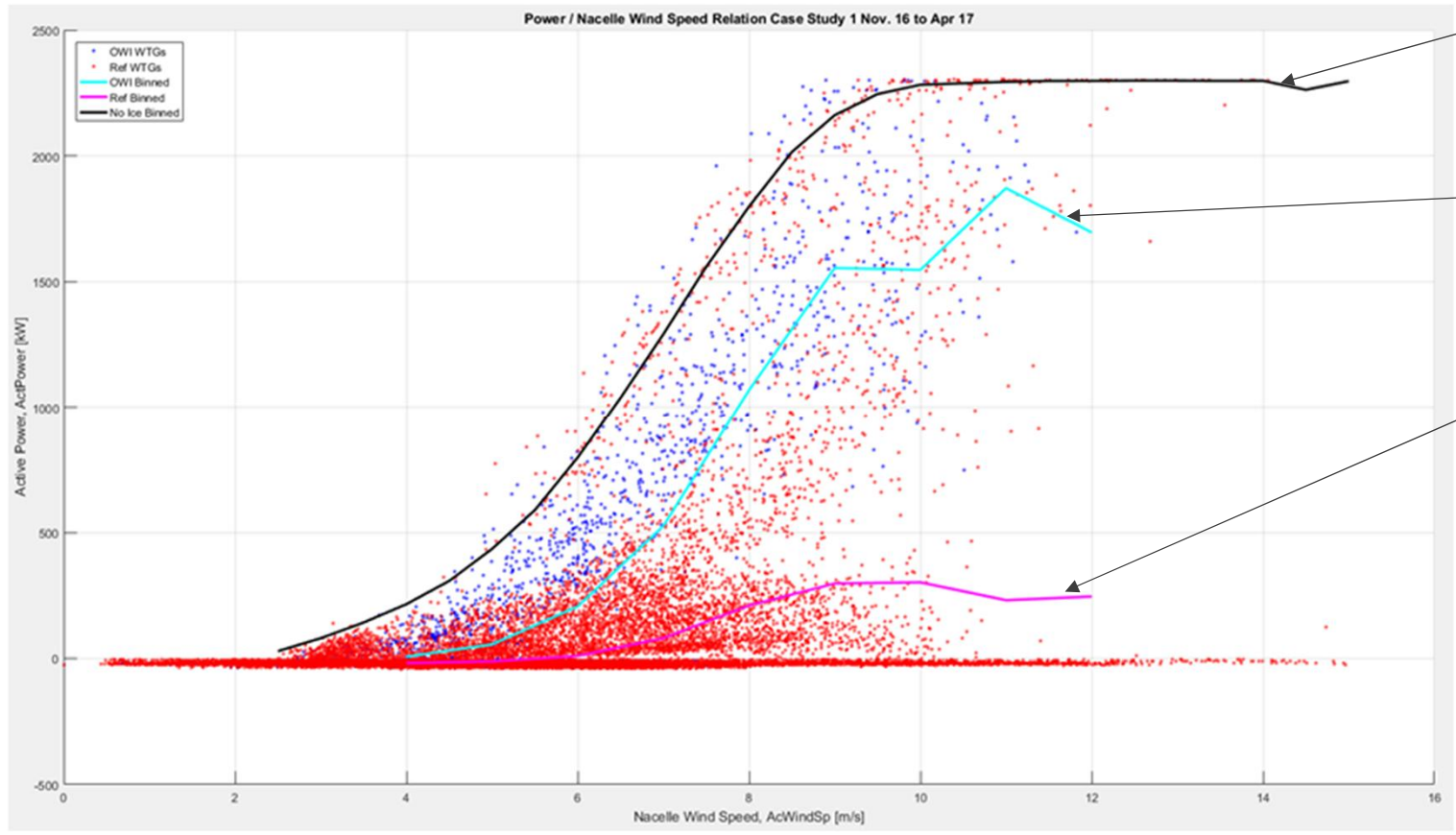
Active power during icing conditions for turbines **with OWI** (binned blue dots)

Active power during icing conditions for turbines **without OWI** (binned red dots)

Winter 15-16: Recovery Rate: 49.6%

Second winter shows consistent recovery rate: retrofit extended to all turbines

Same test configuration: same 2 turbines retrofitted with OWI, balance without



Active power – no ice

Active power during icing conditions for turbines **with OWI** (binned blue dots)

Active power during icing conditions for turbines **without OWI** (binned red dots)

Winter 16-17: Recovery Rate: 47.3%



Innovative craneless solutions

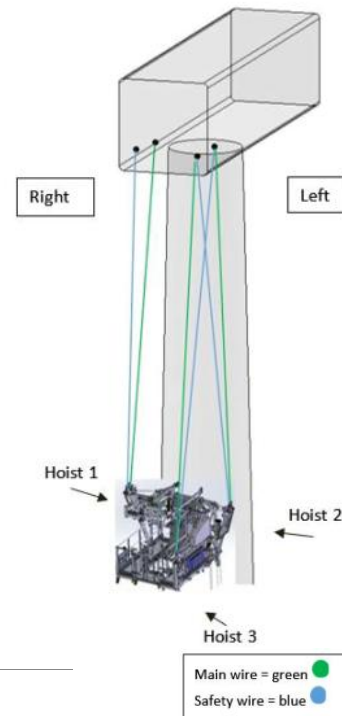
Leveraging our experience to deliver maintenance efficiency

SIEMENS Gamesa
RENEWABLE ENERGY

Maintenance efficiency: craneless blade repair solutions, increases repair season

Fully certified, patented blade access solution

- First introduced in offshore, now used in onshore, tested and deployed in Sweden
- Independent of distance between tower and blade tip
- Safest and most stable blade access platform in the industry: easy safe and fast crew changes
- Optional habitat: light and heat system allow for 24/7 operation
- Easy transport, fits on a trailer, system suitable for public roads
- Highest payload in the industry (up to 600 kg)
- Approved for wind speeds up to 18 m/s





Preparing for the worst:

Operational set-up and seasonal planning

Operational set-up and seasonal planning motivates higher generation

- Extra preventative inspection during annual service to minimize winter condition related faults.
- Site preparedness adapted to actual conditions with service technicians and teams ready, with right spare parts are on site.
- Adapting site specific risk assessments on how to increase safety but minimize lack of turbine access.
- Review turbine fault information prior to winter to ensure that all systems are operational. Test new parameters



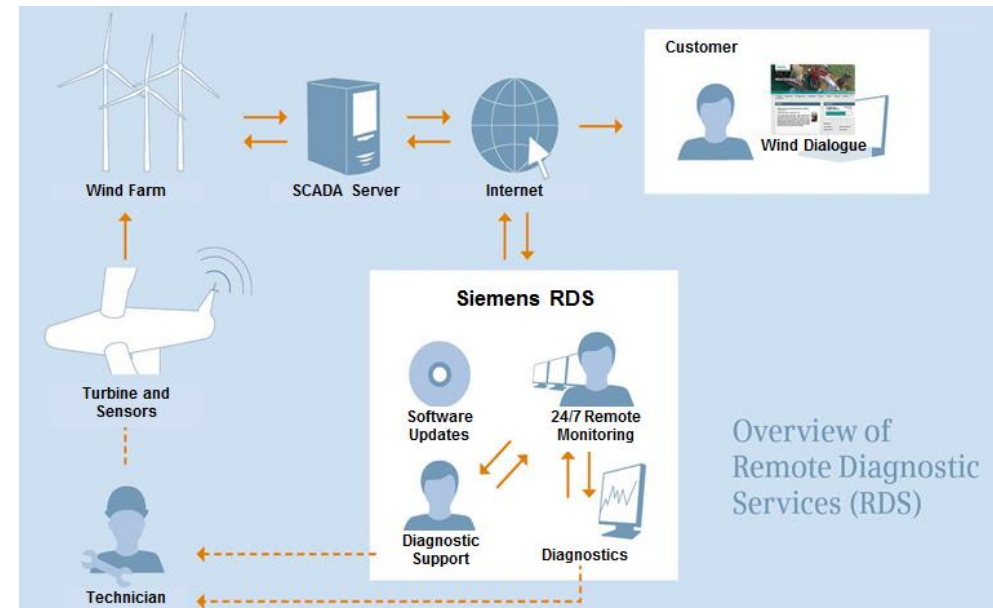
Optimize maintenance strategy, and reduce risk and operational expenditure by predictive methods

What are Remote Diagnostics Services (RDS)?

- Reduce downtime and optimize production by fast remote response
- Improve onsite first time fix rates by analytics and advice to site

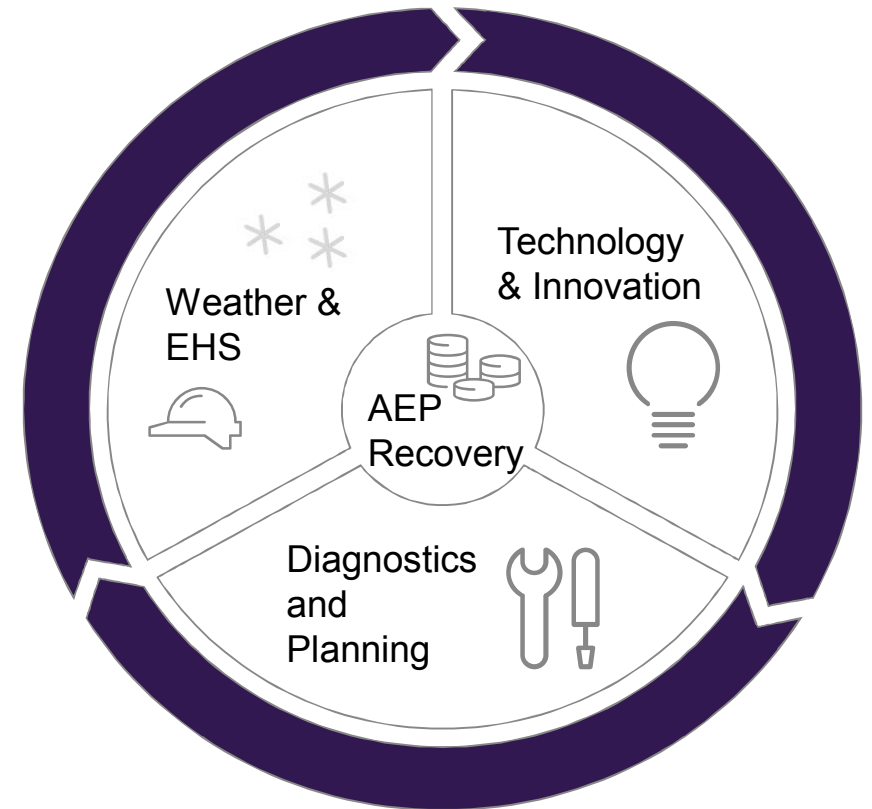
Remote Data Analytics are:

- A proactive approach to improve 24/7 remote alarm resolution and onsite first time fix rate
- Remote data analytics give intelligent advice to site technicians
 - which spare parts, which tools
 - what other repairs could be accomplished during the same visit?



Holistic considerations lead to better AEP recovery

- Safety, diagnostics, planning and technology work in combination to yield the best AEP under actual weather conditions
- Holistic approach will yield the best production.
- Partner with Siemens Gamesa to determine site specific suitability and loading conditions of OWI, testing before contracting.
- Operational Sales contact – Kristina Kaellander to support in making this partnership with customer & operations.





Thank you!

Graeme Wyse
Senior Service Operations PM

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